THE COSMIC ENERGY GRAVITATIONAL GENESIS OF THE INCREASE OF THE
SEISMIC AND VOLCANIC ACTIVITY OF THE EARTH IN THE BEGINNING OF
THE 21ST CENTURY AD

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The founded cosmic geology and the cosmic geophysics [Simonenko, 2007a; 2007b; 2007] are extended by taking into account the established evaluation of the significant energy gravitational influence on the Earth of the Sun owing to the gravitational interaction of the Sun with the outer large planets. The solution of the fundamental problem [Imbrie et al., 1993] of the origin of the major 100-kyr glacial cycle during the Milankovitch chron [Berger, 1994] is presented based on the consideration of the combined predominant energy gravitational influence on the Earth of the Sun, the Moon, the Venus and the Jupiter. The cosmic energy gravitational genesis of the increase of the seismic and volcanic activity of the Earth in the end of the 20th century AD [Abramov, 1997] and in the beginning of the 21st century AD is founded based on the generalized formulation [Simonenko, 2007] of the first law of thermodynamics applied for the Earth subjected to the cosmic non-stationary energy gravitational influences of the Solar System. Based on established range of the fundamental periodicities $T_{\text{clim1,f}} = T_{\text{seis1,f}} = 696 \div 708$ years (determined by the combined non-stationary energy gravitational influences on the Earth of the Sun owing to the Jupiter and the Saturn, the system Sun-Moon, the Venus and the Jupiter) of the global seismotectonic, volcanic and climatic activities of the Earth, the cosmic geophysics is founded the range $2061 \div 2061$ AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past $696 \div 708$ years of the history of humankind.

For specialists in non-equilibrium thermodynamics, continuum mechanics, hydrodynamics, physical oceanography, geology, geophysics, seismology, volcanology, climatology, hydrogeophysics and glaciology.

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This monograph is the result of the lifetime permanent mental work dedicated to the foundation of the Thermohydrogravidynamics (Cosmic Physics) of the Solar System intended for the long-term deterministic predictions of the strong earthquakes, the planetary cataclysms, the Earth’s climate and the Earth’s fresh water resources in order to sustain the stable evolutionary development, the survival, greatness and cosmic dignity of the humankind in the present and forthcoming epochs of the critical surrounding cosmic, seismotectonic, volcanic and climatic conditions of the human existence on the Earth.

The monograph is dedicated to the blessed memory of the great Russian scientist, Academician Victor I. Ilyichev supported in 1993 the author’s hydrodynamic and oceanographic PhD’s studies (as the head of the Doctoral Council of Oceanography) resulted to this monograph.

Nolite flere, non est mortuus, sed dormit.
Dignum laude virum Musa vetat mori.

INTRODUCTION

It is well known that the problems of the effective control of the space-time variations of the oceanic medium [Akulichev, Bezotvetnykh et al., 2001; Akulichev, Dzyuba et al., 2001; Makarov, Uleysky and Prants, 2003; Simonenko and Lobanov, 2012] and the geophysical environment [Dolgikh, 2000; Dolgikh, 2004; Dolgikh et al., 2004], the problems of the long-term predictions of the strong earthquakes [Abramov, 1997; Vikulin, 2003; Dolgikh et al., 2007], the climate change [Milankovitch, 1938; Hays et al., 1976; Berger and Loutre, 1991; Syun-Ichi Akasofu, 2004; Ponomarev et al., 2007] and the planetary cataclysms [Simonenko, 2007] are the significant problems of the modern sciences. In this regard, it was pointed out [Akulichev, Morgunov et al., 2007] that “the global problems of climate change and catastrophic natural phenomena (related with the dynamic oceanic processes) require the extended theoretical and experimental studies in this field with application of newest technologies”.

It is well known that “the deterministic prediction of the time of origin, hypocentral (or epicentral) location, and magnitude of an impending earthquake is an open scientific problem” [Sgrigna and Conti, 2012]. It was conjectured [Sgrigna and Conti, 2012] that the possible earthquake prediction and warning must be carried out on a deterministic basis. However, it was pointed out [Sgrigna and Conti, 2012] with some regret that the modern “study of the physical conditions that give rise to an earthquake and the processes that precede a seismic rupture of an ordinary event are at a very preliminary stage and, consequently, the techniques of prediction of time of origin, epicentre, and magnitude of an impending earthquake now available are below standard”. The authors [Sgrigna and Conti, 2012] argued that “a new strong theoretical scientific effort is necessary to try to understand the physics of the earthquake”. It was conjectured [Sgrigna and Conti, 2012] that the present level of knowledge of the geophysical processes “is unable to achieve the objective of a deterministic prediction of an ordinary seismic event, but it certainly will in a more or less distant future tackle the problem with seriousness and avoiding scientifically incorrect, wasteful, and inconclusive shortcuts, as sometimes has been done”. It was conjectured [Sgrigna and Conti, 2012] conjectured that “it will take long time (may be years, tens of years, or centuries) because this approach requires a great cultural, financial, and organizational effort on an international basis”. It was conjectured [Sgrigna and Conti, 2012] that a possible contribution to a deterministic earthquake prediction approach is related with observations and physical modelling of earthquake precursors to formulate, in perspective, “a unified theory able to explain the causes of its genesis, and the dynamics, rheology, and microphysics of its preparation, occurrence, postseismic relaxation, and interseismic phases”.

It was pointed out [Zhu and Zhan, 2012] that the gravity changes (derived from regional gravity monitoring data in China from 1998 to 2005) exhibited noticeable variations before the occurrence of two large earthquakes in 2008 in the areas surrounding Yutian (Xinjiang) and Wenchuan (Sichian). These results are consistent with the previous empirical finding [Abramov, 1997; p. 60] that the anomalous variations of the gravity field on the background of the Moon-Sun induced variations go in front of the earthquakes. A
recent research by Zhan and his colleagues [Zhan, Zhu et al., 2011] demonstrated that significant gravity changes were observed before all nine large earthquakes that ruptured within or near mainland China from 2001 to 2008. It was pointed out [Zhu and Zhan, 2012] that the past experience and empirical data showed that "earthquakes typically occur within one to two years after a period of significant gravity changes in the region in question". It was concluded [Zhu and Zhan, 2012] that the “additional research is needed to remove the subjective nature in the determination of the timeframe of a forecasted earthquake”.

It was conjectured [Console, Yamaoka and Zhuang, 2012] that the recent destructive earthquakes occurred in China (2008), Italy (2009), Haiti (2010), Chile (2010), New Zealand (2010), and Japan (2011) “have shown that, in present state, scientific researchers have achieved little or almost nothing in the implementation of short- and medium-term earthquake prediction, which would be useful for disaster mitigation measures". It was conjectured [Console, Yamaoka and Zhuang, 2012] that "this regrettable situation could be ascribed to the present poor level of achievements in earthquake forecast". It was pointed out [Console, Yamaoka and Zhuang, 2012] that “although many methods have been claimed to be capable of predicting earthquakes (as numerous presentations on earthquake precursors regularly show at every international meeting), the problem of formulating such predictions in a quantitative, rigorous, and repeatable way is still open”. It was formulated [Console, Yamaoka and Zhuang, 2012] that “another problem of practical implementation of earthquake forecasting could be due to the lack of common understanding and exchange of information between the scientific community and the governmental authorities that are responsible for earthquake damage mitigation in each country: they operate in two different environments, they aim at different tasks, and they generally speak two different languages”. It was pointed out [Console, Yamaoka and Zhuang, 2012] that “the way how seismologists should formulate their forecasts and how they should transfer them to decision-makers and to the public is still a tricky issue”. It was clearly formulated [Console, Yamaoka and Zhuang, 2012] that “the formulation of probabilistic earthquake forecasts with large uncertainties in space and time and very low probability levels is still difficult to be used by decision-making people”. It was conjectured [Console, Yamaoka and Zhuang, 2012] that “in real circumstances the authorities deal with critical problems related to the high cost of evacuating the population from an area where the scientific methods estimate an expected rate of destructive earthquake as one in many thousand days, while they require much more deterministic statements”. The authors [Console, Yamaoka and Zhuang, 2012] invited researchers “to report methods and case studies that could concretely contribute or, at least seemed promising, to improve the present frustrating situation, regarding the practical use of earthquake forecasts”.

In this monograph we found the cosmic energy gravitational genesis of the increase of the seismic and volcanic activity of the Earth in the end of the 20th century AD [Abramov, 1997] and in the beginning of the 21st century AD [Simonenko, 2007]. The cosmic energy gravitational genesis of the increase of the seismic and volcanic activity of the Earth in the end of the 20th century AD [Abramov, 1997] and in the beginning of the 21st century AD [Simonenko, 2007] is based on the generalized formulation [Simonenko, 2007] of the first law of thermodynamics applied for the Earth subjected to the cosmic non-stationary energy gravitational influences of the Solar System.

We use the established generalized differential formulation [Simonenko, 2007a; 2007] of the first law of thermodynamics (for moving rotating deforming compressible heat-conducting stratified macroscopic continuum region \( \tau \) subjected to the non-stationary Newtonian gravity):

\[
dU_\tau + dK_\tau + d\Pi_\tau = \delta Q + \delta A_{np,\tau} + dG
\]

extending the classical formulation [Gibbs, 1873] by taking into account (along with the classical infinitesimal change of heat \( \delta Q \) and the classical infinitesimal change of the internal energy \( dU_\tau \)) the infinitesimal increment of the macroscopic kinetic energy \( dK_\tau \), the infinitesimal increment of the gravitational potential energy \( d\Pi_\tau \), the generalized expression [Simonenko, 2007a; 2007] for the infinitesimal work done on the continuum region \( \tau \) by the surroundings of \( \tau \), the infinitesimal amount \( dG \) of energy (given by the expression (1.52)) added (or lost) as a result of the Newtonian non-stationary gravitational energy influence on the continuum region \( \tau \) during the infinitesimal time interval \( dt \).

In Section 1 we begin by considering the inherent physical incompleteness of the classical expression [de Groot and Mazur, 1962; Gyarmati, 1970] for the macroscopic kinetic energy per unit mass \( \varepsilon_k \) defined (in classical non-equilibrium thermodynamics) as the sum of the macroscopic translational kinetic energy per unit mass \( \varepsilon_t = \frac{1}{2} \varepsilon_t^2 \) of the mass center of a continuum region and the macroscopic internal rotational kinetic energy per unit mass \( \varepsilon_r = \frac{1}{2} \Theta \Theta^2 \), where \( \varepsilon \) is the speed of the mass center of a small continuum region, \( \Theta \) is an angular velocity of internal rotation [Gyarmati, 1970], \( \Theta \) is an inertia moment per unit mass of a small continuum region [de Groot and Mazur, 1962]. The classical de Groot and Mazur expression has inherent physical incompleteness [Simonenko, 2004] related with the questionable assumption about the rigid-like rotation of a small continuum region. The classical de Groot and Mazur expression [de Groot and Mazur, 1962] does not consider the non-equilibrium component of the macroscopic velocity field related with the velocity shear defined by the rate of strain tensor \( \varepsilon_{ij} \).

We proved [Simonenko, 2006] the necessity of development of the new conception of the macroscopic internal shear kinetic energy suggested earlier explicitly by Evans, Hanley and Hess [Evans, Hanley and Hess, 1984] and Simonenko [Simonenko, 1992]. In Subsection 1.1 we present a new physical concept [Simonenko, 2004] of the macroscopic internal shear kinetic energy expressing the macroscopic kinetic energy of the non-equilibrium (irreversible) dissipative shear motion near the mass center of a small macroscopic continuum region. We present also a new physical concept [Simonenko, 2004] of the macroscopic internal kinetic energy of shear-rotation coupling expressing the kinetic energy of local coupling between irreversible dissipative shear and reversible rigid-like rotational macroscopic continuum motions near the mass center of a small macroscopic continuum region. Basing on the analysis of the relative
continuum motion in the Euclidean space in the inertial Cartesian coordinate system $K$, we present the analytical formula (1.6) for the macroscopic kinetic energy [Simonenko, 2004] of a small macroscopic continuum region considered in a stratified shear three-dimensional flow.

The macroscopic kinetic energy $K_\tau$ of a small continuum region $\tau$ (in a stratified shear three-dimensional flow) is presented as the sum of the macroscopic translational kinetic energy $K_\tau$, the classical de Groot and Mazur's macroscopic internal rotational kinetic energy $K_s$ [Simonenko, 2004] and the macroscopic internal kinetic energy of shear-rotational coupling $K_{s,r}^{\text{coop}}$ [Simonenko, 2004] with a small correction of the order $O(\bar{d}^7)$ determined by the diameter $\bar{d}$ of a continuum region $\tau$. In Subsection 1.1 we present also the analytical formula (1.13) [Simonenko, 2004] for the macroscopic kinetic energy per unit mass $\varepsilon_k$ of a small macroscopic continuum region $\tau$ considered in a stratified shear three-dimensional flow. The macroscopic kinetic energy per unit mass $\varepsilon_k$ is presented [Simonenko, 2004] as a sum of the macroscopic translational kinetic energy per unit mass $\varepsilon_t$, the classical macroscopic internal rotational kinetic energy per unit mass $\varepsilon_r$ [de Groot and Mazur, 1962; Gyarmati, 1970], the new macroscopic internal shear kinetic energy per unit mass $\varepsilon_s$ [Simonenko, 2004] and the new macroscopic internal kinetic energy of shear-rotational coupling per unit mass $\varepsilon_{s,r}^{\text{coop}}$, which expresses the kinetic energy of irreversible dissipative shear motion, and also the new macroscopic internal kinetic energy of shear-rotational coupling per unit mass $\varepsilon_{s,r}$, which expresses the kinetic energy of local coupling between irreversible dissipative shear and reversible rigid-like rotational macroscopic continuum motions. The deduced expression (1.13) for $\varepsilon_k$ confirmed [Simonenko, 2004] the postulate [Evans, Hanley and Hess, 1984] that the velocity shear ($e_{ij} \neq 0$) represents an additional energy source in the postulated formulation [Evans, Hanley and Hess, 1984] of the first law of thermodynamics for non-equilibrium deformed states of continuum motion.

Following the “Statistical thermohydrodynamics of irreversible strike-slip-rotational processes” [Simonenko, 2007a] and the “Thermohydrogravidynamics of the Solar System” [Simonenko, 2007], in Subsection 1.2 we present the generalized differential formulation (1.43) of the first law of thermodynamics (in the Galilean frame of reference) for non-equilibrium shear-rotational states of the deformed finite one-component individual continuum (characterized by the symmetric stress tensor $T$) region $\tau$ moving in the non-stationary gravitational field.

In Subsection 1.3 we present the generalized differential formulation [Simonenko, 2007a; 2007] of the first law of thermodynamics (in the Galilean frame of reference) for non-equilibrium shear-rotational states of the deformed finite individual region $\tau$ of the compressible viscous Newtonian one-component continuum moving in the non-stationary gravitational field. We present the generalization [Simonenko, 2007a; 2007] of the classical [Gibbs, 1873] expression $\delta A_{\text{np},\tau} = -\delta W = -p dV$ by taking into account (for Newtonian continuum) the infinitesimal works $\delta A_c$ and $\delta A_s$, respectively, of acoustic and viscous Newtonian forces acting during the infinitesimal time interval $d\tau$ on the boundary surface $\partial \tau$ of the individual continuum region $\tau$. 6
Based on the generalized differential formulation (1.53) of the first law of thermodynamics (equivalent to the formulation (1.43)), in Subsection 1.4 we present the analysis [Simonenko, 2007a; 2007] of the gravitational energy mechanism of the gravitational energy supply into the continuum region $\tau$ owing to the local time increase of the potential $\Psi$ of the gravitational field inside the continuum region $\tau$ subjected to the non-stationary Newtonian gravitational field.

In Subsection 1.5 we present the evaluation [Simonenko, 2007a; 2007] of the time periodicity of the global volcanic and climate variability induced by the non-stationary cosmic energy gravitational influences on the Earth.

Using the established [Simonenko, 2004; 2006] generalized expression (1.6) for the total macroscopic kinetic energy $(K_\tau)_\alpha$ of each subsystem $\alpha$, in Subsection 1.6 we present the conditions [Simonenko, 2007] of the thermodynamic equilibrium in the closed thermohydrogravodynamic system. In Subsection 1.6.1 we consider the equilibrium state of the closed thermohydrodynamic system in classical statistical physics [Landau and Lifshitz, 1976]. In Subsection 1.6.2 we present the foundation [Simonenko, 2007] of the conservation law of the total energy for the closed thermodynamic system $\tau$ in the frame of the continuum model. In Subsection 1.6.3 we present the consideration [Simonenko, 2007] of the classical statistical properties of the thermodynamically equilibrium subsystem in classical statistical physics [Landau and Lifshitz, 1976]. In Subsection 1.6.4 we present the definition of entropy (of the thermodynamic system in classical statistical physics [Landau and Lifshitz, 1976]) related with the Galilean principle of relativity. In Subsection 1.6.5 we present the formulation of the condition [Simonenko, 2007] of the thermodynamic equilibrium for the closed thermohydrogravodynamic system considered in the coordinate system $K'_\text{sys}$ of the mass center $C_\text{sys}$ of the thermohydrogravodynamic system under imposed conservation laws of the total energy and the total angular momentum. In Subsection 1.6.6 we present the generalized expression [Simonenko, 2007] for the angular momentum of the subsystem $\tau_\alpha$ (the small macroscopic continuum region $\tau_\alpha$) for the non-equilibrium thermodynamic state. In Subsection 1.6.7 we present the condition (1.117) of the thermodynamic equilibrium [Simonenko, 2007] for the closed thermohydrogravodynamic system (consisting of $N$ thermohydrogravodynamic subsystems) considering in the inertial coordinate system $K'_\text{sys}$ related with the mass center $C_\text{sys}$ of the thermohydrogravodynamic system. In Subsection 1.6.8 we present the conditions of the thermodynamic equilibrium [Simonenko, 2007] of the closed thermohydrogravodynamic system consisting of $N$ thermohydrogravodynamic subsystem considered in the arbitrary inertial coordinate system $K$. In Subsection 1.6.8.1 we present the condition (1.121) [Simonenko, 2007] of the thermodynamic equilibrium (of the closed thermohydrogravodynamic system) describing the relative movements of the mass centers of all subsystems. In Subsection 1.6.8.2 we present the foundation [Simonenko, 2007] of the conditions (1.125) and (1.118) of the thermodynamic equilibrium of the closed thermohydrogravodynamic system relative to the macroscopic non-equilibrium kinetic energies [Simonenko, 2004] of the subsystems $\tau_\alpha$.

Following the “Statistical thermohydrodynamics of irreversible strike-slip-rotational processes” [Simonenko, 2007a] and the “Thermohydrogravidynamics of the Solar System” [Simonenko, 2007], in Subsection 1.7 we present (taking into account the shear-rotational thermodynamic states of the considered subsystem $\tau$) the generalization of the Le Chatelier – Braun principle [Landau and Lifshitz, 1976] on the closed rotational thermohydrogravidynamic systems $(\tau + \bar{\tau})$ consisting of two subsystems $\tau$ and $\bar{\tau}$. We present the physical interpretation [Simonenko, 2007a; 2007] of the relaxation processes (after the deformational influences on the subsystem $\tau$) in the rotational thermohydrogravidynamic systems $(\tau + \bar{\tau})$ in terms of the total entropy of the rotational thermohydrogravidynamic systems $(\tau + \bar{\tau})$.

In Subsection 1.8 we present the subsequent generalization (1.155) of the established generalized differential formulation (1.50) [Simonenko, 2007a; 2007; 2008; 2009; 2010] of the first law of thermodynamics. The subsequent generalization (1.155) of the first law of thermodynamics is suggested for description of moving rotating deformed compressible heat-conducting stratified individual macroscopic region $\tau$ of turbulent electromagnetic plasma subjected to the non-stationary Newtonian gravitational and electromagnetic fields.

In Section 2 we present the fundamentals of the cosmic geology [Simonenko, 2007] applicable for the planets of the Solar System. In Subsection 2.1 we present the expressions [Simonenko, 2007] for the total energy $E_\tau$ and the total angular momentum $M_\tau$ of the planet $\tau$ (and the satellite of the planet) taking into account the internal thermohydrogravidynamic structure of the planet $\tau$ (and the satellite of the planet).
Considering the Solar System as the open thermohydrogravitodynamic system containing the set of separate thermohydrogravitodynamic subsystems (the planets \( \tau \), and the satellites of the planets) and disregarding the presence of atmospheres and hydrospheres (of the planets and the satellites of the planets), we present the expressions (2.17) and (2.18) for the total energy and the total angular momentum [Simonenko, 2007] of the Solar System consisting of \( N \) cosmic material objects (the Sun, the planets, the satellites of the planets, the midget planets, known asteroids and comets of the Solar System). Using the expressions (2.17) and (2.18), we present the evidence [Simonenko, 2007] of the mutual energy transformations between the accumulated internal energies (of the accumulated internal energies of deformation, compression and strain of the continuum of the planets), the macroscopic internal rotational energy [de Groot and Mazur, 1962; Gyarmati, 1970] and the macroscopic internal non-equilibrium kinetic energies [Simonenko, 2004] of the planets. We present the evidence [Simonenko, 2007] that the mutual energy transformations can result to the evolutionary changes of the directions (and axes) of rotation of the planets and satellites (of the planets) of the Solar System.

Taking into account the system of the expressions (2.19) and (2.20) for the total energy and the total angular momentum of the subsystem \( \tau \) (the subsystem \( \tau \) of the planet \( (\tau + \overline{\tau}) \) without the surrounding subsystem \( \overline{\tau} \) (the atmosphere or the atmosphere and hydrosphere)) of the planet \( (\tau + \overline{\tau}) \), we demonstrate the evidence [Simonenko, 2004a; 2007] of the mutual energy transformations between the accumulated internal energy \( U_\tau \) of the subsystem \( \tau \) and the macroscopic internal rotational kinetic energy \( \left( K_{r\tau} \right)_\tau \) (of the subsystem \( \tau \) of the planet \( (\tau + \overline{\tau}) \)), the macroscopic internal shear kinetic energy \( \left( K_{s\tau} \right)_\tau \) (of the subsystem \( \tau \) of the planet \( (\tau + \overline{\tau}) \)) and the macroscopic internal kinetic energy of shear-rotational coupling \( \left( K_{s\tau}^{\text{coup}} \right)_\tau \) (of the subsystem \( \tau \) of the planet \( (\tau + \overline{\tau}) \)) during the seismotectonic relaxation of the planet \( (\tau + \overline{\tau}) \). We demonstrate that these energy transformations give the real evidence [Simonenko, 2007] to consider the seismotectonic relaxation of the planet \( (\tau + \overline{\tau}) \), which evolve during some time period without formation of the new planetary fractures in the subsystem \( \tau \) surrounding by the subsystem \( \overline{\tau} \) (representing the atmosphere or the atmosphere and hydrosphere).

In Subsection 2.3 we present the syntheses of the cosmic geology [Simonenko, 2007; 2009; 2010] of the Earth (applicable for the terrestrial planets of the Solar System) taking into account the convection in the lower geo-spheres of the Earth (the planet), the density differentiation, the translational, rotational and deformational movements of the tectonic plates, the creation of the new planetary tectonic fractures induced by the energy gravitational influences of the Solar System and our Galaxy. Using the generalized differential formulation (2.21) of the first law of thermodynamics, in Subsection 2.3.1 we present the thermohydrogravitodynamic N-layer model [Simonenko, 2007a; 2007] of the thermohydrogravitodynamic evolution of the total energy of the subsystems \( \tau \) and \( \overline{\tau} \) of the planet \( (\tau + \overline{\tau}) \), which evolve during some time period without formation of the new planetary fractures in the subsystem \( \tau \) surrounding by the subsystem \( \overline{\tau} \) (representing the atmosphere or the atmosphere and hydrosphere).
means of the new global tectonic fracture into two equal parts in the different sides of the main seant plane intersecting the centre of the Earth. Using the evolution equation (2.32) for the sum $K_\tau + \Pi_\tau$ of the total macroscopic kinetic energy $K_\tau$ and the total macroscopic potential (gravitational) energy $\Pi_\tau$ of the subsystem $\tau$ (of the Earth or a planet of the Solar System), we present the evidence [Simonenko, 2007] that the revealed time period 100 million years [Hofmann, 1990] of the maximal endogenous activity of the Earth [Morozov, 2007; p. 496] is induced by the periodic changes (characterized by the time period of 200 million years) of the potential of the gravitational field (of the Solar System and our Galaxy) influencing on the Earth considered as the cosmic material object (in the frame of the Solar System) moving around the center of our Galaxy.

Based on the generalized differential formulation (2.21) of the first law of thermodynamics (containing the new additional term related with the space-time density $e_\tau$ of the sources of heat), in Subsection 2.3.2 we present the synthesis of the thermohydrogravodynamic translational-shear-rotational N-layer tectonic model [Simonenko, 2007] of the fragmentary geo-spheres of the Earth (of the planet $(\tau + \bar{\tau})$ of the Solar System). We present the evolution equation (2.36) of the total energy of the geo-sphere $\tau_1 = \tau_{\text{ext}}$ (the first upper layer of the subsystem $\tau$ of the planet $(\tau + \bar{\tau})$). The evolution equation (2.36) represents the thermohydrogravodynamic model of the translational-shear-rotational tectonics of moving rotating deforming compressible heat-conducting stratified macroscopic geo-blocks $\tau_{ij}$ ($j = 1, 2, \ldots, N_j$) surrounded by the coupled viscous plastic layers and subjected to the non-stationary Newtonian gravity and heating related with disintegration of the radio-active elements (in the geo-sphere $\tau_{\text{ext}}$).

In Subsection 2.3.3 we present the universal energy thermohydrogravdynamic approach [Simonenko, 2007] of formation of the planetary fractures in the frame of the generalized differential formulation (2.21) of the first law of thermodynamics [Simonenko, 2007] and the thermohydrogravdynamic translational-shear-rotational N-layer tectonic model [Simonenko, 2007] (presented in Subsection 2.3.2) of the fragmentary (consisting of geo-blocks) geo-spheres of the Earth (and the planet of the Solar System of the terrestrial group: the Mercury, the Venus and the Mars). Based on the generalized differential formulation (2.21) of the first law of thermodynamics and the mathematical inductive method, we present the evolution equations (2.39), (2.41) and (2.42) describing [Simonenko, 2007] the evolutions of the total energy of the geo-block $\tau_{ij}$ (of the first upper layer (geo-sphere) $\tau_1 = \tau_{\text{ext}}$ of the subsystem $\tau$ of the planet $(\tau + \bar{\tau})$) under formation of the integer number of various uncrossed (between itself) fracture surfaces breaking the Earth’s crust. Using the deduced evolution equations (2.39), (2.41) and (2.42), we formulate the established [Simonenko, 2007] energy sources of the destruction in the geo-block $\tau_{ij}$: the total non-stationary gravitational fields (the external cosmic and the terrestrial), the internal heat related with the disintegration of the radio-active elements, the heat flux from the upper boundary of the situated below second layer (subsystem) $\tau_2$ and the work of stress forces on the surface of the geo-block $\tau_{ij}$.

In Section 3 we present the fundamentals of the cosmic geophysics [Simonenko, 2007] applicable for the planets of the Solar System. In Subsection 3.1 we consider the energy gravitational influences [Simonenko, 2007; 2009; 2010] on the Earth of the inner planets and the outer planets of the Solar System. In Subsection 3.1.1 we present the derivation of the analytical relation [Simonenko, 2009; 2010] for the energy gravitational influences (on the Earth) of the inner and the outer planets in the second approximation of the elliptical orbits of the planets of the Solar System. In Subsection 3.1.2 we present the evaluation [Simonenko, 2007] of the relative maximal instantaneous energy gravitational influences (on the unit mass at the surface point $D_1$ of the Earth) of the inner planets and the outer planets in the first approximation of the circular orbits of the planets. In Subsection 3.1.2 we present also the evaluation [Simonenko, 2009; 2010] of the relative maximal instantaneous energy gravitational influences (on the unit mass of the Earth at the mass center $C_3$ of the Earth) of the inner and the outer planets in the first approximation of the circular orbits of the planets. In Subsection 3.1.3 we present the evaluation [Simonenko, 2007; 2009; 2010] of the relative values of the maximal integral energy gravitational influences on the Earth of the inner planets (the Mercury and the Venus) and the outer planets (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) in the approximation of the circular orbits of the planets of the Solar System.

In Subsection 3.2 we present the evaluations [Simonenko, 2009; 2010] of the relative maximal (instantaneous and integral) energy gravitational influence of the Moon on the Earth as compared with the maximal (instantaneous and integral) energy gravitational influences on the Earth of the planets of the Solar
System. In Subsection 3.2.1 we present the evaluation [Simonenko, 2009; 2010] of the relative maximal instantaneous energy gravitational influence of the Moon on the Earth (as compared with the maximal instantaneous energy gravitational influences on the Earth of the planets of the Solar System) in the second approximation of the elliptical orbits of the Earth and the Moon around the combined mass center $C_{3, \text{MOON}}$ of the Earth and the Moon. In Subsection 3.2.2 we present the evaluation [Simonenko, 2009; 2010] of the maximal integral energy gravitational influence of the Moon on the Earth (as compared with the maximal integral energy gravitational influences on the Earth of the planets of the Solar System) in the second approximation of the elliptical orbits of the Earth and the Moon around the combined mass center $C_{3, \text{MOON}}$ of the Earth and the Moon.

In Subsection 3.3 we evaluate the energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune) of the Solar System. In Subsection 3.3.1 we evaluate the relative characteristic maximal positive instantaneous energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets of the Solar System. In Subsection 3.3.2 we evaluate the maximal positive integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets in the first approximation of the circular orbits of the planets of the Solar System.

In Subsection 3.4 we demonstrate the established [Simonenko, 2007; 2009; 2010] real cosmic energy gravitational genesis of the strong earthquakes and the global planetary cataclysms. Using the expression (3.51) for the maximal positive integral energy gravitational influence $E_g (\tau_2, D_3, m_r)$ of the Venus ($i = 2$) on the macroscopic continuum region $\tau$ of the mass $m_r$ near the surface point $D_3$ of the Earth, in Subsection 3.4.1 we present the confirmation [Simonenko, 2007] of the real cosmic energy gravitational genesis of preparation of earthquakes. In Subsection 3.4.2 we demonstrate the evidence of the integral energy gravitational influence on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter $\tau_5$ and the Saturn $\tau_6$) and the Moon as the predominant cosmic trigger mechanism of the earthquakes preparing by the combined integral energy gravitational influence on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter $\tau_5$ and the Saturn $\tau_6$ the Uranus $\tau_7$ and the Neptune $\tau_8$), the Venus, the Jupiter, the Moon, the Mars and the Mercury. In Subsection 3.4.3 we found the catastrophic planetary configurations established by the cosmic seismology [Simonenko, 2007]. In Subsection 3.4.3.1 we present the established [Simonenko, 2007] catastrophic planetary configurations related with the maximal (positive) and minimal (negative) combined integral energy gravitational influence on the Earth $\tau_3$ of the planets of the Solar System. We formulate the global prediction thermohydrogravidynamic principles (consistent with the generalized differential formulations (1.43) and (1.50) of the first law of thermodynamics of the established cosmic seismology [Simonenko, 2007; 2008; 2009; 2010]) associated with the maximal (positive) and minimal (negative) combined planetary integral energy gravitational influence on the Earth. In Subsection 3.4.3.2 we found the catastrophic planetary configurations related with the maximal (positive) and minimal (negative) combined integral energy gravitational influence on the Earth $\tau_3$ of the Sun (owing to the gravitational interactions of the Sun with the Jupiter $\tau_5$, the Saturn $\tau_6$, the Uranus $\tau_7$ and the Neptune $\tau_8$) and the planets of the Solar System. We formulate the global prediction thermohydrogravidynamic principles (consistent with the generalized differential formulations (1.43) and (1.50) of the first law of thermodynamics of the established cosmic seismology [Simonenko, 2007; 2008; 2009; 2010]) associated with the maximal (positive) and minimal (negative) combined planetary integral energy gravitational influence on the Earth of the planets of the Solar System and the Sun owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter $\tau_5$, the Saturn $\tau_6$, the Uranus $\tau_7$ and the Neptune $\tau_8$).

In Subsection 3.5 we present, classical shear (deformational) model [Короновский и Абрамов, 2000] of the earthquake focal region, the rotational model [Vikulin, 2003] of the earthquake focal region and the generalized thermohydrogravidynamic shear-rotational model [Simonenko, 2007a; 2007; 2008] (of the earthquake focal region) taking into account the classical macroscopic rotational kinetic energy [de Groot and Mazur, 1962; Gyarmati, 1970], the macroscopic non-equilibrium kinetic energies [Simonenko, 2004], the internal (terrestrial) energy gravitational influences and the external (cosmic) energy gravitational influences [Simonenko, 2007a; 2007; 2008] on the focal region of earthquakes. Using the evolution equation (1.67) (deduced from the generalized differential formulation (1.43) of the first law of thermodynamics) of
the total mechanical energy of the macroscopic continuum region $\tau$ (of the compressible viscous Newtonian continuum), in Subsection 3.5.1 we present the thermodynamic foundation of the generalized thermohydrogravidynamic shear-rotational model [Simonenko, 2007a; 2007] and the classical shear (deformational) model [Короновский и Абрамов, 2000] of the earthquake focal region. We demonstrated [Simonenko, 2007a; 2007] the physical adequacy of the classical deformational (shear) model [Короновский и Абрамов, 2000] of the earthquake focal region for the quasi-uniform medium of the Earth’s crust characterized by practically constant viscosity. Using the evolution equation (1.67) of the total mechanical energy of the macroscopic continuum region $\tau$ (of the compressible viscous Newtonian continuum), in Subsection 3.5.2 we present the thermodynamic foundation of the rotational model [Vikulin, 2003] of the earthquake focal region. We demonstrated [Simonenko, 2007a; 2007] the physical adequacy of the rotational model [Vikulin, 2003] of the earthquake focal region for the seismic zone of the Pacific Ring. In Subsection 3.5.3 we found the local energy and entropy prediction thermohydrogravidynamic principles determining the fractures formation in the macroscopic continuum region $\tau$ subjected the combined integral energy gravitational influence of the planets of the Solar System, the Moon and the Sun owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune). In Subsection 3.5.3.1 we formulate the local energy prediction thermohydrogravidynamic principles (determining the fractures formation in the macroscopic continuum region $\tau$) related with the maximal (positive) and minimal (negative), respectively, combined integral energy gravitational influence on the macroscopic continuum region $\tau$ of the planets of the Solar System, the Moon and the Sun owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune). In Subsection 3.5.3.2 we formulate the local entropy prediction thermohydrogravidynamic principle determining the fractures formation in the macroscopic continuum region $\tau$ subjected the combined integral energy gravitational influence of the planets of the Solar System, the Moon and the Sun owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune).

In Subsection 3.6 we present the confirmation of the cosmic energy gravitational genesis [Simonenko, 2007] of the seismotectonic (and volcanic) activity and the global climate variability induced by the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. In Subsection 3.6.1 we present the empirically established [Turner, 1925; Мэй Иш-юн, 1960; Tamrazyan, 1962; Fedotov, 1965; Филиппас, 1965; Davison, 1936; Ambraseys, 1970; Christensen and Ruff 1986; Barrientos and Kansel, 1990; Jacob, 1984; Shimazaki and Nakata, 1980; Suyehiro, 1984; Clark, Dibble, Fyfe, Lensen and Suggate, 1965; Johnston, 1965; Abramov, 1997; p. 72; Vikulin and Vikulina, 1989; Vikulin, 2003; p. 16-17] time periodicities of the seismotectonic activity of the Earth. Using the equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics [Simonenko, 2007] for the Earth, in Subsection 3.6.2 we present (in the frame of the real elliptical orbits of the Earth, the Sun, the Moon, the Venus, the Mars and the Jupiter) the successive approximations [Simonenko, 2007] for the time periodicities of the maximal (instantaneous or integral) separate cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. According to the thermohydrogravidynamic theory [Simonenko, 2007], these time periodicities correspond to the related time periodicities of the Earth’s periodic seismotectonic (and volcanic) activity and the global climate variability induced by the separate cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. In Subsection 3.6.2.1 we present the successive time periodicities [Simonenko, 2007] of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the system Sun-Moon. In Subsection 3.6.2.2 we present the successive time periodicities [Simonenko, 2007] of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Venus. In Subsection 3.6.2.3 we present the successive time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter. In Subsection 3.6.2.4 we present the successive time periodicities [Simonenko, 2007] of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Mars. Based on the equivalent generalized differential formulations (1.43), (1.48) and (1.53) of the first law of thermodynamics [Simonenko, 2007] used for the Earth, in Subsection 3.6.2.5 we present the time periodicities [Simonenko, 2007] of the periodic global seismotectonic (and volcanic) activity and the global climate variability of the Earth induced by the combined different combinations of the cosmic energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter, the Mars and the Sun owing to the gravitational
interaction of the Sun with the Jupiter. In Subsection 3.6.3 we confirm the real cosmic energy gravitational genesis [Simonenko, 2007] of the strongest Japanese earthquakes. In Subsection 3.6.4 we present the previous evaluation [Simonenko, 2007] of the mean time periodicities 94620 years and 107568 years of the global climate variability (related with the $G(a)$-factor and $G(b)$-factor determined by the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) and the mean time periodicities 100845 years and 121612.5 years of the global climate variability related with the $G(b)$-factor determined by the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. In Subsection 3.6.5 we present the real confirmation [Simonenko, 2007] of the cosmic energy gravitational genesis of the modern short-term time periodicities of the Earth’s global climate variability determined by the combined cosmic factors: $G$-factor related with the combined cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Mercury, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter; $G(a)$-factor related to the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the $G$-factor; $G(b)$-factor related to the periodic atmospheric-oceanic warming or cooling as a consequence of the periodic variable (increasing or decreasing) output of the heated greenhouse gases and the related variable greenhouse effect induced by the periodic variable tectonic-volcanic activity (activizaton or weakening) due to the $G$-factor; $G(c)$-factor related to the periodic variations of the solar activity owing to the periodic variations of the combined planetary non-stationary energy gravitational influence on the Sun.

In Subsection 3.7 we found the cosmic energy gravitational genesis of the seismotectonic (and volcanic) activity and the global climate variability induced (owing to the $G$-factor, $G(a)$-factor and $G(b)$-factor) by the combined non-stationary cosmic energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun (owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune). In Subsection 3.7.1 we evaluate the time periodicities of the maximal (instantaneous and integral) energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune). In Subsection 3.7.1.1 we present the time periodicities [Simonenko, 2007] of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. In Subsection 3.7.1.2 we evaluate the time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Saturn and the Sun owing to the gravitational interaction of the Sun with the Saturn. In Subsection 3.7.1.3 we evaluate the time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Uranus and the Sun owing to the gravitational interaction of the Sun with the Uranus. In Subsection 3.7.1.4 we evaluate the time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Neptune and the Sun owing to the gravitational interaction of the Sun with the Neptune. In Subsection 3.7.1.5 we found the fundamental global time periodicities (related to the combined planetary, lunar and solar non-stationary energy gravitational influences on the Earth) of the Earth’s periodic global seismotectonic (and volcanic) activity and the global climate variability induced by the different combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune. In Subsection 3.7.1.6 we present the thermohydrogravidynamic solution of the fundamental problem [Imbrie, Berger et al., 1993] of the origin of the major 100-kyr glacial cycle (during Pleistocene) determined by the non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

In Subsection 3.8 we analyze the global seismicity and volcanic activity of the Earth from the biblical Flood (occurred in 2104 BC according to the orthodox biblical chronology) and predict the forthcoming range 2020 ± 2061 AD of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696 ± 708 years of the history of humankind. In Subsection 3.8.1 we present the foundation of the ranges of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{sec,f} = T_{clim1,f} = 696 ± 708$ years and $T_{sec,f} = T_{clim2,f} = 348 ± 354$ years determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the
natural cataclysms in the ancient history of humankind from the final collapse of the ancient Egyptian Kingdom and the biblical Flood to the increase of the global seismicity and the global volcanic activity in the beginning of the 20th century [Richter, 1969] and the modern increase of the global seismicity and the volcanic activity in the end of the 20th century [Abramov, 1997] and in the beginning of the 21st century [Simonenko, 2007; 2009; 2010]. In Subsection 3.8.4.1 we consider the great natural cataclysms in the history of humankind from the final collapse of the ancient Egyptian Kingdom (near 2190 BC) and the biblical Flood (occurred in 2104 BC according to the orthodox Jewish and Christian biblical chronology). In Subsection 3.8.4.2 we reveal the linkage of the last major eruption of Thera (1450 BC) [LaMoreaux, 1995] and the greatest earthquake destroyed the ancient Pontus (63 BC). In Subsection 3.8.4.3 we reveal the linkage of the greatest earthquake destroyed the ancient Pontus (63 BC), the earthquake destroyed the ancient Greek Temple of Artemis (614 AD) and the great frost event (628 AD) [LaMarche and Hirschboeck, 1984] related with the atmospheric veil (recorded in Europe in 626 AD [Stothers and Rampino, 1983]) induced by the great unknown volcanic eruption (apparently, Rabaul' [LaMarche and Hirschboeck, 1984] eruption). In Subsection 3.8.4.4 we reveal the linkage of the greatest earthquake destroyed the ancient Pontus (63 BC) and the great earthquakes [Vikulin, 2008] occurred in England (1318 AD and 1343 AD), Armenia (1319 AD), Portugal (1320 AD, 1344 AD and 1356 AD) and Japan (1361 AD). In Subsection 3.8.4.5 we reveal the linkage of the final collapse of the ancient Egyptian Kingdom (occurred near 2190 BC), the biblical Flood (occurred in 2104 BC according to the orthodox Jewish and Christian biblical chronology) and the last major eruption of Thera (1450 BC) [LaMoreaux, 1995]. In Subsection 3.8.4.6 we reveal the linkage of the planetary disasters in the Central Asia (10555 BC) [Bunsen, 1848, pp. 77-78, 88] and in the ancient Egyptian Kingdom (10450 BC) [Hancock, 1997], and the greatest earthquake destroyed the ancient Pontus (63 BC). In Subsection 3.8.4.7 we reveal the linkage of the previous great eruptions of Thera (Santorini) (between 1628 and 1450 BC [LaMoreaux, 1995]), the greatest (in the United States in the past 150 years up to 1872) earthquake in Owens Valley, California (1872 AD), the eruptions of Santorini in 1866 and 1925 AD and the great eruption of Krakatau in 1883 AD. In Subsection 3.8.4.8 we reveal the linkage of the eruption of Tambora (1815 AD) and the Thera (Santorini) eruption in the range 1700 ÷ 1640 BC [Betancourt, 1987; Habberten et al., 1989]. In Subsection 3.8.4.9 we reveal the linkage of the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 19th century and in beginning of the 20th century [Richter, 1969] and the eruption of Thera (Santorini) between 1600 and 1500 BC [Antonopoulos, 1992]. In Subsection 3.8.4.10 we reveal the linkage of the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 20th [Abramov, 1997] century and the eruption of Hekla (1300 AD) [Thordarson and Larsen, 2007] in Iceland and the great earthquake (1303 AD) in China [Vikulin, 2008]. In Subsection 3.9 we present the evidence of the established [Simonenko, 2012] forthcoming range 2020 ÷ 2061 AD of the maximal seismotectonic, volcanic and climatic activities of the Earth during...
the past 696 ÷ 708 years of the history of humankind. We present the evidence of the related subsequent
subranges (2023±3 AD, 2040.38 ± 3 AD and 2061±3 AD) of the increased peaks of the forthcoming
global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century.
The main results and conclusions are summarized in Section 4.
1. THE GENERALIZED FORMULATION OF THE FIRST LAW OF THERMODYNAMICS FOR MOVING ROTATING DEFORMING COMPRESSIBLE HEAT-CONDUCTING STRATIFIED MACROSCOPIC INDIVIDUAL CONTINUUM REGION $\tau$ SUBJECTED TO THE NON-STATIONARY NEWTONIAN GRAVITATIONAL AND ELECTROMAGNETIC FIELDS

1.1. The generalized expression for the macroscopic kinetic energy of a small continuum region in non-equilibrium thermodynamics

De Groot and Mazur defined the macroscopic kinetic energy per unit mass $\varepsilon_k$ as [de Groot and Mazur, 1962] the sum of the macroscopic translational kinetic energy per unit mass $\varepsilon_t = \frac{1}{2} \mathbf{v}^2$ of a continuum region (particle) mass center and the macroscopic internal rotational kinetic energy per unit mass $\varepsilon_r = \frac{1}{2} \Theta \mathbf{\omega}^2$:

$$\varepsilon_k = \varepsilon_t + \varepsilon_r = \frac{1}{2} \mathbf{v}^2 + \frac{1}{2} \Theta \mathbf{\omega}^2,$$

(1.1)

where $\mathbf{v}$ is the speed of the mass center of a small continuum region, $\Theta$ is an inertia moment per unit mass of a small continuum region [de Groot and Mazur, 1962]. Gyarmati’s definition [Gyarmati, 1970] of the macroscopic kinetic energy per unit mass is analogous to de Groot and Mazur’s one. The classical de Groot & Mazur’s and Gyarmati’s definition (1.1) of the macroscopic kinetic energy per unit mass for a shear flows has some inherent physical incompleteness associated with the assumption about the rigid-like rotation of the continuum region with the angular velocity vector $\mathbf{\omega}$. This definition is based on the assumption of local thermodynamic equilibrium since it does not consider the non-equilibrium shear component of the macroscopic continuum motion related with the rate of strain tensor $\varepsilon_{ij}$. However, the assumption of local thermodynamic equilibrium, as noted by de Groot and Mazur [de Groot and Mazur, 1962], may be justified only by reasonable agreement of the experimental results with the theoretical deductions based on this assumption.

Thus, we see that the introduction of the conception of the "shear energy" is caused by the incompleteness of the definition for the macroscopic kinetic energy in classical non-equilibrium thermodynamics [de Groot and Mazur, 1962; Gyarmati, 1970]. We derive in Subsection 1.1 the formula for the macroscopic kinetic energy per unit mass of a small continuum region considered in a stratified shear three-dimensional flow. The obtained formula removes the limitations of the classical expression (1.1).

Landau and Lifshitz defined [Landau and Lifshitz, 1976] the macroscopic internal energy of a small macroscopic continuum region as the difference between the total kinetic energy of the continuum region and kinetic energy of the translational macroscopic motion of the continuum region. According to Landau and Lifshitz’s definition [Landau and Lifshitz, 1976] of the macroscopic internal energy, the term $\frac{1}{2} \Theta \mathbf{\omega}^2$ in the expression (1.1) is the internal energy of the macroscopic (hydrodynamic) continuum motion. The classical definition [de Groot and Mazur, 1962; Gyarmati, 1970] of the macroscopic internal rotational kinetic energy per unit mass $\frac{1}{2} \Theta \mathbf{\omega}^2$ is consistent with the Landau and Lifshitz’s definition of the macroscopic internal energy. We shall use further the Landau and Lifshitz’s definition [Landau and Lifshitz, 1976] of the macroscopic internal energy.

Following the works [Simonenko, 2004; 2005; 2006; 2007a; 2007; 2008], we shall present the foundation of the generalized expression for the macroscopic kinetic energy in non-equilibrium thermodynamics. We shall assume that $\tau$ is a small individual continuum region (domain) bounded by the
closed continual boundary surface $\partial \tau$ considered in the three-dimensional Euclidean space with respect to a Cartesian coordinate system $K$. We shall consider the small continuum region $\tau$ in a Galilean frame of reference with respect to a Cartesian coordinate system $K$ centred at the origin $O$ and determined by the axes $X_1, X_2, X_3$ (see Fig. 1).

The unit normal $K$-basis coordinate vectors triad $\mu_1, \mu_2, \mu_3$ is taken in the directions of the axes $X_1, X_2, X_3$, respectively. The $K$-basis vector triad is taken to be right-handed in the order $\mu_1, \mu_2, \mu_3$, see Fig. 1. $\mathbf{g}$ is the local gravity acceleration.

Fig. 1. Cartesian coordinate system $K$ of a Galilean frame of reference and the continuum region mass center-affixed Lagrangian coordinate system $K'$.

An arbitrary point $P$ in three-dimensional physical space will be uniquely defined by the position-vector $\mathbf{r} = X_i \mu_i \equiv (X_1, X_2, X_3)$ originating at the point $O$ and terminating at the point $P$. The continuum region-affixed Lagrangian coordinate system $K'$ (with the axes $x_1, x_2, x_3$) is centered to the mass center $C$ of the continuum region $\tau$. The axes $x_1, x_2, x_3$ are taken parallel to the axes $X_1, X_2, X_3$, respectively: the axis $x_i$ parallel to the axis $X_i$, where $i = 1, 2, 3$. The unit normal $K'$-basis coordinate vectors triad $\nu_1, \nu_2, \nu_3$ is taken in the directions of the axes $x_1, x_2, x_3$, respectively. The $K'$-basis vector triad is taken to be right-handed in the order $\nu_1, \nu_2, \nu_3$. The mathematical differential of the position-vector $\mathbf{r}$, $\delta \mathbf{r} \equiv x_i \nu_i \equiv (x_1, x_2, x_3)$, expressed in terms of the coordinates $x_i$ ($i = 1, 2, 3$) in the $K'$-coordinate system, originates at the mass centre $C$ of the continuum region $\tau$ and terminates at the arbitrary point $P$ of the continuum region.

The position-vector $\mathbf{r}_c$ of the mass center $C$ of the continuum region $\tau$ in the $K$-coordinate system is given by the following expression
\[ \mathbf{r}_c = \frac{1}{m_\tau} \iiint r \rho dV, \]  

(1.2)

where

\[ m_\tau = \iiint \rho dV \]

is the mass of the continuum region \( \tau \), \( dV = dX_1 dX_2 dX_3 \) is the mathematical differential of physical volume of the continuum region, \( \rho \equiv \rho(r, t) \) is the local macroscopic density of mass distribution, \( r \) is the position-vector of the continuum volume \( dV \), \( t \) is the time. The speed of the mass centre \( C \) of the continuum region \( \tau \) is defined by the following expression

\[ \mathbf{v}_c = \frac{\mathbf{d}r_c}{\mathbf{d}t} = \frac{\tau}{m_\tau}, \]  

(1.3)

where \( \mathbf{v} = \frac{\mathbf{d}r}{\mathbf{d}t} \) is the hydrodynamic velocity vector, the operator \( \frac{\mathbf{d}}{\mathbf{d}t} = \partial/\partial t + \mathbf{v} \cdot \nabla \) denotes the total derivative following the continuum substance [Batchelor, 1967]. The relevant three-dimensional fields such as the velocity and the local mass density (and also the first and the second derivatives of the relevant fields) are assumed to vary continuously throughout the entire continuum bulk of the continuum region \( \tau \). The instantaneous macroscopic kinetic energy of the continuum region \( \tau \) (bounded by the continuum boundary surface \( \partial \tau \)) is the sum of the kinetic energies of small parts constituting the continuum region \( \tau \) when the number of the parts, \( n \) tends to infinity and the maximum from their volumes tends to zero [Batchelor, 1967]:

\[ K_\tau \equiv \iiint \frac{\mathbf{v}^2}{2} dV, \]  

(1.4)

where \( \mathbf{v} \) is the local hydrodynamic velocity vector, \( \rho \) is the local mass density, \( dV \) is the mathematical differential of physical volume of the continuum region. We use the common Riemann’s integral here and everywhere.

For the analysis of the relative continuum motion in the physical space in the vicinity of the position-vector \( \mathbf{r}_c \) of the mass centre \( C \) we have the Taylor series expansion (consistent with the Helmholtz’s theorem [Helmholtz, 1858; Sommerfeld, 1949]) of the hydrodynamic velocity vector \( \mathbf{v}(r) \) for each time moment \( t \):

\[ \mathbf{v}(\mathbf{r}_c + \delta \mathbf{r}) = \mathbf{v}(\mathbf{r}_c) + \mathbf{\omega}(\mathbf{r}_c) \times \delta \mathbf{r} + \sum_{i,j=1}^{3} e_{ij}(\mathbf{r}_c) \delta r_j \mathbf{\mu}_i + \]

\[ + \frac{1}{2} \sum_{i,j,k=1}^{3} \frac{\partial^2 v_i}{\partial X_j \partial X_k} \delta r_j \delta r_k \mathbf{\mu}_i + \mathbf{v}_{\text{res}}, \]  

(1.5)

where \( \mathbf{v}(r) \equiv (v_1(r), v_2(r), v_3(r)) \) is the hydrodynamic velocity vector at the position-vector \( r \); \( \delta \mathbf{r} \equiv \mathbf{r} - \mathbf{r}_c \equiv (\delta r_1, \delta r_2, \delta r_3) \equiv (x_1, x_2, x_3) \) is the differential of the position-vector \( \mathbf{r} \); \( \mathbf{\omega}(\mathbf{r}) \equiv \frac{1}{2} (\nabla \times \mathbf{v}(\mathbf{r})) = (\omega_1, \omega_2, \omega_3) \) is the angular velocity of internal rotation (a half of the vorticity vector) in the \( K \)-coordinate system at the position-vector \( \mathbf{r} \); \( \mathbf{\omega}_v(\mathbf{r}) \equiv (\nabla \times \mathbf{v}(\mathbf{r})) \) is the local vorticity in the \( K \)-coordinate system at the position-vector \( \mathbf{r} \); \( e_{ij}(\mathbf{r}) = \frac{1}{2} \left( \frac{\partial v_i(r)}{\partial X_j} + \frac{\partial v_j(r)}{\partial X_i} \right) \)
is the rate of strain tensor in the $K$-coordinate system at the position-vector $r$, $(i,j=1,2,3)$;

$$\nabla \equiv \mu_1 \frac{\partial}{\partial X_1} + \mu_2 \frac{\partial}{\partial X_2} + \mu_3 \frac{\partial}{\partial X_3}$$

is the gradient operator;

$$v_{res} = \sum_{i=1}^{3} w_i \mu_i$$

is the small residual part of the Taylor series expansion (2.5), where

$$w_i = O(d_r^3), \ (i=1,2,3),$$

$$d_r = \sup_{A,B \in \tau} \sqrt{(r(A,B))^2}$$

is the diameter of the continuum region $\tau$, the vector $r(A,B)$ originates at point $A$ and terminates at point $B$ of the surface $\partial \tau$. The linear on $\delta r$ terms of the Taylor series expansion (1.5) are presented in the classical form [Batchelor, 1967].

Substituting formula (1.5) into the formula (1.4) and integrating by parts, then we obtain the following expression [Simonenko, 1995; 2001; 2004; 2006]:

$$K_{\tau} = K_t + K_r + K_s + K_{s,r}^{\text{coupl}} + K_{\text{res}} = \frac{1}{2} m_{\tau} V_c^2 + \frac{1}{2} \sum_{i,k=1}^{3} I_{ik} \omega_i (r_c) \omega_k (r_c) +$$

$$+ \frac{1}{2} \sum_{i,j,k=1}^{3} J_{jk} \epsilon_{ij} (r_c) \epsilon_{jk} (r_c) + \sum_{i,j,k=1}^{3} \epsilon_{ijk} J_{jik} \omega_i (r_c) \epsilon_{km} + K_{\text{res}}, \quad (1.6)$$

where $m_{\tau}$ is the mass of the continuum region $\tau$, $I_{ik}$ is the $ik$-component of the classical inertia tensor depending on the mass distribution in the continuum region $\tau$ under consideration:

$$I_{ik} = \lim_{n \to \infty} \left\{ \sum_{\alpha=1}^{n} m_\alpha \left( \delta_{ik} \sum_{j=1}^{3} x_{aj}^2 - x_{ai} x_{ak} \right) \right\} \equiv \iiint_{\tau,K'} \left( \delta_{ik} \sum_{j=1}^{3} x_j^2 - x_i x_k \right) \rho dV, \quad (1.7)$$

where $x_{ai}, x_{ak}$ are the $i, k$-components, respectively, of the vector $\delta r_\alpha$ originating at the mass centre $C$ of the continuum region $\tau$ and terminating at the $\alpha$-th part of the continuum region $\tau$; $m_\alpha$ is the mass of the $\alpha$-th part; $x_i, x_k$ are the $i, k$-components of the vector $\delta r$, respectively, in the $K'$-coordinate system; $\delta_{ik}$ is the Kronecker delta-tensor: $\delta_{ik}=1$ for $i=k$, $\delta_{ik}=0$ for $i \neq k$; $\epsilon_{ijk}$ is the third-order permutation symbol: $\epsilon_{ijk}=0$ if any two indices are equal, $\epsilon_{ijk}=1$ if $(i,j,k)$ is an even permutation of $(1,2,3)$, $\epsilon_{ijk}=-1$ if $(i,j,k)$ is an odd permutation of $(1,2,3)$; $J_{jk}$ is the $jk$-component classical centrifugal tensor depending on the mass distribution in the continuum region $\tau$ under consideration:

$$J_{jk} = \lim_{n \to \infty} \left\{ \sum_{\alpha=1}^{n} m_\alpha x_{aj} x_{ak} \right\} \equiv \iiint_{\tau,K'} x_j x_k \rho dV, \quad (1.8)$$

$K_{\text{res}} = O(d_r^7)$ is a small residual part of the macroscopic kinetic energy after substitution the Taylor series expansion (1.5) into formula (1.4).

Formula (1.6) states that the macroscopic kinetic energy $K_{\tau}$ of the small continuum region $\tau$ is the sum of the macroscopic translational kinetic energy $K_t$ of the continuum region $\tau$ moving as a whole at speed equal to the speed $V_c$ of the center of mass of the continuum region $\tau$:

$$K_t = \frac{1}{2} m_{\tau} V_c^2; \quad (1.9)$$

the macroscopic internal rotational kinetic energy $K_r$ of the continuum region $\tau$ (rotating with
the angular velocity \( \omega(r_c) \equiv (\omega_1(r_c), \omega_2(r_c), \omega_3(r_c)) \) as a whole:

\[
K_r = \frac{1}{2} \sum_{i,k=1}^{3} I_{ik} \omega_i(r_c) \omega_k(r_c) = \frac{1}{2} I_{ik} \omega_i(r_c) \omega_k(r_c); 
\]

(1.10)

the macroscopic internal shear kinetic energy \( K_s \) of the continuum region \( \tau \) (subjected to deformation by the local shear related with the rate of strain tensor \( e_{ij}(r_c) \)):

\[
K_s = \frac{1}{2} \sum_{i,j,k,l=1}^{3} J_{jk} e_{ij}(r_c) e_{ik}(r_c) = \frac{1}{2} J_{jk} e_{ij}(r_c) e_{ik}(r_c); 
\]

(1.11)

the macroscopic kinetic energy of shear-rotational coupling \( K_{s,r}^{\text{coup}} \) (related with the kinetic energy of local coupling between irreversible dissipative shear and reversible rigid-like rotational macroscopic continuum motions) of the continuum region \( \tau \):

\[
K_{s,r}^{\text{coup}} = \sum_{i,j,k,m=1}^{3} \epsilon_{ijk} J_{jm} \omega_i(r_c) e_{km}(r_c) = \epsilon_{ijk} J_{jm} \omega_i(r_c) e_{km}(r_c). 
\]

(1.12)

We adopt here and everywhere the Einstein summation convention: the repeated indices \( i, j, k, m \) are summed. The macroscopic internal rotational kinetic energy \( K_r \) is the classical [de Groot and Mazur, 1962; Gyarmati, 1970] kinetic energy of reversible (equilibrium) rigid-like macroscopic rotational continuum motion. The macroscopic internal shear kinetic energy \( K_s \) expresses the kinetic energy of irreversible (non-equilibrium) shear continuum motion related with the rate of strain tensor \( e_{ij} \). The macroscopic internal kinetic energy of the shear-rotational coupling \( K_{s,r}^{\text{coup}} \) expresses the kinetic energy of the local coupling between irreversible deformation and reversible rigid-like rotation. We attach the additional word “internal” for designations of macroscopic kinetic energies in accordance with the Landau and Lifshitz’s definition [Landau and Lifshitz, 1976] of the internal energy of a small macroscopic thermodynamic system and also by bearing in mind the de Groot and Mazur’s and Gyarmati’s definition [de Groot and Mazur, 1962; Gyarmati, 1970] of the term \( \epsilon_r = \frac{1}{2} \theta \omega^2 \) in expression (1.1) as the macroscopic internal rotational kinetic energy per unit mass.

The deduced expression (1.6) for \( K_r \) confirms the postulate [Evans, Hanley and Hess, 1984] that the velocity shear \( (e_{ij} \neq 0) \) represents an additional energy source taking into account in the Evans, Hanley and Hess’s extended formulation [Evans, Hanley and Hess, 1984] of the first law of thermodynamics for non-equilibrium deformed states of continuum motion. The energies \( K_r, K_s, K_{s,r}^{\text{coup}} \) and \( K_{s,r}^{\text{res}} \) are the Galilean invariants with respect to different inertial \( K \)-coordinate systems as well as the local kinetic energy dissipation rate per unit mass \( \epsilon_{\text{dis}} = 2\nu (e_{ij})^2 \) in an incompressible viscous Newtonian continuum characterized by the molecular kinematic viscosity \( \nu \).

We obtained [Simonenko, 2004] from (1.6) the following expression for the macroscopic kinetic energy per unit mass \( \epsilon_k = \frac{K_r}{m_r} \):

\[
\epsilon_k = \epsilon_r + \epsilon_i + \epsilon_s + \epsilon_{s,r}^{\text{coup}} + \epsilon_{s,r}^{\text{res}} =
\]

\[
= \frac{1}{2} \nu v^2 + \frac{1}{2} \sum_{i,k=1}^{3} \theta_{ik} \omega_i \omega_k + \frac{1}{2} \sum_{i,j,k=1}^{3} \beta_{jk} e_{ij} e_{ik} + \sum_{i,j,k,m=1}^{3} \epsilon_{ijk} \beta_{jm} \omega_i e_{km} + \epsilon_{s,r}^{\text{res}},
\]

(1.13)

where

\[
\theta_{ik} = \frac{I_{ik}}{m_r} = \frac{I_{ik}}{\iiint_{\tau} \rho dV} \quad (i, k = 1, 2, 3)
\]

(1.14)

is the ik-component of the classical inertia tensor per unit mass of the continuum region \( \tau \);
\[
\beta_{ik} = \frac{J_{ik}}{m_\tau} = \frac{J_{ik}}{\int \int \int \rho \, dV} \quad (i, k = 1, 2, 3) \tag{1.15}
\]

is the ik- component of the classical centrifugal tensor per unit mass of the continuum region \( \tau \); 

\[
\varepsilon_t = \frac{K_t}{m_\tau} = \frac{1}{2} \mathbf{V}_c^2
\tag{1.16}
\]

is the macroscopic translational kinetic energy per unit mass of the continuum region \( \tau \) (moving as a whole at speed \( \mathbf{V}_c \) of the mass center of the continuum region \( \tau \)); 

\[
\varepsilon_r = \frac{K_r}{m_\tau} = \frac{1}{2} \theta_{ik} \omega_i \omega_k
\tag{1.17}
\]

is the macroscopic internal rotational kinetic energy per unit mass of the continuum region \( \tau \) (rotating with the angular velocity \( \omega(r_c) \equiv (\omega_1(r_c), \omega_2(r_c), \omega_3(r_c)) \) as a whole); 

\[
\varepsilon_s = \frac{K_s}{m_\tau} = \frac{1}{2} \beta_{jk} e_{ij} e_{ik}
\tag{1.18}
\]

is the macroscopic internal shear kinetic energy per unit mass of the continuum region \( \tau \) (expressing the kinetic energy of irreversible dissipative shear motion related with the rate of strain tensor \( e_{ij}(r_c) \)); 

\[
\varepsilon_{s,r}^\text{coup} = \frac{K_{s,r}^\text{coup}}{m_\tau} = \varepsilon_{ijk} \beta_{jm} \omega_i \epsilon_{km}
\tag{1.19}
\]

is the macroscopic internal kinetic energy of the shear-rotational coupling per unit mass (of the continuum region \( \tau \)), \( \varepsilon_{\text{res}} = O(d_\tau^4) \) is the residual correction. The energies \( \varepsilon_t, \varepsilon_s, \varepsilon_{s,r}^\text{coup} \) and \( \varepsilon_{\text{res}} \) are the Galilean invariants with respect to different inertial \( K \) coordinate systems as well as the local kinetic energy dissipation rate per unit mass \( \varepsilon_{\text{dis}} = 2 \nu (e_{ij})^2 \), where \( \nu \) is the molecular viscosity. We have 

\[
\varepsilon_r = O(d_\tau^2), \quad \varepsilon_s = O(d_\tau^2), \quad \varepsilon_{s,r}^\text{coup} = O(d_\tau^2), \quad \varepsilon_{\text{res}} = O(d_\tau^4), \quad \text{when } d_\tau \to 0, \quad \text{where } d_\tau \text{ is the earlier defined diameter of the continuum region } \tau.
\]

For a homogeneous continuum region of simple form (sphere or cube) we have

\[
I_{ik} = I \delta_{ik}, \quad J_{jk} = J \delta_{jk},
\tag{1.20}
\]

where \( \delta_{ik}, \delta_{jk} \) are the Kronecker delta-tensors. Formula (1.10) for the macroscopic internal rotational kinetic energy \( K_r \) is reduced to the classical expression

\[
K_r = \frac{1}{2} I \mathbf{\omega}^2,
\tag{1.21}
\]

where \( \mathbf{\omega}^2 = \omega_1^2 + \omega_2^2 + \omega_3^2 \). Formula (1.11) for the macroscopic internal shear kinetic energy \( K_s \) is reduced to the expression [Simonenko, 2004; 2006]: 

\[
K_s = \frac{1}{2} J e_{ij} e_{ij} \equiv \frac{1}{2} J (e_{ij})^2,
\tag{1.22}
\]

which is proportional to the local kinetic energy dissipation rate per unit mass \( \varepsilon_{\text{dis}} = 2 \nu (e_{ij})^2 \) in an incompressible viscous Newtonian continuum, where \( \nu \) is the molecular viscosity. The macroscopic internal kinetic energy of shear-rotational coupling \( K_{s,r}^\text{coup} \) vanishes for the homogeneous continuum region \( \tau \) of the form of the sphere or cube. Consequently, the macroscopic kinetic energy \( K_{\tau} \) for the homogeneous continuum region \( \tau \) of the shape of sphere or cube is given by following expression [Simonenko, 2004; 2006]:

20
\[ K_r = \frac{1}{2} m \mathbf{V}_c^2 + \frac{1}{2} \mathbf{I}\omega^2 + \frac{1}{2} J (\epsilon_{ij})^2 + K_{\text{res}} \]  

(1.23)

Hence, the macroscopic kinetic energy per unit mass \( \varepsilon_{k} \) for the homogeneous continuum sphere or cube \( \tau \) is expressed as the sum of explicit terms [Simonenko, 2004; 2006]:

\[ \varepsilon_{k} = \frac{1}{2} \mathbf{V}_c^2 + \frac{1}{2} \theta \mathbf{\omega}^2 + \frac{1}{2} \beta (\epsilon_{ij})^2 + \varepsilon_{\text{res}}, \]

(1.24)

where \( \varepsilon_t = \frac{1}{2} \mathbf{V}_c^2 \) is the macroscopic translational kinetic energy per unit mass of the continuum region \( \tau \); \( \theta = I / m_c \); \( \beta = J / m_r \); \( \varepsilon_t = \frac{1}{2} \theta \mathbf{\omega}^2 \) is the classical [de Groot and Mazur, 1962; Gyarmati, 1970] macroscopic internal rotational kinetic energy per unit mass of the continuum region \( \tau \); \( \varepsilon_s = \frac{1}{2} \beta (\epsilon_{ij})^2 \) is the macroscopic internal shear kinetic energy per unit mass of the homogeneous continuum sphere or cube \( \tau \) [Simonenko, 2004; 2006].

We have the following expression for the macroscopic internal kinetic energy \( K_{\text{int}} \) of the homogeneous continuum region \( \tau \) of the shape of sphere or cube [Simonenko, 2004; 2006]:

\[ K_{\text{int}} = \frac{1}{2} \mathbf{I}\omega^2 + \frac{1}{2} J (\epsilon_{ij})^2 + K_{\text{res}}. \]

(1.25)

The macroscopic internal kinetic energy per unit mass \( \varepsilon_{\text{int}} \) for the homogeneous continuum region \( \tau \) of the shape of sphere or cube is given by the sum of explicit terms [Simonenko, 2004; 2006]:

\[ \varepsilon_{\text{int}} = \frac{1}{2} \theta \mathbf{\omega}^2 + \frac{1}{2} \beta (\epsilon_{ij})^2 + \varepsilon_{\text{res}}. \]

(1.26)

Compare formula (1.24) with the de Groot and Mazur’s definition (1.1). Expression (1.24) is reduced to de Groot and Mazur’s definition (1.1) under condition

\[ \mathbf{e}_{ij} = \mathbf{0} \quad (i, j = 1, 2, 3) \]

(1.27)

of local thermodynamic equilibrium. Therefore, we can conclude that the definition (1.1) of the macroscopic kinetic energy per unit mass \( \varepsilon_{k} \) in classical non-equilibrium thermodynamics [de Groot and Mazur, 1962; Gyarmati, 1970] is based on the assumption \( \mathbf{e}_{ij} = \mathbf{0} \) of local thermodynamic equilibrium [Evans, Hanley and Hess, 1984; Simonenko, 2004; 2006].

The obtained formula (1.13) for \( \varepsilon_{k} \) and its particular form (1.24) (obtained for homogeneous continuum regions of spherical and cubical shapes) generalized [Simonenko, 2004; 2006] the classical de Groot and Mazur expression (1.1) in classical non-equilibrium thermodynamics [de Groot and Mazur, 1962; Gyarmati, 1970] by taking into account the irreversible dissipative shear component of the macroscopic continuum motion related with the rate of strain tensor \( \mathbf{e}_{ij} \). The expression (1.13) for \( \varepsilon_{k} \) contains the new macroscopic internal shear kinetic energy per unit mass \( \varepsilon_{s} \), which expresses the kinetic energy of irreversible dissipative shear motion, and also the new macroscopic internal kinetic energy of the shear-rotational coupling per unit mass \( \varepsilon_{\text{coup}} \), which expresses the kinetic energy of local coupling between irreversible dissipative shear and reversible rigid-like rotational macroscopic continuum motions. The deduced formula (1.13) for \( \varepsilon_{k} \) confirmed [Simonenko, 2004; 2006] the postulate [Evans, Hanley and Hess, 1984] that the velocity shear (\( \mathbf{e}_{ij} \neq \mathbf{0} \)) represents an additional energy source in the extended formulation [Evans, Hanley and Hess, 1984] of the first law of thermodynamics for non-equilibrium deformed states of continuum motion.

The macroscopic internal shear kinetic energy per unit mass (for homogeneous continuum regions of spherical and cubical shapes):
\[ \varepsilon_s = \frac{1}{2} \beta (e_{ij})^2 \]  

is proportional to the kinetic energy viscous dissipation rate per unit mass:

\[ \varepsilon_{\text{dis, } s} = 2 \nu (e_{ij})^2 \]

in an incompressible viscous Newtonian continuum characterized by the kinematic viscosity \( \nu \). We have shown [Simonenko, 2006] that the proportionality

\[ \varepsilon_s \cong \varepsilon_{\text{dis, } s} = 2 \nu (e_{ij})^2 \]

is the basis of the established association [Prigogine and Stengers, 1984; Nicolis and Prigogine, 1989] between a structure and an order (and, hence, the associated macroscopic kinetic energy), on the one hand, and irreversible dissipation, on the other hand, for the dissipative structures of turbulence in viscous Newtonian fluids.

1.2. The generalized differential formulation of the first law of thermodynamics (in the Galilean frame of reference) for non-equilibrium shear-rotational states of the deformed one-component individual finite continuum region (characterized by the symmetric stress tensor \( T \)) moving in the non-stationary Newtonian gravitational field

Following the works [Simonenko, 2007a; 2007; 2008], we shall present the foundation of the generalized differential formulation of the first law of thermodynamics (in the Galilean frame of reference) for non-equilibrium shear-rotational states of the deformed finite one-component individual continuum region (characterized by the symmetric stress tensor \( T \)) moving in the non-stationary Newtonian gravitational field. We shall consider the deformed finite one-component individual continuum region in non-equilibrium shear-rotational states characterized by the following condition:

\[ e_{ij} \neq 0 \ (i, j=1, 2, 3). \]  

(1.31)

Considering the graphical methods in the thermodynamics of fluids [Gibbs, 1873], Gibbs formulated the first law of thermodynamics for the fluid body (fluid region) as follows (in Gibbs’ designations):

\[ d\varepsilon = dH - dW, \]  

(1.32)

where \( d\varepsilon \) is the differential of the internal thermal energy of the fluid body, \( dH \) is the differential change of heat across the boundary of the fluid body related with the thermal molecular conductivity (associated with the corresponding external or internal heat fluxes), \( dW = pdV \) is the differential work produced by the considered fluid body on its surroundings (surrounding fluid) under the differential change \( dV \) of the fluid region (of volume \( V \)) characterized by the thermodynamic pressure \( p \).

Landau’s and Lifshitz’s formulation [Landau and Lifshitz, 1976; p. 62] of the first law of thermodynamics for the general thermodynamic system (material region) is given by the equivalent form (in Landau’s and Lifshitz’s designations):

\[ dE = dQ - pdV, \]  

(1.33)

where \( dA = -pdV \) is the differential work produced by the surroundings (surroundings of the thermodynamic system) on the thermodynamic system under the differential change \( dV \) of volume \( V \) of the thermodynamic system characterized by the thermodynamic pressure \( p \); \( dQ \) is the differential heat transfer (across the boundary of the thermodynamic system) related with the thermal interaction of the thermodynamic system and the surroundings (surrounding environment), i.e. \( dQ > 0 \) is the differential energy in the form of the added heat to the thermodynamic system (if the thermodynamic system receives the heat from the surroundings) or \( dQ < 0 \) is the differential energy in the form of the returned heat (if the thermodynamic system returns the heat to the surrounding environment); \( E \) is the energy of the
thermodynamic system, which should contain (as supposed [Landau and Lifshitz, 1976]) the kinetic energy of the macroscopic continuum motion.

We shall use the differential formulation of the first law of thermodynamics [de Groot and Mazur, 1962] for the specific volume \( \mathcal{Q} = 1/\rho \) (of unit mass) of the compressible viscous one-component deformed continuum with no chemical reactions:

\[
\frac{du}{dt} = \frac{dq}{dt} - p \frac{d\mathcal{Q}}{dt} - \mathcal{Q} : \text{Grad} \mathbf{v},
\]

(1.34)

where \( u \) is the specific (per unit mass) internal thermal energy, \( d/dt \) is the total derivative following the continuum substance, \( p \) is the thermodynamic pressure, \( \Pi \) is the viscous-stress tensor, \( \mathbf{v} \) is the hydrodynamic velocity of the continuum macro-differential element mass center [de Groot and Mazur, 1962], \( dq \) is the differential change of heat across the boundary of the continuum region (of unit mass) related with the thermal molecular conductivity described by the heat equation [de Groot and Mazur, 1962]:

\[
\rho \frac{dq}{dt} = -\text{div} J_q,
\]

(1.35)

where \( J_q \) is the heat flux [de Groot and Mazur, 1962]. The viscous-stress tensor \( \Pi \) is taken from the decomposition of the pressure tensor \( P \) [de Groot and Mazur, 1962]:

\[
P = \rho \delta + \Pi,
\]

(1.36)

where \( \delta \) is the Kronecker delta-tensor.

Considering the Newtonian viscous-stress tensor \( \mathbf{P}^v \equiv \Pi \) of the compressible viscous Newtonian continuum with the components [Gyarmati, 1970]:

\[
\Pi_{ij} = \left\{ \left( \frac{2}{3} \nu \rho - \eta_v \right) \text{div} \mathbf{v} \right\} \delta_{ij} - 2\nu \rho \mathbf{e}_j,
\]

(1.37)

the differential formulation (1.34) of the first law of thermodynamics (for the continuum region (of unit mass) of the compressible viscous Newtonian one-component deformed continuum with no chemical reactions) can be rewritten as follows

\[
\frac{du}{dt} = \frac{dq}{dt} - p \frac{d\mathcal{Q}}{dt} + \left( \nu_v - \frac{2}{3} \nu \right) (\text{div} \mathbf{v})^2 + 2\nu (\mathbf{e}_j)^2,
\]

(1.38)

where \( \nu = \eta/\rho \) is the coefficient of the molecular kinematic (first) viscosity, \( \nu_v = \eta_v/\rho \) is the coefficient of the molecular volume (second) viscosity [Landau and Lifshitz, 1988]. The first and the second terms in the right-hand side of relation (1.38) are analogous to the corresponding respective first and the second terms in the right-hand side of the classical formulations (1.32) and (1.33). The third term in the right-hand side of relation (1.38):

\[
dq_{i,c} = \left( \frac{\eta_v}{\rho} - \frac{2}{3} \nu \right) (\text{div} \mathbf{v})^2 dt
\]

(1.39)

is related with the “internal” heat induced during the time interval \( dt \) by viscous-compressible irreversibility [Simonenko, 2006]. The fourth term in the right-hand side of relation (1.38):

\[
dq_{i,s} = 2\nu (\mathbf{e}_j)^2 dt
\]

(1.40)

is related with the “internal” heat induced during the time interval \( dt \) by viscous-shear irreversibility [Simonenko, 2006]. The differential formulation (1.38) of the first law of thermodynamics (for the continuum element of the compressible viscous Newtonian one-component deformed continuum with no chemical reactions) is taken into account (in addition to the classical terms) the viscous-compressible irreversibility and viscous-shear irreversibility inside the continuum element of the compressible viscous Newtonian one-component deformed continuum with no chemical reactions.

Using the differential formulation (1.34) of the first law of thermodynamics [de Groot and Mazur, 1962] for the total derivative \( du/dt \) (following the liquid substance) of the specific (per unit mass) internal thermal energy \( u \) of an compressible viscous one-component deformed continuum with no chemical
reactions, the heat equation (1.35) [de Groot and Mazur, 1962], the general equation (based on the Newtonian second law applied for continuum) of continuum movement [Gyarmati, 1970]:

$$\frac{d\mathbf{v}}{dt} = \frac{1}{\rho} \text{div} \mathbf{T} + \mathbf{g}$$

(1.41)

for the deformed continuum characterized by the symmetric stress tensor $\mathbf{T} = -P$ [Gyarmati, 1970] of general form (in particular, with the components [Gyarmati, 1970]):

$$T_{ij} = -\left\{ p + \left(\frac{2}{3} \nu \rho - \eta_v \right) \text{div} \mathbf{v} \right\} \delta_{ij} + 2\nu \rho \mathbf{e}_{ij}$$

(1.42)

for the compressible viscous Newtonian one-component continuum) and taking into account the time variations of the potential $\psi$ of the non-stationary gravity field (characterized by the local gravity acceleration vector $\mathbf{g} = -\nabla \psi$) inside of an arbitrary finite macroscopic individual continuum region $\tau$, we derived [Simonenko, 2007] the generalized differential formulation (for the Galilean frame of reference) of the first law of thermodynamics (for moving rotating deforming compressible heat-conducting stratified macroscopic continuum region $\tau$ subjected to the non-stationary Newtonian gravity):

$$d\left( K_{\tau} + U_{\tau} + \pi_{\tau}\right) = dt \iint_{\partial \tau} (\mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T})) d\Omega_n - dt \iint_{\partial \tau} (\mathbf{J}_q \cdot \mathbf{n}) d\Omega_n + dt \iint_{\partial \tau} \frac{\hat{T} \psi}{\partial t} \rho dV,$$

(1.43)

where

$$\delta A_{np,\partial \tau} = dt \iint_{\partial \tau} (\mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T})) d\Omega_n$$

(1.44)

is the differential work done during the infinitesimal time interval $dt$ by non-potential stress forces (pressure, compressible and viscous forces for Newtonian continuum) acting on the boundary surface $\partial \tau$ of the continuum region $\tau$; $d\Omega_n$ is the differential element (of the boundary surface $\partial \tau$ of the continuum region $\tau$) characterized by the external normal unit vector $\mathbf{n}$ (normal to the differential element of the continuum boundary surface $d\Omega_n \in \partial \tau$); $\mathbf{t} = \mathbf{n} \cdot \mathbf{T}$ is the stress vector [Gyarmati, 1970], $\mathbf{T} = -P$ [Gyarmati, 1970], where $\mathbf{P}$ is the pressure tensor characterized (in particular, for the model of the compressible viscous Newtonian continuum characterized by the coefficients of kinematic viscosity $\nu$ and the volume viscosity $\eta_v$) by components:

$$P_{ij} = \left\{ p + \left(\frac{2}{3} \nu \rho - \eta_v \right) \text{div} \mathbf{v} \right\} \delta_{ij} - 2\nu \rho \mathbf{e}_{ij};$$

(1.45)

$$\delta Q = -dt \iint_{\partial \tau} (\mathbf{J}_q \cdot \mathbf{n}) d\Omega_n$$

(1.46)

is the differential (infinitesimal) change of heat of the macroscopic individual continuum region $\tau$ related with the thermal molecular conductivity of heat across the boundary $\partial \tau$ of the continuum region $\tau$ (more precisely, $\delta Q$ is the differential (infinitesimal) amount of energy exchanged across the boundary $\partial \tau$ of the continuum region $\tau$ as a result of thermal molecular conductivity of heat, $\mathbf{J}_q$ is the heat flux [de Groot and Mazur, 1962] (across the element $d\Omega_n$ of the continuum boundary surface $\partial \tau$) describing by the heat equation (1.35);

$$\pi_{\tau} = \iiint_\tau \psi \rho dV$$

(1.47)

is the macroscopic potential energy (of the macroscopic individual continuum region $\tau$) related with the non-stationary potential $\psi$ of the gravity field (characterized by the local gravity acceleration vector $\mathbf{g} = -\nabla \psi$);

$$U_{\tau} = \iiint_\tau u \rho dV$$

(1.48)

is the classical microscopic internal thermal energy of the macroscopic individual continuum region $\tau$;
\[
K_\tau = \iiint_\tau \frac{\rho v^2}{2} dV
\]  

(1.49)

is the instantaneous macroscopic kinetic energy (earlier defined in Subsection 1.1 by expression (1.4)) of the macroscopic individual continuum region \( \tau \) (bounded by the continuum boundary surface \( \partial \tau \)). The instantaneous macroscopic kinetic energy \( K_\tau \) is given by the relation (1.6) [Simonenko, 2004; 2006] for the small macroscopic individual continuum region \( \tau \).

The generalized differential formulation (1.43) of the first law of thermodynamics can be rewritten as follows:

\[
dU_\tau + dK_\tau + d\pi_\tau = \delta Q + \delta A_{np,\tau} + dG
\]

(1.50)

extending the classical [Gibbs, 1873] formulations (1.32) and (1.33):

\[
dU = \delta Q - p dV,
\]

(1.51)

by taking into account (along with the classical infinitesimal change of heat \( \delta Q \)) and the classical infinitesimal change of the internal energy \( dU_\tau \equiv dU \) the infinitesimal increment of the macroscopic kinetic energy \( dK_\tau \), the infinitesimal increment of the gravitational potential energy \( d\pi_\tau \), the generalized infinitesimal work \( \delta A_{np,\tau} \) done on the continuum region \( \tau \) by the surroundings of \( \tau \), the infinitesimal amount \( dG \) of energy:

\[
dG = dt \iiint_\tau \frac{\partial \psi}{\partial t} \rho dV
\]

(1.52)

added (or lost) as the result of the Newtonian non-stationary gravitational energy influence on the continuum region \( \tau \) during the infinitesimal time interval \( dt \).

The generalized differential formulation (1.43) of the first law of thermodynamics can be rewritten as follows [Simonenko, 2007a; 2007; 2008]:

\[
\frac{dE_\tau}{dt} = \frac{d}{dt} \left( K_\tau + U_\tau + \pi_\tau \right) = \iiint_\tau \left( \frac{1}{2} v^2 + u + \psi \right) \rho dV -
\]

\[
= \iiint_\tau \left( v \cdot (n \cdot T) \right) d\Omega_a - \iiint_\tau (J_q \cdot n) d\Omega_a + \iiint_\tau \frac{\partial \psi}{\partial t} \rho dV.
\]

(1.53)

The equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics take into account the following factors:

1) the classical heat thermal molecular conductivity (across the boundary \( \partial \tau \) of the macroscopic continuum region \( \tau \)) related with the classical infinitesimal change of heat \( \delta Q \):

\[
\delta Q = -dt \iiint_\tau (J_q \cdot n) d\Omega_a.
\]

(1.54)

2) the classical infinitesimal change of the internal energy \( dU_\tau \) of the macroscopic continuum region \( \tau \):

\[
dU_\tau \equiv d \iiint_\tau u dV,
\]

(1.55)

3) the established [Simonenko, 2007] infinitesimal increment of the macroscopic kinetic energy \( dK_\tau \) of the macroscopic continuum region \( \tau \):

\[
dK_\tau = d \iiint_\tau \frac{\rho v^2}{2} dV,
\]

(1.56)

4) the established [Simonenko, 2007] infinitesimal increment of the gravitational potential energy \( d\pi_\tau \) of the macroscopic continuum region \( \tau \):
\[ d\pi_t = d\iiint_t \psi dV, \]  

(1.57)

5) the established [Simonenko, 2007] generalized infinitesimal work \( \delta A_{np,\partial t} \) done on the macroscopic continuum region \( \tau \) by the surroundings of \( \tau \):

\[ \delta A_{np,\partial t} = dt\iint_t (v \cdot (n \cdot T)) d\Omega_n, \]  

(1.58)

6) the established [Simonenko, 2007] infinitesimal amount \( dG \) of energy added (or lost) as the result of the Newtonian non-stationary gravitational energy influence on the macroscopic continuum region \( \tau \) during the infinitesimal time interval \( dt \):

\[ dG = dt\iint_t \frac{\partial \psi}{\partial t} dV. \]  

(1.59)

The generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics (given for the Galilean frame of reference) are valid for non-equilibrium shear-rotational states of the deformed finite individual continuum region (characterized by the symmetric stress tensor \( T \) in the general equation (1.41) of continuum movement [Gyarmati, 1970]) moving in the non-stationary gravitational field. The generalized differential formulations (1.43) and (1.50) of the first law of thermodynamics [Simonenko, 2007] are the subsequent generalizations of the classical formulations (1.32) and (1.33) of the first law of thermodynamics taking into account: 1) the generalized expression (1.44) for the differential work \( \delta A_{np,\partial t} \) done during the infinitesimal time interval \( dt \) by non-potential stress forces acting on the boundary surface \( \partial \tau \) of the individual continuum region \( \tau \) and 2) the time variations of the potential \( \psi \) of the non-stationary gravitational field inside the individual continuum region \( \tau \) due to the deformation of the individual continuum region \( \tau \) and due to the external gravitational influence (of the external gravity field) on the individual continuum region \( \tau \) moving in the combined (terrestrial + cosmic) non-stationary gravitational field.

The generalized expression [Simonenko, 2007] for the infinitesimal work \( \delta A_{np,\partial t} \) (done during the infinitesimal time interval \( dt \) by non-potential pressure and viscous forces acting on the boundary surface \( \partial \tau \) of the individual macroscopic continuum region \( \tau \)) is given in Subsection 1.3 for the Newtonian symmetric stress tensor \( T \) characterized by the components (1.42).

### 1.3. The generalized differential formulation of the first law of thermodynamics (in the Galilean frame of reference) for non-equilibrium shear-rotational states of the deformed finite individual region of the compressible viscous Newtonian one-component continuum moving in the non-stationary gravitational field

There are evidences [Verhoogen, Turner, Weiss, Wahrhaftig, Fyte, 1970] that the rocks of the Earth’s crust at protracted loadings may be considered as fluids characterized by the very high viscosity. According to the classical viewpoint [Verhoogen, Turner, Weiss, Wahrhaftig and Fyte, 1970], the local mechanism of creation of the earthquakes is related with the release of the accumulated potential energy of the elastic deformation during the sudden local break (i.e., the discontinuous shear) of the Earth’s crust (or the sudden increase of fluidity in the local region of the Earth’ crust) accompanied by viscous relaxation and generation of seismic waves. It was conjectured [Ranguelov, Dimitrova, Gospodinov, Lamykina, 2003] that “more punctual and refined methods of the mathematical analysis are obligatory” for “the practical assessment of the seismic hazard”. Taking into account the established [Simonenko, 2004] conception of the macroscopic internal shear kinetic energy (per unit mass) \( E_s \) related with the rate of medium deformation (i.e., with the rate of strain tensor \( \varepsilon_{ij} = \frac{d\varepsilon_{ij}}{dt} \), where \( \varepsilon_{ij} \) is the deformation tensor [Sommerfeld, 1949]), we have elucidated [Simonenko, 2005] (from the viewpoint of non-equilibrium thermodynamics) the mechanism of...
generation of seismic waves from the deformed finite zone of the Earth’s crust. The proportionality (1.30) takes place also for deformed compressible finite region of the Earth’s crust for sudden rise of fluidity (in a local region of the Earth’s crust) related with the local sudden medium deformation in the separate seismic zones of the seismic activity. Taking into account the established [Simonenko, 2004] proportionality (1.30), we have assumed [Simonenko, 2005] that the accumulated potential energy of the elastic deformation (related with the deformation tensor $\epsilon_{ij}$) converts to the macroscopic internal shear kinetic energy $K_s$ (related with the rate of strain tensor $\epsilon_{ij}$) in the seismic zone simultaneously with the damping of $K_s$ by viscous dissipation and radiation of seismic waves during several oscillations. In Section 3 we shall evaluate this mechanism on the basis of the generalized differential formulation (1.43) of the first law of thermodynamics in the Galilean frame of reference for non-equilibrium shear-rotational states of the deformed finite individual continuum region (characterized by the symmetric stress tensor $T$) moving in the non-stationary gravity field.

Following the works [Simonenko, 2007a; 2007; 2008], we shall present the foundation of the generalized differential formulation of the first law of thermodynamics (in the Galilean frame of reference) for non-equilibrium shear-rotational states of the deformed finite individual region of the compressible viscous Newtonian one-component continuum moving in the non-stationary gravity field. The generalized differential formulation (1.43) of the first law of thermodynamics (formulated for the Galilean frame of reference) is valid for arbitrary symmetric stress tensor $T$, in particular for non-equilibrium shear-rotational states of the deformed finite individual region of the compressible viscous Newtonian one-component continuum moving in the non-stationary gravity field. The coefficient of molecular kinematic (first, shear) viscosity $\nu$ and the coefficient of molecular volume (second) viscosity $\nu_2 = \eta/v$ are assumed to vary for each time moment $t$ as an arbitrary continuous functions of the Cartesian space (three-dimensional) coordinates.

The generalized differential work $\delta A_{np,\partial_t} = \delta A_p + \delta A_c + \delta A_s$ (1.60)

where

$\delta A_p = -\delta t \iint p(\mathbf{v} \cdot \mathbf{n}) d\Omega_n$ (1.61)

$\delta A_c = -\delta t \iint \left( \frac{2}{3} \eta - \eta_\nu \right) \text{div} \mathbf{v}(\mathbf{v} \cdot \mathbf{n}) d\Omega_n$ (1.62)

$\delta A_s = \delta t \iint 2\eta \nu_2 n_a e_{ap} d\Omega_n$ (1.63)

is the differential work of the viscous Newtonian forces (related with the combined effect of the velocity shear, i.e. the deformation of the continuum region $\tau$, and the molecular kinematic viscosity) acting on the boundary surface $\partial \tau$ of the individual continuum region $\tau$ (bounded by the continuum boundary surface $\partial \tau$) during the infinitesimal time interval $dt$. 

is the differential work of the hydrodynamic pressure forces acting on the boundary surface $\partial \tau$ of the individual continuum region $\tau$ (bounded by the continuum boundary surface $\partial \tau$) during the infinitesimal time interval $dt$;

is the differential work of the combined effects of the acoustic compressibility, molecular kinematic viscosity and molecular volume viscosity) of the acoustic (compressible) pressure forces acting on the boundary surface $\partial \tau$ of the individual continuum region $\tau$ (bounded by the continuum boundary surface $\partial \tau$) during the infinitesimal time interval $dt$;
Along with the equation (1.38) of the differential formulation of the first law of thermodynamics [de Groot and Mazur, 1962] for the total derivative $\frac{du}{dt}$ (following the continuum substance) of the internal thermal energy per unit mass $u$ of the one-component deformed continuum with no chemical reactions, the thermohydrodynamic theory [de Groot and Mazur, 1962] contains additionally the equations of the mass and momentum balances:

\[
\frac{\partial \rho}{\partial t} = -\text{div} \rho \mathbf{v}, \quad (1.64)
\]

\[
\rho \frac{d\mathbf{v}}{dt} = -\text{Grad} \mathbf{p} + \eta \Delta \mathbf{v} + \left(\frac{1}{3} \eta + \eta_v\right) \text{Grad} \text{div} \mathbf{v}. \quad (1.65)
\]

The generalized differential formulation (1.43) of the first law of thermodynamics (together with the generalized differential work $\delta A_{\text{np},\tau}$ given by the expression (1.60)) is valid for non-equilibrium shear-rotational states of the deformed finite individual region of the compressible Newtonian one-component continuum moving in the non-stationary gravity field. The coefficient of molecular kinematic (first, shear) viscosity $\eta = \eta/\rho$ and the coefficient of molecular volume (second) viscosity $\eta_2 = \eta_v/\rho$ are assumed to vary for each time moment $t$ as an arbitrary continuous functions of Cartesian space (three-dimensional) coordinates.

The generalized differential formulation (1.43) of the first law of thermodynamics takes into account the dependences of the hydrodynamic pressure on the hydrodynamic vorticity $\mathbf{\omega}$ and on the rate of strain tensor $\mathbf{e}_{ij}$ (for compressible viscous Newtonian one-component continuum moving in the non-stationary gravity field) by means of the component $\delta A_p$ (in the expression (1.60) for $\delta A_{\text{np},\tau}$) given by the expression (1.61). The presence of the third term $\delta A_s$ (given by the expression (1.63) and related with the combined effect of the molecular kinematic viscosity and the deformation of the continuum region $\tau$ defined by the rate of strain tensor $\mathbf{e}_{\alpha\beta}$) in the expression (1.60) for $\delta A_{\text{np},\tau}$ is generalized essentially the classical formulations (1.32) and (1.33) of the first law of thermodynamics by taking into account the differential work of the viscous Newtonian forces acting on the boundary continuum surface $\partial \tau$ of the individual continuum region $\tau$.

The general equation (1.41) of continuum movement [Gyarmati, 1970] for the compressible viscous Newtonian one-component continuum (characterized by the coefficient of molecular kinematic viscosity $\eta = \eta/\rho$ and the coefficient of molecular volume viscosity $\eta_2 = \eta_v/\rho$ considering as the continuous functions of Cartesian three-dimensional coordinates) is reduced to the following equation

\[
\rho \frac{d\mathbf{v}}{dt} = -\text{Grad} \mathbf{p} + \eta \Delta \mathbf{v} + \left(\frac{1}{3} \eta + \eta_v\right) \text{Grad} \text{div} \mathbf{v} + (\text{Grad} \eta) \cdot \mathbf{e} - \text{div} \mathbf{v} \text{Grad} \left(\frac{1}{3} \eta \cdot \eta_v\right) + \mathbf{g}, \quad (1.66)
\]

where $(\text{Grad} \eta) \cdot \mathbf{e}$ is the internal multiplication of the vector $(\text{Grad} \eta)$ and the rate of strain tensor $\mathbf{e}$ ($\mathbf{e}_{\alpha\beta}$) in accordance with the corresponding definition [Gyarmati, 1970]. The equation (1.66) generalizes the Navier-Stokes equation (1.65) (given for $\mathbf{g} = 0$) by taking into account the dependences of the coefficient of molecular kinematic viscosity $\eta = \eta/\rho$ and the coefficient of molecular volume viscosity $\eta_2 = \eta_v/\rho$ on the space (three-dimensional) Cartesian coordinates.

The relevant example for illustration of the significance of the term $\delta A_s$ (in the expression (1.60) for the differential work $\delta A_{\text{np},\tau}$) is related with the thermodynamic consideration [Simonenko, 2007] of the processes of the energy exchange [Dolgikh, 2000] between the oceans and the lithosphere of the Earth. According to the expression (1.63) for the term $\delta A_s$, the energy exchange between the oceans (and the atmosphere) and the lithosphere of the Earth is possible only under the presence of the medium acoustic compressibility (i.e., div $\mathbf{v} \neq 0$) and the medium deformations (i.e., $\mathbf{e}_{\alpha\beta} \neq 0$) in the boundary regions of fluid (in the oceans), air (in the atmosphere) and the compressible deformed lithosphere of the Earth.
According to the generalized expression (1.60) for the differential work \( \delta A_{\text{np},\partial \tau} \), the energy exchange between the oceans (and the atmosphere) and the lithosphere of the Earth is impossible for absolutely rigid non-deformed (\( \mathbf{e}_{\text{aff}} = 0 \)) and non-compressible (\( \text{div} \mathbf{v} = 0 \)) lithosphere.

We have the evolution equation for the total mechanical energy \( (K_{\tau} + \Pi_{\tau}) \) of the deformed finite individual macroscopic continuum region \( \tau \) [Simonenko, 2007a; 2007]:

\[
\frac{d}{dt}(K_{\tau} + \Pi_{\tau}) = \int \int \int (\frac{1}{2} \mathbf{v}^2 + \psi) \rho dV = \\
= \int \int \int \text{div} \mathbf{v} dV + \int \int \int \left( \frac{2}{3} \mathbf{\eta} - \mathbf{\eta}_v \right) (\text{div} \mathbf{v})^2 dV - \int \int \int 2\mathbf{e}_{ij}^2 \rho dV + \\
+ \int \int \mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T}) d\Omega_n + \int \int \frac{\partial \psi}{\partial t} \rho dV
\]

obtained from the generalized differential formulation (1.43) of the first law of thermodynamics for the compressible viscous Newtonian one-component continuum moving in the non-stationary gravity field.

In the Section 3 we shall use the evolution equation (1.67) of the total mechanical energy to found the rotational, shear and the shear-rotational models [Simonenko, 2007a; 2007] of the earthquake macroscopic focal region.

1.4. Cosmic and terrestrial energy gravitational genesis of the seismotectonic (and volcanic) activity of the Earth induced by the combined cosmic (due to the energy gravitational influences of the Sun, the Moon, the planets of the Solar System and our Galaxy) non-stationary energy gravitational influences on the individual continuum region \( \tau \) (of the Earth) and by the non-potential terrestrial stress forces acting on the boundary surface \( \partial \tau \) of the individual continuum region \( \tau \)

Following the works [Simonenko, 2007a; 2007; 2008], we present the physical mechanisms of the energy fluxes to the continuum region \( \tau \) related with preparation of earthquakes. The equivalent generalized differential formulations (1.43) and (1.53) of the first law of thermodynamics show that the non-stationary gravitational potential \( \psi \) gives the following gravitational energy power

\[
W_{\text{gr}}(\tau) = \int \int \int \frac{\partial \psi}{\partial t} \rho dV = \frac{dG}{dt}
\]

associated with the gravitational energy power of the total (external and internal) non-stationary gravity fields. According to the equivalent generalized differential formulations (1.43) and (1.53) of the first law of thermodynamics and to the evolution equation (1.67) for the total mechanical energy \( (K_{\tau} + \Pi_{\tau}) \) of the deformed finite individual macroscopic continuum region \( \tau \), the energy power of the non-stationary gravitational field may produce the fractures in the continuum region \( \tau \). We shall consider this aspect in Section 3.

The generalized differential formulation (1.53) of the first law of thermodynamics and the expression (1.68) for the gravitational energy power \( W_{\text{gr}}(\tau) \) show that the local time increase of the potential \( \psi \) of the gravitational field inside the continuum region \( \tau \) (\( \frac{\partial \psi}{\partial t} > 0 \)) is related with the supply of the gravitational energy into the continuum region \( \tau \). According to the generalized differential formulation (1.53) and to the evolution equation (1.67), the total energy \( (K_{\tau} + U_{\tau} + \Pi_{\tau}) \) of the continuum region \( \tau \) and the total mechanical energy \( (K_{\tau} + \Pi_{\tau}) \) of the continuum region \( \tau \) are increased if \( \frac{\partial \psi}{\partial t} > 0 \).

According to the generalized differential formulation (1.53) of the first law of thermodynamics and to the evolution equation (1.67), the gravitational energy supply into the continuum region \( \tau \) may induce the
formation of fractures in the continuum region \( \tau \) related with the production of earthquake. This conclusion corresponds to the conception [Abramov, 1997; p. 60] that the anomalous variations of the gravity field on the background of the Moon-Sun induced variations go in front of earthquakes. The established first stage [Abramov, 1997; p. 60] of the anomalous variations of the gravity field related with the time increase of the gravity field corresponds to the gravitational energy supply into the continuum region \( \tau \) before the earthquake. The generalized differential formulation (1.53) of the first law of thermodynamics gives also the theoretical foundation of the detected non-relativistic classical “gravitational” waves [Korochentsev, 2009] (the propagating disturbances of the gravitational field of the Earth) from the moving focal regions of earthquakes. The theoretical foundation of the non-relativistic classical “gravitational” waves is based on the fact that the last term of the generalized differential formulation (1.53) can be rewritten as

\[
W_{gr}(\tau) = \int \int \int \int \frac{\partial \psi}{\partial t} \rho dV = \int \int \left( J_{g} \cdot \mathbf{n} \right) d\Omega_{n} \div \mathbf{J}_{g} = \rho \frac{\partial \psi}{\partial t},
\]

(1.68a)

where \( J_{g} \) is the energy flux (across the boundary \( \partial \tau \) of the continuum region \( \tau \)) of the gravitational energy related with the change of the total energy of the continuum region \( \tau \).

According to the generalized formulation (1.53) of the first law of thermodynamics and to the evolution equation (1.67), the supply of energy into the continuum region \( \tau \) is related with the work:

\[
A_{np,\partial \tau} = \int_{t_{0}}^{t} \int \int \left( \mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T}) \right) d\Omega_{n}
\]

(1.69)
done by non-potential stress forces (pressure, compressible and viscous forces for Newtonian continuum) acting on the boundary surface \( \partial \tau \) of the continuum region \( \tau \) during the time interval \( (t - t_{0}) \).

The considered mechanisms of the energy supply to the Earth’s macroscopic continuum region \( \tau \) should result to the irreversible process of the splits formation in the rocks related with the generation of the high-frequency acoustic waves from the focal continuum region \( \tau \) before the earthquake. Taking this into account, the sum \( \delta A_{c} + \delta A_{s} \) in the expression (1.60) may be interpreted [Landau and Lifshitz, 1988; p. 78] as the energy flux (related with the compressible and viscous forces acting on the boundary surface \( \partial \tau \) of the continuum region \( \tau \)) [Simonenko, 2008, 2009, 2010]:

\[
\delta F_{vis,c} = \delta A_{c} + \delta A_{s}
\]

(1.70)
directed across the boundary \( \partial \tau \) of the continuum region \( \tau \). The considered mechanisms of the energy supply to the Earth’s macroscopic continuum region \( \tau \) is related with the experimentally detected [Dolgikh et al., 2007] significant increase of the energy flux \( \delta F_{vis,c} \) of the geo-acoustic energy from the focal region \( \tau \) before the earthquake.

1.5. Cosmic energy gravitational genesis of the global volcanic and climate variability induced by the cosmic non-stationary energy gravitational influences on the Earth

Using the evolution equation (1.67) for the total mechanical energy \( K_{t} + \Pi_{t} \) (of the deformed finite individual macroscopic continuum region \( \tau \)) and the generalized differential formulation (1.53) of the first law of thermodynamics, we derived the evolution equation for the internal energy \( U_{t} \) of the macroscopic continuum region \( \tau \) [Simonenko, 2007, 2008]:

\[
\frac{d}{dt}U_{t} = - \int \left( J_{q} \cdot \mathbf{n} \right) d\Omega_{n} + \int \int 2\mathbf{v}(\mathbf{e}_{ij})^{2} \rho dV - \int \left( \frac{2}{3} \mathbf{\eta} \cdot \mathbf{\eta} \right) (\div \mathbf{v})^{2} dV - \int \int \rho \div \mathbf{v} dV.
\]

(1.71)

If the period of variations of the potential of the external cosmic non-stationary gravitational field (of the Sun, the Moon, the planets of the Solar System and our Galaxy influencing on the continuum region \( \tau \) of the Earth \( \tau_{3} \)) is equal to \( T_{eg}(\tau) \equiv T_{\text{energy}}(\tau) \) then the same time periodicity \( T_{eg}(\tau) \equiv T_{\text{energy}}(\tau) \) will characterize the periodic variations of the rate of strain tensor \( \mathbf{e}_{ij} \) and the divergence \( \div \mathbf{v} \) of the velocity vector \( \mathbf{v} \) of the continuum motion inside of the subsystem \( \tau \) of the Earth \( \tau_{3} \). Taking into account that
the quadratic functions \((e_{ij})^2\) and \((\text{div}\mathbf{v})^2\) have the time period \(\frac{1}{2} T_{\text{eg}}(\tau)\) of temporal variations, we obtained [Simonenko, 2007, 2008], according to the evolution equation (1.71), the time periodicity \(T_{\text{endog}}(\tau)\)

\[
T_{\text{endog}}(\tau) = \frac{1}{2} T_{\text{eg}}(\tau)
\]

(1.72)
of variations of the internal energy \(U_\tau\) of the macroscopic continuum region \(\tau\) as a result of the irreversible dissipation of the macroscopic kinetic energy determined by the second and the third terms in the right-hand side of the evolution equation (1.71).

### 1.6. Thermodynamic equilibrium of the closed thermohydrogravidynamic system

#### 1.6.1. The equilibrium state of the closed thermodynamic system in classical statistical physics

Following the “Thermohydrogravidynamics of the Solar System” [Simonenko, 2007] and using the established [Simonenko, 2004; 2006] generalized expression (1.6) for the total macroscopic kinetic energy \((K_\tau)_{\alpha}\) of each subsystem \(\alpha\), in Subsection 1.6 we present the foundation of the conditions of the thermodynamic equilibrium for the closed thermohydrogravidynamic system. Landau and Lifshitz [Landau and Lifshitz, 1976] considered the problem of finding of the maximal total entropy of the thermodynamic system consisting of \(N\) subsystems not taking into account the internal structure of each subsystem (considering the subsystems as the material points). Considering the entropy \(S_\alpha\) of each subsystem \(\alpha\) as a function of the internal energy, Landau and Lifshitz [Landau and Lifshitz, 1976; p. 52] postulated the following expression for the total entropy \(S_{\text{tot}}\) of the closed thermodynamic system (taking into account the Galilean principle of relativity):

\[
S_{\text{tot}} = \sum_{\alpha=1}^{N} S_\alpha \left( E_\alpha - \frac{1}{2} \frac{P_\alpha^2}{m_\alpha} \right),
\]

(1.73)

where \(E_\alpha\) is the total energy of each subsystem \(\alpha\), \(P_\alpha/(2m_\alpha)\) is the macroscopic kinetic energy of the translational motion of each subsystem \(\alpha\), \(P_\alpha\) is the momentum of each subsystem \(\alpha\), \(m_\alpha\) is the mass of each subsystem \(\alpha\), \(S\) is the universal function. Landau and Lifshitz considered the problem of finding of the maximal total entropy \(S_{\text{tot}}\) of the thermodynamic system under imposed conservation laws of the total momentum \(P_{\text{tot}}\) and total angular momentum \(M_{\text{tot}}\):

\[
\sum_{\alpha=1}^{N} P_\alpha = P_{\text{tot}} = \text{const}_1,
\]

(1.74)

\[
\sum_{\alpha=1}^{N} \left[ r_\alpha \times P_\alpha \right] = M_{\text{tot}} = \text{const}_2.
\]

(1.75)

Following to the Lagrang’s method and considering the uncertain vectors \(a\) and \(b\), Landau and Lifshitz obtained the condition of the maximum of \(S_{\text{tot}}\) by equating to zero the derivative of the Lagrang’s function

\[
L = \sum_{\alpha=1}^{N} \left[ S_\alpha + a \cdot P_\alpha + b \cdot \left[ r_\alpha \times P_\alpha \right] \right]
\]

(1.76)
on the momentums $\mathbf{P}_\alpha$ of each subsystem $\alpha$. Taking into account the thermodynamic definition of temperature, the derivative of $S_\alpha$ on the momentum $\mathbf{P}_\alpha$ is presented in the following form [Landau and Lifshitz, 1976]:

$$\frac{\partial S_\alpha}{\partial \mathbf{P}_\alpha} \left( E_\alpha - \frac{\mathbf{P}_\alpha^2}{2m_\alpha} \right) = \frac{\partial S_\alpha}{\partial E_\alpha} \left( E_\alpha - \frac{\mathbf{P}_\alpha^2}{2m_\alpha} \right) \frac{\partial}{\partial \mathbf{P}_\alpha} \left( E_\alpha - \frac{\mathbf{P}_\alpha^2}{2m_\alpha} \right) = -\frac{1}{T_\alpha} \frac{\mathbf{P}_\alpha}{m_\alpha} = -\frac{\mathbf{V}_\alpha}{T_\alpha}, \quad (1.77)$$

where $\mathbf{V}_\alpha$ is the macroscopic translational speed of the subsystem $\alpha$.

The derivative of the scalar product $a \cdot \mathbf{P}_\alpha$ on the momentum $\mathbf{P}_\alpha$ is presented in the following form [Landau and Lifshitz, 1976]:

$$\frac{\partial}{\partial \mathbf{P}_\alpha} a \cdot \mathbf{P}_\alpha = a. \quad (1.78)$$

The derivative of the scalar product $\mathbf{b} \cdot [\mathbf{r}_\alpha \times \mathbf{P}_\alpha]$ on the momentum $\mathbf{P}_\alpha$ is presented in the following form [Landau and Lifshitz, 1976]:

$$\frac{\partial}{\partial \mathbf{P}_\alpha} \mathbf{b} \cdot [\mathbf{r}_\alpha \times \mathbf{P}_\alpha] = [\mathbf{b} \times \mathbf{r}_\alpha]. \quad (1.79)$$

Consequently, the derivative of the Lagrang’s function on the momentum $\mathbf{P}_\alpha$ is given by the following expression [Landau and Lifshitz, 1976]:

$$\frac{\partial L}{\partial \mathbf{P}_\alpha} = -\frac{\mathbf{V}_\alpha}{T} + a + [\mathbf{b} \times \mathbf{r}_\alpha], \quad (1.80)$$

from which we have (under condition $\frac{\partial L}{\partial \mathbf{P}_\alpha} = 0$) the following expression [Landau and Lifshitz, 1976]:

$$\mathbf{V}_\alpha = u + [\Omega \times \mathbf{r}_\alpha], \quad (1.81)$$

where

$$u = T a, \quad \Omega = T b. \quad (1.82)$$

Landau and Lifshitz concluded from expression (1.81) that the translational macroscopic motion and the rigid-like rotation as a whole characterize the state of the thermodynamic equilibrium [Landau and Lifshitz, 1976]. Landau and Lifshitz considered the imposed conservation laws (1.74) and (1.75) of the total momentum $\mathbf{P}_\text{tot}$ and the total angular momentum not taking into account the thermohydrogravidynamic structure of each subsystem $\alpha$ (considered as a material point) and the gravity field. In this Section we shall consider further the thermohydrogravidynamic structure of each subsystem $\alpha$ considering as a finite continuum region $\tau_\alpha$ subjected to the gravitational field.
1.6.2. The conservation law of the total energy for the closed thermohydrogradivodynamic system \( \tau \) in the frame of continuum model

Prigogine and Stengers [Prigogine and Stengers, 1984] considered the differential \( dE \) (during the time interval \( dt \)) of the total energy \( E \) of the unclosed thermodynamic system in the following form:

\[
dE = d_i E + d_e E.
\] (1.83)

The term \( d_i E \) related with the internal production of energy is considered equal to zero as a consequence of the conservation law [Prigogine and Stengers, 1984]. Consequently, the total increment of energy \( dE \) is related with the term \( d_e E \) describing the energy exchange with the external surroundings of the considered thermodynamic system [Prigogine and Stengers, 1984].

We postulate the conservation law for the total energy \( E_\tau \):

\[
dE_\tau = d (K_\tau + U_\tau + \pi_\tau) = 0,
\] (1.84)

or

\[
(K_\tau + U_\tau + \pi_\tau) = E_\tau = \text{const}
\] (1.85)

for the closed thermodynamic system \( \tau \) subjected to the self-induced own gravitational field. Considering the problem of finding of the maximal entropy of the thermodynamic system, we shall postulate the conservation of the total momentum, the total angular momentum and the total energy of the thermodynamic system considering in the frame of the model of continuum subjected to the self-induced own gravitational field.

The expression (1.85) can be rewritten for closed system in the following form:

\[
(K_\tau + U_\tau + \pi_\tau) = \iiint \left( \frac{1}{2} \rho v^2 + u + \psi \right) \rho dV = E_\tau = \text{const},
\] (1.86)

where \( U_\tau = \iiint u \rho dV \) is the classical internal thermal energy of molecular chaos and the short-range intermolecular electromagnetic interactions [de Groot and Mazur, 1962; Sommerfeld, 1954], \( \pi_\tau = \iiint \psi \rho dV \) is the potential energy of the thermodynamic system \( \tau \), \( \psi \) is the potential of gravitational forces in the point characterized by the position-vector \( r \), \( \rho dV \) is the mass concentrated in volume \( dV \) of the three-dimensional Euclidean space. We consider the classical Newtonian gravitation and assume that the potential \( \psi \) do not depend on the speed of the material bodies containing in the thermodynamic system \( \tau \).
1.6.3. Statistical properties of thermodynamically equilibrium subsystem in classical statistical physics

According to Landau and Lifshitz [Landau and Lifshitz, 1976], the statistical properties of each thermodynamic subsystem $\alpha$ is defined by its energy $E_\alpha(p,q)$, the momentum $P_\alpha(p,q)$ and the angular momentum $M_\alpha(p,q)$ considering as a functions of coordinates $q = (q_1, q_2, ..., q_N)$ and momentums $p = (p_1, p_2, ..., p_N)$ of all $N$ particles constituting the thermodynamic subsystem $\alpha$.

The unique additive combination of this values is the linear combination [Landau and Lifshitz, 1976] for the distribution function $\rho_\alpha$ of each thermodynamic subsystem $\alpha$:

$$\ln \rho_\alpha = \alpha_a + \beta E_\alpha(p,q) + \gamma \cdot P_\alpha(p,q) + \delta \cdot M_\alpha(p,q)$$

characterized by constant identical factors $\alpha_a, \beta, \gamma, \delta$ for each thermodynamic subsystem $\alpha$ of the closed thermodynamic system. Taking into account the existence of only seven independent additive integrals of movement: the energy, three components of the momentum vector and three component of the angular momentum vector, Landau and Lifshitz [Landau and Lifshitz, 1976] concluded that the seven independent constants $\beta, \gamma, \delta$ can, obviously, be defined using the seven constants of additive integrals of movement for all closed thermodynamic system.

Thus, the values of additive integrals of movement (the energy, three components of the momentum vector and three component of the angular momentum vector) are completely define the statistical properties of the closed thermodynamic system [Landau and Lifshitz, 1976] including the average values of the physical values. Using the stated reasons, Landau and Lifshitz [Landau and Lifshitz, 1976] considered the distribution function $\rho$ for the closed thermodynamic system:

$$\rho = \text{const} \delta(E - E_o) \delta(P - P_o) \delta(M - M_o),$$

for the micro-canonical distribution corresponding to the constant values of the energy $E_o$, the impulse $P_o$, momentum and the angular momentum $M_o$ of the thermodynamic system. Taking into account that the impulse and the angular momentum are related with the movement as a whole (uniform translational movement and uniform rotation for system in the state of thermodynamic equilibrium), Landau and Lifshitz [Landau and Lifshitz, 1976] concluded that statistical condition of the system depends only on the energy. This statement is valid for the closed thermodynamic system considered in the state of thermodynamic (statistical) equilibrium. We have the micro-canonical distribution for the closed thermodynamic system [Gibbs, 1928; Landau and Lifshitz, 1976] considered in the state of thermodynamic (statistical) equilibrium:

$$\rho = \text{const} \delta(E - E_o)$$

corresponding to the constant value of energy $E_o$ of the closed thermodynamic system.

Thus, the total energy defines the statistical properties of the closed thermodynamic system considered in the state of thermodynamic (statistical) equilibrium. We see that the reasons of the classical statistical physics testify in favour of using of the energy for consideration of the problem of thermodynamic equilibrium for the closed thermodynamic system.

In Subsection 1.6.6 we shall consider the angular momentum for each subsystem $\alpha$ defined by the following form:

$$\sum_{\beta=1}^{N} [r_\beta \times P_\beta].$$

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where index $\beta$ characterizes the small macro-differential parts of the subsystem $\alpha$. We shall conclude that the angular velocity of rotation $\omega_{\alpha}$ of the subsystem $\alpha$ as a whole and the classical inertia tensor $(I_{ij})_{\alpha}$ (defining the classical macroscopic internal rotational kinetic energy $K_r$) define the sum (1.90) also for the state of thermodynamic equilibrium ($e_{ij} = 0$) of the subsystem $\alpha$. We shall see that the sum (1.90) depends on the classical centrifugal tensor $(J_{ij})_{\alpha}$ of the subsystem $\alpha$ and on the rate of strain tensor ($(e_{ij})_{\alpha}$ (defining the established [Simonenko, 2004] macroscopic non-equilibrium kinetic energies) if the subsystem $\alpha$ is far ($e_{ij} \neq 0$) from the state of thermodynamic equilibrium ($e_{ij} = 0$).

1.6.4. Entropy of the thermodynamic system in classical statistical physics and the Galilean principle of relativity

Taking into account that the entropy is the Galilean invariant [Landau and Lifshitz, 1976], the entropy $S_{\alpha}$ of the thermodynamic subsystem $\tau_{\alpha}$ (designated also by $\alpha$) is the universal function $S$ of the internal energy

$$E_{\text{int}, \alpha} = E_{\alpha} - \frac{P_{c,\alpha}^2}{2m_{\alpha}},$$

i.e.

$$S_{\alpha} = S\left(E_{\alpha} - \frac{1}{2} V_{c,\alpha}^2 m_{\alpha}\right),$$

where $E_{\alpha}$ is the total energy of the subsystem $\alpha$. The internal energy $E_{\text{int}, \alpha}$ of the subsystem $\alpha$ contains the all possible and admissible energies (except the kinetic energy of the translational movement of the mass center of the subsystem $\alpha$). The internal energy $E_{\text{int}, \alpha}$ of each subsystem $\alpha$ contains the energies $K_r$, $K_s$, $K_{s,r}$, $K_{res}$, $U$, $\pi$ corresponding to the subsystem $\alpha$.

Following to Landau and Lifshitz [Landau and Lifshitz, 1976], we postulate the entropy $S_{\text{tot}}$ of the total thermodynamic system by the following expression:

$$S_{\text{tot}} = \sum_{\alpha=1}^{n} S_{\alpha} = \sum_{\alpha=1}^{n} S\left(E_{\alpha} - \frac{1}{2} V_{c,\alpha}^2 m_{\alpha}\right).$$

(1.93)

From definition (1.93) we see that the entropy $S_{\text{tot}}$ is the total value describing the thermodynamic system.

Let us find the maximum of function $S_{\text{tot}}$ considered as a function of the following variables:

$$K_r, K_s, K_{s,r}^{\text{coup}}, U, \pi$$

(1) (2) (3) (4) (5)

for each subsystem $\alpha$ ($\alpha = 1, \ldots, N$), i.e. let us find the maximum of function $S_{\text{tot}}$ depending on $5N$ variables, where $N$ is the number of considered subsystems. Since each subsystem $\alpha$ is defined also by the position-vector $r_{c,\alpha}$ of the mass center (C, $\alpha$), then we add also $3N$ variables not considering the
configuration of the subsystem $\alpha$ defined by the boundary surface $\partial \tau_\alpha$.

Though the entropy of each subsystem $\alpha$, according to definition (1.92), does not depend on the momentum $P_{c,\alpha}$ of this subsystem $\alpha$, nevertheless, the total entropy $S_{\text{tot}}$ depends on the set of momentums $P_{c,\alpha}$ ($\alpha = 1, \ldots, N$).

We shall find the maximum of $S_{\text{tot}}$ under imposed restrictions (on the closed thermodynamic system) characterized by the conservation laws of the total energy and the total angular momentum [Simonenko, 2007]:

$$
\sum_{\alpha=1}^{N} E_\alpha = \sum_{\alpha=1}^{N} \iiint_{\tau_\alpha} \left( \frac{1}{2} \rho v^2 + u \rho + \psi \rho \right) \, dV = E_{\text{tot}} = \text{const}_1, \quad (1.95)
$$

$$
\sum_{\alpha=1}^{N} \iiint_{\tau_\alpha} [r \times \rho v] \, dV = M_{\text{tot}} = \text{const}_2 \quad (1.96)
$$
presented for the coordinate system $K'_{\text{sys}}$ related with the mass center $C_{\text{sys}}$ of the thermodynamic system.

1.6.5. The condition of the thermodynamic equilibrium for the closed thermohydrogravidynamic system considered in the coordinate system $K'_{\text{sys}}$ of the mass center $C_{\text{sys}}$ of the thermohydrogravidynamic system under imposed conservation laws of the total energy and the total angular momentum

We divide mentally the thermohydrogravidynamic system into sufficiently small but finite macroscopic subsystems $\alpha$ ($\alpha = 1, \ldots, N$). We define by symbol $V_{c,\alpha}$ the speed of the mass center of each subsystem relative to inertial coordinate system $K'_{\text{sys}}$ related with the mass center $C_{\text{sys}}$ of the thermohydrogravidynamic system. We assume that the subsystems $\alpha$ ($\alpha = 1, \ldots, N$) are not in the states of thermodynamic equilibrium at the initial time moment. We postulate the conservation laws (1.95) and (1.96) for the total energy $E_{\text{tot}}$ and the total angular momentum $M_{\text{tot}}$ obtained in the inertial coordinate system $K'_{\text{sys}}$.

In accordance with the second law of thermodynamics [Prigogine and Stengers, 1986; Nicolis and Prigogine, 1990], we shall find the maximum of entropy $S_{\text{tot}}$ [Simonenko, 2007]:

$$
\max \left\{ \sum_{\alpha=1}^{N} \left( E_\alpha - \frac{1}{2} m_\alpha V_{c,\alpha}^2 \right) \right\} \quad (1.97)
$$

under imposed conditions (1.95) and (1.96), according to which the total energy $E_\alpha$ of the subsystem $\alpha$ and the total angular momentum $M_\alpha$ of the subsystem $\alpha$ are defined by the following expressions [Simonenko, 2007]:

$$
E_{\tau_\alpha} \equiv E_\alpha = \iiint_{\tau_\alpha} \left( \frac{1}{2} \rho v^2 + u \rho + \psi \rho \right) \, dV, \quad (1.98)
$$
\[ \mathbf{M}_{\tau_a} \equiv \mathbf{M}_a = \iiint_{\tau_a} \left[ \mathbf{r} \times \rho \mathbf{v} \right] \, d\mathbf{V}. \] (1.99)

The potential \( \psi \) of the gravitational field in non-relativistic approximation (Newtonian gravity in Euclidean space) for mass distribution in the thermohydrogravidynamic system \( \tau = \sum_{\alpha=1}^{N} \tau_a \equiv \sum_{\alpha=1}^{N} U_{\tau_a} \) (representing the set of subsystems \( \tau_a \)) is given by classical expression [Landau and Lifshitz, 1988, Theory of Field; p. 382]:

\[ \psi = -\gamma \iiint_{\tau} \frac{\rho d\mathbf{V}}{R}, \] (1.100)

where \( R \) is the distance from the point of space (in which the potential \( \psi \) is calculated) to the element of mass \( \rho d\mathbf{V} \), \( \gamma \) is the gravitational constant.

1.6.6. Angular momentum of the subsystem \( \tau_\alpha \) (macroscopic continuum region \( \tau_\alpha \)) for the non-equilibrium thermodynamic state

Let us calculate the angular momentum (1.99) of the macroscopic subsystem \( \tau_\alpha \) (continuum region \( \tau_\alpha \)). Landau and Lifshitz [Landau and Lifshitz, 1976; p. 53] considered the expression \( [\mathbf{r}_a \times \mathbf{P}_a] \) instead of the integral (1.99). It means the consideration of the finite macroscopic thermohydrogravidynamic systems as the material point that is inconsistent with the considered continuum approach. Let us calculate the integral (1.99) for arbitrary distributions of density \( \rho \) and the continuum velocity \( \mathbf{v} \) in the continuum region \( \tau_\alpha \).

For the analysis of the relative continuum motion in the physical space in the vicinity of the position-vector \( \mathbf{r}_{c,\alpha} \) of the mass centre \( \mathbf{C}_\alpha = (C, \alpha) \) of the continuum region \( \tau_\alpha \), we have [Simonenko, 2004; 2005; 2006] the Taylor series expansion of the hydrodynamic velocity vector \( \mathbf{v}(\mathbf{r}) \) for each time moment \( t \):

\[
\mathbf{v}(\mathbf{r}_{c,\alpha} + \delta \mathbf{r}) = \mathbf{v}(\mathbf{r}_{c,\alpha}) + \left[ \mathbf{\omega}(\mathbf{r}_{c,\alpha}) \times \delta \mathbf{r} \right] + \sum_{i,j=1}^{3} e_{ij} (\mathbf{r}_{c,\alpha}) \delta r_i \mathbf{u}_j + \frac{1}{2} \sum_{i,j,k=1}^{3} \frac{\partial^2 v_i}{\partial X_j \partial X_k} \delta r_j \delta r_k \mathbf{u}_i + \mathbf{v}_{\text{res}}.
\] (1.101)

Integral (1.99) is calculated by Saffman [Saffman, 1992] by neglecting the square-law and subsequent terms in relation (1.101). Saffman [Saffman, 1992] calculated the angular momentum \( \mathbf{M}_{\tau_a}^c \) (characterized by the i-component \( \mathbf{M}^c_{\tau_a}(i) \) of the vector \( \mathbf{M}_{\tau_a}^c \)) of the continuum region \( \tau_\alpha \) relative to the mass center \( \mathbf{C}_\alpha \) (defined by the position-vector \( \mathbf{r}_{c,\alpha} \) in the coordinate system \( K \)) in the following form:

\[
\mathbf{M}^c_{\tau_a}(i) = \varepsilon_{ijk} e_{kl} J^{(1)}_{ji} + \frac{1}{2} \left( \delta_{ij} J^{(2)}_{kk} - J^{(2)}_{ij} \right) \omega_j,
\] (1.102)

where \( J^{(1)}_{ji} \) is the \( ji \)-component of the centrifugal tensor written (in approximation \( \rho = \text{const} \)) in the following form [Saffman, 1992]:

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\[ J_{ij} = \rho \int \int \int \delta x_i \delta x_j \, dV. \quad (1.103) \]

The first term (1) in expression (1.102) is reduced to zero if the continuum region \( \tau_\alpha \) has the spherical symmetry [Saffman, 1992], when the continuum region \( \tau_\alpha \) has the center of symmetry as for case of homogeneous cube or sphere.

The expression (1.102) shows that the angular momentum \( \mathbf{M}^c_{\tau_\alpha} \) of deformed continuum region \( \tau_\alpha \) depends on the rate of strain tensor \( e_{kl} \) in the point \( C_\alpha \) of the mass center defined by the position-vector \( r_{c,\alpha} \). Formula (1.102) generalizes the classical definition [de Groot and Mazur, 1962] of the angular momentum \( \mathbf{M} \) of the fluid region (of mass \( m_\tau \)) in non-equilibrium thermodynamics:

\[ \frac{\mathbf{M}}{m_\tau} = \Theta \omega \quad (1.104) \]

for non-equilibrium states of continuum motion. Taking into account the expression (1.102), we obtained from expression (1.99) the following relation [Simonenko, 2007]:

\[ \mathbf{M}_{\tau_\alpha} = \int \int \int \left( \left( r_{c,\alpha} + \delta \mathbf{r} \right) \times \rho \mathbf{v} \right) \, dV = \left[ r_{c,\alpha} \times \int \int \int \rho \mathbf{v} \, dV \right] + \mathbf{M}^c_{\tau_\alpha} = \]

\[ = \left[ r_{c,\alpha} \times \mathbf{P}_{\tau_\alpha} \right] + \sum_{i=1}^{3} \varepsilon_{ijk} e_{kl}^j J_i^r \mathbf{\mu}_i + \sum_{i=1}^{3} \frac{1}{2} \left( \delta_{ij} J_{kk}^r - J_{ij} \right) \omega_j \mathbf{\mu}_i, \quad (1.105) \]

where the vector \( \mathbf{M}^c_{\tau_\alpha} \) is described by two components given by expression (1.102). We see that expression (1.105) for the angular momentum \( \mathbf{M}_{\tau_\alpha} \) of a small macroscopic continuum region \( \tau_\alpha \) contains two additional terms [Saffman, 1992] along with the classical [Landau and Lifshitz, 1976] term \( \left[ r_{c,\alpha} \times \mathbf{P}_{\tau_\alpha} \right] \).

In expression (1.105) the first additional term characterized by components \( (\mathbf{M}_s)_i = \varepsilon_{ijk} e_{kl}^j J_i^r \) is related with the non-equilibrium shear local continuum velocity field. In expression (1.105) the second additional term characterized by components \( (\mathbf{M}_r)_i = \frac{1}{2} \left( \delta_{ij} J_{kk} - J_{ij} \right) \omega_j \) is related with the equilibrium rotational local continuum velocity field. In expression (1.105) these two additional terms do not depend on the momentum \( \mathbf{P}_{\tau_\alpha} \) of the subsystem \( \alpha \) (continuum region \( \tau_\alpha \)):

\[ \mathbf{M}_s = \sum_{i=1}^{3} (\mathbf{M}_s)_i \mathbf{\mu}_i = \sum_{i=1}^{3} \varepsilon_{ijk} e_{kl}^j J_i^r \mathbf{\mu}_i, \quad (1.106) \]

\[ \mathbf{M}_r = \sum_{i=1}^{3} (\mathbf{M}_r)_i \mathbf{\mu}_i = \sum_{i=1}^{3} \frac{1}{2} \left( \delta_{ij} J_{kk} - J_{ij} \right) \omega_j \mathbf{\mu}_i. \quad (1.107) \]

Formula (1.105) generalizes the classical expression \( \left[ r_{c,\alpha} \times \mathbf{P}_{\tau_\alpha} \right] \) in the classical statistical physics [Landau and Lifshitz, 1976]. The importance of the shear component \( \mathbf{M}_s \) (of the total macroscopic internal
angular momentum $M^c_{\tau_a} = \sum_{i=1}^{3} M^c_{\tau_a}(i)\mu_i$ is obvious for the continuum region $\tau_a$ characterized by arbitrary non-symmetric (relative to the mass center) form.

1.6.7. The conditions of the thermodynamic equilibrium for the closed thermohydrogravidynamic system (consisting of N thermohydrogravidynamic subsystems) considering in the inertial coordinate system $K'_\text{sys}$ related with the mass center $C_\text{sys}$ of the thermohydrogravidynamic system

The expression (1.98) can be rewritten in the following form [Simonenko, 2007]:

$$E_a = \frac{1}{2} m_a V_{c,a}^2 + (K_s)_a + (K_r)_a + (K_{\text{coup}})_a + U_a + \pi a = P_{\tau_a} = \frac{2m_a}{(K_s)_a + (K_r)_a + (K_{\text{coup}})_a + U_a + \pi a}$$

(1.108)

As a result, expression (1.95) can be rewritten in the following form:

$$\sum_{\alpha=1}^{N} P_{\tau_a}^2 = (K_s)_a + (K_r)_a + (K_{\text{coup}})_a + U_a + \pi a = E_{\text{tot}}.$$  

(1.109)

Taking into account the expression (1.105), the conservation law of the total angular momentum (1.96) can be rewritten in the following form [Simonenko, 2007]:

$$\sum_{\alpha=1}^{N} (R_{c,a} \times P_{\tau_a}) + M^c_{\tau_a} = M_{\text{tot}},$$

(1.110)

where the vector $M^c_{\tau_a}$ is given by the expression (1.102) for each component $M^c_{\tau_a}(i)$. To find the maximum (1.97) of the total entropy $S_{\text{tot}}$ (given by the expression (1.93)):

$$\max\{ \sum_{\alpha=1}^{N} S(E_a - \frac{1}{2} m_a V_{c,a}^2) \},$$

we follow the Lagrang’s method and consider the uncertain factors $a$ (vector) and $\beta_T$ (scalar value). The Lagrang’s function has the following form [Simonenko, 2007]:

$$L = \sum_{\alpha=1}^{N} \{ S(E_a - \frac{1}{2} m_a V_{c,a}^2) + a \cdot (R_{c,a} \times P_{\tau_a}) + M^c_{\tau_a} \} + \beta_T \left[ \frac{P_{\tau_a}^2}{2m_a} + (K_s)_a + (K_r)_a + (K_{\text{coup}})_a + U_a + \pi a \right],$$

(1.111)

where the point (·) after the vector designates the scalar product of the corresponding vectors, $S$ is some universal function of thermodynamic state.

We find the first (from the set of conditions) condition of the maximum of the Lagrang’s function (1.111) by equating to zero the derivative of $L$ on momentums $P_{\tau_a}$ (for $\alpha = 1, 2, \ldots, N$):

$$\sum_{i=1}^{N} \left\{ \frac{\partial S}{\partial P_{\tau_a}} (E_i - \frac{1}{2} m_a V_{c,i}^2) + \frac{\partial}{\partial P_{\tau_a}} (a \cdot (R_{c,i} \times P_{\tau_a}) + M^c_{\tau_a}) \right\} + \beta_T \left[ \frac{P_{\tau_i}^2}{2m_i} + (K_s)_i + (K_r)_i + (K_{\text{coup}})_i + U_i + \pi_i \right] = 0,$$

(1.112)
where the vector $\mathbf{a}$ and the scalar value $\beta_T$ will be find. Using the equality:

$$\frac{\partial}{\partial \mathbf{P}_{\tau_a}} S(E_i \cdot \frac{\mathbf{P}_{\tau_a}}{2m_i}) = -\frac{1}{T_{\alpha}} \frac{\mathbf{P}_{\tau_a}}{m_{\alpha}} = -\frac{1}{T_{\alpha}} \mathbf{V}_{c,a},$$

(1.113)

and also the identity:

$$\frac{\partial}{\partial \mathbf{P}_{\tau_a}} (\mathbf{a} \cdot [\mathbf{r}_{c,a} \times \mathbf{P}_{\tau_a}]) = [\mathbf{a} \times \mathbf{r}_{c,a}],$$

(1.114)

we get the necessary condition of maximum of the total entropy $S_{\text{tot}}$:

$$\frac{\mathbf{V}_{c,a}}{T_{\alpha}} + [\mathbf{a} \times \mathbf{r}_{c,a}] + \beta_T \frac{\mathbf{P}_{\tau_a}}{m_{\alpha}} = 0,$$

(1.115)

where $\mathbf{r}_{c,a}$ is the position-vector of the mass center of the thermodynamic subsystem $\tau_a$. We used the identity

$$\frac{\partial (\mathbf{P}_{\tau_a} \cdot \mathbf{P}_{\tau_a})}{\partial \mathbf{P}_{\tau_a}} = 2 \mathbf{P}_{\tau_a},$$

(1.116)

for deduction of expression (1.115). We obtained from expression (1.115) the following relation [Simonenko, 2007]:

$$\frac{\mathbf{V}_{c,a}}{T_{\alpha}} + [\mathbf{a} \times \mathbf{r}_{c,a}] + \beta_T \mathbf{V}_{c,a} = 0.$$

As a result, we obtained the following relation [Simonenko, 2007]:

$$\mathbf{V}_{c,a} = \left( \frac{1}{T_{\alpha}} - \beta_T \right) [\mathbf{a} \times \mathbf{r}_{c,a}].$$

Finally, we obtained the condition of the thermodynamic equilibrium [Simonenko, 2007]:

$$\mathbf{V}_{c,a} = \left( \frac{1}{T_{\alpha}} - \beta_T \right) [\mathbf{a} \times \mathbf{r}_{c,a}],$$

(1.117)

Since we consider the subsystems in the inertial coordinate system $K'_\text{sys}$ (related with the mass center $C_{\text{sys}}$ of the closed thermohydrogravidynamic system) then the speed of the translational movement of each subsystem $\tau_a$ is equally to 0 as it is obvious from the expression (1.117). If $T_{\alpha} = \text{const}$ then the condition (1.117) do not means that each subsystem $\tau_a$ rotates as a whole (as a rigid body) with the angular velocity $a / (1/T_{\alpha} - \beta_T)$ in the equilibrium state. Expression (1.117) shows only that the mass centers of all subsystems $\alpha$ (in the equilibrium state characterized by maximum of entropy $S_{\text{tot}}$) rotate as a rigid-like body.

In Subsection 1.6.8.2 we shall show that the equilibrium state of the closed thermohydrogravidynamic system is characterized by the following conditions for each subsystem $\tau_a$:

$$\left( K_s \right)_\alpha = 0, \left( K_{s,r}^{\text{coup}} \right)_\alpha = 0.$$  

(1.118)
1.6.8. The conditions of the thermodynamic equilibrium of the closed thermohydrogravidynamic system consisting of \( N \) thermohydrogravidynamic subsystem considered in the inertial coordinate system \( K \)

1.6.8.1. The condition of the thermodynamic equilibrium (of the closed thermohydrogravidynamic system) describing the relative movements of the mass centers of all subsystems

Now we consider the problem of finding of the maximal entropy \( S_{\text{tot}} \) of the thermohydrogravidynamic system in the arbitrary inertial coordinate system \( K \) not connected with the mass center \( C_{\text{sys}} \) of the thermohydrogravidynamic system. We add (in addition to the postulated conservation laws (1.109) and (1.110)) the additional conservation law of the total momentum of the thermohydrogravidynamic system. The Lagrang’s function (1.111) with the additional term \( \mathbf{c} \cdot \mathbf{P}_{\tau_a} \) [Landau and Lifshitz, 1976] (characterized by the uncertain vector \( \mathbf{c} \)) can be rewritten [Simonenko, 2007]:

\[
L = \sum_{a=1}^{N} \left\{ \frac{1}{2} m_a V_{c,a}^2 + a \cdot [r_{c,a} \times \mathbf{P}_{\tau_a}] + M_{\tau_a}^c \right\} + \beta_T \left( \frac{P_{\tau_a}^2}{2m_a} + (K_s)_a + (K_T)_a + (K_{s,coupl})_a + U_a + \Pi_a \right) + \mathbf{c} \cdot \mathbf{P}_{\tau_a}. \tag{1.119}
\]

As a result, the condition (1.115) can be rewritten in the following form [Simonenko, 2007]:

\[
\frac{V_{c,a}}{T_a} + c + [a \times r_{c,a}] + \beta_T V_{c,a} = 0, \tag{1.120}
\]

which gives the expression for the speed \( V_{c,a} \) of the mass center \( (C_a, \alpha) \) of the subsystem \( \tau_a \) [Simonenko, 2007]:

\[
V_{c,a} = \frac{1}{\left( \frac{1}{T_a} - \beta_T \right)} \left( \frac{1}{T_a} - \beta_T \right)
\]

Using the expression (1.121), we obtained [Simonenko, 2007] that the mass centers of subsystem can move as a whole in a translational motion and a rigid-like rotation only for \( T_a = \text{const} \). Consequently, the constant temperature \( T_a = \text{const} \) is the necessary but not sufficient condition of the thermodynamic equilibrium of the thermohydrogravidynamic system. If \( T_a = T = \text{const} \) then the vector value (in formula (1.121))

\[
V_c = \frac{\mathbf{c}}{\left( \frac{1}{T} - \beta_T \right)} \tag{1.122}
\]

can be considered as the speed \( V_c \) of the mass center \( C_{\text{sys}} \) of the closed thermohydrogravidynamic system

\[
\tau = \sum_{a=1}^{N} \tau_a \equiv \bigcup_{a=1}^{N} \tau_a \text{ containing the set of subsystem } \tau_a.
\]
1.6.8.2. The conditions of the thermodynamic equilibrium of the closed thermohydrogravidynamic system relative to the macroscopic non-equilibrium kinetic energies of the subsystems $T_{\alpha}$

Let us find the conditions of maximal entropy $S_{\text{tot}}$ relative to the macroscopic internal shear kinetic energies $(K_{S})_{\alpha}$ (for $\alpha = 1, 2, \ldots, N$) under conservation laws for the total momentum, the total angular momentum and the total energy of the closed thermohydrogravidynamic system. Considering the entropy $S_{\text{tot}}$ of the closed thermohydrogravidynamic system as a function of the macroscopic internal shear kinetic energies $(K_{S})_{\alpha}$ (for $\alpha = 1, 2, \ldots, N$) and by equating to zero the derivative of the Lagrang’s function $L$ (given by expression (1.119)) on $(K_{S})_{\alpha}$, we obtained the necessary condition for the maximum of the entropy $S_{\text{tot}}$ [Simonenko, 2007]:

\[
\sum_{\alpha=1}^{N} \left\{ \frac{\partial S}{\partial (K_{S})_{\alpha}} \left( E_{\alpha} - \frac{1}{2} \frac{P_{\alpha}}{m_{\alpha}} \right) + \frac{\partial}{\partial (K_{S})_{\alpha}} \left( a \cdot \left[ r_{c,\alpha} \times P_{\alpha} \right] + M_{c}^{\alpha} \right) \right\} + \\
+ \frac{\partial}{\partial (K_{S})_{\alpha}} \beta_{T} \left( \frac{P_{\tau_{\alpha}}^{2}}{2m_{\alpha}} + (K_{S})_{\alpha} + (K_{r})_{\alpha} + (K_{s,\alpha}^\text{coup}) + U_{\alpha} + \pi_{\alpha} \right) + \frac{\partial}{\partial (K_{S})_{\alpha}} \left( c \cdot P_{\alpha} \right) = 0. 
\]

(1.123)

We obtained the relation [Simonenko, 2007]:

\[
\frac{\partial}{\partial (K_{S})_{\alpha}} \left( E_{\alpha} - \frac{P_{\tau_{\alpha}}^{2}}{2m_{\alpha}} \right) = \frac{1}{T_{\alpha}}
\]

by using the postulated relation

\[
\frac{\partial S \left( E_{\alpha} - \frac{P_{\tau_{\alpha}}^{2}}{2m_{\alpha}} \right)}{\partial \left( E_{\alpha} - \frac{P_{\tau_{\alpha}}^{2}}{2m_{\alpha}} \right)} = \frac{1}{T_{\alpha}}
\]

(1.124)

for the temperature $T_{\alpha}$ in the analogous way as it was early implicitly postulated by Landau and Lifshitz [Landau and Lifshitz, 1976] in deduction of the condition (1.77). Since the momentums $P_{\tau_{\alpha}}$ and the internal angular momentums $M_{c}^{\alpha}$ do not depend explicitly from $(K_{S})_{\alpha}$ then we obtained from the condition (1.123) the following relation [Simonenko, 2007]:

\[
\frac{1}{T_{\alpha}} + \beta_{T} = 0.
\]

Consequently, we have for any subsystem $\alpha$ the following relation [Simonenko, 2007]:

\[
\beta_{T} = -\frac{1}{T_{\alpha}} = \text{const}. 
\]

(1.125)

If $T_{\alpha} = T = \text{const}$ then (using (1.125)) we obtained [Simonenko, 2007] the expression for $V_{c}$ in relation (1.122)

\[
V_{c} = \frac{c}{2} T. 
\]

(1.126)

We obtained then (in relation (1.121)) the expression for the angular velocity $\Omega$ of rotation of the mass center of each subsystem $\alpha$ [Simonenko, 2007]:

\[
\Omega = \frac{a T}{2}. 
\]

(1.127)

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We see that the angular velocities of rotation of the mass center of each subsystem $\alpha$ are equal in the state of thermodynamic equilibrium. Thus, we obtained [Simonenko, 2007] from the condition (1.123) the expression $\beta_T = -\frac{1}{T_\alpha} = -\frac{1}{T}$ (given by (1.125)) in relation (1.121) for the speeds $V_{c,\alpha}$ of the mass centers of all subsystems. It is clear that the coefficient $\beta_T$ must have the same physical dimension as the physical dimension of the value $\frac{1}{T_\alpha}$. However, the determination $\beta_T$ by equating to zero of the derivative of the Lagrangian function $L$ (determined by expression (1.123)) on $T_\beta$ do not elucidate the question relative to the values of $(K_s)_\alpha$, which give the maximal value of the entropy $S_{tot}$. We obtained [Simonenko, 2007] the constants $a$ and $c$ (for $T_\alpha = T = \text{const}$):

$$a = \frac{2\Omega}{T}, \quad c = \frac{2V_c}{T}$$

(1.128)

and showed that the mass centers of all subsystems (see the expression (1.121)) rotate as a whole in the rigid-like rotational continuum motion. The value $\beta_T$ must be constant for all subsystems in the state of thermodynamic equilibrium. Consequently, from relation (1.125) we concluded that $\beta_T = -\frac{1}{T}$ in the state of thermodynamic equilibrium in which the temperature of all subsystems are equal: $T_\alpha = T$.

We have shown above that the condition of maximal entropy at the state of thermodynamic equilibrium gives that the mass center of each subsystem rotate on the circular trajectory characterized by the corresponding fix distance from the axis of rotation $\Omega$. Let us analyze the question relative to the values of the macroscopic internal shear kinetic energies $(K_s)_\alpha$ and $(K_{s,\tau})_\alpha$ defining the state of the thermodynamic equilibrium of each subsystem $\alpha$. Using the condition (1.27) of local thermodynamic equilibrium and the definitions (1.11) and (1.12), respectively, for the macroscopic internal shear kinetic energy $K_s$ of the continuum region $\tau$ and the macroscopic kinetic energy of shear-rotational coupling $K_{s,\tau}^{\text{coup}}$, we obtained [Simonenko, 2007] that the subsystems $\alpha$ ($\alpha = 1, 2, ..., N$) have the non-equilibrium macroscopic internal shear kinetic energies $(K_s)_\alpha = 0$ and the non-equilibrium macroscopic internal kinetic energies of shear-rotational coupling $(K_{s,\tau}^{\text{coup}})_\alpha = 0$ in the state of thermodynamic equilibrium characterized by the conditions (1.118).

It means that the all composite parts of each subsystem rotate in a rigid-like motion in the state of thermodynamic equilibrium. Since the vector $\Omega$ is fixed for the total thermohydrogravidynamic system then the projection of the vector $r_{c,\alpha}$ (on the direction perpendicular to $\Omega$) is constant. We showed [Simonenko, 2007] that the rigid-like rotation (of the closed thermohydrogravidynamic system) is the state of thermodynamic equilibrium characterized by the maximal entropy under the imposed conservation laws for the total energy, the total momentum and the total angular momentum of the thermohydrogravidynamic system. We concluded [Simonenko, 2007] that the planets of the Solar System cannot rotate ideally (with constant angular velocities of internal rotation) owing to the external (cosmic) disturbing energy gravitational influences (acting on the planets of the Solar System).

1.7. Generalized Le Chatelier-Braun’s principle for rotational thermohydrogravidynamic systems characterized by the shear-rotational states

Following the “Thermohydrogravidynamics of the Solar System” [Simonenko, 2007], in Subsection 1.7 we present the generalization of the Le Chatelier – Braun principle [Landau and Lifshitz, 1976] on the closed rotational thermohydrogravidynamic systems ($\tau + \overline{\tau}$) consisting of two subsystems $\tau$ and $\overline{\tau}$. The
Le Chatelier-Braun’s principle (for induced small deviations of the subsystem $\tau$ from the state of the thermodynamic equilibrium) is formulated [Landau and Lifshitz, 1976; p. 84] as follows. The external action (disturbing the body from the state of thermodynamic equilibrium) stimulates the processes, which tend to diminish the results of this disturbing action [Landau and Lifshitz, 1976; p. 84].

Let us consider the closed rotating thermodynamic system ($\tau + \overline{\tau}$) consisting of the unclosed individual macroscopic continuum region $\tau$ (the subsystem in the viscous compressible continuum, which can be the focal region of earthquakes) and some large subsystem $\overline{\tau}$ complementing the subsystem $\tau$ to obtain the closed thermodynamic system ($\tau + \overline{\tau}$). Let $S$ be the total entropy of the thermodynamic system, $y$ is the same quantity determining the state of the subsystem $\tau$, such as that the condition of maximal entropy $S$ relative to $y$:

$$\frac{\partial S}{\partial y} = 0$$  \hspace{1cm} (1.129)

indicates that the subsystem $\tau$ is in the state of the partial thermodynamic equilibrium. Under such condition, the subsystem $\tau$ is not necessary in the thermodynamic equilibrium with the surrounding subsystem $\overline{\tau}$. We, obviously, consider here the partial (internal) thermodynamic equilibrium of the subsystem $\tau$ located in the closed thermodynamic system ($\tau + \overline{\tau}$).

Let $x$ be the second thermodynamic variable (describing the subsystem $\tau$) such as that if we have also the condition:

$$\frac{\partial S}{\partial x} = 0$$  \hspace{1cm} (1.130)

at the same time with the condition (1.129) then it means that the subsystem $\tau$ is not only in the internal (partial) thermodynamic equilibrium, but the subsystem $\tau$ is also in the thermodynamic equilibrium with the surrounding subsystem $\overline{\tau}$.

We assume that the total energies $E_{\tau}$ and $E_{\overline{\tau}}$ of the macroscopic subsystems $\tau$ and $\overline{\tau}$, respectively, can be expressed by the following relations [Simonenko, 2007]:

$$E_{\tau} = K_{\tau} + U_{\tau} + \pi_{\tau} = (K_{p})_{\tau} + (K_{s})_{\tau} + (K_{sc})_{\tau} + (K_{res})_{\tau} + U_{\tau} + \pi_{\tau}, \hspace{1cm} (1.131)$$

$$E_{\overline{\tau}} = K_{\overline{\tau}} + U_{\overline{\tau}} + \pi_{\overline{\tau}} = (K_{p})_{\overline{\tau}} + (K_{s})_{\overline{\tau}} + (K_{sc})_{\overline{\tau}} + (K_{res})_{\overline{\tau}} + U_{\overline{\tau}} + \pi_{\overline{\tau}}. \hspace{1cm} (1.132)$$

in accordance with the generalized formulation (1.43) of the first law of thermodynamics and in accordance with the generalized formula (1.6) for the macroscopic kinetic energy of the small continuum regions: the subsystems $\tau$ and $\overline{\tau}$.

The definitions of all terms corresponding to subsystem $\tau$ in formula (1.131) are given in Subsection 1.2. The definitions of all terms corresponding to the subsystem $\overline{\tau}$ in formula (1.132) are analogous.

Let us consider the angular momentum $M_{\tau}$ of the macroscopic continuum region $\tau$ as the variable $y$. We designate the angular momentum of the subsystem $\overline{\tau}$ by the symbol $M_{\overline{\tau}}$. Considering the total entropy of the closed system ($\tau + \overline{\tau}$) (containing the subsystems $\tau$ and $\overline{\tau}$):

$$S = S_{\tau}(M_{\tau}, E_{\tau}) + S_{\overline{\tau}}(M_{\overline{\tau}}, E_{\overline{\tau}})$$

and supposing that the total angular momentum $M$ of the closed system ($\tau + \overline{\tau}$) is constant:

$$M = M_{\tau} + M_{\overline{\tau}} = \text{const},$$

we obtained [simonenko, 2007] that the condition (1.129) gives the relation:

$$\frac{\partial S}{\partial M_{\tau}} = \frac{\partial S_{\tau}}{\partial M_{\tau}} + \frac{\partial S_{\overline{\tau}}}{\partial M_{\tau}} = \frac{\partial S_{\tau}}{\partial M_{\tau}} - \frac{\partial S_{\overline{\tau}}}{\partial M_{\overline{\tau}}} = 0,$$

from which we obtained [simonenko, 2007] the condition:

$$\frac{\Omega_{\tau}}{T_{\tau}} = \frac{\Omega_{\overline{\tau}}}{T_{\overline{\tau}}}$$  \hspace{1cm} (1.133)

as a consequence of the formula [Landau and Lifshitz, 1976; p. 51, 93]:

$$\frac{\partial S}{\partial M} = \frac{\partial S}{\partial E} \left( \frac{\partial E}{\partial M} \right)_{S} = \frac{1}{T} \Omega.$$
According to the previous results of Subsection 1.6, the temperature $T_\tau$ of the subsystem $\tau$ and the temperature $T_\tau'$ of the surrounding subsystem $\overline{\tau}$ are equal ($T_\tau = T_\tau'$) in the state of thermodynamic equilibrium. Then we have from relation (1.133) the equality of the angular velocity $\Omega_\tau$ of rotation of the subsystem $\tau$ and the angular velocity $\Omega_\tau'$ of rotation of the surrounding subsystem $\overline{\tau}$ for $T_\tau = T_\tau'$ in accordance with the results of Subsection 1.6. Thus, the condition (1.129) means for $y = M_\tau$ that the angular velocities of rotation $\Omega_\tau$ and $\Omega_\tau'$ are equal ($\Omega_\tau = \Omega_\tau'$) for the subsystem $\tau$ and for the surrounding subsystem $\overline{\tau}$. This is the partial condition of the thermodynamic equilibrium for the subsystem $\tau$.

Let us consider the macroscopic internal shear kinetic energy $\left[ \text{Simonenko, 2004} \right]$ of the macroscopic continuum region $\tau$ as the variable. Considering the condition (1.130) of equilibrium for $x = (K_\tau)_\tau$:

$$\frac{\partial S}{\partial (K_\tau)_\tau} = 0$$

(1.134)

and assuming that the total energy of the closed thermodynamic system is constant:

$$E_\tau + E_{\overline{\tau}} = \text{const}_E,$$

we obtained [Simonenko, 2007] the following condition:

$$\frac{\partial S}{\partial (K_\tau)_\tau} = \frac{\partial E_\tau}{\partial (K_\tau)_\tau} - \frac{\partial S_{\overline{\tau}}}{\partial (K_\tau)_\tau} = 0,$$

(1.135)

from which we derived the following condition [Simonenko, 2007]:

$$\frac{1}{T_\tau} = \frac{1}{T_{\overline{\tau}}},$$

(1.136)

as a consequence of formula [Landau and Lifshitz, 1976; p. 93 and p. 51]:

$$\frac{\partial S}{\partial E} = \frac{1}{T}$$

and relation

$$\frac{\partial E_\tau}{\partial (K_\tau)_\tau} = \frac{\partial E_{\overline{\tau}}}{\partial (K_\tau)_\tau} = 1.$$

From relation (1.136) we obtained [Simonenko, 2007] that the temperature $T_\tau$ of the macroscopic region $\tau$ is equal to the temperature $T_{\overline{\tau}}$ of the surrounding subsystem $\overline{\tau}$. It is the partial condition of the thermodynamic equilibrium. The choice of the variable $x = (K_\tau)_\tau$ is made to show that the energy $(K_\tau)_\tau$ is the physically significant variable. We also showed [Simonenko, 2007] that the total energies of the subsystems $\tau$ and $\overline{\tau}$ may be calculated by using the formulae (1.131) and (1.132). In Section 3 it will be used. Thus, the conditions (1.129) and (1.130) denote that the subsystem $\tau$ is characterized by the internal thermodynamic equilibrium (the rigid-like rotation at constant temperature) and simultaneously the subsystem $\tau$ is characterized by the thermodynamic equilibrium with the surrounding environment (medium) having the same temperature and rotating with the same angular velocity of rotation. Thus, we evaluated [Simonenko, 2007] the physical significance of the thermodynamic parameters (variables) $y = M_\tau$ and $x = (K_\tau)_\tau$ for the subsystem $\tau$. The consideration of these variables results to the classical conditions [Landau and Lifshitz, 1976] of the thermodynamic equilibrium for the rotating body. This gives the basis to consider the generalized thermodynamic forces (acting on the subsystem $\tau$):

$$F_x = \frac{\partial S}{\partial x} = \frac{\partial S}{\partial (K_\tau)_\tau},$$

(1.137)

$$F_y \equiv F_{y_\tau} = \frac{\partial S}{\partial y} = \frac{\partial S}{\partial (M_\tau)_\tau}.$$  

(1.138)

We considered [Simonenko, 2007] the conditions of the thermodynamic equilibrium [de Groot and Mazur, 1962; Prigogine, 1977] of the subsystem $\tau$:  

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which are equivalent to conditions (1.129) and (1.130). The conditions (1.139) and (1.140) of the thermodynamic equilibrium denote [Prigogine, 1977] the following condition for the first differential $dS$:

$$dS = \frac{\partial S}{\partial x} dx + \frac{\partial S}{\partial y} dy = 0$$

for the state of the thermodynamic equilibrium of the closed thermodynamic system. Decomposing the change of the entropy $S$ of the total thermodynamic system relative to the value $S_0$ of the entropy in the equilibrium state [Prigogine, 1977]:

$$S - S_0 \approx dS + \frac{1}{2} d^2S,$$

we obtained [Simonenko, 2007] (taking into account that $dS = 0$ in the state of the thermodynamic equilibrium) the negative sign of the second differential $d^2S$, i.e. $d^2S < 0$. We obtained [Simonenko, 2007] the conditions:

$$\frac{\partial^2 S}{\partial x^2} = \left( \frac{\partial F_x}{\partial x} \right)_y < 0,$$

$$\left( \frac{\partial F_x}{\partial x} \right)_y \left( \frac{\partial F_y}{\partial y} \right)_x - \left( \frac{\partial F_y}{\partial y} \right)_x \left( \frac{\partial F_x}{\partial x} \right)_y \equiv \frac{\partial^2 S}{\partial x^2} \frac{\partial^2 S}{\partial y^2} - \left( \frac{\partial^2 S}{\partial x \partial y} \right)^2 > 0$$

in addition to conditions (1.139) and (1.140) as a consequence of the negative sign ($d^2S < 0$) of the second differential $d^2S$ of entropy $S$.

We also obtained [Simonenko, 2007] the necessary condition:

$$\frac{\partial^2 S}{\partial y^2} = \left( \frac{\partial F_y}{\partial y} \right)_x < 0$$

from conditions (1.142) and (1.143).

It is well known that the state of the thermodynamic equilibrium of the closed thermodynamic system is stable [Prigogine, 1977]. Consequently, the subsystem $\tau$ of the closed equilibrium thermodynamic system cannot obtain the macroscopic internal shear kinetic energy $K_\tau$ by action of the surroundings (the ambient environment $K$) of the subsystem $\tau$. It is clear that we can create the condition $(K_\tau) > 0$ only by action on the subsystem $\tau$ of the external (for the closed system) force (for example, the external force of gravitation). Considering the Le Chatelier-Braun’s principle, Landau and Lifshitz [Landau and Lifshitz, 1976] supposed also the availability the external action disturbing the thermodynamic equilibrium of the continuum region $\tau$ with the ambient environment $(K)$ in the closed thermodynamic system.

We showed [Simonenko, 2007] that the transient external influence on the subsystem $\tau$ (related with the added macroscopic internal shear kinetic energy $(K_\tau) > 0$ to the subsystem $\tau$ during this influence) can decrease the entropy $S$ of the total system up to some quantity $S_{\tau}^0$, which is less than the value $S_0$ in the equilibrium state (in accordance with the Reif’s understanding [Reif, 1977] of the mechanism of decreasing of the entropy of the body as the result of interaction with external bodies). We showed [Simonenko, 2007] then that the entropy $S$ of the thermodynamic system is increased after the relaxation processes in closed system, but do not reach the value $S_0$ in the initial equilibrium state. The entropy $S$ is less than $S_0$ as a result of the relaxation processes diminishing the result of the external action on the subsystem $\tau$.

The external influence on the subsystem $\tau$ disturbs the thermodynamic equilibrium of the subsystem $\tau$ with the surrounding subsystem $K$ by means of the added macroscopic internal shear kinetic energy $(K_\tau) > 0$ and the subsequent violation of the condition (1.139) of thermodynamic equilibrium denoting (as a consequence of condition (1.136)) the equality of temperature $T_\tau$ of the subsystem $\tau$ and the temperature $T_K$ of the surrounding environment (medium) $K$ of the closed thermodynamic system. Really, the
deformation of the subsystem $\tau$ is related with the increase $(K_s)_\tau$, relative to the zero equilibrium value. It develops the relaxation processes in the subsystem $\tau$ related with dissipation of the energy $(K_s)_\tau$ to heat and corresponding heating of the subsystem $\tau$ as a result of shear and volume molecular viscosity in the considered continuum. This results to the violation of the condition (1.139). Some amount of energy $(K_s)_\tau$ converts to the radiation of seismic acoustic waves.

Following to the formal scheme [Landau and Lifshitz, 1976] of presentation of the Le Chatelier-Braun’s principle, we assumed [Simonenko, 2007] that some projection $y \equiv y_i = (M_i)_i$ (the projection of the vector $M_i$ on the axis $x_i$ of the Cartesian coordinate system $K$) do not change immediately as a result of the sharp change $(K_s)_\tau > 0$ relative to the equilibrium zero value. Such spontaneous influence $(K_s)_\tau > 0$, as shown above, is not possible in equilibrium thermodynamic fluid system since the liquid deforms under the weak stress forces. It is possible for the solid Earth’s crust of the lithosphere as a result of transformation of the accumulated potential energy [Abramov, 1997] of elastic compression and deformation to the macroscopic internal shear kinetic energy $(K_s)_\tau$. The gravitational influence of the system Sun-Earth-Moon is considered [Abramov, 1997] as the trigger mechanism of discharge (of the accumulated potential energy) in the focal regions of earthquakes. The last term in the right of the generalized differential formulation (1.43) of the first law of thermodynamics express the total influence (on the macroscopic volume $\tau$) of the non-stationary (time-dependent) gravitational field induced by planets (and satellites) of the Solar System, the Sun, Moon, the midget planets, known asteroids and comets of the Solar System. The last term in the right-hand side of the generalized differential formulation (1.43) describes, obviously, the mechanism of the energy gravitational influence on the earthquake focal region. In Section 3 we shall present the foundation of the significance of the energy gravitational influences of the Moon, the Sun, the Venus, the Jupiter and the Mercury as the cosmic trigger mechanism of discharge in the focal regions of earthquakes.

Following to the formal scheme [Simonenko, 2007], let $\Delta x = \Delta(K_s)_\tau \equiv (K_s)_\tau$ be the change of the macroscopic internal shear kinetic energy relative to zero equilibrium value for the momentary action on the subsystem $\tau$. The change $\Delta F_x$ of the magnitude of the generalized thermodynamic force $F_x$ (as a result of the external action on the subsystem $\tau$) is equal (under condition $y \equiv y_i = (M_i)_i = \text{const}$) [Simonenko, 2007]:

$$\langle \Delta E \rangle_x = \left( \frac{\partial F_x}{\partial x} \right)_y \Delta x = \left( \frac{\partial F_x}{\partial x} \right)_y (K_s)_\tau. \quad (1.145)$$

The change of the value $x = (K_s)_\tau$ after the action on the subsystem $\tau$ leads to the violation of the condition of thermodynamic equilibrium (1.140), corresponding to equality (1.133), since the temperature $T_\tau$ is increased in the subsystem $\tau$ (as a result of dissipation of the macroscopic internal shear kinetic energy $(K_s)_\tau$) and the angular velocity of rotation $\Omega_\tau$ of the subsystem $\tau$ is changed in accordance with the generalized differential formulation (1.43) of the first law of thermodynamics. The generalized thermodynamic force $F_x \equiv \Delta F_x$ will have the following value [Simonenko, 2007]:

$$(F_x)_{F_x=0} = \left( \frac{\partial F_x}{\partial x} \right)_{F_x=0} \Delta x \quad (1.146)$$

after the time moment of attainment of the condition $F_y = 0$ of internal equilibrium in the subsystem $\tau$ (and the satisfaction of the conditions (1.133) and (1.136) as a result of the outflow of heat from subsystem $\tau$ and the attainment of equality of the angular velocity $\Omega_\tau$ of rotation of the subsystem $\tau$ and the angular velocity $\Omega_\tau$ of rotation of the surrounding subsystem $\overline{\tau}$ (as a result of radiation of the seismic acoustic waves from the subsystem $\tau$ and its surroundings). Here the derivative is taken for the constant value $F_y = 0$.

We compared [Simonenko, 2007] the changes of the magnitude of the generalized thermodynamic forces $(\Delta F_x)_y$ and $(\Delta F_x)_{F_x=0}$, given by the expressions (1.145) and (1.146), respectively. Using the results [Landau and Lifshitz, 1976], we obtained [Simonenko, 2007]:
\[
\left( \frac{\partial F_x}{\partial x} \right)_{F_y=0} = \frac{\partial F_x}{\partial x} = \frac{\partial (F_x, F_y)}{\partial x} = \frac{\partial F_x}{\partial x} = \frac{\partial F_x}{\partial x} = \frac{\partial (F_x, F_y)}{\partial x}.
\]

(1.147)

Taking into account the inequality (1.143) and also the negative sign (according to inequality (1.144)) of the denominator in the second term of (1.147), we obtained [Simonenko, 2007] the condition:

\[
\left( \frac{\partial F_x}{\partial x} \right)_y \left( \frac{\partial F_x}{\partial x} \right)_y < 0.
\]

(1.148)

or

\[
\left( \Delta F_X \right)_y < \left( \Delta F_X \right)_{F_y=0}.
\]

(1.149)

We obtained [Simonenko, 2007] from expressions (1.142) and (1.145):

\[
\left( \Delta F_X \right)_y = \left( \frac{\partial F_x}{\partial x} \right)_y \Delta x = \frac{\partial^2 S}{\partial x^2} \Delta x = \frac{\partial^2 S}{\partial (K_s)_{\tau}^2} (K_s)_{\tau} < 0,
\]

(1.150)

\[
\left( \Delta F_X \right)_{F_y=0} = \left( \frac{\partial^2 S}{\partial x^2} \right)_{F_y=0} \Delta x > \left( \Delta F_X \right)_y < 0.
\]

(1.151)

We showed [Simonenko, 2007] that \((F_x)_{F_y=0} < 0\). Taking into account the expressions of the second differentials of entropy:

\[
d^2S|_y = \frac{1}{2} \left( \frac{\partial^2 S}{\partial x^2} \right)_y (\Delta x)^2 = \frac{1}{2} \frac{\partial^2 S}{\partial (K_s)_{\tau}^2} (K_s)_{\tau}^2,
\]

\[
d^2S|_{F_y=0} = \frac{1}{2} \left( \frac{\partial^2 S}{\partial x^2} \right)_{F_y=0} (\Delta x)^2.
\]

for constant \(y\) and \(F_Y = 0\), respectively, and also the inequality (1.149) and condition \(d^2S < 0\), we obtained [Simonenko, 2007] that relations (1.150) and (1.151) give the inequality [Simonenko, 2007]:

\[
d^2S|_y < d^2S|_{F_y=0} < 0,
\]

(1.152)

from which follows that \((F_x)_{F_y=0} < 0\). Thus, the external deformational influence on the subsystem \(\tau\) (in the form of the added macroscopic internal shear kinetic energy \((K_s)_{\tau}\) creating the condition \(d^2S|_y < 0\) stimulates the relaxation processes in the subsystem \(\tau\), which give the attainment of the inequality (1.152). We see that the relaxation processes attenuate the decrease of entropy of the thermodynamic system as a result of the added macroscopic internal shear kinetic energy \((K_s)_{\tau}\) to the subsystem \(\tau\). Taking into account that the generalized thermodynamic forces \((F_x)_y\) and \((F_x)_{F_y=0}\) are negative in inequalities (1.150) and (1.151), the inequality (1.149) can be rewritten as the following inequality [Simonenko, 2007]:

\[
\left| \Delta F_X \right)_y > \left| \Delta F_X \right)_{F_y=0}\n\]

(1.153)

which presents the content of the stated [Landau and Lifshitz, 1976] above the Le Chatelier-Braun’s principle for induced small deviations of the subsystem \(\tau\) (located in the surrounding environment \(\bar{\mathcal{S}}\) composing with the subsystem \(\tau\) the closed thermodynamic system) from the state of thermodynamic equilibrium. Using the inequality (1.152), we obtained [Simonenko, 2007]

\[
S|_{F_y=0} = S_o + \frac{1}{2} d^2S|_{F_y=0} > S|_y = S_o + \frac{1}{2} d^2S|_y,
\]

(1.154)

i.e. the entropy \(S|_{F_y=0}\) is increased in compared to the entropy \(S|_y\) (related with the added macroscopic internal shear kinetic energy \((K_s)_{\tau} > 0\) to the subsystem \(\tau\) ) after completion of the relaxation processes in the thermodynamic system. However, the entropy of the thermodynamic system (after completion of the
relaxation processes) do not attain the value $S_0$ corresponding to the initial equilibrium state but it is less than $S_0$. We obtained [Simonenko, 2007] the increase of entropy $\Delta S = S|_{F_y=0} - S_y > 0$ in the thermodynamic system as a result of irreversible processes relaxing the deformational influence (related with the added macroscopic internal shear kinetic energy $(K_S)_i > 0$ to the subsystem $\tau$) on the subsystem $\tau$.

Thus, we have shown that the macroscopic internal shear kinetic energy $(K_S)_i$ and the angular momentum $\mathbf{M}_i$ (of the macroscopic continuum region $\tau$) can be considered as the thermodynamic variables ($x$ and $y$) describing the state of the macroscopic continuum region $\tau$ (the subsystem $\tau$ located in the closed thermodynamic system). We established [Simonenko, 2007] that the entropy $S$ of the thermodynamic system is reduced up to the same value $S|_{F_y=0}$ (which is less than the value $S_0$ characterized the equilibrium state of the thermodynamic system) as a result of the external momentary deformational influence (especially, induced by cosmic gravitation) on subsystem $\tau$ related with the added macroscopic internal shear kinetic energy $(K_S)_i$, when the some component $\mathbf{y} \equiv y_i = (\mathbf{M}_i)_i$ of the angular momentum $\mathbf{M}_\tau$ do not change directly as a result of sharp change $(K_S)_i > 0$ relative to the equilibrium zero value. Generalizing the Le Chatelier-Braun’s principle on the rotational thermodynamic systems, we showed [Simonenko, 2007] that the total entropy of the closed thermodynamic system is increased up to the value $S|_{F_y=0}$, which is less than the value $S_0$ and is larger than the value $S_\tau$ ($S_\tau > S|_{F_y=0} > S|_{F_y=0}$) as a result of irreversible relaxation processes in the thermodynamic system diminishing the result of the deformation influence on the subsystem $\tau$ related with the added macroscopic internal shear kinetic energy $(K_S)_i > 0$ to the subsystem $\tau$.

1.8. The non-equilibrium statistical thermohydrogravidynamics of turbulent plasma subjected to the non-stationary gravitational and electromagnetic fields

Based on the founded Non-equilibrium Statistical Thermohydrodynamics of Turbulence [Simonenko, 2004; 2006] and the Thermohydrogravidynamics of the Solar System [Simonenko, 2007; 2008; 2009; 2010] it was deduced (in 2011) the subsequent generalization of the first law of thermodynamics (for moving rotating deformed compressible heat-conducting stratified individual macroscopic region $\tau$ of turbulent electromagnetic plasma subjected to the non-stationary Newtonian gravity and the non-stationary electromagnetic field):

$$P(t)dt + dU_\tau + dK_\tau + d\pi_\tau + dE_{c,m,\tau} + \delta F_{e,m} = \delta Q_{e,m} + \delta Q + da_{np} + dG + c^2 dm_\tau$$

(1.155)

extending the established generalized differential formulation (1.50) by taking into account the infinitesimal change $dU_\tau$ of the internal energy $U_\tau$ of turbulent plasma without the emitted fast neutrons in the individual region $\tau$, the increment $dK_\tau$ of the macroscopic kinetic energy $K_\tau$ of turbulent plasma in the individual region $\tau$, and the following additional terms: the useful energy production $P(t)dt$ of fast neutrons (emitted during time interval $dt$ due to the thermonuclear reaction between two nuclei of deuterium or between nuclei of deuterium and tritium in a high temperature plasma) characterized by the positive released energy power $P(t)$ (which should be directed from the individual region $\tau$ to sustain the controlled thermonuclear process), the differential change $dE_{c,m,\tau}$ of electromagnetic energy $E_{c,m,\tau}$ inside the individual region $\tau$ of plasma, the energy flux $\delta F_{e,m}$ of electromagnetic energy radiated across the boundary surface $\partial \tau$ of the individual region $\tau$, the differential heating $\delta Q_{e,m}$ due to the differential work of electrodynamic forces (resulted to the Joule heating owing to the plasma current) and due to the dissipated electromagnetic waves inside the individual region $\tau$, and the differential amount of energy $c^2 dm_\tau > 0$ released (as a consequence of the thermonuclear burning mechanism proposed by Dr. Hans Bethe in 1939 for the Sun) due to the thermonuclear reaction related to the conversion of the differential amount of mass.
(a small difference between the initial and final reactive components of the thermonuclear reaction inside the individual region $\tau$) into energy. The problem of the controlled thermonuclear reactions (analyzed by Academician P.L. Kapitza in 1978 in his Nobel Lecture [Kapitza, 1978]) has not yet been solved by the world national and international research centers. It is clear that the general generalized differential formulation (1.155) represents the thermodynamic key for the final solution of this problem. The general generalized differential formulation (1.155) of the first law of thermodynamics is deduced to describe the combined thermohydrogravielectromagnetic dynamics of the controlled thermonuclear reactions inside the individual region $\tau$ of turbulent electromagnetic plasma subjected to the non-stationary Newtonian gravity and the non-stationary electromagnetic field. In particular, the reduced differential formulation

$$dE_{e.m.,\tau} = \delta A_p = -pdV_t$$

(1.156)

(with zero others terms in formulation (1.155)) leads to the Stefan-Boltzman law

$$E_{e.m.,\tau} / V_t \sim T^4$$

(1.157)

and to the classical [Landau and Lifshitz, Statistical Physics, 1976] relation

$$pV_t^{4/3} = \text{const}$$

(1.158)

for the adiabatic process related with the equilibrium electromagnetic black-body radiation (the gas of photons) contained in the individual region $\tau$ characterized by the volume $V_t$. It is clear without any doubt that the sustainable controlled thermonuclear reactions can be realized under the reliable controlled synchronization of the different differential terms in the general generalized formulation (1.155), which takes into account the combined thermohydrogravielectromagnetic dynamics related with the sustainable thermonuclear process characterized by the useful energy power $P(t) > 0$ released from the individual region $\tau$ of turbulent electromagnetic plasma subjected to thermonuclear reaction.

The generalized formulation (1.155) of the first law of thermodynamics (for moving rotating deformed compressible heat-conducting stratified individual macroscopic region $\tau$ of turbulent electromagnetic plasma subjected to the non-stationary Newtonian gravity and the non-stationary electromagnetic field) can be used by the young scientists and researchers of the world (“Benedictio Domini sit vobiscum”) for the urgent nearest practical realization of the controlled thermonuclear reactions to enhance the energy power of humankind before the forthcoming range 2020÷2061AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century during the past 696÷708 years of the history of humankind.
2. THE COSMIC GEOLOGY

2.1. The total energy and the total angular momentum of the Solar System

Following the works [Simonenko, 2007a; 2007; 2008; 2009; 2010], we present the fundamentals of the cosmic geology. We consider the Solar System as the unclosed non-equilibrium thermodynamic system by taking into account the influences of the external (cosmic) gravitational field of our Galaxy. We consider the planets of the Solar System as unclosed non-equilibrium thermodynamic systems subjected to the gravitational influences of the Solar System and the external (cosmic) gravitational field of our Galaxy. The gravitational influences of the Solar System and the external (cosmic) gravitational field of our Galaxy deform the lithosphere of the Earth and displace the tectonic geo-blocks disturbing the Earth’s continuum near the ideal rigid-like rotational state of the thermodynamic equilibrium.

We deduced [Simonenko, 2007; 2008; 2009; 2010] the expressions for the total energy and the total angular momentum of the Solar System. The position-vector $\mathbf{r}_{c,\alpha}$ of the mass center of the planet $\tau_\alpha$ is given by the following expression [Simonenko, 2007; 2008; 2009; 2010]:

$$
\mathbf{r}_{c,\alpha} = \frac{1}{m_{\tau_\alpha}} \iiint_{\tau_\alpha} \rho \, dV = \frac{\tau_\alpha}{\iiint_{\tau_\alpha} \rho \, dV}. 
$$

(2.1)

The speed of the mass center $\mathbf{V}_{c,\alpha}$ of the planet $\tau_\alpha$ (characterized by mass $m_{\tau_\alpha}$) is given by the following expression [Simonenko, 2007; 2008; 2009; 2010]:

$$
\mathbf{V}_{c,\alpha} = \frac{\tau_\alpha}{m_{\tau_\alpha}}. 
$$

(2.2)

The macroscopic kinetic energy of the planet $\tau_\alpha$ is given by the following expression [Simonenko, 2007; 2008; 2009; 2010]:

$$
K_{\tau_\alpha} = \iiint_{\tau_\alpha} \frac{\mathbf{v}^2}{2} \, dV.
$$

(2.3)

The hydrodynamic continuum velocity in the vicinity of the position-vector $\mathbf{r}_{c,\alpha}$ of the mass center $\mathbf{C}_{\alpha}$ of the planet $\tau_\alpha$ is given by the Taylor series expansion [Simonenko, 2004; 2006; 2007; 2008; 2009; 2010]:

$$
\mathbf{v} (\mathbf{r}_{c,\alpha} + \delta \mathbf{r}) = \mathbf{v} (\mathbf{r}_{c,\alpha}) + \omega (\mathbf{r}_{c,\alpha}) \times \delta \mathbf{r} + \sum_{i,j=1}^{3} \epsilon_{ij} (\mathbf{r}_{c,\alpha}) \delta r_j \, \mathbf{\mu}_i + 
$$

$$
+ \frac{1}{2} \sum_{i,j,k=1}^{3} \frac{\partial^2 v_i (\mathbf{r}_{c,\alpha})}{\partial x_j \partial x_k} \delta r_j \delta r_k \, \mathbf{\mu}_i + \mathbf{v}_{\alpha,\text{res}},
$$

(2.4)

where

$$
\delta \mathbf{r} \equiv \mathbf{r} - \mathbf{r}_{c,\alpha} \equiv (\delta r_1, \delta r_2, \delta r_3) \equiv (x_1, x_2, x_3);
$$

$$
\omega (\mathbf{r}_{c,\alpha}) \equiv \frac{1}{2} [\nabla \times \mathbf{v} (\mathbf{r})] \equiv (\omega_{\alpha,1}, \omega_{\alpha,2}, \omega_{\alpha,3})
$$

is the angular velocity vector of rotation of the planet $\tau_\alpha$;

$$
\epsilon_{ij} (\mathbf{r}_{c,\alpha}) = \frac{1}{2} \left( \frac{\partial v_i (\mathbf{r})}{\partial x_j} + \frac{\partial v_j (\mathbf{r})}{\partial x_i} \right)
$$

is the rate of strain tensor at the position-vector $\mathbf{r}_{c,\alpha}$ of the mass center $\mathbf{C}_{\alpha}$ of the planet $\tau_\alpha$. 

\[ v_{\tau_\alpha, \text{res}} = \sum_{i=1}^{3} w_{\alpha,i} \mu_i \] is the residual part of the Taylor series expansion (2.4) for the planet \( \tau_\alpha; \)

\[ w_{\alpha,i} = O(d_{\tau_\alpha}^3), \quad (i = 1, 2, 3); \]

\[ d_{\tau_\alpha} = \sup_{A,B \in \partial_{\tau_\alpha}} \sqrt{(r(A, B))^2} \]

is the diameter of the planet \( \tau_\alpha, \) \( \partial_{\tau_\alpha} \) is the boundary surface of the planet’s \( \tau_\alpha \) continuum.

The macroscopic kinetic energy of the planet \( \tau_\alpha \) (considered as the macroscopic continuum region \( \tau_\alpha \)) characterized by practically constant values of the angular velocity vector \( \omega (r_{c,\alpha}) \) and the rate of strain tensor \( e_{ij}(r_{c,\alpha}) \) for the continuum region \( \tau_\alpha \) is given by the following expression [Simonenko, 2004; 2005; 2006; 2007; 2008]:

\[
K_{\tau_\alpha} = (K_l)_{\tau_\alpha} + (K_r)_{\tau_\alpha} + (K_s)_{\tau_\alpha} + (K_{s,r})_{\tau_\alpha} + (K_{\text{res}})_{\tau_\alpha} = \frac{1}{2} m_V V_c^2 + \frac{1}{2} \sum_{i,k=1}^{3} l_{ik}(C_\alpha) \omega_i (r_{c,\alpha}) \omega_k (r_{c,\alpha}) + \frac{1}{2} \sum_{i,j,k=1}^{3} j_{jk}(C_\alpha) e_{ij}(r_{c,\alpha}) e_{ik}(r_{c,\alpha}) + \sum_{i,j,k,m=1}^{3} e_{ijk} J_{jm}(C_\alpha) \omega_i (r_{c,\alpha}) e_{km}(r_{c,\alpha}) + (K_{\text{res}})_{\tau_\alpha},
\]

(2.5)

where

\[
(K_l)_{\tau_\alpha} = \frac{(P_{\tau_\alpha})^2}{2 m_{\tau_\alpha}} = \frac{1}{2} m_{\tau_\alpha} V_c^2
\]

(2.6)

is the macroscopic translational kinetic energy of the orbital movement of the planet \( \tau_\alpha \) moving as a whole at speed \( V_{c,\alpha} \) of the mass center of the continuum region of the planet \( \tau_\alpha, \)

\[
(K_r)_{\tau_\alpha} = \frac{1}{2} \sum_{i,k=1}^{3} l_{ik}(C_\alpha) \omega_i (r_{c,\alpha}) \omega_k (r_{c,\alpha})
\]

(2.7)

the macroscopic internal rotational kinetic energy of the planet \( \tau_\alpha \) rotating with the angular velocity \( \omega (r_{c,\alpha}) \) as a whole,

\[
(K_s)_{\tau_\alpha} = \frac{1}{2} \sum_{i,j,k=1}^{3} j_{jk}(C_\alpha) e_{ij}(r_{c,\alpha}) e_{ik}(r_{c,\alpha})
\]

(2.8)

is the macroscopic internal shear kinetic energy of the planet \( \tau_\alpha \) subjected to continuum deformation by the local shear related with the rate of strain tensor \( e_{ij}(r_{c,\alpha}) \),

\[
(K_{s,r})_{\tau_\alpha} = \sum_{i,j,k,m=1}^{3} e_{ijk} J_{jm}(C_\alpha) \omega_i (r_{c,\alpha}) e_{km}(r_{c,\alpha})
\]

(2.9)

is the macroscopic kinetic energy of shear-rotational coupling of the planet \( \tau_\alpha \) (related with the kinetic energy of planetary coupling between irreversible dissipative shear and reversible rigid-like rotational macroscopic continuum motions in the continuum region of the planet \( \tau_\alpha), \)

\[
(K_{\text{res}})_{\tau_\alpha} = O(d_{\tau_\alpha}^3)
\]

is a small residual part of the macroscopic kinetic energy of the planet \( \tau_\alpha \) related with the residual terms in the Taylor series expansion (2.4).

The classical inertia tensor \( l_{ik}(C_\alpha) \) and the classical centrifugal tensor \( J_{jk}(C_\alpha) \) of the planet \( \tau_\alpha \) (relative to the mass center \( C_\alpha \) of the planet \( \tau_\alpha \)) are given by the classical expressions
\[ I_{ik} (C_\alpha) = \iiint_{\tau_a, K} \left( \delta_{ik} \left( \sum_{j=1}^{3} x_j^2 \right) - x_i x_k \right) \rho dV, \quad (i, k = 1, 2, 3), \quad (2.10) \]

\[ J_{jk} (C_\alpha) = \iiint_{\tau_a, K} x_j x_k \rho dV, \quad (j, k = 1, 2, 3). \quad (2.11) \]

The component \( M_{ta}^C (i) \) of the angular momentum (relative to the mass center \( C_\alpha \) of the planet \( \tau_a \)) of the planet \( \tau_a \) is given by the following expression [Saffman, 1992]:

\[ M_{ta}^C (i) = \varepsilon_{ijk} e_{kl} (r_{c, \alpha}) J_{ji} (C_\alpha) + \frac{1}{2} \left( \delta_{ij} J_{kk} (C_\alpha) - J_{ij} (C_\alpha) \right) \omega_j (r_{c, \alpha}). \quad (2.12) \]

We obtained [Simonenko, 2007; 2008] from expression (2.12) the classical formula [de Groot and Mazur, 1962; Gyarmati, 1970] for uniform spherical continuum region \( \tau_a \) (characterized by constant density):

\[ \frac{M_{ta}^C}{m_{ta}} = 0 \omega. \quad (2.13) \]

We obtained [Simonenko, 2007; 2008] the following expression for the total angular momentum \( M_{\tau_a} \) of the planet \( \tau_a \) (or the satellite \( \tau_a \) of a planet):

\[ M_{\tau_a} = \iiint_{\tau} (r_{c, \alpha} + \delta r) \times \rho v dV = \left[ r_{c, \alpha} \times \iiint_{\tau_a} \rho v dV \right] + M_{ta}^C = \]

\[ = \left[ r_{c, \alpha} \times P_{\tau_a} \right] + \sum_{i=1}^{3} \varepsilon_{ijk} e_{kl} (r_{c, \alpha}) J_{ji} (C_\alpha) \mu_i + \sum_{i=1}^{3} \frac{1}{2} (\delta_{ij} J_{kk} (C_\alpha) - J_{ij} (C_\alpha)) \omega_j (r_{c, \alpha}) \mu_i. \quad (2.14) \]

The first term (1) of the expression (2.14) is the orbital angular momentum of the planet \( \tau_a \) related with the orbital movement of the planet \( \tau_a \), the second term (2) is the internal shear angular momentum related with the non-equilibrium deformation of the planet \( \tau_a \) (the continuum region of the planet \( \tau_a \)), the third term (3) is the internal rotational angular momentum related with the equilibrium rotational motion of the planet \( \tau_a \) (the continuum region of the planet \( \tau_a \)).

The total energy \( E_{\tau_a} \) of the planet \( \tau_a \) is given by the following expression [Simonenko, 2007; 2008]:

\[ E_{\tau_a} = K_{\tau_a} + U_{\tau_a} + \Pi_{\tau_a} = \]

\[ = \left( K_1 \right)_{\tau_a} + \left( K_r \right)_{\tau_a} + \left( K_s \right)_{\tau_a} + \left( K_{\text{coup}} \right)_{\tau_a} + \left( K_{\text{res}} \right)_{\tau_a} + U_{\tau_a} + \Pi_{\tau_a}, \quad (2.15) \]

where

\[ \Pi_{\tau_a} = \iiint_{\tau_a} \psi \rho dV \quad (2.15a) \]

is the macroscopic potential energy of the planet \( \tau_a \) related with the non-stationary potential \( \Psi \) of the gravity field produced by the planet \( \tau_a \) and by the surrounding planets (and satellites) of the Solar System, the Sun, the Moon, midget planets, known asteroids and comets of the Solar System and by our Galaxy,

\[ U_{\tau_a} = \iiint_{\tau_a} udV \quad (2.15b) \]

is the classical internal thermal energy of the planet \( \tau_a \),

\[ \psi (r, t) = -\gamma \iiint_{R} \frac{pdV}{R} \quad (2.16) \]

is the potential of the gravitational forces created for time moment \( t \) by the mass distribution (of the
surrounding planets (and satellites) of the Solar System, the Sun, the Moon, midget planets, known asteroids and comets of the Solar System) characterized by the mass density ρ at the point of the three-dimensional space defined by the position-vector \( \mathbf{r} \), R is the distance between the element of mass \( \rho \, dV \) and the point of space characterized by the position-vector \( \mathbf{r}' \).

Considering the Solar System as the open thermodynamic system containing the set of separate thermodynamic subsystems (planets \( \tau_a \) and satellites of the planets) and disregarding the presence of atmospheres and hydrospheres (of planets and satellites of the planets), we derived the expressions [Simonenko, 2004a; 2007; 2008] for the total energy and the total angular momentum for the Solar System consisting of \( N \) cosmic material objects (the surrounding planets (and satellites) of the Solar System, the Sun, the Moon, midget planets, known asteroids and comets of the Solar System):

\[
\sum_{a=0}^{N} \left\{ \frac{(P_{\tau_a})^2}{2m_{\tau_a}} + (K_{\tau_a}) + (K_{s,\tau}) + (K_{\text{coup}})_{\tau_a} + (K_{\text{res}})_{\tau_a} + U_{\tau_a} + \pi_{\tau_a} \right\} = E_{\text{tot}} (t) = E_{\text{tot}} (t_o) + \delta E_{\text{tot}} (t), \quad (2.17)
\]

\[
\sum_{a=0}^{N} \left\{ \mathbf{r}_{\tau_a} \times P_{\tau_a} + \sum_{i=1}^{3} e_{ijk} e_{kl}(r_{\tau_a})J_{ij}(C_{\tau_a})\mathbf{u}_i + \sum_{i=1}^{3} \frac{1}{2} (\delta_{ij} - J_{kk}(C_{\tau_a}) - J_{ij}(C_{\tau_a}))\omega_j (r_{\tau_a})\mathbf{u}_i \right\} = -M_{\text{tot}} (t) - M_{\text{tot}} (t_o) + \delta M_{\text{tot}} (t), \quad (2.18)
\]

where the index \( \alpha = 0 \) corresponds to the Sun, the non-zero indexes \( \alpha \neq 0 \) correspond to the cosmic material objects (planets, satellites of planets, midget planets, known asteroids and comets of the Solar System). The system (2.17) and (2.18) of algebraic equations (which contains the all real parameters of the Sun, planets, satellites of planets, midget planets, known asteroids and comets of the Solar System) gives the possibility of transformations between the different energies (of the surrounding planets (and satellites) of the Solar System, the Sun, the Moon, midget planets, known asteroids and comets of the Solar System) related with the corresponding changes of orbital parameters (of the surrounding planets (and satellites) of the Solar System, the Sun, the Moon, midget planets, known asteroids and comets of the Solar System) and the directions of rotation of the surrounding planets (and satellites) of the Solar System, the Sun, the Moon, midget planets and known asteroids of the Solar System. It was pointed [Vikulin and Melekestcev, 2007] the predominant contribution of the Jupiter (more than 60%) and the Saturn (near 30%) into the total angular momentum of the Solar System.

The system of equations (2.17) and (2.18) contains in the right-hand sides the variation of the total energy \( \delta E_{\text{tot}} (t) \) and the variation of the total angular momentum \( \delta M_{\text{tot}} \) related with the external (cosmic) energy gravitational influences of our Galaxy on the Solar System. We deduced [Simonenko, 2009; 2010] the expression for the total energy \( E_{\text{tot}} (t) \) of the Solar System by taking into account the atmospheres and hydrospheres of the planets and satellites, the midget planets and known asteroids of the Solar System.

Each planet (and the satellite, for example, the Moon) subjected to the external energy gravitational influences can reduce the overfilled internal energy (of the accumulated internal energy of continuum deformation, compression and strain) by creation of the new planetary fractures during the process of synchronization of the Earth and the planets of the Solar System. We evaluated [Simonenko, 2004a; 2007; 2008] the result of the thermodynamic process of the seismic (tectonic) relaxation of the planet \( (\tau + \overline{\tau}) \) after formation of the new planetary fracture. Disregarding the influences of atmosphere and (or) hydrosphere \( \overline{\tau} \) during the small time of the seismic (tectonic) relaxation of the planet \( (\tau + \overline{\tau}) \), we considered [Simonenko, 2004a; 2007; 2008] the system of the conservation laws of the total energy and the total angular momentum of the subsystem \( \tau \) of the planet \( (\tau + \overline{\tau}) \):

\[
\frac{(P_{\tau})^2}{2m_{\tau}} + (K_{\tau})_{\tau} + (K_{s,\tau})_{\tau} + U_{\tau} + \pi_{\tau} = (E(t))_{\tau} = E_{\text{tot}} (\tau), \quad (2.19)
\]

\[
[r_{\tau} \times P_{\tau}] + \sum_{ij,k,l=1}^{3} e_{ijk} e_{kl}(r_{\tau})(C)\mathbf{u}_i + \sum_{ij,k,l=1}^{3} \frac{1}{2} (\delta_{ij} - J_{kk}(C) - J_{ij}(C))\omega_j (r_{\tau})\mathbf{u}_i = (M(t))_{\tau} = M_{\text{tot}} (\tau). \quad (2.20)
\]

Taking into account the weakness of the interaction effect between the subsystems \( \tau \) and \( \overline{\tau} \) (atmosphere and (or) hydrosphere) on the boundary surface \( \partial \tau \) and disregarding the energy gravitational interaction of the subsystem \( \tau \) with subsystem \( \overline{\tau} \) and others cosmic material objects during the small time
of the seismic (tectonic) relaxation, it was shown [Simonenko, 2004a] that the system of equations (2.19) and (2.20) admits the oscillating energy transformations between the accumulated internal energy $U_\tau$ (of the accumulated internal energy of continuum deformation, compression and strain of the subsystem $\tau$) and the macroscopic internal kinetic energies $(K_s)_\tau$, $(K_r)_\tau$, $(K^{coup}_{s\tau})_\tau$. The oscillating energy transformations (subjected to the damping due to viscosity) are related with the small final change of the direction of rotation of the subsystem $\tau$ of the planet $(\tau + \overline{\tau})$ [Simonenko, 2004a].

Recognizing in 2004 [Simonenko, 2004a] the general mathematical nature of the generalized differential formulation (1.50) of the first law of thermodynamics (valid for arbitrary finite macroscopic continuum regions of the ocean, atmosphere and the Earth’s interior), the author made the mental jump from the turbulent eddy [Simonenko, 2004; 2005; 2006] to the planets of the Solar System [Simonenko, 2007]. Based on the generalizations (1.6) and (1.50) used for the planet (the Earth) of the Solar System, the author reported (in September 15, 2004 in the report “The macroscopic non-equilibrium kinetic energies of a small fluid particle” [Simonenko, 2004a] on the International conference on the Arctic and North Pacific, Chapter 1: Climate change and natural disasters) about the inevitable abrupt change of the angular velocity vector of the Earth’s rotation during the strong earthquake. Since the convincing confirmation of this prediction for the December 26, 2004 Indonesia earthquake, the author concentrated during 2004-2010 on the subsequent parallel development of the Non-equilibrium Statistical Thermohydrodynamics of Turbulence [Simonenko, 2005; 2006] and the Thermohydrogravidynamics (Cosmic Physics) of the Solar System [Simonenko, 2007; 2008; 2009; 2010] by synthesizing the Newton’s theory of gravitation, the Newton’s laws of motion and the classical thermodynamic, continuum mechanical, hydrodynamic, astronomical, geological, geophysical, seismological, climatological, hydro-geophysical and oceanological approaches into the presented deductive thermohydrogravidynamic theory of the global geological and geophysical planetary processes subjected to the non-stationary Newtonian gravitational field of the Solar System and our Galaxy. The predicted effect [Simonenko, 2004a] of the small abrupt change of the direction of rotation of the subsystem $\tau$ of the Earth is consistent with the real geophysical data [Kotlyar and Kim, 1994] demonstrating of the small abrupt change of the angular velocity of Earth’ rotation during the strong earthquakes.

2.2. Non-catastrophic models of the thermohydrogravidynamic evolution of the total energy of the subsystems of the planet $(\tau + \overline{\tau})$ subjected to the cosmic non-stationary energy gravitational influences of the Solar System and our Galaxy

2.2.1. Thermohydrogravidynamic evolution of the total energy $E_\tau$ of the subsystem $\tau$ bounded by the external boundary surface $\partial \tau$, on which the subsystem $\tau$ interacts with the subsystem $\overline{\tau}$ representing the atmosphere or atmosphere and hydrosphere of the planet $(\tau + \overline{\tau})$

It was noted earlier [Zhirmunsky and Kuzmin, 1990] that the periods of circulation of the main majority of the planets of the Solar System (including the asteroids between the Mars and Jupiter) are close to the geometric progression characterized by the module $C$ ($C = 2.7182...$), while the Earth and Neptune fall out from these planets. It demonstrates the special positions of the Earth and Neptune in respect to the others planets during process of formation of the Solar System and in the present time. It shows that the periods of circulation of the Earth and Neptune are not synchronized with the all totality of periods of circulation for others planets. The average distances of the planets of the Solar System from the Sun are practically synchronized forming the geometric progression characterized by module $C^{2/3}$ [Zhirmunsky and Kuzmin, 1990]. Consequently, it means the possible change of parameters of the orbit of the Earth (in the process of synchronization of the Earth and the all totality of the planets of the Solar System) related with the change of the total energy (including the change of the angular velocity of the Earth’s rotation) and the periodic activation of the tectonic processes.

Following the works [Simonenko, 2007a; 2007; 2008; 2009; 2010], we present the formulation of the non-catastrophic model of the thermohydrogravidynamic evolution of the total energy $E_\tau$ of the subsystem $\tau$ subjected to the cosmic non-stationary energy gravitational influences of the Solar System and our
Galaxy. The subsystem $\tau$ is bounded by the external boundary surface $\partial \tau$, on which the subsystem $\tau$ interacts with the subsystem $\overline{\tau}$ representing the atmosphere or atmosphere and hydrosphere of the planet $(\tau + \overline{\tau})$ subjected to the cosmic non-stationary energy gravitational influences of the Solar System and our Galaxy. Following to Gor’kavyi and Fridman [Gor’kavyi and Fridman, 1994], we consider the Solar System as the complex hierarchy of the thermohydrogravidynamic subsystems saturating by different energy sources and possessing by the amazing wealth of the collective processes. Using the generalized differential formulation (1.53) of the first law of thermodynamics, we deduced [Simonenko, 2007a; 2007; 2008; 2009; 2010] (in the right-hand side of the generalized differential formulation (1.53) of the first law of thermodynamics) the new additional term related with the space-time density $\varepsilon_i$ of the sources of heat. Taking into account the additional energy source $\varepsilon_i$, the formulation (1.53) can be rewritten as follows [Simonenko, 2007a; 2007; 2008; 2009; 2010]:

$$\frac{dE}{dt} = \frac{d}{dt}(K_\tau(t) + U_\tau + \Pi_\tau) = \frac{d}{dt} \int \int \left( \frac{1}{2} \mathbf{v}^2 + u + \psi \right) dV =$$

$$= \int \int \left( \mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T}) \right) d\Omega_n \cdot \int \int (J_q \cdot \mathbf{n}) d\Omega_n + \int \int \int \frac{\partial \psi}{\partial t} dV + \int \int \varepsilon_i dV$$

(2.21)

for the macroscopic continuum region $\tau$, for example for the subsystem $\tau$ bounded by the external boundary surface $\partial \tau$, on which the subsystem $\tau$ interacts with the subsystem $\overline{\tau}$ representing the atmosphere or atmosphere and hydrosphere of the planet $(\tau + \overline{\tau})$. Here $\mathbf{n}$ is the external unit normal vector of the surface $\partial \tau$. The potential of the non-stationary gravity field $\psi$ (in the subsystem $\tau$) is created owing to all objects of our Galaxy. The differential formulations (1.53) and (2.21) of the first law of thermodynamics take into account the heating related with the gravitational differentiation of the stratified continuum (inside the continuum region $\tau$) and the heating related with with the gravitational interaction of the considered subsystem $\tau$ with the surrounding material objects of our Galaxy.

Integrating the equation (2.21), we obtained [Simonenko, 2007a; 2007; 2008; 2009; 2010] the expression for the total energy $(E(t))_\tau$ of the subsystem $\tau$ of the planet $(\tau + \overline{\tau})$:

$$(E(t))_\tau = (K_\tau(t))_\tau + (K_\tau(t))_\tau + (K_s(t))_\tau + (K_{s\tau}(t))_\tau + U_\tau(t) + \Pi_\tau(t) =$$

$$= (K_\tau(t_0))_\tau + (K_{\tau}(t_0))_\tau + (K_s(t_0))_\tau + (K_{s\tau}(t_0))_\tau + U_\tau(t_0) + \Pi_\tau(t_0) +$$

$$+ \int \int \left( \mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T}) \right) d\Omega_n \int_{t_0}^{t} dt' - \int \int (J_q \cdot \mathbf{n}) d\Omega_n \int_{t_0}^{t} dt' +$$

$$+ \int \int \left( \int \int \frac{\partial \psi}{\partial t} dV \right) dt' + \int \int \varepsilon_i dV \int_{t_0}^{t} dt'.$$

(2.22)

The first term in the third row of the expressions (2.22) gives the energy exchange between the oceans and the atmosphere (containing the subsystem $\overline{\tau}$) and the subsystem $\tau$ containing the geo-spheres of the planet including the lithospheres of the Earth and the planets of the terrestrial group. The first term in the third row of the expressions (2.22) controls the angular velocity of rotation of the planet’s subsystem $\tau$. According to the expressions (2.22), the long-range changes of the Earth’s angular velocity of rotation are defined by the following factors: the periodic variation of the gravitational potential $\psi$ (related with the first term in the fourth row of the expressions (2.22)) of the non-stationary gravity field (produced by the planets (and satellites) of the Solar System, the Earth, the Sun, the Moon, midget planets, known asteroids and comets of the Solar System), the periodic changes of the intensity of solar radiation (the second term in the third row of the expressions (2.22)), which change the distribution of average circulations of the
atmosphere and oceans and the corresponding thermohydrodynamic parameters (related with the first term in the third row of the expressions (2.22)) near the upper boundary of the Earth’s lithosphere. Considering the factor of the solar influence on the rotational motion of the Earth on the basis of the actual observations, it was obtained [Girencon, 1958; p. 36] the similar conclusion about the universal role of the solar activity controlling partially the absolute value of the angular velocity of the Earth’s rotation. It is important to use the real information [Dolgikh, 2000] about the lithosphere oscillations for modeling of the energy exchange (described by the first term in the third row of the expressions (2.22)) between the oceans and the atmosphere (containing the subsystem $\tau$) and the subsystem $\bar{\tau}$ containing the lithosphere and others geo-spheres of the Earth.

The first term in the fourth row of expression (2.22) gives the contribution to the change of the total energy of the subsystem $\tau$ taking into account the change of the potential $\Psi$ of the non-stationary gravitational field (produced by the planet $(\tau + \bar{\tau})$ and others planets of the Solar System) in the subsystem $\tau$ of the planet $(\tau + \bar{\tau})$. According to the expression (2.22), the compression of the subsystem $\tau$ of the planet $(\tau + \bar{\tau})$ accompanied by the increase of the gravitation potential $\Psi$ in the fixed point of space must induce the increase of the internal thermal energy and the corresponding heat flux from the kernel of the planet. This conclusion is in agreement with the Milanovsky’s conclusion [Milanovsky, 1979] that the geological eras of the intensive increase of the heat flux correspond to the eras of general compression of the Earth. Three full cycles (of the geological eras of compression, stretching and more long-lasting reduction of the tectonic motions) [Milanovsky, 1979] of the total duration of 570 million years correspond approximately to three cycles of circulation (characterized by the period of 200 million years [Kazancev, 2002; p. 10]) of the Solar System around the center of our Galaxy. Taking this into account, we revealed [Simonenko, 2007] the galactic energy gravitational genesis of each cycle (the compression, stretching and more long-lasting reduction of the tectonic motions) of the geological eras of the Earth during the latest 570 million years.

We obtained [Simonenko, 2007a; 2007; 2008] the time evolution of the total energy $(E(t))_\tau$ for the planet $\tau$ not having the atmosphere (for example, the Mercury) or for arbitrary satellite of the planet, except the Titan possessing the developed atmosphere and except the Triton possessing the weak atmosphere [Bazilevskii, 2000]. Integrating the equation (2.21) under the obvious condition

$$\int_{\tau}^{(v \cdot (n \cdot T))} d\Omega_n = 0$$

on the external boundary $\partial \tau$ of the considered celestial objects, we obtained [Simonenko, 2007a; 2007; 2008] the time evolution law of the total energy $(E(t))_\tau$:

$$\begin{align*}
(E(t))_\tau &= (K_1(t))_\tau + (K_\tau(t))_\tau + (K_s(t))_\tau + (K_{s,\tau}(t))_\tau + U_{\tau}(t) + \Pi_{\tau}(t) = \\
&= (K_1(t_0))_\tau + (K_\tau(t_0))_\tau + (K_s(t_0))_\tau + (K_{s,\tau}(t_0))_\tau + U_{\tau}(t_0) + \Pi_{\tau}(t_0) - \\
&- \int_{t_0}^{t} \int_{\tau}^{(J_q \cdot n)} d\Omega_n dt' + \int_{t_0}^{t} \int_{\tau}^{(\frac{\partial \Psi}{\partial t'} \rho dV)} dt' + \int_{t_0}^{t} \int_{\tau}^{(\epsilon_{\tau} \rho dV)} dt' .
\end{align*}$$

(2.23)

2.2.2. Thermohydrogravidynamic evolution of the total energy $E_{\tau}$

of the subsystem $\bar{\tau}$ representing the atmosphere
or atmosphere and hydrosphere of the planet $(\tau + \bar{\tau})$

Following the works [Simonenko, 2007a; 2007; 2008], we shall present the formulation of the non-catastrophic model of the thermohydrogravidynamic evolution of the total energy $E_{\tau}$ of the subsystem $\bar{\tau}$ representing the atmosphere or atmosphere and hydrosphere of the planet $(\tau + \bar{\tau})$ subjected to the cosmic non-stationary energy gravitational influences of the Solar System and our Galaxy. Considering the differential formulation (1.53) of the first law of thermodynamics (with the additional source $e_{\tau}$ of heat in
the subsystem \( \tau \) for the subsystem \( \bar{\tau} \) (atmosphere or atmosphere and hydrosphere), which surrounds the subsystem \( \tau \), we obtained [Simonenko, 2007a; 2007; 2008] the evolution equation for the total energy \( E_\tau \) of the subsystem \( \bar{\tau} \) (which has the external boundary surface \( \partial(\tau + \bar{\tau}) \) and the inner boundary surface \( \partial\tau \)):

\[
\frac{dE_\tau}{dt} = \frac{d}{dt} \left( K_\tau + U_\tau + \pi_\tau \right) = \frac{d}{dt} \left( \int \int \int \left( \frac{1}{2} v^2 + u + \psi \right) \rho dV \right) - \int \int \left( \mathbf{v} \cdot \left( \mathbf{n} \cdot \mathbf{T} \right) \right) d\Omega_n + \\
+ \int \int \left( \mathbf{J}_q \cdot \mathbf{n} \right) d\Omega_n + \int \int \frac{\partial \psi}{\partial t} \rho dV + \int \int \left( \mathbf{v} \cdot \left( \mathbf{k} \cdot \mathbf{T} \right) \right) d\Sigma_k - \\
- \int \int \left( \mathbf{J}_q \cdot \mathbf{k} \right) d\Sigma_k + \int \int e_{\tau} \rho dV,
\]

(2.24)

where \( \mathbf{k} \) is the external unit normal vector of the external boundary surface \( \partial(\tau + \bar{\tau}) \), \( d\Sigma_k \) is the differential element of area of the surface \( \partial(\tau + \bar{\tau}) \), \( - \mathbf{n} \) is the external unit normal vector of the inner boundary surface \( \partial\tau \) of the subsystem \( \bar{\tau} \).

### 2.2.3. Thermohydrogravodynamic evolution of the total energy \( E_{(\tau + \bar{\tau})} \)

of the planet \( (\tau + \bar{\tau}) \) consisting from interacting (on the surface \( \partial\tau \)) subsystems \( \tau \) and \( \bar{\tau} \) (the atmosphere or atmosphere and hydrosphere of the planet \( (\tau + \bar{\tau}) \))

Following the works [Simonenko, 2007a; 2007; 2008], we present the formulation of the non-catastrophic model of the thermohydrogravodynamic evolution of the total energy \( E_{(\tau + \bar{\tau})} \) of the planet \( (\tau + \bar{\tau}) \) consisting from interacting (on the surface \( \partial\tau \)) subsystems \( \tau \) and \( \bar{\tau} \) (the atmosphere or atmosphere and hydrosphere of the planet \( (\tau + \bar{\tau}) \)) subjected to the cosmic non-stationary energy gravitational influences of the Solar System and our Galaxy. Adding the equations (2.21) and (2.24), we obtained [Simonenko, 2007a; 2007; 2008] the evolution equation for the total energy \( E_{(\tau + \bar{\tau})} \) of the planet \( (\tau + \bar{\tau}) \) consisting from interacting (on the surface \( \partial\tau \)) subsystems \( \tau \) and \( \bar{\tau} \):

\[
\frac{dE_{(\tau + \bar{\tau})}}{dt} = \frac{dE_\tau}{dt} + \frac{dE_{\bar{\tau}}}{dt} = \frac{d}{dt} \left( \int \int \int \left( \frac{1}{2} v^2 + u + \psi \right) \rho dV \right) + \frac{d}{dt} \left( \int \int \int \left( \frac{1}{2} v^2 + u + \psi \right) \rho dV \right) = \\
= \int \int \left( \mathbf{v} \cdot \left( \mathbf{k} \cdot \mathbf{T} \right) \right) d\Sigma_k - \int \int \left( \mathbf{J}_q \cdot \mathbf{k} \right) d\Sigma_k + \int \int \frac{\partial \psi}{\partial t} \rho dV + \int \int e_{\tau} \rho dV + \int \int e_{\bar{\tau}} \rho dV.
\]

(2.25)

Integrating the equation (2.25) under the obvious condition \( \int \int \left( \mathbf{v} \cdot \left( \mathbf{k} \cdot \mathbf{T} \right) \right) d\Sigma_k = 0 \) on the external boundary surface \( \partial(\tau + \bar{\tau}) \) of the planet \( (\tau + \bar{\tau}) \), we obtained [Simonenko, 2007a; 2007; 2008] the time dependence of the total energy \( E(t)_{(\tau + \bar{\tau})} \) of the planet \( (\tau + \bar{\tau}) \):

\[
\left( E(t)_{(\tau + \bar{\tau})} \right) = \left( K_\tau (t) \right) + \left( K_\tau (t) \right) + \left( K_s (t) \right) + \left( K_{\tau_s}^c (t) \right) + U_\tau (t) + \pi_\tau (t) + \left( K(t) \right) + \\
+ U_\tau (t) + \pi_\tau (t) + \left( K_\tau (t_o) \right) + \left( K_\tau (t_o) \right) + \left( K_s (t_o) \right) + \left( K_{\tau_s}^c (t_o) \right) + U_\tau (t_o) + \\
+ \pi_\tau (t_o) + \left( K(t_o) \right) + U_\tau (t_o) + \pi_\tau (t_o) - \int \int \left( \mathbf{J}_q \cdot \mathbf{k} \right) d\Sigma_k \right) dt' +
\]

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\[
+ \int_{t_0}^{t} \int \int \int \frac{\partial \psi}{\partial t} \rho \, dV \, dt' + \int_{t_0}^{t} \int \int \int \epsilon_\tau \rho \, dV \, dt' + \int_{t_0}^{t} \int \int \int \epsilon_{\tau_3} \rho \, dV \, dt'.
\]

(2.26)

The expression (2.26) shows that the total kinetic energy of the planet \((\tau + \overline{\tau})\) cannot be presented as the sum of the kinetic energies of translational, rotational, shear and the shear-rotational coupling for the planet (as a whole) as a consequence of the thermodynamic non-equilibrium of the considered planetary continuum related with the shear continuum motion in the atmosphere and hydrosphere \(\overline{\tau}\) of the planet \((\tau + \overline{\tau})\). The relation (2.26) shows that the total kinetic energy \(\mathbf{K}(\tau)\), the total internal thermal energy \(U_{\tau}(t)\) and the total potential gravitational energy \(\mathbf{P}_{\tau}(t)\) of the subsystem \(\overline{\tau}\) are the energy factors, which regulate the angular velocity of rotation of the subsystem \(\tau\) of the planet \((\tau + \overline{\tau})\), in particular the subsystem \(\tau_{3,0}\) of the Earth \((\tau_{3,0} + \tau_{3,0})\) containing the atmosphere and hydrosphere \(\tau_{3,0}\).

According to the expression (2.26), the total energy \(E(t)\) of the planet \((\tau + \overline{\tau})\) changes as a result of the following factors: the heat flux in the form of electromagnetic radiation of the Sun on the external boundary surface \(\partial(\tau + \overline{\tau})\) of the planet \((\tau + \overline{\tau})\), the variation of the gravitational potential in subsystems \(\tau\) and \(\overline{\tau}\) of the planet \((\tau + \overline{\tau})\) due to the gravitational influences of celestial objects of the Solar System (including the own gravitational contribution of the planet) and the cosmic non-stationary gravitational influence of our Galaxy, the heating (inside the subsystem \(\tau\)) due to the disintegration of radioactive elements, the heating in atmosphere and hydrosphere of the planet due to the human industrial activity (now for Earth and on others planets in future).

Considering the space-time energy density \(e_{\tau}\) as the energy density of the thermonuclear reaction inside the Sun and rejecting the last term (containing space-time energy density \(e_{\overline{\tau}}\), we used [Simonenko, 2009; 2010] the equation (2.26) for the evaluation [Simonenko, 2009, p. 206; 2010, p. 206] of the relative maximal instantaneous energy gravitational influences of the planets of the Solar System on the Sun and for the foundation [Simonenko, 2009, p. 214; 2010, p. 214] of the cosmic energy gravitational genesis of the time periodicities of the solar activity induced by the planetary energy gravitational influences on the Sun.

2.3. Cosmic geology of the Earth (of the terrestrial planet of the Solar System) taking into account the convection in the lower geo-spheres of the Earth (of the planet),

- the solar radiation, the disintegration of the radio-active elements, the density differentiation, the translational, rotational, deformational and compressible movements of the tectonic plates, the creation of the new planetary fractures induced by the energy gravitational influences of the Solar System and our Galaxy

2.3.1. Thermohydrogravidynamic N-layer model of the non-fragmentary geo-spheres of the Earth (of the planet of the Solar System)

Following the monographs [Simonenko, 2007; 2008], we shall present the thermohydrogravidynamic N-layer model of the non-fragmentary geo-spheres of the Earth (of the planet of the Solar System) taking into account the convection in the lower geo-spheres of the Earth (of the planet), the solar radiation, the disintegration of the radio-active elements, the density differentiation, the translational, rotational, deformational and compressible movements of the tectonic plates, the creation of the new planetary fractures induced by the energy gravitational influences of the Solar System and our Galaxy. Let us consider the thermohydrogravidynamic N-layer model [Simonenko, 2007; 2008] for the planet \((\tau + \overline{\tau})\) having the atmosphere or the atmosphere and hydrosphere considered as the subsystem \(\overline{\tau}\). We shall use for each planet of the Solar System the division of the inner material continuum of the planet on some number of N layers (different for each planet) in accordance with the established (in geology and geophysics) traditional conception [Abramov, 1993; Khain, 2003; Abramov and Molev, 2005] considering the internal structure of the Earth consisting of several geo-spheres characterized by the different physical-chemical and thermodynamic properties.
Taking into consideration the generalized formulation (1.53) of the first law of thermodynamics, we obtained [Simonenko, 2007; 2008] the evolution equation (2.24) for the total energy $E_\tau$ of the subsystem $\tau$ (which is the first upper layer (gas and liquid substance) of the atmospheric and hydrospheric planet). The evolution equation (2.24) take into account the next factors: the flux to the subsystem $\tau$ of the heat in the form of electromagnetic radiation of the Sun on the external boundary surface $\partial(\tau + \bar{\tau})$ of the subsystem $\bar{\tau}$, the energy gravitational influence (external and internal) on the subsystem $\tau$, the energy interaction between the subsystem $\tau$ of the planet ($\tau + \bar{\tau}$) on the inner boundary surface $\partial\tau$, the heating of the subsystem $\bar{\tau}$ as a result of various sources (disintegration of the radio-active elements and human industrial activity).

Let us consider the subsystem $\tau_{ext}$ (the first layer after the subsystem $\tau_{int}$), having the external (for $\tau_{ext}$) surface $\partial\tau$ (see Fig. 2) as the inner boundary surface of the subsystem $\bar{\tau}$. The subsystem $\tau_{ext}$ has the inner boundary surface $\partial\tau_{int}$, which delimits the subsystem $\tau_{ext}$ from the next subsystem $\tau_{int}$. Based on the generalized formulation (1.53) of the first law of thermodynamics, we obtained [Simonenko, 2007; 2008] the evolution equation for the total energy of the subsystem $\tau_{ext}$:

$$\frac{d}{dt} \left( K_{\tau_{ext}} + U_{\tau_{ext}} + \pi_{\tau_{ext}} \right) = \frac{d}{dt} \iiint_{\tau_{ext}} \left( \frac{1}{2} \mathbf{v}^2 + u + \psi \right) \rho dV =$$

$$= \iint_{\partial\tau_{ext}} \left( \mathbf{v} \cdot (n \cdot \mathbf{T}) - (J_q 
 \cdot n) \right) d\Omega_n - \iint_{\partial\tau_i} \left( \mathbf{v}_{ext} \cdot (\partial\tau_i) \cdot (m_i \cdot \mathbf{T}) - (J_q \cdot m_i) \right) d\Sigma_{-m_i} +$$

$$+ \iiint_{\tau_{ext}} \frac{\partial\psi}{\partial t} \rho dV + \iiint_{\tau_{ext}} e_{\tau_{ext}} \rho dV,$$

(2.27)

where (apart from the usual designations) $n$ is the external unit normal vector of the surface $\partial\tau$, $-m_i$ is the external unit normal vector of the internal surface $\partial\tau_i$ of the subsystem $\tau_{ext}$, $\mathbf{v}_{ext}(\partial\tau_i)$ is the vector of the continuum velocity on the external side of the surface $\partial\tau_i$ inside the subsystem $\tau_{ext}$, $e_{\tau_{ext}}$ is the space-time density of the heat sources related with disintegration of the radio-active elements in the subsystem $\tau_{ext}$.

Taking into account that the subsystem $\tau_{int}$ (confined by the external surface $\partial\tau_i$ and located inside the subsystem $\tau_{ext}$) has no jumps of the velocity continuum, we obtained [Simonenko, 2007; 2008] the evolution equation for the total energy of the subsystem $\tau_{int}$ (of the planet ($\tau + \bar{\tau}$)):

$$\frac{d}{dt} \left( K_{\tau_{int}} + U_{\tau_{int}} + \pi_{\tau_{int}} \right) = \frac{d}{dt} \iiint_{\tau_{int}} \left( \frac{1}{2} \mathbf{v}^2 + u + \psi \right) \rho dV =$$

$$= \iint_{\partial\tau_i} \left( \mathbf{v}_{int} \cdot (m_i \cdot \mathbf{T}) - (J_q \cdot m_i) \right) d\Sigma_{-m_i} + \iiint_{\tau_{int}} \frac{\partial\psi}{\partial t} \rho dV + \iiint_{\tau_{int}} e_{\tau_{int}} \rho dV,$$

(2.28)

where $\mathbf{v}_{int}(\partial\tau_i)$ is the vector of the continuum velocity on the internal side of the surface $\partial\tau_i$ in the subsystem $\tau_{int}$, $m_i$ is the external unit normal vector of the surface $\partial\tau_i$ of the subsystem $\tau_{int}$, $e_{\tau_{int}}$ is the space-time density of the heat sources related with disintegration of the radio-active elements in the subsystem $\tau_{int}$.

Adding the equations (2.27) and (2.28) (by using the equality $d\Sigma_{m_i} = d\Sigma_{-m_i}$ of the elements of area of the surface $\partial\tau_i$), we obtained [Simonenko, 2007; 2008] the evolution equation for the total energy of
the thermodynamic subsystem $\tau = \tau_{\text{int}} + \tau_{\text{ext}}$ consisting from two (interacting on the surface $\partial \tau_i$ of the tangential jump of the continuum velocity) subsystems $\tau_{\text{ext}}$ and $\tau_{\text{int}}$ enclosed inside of the subsystem $\tau_{\text{ext}}$:

$$\frac{d}{dt}(K_\tau + U_\tau + \Pi_\tau) = \frac{d}{dt} \iiint_\tau \left( \frac{1}{2} \mathbf{v}^2 + u + \psi \right) \rho dV =$$

$$= \int \{ \mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T}) - (\mathbf{J}_q \cdot \mathbf{n}) \} d\Omega_n + \int \{ \mathbf{v}_{\text{int}} (\partial \tau_i) - \mathbf{v}_{\text{ext}} (\partial \tau_i) \} \cdot (\mathbf{m}_i \cdot \mathbf{T}) d\Sigma_{m_i} +$$

$$+ \iiint_\tau \frac{\partial \psi}{\partial t} \rho dV + \iiint_\tau e_t \rho dV,$$

(2.29)

where $e_\tau$ is the space-time density of the heat sources related with disintegration of the radio-active elements in the thermodynamic subsystem $\tau = \tau_{\text{int}} + \tau_{\text{ext}}$, the function $e_\tau$ is equal to the function $e_{\tau_{\text{int}}}$ inside of the subsystem $\tau_{\text{int}}$ and the function $e_\tau$ is equal to function $e_{\tau_{\text{ext}}}$ inside of the subsystem $\tau_{\text{ext}}$.

![Fig. 2. The geometric sketch of the planetary structure](image)

Using the mathematical inductive method and the generalized formulation (1.53) of the first law of thermodynamics, we obtained [Simonenko, 2007; 2008] the evolution equation for the total energy $E_\tau$ of the subsystem $\tau$ (consisting of $N$ successively embedded to each other subsystems (geo-spheres) $\tau_N$, $\tau_{N-1}$, $\cdots$,$\tau_1$).
..., $\tau_2, \tau_1$, from which the subsystem $\tau_1 = \tau_{ext}$ is first upper layer (geo-sphere) of the subsystem $\tau$, and the subsystem $\tau_N$ is the internal kernel of the subsystem $\tau$ of the planet $(\tau + \tau)$:

$$
\frac{dE_{\tau}}{dt} = \frac{d}{dt} (K_{\tau} + U_{\tau} + \pi_{\tau}) - \frac{d}{dt} \iint \left( \frac{1}{2} v^2 + u + \psi \right) dV =
$$

$$
= \frac{d}{dt} \sum_{i=1}^{N} \left( K_{\tau_i} + U_{\tau_i} + \pi_{\tau_i} \right) = \iint_{\partial \tau} \left\{ \mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T}) - (J_q \cdot \mathbf{n}) \right\} d\Omega_n +
$$

$$
+ \sum_{i=1}^{N-1} \iint_{\partial \tau_i} \left\{ \mathbf{v}_{int} (\partial \tau_i) - \mathbf{v}_{ext} (\partial \tau_i) \right\} \cdot (\mathbf{m}_i \cdot \mathbf{T}) d\Sigma_{m_i} + \iint_{\partial \tau} \frac{\partial \psi}{\partial t} dV + \iint e_{\mathbf{p}} dV,
$$

(2.30)

where $\partial \tau_i$ is the surface (characterized by the number $i$, $i = 1, 2, \ldots, N-1$) of the jump of the velocity (vector) continuum, on which (or only on a certain part) the velocity vector of continuum has the jump from the functional vector values $\mathbf{v}_{int} (\partial \tau_i)$ (having on the internal side of the surface $\partial \tau_i$) up to the functional vector values $\mathbf{v}_{ext} (\partial \tau_i)$ having on the external side of surface $\partial \tau_i$. Taking into account the fundamental uniformity of the considered thermohydrogravidynamic approach to the planets of the Solar System, the evolution equation (2.30) of the total energy of the subsystem $\tau$ is valid for the subsystem $\tau$ of each planet $(\tau + \tau)$ of the Solar System.

Considering the subsystem $\tau = \tau_{3,0}$ of the Earth $(\tau_{3,0} + \tau_{3,0})$, the stress tensor $\mathbf{T}$ in equation (2.30) can be taken into account for the real physical structure [Abramov, 1993; Khain, 2003; Abramov and Molev, 2005] of all $N$ successively embedded to each other subsystems $\tau_{N}, \tau_{N+1}, \ldots, \tau_2, \tau_1$ (geo-spheres [Khain, 2003; Abramov and Molev, 2005]). The deduction of equation (2.30) is realized strictly mathematically in a general case for arbitrary symmetrical stress tensor $\mathbf{T}$. The deduction of equation (2.30) does not suppose any simplifications related with suggestion of the spherical forms of the boundary surfaces $\partial \tau_i$ (i = 1, 2, ..., N-1), which delimit a different subsystems $\tau_1, \tau_2, \ldots, \tau_{N-1}, \tau_N$. If there are no jumps of the velocity (vector) continuum on the boundary surfaces $\partial \tau_i$ then we have the equalities $\mathbf{v}_{int} (\partial \tau_i) = \mathbf{v}_{ext} (\partial \tau_i)$ for each $i$. In this case, we have from equation (2.30) the reduced equation (2.21).

The equation (2.30) shows that the energy can be received from the non-stationary external (of the Sun, the Moon, planets, satellites of planets, midget planets, known asteroids and comets of the Solar System and the material objects of our Galaxy) and internal (of the Earth) gravity fields to create the jumps of the velocity continuum related with rotation of the geo-spheres with respect to each other and characterized by the slippage on the boundary surfaces $\partial \tau_i$ (i = 1, 2, ..., N-1).

Taking into account the data about the continental and oceanic planetary tectonic formations characterized [Abramov and Molev, 2005; p. 245] by the mantle penetrated deep roots reaching the kernel of the Earth, the consideration of the first term in the third row of equation (2.30) gives the following expression (after integration of this term on the area section $\Delta \Sigma_i$ of the deepening crystalline planetary tectonic root):

$$
W_{br} (\Delta \Sigma_i) = - \iint_{\Delta \Sigma_i} \left\{ \mathbf{v}_{int} (\partial \tau_i) - \mathbf{v}_{ext} (\partial \tau_i) \right\} \cdot (\mathbf{m}_i \cdot \mathbf{T}) d\Sigma_{m_i},
$$

(2.31)

for the necessary power (in particular, of the external energy gravitational influence), which is sufficient to break the considered crystalline root in one section characterized by the area $\Delta \Sigma_i$. It was noted [Abramov and Molev, 2005; p. 247] that even the gravitational and rotational momentums of forces have not destroyed the roots of crystalline shields formed before the Cambrian time. This, according to equation (2.30), leads to the weak mobility of the crystalline shields relative to their surroundings. As a result, we obtained [Simonenko, 2007; 2008] (for the considered planetary tectonic formations [Abramov and Molev, 2005; p. 245]) the impossibility of slippage of the upper mantle as a whole relative to the lower mantle of the Earth.

Taking into account the data [Pavlenkova, 2007; p. 107] about the deep roots of the continents, we
derived [Simonenko, 2007; 2008] from equation (2.30) the possibility of rotation of the upper mantle (as a whole) relative to the lower mantle (characterized by the slippage in the intermediate connecting zone) under sufficiently powerful external energy gravitational influences if the roots of the oceanic and continental planetary formations do not lower below the upper mantle. We obtained [Simonenko, 2007; 2008] from equation (2.30) that (for two data [Abramov and Molev, 2005; p. 245; Pavlenkova, 2007; p. 107] about the roots of continents) the mantle can rotate as a whole with the slippage on the dividing boundary of the mantle and the external fluid kernel. This theoretical conclusion confirmed [Simonenko, 2007; 2008] the considered [Pavlenkova, 1995] suggestion about rotation of the mantle relative to the kernel. The obtained theoretical result is consistent with the modern data [Pavlenkova, 2007; p. 107] about the rotation of the mantle relative to the kernel.

From equation (2.30) we obtained [Simonenko, 2007; 2008] that the translational mobility of the upper subsystem \( \tau_i = \tau_{ext} \) of the Earth (also as a separate tectonic plates and geo-blocks of the subsystem \( \tau_i = \tau_{ext} \)) is greatly restricted as a result of deepened roots of the continental and oceanic planetary formations (for two data [Abramov and Molev, 2005; p. 245; Pavlenkova, 2007] about the roots of continents). According to the evolution equation (2.27) of the total energy of the subsystem \( \tau_{ext} \), the restriction of the translational mobility of the upper subsystem \( \tau_i = \tau_{ext} \) of the Earth leads to the intensification of the deformational and rotational motions [Khain and Poletaev, 2007; Vikulin and Melekestcev, 2007; Pavlenkova, 2007; Tveritinova and Vikulin, 2007] of a separate tectonic plates and geo-blocks (in the subsystem \( \tau_{ext} \)) under the external energy gravitational influences on the Earth. The intensification of the deformation and rotation of a separate tectonic plates and geo-blocks (in the subsystem \( \tau_{ext} \)) has the main role in the natural seismic activity of the Earth [Melnikov, 2007].

It was shown [Simonenko, 2007; 2009; 2010] that it is easier to realize (by action of the external cosmic gravitational field) the rotation of the separate geo-block (weakly coupled with the surrounding geo-blocks by means of the plastic surroundings (surrounding continuum) in the seismic zone of the Pacific Ring) than to split the geo-block by means of formation of the main line flat fracture. Using the similar reasoning (as for foundation of the stated above result of the monographs [Simonenko, 2007; 2009; 2010]) to the tectonic plate coupled by means of the plastic surroundings with the adjacent tectonic plates in the upper mantle, we established [Simonenko, 2007; 2009; 2010] that it is easier to realize (by action of the external cosmic gravitational field) the rotation of the separate tectonic plate (weakly coupled with the adjacent tectonic plates by means of the plastic surroundings) than to split of the tectonic plate by means of formation of the new main line flat tectonic fracture. We deduced [Simonenko, 2009; 2010] also that it is easier to realize (by action of the external cosmic gravitational field) the rotation of the mantle (as a whole relative to the fluid kernel with the slippage on the boundary of the kernel and the mantle of the Earth) than to split the mantle of the Earth by means of the new global tectonic fracture into two equal parts in the different sides of the main secant plane intersecting the centre of the Earth. This result is the base of the initial consideration of the model of the non-fragmentary geo-spheres of the planet. It was concluded [Simonenko, 2007; 2009; 2010] that the slippage of the mantle on the surface of the fluid kernel, deformation and rotation of the separate tectonic plates and geo-blocks relative to each other are the main non-equilibrium tectonic processes (mechanisms), which relax the external cosmic energy gravitational influences on the Earth (and on the planets of the Solar System).

Taking into account two estimates (180 million years [Zhirmunsky and Kuzmin, 1988] or 200 million years [Kazancev, 2002; p. 10]) for the time period of circulation of the Solar System around the center of our Galaxy and also the established unique period of 100 million years [Hofmann, 1990] of the maximal endogenous activity of the Earth [Morozov, 2007; p. 496], we concluded [Simonenko, 2007; 2009; 2010] that the time period of 200 million years corresponds exactly to the one circulation of the Solar System around the center of our Galaxy. In the frame of the considered thermohydrogravidynamic N-layer model of the non-fragmentary geo-spheres of the Earth (the planet of the Solar System), the time period of 200 million years corresponds really to the established unique period of 100 million years [Hofmann, 1990] of the maximal endogenous activity of the Earth. This correspondence is deduced rigorously from the evolution equation:

\[
\frac{d}{dt}(\mathbf{K}_i + \mathbf{\pi}_i) = \frac{d}{dt} \iiint_V \left( \frac{1}{2} \mathbf{v}^2 + \psi \right) \rho dV
\]
\[
\begin{align*}
&= \iint_{\tau} \text{div} v \, dV + \iint_{\tau} \left( \frac{2}{3} \eta - \eta_v \right) \left( \text{div} v \right)^2 \, dV - \iint_{\tau} 2 v (e_{ij})^2 \rho \, dV + \iint_{\tau} \left( v \cdot (n \cdot T) \right) d\Omega_n + \\
&\quad + \iint_{\tau} \left( (v_{int} \cdot \partial \tau_i) - v_{ext} (\partial \tau_i) \right) \cdot (m_i \cdot T) \, d\Sigma_{mi} + \iint_{\tau} \frac{\partial \Psi}{\partial t} \, dV,
\end{align*}
\]

for the sum \( K_{\tau} + \pi_{\tau} \) of the total macroscopic kinetic energy \( K_{\tau} \) and the total macroscopic potential (gravitational) energy \( \pi_{\tau} \) of the subsystem \( \tau \) (of the Earth or the planet of the Solar System) consisting from two subsystems (of the Newtonian compressible continuum): the whole kernel \( \tau_{int} \) and the whole mantle \( \tau_{ext} \) (surrounding the kernel), which can slip (as a whole) on the boundary surface \( \partial \tau_i \) (the surface of the kernel \( \tau_{int} \)) related with the tangential jump of the continuum velocity. Here (apart from the usual designations) \( n \) is the external unit normal vector of the surface \( \partial \tau \) of the subsystem \( \tau \) of the Earth (the planet \( \tau + \bar{\tau} \) of the Solar System), \( -m_i \) is the external unit normal vector of the internal surface \( \partial \tau_i \) of the mantle \( \tau_{ext} \), \( m_i \) is the external unit normal vector of the surface \( \partial \tau_i \) of the kernel \( \tau_{int} \), \( v_{ext} (\partial \tau_i) \) is the vector of the continuum velocity on the external side of the surface \( \partial \tau_i \) inside the mantle \( \tau_{ext} \), \( v_{int} (\partial \tau_i) \) is the vector of the continuum velocity on the internal side of the surface \( \partial \tau_i \) in the kernel \( \tau_{int} \). We remind that \( \Psi \) (in equation (2.32)) is the total gravitational potential taking into account the internal gravitational field (created by the subsystem \( \tau = \tau_{ext} + \tau_{int} \)) and the external gravitational field created by the whole external surroundings of the subsystem \( \tau = \tau_{ext} + \tau_{int} \): the subsystem \( \tau \) of the planet \( \tau + \bar{\tau} \), the Solar System and our Galaxy.

If the period of variations of the potential of the external gravitational field (acting on the composite subsystem \( \tau = \tau_{ext} + \tau_{int} \) of the planet \( \tau + \bar{\tau} \)) is equal to \( T_{eg} (\tau) \) then the same period of time \( T_{eg} (\tau) \) will characterize the periodic variations of the rate of strain tensor \( e_{ij} \) and the divergence \( \text{div} v \) of the velocity vector \( V \) of the continuum motion inside of the subsystem \( \tau = \tau_{ext} + \tau_{int} \) of the planet \( \tau + \bar{\tau} \). Then, according to equation (2.32), the period of variations of the total macroscopic kinetic and gravitational energies of the subsystem \( \tau = \tau_{ext} + \tau_{int} \) of the planet \( \tau + \bar{\tau} \) (as a result of the irreversible dissipation of the macroscopic kinetic energy described by the second and the third terms in the right-hand side of equation (2.32)) is equal to \( \frac{1}{2} T_{eg} (\tau) \) as a consequence that the quadratic functions \( (e_{ij})^2 \) and \( (\text{div} v)^2 \) have the time period \( \frac{1}{2} T_{eg} (\tau) \). It can be established for the harmonic law of change of the partial derivative \( \frac{\partial \Psi}{\partial t} \) on time.

The last term

\[
W_{gr} (\tau) = \iint_{\tau} \frac{\partial \Psi}{\partial t} \, dV
\]

in the right-hand side of equation (2.32) changes periodically owing to the periodic realignments of the structure of the Solar System during circulations of the Solar System (around the centre of our Galaxy) characterized by the time period of 200 million years, which is exactly two times larger than the time period 100 million years [Hofmann, 1990] of the maximal endogenous activity of the Earth [Morozov, 2007; p. 496]. These realignments of the structure of the Solar System must induce the periodic changes (characterized by the time period of 200 million years) of the gravitational field of the Sun and the planets of the Solar System influencing on the Earth.
We concluded [Simonenko, 2007; 2008; 2009; 2010] that the established time period of 100 million years [Hofmann, 1990] of the maximal endogenous activity of the Earth is the result (according to the equation (2.32)) of the periodic changes (characterized by the time period of 200 million years) of the potential of the gravitational field (of the Solar System and our Galaxy) influencing on the Earth considered in the frame of the Solar System as the cosmic material object moving around the center of our Galaxy. It was also concluded [Simonenko, 2007; 2008; 2009; 2010] that the same time period of 100 million years must characterize the maximal endogenous activities of all planets (and the satellites of the planets) of the Solar System.

2.3.2. Thermohydrogravidynamic translational-shear-rotational N-layer tectonic model of the fragmentary geo-spheres of the Earth (of a planet of the Solar System)

Following the monographs [Simonenko, 2007; 2008; 2009; 2010], we consider the thermohydrogravidynamic translational-shear-rotational N-layer tectonic model of the fragmentary geo-spheres of the Earth (of a planet of the Solar System) taking into account the convection in the lower geo-spheres of the Earth (of the planet), the solar radiation, the disintegration of the radio-active elements, the density differentiation, the translational, rotational, deformational and compressible movements of the tectonic plates, the creation of the new planetary fractures induced by the energy gravitational influences of the Solar System and our Galaxy. In accordance with the adopted conception [Abramov, 1993; Vikulin, 2003; Khain, 2003; Abramov and Molev, 2005] about the structure of the upper mantle of the Earth, we shall consider that the upper subsystem \( \tau_{\text{ext}} \) of a planet (of the terrestrial group) consists of a separate geo-fragments: tectonic plates and geo-blocks, which we shall designate as geo-blocks to not reduce the generality of the considered thermohydrogravidynamic approach. Consider an arbitrary j-th geo-block \( \tau_{ij} \) of the first upper subsystem \( \tau_{\text{ext}} \) of the planet (for example, the Earth). If the geo-block \( \tau_{ij} \) slips with the jump of the continuum velocity relative to a plastic layer \( \tau_{ij}^{\text{ext}} \) surrounding the geo-block \( \tau_{ij} \), then it gives [Simonenko, 2007; 2008; 2009; 2010] the additional term in the right-hand side of equation (2.27):

\[
\sum_{j=1}^{N_1} \int_{\partial \tau_{ij}} \left\{ \mathbf{v}_{\text{int}} (\partial \tau_{ij}) - \mathbf{v}_{\text{ext}} (\partial \tau_{ij}) \right\} \cdot (\mathbf{n}_{ij} \cdot \mathbf{T}) d\Sigma_{n_{ij}}, \tag{2.34}
\]

where \( \partial \tau_{ij} \) is the boundary surface of the geo-block \( \tau_{ij} \), \( \mathbf{v}_{\text{int}} (\partial \tau_{ij}) \) is the continuum velocity on the boundary surface \( \partial \tau_{ij} \) inside the geo-block \( \tau_{ij} \), \( \mathbf{v}_{\text{ext}} (\partial \tau_{ij}) \) is the continuum velocity (of the plastic layer surrounding the geo-block \( \tau_{ij} \)) on the boundary surface \( \partial \tau_{ij} \) inside the plastic layer, \( \mathbf{n}_{ij} \) is the external unit normal vector of the surface \( \partial \tau_{ij} \). Considering the geo-block \( \tau_{ij} \) surrounded by the plastic layer around the lateral and the lower boundary surfaces, we refer the plastic layer below the geo-block \( \tau_{ij} \) to the subsystem \( \tau_{\text{ext}} \) in the considered model of the subsystem \( \tau_{\text{ext}} \).

Consider the general case. We assume that for \( N_1 \) geo-blocks (plates) \( \tau_{ij} \) \((j = 1, 2, \ldots, N_1)\) of the first subsystem (layer or the geo-sphere) \( \tau_i = \tau_{\text{ext}} \) of the Earth there are the differences of the continuum velocities on the boundary surface \( \partial \tau_{ij} \) of each \( j = 1, 2, \ldots, N_1 \) geo-block \( \tau_{ij} \) \((j = 1, 2, \ldots, N_1)\) and in the plastic layer directly attached to the boundary \( \partial \tau_{ij} \). It is necessary [Simonenko, 2007; 2008; 2009; 2010] for this case to add the additional term (in the right-hand side of equation (2.27)) consisting of the sum of separate components (2.34) for each geo-block \( \tau_{ij} \) characterized by the number \( j \) \((j = 1, 2, \ldots, N_1)\):

\[
\sum_{i=1}^{N_1} \int_{\partial \tau_{ij}} \left\{ \mathbf{v}_{\text{int}} (\partial \tau_{ij}) - \mathbf{v}_{\text{ext}} (\partial \tau_{ij}) \right\} \cdot (\mathbf{n}_{ij} \cdot \mathbf{T}) d\Sigma_{n_{ij}}. \tag{2.35}
\]
Thus, if the subsystem $\tau_{\text{ext}}$ consists of $N_1$ separate geo-blocks $\tau_{ij}$ surrounded by the plastic layers then the equation (2.27) can be rewritten as follows [Simonenko, 2007; 2008; 2009; 2010]:

$$
\frac{d}{dt}(K_{\tau_{\text{ext}}} + U_{\tau_{\text{ext}}} + \Pi_{\tau_{\text{ext}}}) = \frac{d}{dt} \iint \left( \frac{1}{2} \mathbf{v}^2 + u + \psi \right) dV =
$$

$$
= \int \int \left\{ \mathbf{v} \cdot (n \cdot \mathbf{T}) - (J_q \cdot n) \right\} d\Omega_n - \int \int \left\{ \mathbf{v}_{\text{ext}} \cdot (\partial \tau_{ij}) \cdot (m_i \cdot \mathbf{T}) - (J_q \cdot m_i) \right\} d\Sigma_{m_i} +
$$

$$
+ \int \int \int \frac{\partial \psi}{\partial t} dV + \int \int \int \mathbf{e}_{\tau_{\text{ext}}} \cdot dV + \sum_{j=1}^{N_1} \int \int \left\{ \mathbf{v}_{\text{int}} \cdot (\partial \tau_{ij}) - \mathbf{v}_{\text{ext}} \right\} \cdot (n_{ij} \cdot \mathbf{T}) d\Sigma_{n_{ij}},
$$

where $\tau_{\text{ext}}$ is the upper subsystem containing of $N_1$ geo-blocks $\tau_{ij}$ ($j = 1, 2, \ldots, N_1$) surrounded by the plastic layers included completely to the subsystem $\tau_{\text{ext}}$. The macroscopic kinetic energy $K_{\tau_{\text{ext}}}$, the microscopic (molecular) internal energy $U_{\tau_{\text{ext}}}$ and the potential gravitational energy $\Pi_{\tau_{\text{ext}}}$ of the subsystem $\tau_{\text{ext}}$ consist of the corresponding sums of the energies of a separate geo-blocks and the corresponding energies of all plastic layers. The energies of a separate geo-blocks (for the great sizes of geo-blocks and narrow plastic layers) are much greater than the energies of plastic layers, which can be neglected. However, we cannot neglect the last term (presented by the sum in the right-hand side of equation (2.36)) since it expresses the power of energy expenses needed for the slippage of all geo-blocks $\tau_{ij}$ ($j = 1, 2, \ldots, N_1$) relative to its plastic surroundings. This term is very significant in the total energy balance. The equation (2.36) shows that the energy sources of the slippage of the geo-blocks $\tau_{ij}$ ($j = 1, 2, \ldots, N_1$) of the upper subsystem $\tau_1 = \tau_{\text{ext}}$ relative to the plastic surroundings (and also of the translational motions, rotations and deformations of the geo-blocks) are the non-stationary gravitational field (in the subsystem $\tau_{\text{ext}}$), the heating related with disintegration of radio-active elements (in the subsystem $\tau_{\text{ext}}$), the heat flux from the upper boundary of the (situated below) second layer (the subsystem) $\tau_2$ and the works of the stress forces on the upper boundary $\partial \tau$ and on the lower boundary $\partial \tau_1$ of the subsystem $\tau_1 = \tau_{\text{ext}}$ of the planet ($\tau + \overline{\tau}$).

In the following Subsection we consider the energy aspects related with the fracture formation in the arbitrary geo-block $\tau_{ij}$ defined by the index $j$ in the range from $j = 1$ up to $j = N_1$.

### 2.3.3. The universal thermohydrogravidynamic theory of formation of the planetary fractures in the frame of the generalized differential formulation of the first law of thermodynamics and the thermohydrogravidynamic translational-shear-rotational N-layer tectonic model of the fragmentary (consisting of geo-blocks) geo-spheres of the Earth (of the planet of the Solar System)

Following the monographs [Simonenko, 2007; 2008; 2009; 2010], we consider the universal thermohydrogravidynamic theory of formation of the planetary fractures in the frame of the generalized differential formulation (2.21) of the first law of thermodynamics and the thermohydrogravidynamic translational-shear-rotational N-layer tectonic model of the fragmentary (consisting of geo-blocks) geo-spheres of the Earth (of the planet of the Solar System). It was shown [Simonenko, 2007; 2008; 2009; 2010] that for the Pacific Ring (characterized by the presence of the plastic layers around the geo-blocks) it is more probably (from the energy viewpoint) to realize the rotation of the geo-blocks than to break up the geo-blocks related with formation of the new main line flat fractures. The process of formation of the main line flat fractures can be energetically more probable in reality with respect to the geo-blocks rotation for geo-blocks powerfully coupled between each other (as for solid crystalline rocks).
The splitting of the geo-block $\tau_{ij}$ (of the first layer (geo-sphere) $\tau_i = \tau_{\text{ext}}$ of the Earth) can be realized in reality by three possible variants: by formation of one or several main line flat fractures splitting the geo-block $\tau_{ij}$ into two or more number of parts, by formation of one or several twisted surfaces of fractures transient or not transient into the closed surfaces, and also by combination of one or several main line flat fractures with one or several twisted surfaces of fractures transient or not transient into the closed surfaces.

We consider now two (evaluated in monographs [Simonenko, 2007; 2008; 2009; 2010]) energy thermohydrogravidynamic approaches (describing the formation of the main line flat fracture of the geo-block and rotation of the geo-block surrounded by the plastic layer) and also three possible more general and pointed above variants of the geo-block destruction within the framework of the universal energy thermohydrogravidynamic approach describing the formation of an arbitrary breaking (to pieces) surface in the chosen geo-block $\tau_{ij}$.

Consider the energy aspect of the process of the fracture formation on the arbitrary surface $F_{ij}(\tau_{ij})$ (flat or twisted and finally, possibly, becoming closed) in the chosen geo-block $\tau_{ij}$. There is the possibility [Simonenko, 2007; 2008; 2009; 2010] to consider the processes of the fracture formation of various forms within the framework of the universal energy thermohydrogravidynamic approach. To use the energy thermohydrogravidynamic approaches [Simonenko, 2007; 2008; 2009; 2010] for the breaking (to pieces) surfaces of various forms it is necessary to adopt the following terminology and consider the additional geometric development.

Let us consider in beginning the formation of one arbitrary fracture surface (the continuum break) $F_{ij}(\tau_{ij})$ in the chosen geo-block $\tau_{ij}$ confined by the external surface $\partial \tau_{ij}$. If the surface $F_{ij}(\tau_{ij})$ is closed initially then we have the functional values of the continuum velocities vectors $v_{\text{int}}(F_{ij}(\tau_{ij}))$ and $v_{\text{ext}}(F_{ij}(\tau_{ij}))$ on the inner side of the surface $F_{ij}(\tau_{ij})$ and on the outer side of the surface $F_{ij}(\tau_{ij})$, respectively. Writing the evolution equations of the total energy for the internal subsystem ($\tau_{ij})_{\text{int}}$ (situated inside of the surface $F_{ij}(\tau_{ij})$) and for external subsystem ($\tau_{ij})_{\text{ext}}$ (situated between the surfaces $F_{ij}(\tau_{ij})$ and $\partial \tau_{ij}$) and then adding these equations, we obtained (similarly as it was made in Subsection 2.3.1 with equations (2.27) and (2.28) for the total energy of two combined subsystems $\tau_{\text{int}}$ and $\tau_{\text{ext}}$) the evolution equation [Simonenko, 2007; 2008; 2009; 2010] of the total energy of the geo-block $\tau_{ij}$ consisting of two interacting subsystem ($\tau_{ij})_{\text{int}}$ and ($\tau_{ij})_{\text{ext}}$:

$$
\frac{d}{dt} \left( K_{\tau_{ij}} + U_{\tau_{ij}} + \Pi_{\tau_{ij}} \right) = \frac{d}{dt} \int_{\tau_{ij}} \int \left( \frac{1}{2} v^2 + u + \psi \right) dV = 
\int_{\partial \tau_{ij}} \left( v \cdot (n_{ij} \cdot T) - (J_q \cdot n_{ij}) \right) d\Omega_{n_{ij}} + 
\int_{F_{ij}(\tau_{ij})} \left( v_{\text{int}}(F_{ij}(\tau_{ij})) - v_{\text{ext}}(F_{ij}(\tau_{ij})) \right) \cdot (m(F_{ij}(\tau_{ij})) \cdot T) d\Sigma m(F_{ij}(\tau_{ij})) + 
\int_{\tau_{ij}} \frac{\partial \psi}{\partial t} dV + \int_{\tau_{ij}} e_{\tau_{ij}} dV,
$$

where $v_{\text{int}}(F_{ij}(\tau_{ij}))$ is the continuum velocity vector on the inner side of the surface $F_{ij}(\tau_{ij})$ in the subsystem ($\tau_{ij})_{\text{int}}$, $v_{\text{ext}}(F_{ij}(\tau_{ij}))$ is the continuum velocity vector on the outer side of the surface $F_{ij}(\tau_{ij})$ in the subsystem ($\tau_{ij})_{\text{ext}}$, $n_{ij}$ is the external unit normal vector of the surface $\partial \tau_{ij}$ confined the geo-block $\tau_{ij}$, $d\Sigma m(F_{ij}(\tau_{ij}))$ is the element of area of the surface $\partial \tau_{ij}$, $m(F_{ij}(\tau_{ij}))$ is the external unit normal vector of the surface $F_{ij}(\tau_{ij})$, $e_{\tau_{ij}}$ is the space-time density of the heat sources (in the geo-block.
\( \tau_{ij} \) related with disintegration of radio-active elements.

Considering the formation of the integer number \( k_{ij}^{cl} \) of uncrossed between itself closed breaking (to pieces) surfaces \((F_{ij}(\tau_{ij}))_i \) \((i = 1, 2, \ldots, k_{ij}^{cl})\) in the geo-block \( \tau_{ij} \), we modified [Simonenko, 2007; 2008; 2009; 2010] the equation (2.37) by the change of the term presented in the third row by the following sum:

\[
\sum_{i=1}^{k_{ij}^{cl}} \int \int \left\{ v_{int}(F_{ij}(\tau_{ij}))_i - v_{ext}(F_{ij}(\tau_{ij}))_i \right\} \cdot (m(F_{ij}(\tau_{ij}))_i \cdot T)d\Sigma m(F_{ij}(\tau_{ij}))_i, \tag{2.38}
\]

where the index \( i \) designates the same values as in equation (2.37), only on the surface \((F_{ij}(\tau_{ij}))_i \). As a result (by using the mathematical inductive method), we obtained [Simonenko, 2007; 2008; 2009; 2010] the evolution equation (instead of equation (2.37)) for description of the total energy of the geo-block \( \tau_{ij} \) during formation of the integer number \( k_{ij}^{cl} \) of uncrossed between itself closed breaking (to pieces) surfaces \((F_{ij}(\tau_{ij}))_i \), \((i = 1, 2, \ldots, k_{ij}^{cl})\):

\[
\frac{d}{dt} \left( K_{\tau_{ij}} + U_{\tau_{ij}} + \Pi_{\tau_{ij}} \right) = \frac{d}{dt} \int \int \int \left( \frac{1}{2} v^2 + u + \psi \right) dV = \int \int \left\{ v \cdot (n_{\tau_{ij}} \cdot T) - (J_q \cdot n_{\tau_{ij}}) \right\} d\Omega_{n_{\tau_{ij}}} + \\
+ \sum_{i=1}^{k_{ij}^{cl}} \int \int \int \frac{\partial \psi}{\partial t} dV + \int \int \int e_{\tau_{ij}} dV. \tag{2.39}
\]

Let us consider now the formation of the unclosed breaking (to pieces) surface \( S_{ij}(\tau_{ij}) \) inside of the geo-block \( \tau_{ij} \) assuming that the surface \( S_{ij}(\tau_{ij}) \) do not reach the boundary surface \( \partial \tau_{ij} \) of the geo-block \( \tau_{ij} \). It is possible in this case to close mentally the surface as a result of the conceivable additional surface supposing naturally the equal values of the continuum velocities on the different sides of the conceivable additional surface. We obtained [Simonenko, 2007; 2008; 2009; 2010] in this case the evolution equation for the total energy:

\[
\frac{d}{dt} \left( K_{\tau_{ij}} + U_{\tau_{ij}} + \Pi_{\tau_{ij}} \right) = \frac{d}{dt} \int \int \int \left( \frac{1}{2} v^2 + u + \psi \right) dV = \int \int \left\{ v \cdot (n_{\tau_{ij}} \cdot T) - (J_q \cdot n_{\tau_{ij}}) \right\} d\Omega_{n_{\tau_{ij}}} + \\
+ \int \int \left\{ v_{int}(S_{ij}(\tau_{ij}))-v_{ext}(S_{ij}(\tau_{ij})) \right\} \cdot (m(S_{ij}(\tau_{ij})) \cdot T)d\Sigma m(S_{ij}(\tau_{ij})) + \\
+ \int \int \int \frac{\partial \psi}{\partial t} dV + \int \int \int e_{\tau_{ij}} dV, \tag{2.40}
\]

which is analogous to equation (2.37) with the corresponding to the considered case designations. The question concerning to the definition of the “internal” and “external” parts of the unclosed breaking surface \( S_{ij}(\tau_{ij}) \) and the corresponding continuum velocities \( v_{int}(S_{ij}(\tau_{ij})) \) and \( v_{ext}(S_{ij}(\tau_{ij})) \), respectively,
on the “internal” and “external” parts of the unclosed surface \( S_{ij}(\tau_{ij}) \) is decided by the simple agreement: by closing mentally unclosed breaking surface \( S_{ij}(\tau_{ij}) \) by the conceivable additional surface (on which there is no the jump of the continuum velocities), let us agree that this additional surface together with the surface \( S_{ij}(\tau_{ij}) \) should contain the mass center of the geo-block \( \tau_{ij} \). Then naturally to name by the “internal” part of the formed closed surface the side of this surface, inside of which is found the mass center of the considered geo-block.

Considering the formation of the integer number \( k_{ij}^{\text{uncl}} \) of unclosed uncrossed between itself breaking surfaces \( (S_{ij}(\tau_{ij}))_l \) \((l = 1, 2, \ldots, k_{ij}^{\text{uncl}})\) in the geo-block \( \tau_{ij} \), we also close mentally each surface \( (S_{ij}(\tau_{ij}))_l \) to obtain the closed surface (together with the conceivable additional surface for each \( l \)) containing the mass center of the geo-block \( \tau_{ij} \). In this case we modify the equation (2.40) by the change of the term situated in the third row by the sum. As a result, we obtained [Simonenko, 2007; 2008; 2009; 2010] the following evolution equation (by using the mathematical inductive method) for the total energy of the geo-block \( \tau_{ij} \) having \( k_{ij}^{\text{uncl}} \) unclosed uncrossed between itself breaking surfaces \( (S_{ij}(\tau_{ij}))_l \) \((l = 1, 2, \ldots, k_{ij}^{\text{uncl}})\):

\[
\frac{d}{dt}(K_{\tau_{ij}} + U_{\tau_{ij}} + \pi_{\tau_{ij}}) = \frac{d}{dt} \iiint_{\tau_{ij}} \left( \frac{1}{2} \mathbf{v}^2 + u + \psi \right) \rho dV = \\
= \iiint_{\tau_{ij}} \left\{ \mathbf{v} \cdot (\mathbf{n}_{ij} \cdot \mathbf{T}) - (\mathbf{J}_q \cdot \mathbf{n}_{ij}) \right\} d\Omega_{n_{ij}} + \\
+ \sum_{l=1}^{k_{ij}^{\text{uncl}}} \iiint_{(S_{ij}(\tau_{ij}))_l} \left\{ \mathbf{v}_{\text{int}} (S_{ij}(\tau_{ij}))_l - \mathbf{v}_{\text{ext}} (S_{ij}(\tau_{ij}))_l \right\} \cdot \left( \mathbf{m}(S_{ij}(\tau_{ij}))_l \cdot \mathbf{T} \right) d\Sigma_{m(S_{ij}(\tau_{ij}))_l} + \\
+ \iiint_{\tau_{ij}} \frac{\partial \psi}{\partial t} \rho dV + \iiint_{\tau_{ij}} \mathbf{e}_{\tau_{ij}} \rho dV, \quad (2.41)
\]

where the index \( l \) denotes the same values as in equation (2.40) only on the surface \( (F_{ij}(\tau_{ij}))_l \) for each \( l \).

It is clear that if some surface \( (F_{ij}(\tau_{ij}))_l \) (for certain \( l \)) reaches the surface \( \partial \tau_{ij} \) of the geo-block \( \tau_{ij} \) then the split geo-block \( \tau_{ij} \) gives two separate geo-blocks. We can consider in this case separately each split part of the geo-block \( \tau_{ij} \).

Using the previous results and designations, we deduced [Simonenko, 2007; 2008; 2009; 2010] the evolution equation (using the mathematical inductive method) for the total energy of the geo-block \( \tau_{ij} \) during the simultaneous formation (in the geo-block \( \tau_{ij} \)) of the integer number \( k_{ij}^{\text{cl}} \) of uncrossed between itself closed breaking surfaces \( (F_{ij}(\tau_{ij}))_i \) \((i = 1, 2, \ldots, k_{ij}^{\text{cl}})\) and the integer number \( k_{ij}^{\text{uncl}} \) of unclosed uncrossed between itself breaking surfaces \( (S_{ij}(\tau_{ij}))_l \) \((l = 1, 2, \ldots, k_{ij}^{\text{uncl}})\):

\[
\frac{d}{dt}(K_{\tau_{ij}} + U_{\tau_{ij}} + \pi_{\tau_{ij}}) = \frac{d}{dt} \iiint_{\tau_{ij}} \left( \frac{1}{2} \mathbf{v}^2 + u + \psi \right) \rho dV = \\
= \iiint_{\tau_{ij}} \left\{ \mathbf{v} \cdot (\mathbf{n}_{ij} \cdot \mathbf{T}) - (\mathbf{J}_q \cdot \mathbf{n}_{ij}) \right\} d\Omega_{n_{ij}} + \\
+ \sum_{i=1}^{k_{ij}^{\text{cl}}} \iiint_{(F_{ij}(\tau_{ij}))_i} \left\{ \mathbf{v}_{\text{int}} (F_{ij}(\tau_{ij}))_i - \mathbf{v}_{\text{ext}} (F_{ij}(\tau_{ij}))_i \right\} \cdot \left( \mathbf{m}(F_{ij}(\tau_{ij}))_i \cdot \mathbf{T} \right) d\Sigma_{m(F_{ij}(\tau_{ij}))_i} + \\
+ \sum_{l=1}^{k_{ij}^{\text{uncl}}} \iiint_{(S_{ij}(\tau_{ij}))_l} \left\{ \mathbf{v}_{\text{int}} (S_{ij}(\tau_{ij}))_l - \mathbf{v}_{\text{ext}} (S_{ij}(\tau_{ij}))_l \right\} \cdot \left( \mathbf{m}(S_{ij}(\tau_{ij}))_l \cdot \mathbf{T} \right) d\Sigma_{m(S_{ij}(\tau_{ij}))_l} + \\
+ \iiint_{\tau_{ij}} \frac{\partial \psi}{\partial t} \rho dV + \iiint_{\tau_{ij}} \mathbf{e}_{\tau_{ij}} \rho dV, \quad (2.41)
\]
According to the evolution equation (2.42) for the total energy of the geo-block $\tau_{ij}$, the real realization in the geo-block $\tau_{ij}$ of the integer number $k_{ij}^{el}$ of uncrossed between itself closed breaking surfaces $(F_{ij}(\tau_{ij}))_i$ (i = 1, 2, … , $k_{ij}^{el}$) and the integer number $k_{ij}^{unc}$ of unclosed uncrossed between itself breaking surfaces $(S_{ij}(\tau_{ij}))_l$ (l = 1, 2, … , $k_{ij}^{unc}$) requires the necessary energy power, which can realize the formation of fractures in the geo-block $\tau_{ij}$.

The process of the fractures formation (destruction) in the geo-block $\tau_{ij}$ (according to the evolution equation (2.42)) is defined by the energy powers (available for given geo-block $\tau_{ij}$) of different destructive energy influences (sources). These energy sources (according to the evolution equation (2.42)) for given geo-block $\tau_{ij}$ are: the total non-stationary gravitational fields (the external cosmic and the planetary), the internal heat related with the disintegration of the radio-active elements, the heat flux from the upper boundary of the situated below second layer (subsystem) $\tau_2$ and the work of stress forces on the surface of the geo-block $\tau_{ij}$. The role of the external non-stationary gravitational field (according to the evolution equation (2.42)) as the source of formation of fractures is increased by the fact [Abramov, 1993] that the gravitational energy dominates among all others energies for the Earth. It was also shown earlier [Avsjuk, 1996; Avsjuk and Suvorova, 2007] that the global evolution of the Sun-Earth-Moon system is determined by the non-stationary gravitational field.

It is clear that weak external non-stationary influences (including the gravitational influence) on the considered geo-block $\tau_{ij}$ cannot realize the fractures or can realize only one fracture from the considered closed or unclosed fractures of the geo-block $\tau_{ij}$ since the formation of fractures requires the sufficient power of the external energy influence on the considered geo-block $\tau_{ij}$. Obviously, the processes of formation of fractures in the Earth’s crust occur in reality in accordance with the formulated variational principle [Simonenko, 2007; 2008; 2009; 2010]: the processes of the fractures formation in the Earth’s crust occur on the surfaces, where the forced energy influences are sufficiently intense to form the fractures formation.

Considering the total ensemble of geo-blocks $\tau_{ij}$ (j = 1, 2, … , $N_1$) of the first upper geo-sphere $\tau_1 = \tau_{ext}$ of the planet (for example, the Earth) and using the set of equations (2.42) for j = 1, 2, … , $N_1$, we deduced [Simonenko, 2007; 2008; 2009; 2010] that the processes of destruction and rotation of the geo-blocks in the upper geo-sphere $\tau_i = \tau_{ext}$ (or in the some subsystem of the upper geo-sphere $\tau_i = \tau_{ext}$) should be initiated (owing to the specific characteristics of the geo-blocks structure and the properties of the plastic surroundings of the geo-blocks) by the general increase ($\partial\psi/\partial t > 0$) of the gravitational potential and by the increase of intensity of the others earlier established factors of the fracture formation. It was concluded [Simonenko, 2007; 2008; 2009; 2010] that the general increase of the gravitational potential ($\partial\psi/\partial t > 0$) is related with the general increase of the seismotectonic activity (associated with the partial or total splitting of the separate geo-blocks, by the geo-blocks rotation and by the slippage of the separate adjacent geo-blocks) before the strong earthquakes (characterized by the simultaneous slippage, splitting,
rotation of the several geo-blocks coupled by the plastic layers) and before the global planetary cataclysms characterized by the slippage along the weakened global planetary fractures (such as the “Atlantiok” zone [Abramov, 1997; p. 70] penetrating the Eurasian continent from the Pacific Ocean to the Atlantic Ocean and the Great Britain, the rotation of the upper mantle (as a whole) relative the lower mantle characterized by the slippage in the intermediate connecting zone [Pavlenkova, 2007; p. 107], and by formation of the new global planetary fractures penetrating the Earth’s continents as a whole. The stated theoretical conclusion [Simonenko, 2007; 2008; 2009; 2010] is in agreement with the early established [Keylis-Borok and Malinovskaya, 1964] and exceptionally significant [Richter, 1964] regularity related with the general increase of seismic activity before the strong earthquakes.

Thus, we have demonstrated the established [Simonenko, 2007; 2008; 2009; 2010] exceptionally significant role of the external cosmic non-stationary gravitational field (changing the figure of the Earth and the gravitational field of the Earth acting on the considered geo-block $\tau_{ij}$) for formation of fractures realizing the tectonic processes in the Earth’s crust. The stated [Simonenko, 2007; 2008; 2009; 2010] conclusion confirmed the Khain’s suggestion that the movements along the weakened planetary fractures “can occur owing to the influence of the astronomical factors” [Khain, 1958; p. 138].

In the following Subsection we shall present the evaluated [Simonenko, 2007; 2008; 2009; 2010] deterministic cosmic energy gravitational influences on the Earth of the planets of the Solar System and the Moon, and also the new evaluations of the very significant deterministic cosmic energy gravitational influences on the Earth of the Sun owing to the gravitational interaction of the Sun with the outer large planets (mainly due to energy gravitational influences of the Jupiter and the Saturn on the Sun).
3. THE COSMIC GEOPHYSICS

3.1. The energy gravitational influences on the Earth of the planets of the Solar System

3.1.1. The instantaneous energy gravitational influences on the Earth of the planets of the Solar System in the approximation of the elliptical orbits of the planets

We consider the movement of the Earth $\tau_i$ and the inner (or outer) planet $\tau_i$ around the Sun $\tau_{0,0}$ in the approximation of the elliptical orbits of the planets. The planets revolve in the ecliptic plane $XZ$ (see Fig. 4). To obtain the expression for the energy gravitational influences on the Earth (in the second approximation) of the inner and the outer planets, we consider the mass center of the Sun located at the fixed point O of the origin of the coordinate system. The mass center $C_i$ of the Earth $\tau_i$, the mass center O of the Sun and the mass center $C_i$ of the inner $(i=1, 2)$ and the outer $(i=4, 5, 6, 7, 8, 9)$ planet $\tau_i$ are located on the direct coordinate axis $X$ at a certain initial time moment $t = 0$ characterized by the minimal distance between the mass center $C_i$ of the inner $(i=1, 2)$ and the outer $(i=4, 5, 6, 7, 8, 9)$ planet $\tau_i$ and the mass center $C_i$ of the Earth $\tau_i$. The fixed mass center O of the Sun is considered as the right focus of the elliptical orbits of the inner $(i=1, 2)$ planet $\tau_i$, the outer $(i=4, 5, 6, 7, 8, 9)$ planet $\tau_i$ and the Earth $\tau_i$.

![Fig. 4. The geometric sketch of circulation of the outer planet $\tau_i$ (the Mars or the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) and the Earth $\tau_3$ around the mass center O of the Sun](image)

We have the following relations:

$$r_i(\varphi_i(t)) = \frac{p_i}{(1 + e_i \cos \varphi_i(t))}, \quad (i=1, 2, 4, 5, 6, 7, 8, 9)$$

(3.1)
\[ \psi_{3i}(C_3, \text{int, ext, } t, \varphi_i(t)) = -\frac{\gamma M_i}{r_{3i}(C_3, C_i, t)}, \]  

(3.3)

for the distance \( r_i(\varphi_i(t)) \) between the mass center \( O \) of the Sun and the mass center \( C_i \) of the inner \((i=1, 2)\) or the outer \((i=4, 5, 6, 7, 8, 9)\) planet \( \tau_i \) and for the distance \( r_3(\varphi_3(t)) \) between the mass center \( O \) of the Sun and the mass center \( C_4 \) of the Earth \( \tau_4 \). Here \( P_i \) and \( e_i \) are the focal parameter and the eccentricity, respectively, of the elliptical orbit of the inner \((i=1, 2)\) and the outer \((i=4, 5, 6, 7, 8, 9)\) planet \( \tau_i \), \( P_3 \) and \( e_3 \) are the focal parameter and the eccentricity, respectively, of the elliptical Earth’s orbit. We have \( \varphi_i(0) = 0 \) \((i=1, 2, 3, 4, 5, 6, 7, 8, 9)\) for the initial time moment \( t = 0 \).

We shall consider the gravitational potential \( \psi_{3i}(C_3, \text{int, ext, } t, r_3(\varphi_3(t))) \) created by the inner \((i=1, 2)\) or the outer \((i=4, 5, 6, 7, 8, 9)\) planet \( \tau_i \) in the mass center \( C_i \) (of the Earth \( \tau_4 \)) characterized by the distance \( r_3(\varphi_3(t)) \) from the mass center \( O \) of the Sun:

\[ \psi_{3i}(C_3, \text{int, ext, } t, r_3(\varphi_3(t))) = -\frac{\gamma M_i}{r_{3i}(C_3, C_i, t)}, \]  

(3.3)

where \( r_{3i}(C_3, C_i, t) \) is the distance between the mass center \( C_i \) of the Earth \( \tau_i \) and the mass center \( C_i \) of the inner \((i=1, 2)\) or the outer \((i=4, 5, 6, 7, 8, 9)\) planet \( \tau_i \). We find the distance \( r_{3i}(C_3, C_i, t) \) for the outer \((i=4, 5, 6, 7, 8, 9)\) planet \( \tau_i \) from the following relation:

\[ (r_{3i}(C_3, C_i, t))^2 = (r_3(\varphi_3(t)))^2 + (r_i(\varphi_i(t)))^2 - r_3(\varphi_3(t)) r_i(\varphi_i(t)) \cos(\varphi_3(t) - \varphi_i(t)), \]  

(3.4)

which is valid also for the inner \((i=1, 2)\) planet \( \tau_i \) owing to the equality \( \cos(\varphi_3(t) - \varphi_i(t)) = \cos(\varphi_i(t) - \varphi_3(t)) \). Consequently, the relation (3.3) can be rewritten as follows:

\[ \psi_{3i}(C_3, \text{int, ext, } t, r_3(\varphi_3(t))) = \]  

(3.5)

and the partial derivative \( \frac{\partial}{\partial t} \psi_{3i}(C_3, \text{int, ext, } t, r_3(\varphi_3(t))) \) of the gravitational potential (3.5):

\[ \frac{\partial}{\partial t} \psi_{3i}(C_3, \text{int, ext, } t, r_3(\varphi_3(t))) = \]  

(3.6)

where \( r_i(\varphi_i(t)) \) (between the mass center \( O \) of the Sun and the mass center \( C_i \) of the inner \((i=1, 2)\) or the outer \((i=4, 5, 6, 7, 8, 9)\) planet \( \tau_i \) ) and the distance \( r_3(\varphi_3(t)) \) (between the mass center \( O \) of the Sun and the mass center \( C_i \) of the Earth \( \tau_4 \) ) are given by the relations (3.1) and (3.2), respectively.
The expression (3.6) is reduced to the expression [Simonenko, 2007]

\[
\frac{\partial}{\partial t} \psi_3(C_3, \text{int}) = \frac{\partial}{\partial t} \psi_3(C_3, \text{ext}) = \frac{\gamma M_i R_{03} R_{03} \omega_i \sin(\omega_i - \omega_i) t}{\left[R_{03}^2 + R_{03}^2 - 2R_{03} R_{03} \cos(\omega_i - \omega_i) t\right]^{3/2}}
\]

(3.7)

under the following conditions: \( e_i = 0, \ e_3 = 0 \) and \( d\varphi_i(t)/dt = \omega_i \) corresponding to the circular orbits of the planet \( \tau_i \) (i=1, 2, 4, 5, 6, 7, 8, 9) and the Earth \( \tau_\text{e} \). The obtained expression (3.6) for the partial derivative \( \frac{\partial}{\partial t} \psi_3(C_3, \text{int}, \text{ext}, t, r_3(\varphi_3(t))) \) generalizes the expression (3.7) corresponding to the circular orbits of the planet \( \tau_i \) (i=1, 2, 4, 5, 6, 7, 8, 9) and the Earth \( \tau_\text{e} \) by taking into account the eccentricity \( e_i \) of the elliptical orbit of the inner (i=1, 2) or the outer (i=4, 5, 6, 7, 8, 9) planet \( \tau_i \) and the eccentricity \( e_3 \) of the elliptical orbit of the Earth \( \tau_\text{e} \).

The first term in the figured brackets of the expression (3.6) gives the principal contribution to the partial derivative \( \frac{\partial}{\partial t} \psi_3(C_3, \text{int}, \text{ext}, t, r_3(\varphi_3(t))) \). The expression (3.6) contains the additional two small terms (vanishing at \( e_i \to 0 \) and \( e_3 \to 0 \)) related with the contribution to the partial derivative \( \frac{\partial}{\partial t} \psi_3(C_3, \text{int}, \text{ext}, t, r_3(\varphi_3(t))) \) of the eccentricities \( e_i \) and \( e_3 \) of the elliptical orbits of the planet \( \tau_i \) (i=1, 2, 4, 5, 6, 7, 8, 9) and the Earth \( \tau_\text{e} \), respectively.

The combined maximal contribution of these additional two terms to the partial derivative \( \frac{\partial}{\partial t} \psi_3(C_3, \text{int}, \text{ext}, t, r_3(\varphi_3(t))) \) is of the order

\[
O(e_i, e_3) \left( \max \left| \frac{\partial}{\partial t} \psi_3(C_3, \text{int}) \right| \right) \quad (3.8)
\]

for the inner (i=1, 2) planet \( \tau_1 \), and of the order

\[
O(e_i, e_3) \left( \max \left| \frac{\partial}{\partial t} \psi_3(C_3, \text{ext}) \right| \right) \quad (3.9)
\]

for the outer (i=4, 5, 6, 7, 8, 9) planet \( \tau_4 \). Consequently, the contribution of the first term in the figured brackets of the expression (3.6) is \( O(1/|e_i|, 1/|e_3|) \) times larger than the contribution of the additional two new terms related with the eccentricities \( e_i \) and \( e_3 \) of the elliptical orbits of the planet \( \tau_i \) (i=1, 2, 4, 5, 6, 7, 8, 9) and the Earth \( \tau_\text{e} \), respectively. Using the maximal eccentricity \( e_i = 0.206 \) of the Mercury’s orbit, we have that the contribution of the first term in the figured brackets of the expression (3.6) is approximately 5 times larger than the contribution of the additional two new terms (in the figured brackets of the expression (3.6)) related with the eccentricities \( e_i = 0.206 \) and \( e_3 = 0.017 \) of the elliptical orbits of the Mercury \( \tau_1 \) and the Earth \( \tau_\text{e} \), respectively. We have that the first term (in the figured brackets of the expression (3.6)) is significantly larger than the contribution of the additional two new terms for the others planets (of the Solar System) having the small eccentricities of the elliptical orbits.

Thus, the obtained [Simonenko, 2007; 2009; 2010] evaluation (in the frame of the first approximation of the circular orbits of the planets) of the relative maximal energy gravitational influences on the Earth (of the planets of the Solar System) may be considered as the first sound approximation for the evaluation of the relative maximal energy gravitational influences of the inner (i=1, 2) and the outer (i=4, 5, 6, 7, 8, 9) planets on the Earth. We present in Subsection 3.1.2 the obtained [Simonenko, 2007; 2009; 2010] evaluation of the maximal positive value \( \max \left| \frac{\partial}{\partial t} \psi_3(C_3, \text{int}) \right| \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_3(C_3, \text{int}) \) of
the gravitational potential $\psi_{3_1}(C_3,\text{int})$ created by the inner planet $\tau_i$ at the mass center $C_3$ of the Earth $\tau_s$) and the maximal positive value $\max \frac{\partial}{\partial t} \psi_{3_1}(C_3,\text{ext})$ (of the partial derivative $\frac{\partial}{\partial t} \psi_{3_1}(C_3,\text{ext})$) of the gravitational potential $\psi_{3_1}(C_3,\text{ext})$ created by the outer planet $\tau_i$ at the mass center $C_3$ of the Earth $\tau_s$. 

3.1.2. The evaluation of the relative maximal planetary instantaneous energy gravitational influences on the Earth in the approximation of the circular orbits of the planets of the Solar System

Following the monograph [Simonenko, 2007], we consider the movement of the Earth $\tau_s$ and the inner planet $\tau_i$ around the Sun $\tau_{0,0}$ in the first approximation of the circular orbits of the planets. The planets revolve in the ecliptic plane $XZ$ (see Fig. 5 and Fig. 6). The mass center of the Sun is located at the fixed point $O$ of the origin of the coordinate system. The mass center $C_3$ of the Earth, the mass center $O$ of the Sun and the mass center $C_i$ of the inner planet $\tau_i$ are located on the direct coordinate axis $X$ at a certain initial time moment $t=0$ characterized by the minimal distance between the Earth and the inner planet $\tau_i$ (see Fig. 5).

![Diagram](image)

Fig. 5. The initial ($t=0$) planetary configuration characterized by the opposition of the inner planet $\tau_i$ (the Mercury or the Venus) and the Earth $\tau_s$.

We have the expressions for the angles $\varphi_i$ and $\varphi_s$:

$$\varphi_i = \omega_i t = \frac{2\pi}{T_i} t,$$

(3.10)
which describe the positions of the mass centers of the planet $\tau_i$ and the Earth $\tau_i$ during the time $t$.

We shall consider the gravitational potential $\psi_{\text{int}}(C_3, \text{int})$

$$\psi_{\text{int}}(C_3, \text{int}) = -\gamma \frac{M_i}{d_{\text{int}}(C_3)}$$  \hspace{1cm} (3.12)

created by the inner planet $\tau_i$ in the mass center $C_3$ of the Earth. We find the distance $d_{\text{int}}(C_3)$ between the mass center $C_i$ of the inner planet $\tau_i$ and the mass center $C_3$ of the Earth (see Fig. 7) from the following relation:

$$d_{\text{int}}^2(C_3) = (R_{O3}^2 + R_{Oi}^2 - 2R_{O3}R_{Oi}\cos(\omega_i t - \varphi_i)).$$  \hspace{1cm} (3.13)

The relation (3.12) can be rewritten as follows [Simonenko, 2007]:

$$\psi_{\text{int}}(C_3, \text{int}) = -\gamma \frac{M_i}{\sqrt{R_{O3}^2 + R_{Oi}^2 - 2R_{O3}R_{Oi}\cos(\omega_i t - \varphi_i)}}.$$  \hspace{1cm} (3.14)

Fig. 6. The initial planetary configuration of the outer planet $\tau_i$ (the Mars or the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) and the Earth $\tau_i$

We derived [Simonenko, 2007] the expression for the partial derivative $\frac{\partial}{\partial t} \psi_{\text{int}}(C_3, \text{int})$ of the gravitational potential (3.14):
\[ \frac{\partial}{\partial t} \psi_{3i}(C_i, \text{int}) = \frac{\gamma M_i R_{03} R_{0i} \omega_i \sin(\omega_i - \omega_i) t}{[R_{03}^2 + R_{0i}^2 - 2R_{03} R_{0i} \cos(\omega_i - \omega_i) t]^{3/2}}, \]  

(3.15)

which reduces to zero for the time moments \( t_n(i, 3) = \frac{T_i T_n}{2 (T_i - T_n)} \) (for \( i = 1, 2; n = 0, 1, 2,... \)), when the mass centers of the Sun, the Earth and the inner planet \( \tau_i \) are located on the direct line.

Let us consider Fig. 8 for the Earth and the outer planet \( \tau_i \). We have (for configuration of the Earth and the outer planet \( \tau_i \), shown on Fig. 8) the expression for the distance \( d_{3i}(C_3) \) between the mass center \( C_i \) of the planet \( \tau_i \) and the mass center \( C_3 \) of the Earth:

\[ d_{3i}^2(C_3) = R_{03}^2 + R_{0i}^2 - 2R_{03} R_{0i} \cos(\omega_i - \omega_i) t. \]  

(3.16)

The gravitational potential created by the outer planet \( \tau_i \) at the point \( C_3 \) (for configuration shown on Fig. 8) is given by the following expression:

\[ \psi_{3i}(C_3, \text{ext}) = -\frac{\gamma M_i}{d_{3i}(C_3)} = -\frac{\gamma M_i}{\sqrt{R_{03}^2 + R_{0i}^2 - 2R_{03} R_{0i} \cos(\omega_i - \omega_i) t}}. \]  

(3.17)

We derived [Simonenko, 2007] the expression of the partial derivative \( \frac{\partial}{\partial t} \psi_{3i}(C_3, \text{ext}) \) of the expression (3.17):

\[ \frac{\partial}{\partial t} \psi_{3i}(C_3, \text{ext}) = -\frac{\gamma M_i R_{03} R_{0i} \omega_i \sin(\omega_i - \omega_i) t}{[R_{03}^2 + R_{0i}^2 - 2R_{03} R_{0i} \cos(\omega_i - \omega_i) t]^{3/2}}. \]  

(3.18)

![Fig. 7. The geometric sketch of circulations of the Earth \( \tau_3 \) and the inner planet \( \tau_i \) (the Mercury or the Venus) around the mass center \( O \) of the Sun](image)

We used [Simonenko, 2009; 2010] the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \) of the gravitational potential \( \psi_{3M}(C_3, \text{int}) \) created by the Mercury at the mass center \( C_3 \) of the Earth) as a scale of the energy gravitational influence of the planets of the Solar System on...
the Earth in the considered first approximation of the circular orbits of the planets. To evaluate the relative energy gravitational influence of the inner planet \( \tau \) (the Mercury or the Venus) at the mass center \( C_3 \) of the Earth, we considered [Simonenko, 2009; 2010] the ratio \( f(i, C_3) \) of the maximal positive value \[ \max \frac{\partial \psi_{3i}(C_3, \text{int})}{\partial t} \] (of the partial derivative \( \frac{\partial \psi_{3i}(C_3, \text{int})}{\partial t} \)) of the gravitational potential \( \psi_{3i}(C_3, \text{int}) \) created by the inner planet \( \tau_i \) at the point \( C_3 \) and the maximal positive value \[ \max \frac{\partial \psi_{3m}(C_3, \text{int})}{\partial t} \] (of the partial derivative \( \frac{\partial \psi_{3m}(C_3, \text{int})}{\partial t} \)) of the gravitational potential \( \psi_{3m}(C_3, \text{int}) \equiv \psi_{3m}(C_3, \text{int}) \) created by the Mercury at the mass center \( C_3 \) of the Earth):

\[
f(i, C_3) = \frac{\max \frac{\partial \psi_{3i}(C_3, \text{int})}{\partial t}}{\max \frac{\partial \psi_{3m}(C_3, \text{int})}{\partial t}} \quad (i = 1, 2)
\]

(3.19)

\[ \text{Fig. 8. The geometric sketch of circulation of the outer planet } \tau_1 (\text{the Mars or the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto}) \text{ and the Earth } \tau_3 \text{ around the mass center } O \text{ of the Sun} \]

We obtained [Simonenko, 2009; 2010] from expression (3.19) the obvious value \( f(1, C_3) = 1 \) for the Mercury \( \tau_1 \) \((i = 1)\). Using the formula (3.19) for the Venus \((i = 2)\), we calculated [Simonenko, 2009; 2010] the numerical value \( f(2, C_3) = 37.69807434 \) for the following numerical values [Zhirmunsky and Kuzmin, 1990]: the mass \( M_M = 0.06M_3 \) of the Mercury, where \( M_3 \) is the mass of the Earth; the mass \( M_V = M_2 = 0.82M_3 \) of the Venus; the time period \( T_3 = 365.3 \) days of the Earth’s circulation around the Sun; the time period \( T_M = 88 \) days of the Mercury’s circulation around the Sun; the time period \( T_V = T_2 = 224.7 \) days of the Venusian circulation around the Sun; the average radius \( R_{OM} = R_{O1} = 57.85 \cdot 10^6 \) km of the Mercury’s orbit around the Sun; the average radius \( R_{O3} = 149.6 \cdot 10^6 \) km of the Earth’s orbit and the average radius \( R_{OV} = R_{O2} = 108.1 \cdot 10^6 \) km of the Venusian orbit around the Sun. The calculated value \( f(2, C_3) = 37.69807434 \) means that the power of the maximal energy gravitational Venusian influence (on the unit mass at the mass center \( C_3 \) of the Earth) is \( f(2, C_3) = 37.69807434 \) times larger than the power of the maximal energy gravitational
To evaluate the relative energy gravitational influence on the Earth of the outer planet \( \tau_i \) at the mass center \( C_3 \) of the Earth, we considered [Simonenko, 2009; 2010] the ratio \( f(i, C_3) \) (for \( i = 4, 5, 6, 7, 8, 9 \)) of the maximal value \( \max \frac{\partial}{\partial t} \psi_3(C_3, \text{ext}) \) of the partial derivative \( \frac{\partial}{\partial t} \psi_3(C_3, \text{ext}) \) of the gravitational potential \( \psi_3(C_3, \text{ext}) \) (created by the outer planet \( \tau_i \) at the mass center \( C_3 \) of the Earth) and the maximal value \( \max \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \) of the partial derivative \( \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \) of the gravitational potential \( \psi_{3M}(D_3, \text{int}) \) (created by the Mercury at the mass center \( C_3 \) of the Earth):

\[
f(i, C_3) = \frac{\max \frac{\partial}{\partial t} \psi_3(C_3, \text{ext})}{\max \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int})}. \quad (i = 4, 5, 6, 7, 8, 9)
\]

Using the formula (3.20), we calculated [Simonenko, 2009; 2010] the following numerical values:

\[
f(4, C_3) = 0.67441034 \quad \text{(for the Mars \( \tau_4 \), \( i = 4 \))}, \quad f(5, C_3) = 7.41055774 \quad \text{(for the Jupiter \( \tau_5 \), \( i = 5 \))}, \quad f(6, C_3) = 0.24601009 \quad \text{(for the Saturn \( \tau_6 \), \( i = 6 \))}, \quad f(7, C_3) = 0.00319056 \quad \text{(for the Uranus \( \tau_7 \), \( i = 7 \))}, \quad f(8, C_3) = 0.00077565 \quad \text{(for the Neptune \( \tau_8 \), \( i = 8 \))} \quad \text{and} \quad f(9, C_3) = 3.4813 \times 10^8 \quad \text{(for the Pluto \( \tau_9 \), \( i = 9 \))}.
\]

We used the following additional planetary numerical values [Zhirmunsky and Kuzmin, 1990]: the mass \( M_{\text{MARS}} = M_4 = 0.11 M_3 \) of the Mars, the time period \( T_{\text{MARS}} = T_4 = 687 \) days of the Mars circulation around the Sun, the average radius \( R_{\text{MARS}} = R_4 = 227.7 \times 10^6 \) km of the Mars’ orbit, the mass \( M_5 = 318 M_3 \) of the Jupiter, the time period \( T_5 = T_5 = 4332 \) days of the Jupiter’s circulation around the Sun, the average radius \( R_5 = R_5 = 776.6 \times 10^8 \) km of the Jupiter’s orbit, the time period \( T_{\text{SAT}} = T_6 = 10759 \) days of the Saturn’s circulation around the Sun, the mass \( M_{\text{SAT}} = M_9 = 95.2 M_3 \) of the Saturn, the average radius \( R_{\text{SAT}} = R_6 = 1426 \times 10^8 \) km of the Saturn’s orbit, the mass \( M_6 = M_6 = 146 M_3 \) of the Uranus, the time period \( T_6 = T_6 = 30685 \) days of the Uranus’ circulation around the Sun, the average radius \( R_{\text{U}} = R_7 = 2868 \times 10^8 \) km of the Uranus’ orbit, the mass \( M_7 = M_7 = 172 M_5 \) of the Neptune, the average radius \( R_8 = R_8 = 4497 \times 10^8 \) km of the Neptune’s orbit, the time period \( T_7 = T_7 = 60189 \) days of the Neptune’s circulation around the Sun, the mass \( M_8 = M_8 = 0.002 M_5 \) of the Pluto, the time period \( T_8 = T_8 = 90465 \) days of the Pluto’s circulation around the Sun and the average radius \( R_9 = R_9 = 5900 \times 10^8 \) km of the Pluto’s orbit.

Taking into account the calculated powers of the maximal energy gravitational influences of the planets on the unit mass of the Earth (at the mass center \( C_3 \) of the Earth) in the frame of the considered first approximation of the circular orbits of the planets, we obtained [Simonenko, 2009; 2010] the following numerical sequence of the non-dimensional relative maximal powers of the planetary energy gravitational influences on the unit mass of the Earth (at the mass center \( C_3 \) of the Earth): \( f(2, C_3) = 37.69807434 \) (for the Venus), \( f(5, C_3) = 7.41055774 \) (for the Jupiter), \( f(1, C_3) = 1 \) (for the Mercury), \( f(4, C_3) = 0.67441034 \) (for the Mars), \( f(6, C_3) = 0.24601009 \) (for the Saturn), \( f(7, C_3) = 0.00319056 \) (for the Uranus), \( f(8, C_3) = 0.00077565 \) (for the Neptune) and \( f(9, C_3) = 3.4813 \times 10^8 \) (for the Pluto).

To evaluate the relative energy gravitational influence of the inner planets \( \tau_i \) (the Mercury and the Venus) and the outer planets \( \tau_i \) (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) at the surface point \( D_3 \) (which is the intersection of the direct line (connecting the mass center \( O \) of the Sun and the mass center \( C_3 \) of the Earth) with the surface of the Earth), we obtained [Simonenko, 2007] the gravitational potential \( \psi_3(D_3, \text{int}) \)

\[
\psi_3(D_3, \text{int}) = \frac{\gamma M_i}{\sqrt{(R_3 - R_3)^2 + R_3^2 - 2(R_3 - R_3)R_3 \cos(\omega_1 t - \varphi_1)}}. \quad (3.21)
\]

created by the inner planet \( \tau_i \) at the surface point \( D_3 \) of the Earth. We derived [Simonenko, 2007] the expression for the partial derivative \( \frac{\partial}{\partial t} \psi_3(D_3, \text{int}) \) of the gravitational potential (3.21):
\[
\frac{\partial}{\partial t} \psi_{3\alpha}(D_1, \text{int}) = \frac{\gamma M_i (R_{o3} - R_3) R_{o3} \omega_3 \sin(\omega_3 - \omega_i) t}{[(R_{o3} - R_3)^2 + R_{o3}^2 - 2(R_{o3} - R_3) R_{o3} \cos(\omega_3 - \omega_i) t]^{3/2}}. \tag{3.22}
\]

The gravitational potential created by the outer planet \( \tau_i \) at the surface point \( D_3 \) (for configuration shown in Fig. 8) is given by the following expression [Simonenko, 2007]:

\[
\psi_{3\alpha}(D_3, \text{ext}) = -\frac{\gamma M_i}{d_3(D_3)} = -\frac{\gamma M_i}{\sqrt{(R_{o3} - R_3)^2 + R_{o3}^2 - 2(R_{o3} - R_3) R_{o3} \cos(\phi_3 - \omega_i) t}}. \tag{3.23}
\]

We derived [Simonenko, 2007] the expression of the partial derivative \( \frac{\partial}{\partial t} \psi_{3\alpha}(D_3, \text{ext}) \) of the gravitational potential (3.23):

\[
\frac{\partial}{\partial t} \psi_{3\alpha}(D_3, \text{ext}) = -\frac{\gamma M_i (R_{o3} - R_3) R_{o3} \omega_3 \sin(\omega_3 - \omega_i) t}{[(R_{o3} - R_3)^2 + R_{o3}^2 - 2(R_{o3} - R_3) R_{o3} \cos(\omega_3 - \omega_i) t]^{3/2}}, \tag{3.24}
\]

which is reduced to the relation (3.22) as a consequence of the equalities \( \sin(\omega_3 - \omega_i) t = -\sin(\omega_3 - \omega_i) t \) and \( \cos(\omega_3 - \omega_i) t = \cos(\omega_3 - \omega_i) t \). However, we take into account that the expression (3.24) is given for the outer planet \( \tau_i \), but the expression (3.22) is given for the inner planet \( \tau_i \).

We used [Simonenko, 2007; 2009; 2010] the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3M}(D_3, \text{int}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3M}(D_3, \text{int}) \) of the gravitational potential \( \psi_{3M}(D_3, \text{int}) \) created by the Mercury at the surface point \( D_3 \) of the Earth) as a scale of the energy gravitational influence of the planets of the Solar System on the Earth (at the surface point \( D_3 \)) in the considered first approximation of the circular orbits of the planets.

To evaluate the relative energy gravitational influence of the inner planet \( \tau_i \) (the Mercury and the Venus) at the surface point \( D_3 \), we considered [Simonenko, 2007; 2009; 2010] the ratio \( f(i, D_3) \) of the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3\alpha}(D_3, \text{int}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3\alpha}(D_3, \text{int}) \) of the gravitational potential \( \psi_{3\alpha}(D_3, \text{int}) \) created by the inner planet \( \tau_i \) at the point \( D_3 \)) and the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3M}(D_3, \text{int}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3M}(D_3, \text{int}) \) of the gravitational potential \( \psi_{3M}(D_3, \text{int}) \equiv \psi_{3M}(D_3, \text{int}) \) created by the Mercury at the surface point \( D_3 \) of the Earth):

\[
f(i, D_3) = \frac{\max \frac{\partial}{\partial t} \psi_{3\alpha}(D_3, \text{int})}{\max \frac{\partial}{\partial t} \psi_{3M}(D_3, \text{int})}. \tag{3.25}
\]

To evaluate the relative energy gravitational influence of the outer planet \( \tau_i \) at the surface point \( D_3 \) of the Earth, we considered [Simonenko, 2007; 2009; 2010] the ratio \( f(i, D_3) \) (for \( i = 4, 5, 6, 7, 8, 9 \)) of the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3\alpha}(D_3, \text{ext}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3\alpha}(D_3, \text{ext}) \) of the gravitational potential \( \psi_{3\alpha}(D_3, \text{ext}) \) created by the outer planet \( \tau_i \) at the surface point \( D_3 \)) and the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3M}(D_3, \text{int}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3M}(D_3, \text{int}) \) of the gravitational potential \( \psi_{3M}(D_3, \text{int}) \) created by the Mercury at surface point \( D_3 \)).
Using the formulae (3.25) and (3.26) with the average radius \( R = 6371 \) km of the Earth and with the additional planetary numerical values [Zhirmunsky and Kuzmin, 1990], we calculated [Simonenko, 2007; 2009; 2010] the following numerical values (corrected slightly the previous numerical values of \( f(i,D_3) \) [Simonenko, 2007]): \( f(2,D_3) = 37.70428085 \) (for the Venus), \( f(5,D_3) = 7.40926122 \) (for the Jupiter), \( f(1,D_3) = 1 \) (for the Mercury), \( f(4,D_3) = 6.7420160 \) (for the Mars), \( f(6,D_3) = 0.24596865 \) (for the Saturn), \( f(7,D_3) = 0.00319004 \) (for the Uranus), \( f(8,D_3) = 0.00077552 \) (for the Neptune) and \( f(9,D_3) = 3.4807 \times 10^{-8} \) (for the Pluto).

Taking into account the calculated powers of the maximal energy gravitational influences of the planets on the unit mass of the Earth (at the mass center \( C_3 \) of the Earth and at the surface point \( D_3 \) of the Earth) in the frame of the considered first approximation of the circular orbits of the planets, we obtained [Simonenko, 2007; 2009; 2010] the following order of signification of the planets of the Solar System (Venus, the Jupiter, the Mercury, the Mars, the Saturn, the Uranus, the Neptune and the Pluto) in respect of the planetary power of the maximal energy gravitational influences on the unit mass of the Earth.

To evaluate the relative energy gravitational influence of the inner planet \( \tau_i \) at the surface point \( D_3 \) and at the mass center \( C_3 \) of the Earth, we considered [Simonenko, 2009; 2010] the ratio \( q_i(D_3,C_3) \) of the maximal value \( \max \frac{\partial}{\partial t} \Psi_3(D_3, \text{int}) \) and the maximal value \( \max \frac{\partial}{\partial t} \Psi_3(C_3, \text{int}) \):

\[
q_i(D_3,C_3) = \frac{\max \frac{\partial}{\partial t} \Psi_3(D_3, \text{int})}{\max \frac{\partial}{\partial t} \Psi_3(C_3, \text{int})} \quad (i = 1, 2) \tag{3.27}
\]

To evaluate the relative energy gravitational influence of the outer planet \( \tau_i \) at the surface point \( D_3 \) and at the mass center \( C_3 \) of the Earth, we considered [Simonenko, 2009; 2010] the ratio \( q_i(D_3,C_3) \) of the maximal value \( \max \frac{\partial}{\partial t} \Psi_3(D_3, \text{ext}) \) and the maximal value \( \max \frac{\partial}{\partial t} \Psi_3(C_3, \text{ext}) \):

\[
q_i(D_3,C_3) = \frac{\max \frac{\partial}{\partial t} \Psi_3(D_3, \text{ext})}{\max \frac{\partial}{\partial t} \Psi_3(C_3, \text{ext})} \quad (i = 4, 5, 6, 7, 8, 9) \tag{3.28}
\]

Using the formulae (3.27) and (3.28), we calculated [Simonenko, 2009; 2010] the following numerical values: \( q_1(D_3,C_3) = 1.000123023 \) (for the Mercury) and \( q_2(D_3,C_3) = 1.000287771 \) (for the Venus). Using the formula (3.28), we calculated [Simonenko, 2009; 2010] the following numerical values: \( q_4(D_3,C_3) = 0.999813318 \) (for the Mars), \( q_5(D_3,C_3) = 0.999948084 \) (for the Jupiter), \( q_6(D_3,C_3) = 0.999954640 \) (for the Saturn), \( q_7(D_3,C_3) = 0.999956727 \) (for the Uranus), \( q_8(D_3,C_3) = 0.999957084 \) (for the Neptune) and \( q_9(D_3,C_3) = 0.999957263 \) (for the Pluto).

The revealed [Simonenko, 2009; 2010] small difference of the maximal energy gravitational influence of each planet at the surface point \( D_3 \) and at the mass center \( C_3 \) of the Earth results to the small difference of the combined maximal energy gravitational influences of the planets of the Solar System at the points \( C_3 \) and \( D_3 \) of the Earth. It was recognized [Simonenko, 2009; 2010] that the small difference of the combined planetary maximal energy gravitational influences at the surface point \( D_3 \) and at the mass center \( C_3 \) of the Earth must lead to the following related geophysical phenomena: the small oscillatory motion of the rigid kernel of the Earth relative to the fluid kernel of the Earth; the small oscillation of the Earth’s pole (i.e., the Chandler’s wobble of the Earth’s pole); the small oscillations of the boundary of the Pacific Ocean (i.e., the seismic zone of the Pacific Ring); the oscillations, rotations and deformations of the geo-blocks weakly...
coupled with the surrounding plastic layers in all seismic zones of the Earth and the formation of fractures related with the strong earthquakes and the planetary cataclysms.

3.1.3. The evaluation of the relative maximal planetary integral energy gravitational influences on the Earth in the approximation of the circular orbits of the planets of the Solar System

We assume that \( \varphi_{0i} \) and \( \varphi_{0t} \) are the initial phases of the Earth \( \tau_s \) and the planet \( \tau_i \), respectively. Consequently, the positions of the center of the Earth \( \tau_s \) and the center of the planet \( \tau_i \) (inner or outer) for the time moment \( t \) are given (instead of the relations (3.10) and (3.11)) by the following expressions:

\[
\varphi_s = \omega_s t = \frac{2\pi}{T_s} t + \varphi_{0s},
\]

\( (3.29) \)

\[
\varphi_i = \omega_i t = \frac{2\pi}{T_i} t + \varphi_{0i}.
\]

\( (3.30) \)

Taking into account the initial phases \( \varphi_{0s} \) and \( \varphi_{0i} \), the expressions (3.15), (3.18), (3.22) and (3.24) can be generalized as follows [Simonenko, 2009; 2010]:

\[
\frac{\partial}{\partial t} \psi_3(C_3, \text{int}) = \frac{\partial}{\partial t} \psi_3(C_3, \text{ext}) = \frac{\partial}{\partial t} \psi_3(C_3) = \frac{\gamma M_3 R_{03} R_{0i} \omega_3 \sin \{(\omega_i - \omega_s)t + \varphi_{0i} - \varphi_{0s}\}}{[R_{03}^2 + R_{0i}^2 - 2R_{03} R_{0i} \cos \{(\omega_i - \omega_s)t + \varphi_{0i} - \varphi_{0s}\}]^{3/2}},
\]

\( (3.31) \)

\[
\frac{\partial}{\partial t} \psi_3(D_3, \text{int}) = \frac{\partial}{\partial t} \psi_3(D_3, \text{ext}) = \frac{\partial}{\partial t} \psi_3(D_3) = \frac{\gamma M_3 (R_{03} - R_{0i}) R_{03} \omega_3 \sin \{(\omega_i - \omega_s)t + \varphi_{0i} - \varphi_{0s}\}}{[(R_{03} - R_{0i})^2 + R_{0i}^2 - 2(R_{03} - R_{0i}) R_{0i} \cos \{(\omega_i - \omega_s)t + \varphi_{0i} - \varphi_{0s}\}]^{3/2}},
\]

\( (3.32) \)

We obtained [Simonenko, 2007] the integral energy gravitational influence \( \Delta_g E_3(\tau_s, \varphi_{0i}, \varphi_{0s}, t, t_0) \) on the Earth \( \tau_s \) owing to the non-stationary instantaneous energy gravitational influence of the planet \( \tau_i \) (inner or outer) during the time interval \( (t_0, t) \):

\[
\Delta_g E_3(\tau_s, \varphi_{0i}, \varphi_{0s}, t, t_0) = \int_{t_0}^{t} \int_{t}^{t} \int_{t}^{t} \left( \frac{\partial \psi_3(C_3)}{\partial t'} \right) \text{d}V \text{dt'} \approx M_3 \int_{t_0}^{t} \left( \frac{\partial \psi_3(C_3)}{\partial t'} \right) \text{dt'},
\]

\( (3.33) \)

where \( M_3 \) is the mass of the Earth. Substituting (3.31) into (3.33), we obtained [Simonenko, 2007]:

\[
\Delta_g E_3(\tau_s, \varphi_{0i}, \varphi_{0s}, t, t_0) = M_3 \int_{t_0}^{t} \frac{\gamma M_3 R_{03} R_{0i} \omega_3 \sin \{(\omega_i - \omega_s)t' + \varphi_{0i} - \varphi_{0s}\}}{[(R_{03})^2 + R_{0i}^2 - 2R_{03} R_{0i} \cos \{(\omega_i - \omega_s)t' + \varphi_{0i} - \varphi_{0s}\}]^{3/2}} \text{dt'}.
\]

\( (3.34) \)

The result of integration of the expression (3.34) is given by the analytical relation [Simonenko, 2007]:

\[
\Delta_g E_3(\tau_s, \varphi_{0i}, \varphi_{0s}, t, t_0) = \frac{2\omega_i}{(\omega_i - \omega_s) \chi_i} \left[ \beta_{i1} - \chi_i \cos \{(\omega_i - \omega_s)t_0 + \varphi_{0i} - \varphi_{0s}\} \right] - \frac{1}{\left[ \beta_{i1} - \chi_i \cos \{(\omega_i - \omega_s)t + \varphi_{0i} - \varphi_{0s}\} \right]^2}
\]

\( (3.35) \)

characterized by the following coefficients

\[
\alpha_i = \gamma M_3 M_1 R_{03} R_{0i} \omega_i, \quad \beta_i = (R_{03})^2 + (R_{0i})^2, \quad \chi_i = 2R_{03} R_{0i} \omega_i.
\]

\( (3.36) \)

Using the initial phases \( \varphi_{0s} = 0 \) and \( \varphi_{0i} = 0 \) for the initial time moment \( t_0 = 0 \), the expression (3.35)
gives the more simple relation [Simonenko, 2007]:

$$\Delta_{g}E_{g}(\tau_{i},0,0,t,0) = \frac{2\alpha_{i}}{(\omega_{i} - \omega_{i})\chi_{i}} \left[ \frac{1}{[\beta_{i} - \chi_{i}]^{1/2}} - \frac{1}{[\beta_{i} - \chi_{i} \cos \{ (\omega_{i} - \omega_{i})t \}]^{1/2}} \right]$$  \hspace{0.5cm} (3.37)

used for calculation of the maximal integral energy gravitational influence of the planet \( \tau_{i} \) (inner or outer) on the Earth \( \tau_{s} \). Consider the expression (3.37) by taking into account that the mass center \( C_{i} \) of the inner planet \( \tau_{i} \), the mass center \( C_{s} \) of the Earth \( \tau_{s} \), and the mass center \( O \) of the Sun are located on the axis \( X \) for the initial time moment \( t_{0} = 0 \) as it is shown on Fig. 6. Considering the time duration

$$t_{i}^{*}(i,3) = \frac{1}{2} \frac{T_{i}T_{s}}{(T_{i} - T_{s})}, \quad (i = 1, 2)$$  \hspace{0.5cm} (3.38)

we obtain that the mass center \( C_{i} \) of the inner planet \( \tau_{i} \), the mass center \( C_{s} \) of the Earth \( \tau_{s} \), and the mass center \( O \) of the Sun will be localized again on the same straight line and the distance between the mass centers of the inner planet \( \tau_{i} \) and the Earth \( \tau_{s} \) will be maximal. We obtained [Simonenko, 2007; 2009; 2010] from relation (3.37) the positive integral energy gravitational influence on the Earth’s continuum during the time \( t_{i}^{*}(i,3) \):

$$\Delta_{g}E_{g}(\tau_{i},0,0,t_{i}^{*}(i,3),0) = \frac{2\alpha_{i}}{(\omega_{i} - \omega_{s})\chi_{i}} \left[ \frac{1}{[R_{O3} - R_{Oi}]} - \frac{1}{[R_{O3} + R_{Oi}]} \right] > 0.$$  \hspace{0.5cm} (3.39)

We obtained [Simonenko, 2007] from relation (3.37) that the integral energy gravitational influence on the Earth of the inner planet \( \tau_{i} \) is equal to the zero

$$\Delta_{g}E_{g}(\tau_{i},0,0,t_{i}^{*}(i,3),0) = 0$$  \hspace{0.5cm} (3.40)

during the time duration

$$t_{i}^{*}(i,3) = \frac{1}{2} \frac{T_{i}T_{s}}{(T_{i} - T_{s})}, \quad (i = 1, 2)$$  \hspace{0.5cm} (3.41)

when the distance between the mass centers of the inner planet \( \tau_{i} \) and the Earth \( \tau_{s} \) will be minimal.

We tested [Simonenko, 2007] the relation (3.37) for the outer planet \( \tau_{i} \) and the Earth \( \tau_{s} \), assuming that the mass centers the outer planet \( \tau_{i} \), the Earth \( \tau_{s} \), and the mass center \( O \) of the Sun are located on the axis \( X \) for the initial time moment \( t_{0} = 0 \) as it is shown on Fig. 6. Considering the time duration

$$t_{i}^{*}(3,i) = \frac{1}{2} \frac{T_{i}T_{s}}{(T_{i} - T_{s})}, \quad (i = 4, 5, 6, 7, 8, 9)$$  \hspace{0.5cm} (3.42)

we have that the mass center of the outer planet \( \tau_{i} \), the mass center \( C_{s} \) of the Earth \( \tau_{s} \), and the mass center \( O \) of the Sun will again located on the same straight line and the distance between the mass centers of the outer planet \( \tau_{i} \) and the Earth \( \tau_{s} \) will be maximal. We obtained [Simonenko, 2007] from relation (3.37) the negative integral energy gravitational influence on the Earth of outer planet \( \tau_{i} \) during the time \( t_{i}^{*}(3,i) \):

$$\Delta_{g}E_{g}(\tau_{i},0,0,t_{i}^{*}(3,i),0) = \frac{2\alpha_{i}}{(\omega_{i} - \omega_{s})\chi_{i}} \left[ \frac{1}{[R_{O3} - R_{Oi}]} - \frac{1}{[R_{O3} + R_{Oi}]} \right] < 0.$$  \hspace{0.5cm} (3.43)

Considering the time duration

$$t_{i}^{*}(3,i) = \frac{1}{2} \frac{T_{i}T_{s}}{(T_{i} - T_{s})},$$  \hspace{0.5cm} (3.44)

we obtained [Simonenko, 2007] from relation (3.37) the zero integral energy gravitational influence on the Earth from the outer planet \( \tau_{i} \) during the time \( t_{i}^{*}(3,i) \):

$$\Delta_{g}E_{g}(\tau_{i},0,0,t_{i}^{*}(3,i),0) = 0.$$  \hspace{0.5cm} (3.45)

Using the expressions (3.36), we established [Simonenko, 2007] that the expressions (3.39) and (3.43) give the following extreme values
\[
\max_{\tau} \Delta_g E_3 (\tau, 0, 0, t, 0) = \Delta_g E_3 (\tau, 0, 0, t_i(i,3), 0) = \\
= 2\gamma M_3 M_i \frac{R_{O3} T_3}{(R_{O3} - R_{O1})(T_3 - T_i)} > 0, \quad (i = 1, 2),
\] (3.46)

\[
\min_{\tau} \Delta_g E_3 (\tau, 0, 0, t, 0) = \Delta_g E_3 (\tau, 0, 0, t_i(3,i), 0) = \\
= 2\gamma M_3 M_i \frac{R_{O3} T_3}{(R_{O3} - R_{O1})(T_3 - T_i)} < 0, \quad (i = 4, 5, 6, 7, 8, 9)
\] (3.47)

do  the integral energy gravitational influences (respectively, the positive maximal integral energy gravitational influence from the inner planet \( \tau_i \) and the negative minimal integral energy gravitational influence from the outer planet \( \tau_i \)) for the given initial phases \( \phi_{03} = 0 \) and \( \phi_{0i} = 0 \) (for the initial time moment \( t_0 = 0 \)) corresponding to the initial configurations shown on Fig. 5 and Fig. 6, respectively.

Using the relation (3.46), we obtained [Simonenko, 2007] for the Mercury (\( i = 1 \)) and for the Venus (\( i = 2 \)) the following expressions of the maximal positive integral energy gravitational influences on the Earth:

\[
\max_{\tau} \Delta_g E_3 (\tau, 0, 0, t, 0) = \Delta_g E_3 (\tau, 0, 0, t_1(i,3), 0) = \\
= 2\gamma M_3 M_1 \frac{R_{O1} T_3}{(R_{O1} - R_{O2})(T_3 - T_1)} > 0, \quad i = 1,
\] (3.48)

\[
\max_{\tau} \Delta_g E_3 (\tau, 0, 0, t, 0) = \Delta_g E_3 (\tau, 0, 0, t_1(2,3), 0) = \\
= 2\gamma M_3 M_2 \frac{R_{O1} T_3}{(R_{O1} - R_{O2})(T_3 - T_2)} > 0, \quad i = 2.
\] (3.49)

Considering the mass \( m_1 \) of the macroscopic continuum region near the surface point \( D_1 \) (instead of the mass \( M_3 \) of the Earth) in relations (3.48) and (3.49), we obtained [Simonenko, 2007] the following expressions for the positive integral energy gravitational influences of the Mercury (\( i = 1 \)) and the Venus (\( i = 2 \)) on the macroscopic continuum region of the mass \( m_1 \) near the surface point \( D_1 \) of the Earth:

\[
\max_{\tau} \Delta_g E_3 (\tau, D_3, m, 0, 0, t, 0) = \Delta_g E_3 (\tau, D_3, m_1, 0, 0, t_1(i,3), 0) = \\
= 2\gamma m_1 M_1 \frac{R_{O1} T_3}{(R_{O1} - R_{O2})(T_3 - T_1)} > 0, \quad i = 1,
\] (3.50)

\[
\max_{\tau} \Delta_g E_3 (\tau, D_3, m_1, 0, 0, t, 0) = \Delta_g E_3 (\tau, D_3, m_1, 0, 0, t_1(2,3), 0) = \\
= 2\gamma m_1 M_2 \frac{R_{O1} T_3}{(R_{O1} - R_{O2})(T_3 - T_2)} > 0, \quad i = 2.
\] (3.51)

We shall use the expression (3.48) as a measuring unit for evaluations of the maximal absolute values of the integral energy gravitational influences on the Earth of the planets of the Solar System and the Moon.

Considering the ratio of the extremal value \( \max_{\tau} \Delta_g E_3 (\tau, 0, 0, t, 0) \) (given by the expression (3.46)) and the maximal positive integral energy gravitational influence \( \max_{\tau} \Delta_g E_3 (\tau, 0, 0, t, 0) \) (given by the expression (3.48)) of the Mercury on the Earth, we obtained [Simonenko, 2007] the relative values \( S(i) \) of the maximal integral energy gravitational influences on the Earth of the inner planets:

\[
S(i) = \frac{\max_{\tau} \Delta_g E_3 (\tau, 0, 0, t, 0)}{\max_{\tau} \Delta_g E_3 (\tau, 0, 0, t, 0)} = \frac{M_i}{M_1} \frac{R_{O1}(R_{O1}^2 - R_{O2}^2)(T_3 - T_i)}{R_{O1}(R_{O1}^2 - R_{O2}^2)(T_3 - T_1)}, \quad i = 1, 2.
\] (3.52)

We have the obvious value \( S(1) = 1 \) for the Mercury (\( i = 1 \)). We calculated [Simonenko, 2007] the value \( S(2) = 89.6409 \) for the Venus (\( i = 2 \)) based on the planetary numerical values [Zhirmunsky and Kuzmin, 1990] of the average radii of the orbits, the time periods of circulations around the Sun and the
masses of the Earth, the Venus and the Mercury.  
Since the values given by the expression (3.47) are negative for the outer planets, we used the absolute (positive) value

\[
\min \Delta g E_3(\tau_1,0,0,t,0) = \left| \Delta g E_3(\tau_1,0,0,t^* (3,i),0) \right| = 2\gamma M_3 M_i \frac{R_{o3} T_3}{(R_{o3}^2 - R_{o1}^2)(T_1 - T_3)} > 0, \ i = 4, 5, 6, 7, 8, 9. \quad (3.53)
\]

Using the expressions (3.53) and (3.48), we obtained [Simonenko, 2007] the relative values \( s(i) \) of the maximal integral energy gravitational influences on the Earth of the outer planets of the Solar System (\( i = 4, 5, 6, 7, 8, 9 \)):

\[
s(i) = \frac{\min \Delta g E_3(\tau_1,0,0,t,0)}{\max \Delta g E_3(\tau_1,0,0,t,0)} = \frac{M_1}{M_i} \frac{R_{o3}(R_{o3}^2 - R_{o1}^2)(T_3 - T_1)}{R_{o1}(R_{o1}^2 - R_{o3}^2)(T_1 - T_3)}, \ i = 4, 5, 6, 7, 8, 9. \quad (3.54)
\]

Based on the planetary numerical values [Zhirmunsky and Kuzmin, 1990], we calculated the following numerical values [Simonenko, 2007]: \( s(4) = 2.6396 \) for the Mars (\( i=4 \)), \( s(5) = 31.319 \) for the Jupiter (\( i=5 \)), \( s(6) = 1.036 \) for the Saturn (\( i=6 \)), \( s(7) = 0.0133 \) for the Uranus (\( i=7 \)), \( s(8) = 0.003229 \) for the Neptune (\( i=8 \)) and \( s(9) = 1.4495 \cdot 10^{-7} \) for the Pluto (\( i=9 \)).

Taking into account the calculated relative values \( s(i) \) of the maximal integral energy gravitational influences on the Earth of the planets of the Solar System, we obtained [Simonenko, 2007] the following order of significance of the planets of the Solar System: the Venus (\( s(2) = 89.6409 \)), the Jupiter (\( s(5) = 31.319 \)), the Mars (\( s(4) = 2.6396 \)), the Saturn (\( s(6) = 1.036 \)), the Mercury (\( s(1) = 1 \)), the Uranus (\( s(7) = 0.0133 \)), the Neptune (\( s(8) = 0.003229 \)) and the Pluto (\( s(9) = 1.4495 \cdot 10^{-7} \)) in respect of the established significance of the planetary maximal integral energy gravitational influences on the Earth.

We established [Simonenko, 2007] that the Venus and the Jupiter induce the main maximal integral energy gravitational influences on the Earth. The Mars, the Saturn and the Mercury induce the combined maximal integral energy gravitational influence on the Earth, which is one order of the magnitude smaller than the maximal integral energy gravitational influence of the Jupiter. The maximal integral energy gravitational influences on the Earth of the Uranus, the Neptune and the Pluto are two, three and seven orders of the magnitude, respectively, smaller than the maximal integral energy gravitational influence of the Mercury.

### 3.2. The energy gravitational influence on the Earth of the Moon

#### 3.2.1. The evaluation of the relative maximal instantaneous energy gravitational influence of the Moon on the Earth in the second approximation of the elliptical orbits of the Earth and the Moon around the combined mass center \( C_{3,MOON} \) of the Earth and the Moon

We consider the movement of the Earth \( \tau_1 \) and the Moon along the elliptical orbits around the combined mass center \( C_{3,MOON} \) of the Earth and the Moon. We have the following relations

\[
r_{MOON}(\varphi_{MOON}(t)) = \frac{p_{MOON}}{1 + e_{MOON}\cos\varphi_{MOON}(t)}, \quad (3.55)
\]

\[
r_{E}(\varphi_E(t)) = r_{E}(\varphi_{MOON}(t) + \pi) = \frac{p_E}{1 - e_E\cos(\varphi_{MOON}(t) + \pi)} = \frac{p_E}{1 + e_E\cos\varphi_{MOON}(t)}, \quad (3.56)
\]
for the distance $r_{\text{MOON}}(\varphi_{\text{MOON}}(t))$ between the combined mass center $C_{3,\text{MOON}}$ (of the Earth and the Moon) and the mass center $C_{\text{MOON}}$ of the Moon and for the distance $r_{E}(\varphi_{E}(t))$ between the combined mass center $C_{3,\text{MOON}}$ and the mass center $C_{E}$ of the Earth $\tau_{E}$. We have the focal parameter and the eccentricity $P_{\text{MOON}}$ and $e_{\text{MOON}}$, respectively, of the elliptical orbit of the Moon. $P_{E}$ and $e_{E}$ (where $e_{E} = e_{\text{MOON}}$) are the focal parameter and the eccentricity, respectively, of the elliptical Earth’s orbit around the combined mass center $C_{3,\text{MOON}}$ of the Earth and the Moon. We have the expression for the distance $d_{3M}(E_{M})$:

$$d_{3M}(E_{M}) = \frac{P_{\text{MOON}}}{(1 + e_{\text{MOON}} \cos \varphi_{\text{MOON}}(t))} + \frac{P_{E}}{1 + e_{E} \cos \varphi_{\text{MOON}}(t)} - R_{3}$$  \hspace{1cm} (3.57)

between the mass center $C_{\text{MOON}}$ of the Moon and the point $E_{M}$, which is the intersection of the direct line (connecting the mass center $C_{\text{MOON}}$ of the Moon and the mass center $C_{E}$ of the Earth $\tau_{E}$) with the surface of the Earth $\tau_{E}$. We have the expression for the gravitational potential $\psi_{3\text{MOON}}(E_{M})$ created by the Moon at the point $E_{M}$ of the Earth $\tau_{E}$:

$$\psi_{3\text{MOON}}(E_{M}) = -\gamma \frac{M_{\text{MOON}}}{d_{3M}(E_{M})}.$$  \hspace{1cm} (3.58)

Fig. 9. The geometric sketch of circulation of the mass center $C_{E}$ of the Earth $\tau_{E}$ and the mass center $C_{\text{MOON}}$ of the Moon around the combined mass center $C_{3,\text{MOON}}$ of the system Earth-Moon

We obtained [Sioneneko, 2009; 2010] from the relation (3.58) the expression for the partial derivative $\frac{\partial}{\partial t} \psi_{3\text{MOON}}(E_{M})$ of the gravitational potential $\psi_{3\text{MOON}}(E_{M})$ created by the Moon at the point $E_{M}$ of the Earth $\tau_{E}$:

$$\frac{\partial}{\partial t} \psi_{3\text{MOON}}(E_{M}) = \frac{\gamma M_{\text{MOON}} e_{\text{MOON}} P_{\text{MOON}} \sin(\varphi_{\text{MOON}}(t))}{(P_{\text{MOON}} + P_{E} - R_{3} (1 - e_{\text{MOON}} \cos \varphi_{\text{MOON}}(t)))^{2}} \frac{d\varphi_{\text{MOON}}(t)}{dt}.$$  \hspace{1cm} (3.59)

We have the expression for the distance $d_{3M}(C_{3})$:
between the mass center $C_{\text{MOON}}$ of the Moon and the mass center $C_{\text{E}}$ of the Earth $\tau_{E}$. We have the expression for the gravitational potential $\psi_{3\text{MOON}}(C_{3})$ created by the Moon at the mass center $C_{3}$ of the Earth $\tau_{3}$:

$$\psi_{3\text{MOON}}(C_{3}) = -\frac{\gamma M_{\text{MOON}}}{a_{3\text{MOON}}(C_{3})}. \quad (3.61)$$

We obtained [Simonenko, 2009; 2010] from the relation (3.61) the expression for the partial derivative $\frac{\partial}{\partial t} \psi_{3\text{MOON}}(C_{3})$ (of the gravitational potential $\psi_{3\text{MOON}}(C_{3})$ created by the Moon at the mass center $C_{3}$ of the Earth $\tau_{3}$):

$$\frac{\partial}{\partial t} \psi_{3\text{MOON}}(C_{3}) = \frac{\gamma M_{\text{MOON}} e_{\text{MOON}} \sin(\varphi_{\text{MOON}}(t))}{(p_{\text{MOON}} + p_{E})^2} \frac{d\varphi_{\text{MOON}}(t)}{dt}. \quad (3.62)$$

We can obtain the focal parameter $p_{\text{MOON}}$ of the elliptical orbit of the Moon in terms of the average distance $R_{3\text{MOON}}$ (between the mass centers of the Earth and the Moon) and the eccentricity $e_{\text{MOON}} = e_{E}$ of the elliptical orbits of the Moon and the Earth around the combined mass center $C_{3,\text{MOON}}$ of the Earth and the Moon.

Using the relation (3.55), we have the relation for the large semi-axis $a_{\text{MOON}}$ of the elliptical orbit of the Moon:

$$2a_{\text{MOON}} = r_{\text{MOON}}(0) + r_{\text{MOON}}(\pi) = \frac{p_{\text{MOON}}}{(1 + e_{\text{MOON}})} + \frac{p_{\text{MOON}}}{(1 - e_{\text{MOON}})} = \frac{2p_{\text{MOON}}}{(1 - e_{\text{MOON}}^2)}, \quad (3.63)$$

which gives the relation for the focal parameter $p_{\text{MOON}}$ of the elliptical orbit of the Moon in terms of the eccentricity $e_{\text{MOON}}$ and the large semi-axis $a_{\text{MOON}}$ of the elliptical orbit of the Moon:

$$p_{\text{MOON}} = (1 - e_{\text{MOON}}^2) a_{\text{MOON}}. \quad (3.64)$$

We can obtain the large semi-axis $a_{\text{MOON}}$ of the elliptical orbit of the Moon in terms of the average distance $R_{3\text{MOON}}$ (between the mass centers of the Earth and the Moon) and the eccentricity $e_{\text{MOON}}$ of the elliptical orbit of the Moon. Defining the average distance $R_{3\text{MOON}}$ (between the mass centers of the Earth and the Moon) as the average arithmetic value of the large semi-axis $a_{\text{MOON}}$ and the small semi-axis $b_{\text{MOON}}$ of the elliptical orbit of the Moon:

$$R_{3\text{MOON}} = \frac{(a_{\text{MOON}} + b_{\text{MOON}})}{2}, \quad (3.65)$$

and using the definition of the eccentricity $e_{\text{MOON}}$ of the elliptical orbit of the Moon:

$$e_{\text{MOON}} = \frac{e_{\text{MOON}}}{a_{\text{MOON}}} = \frac{\sqrt{a_{\text{MOON}}^2 - b_{\text{MOON}}^2}}{a_{\text{MOON}}}, \quad (3.66)$$

we obtained [Simonenko, 2009; 2010] the relation for the average distance $R_{3\text{MOON}}$ (between the mass centers of the Earth and the Moon):
\[ R_{3M} = \frac{a_{\text{MOON}}}{2} \left(1 + \sqrt{1 - e_{\text{MOON}}^2} \right), \]  

which leads to the relation for the large semi-axis \( a_{\text{MOON}} \) (of the elliptical orbit of the Moon) in terms of the average distance \( R_{3M} \) (between the mass centers of the Earth and the Moon) and the eccentricity \( e_{\text{MOON}} \) of the elliptical orbit of the Moon:

\[ a_{\text{MOON}} = \frac{2R_{3M}}{1 + \sqrt{1 - e_{\text{MOON}}^2}}. \]  

Using the relations (3.64) and (3.68), we obtained [Simonenko, 2009; 2010] the relation for the focal parameter \( p_{\text{MOON}} \) of the elliptical orbit of the Moon in terms of the average distance \( R_{3M} \) (between the mass centers of the Earth and the Moon) and the eccentricity \( e_{\text{MOON}} \) of the elliptical orbit of the Moon:

\[ p_{\text{MOON}} = \frac{2R_{3M}(1 - e_{\text{MOON}}^2)}{1 + \sqrt{1 - e_{\text{MOON}}^2}}. \]  

Using the relation (3.69) and the relations [Savelyev, 1991]:

\begin{align*}
\rho_{\text{MOON}} &= \frac{M_3}{(M_3 + M_{\text{MOON}})}, \\
\rho_E &= \frac{M_{\text{MOON}}}{(M_3 + M_{\text{MOON}})},
\end{align*}

the relation (3.62) can be rewritten as follows [Simonenko, 2009; 2010]:

\[ \frac{\partial}{\partial t} \psi_{3\text{MOON}}(C_3) = \frac{\gamma M_{\text{MOON}} e_{\text{MOON}}}{1 + \sqrt{1 - e_{\text{MOON}}^2}} \sin(\varphi_{\text{MOON}}(t)) \frac{d\varphi_{\text{MOON}}(t)}{dt}. \]  

\[ 2R_{3M}(1 - e_{\text{MOON}}^2) \left( \frac{M_{\text{MOON}}}{M_3} + 1 \right)^2 \]

Taking \( \sin(\varphi_{\text{MOON}}(t)) = 1 \) and equating \( \frac{d\varphi_{\text{MOON}}(t)}{dt} \) to \( \omega_{\text{MOON}} \) (for the corresponding hypothetical circular orbits of the Earth and the Moon), we obtained [Simonenko, 2009; 2010] the characteristic maximal positive value \( \text{char. max. pos.} \frac{\partial}{\partial t} \psi_{3\text{MOON}}(C_3, \text{second approx.}) \) of the partial derivative \( \frac{\partial}{\partial t} \psi_{3\text{MOON}}(C_3) \) (obtained in the second approximation of the elliptical orbits of the Earth and the Moon around the combined mass center \( C_{3,\text{MOON}} \) of the Earth and the Moon):

\[ \text{char. max. pos.} \frac{\partial}{\partial t} \psi_{3\text{MOON}}(C_3, \text{second approx.}) = \frac{\gamma M_{\text{MOON}} e_{\text{MOON}}}{1 + \sqrt{1 - e_{\text{MOON}}^2}} \omega_{\text{MOON}}. \]

\[ 2R_{3M}(1 - e_{\text{MOON}}^2) \left( \frac{M_{\text{MOON}}}{M_3} + 1 \right)^2 \]

We used the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \)) of the gravitational potential \( \psi_{3M}(C_3, \text{int}) \) created by the Mercury at the mass center \( C_3 \) of the Earth.
moving around the mass center O of the Sun along the hypothetical circular orbit) as a scale of the energy gravitational influence of the Moon on the Earth. To evaluate (in the second approximation) the relative power of the energy gravitational influence of the Moon on the Earth, we obtained [Simonenko, 2009; 2010] the ratio \( f_{\text{MOON}}(C_3, \text{second approx.}) \) of the characteristic maximal positive value \( \frac{\partial}{\partial t} \psi_{\text{MOON}}(C_3, \text{second approx.}) \) and the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{\text{M}}(C_3, \text{int}) \):

\[
f_{\text{MOON}}(C_3, \text{second approx.}) = \frac{\text{char. max. pos. } \frac{\partial}{\partial t} \psi_{\text{MOON}}(C_3, \text{second approx.})}{\max \frac{\partial}{\partial t} \psi_{\text{M}}(C_3, \text{int})}.
\]

(3.74)

We calculated [Simonenko, 2009; 2010] the corresponding numerical value \( f_{\text{MOON}}(C_3, \text{second approx.}) = 19.44083 \) taking into account the following numerical values: \( \mathbf{e}_{\text{MOON}} = 0.05 \), \( M_{\text{MOON}} = M_3 / 81 \), \( M_\text{M} = 0.06 M_3 \), \( T_{\text{MOON}} = 29.5306 \) days and \( T_\text{M} = 88 \) days.

The calculated numerical value \( f_{\text{MOON}}(C_3, \text{second approx.}) = 19.44083 \) (evaluated in the frame of the considered second approximation) means that the power of the maximal energy gravitational influence of the Moon (on the unit mass of the Earth at the mass center \( C_3 \) of the Earth) is \( f_{\text{MOON}}(C_3, \text{second approx.}) = 19.44083 \) times larger than the maximal power of the energy gravitational influence (on the unit mass at the mass center \( C_3 \) of the Earth) of the Mercury moving around the mass center O of the Sun along the hypothetical circular orbit.

Taking into account the calculated [Simonenko, 2009; 2010] non-dimensional maximal instantaneous energy gravitational influences on the unit mass of the Earth at the mass center \( C_3 \) of the Earth:

\[
f(2, C_3) = 37.69807434 \text{ (for the Venus), } \quad f(5, C_3) = 7.41055774 \text{ (for the Jupiter), } \quad f(1, C_3) = 1 \text{ (for the Mercury), } \quad f(4, C_3) = 0.67441034 \text{ (for the Mars), } \quad f(6, C_3) = 0.24601009 \text{ (for the Saturn), } \quad f(7, C_3) = 0.00319056 \text{ (for the Uranus), } \quad f(8, C_3) = 0.00077565 \text{ (for the Neptune) and } \quad f(9, C_3) = 3.4813 \times 10^{-8} \text{ (for the Pluto),}
\]

we obtained [Simonenko, 2009; 2010] the following order of significance (in the frame of the considered second approximation) of the Moon and the planets of the Solar System: the Venus, the Moon, the Jupiter, the Mercury, the Mars, the Saturn, the Uranus, the Neptune and the Pluto. The obtained numerical sequence (of the non-dimensional maximal instantaneous energy gravitational influences on the unit mass of the Earth at the mass center \( C_3 \) of the Earth) revealed [Simonenko, 2009; 2010] the main instantaneous energy gravitational influences on the Earth of the Venus, the Moon, the Jupiter, the Mercury and the Mars, which determine (in collection) the main combined instantaneous energy gravitational influence on the Earth (not taking into account the instantaneous energy gravitational influences of the Sun and our Galaxy).
3.2.2. The evaluation of the maximal integral energy gravitational influence of the Moon on the Earth in the second approximation of the elliptical orbits of the Earth and the Moon around the combined mass center \( C_{3,\text{MOON}} \) of the Earth and the Moon

We evaluated [Simonenko, 2009; 2010] the maximal integral energy gravitational influence of the Moon on the Earth in the approximation of the elliptic orbits of the Earth and the Moon around the combined mass center \( C_{3,\text{MOON}} \) of the Earth and the Moon. We have the integral energy gravitational influence \( \Delta g E_3(\text{Moon}, \varphi_{\text{MOON}}(t_0), t, t_0) \) of the Moon on the Earth \( \tau \) during the time interval \((t_0, t)\):

\[
\Delta g E_3(\text{Moon}, \varphi_{\text{MOON}}(t_0), t, t_0) = \int_{t_0}^{t} \int_{\tau} \left( \frac{\partial \varphi_{\text{MOON}}(C_3)}{\partial t'} \right) \rho \ dV \ dt' \approx M_3 \int_{t_0}^{t} \left( \frac{\partial \varphi_{\text{MOON}}(C_3)}{\partial t'} \right) \ dt',
\]

(3.75)

where \( M_3 \) is the mass of the Earth. Substituting the expression (3.72) into formula (3.75) and integrating, we obtained [Simonenko, 2009; 2010] the following analytical relation:

\[
\Delta g E_3(\text{Moon}, \varphi_{\text{MOON}}(t_0), t, t_0) = -\frac{\gamma M_3 M_{\text{MOON}} e_{\text{MOON}}}{2 R_3 M_3} \left( 1 + \sqrt{1 - e_{\text{MOON}}^2} \right) \left( \cos(\varphi_{\text{MOON}}(t)) - \cos(\varphi_{\text{MOON}}(t_0)) \right),
\]

(3.76)

Considering the following phases: \( \varphi_{\text{MOON}}(t) = \pi \) and \( \varphi_{\text{MOON}}(t_0) = 0 \), we obtained [Simonenko, 2009; 2010] from relation (3.76) the maximal positive value of the integral energy gravitational influence of the Moon on the Earth:

\[
\max \Delta g E_3(\text{Moon}, \varphi_{\text{MOON}}(t_0), t, t_0) = \frac{\gamma M_3 M_{\text{MOON}} e_{\text{MOON}}}{R_3 M_3} \left( 1 + \sqrt{1 - e_{\text{MOON}}^2} \right) \left( \frac{M_{\text{MOON}}}{M_3} + 1 \right)^2.
\]

(3.77)

To evaluate (in the second approximation) the maximal integral energy gravitational influence of the Moon on the Earth, we considered [Simonenko, 2009; 2010] the ratio \( s(\text{Moon, second approx.}) \) of the maximal positive value (3.77) (of the integral energy gravitational influence of the Moon on the Earth) and the maximal positive value (3.48) (of the integral energy gravitational influence of the Mercury on the Earth):

\[
s(\text{Moon, second approx.}) = \frac{\max \Delta g E_3(\text{Moon}, \varphi_{\text{MOON}}(t_0), t, t_0)}{\max \Delta g E_3(\tau_1, t_0, t)} = \frac{e_{\text{MOON}} \left( 1 + \sqrt{1 - e_{\text{MOON}}^2} \right) M_{\text{MOON}} (R_{\text{MOON}}^2 - R_{\text{C3}}^2)(T_3 - T_1)}{(1 - e_{\text{MOON}}^2) \left( \frac{M_{\text{MOON}}}{M_3} + 1 \right)^2 M_3 R_{\text{MOON}} R_{\text{C3}} T_3}.
\]

(3.78)

Using the relation (3.78), we calculated [Simonenko, 2009; 2010] the numerical value \( s(\text{Moon, second approx.}) = 13.0693 \) for the following numerical values: the eccentricity \( e_{\text{MOON}} = 0.05 \) of the elliptical orbits of the Moon and the Earth around the combined mass center \( C_{3,\text{MOON}} \) of the Earth and the Moon, the mass \( M_1 = M_M = 0.06 M_3 \) of the Mercury, the mass \( M_{\text{MOON}} = M_3 / 81 \) of the Moon, the average distance \( R_{3M} = 384400 \) km between the mass centers of the Earth and the Moon, the time period \( T_3 = 365.3 \) days of the Earth’s circulation around the Sun; the time period \( T_1 = T_M = 88 \) days of the Mercury’s circulation around the Sun, the average radius \( R_{\text{OM}} = R_{O1} = 75.85 \cdot 10^6 \) km of the Mercury’s orbit around the Sun, the average radius \( R_{\text{C3}} = 149.6 \cdot 10^6 \) km of the Earth’s orbit around the Sun. The calculated numerical value \( s(\text{Moon, second approx.}) = 13.0693 \) revealed [Simonenko, 2009; 2010] the very significant
correction of the previous numerical value \( s(\text{Moon}) = 2.9178 \) [Simonenko, 2007] obtained in the first approximation for the surface point \( D_3 \) of the Earth.

Thus, considering the aspect of the planetary gravitational preparation of the strong earthquakes, we demonstrated [Simonenko, 2007] the Venusian \( s(2) = 89.6409 \) and the Jupiter’s \( s(5) = 31.319 \) energy gravitational predominance [Simonenko, 2007] in supplying of the cosmic planetary gravitational energy to the focal region of the preparing earthquakes. We demonstrated [Simonenko, 2009; 2010] the very significant \( s(\text{Moon}, \text{second approx.}) = 13.0693 \) maximal integral energy gravitational influence of the Moon on the Earth. The Venus, the Jupiter and the Moon induce the main combined planetary and lunar integral energy gravitational influence on the Earth. The combined maximal integral energy gravitational influence on the Earth of the Mars \( s(4) = 2.6396 \), the Saturn \( s(6) = 1.036 \) and the Mercury \( s(1) = 1 \) is one order of the magnitude smaller than the maximal integral energy gravitational influence of the Venus. The combined maximal integral energy gravitational influence on the Earth of the Uranus \( s(7) = 0.0133 \), the Neptune \( s(8) = 0.003229 \) and the Pluto \( s(9) = 1.4495 \cdot 10^{-7} \) is two orders of the magnitude smaller (i.e., negligible) than the maximal integral energy gravitational influence of the Mercury.

It was suggested [Avsjuk, 1996] the hypothesis that the Chandler’s wobble of the Earth’s pole can be generated by the motion of the rigid kernel of the Earth induced by the disturbances in the system Sun-Earth-Moon. Taking into account the considered results of Subsections 3.1 and 3.2, we stated [Simonenko, 2009; 2010] that the mentioned above related geophysical phenomena (the small oscillatory motion of the rigid kernel of the Earth relative to the fluid kernel of the Earth; the small oscillation of the Earth’s pole (i.e., the Chandler’s wobble of the Earth’s pole); the small oscillations of the boundary of the Pacific Ocean (i.e., the seismic zone of the Pacific Ring); the oscillations, rotations and deformations of the geo-blocks weakly coupled with the surrounding plastic layers in all seismic zones of the Earth and the formation of fractures related with the strong earthquakes and the planetary cataclysms) are induced by the combined non-stationary cosmic energy gravitational influence of the planets of the Solar System, the Sun and the Moon.

### 3.3. The energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune) of the Solar System

#### 3.3.1. The evaluations of the relative characteristic maximal positive instantaneous energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets of the Solar System

We shall consider the movement of the Sun, the Earth \( \tau_j \) and the outer large planet \( \tau_j \ (j = 5, 6, 7, 8) \) in the ecliptic plane (see Fig. 10) around the combined mass center \( C(S, j) \) of the Sun and the outer large planet \( \tau_j \) in the approximation of the elliptical orbits of the Sun, the Earth and the outer large planet \( \tau_j \). The combined mass center \( C(S, j) \) of the system the Sun – the outer large planet \( \tau_j \) (the Sun and the outer large planet \( \tau_j \)) is considered as the right focus \( F_j = C(S, j) \) of the elliptical orbits of the outer large planet \( \tau_j \ (j = 5, 6, 7, 8) \) and the Earth \( \tau_j \).

We have the following relations:

\[
r_j(\varphi_j(t)) = \frac{p_j}{(1 + e_j \cos \varphi_j(t))}, \quad (j = 5, 6, 7, 8)
\]  

(3.79)
\[ r_{S_j}(\varphi_{S_j}(t)) = r_{S_j}(\varphi_j(t) + \pi) = \frac{p_{S_j}}{(1 + e_{S_j}\cos\varphi_j(t))}, \quad (j = 5, 6, 7, 8) \]  

\[ r_3(\varphi_3(t)) = \frac{p_3}{(1 + e_3\cos\varphi_3(t))}. \]  

for the distance \( r_j(\varphi_j) \) between combined mass center \( C(S, j) \) and the mass center \( C_j \) of the planet \( \tau_j \), for the distance \( r_{S_j}(\varphi_j + \pi) \) between combined mass center \( C(S, j) \) and the mass center \( C_S \equiv O \) of the Sun, and for the distance \( r_j(\varphi_j(t)) \) between combined mass center \( C(S, j) \) and the mass center \( C_3 \) of the Earth \( \tau_3 \), respectively. Here \( p_j \) and \( e_j \) are the focal parameter and the eccentricity, respectively, of the elliptical orbit of the planet \( \tau_j \) \((j = 5, 6, 7, 8)\). \( p_{S_j} \) and \( e_{S_j} = e_j \) are the focal parameter and the eccentricity, respectively, of the elliptical orbit of the mass center \( C_S \equiv O \) of the Sun. \( p_3 \) and \( e_3 \) are the focal parameter and the eccentricity, respectively, of the elliptical Earth’s orbit. We have \( \varphi_j(0) = 0 \) \((j = 5, 6, 7, 8)\), \( \varphi_{S_j}(0) = \pi \) and \( \varphi_3(0) = 0 \), respectively, for the initial time moment \( t = 0 \).

We shall consider the gravitational potential \( \psi^S_{3j}(C_3, t) \equiv \psi^S_{3j}(C_3, t, r_3(\varphi_3(t))) \) created by the Sun in the mass center \( C_3 \) \((of the Earth \tau_3)\) characterized by the distance \( r_3(\varphi_3(t)) \) between from the combined mass center \( C(S, j) \) of the Sun and the planet \( \tau_j \):

\[ \psi^S_{3j}(C_3, t, r_3(\varphi_3(t))) = -\gamma \frac{M_S}{r_{S_3}(t)}, \]  

where \( M_S = 333000 \cdot M_3 \) is the mass of the Sun, \( r_{S_3}(t) = |r_{S_3}(t)| \) is the distance between the mass center \( C_S \equiv O \) of the Sun and the mass center \( C_3 \) of the Earth \( \tau_3 \).
Fig. 10. The geometric sketch of movement of the outer large planet \( \tau_j \) (the Jupiter, the Saturn, the Uranus and the Neptune) and the Earth \( \tau_3 \) around the combined mass center \( C(S, j) \) of the Sun and the outer large planet \( \tau_j \).

We find the distance \( r_{3j}(t) \) from the following relation:

\[
(r_{3j}(t))^2 = (r_{sj}(t))^2 + (r_3(t))^2 - 2r_{sj}(t)r_3(t)\cos(\pi + \varphi_j(t) - \varphi_3(t)).
\]

(3.83)

Consequently, the relation (3.82) can be rewritten as follows:

\[
\psi_s(C_3, t) = -\frac{\gamma M_s}{\sqrt{(r_{sj}(t))^2 + (r_3(t))^2 - 2r_{sj}(t)r_3(t)\cos(\pi + \varphi_j(t) - \varphi_3(t))}}.
\]

(3.84)

We obtain the expression for the partial derivative \( \frac{\partial}{\partial t} \psi_s(C_3, t) \) of the gravitational potential \( \psi_s(C_3, t) \):

\[
\frac{\partial}{\partial t} \psi_s(C_3, t) = \frac{\gamma M_s r_{sj}(\varphi_j + \pi) r_3(\varphi_3 - \varphi_j) \sin(\varphi_3 - \varphi_j) \, d\varphi_j(t)}{(r_{3j}(t))^3} + \frac{\gamma M_s r_{sj} r_3(\varphi_j + \pi) e_{sj} \sin \varphi_j [r_{sj}(\varphi_j + \pi) + r_3(\varphi_3 - \varphi_j)] \, d\varphi_j(t)}{(r_{3j}(t))^3 (1 + e_{sj} \cos \varphi_j)}.
\]

(3.85)

Using the expressions (3.80), (3.81) and (3.83), the relation (3.85) can be rewritten as follows:

\[
\frac{\partial}{\partial t} \psi_s(C_3, t) = \gamma M_s \frac{p_{sj}}{(1 + e_{sj} \cos \varphi_j)} \frac{p_3}{(1 + e_3 \cos \varphi_3)} \sin(\varphi_3 - \varphi_j) \times
\]
\[
\frac{d \varphi_j(t)}{dt} \times \left[ \left( \frac{p_{Sj}}{1 + e_{Sj} \cos \varphi_j} \right)^2 + \left( \frac{p_3}{1 + e_3 \cos \varphi_3} \right)^2 + 2 \frac{p_{Sj} p_3 \cos (\varphi_j - \varphi_3)}{(1 + e_{Sj} \cos \varphi_j)(1 + e_3 \cos \varphi_3)} \right]^{\frac{3}{2}} + \\
\gamma M_3 p_{Sj} e_{Sj} \sin \varphi_j \left[ \left( \frac{p_{Sj}}{1 + e_{Sj} \cos \varphi_j} \right)^2 + \left( \frac{p_3}{1 + e_3 \cos \varphi_3} \right)^2 + 2 \frac{p_{Sj} p_3 \cos (\varphi_3 - \varphi_j)}{(1 + e_{Sj} \cos \varphi_j)(1 + e_3 \cos \varphi_3)} \right] \times \\
\frac{d \varphi_j(t)}{dt} \times \left[ \left( \frac{p_{Sj}}{1 + e_{Sj} \cos \varphi_j} \right)^2 + \left( \frac{p_3}{1 + e_3 \cos \varphi_3} \right)^2 + 2 \frac{p_{Sj} p_3 \cos (\varphi_j - \varphi_3)}{(1 + e_{Sj} \cos \varphi_j)(1 + e_3 \cos \varphi_3)} \right]^{\frac{3}{2}}.
\]

The first term of the expression (3.86) gives the principal contribution to the partial derivative \( \frac{\partial}{\partial t} \psi^S_j(C_3, t) \). The expression (3.86) contains the additional second term (vanishing at \( e_{Sj} \to 0 \)) related with the contribution to the partial derivative \( \frac{\partial}{\partial t} \psi^S_j(C_3, t) \) of the eccentricities \( e_j \) and \( e_{Sj} = e_j \) of the elliptical orbits of the outer large planet \( \tau_j \) \( (j=5, 6, 7, 8) \) and the Sun, respectively.

The combined maximal contribution of this additional second term to the partial derivative \( \frac{\partial}{\partial t} \psi^S_j(C_3, t) \) is of the order

\[
O(e_j) \left( \max \frac{\partial}{\partial t} \psi^S_j(C_3, t) \right).
\]

(3.87)

Consequently, the contribution of the first term of the expression (3.86) is \( O(1/e_j) \) times larger than the contribution of the additional second term related with the eccentricities \( e_j \) and \( e_{Sj} = e_j \) of the elliptical orbits of the outer planet \( \tau_j \) \( (j=5, 6, 7, 8) \) and the Sun, respectively.

To evaluate the characteristic maximal positive value \( \text{char.max.pos.} \frac{\partial}{\partial t} \psi^S_j(C_3, t) \) of the partial derivative \( \frac{\partial}{\partial t} \psi^S_j(C_3, t) \) (given by the expression (3.86)) we consider the time moments \( t_*(k) \), related with the conditions

\[
\sin(\varphi_3 - \varphi_j) = 1, \quad \cos(\varphi_3 - \varphi_j) = 0,
\]

(3.88)

which give the following relation for the angles \( \varphi_3 \) and \( \varphi_j \)

\[
(\varphi_3 - \varphi_j) = \frac{\pi}{2} + 2\pi k, \quad k = 0, 1, 2, \ldots.
\]

(3.89)

Considering the following relations (for the corresponding hypothetical circular orbits of the Earth and the planet \( \tau_j \) \( (j = 5, 6, 7, 8) \)) for the angles \( \varphi_3(t) \) and \( \varphi_j(t) \):

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\[ \varphi_j(t) \approx \frac{2\pi}{T_j} t, \quad \varphi_j(t) \approx \frac{2\pi}{T_j} t, \quad (3.90) \]

The condition (3.89) gives (for \( k = 0 \)) the following time \( t_* \) and the corresponding angles \( \varphi_j(t_*) \) and \( \varphi_j(t_*) \):

\[ t_* = \frac{1}{4} \frac{T_j T_3}{(T_j - T_3)}, \quad \varphi_j(t_*) = \frac{\pi}{2} \frac{T_j}{(T_j - T_3)}, \quad \varphi_j(t_*) = \frac{\pi}{2} \frac{T_3}{(T_j - T_3)}. \quad (3.91) \]

Which result to the characteristic maximal positive value char. max. pos. \( \frac{\partial}{\partial t} \psi^S_j(C_3, t) \) of the partial derivative \( \frac{\partial}{\partial t} \psi^S_j(C_3, t) \):

\[
\text{char. max. pos. } \frac{\partial}{\partial t} \psi^S_j(C_3, t) = \frac{\gamma M_s p_{S_j}}{(1 + e_{S_j} \cos \varphi_j(t_*))} \frac{p_3}{(1 + e_3 \cos \varphi_3(t_*))} \omega_j \times \]

\[
\times \left[ \frac{p_{S_j}}{(1 + e_{S_j} \cos \varphi_j(t_*))} \right]^2 + \left[ \frac{p_3}{(1 + e_3 \cos \varphi_3(t_*))} \right]^2 \]^{-\frac{1}{2}} + \]

\[
+ \gamma M_s p_{S_j} e_{S_j} \sin \varphi_j(t_*) \frac{1}{(1 + e_{S_j} \cos \varphi_j(t_*))} \omega_j \left[ \frac{p_{S_j}}{(1 + e_{S_j} \cos \varphi_j(t_*))} \right]^2 + \left[ \frac{p_3}{(1 + e_3 \cos \varphi_3(t_*))} \right]^2 \]^{-\frac{1}{2}}. 

(3.92)

We shall use the relation [Simonenko, 2007; 2009; 2010] for the maximal positive value \( \max \frac{\partial}{\partial t} \psi^M_3(C_3, \text{int}) \) of the partial derivative \( \frac{\partial}{\partial t} \psi^M_3(C_3, \text{int}) \) of the gravitational potential \( \psi^M_3(C_3, \text{int}) \) created by the Mercury (moving around the mass center \( O \) of the Sun along the hypothetical circular orbit) at the mass center \( C_3 \) of the Earth:

\[
\max \frac{\partial}{\partial t} \psi^M_3(C_3, \text{int}) = p(1, C_3) \frac{\gamma M_s M_R^2}{R_{03}^2 + R_{0M}^2} \omega_M \]

(3.93)

As a scale of the energy gravitational influence of the Sun (owing to the outer large planets \( \tau_j \) \((j=5, 6, 7, 8)\) of the Solar System) on the Earth. To evaluate the relative power of the energy gravitational influence of the Sun (owing to the outer large planets \( \tau_j \) \((j=5, 6, 7, 8)\) of the Solar System) on the Earth as compared with the power of the energy gravitational influence of the Mercury, we find the ratio \( f_{\text{SUN,M}}(j, C_3, \text{char.}) \) of the characteristic maximal positive value char. max. pos. \( \frac{\partial}{\partial t} \psi^S_j(C_3, t) \) (given by the expression (3.92)) and the maximal positive value \( \max \frac{\partial}{\partial t} \psi^M_3(C_3, \text{int}) \) (given by the expression (3.93)):

\[
f_{\text{SUN,M}}(j, C_3, \text{char.}) = \frac{\text{char. max. pos. } \frac{\partial}{\partial t} \psi^S_j(C_3, t)}{\max \frac{\partial}{\partial t} \psi^M_3(C_3, \text{int})} = \]

\[
\frac{1}{2p(1, C_3)} \frac{M_j}{M_1} \left[ R_{03}^2 + R_{01}^2 \right]^{\frac{1}{2}} \frac{R_{03} T_j}{R_{03} R_{01}} \frac{(1 - e_j^2)}{(1 + \sqrt{1 - e_j^2})^2} \frac{(1 - e_j^2)^2}{(1 + \sqrt{1 - e_j^2})^2} \times \]

\[
\frac{1}{(1 + e_j^2)^2} \frac{(1 + \sqrt{1 - e_j^2})^2}{(1 + \sqrt{1 - e_j^2})^2} \]

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\[
\frac{1}{(1 + e_S^2 \cos \varphi_j(t))} \left( \frac{p_{S_i}}{p_j} \right)^2 \left( \frac{1}{(1 + e_S^2 \cos \varphi_j(t))^2} + \frac{1}{(1 + e_j^2 \cos \varphi_j(t))^2} \right)^{3/2} \times \\
\left[ \frac{1}{(1 + e_j^2 \cos \varphi_j(t))} + \frac{e_S \sin \varphi_j(t)}{(1 + e_S^2 \cos \varphi_j(t))^2} \right] \frac{p_{S_i}}{p_j}, \quad (j = 5, 6, 7, 8)
\]

where \( \left( \frac{p_{S_i}}{p_j} \right)^2 \) is given by the following relation \( (j = 5, 6, 7, 8) \):

\[
\left( \frac{p_{S_i}}{p_j} \right)^2 = \left( \frac{p_{M_i}}{M_{S_i}} \right)^2 = \left( \frac{M_j}{M_S} \right)^2 \left( \frac{p_j}{p_3} \right)^2 = \left( \frac{M_j}{M_S} \right)^2 \frac{(1 - e_j^2)}{(1 - e_j^2)} \frac{R_{O_i}}{(1 + \sqrt{1 - e_j^2})^2}.
\]

Using the relation (3.95), the ratio \( f_{\text{SUN} M}(j, C_3, \text{char.}) \) (given by the expression (3.94)) can be rewritten as follows:

\[
f_{\text{SUN} M}(j, C_3, \text{char.}) = \frac{M_j \left[ R_{O_3}^2 + R_{O_i}^2 \right]}{2 p(1, C_3) M_j R_{O_3}^3 R_{O_i} \left( (1 - e_i^2)(1 + \sqrt{1 - e_i^2}) \right)^2} \times
\]

\[
\left( \frac{M_j}{M_S} \right)^2 \left( \frac{(1 - e_j^2)}{(1 + \sqrt{1 - e_j^2})} \right)^2 \left( \frac{1}{(1 + e_j^2 \cos \varphi_j(t))^2} + \frac{1}{(1 + e_j^2 \cos \varphi_j(t))^2} \right)^{3/2} \times \\
\left[ \frac{1}{(1 + e_j^2 \cos \varphi_j(t))} + \frac{e_S \sin \varphi_j(t)}{(1 + e_S^2 \cos \varphi_j(t))^2} \right] \frac{M_j}{M_S} \frac{(1 - e_j^2)}{(1 + \sqrt{1 - e_j^2})} \frac{R_{O_i}}{(1 + \sqrt{1 - e_j^2})}, \quad (j = 5, 6, 7, 8)
\]

The obtained formula (3.96) is valid only for the outer large planets (the Jupiter, the Saturn, the Uranus \( (\tau_5) \) and the Neptune) of the Solar System. Using the formula (3.96) and the planetary numerical values [Zhirmunsky and Kuzmin, 1990; Simonenko, 2007; 2008; 2009; 2010], we calculate the following numerical values (of the non-dimensional energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets): \( f_{\text{SUN} M}(5, C_3, \text{char.}) = 884.935424 \) (for the Sun owing to the gravitational interaction of the Sun with the Jupiter), \( f_{\text{SUN} M}(6, C_3, \text{char.}) = 194.923355 \) (for the Sun owing to the gravitational interaction of the Sun with the Saturn), \( f_{\text{SUN} M}(7, C_3, \text{char.}) = 21.279511 \) (for the Sun owing to the gravitational interaction of the Sun with the Uranus) and \( f_{\text{SUN} M}(8, C_3, \text{char.}) = 20.833557 \) (for the Sun owing to the gravitational interaction of the Sun with the Neptune).

Taking into account the calculated numerical values \( f_{\text{SUN} M}(j, C_3, \text{char.}) \) \( (j = 5, 6, 7, 8) \), we obtain the following order of significance of the outer large planets of the Solar System: the Jupiter \( (\tau_5) \), the Saturn \( (\tau_6) \), the Uranus \( (\tau_7) \) and the Neptune \( (\tau_7) \) in respect of the evaluated characteristic maximal positive instantaneous energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets of the Solar System.
3.3.2. The evaluations of the maximal positive integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets in the first approximation of the circular orbits of the planets of the Solar System

We shall use the relation (3.85) for the evaluation of the maximal positive integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets in the first approximation of the circular orbits of the outer large planets of the Solar System. Considering the orbit of the outer large planet \( \tau_j \) \((j = 5, 6, 7, 8)\) of the Solar System as the circular (in the first approximation), we obtain that the orbit of the mass center \( C_S \equiv O \) of the Sun may be considered as circular also (in the first approximation) for the closed system the Sun – the outer large planet \( \tau_j \) (the Sun and the outer large planet \( \tau_j \)). Consequently, we can consider (in the first approximation) in the relation (3.85) the average radius \( \langle r_{Sj} \rangle \) instead of \( r_{Sj} \) for the hypothetical circular orbit of the mass center \( C_S \equiv O \) of the Sun in the closed system the Sun – the outer large planet \( \tau_j \) \((j = 5, 6, 7, 8)\). We can consider (in the first approximation) in the relation (3.85) the average radius \( R_{O3} \) of the Earth’s orbit instead of \( R \). The average radius \( \langle r_{Sj} \rangle \) is given by the following expression

\[
\langle r_{Sj} \rangle = R_{Oj} \frac{M_j}{M_S}, \quad (3.97)
\]

where \( M_S \) is the mass of the Sun, \( M_j \) is the mass of the planet \( \tau_j \) \((j = 5, 6, 7, 8)\). Using the relation (3.97) and the relations \( \varphi_3 = \omega_j t, \varphi_j = \omega_j t \) (for the hypothetical circular orbits of the Earth and the planet \( \tau_j \) around the combined mass center \( C(S,j) \) of the Sun and the planet \( \tau_j \)), the relation (3.85) can be rewritten as follows

\[
\frac{\partial}{\partial t} \psi^S_j(C_3, t) = \frac{\gamma M_j R_{Oj} R_{O3} \omega_j \sin(\omega_j - \omega_j) t}{\left[ R_{Oj} \frac{M_j}{M_S} \right]^2 + R_{O3}^2 + 2 R_{Oj} \frac{M_j}{M_S} R_{O3} \cos(\omega_j - \omega_j) t}^{3/2}. \quad (3.98)
\]

The main interest of this Subsection is related with the maximal positive integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j \) \((j = 5, 6, 7, 8)\):

\[
\max_t \Delta \varepsilon E_3(\text{Sun} - \tau_j, \varphi_{Oj}, \varphi_{O3}, t, t_0) \quad (3.99)
\]

under the following initial (for the initial time moment \( t = t_0 \)) angles: \( \varphi_{Oj} = 0 \) and \( \varphi_{O3} = 0 \) characterizing the initial configuration of the outer large planet \( \tau_j \) and the Earth \( \tau_3 \), respectively. These initial angles \((\varphi_{Oj} = 0 \text{ and } \varphi_{O3} = 0)\) correspond (see Fig. 10) to the minimal distance between the mass center \( C_j \) of the outer large planet \( \tau_j \) and the mass center \( C_3 \) the Earth \( \tau_3 \) for the initial time moment \( t = t_0 = 0 \). Taking into account \( \varphi_{Oj} = 0, \varphi_{O3} = 0 \) and using the derived expression (3.98) for \( \frac{\partial}{\partial t} \psi^S_j(C_3, t) \), we have the following expression for the integral energy gravitational influence of the Sun on the Earth owing to the
The gravitational interaction of the Sun with the outer large planet $\tau_j$:

$$\Delta E_j = \int_{t_0}^{t} \left[ \frac{\partial}{\partial t} \Psi_j(C_3, \tau') \right] dt' = M_j \int_{t_0}^{t} \frac{\gamma M R_{Oj} R_{O3} \omega_j \sin(\omega_j - \omega_j)t'}{(R_{Oj} \frac{M_j}{M_S})^2 + R_{O3}^2 + 2R_{Oj} \frac{M_j}{M_S} R_{O3} \cos(\omega_j - \omega_j)t'}^{3/2}. \quad (3.100)$$

Introducing the following designations

$$\beta_{Sj} = R_{Oj}^2 + \left( R_{Oj} \frac{M_j}{M_S} \right)^2, \quad \chi_{Sj} = 2R_{Oj} R_{O3} \frac{M_j}{M_S}, \quad \alpha_j = \gamma M_j R_{O3} R_{O3} \omega_j, \quad (3.101)$$

the expression (3.100) can be rewritten as follows

$$\Delta E_j = (\text{Sun} - \tau_j, 0, 0, t, t_0) = \int_{t_0}^{t} \frac{\alpha_j \sin(\omega_j - \omega_j)t'}{(\omega_j - \omega_j) \chi_{Sj} [\beta_{Sj} + \chi_{Sj} \cos(\omega_j - \omega_j)t']^{3/2}}. \quad (3.102)$$

Introducing the new variable $u = \cos(\omega_j - \omega_j)t'$, the expression (3.102) can be rewritten as follows

$$\Delta E_j = (\text{Sun} - \tau_j, 0, 0, t, t_0) = \int_{\cos(\omega_j - \omega_j)t_0}^{\cos(\omega_j - \omega_j)t} \frac{du}{(\omega_j - \omega_j) \chi_{Sj} [\beta_{Sj} + \chi_{Sj} u]^{3/2}}. \quad (3.103)$$

Taking into account the relation

$$\int \frac{du}{\beta_{Sj} + \chi_{Sj} u} = \frac{1}{\chi_{Sj} [\beta_{Sj} + \chi_{Sj} u]^{3/2}} + C, \quad (3.104)$$

and integrating the relation (3.103), we have the following expression

$$\Delta E_j = \frac{2\alpha_j}{(\omega_j - \omega_j) \chi_{Sj}} \left[ \frac{1}{\beta_{Sj} + \chi_{Sj} \cos(\omega_j - \omega_j)t_0]^{3/2}} - \frac{1}{\beta_{Sj} + \chi_{Sj} \cos(\omega_j - \omega_j)t_0} \right]. \quad (3.105)$$

Considering the initial time moment $t_0 = 0$, the expression (3.105) gives the relation:

$$\Delta E_j = \frac{2\alpha_j}{(\omega_j - \omega_j) \chi_{Sj}} \left[ \frac{1}{\beta_{Sj} + \chi_{Sj} \cos(\omega_j - \omega_j)t_0]^{3/2}} - \frac{1}{\beta_{Sj} + \chi_{Sj}} \right]. \quad (3.106)$$

The relation (3.106) gives the maximal positive integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets $\tau_j$ ($j = 5, 6, 7, 8$):

$$\max \Delta E_j (\text{Sun} - \tau_j, 0, 0, t, 0) = \Delta E_j (\text{Sun} - \tau_j, 0, 0, t^*_j(3, j), 0) = \frac{2\alpha_j}{(\omega_j - \omega_j) \chi_{Sj}} \left[ \frac{1}{\beta_{Sj} + \chi_{Sj} \cos(\omega_j - \omega_j)t_0]^{3/2}} - \frac{1}{\beta_{Sj} + \chi_{Sj}} \right], \quad (3.107)$$

which are attained at first under the time moments $t = t^*_j(3, j) = \frac{T_j T_j}{\left( T_j - T_3 \right)}$, where $j = 5, 6, 7, 8$. The following time moments

$$t^*_n(3, j) = \frac{T_j T_j}{\left( T_j - T_3 \right)} + \frac{T_j T_j}{\left( T_j - T_3 \right)}, \quad (j = 5, 6, 7, 9; n = 0, 2, 3, \ldots)$$

give the same maxima

$$\max \Delta E_j (\text{Sun} - \tau_j, 0, 0, t, 0) = \Delta E_j (\text{Sun} - \tau_j, 0, 0, t^*_n(3, j), 0) = \frac{2\alpha_j}{(\omega_j - \omega_j) \chi_{Sj}} \left[ \frac{1}{\beta_{Sj} + \chi_{Sj} \cos(\omega_j - \omega_j)t_0]^{3/2}} - \frac{1}{\beta_{Sj} + \chi_{Sj}} \right], \quad (3.108)$$
which are attained under the time moments $t = t_n^j(3,j)$, where $j = 5, 6, 7, 9$; $n = 0, 1, 2, 3, \ldots$. The time moments $t = t_n^j(3,j)$ define the planetary configurations characterizing by the maximal distances between the mass center $C_j$ of the outer large planet $\tau_j$ ($j = 5, 6, 7, 9$) and the mass center $C_3$ of the Earth $\tau_3$. Taking into account the designations (3.101), the relation (3.108) can be rewritten as follows

$$\max_t \Delta g E_3(\text{Sun} - \tau_j, 0, 0, t, 0) = \frac{2\gamma M_j M_3 R_{O_3} T_j}{(T_j - T_3) \left( R_{O_3}^2 - \left( \frac{R_{O_3} M_j}{M_3} \right)^2 \right)} .$$

We shall use the expression (3.48) as a maximal positive integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planet $\tau_j$ ($j = 5, 6, 7, 8$). Considering the ratio of the maximal positive integral energy gravitational influence $\max_t \Delta g E_j(\text{Sun} - \tau_j, 0, 0, t, 0)$ (given by the expression (3.109)) of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planets $\tau_j$) and the maximal positive integral energy gravitational influence $\max_t \Delta g E_3(\tau, 0, 0, t, 0)$ (given by the expression (3.48)) of the Mercury on the Earth, we obtain the relative values $s(\text{Sun} - \tau_j, \text{first approx.})$ of the maximal integral energy gravitational influences of the Sun on the Earth with the outer large planets $\tau_j$ ($j = 5, 6, 7, 8$):

$$s(\text{Sun} - \tau_j, \text{first approx.}) = \frac{\max_t \Delta g E_j(\text{Sun} - \tau_j, 0, 0, t, 0)}{\max_t \Delta g E_3(\tau, 0, 0, t, 0)} =$$

$$= \frac{M_j}{M_3} \frac{R_{O_3}}{R_{O_1}} \frac{(T_j - T_3)}{(T_j - T_3)} \left( \frac{R_{O_3}^2 - R_{O_1}^2}{R_{O_3}^2 - \left( \frac{R_{O_3} M_j}{M_3} \right)^2} \right) .$$

Using the formula (3.110) and the planetary numerical values [Zhirmunsky and Kuzmin, 1990; Simonenko, 2007] of the average radii of orbits of the Earth, the Mercury and the Jupiter ($j=5$), the time periods of circulations around the Sun and the masses of the Jupiter, the Mercury and the Sun, we calculate the numerical value $s(\text{Sun} - \tau_5, \text{first approx.}) = 4235.613239$, which means that the maximal integral energy gravitational influence of the Sun (owing to the gravitational interaction of the Sun with the Jupiter) on the unit mass of the Earth (at the mass center $C_3$ the Earth $\tau_3$) is $s(\text{Sun} - \tau_5, \text{first approx.})/s(5) = 4235.613239/31.319 = 135.2410115$ times larger than the power of the maximal integral energy gravitational influence of the Jupiter (at the mass center $C_3$ the Earth $\tau_3$).

Using the formula (3.110) and the planetary numerical values [Zhirmunsky and Kuzmin, 1990; Simonenko, 2007] of the average radii of orbits of the Earth, the Mercury and the Saturn ($j=6$), the time periods of circulations around the Sun and the masses of the Saturn, the Mercury and the Sun, we calculate the numerical value $s(\text{Sun} - \tau_6, \text{first approx.}) = 887.4442965$, which means that the maximal integral energy gravitational influence of the Sun (owing to the gravitational interaction of the Sun with the Saturn) on the unit mass of the Earth (at the mass center $C_3$ the Earth $\tau_3$) is $s(\text{Sun} - \tau_6, \text{first approx.})/s(6) = 887.4442965/1.036 = 856.6064638$ times larger than the power of the maximal integral energy gravitational influence of the Saturn (at the mass center $C_3$ of the Earth $\tau_3$).

Using the formula (3.110) and the planetary numerical values [Zhirmunsky and Kuzmin, 1990; Simonenko, 2007] of the average radii of orbits of the Earth, the Mercury and the Uranus ($j=7$), the time periods of circulations around the Sun and the masses of the Uranus, the Mercury and the Sun, we calculate the numerical value $s(\text{Sun} - \tau_7, \text{first approx.}) = 93.8337322$, which means that the maximal integral
energy gravitational influence of the Sun (owing to the gravitational interaction of the Sun with the Uranus) on the unit mass of the Earth (at the mass center \( C_j \) of the Earth \( \tau_j \)) is \( s(\text{Sun} - \tau_j, \text{first approx.}) = 93.8337322/0.0133 = 7055.167834 \) times larger than the power of the maximal integral energy gravitational influence of the Uranus (at the mass center \( C_j \) of the Earth \( \tau_j \)).

Using the formula (3.110) and the planetary numerical values [Zhirmunsky and Kuzmin, 1990; Simonenko, 2007] of the average radii of orbits of the Earth, the Mercury and the Neptune \( (j=8) \), the time periods of circulations around the Sun and the masses of the Neptune, the Mercury and the Sun, we calculate the numerical value \( s(\text{Sun} - \tau_s, \text{first approx.}) = 87.8477601 \), which means that the maximal integral energy gravitational influence of the Sun (owing to the gravitational interaction of the Sun with the Neptune) on the unit mass of the Earth (at the mass center \( C_j \) of the Earth \( \tau_j \)) is \( s(\text{Sun} - \tau_s, \text{first approx.})/s(\text{Sun} - \tau_s, \text{first approx.}) = 87.8477601/0.003229 = 27205.87182 \) times larger than the power of the maximal integral energy gravitational influence of the Neptune (at the mass center \( C_j \) of the Earth \( \tau_j \)).

Thus, taking into account the calculated relative values \( s(\text{Sun} - \tau_j, \text{first approx.}) \) of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j \) \( (j=5, 6, 7, 8) \), we obtain the following order of signification of the outer large planets \( \tau_j \) \( (j=5, 6, 7, 8) \) of the Solar System: the Jupiter \( (s(\text{Sun} - \tau_5, \text{first approx.}) = 4235.613239) \), the Saturn \( (s(\text{Sun} - \tau_6, \text{first approx.}) = 887.4442965) \), the Uranus \( (s(\text{Sun} - \tau_7, \text{first approx.}) = 93.8337322) \) and the Neptune \( (s(\text{Sun} - \tau_8, \text{first approx.}) = 87.8477601) \) in respect of the established evaluation of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j \) \( (j=5, 6, 7, 8) \). We establish that the Sun induce the main maximal integral energy gravitational influences on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j \) \( (j=5, 6, 7, 8) \).

Considering the aspect of the cosmic gravitational preparation of the strong earthquakes, we can state the established predominance of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the Jupiter \( (s(\text{Sun} - \tau_5, \text{first approx.}) = 4235.613239) \), the Saturn \( (s(\text{Sun} - \tau_6, \text{first approx.}) = 887.4442965) \), the Uranus \( (s(\text{Sun} - \tau_7, \text{first approx.}) = 93.8337322) \) and the Neptune \( (s(\text{Sun} - \tau_8, \text{first approx.}) = 87.8477601) \) along with the established [Simonenko, 2007; 2009] Venusian \( (s(2) = 89.6409) \) and the Jupiter’s \( (s(5) = 31.319) \) planetary energy gravitational predominance and the established [Simonenko, 2009; 2010] significant maximal integral energy gravitational influence of the Moon \( (s(\text{Moon}, \text{second approx.}) = 13.0693) \) on the Earth.

Thus, taking into account the previously established planetary [Simonenko, 2007] and lunar [Simonenko, 2009; 2010] numerical values and also the calculated relative values \( s(\text{Sun} - \tau_j, \text{first approx.}) \) of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j \) \( (j=5, 6, 7, 8) \), we obtain the following order of signification of the cosmic bodies of the Solar System: the Sun (owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune), the Venus, the Jupiter, the Moon, the Mars, the Saturn, the Mercury, the Uranus, the Neptune and the Pluto in respect of the evaluated integral energy gravitational influences of these cosmic bodies on the Earth.

### 3.4. The real cosmic energy gravitational genesis of the strong earthquakes and the global planetary cataclysms

#### 3.4.1. The confirmation of the real cosmic energy gravitational genesis of preparation of earthquakes
Using the formula (3.51), we evaluated [Simonenko, 2007; 2009; 2010] the numerical value $E_g(\tau_2, D_3, m_\tau)$ of the integral energy gravitational influence of the Venus on the macroscopic continuum region $\tau$ (the focal region of the preparing earthquake) of mass $m_\tau$ near the surface point $D_3$ of the Earth during the time

$$T_\tau(2) = T_{\tau_r}^*(3.2) = \frac{1}{2} \left( \frac{T_2 T_3}{(T_2 - T_3)} \right) = 291.902 \text{ days} \tag{3.111}$$

of the energy gravitational influence of the Venus on the macroscopic continuum region $\tau$ of the Earth. Using the expression (3.51) for the maximal positive integral energy gravitational influence $E_g(\tau_2, D_3, m_\tau)$ of the Venus ($i = 2$) on the macroscopic continuum region $\tau$ of mass $m_\tau$ near the point $D_3$ of the Earth, we obtained [Simonenko, 2007; 2009; 2010] the obvious estimation for the value $E_g(\tau_2, D_3, m_\tau)$:

$$E_g(\tau_2, D_3, m_\tau) = 2\gamma m_\tau M_2 \frac{R_{02} T_3}{(R_{03} - R_{02}) (T_3 - T_2)} = 2\gamma (l_\tau)^3 \rho M_2 \frac{R_{02} T_3}{(R_{03} - R_{02}) (T_3 - T_2)} > 0 \tag{3.112}$$

where the final expression for the estimation $E_g(\tau_2, D_3, m_\tau)$ is given for the focal region of the cubical form characterized by the size $l_\tau$ of the cube. Considering the following numerical values: $l_\tau = 10 \text{ km}$, $\rho = 5000 \text{ kg/m}^3$ (the average density of the cubical focal region) and using the numerical value $\gamma = 6.67 \cdot 10^{-11} \text{ J} \cdot \text{m/kg}^2$ (of the gravitational constant) and the following known [Zhirmunsky and Kuzmin, 1990] parameters of the Solar System: $T_V = T_2 = 224.7 \text{ days}$, $R_{0V} = R_{02} = 108.1 \cdot 10^6 \text{ km}$, $M_V = M_2 = 0.82M_3$, $M_3 = 6 \cdot 10^{24} \text{ kg}$, $T_3 = 365.3 \text{ days}$, we calculated [Simonenko, 2007; 2009; 2010] from the expression (3.112) the numerical estimation for the value $E_g(\tau_2, D_3, m_\tau)$:

$$E_g(\tau_2, D_3, m_\tau) = 8.619 \cdot 10^{19} \text{ J} \tag{3.113}$$

which is close to the change $\Delta W \approx 10^{20} \text{ J}$ [Vikulin, 2003; p. 94] of the rotational kinetic energy of the Earth during the strongest earthquakes. The order of magnitude of the estimation (3.113) for the value $E_g(\tau_2, D_3, m_\tau)$ is consistent with the earlier estimation of the seismotectonic energy $E_{ST}$ [Vikulin, 2003; p. 94], which can discharge in the focal region of the strongest earthquakes. Obviously, the seismotectonic energy $E_{ST}(\tau_2, D_3, m_\tau)$ cannot be larger than $E_g(\tau_2, D_3, m_\tau)$:

$$E_{ST}(\tau_2, D_3, m_\tau) \leq E_g(\tau_2, D_3, m_\tau) \tag{3.114}$$

It was pointed out [Vikulin, 2003; p. 96] that the coincidence of the values $E_{ST}$ and $\Delta W$ is not the casual fact: it is the indication that the strongest earthquake can be considered as the energy quantum corresponding to the regular change of the rotational regime of the Earth. Using the equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics for the focal region $\tau$ of the preparing earthquake, we found rigorously the equality of the orders of the magnitude of the values $E_{ST}$ and $\Delta W$ for the strongest earthquakes. Consequently, the coincidence of the orders of the magnitude of the values $E_{ST}$, $\Delta W$ and $E_g(\tau_2, D_3, m_\tau)$ is the indication that the regular changes of the rotational regime of the Earth are related with the regular discharges of the accumulated potential energy (in the different focal regions of earthquakes) supplying by the cosmic gravitational energy influences of the planets of the Solar System, the Sun and the Moon.

Thus, based on the equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics used for the Earth’s macroscopic continuum region $\tau$ (the focal region of the preparing earthquake), we evaluated [Simonenko, 2007; 2009; 2010] the reality of the cosmic energy
3.4.2. The evidence of the integral energy gravitational influence on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter $\tau_5$ and the Saturn $\tau_6$) and the Moon as the predominant cosmic trigger mechanism of the earthquakes preparing by the combined integral energy gravitational influence on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter $\tau_5$, the Saturn $\tau_6$, the Uranus $\tau_7$ and the Neptune $\tau_8$), the Venus, the Jupiter, the Moon, the Mars and the Mercury.

We evaluated [Simonenko, 2007] the relative (normalized on the maximal integral energy gravitational influence of the Mercury $\tau_1$ on the Earth) average integral energy gravitational planetary influences corresponding to the time duration $T_{\text{MOON}}/2$ of the maximal integral energy gravitational influence of the Moon on the Earth. We took into account the time durations of the maximal integral energy gravitational influences on the Earth of the inner planets (the Mercury $\tau_1$ and the Venus $\tau_2$):

$$T_g(i) = t_g(i,3) = \frac{T_i T_3}{2(T_3 - T_i)}, \quad (i = 1, 2),$$

which are the time durations of supplying of the cosmic planetary gravitational energy from the inner planets ($i=1, 2$) to the focal region of the preparing earthquakes. We took into account the time durations of the maximal integral energy gravitational influences on the Earth of the outer planets (the Mars $\tau_4$, the Jupiter $\tau_5$, the Saturn $\tau_6$, the Uranus $\tau_7$, the Neptune $\tau_8$ and the Pluto $\tau_9$):

$$T_g(i) = t_g(i,3) = \frac{T_i T_3}{2(T_3 - T_i)}, \quad (i = 4, 5, 6, 7, 8, 9)$$

which are the time durations of supplying of the cosmic planetary gravitational energy from the outer planets ($i = 4, 5, 6, 7, 8, 9$) to the focal region of the preparing earthquakes.

We defined [Simonenko, 2007] and calculated the relative values $S(i)$ (normalized on the maximal integral energy gravitational influence of the Mercury ($i = 1$) on the Earth) of the maximal integral energy gravitational influences on the Earth of the planets of the Solar System ($i = 1, 2, 4, 5, 6, 7, 8, 9$). We evaluated [Simonenko, 2007] the relative (normalized on the maximal integral energy gravitational influence of the Mercury ($i = 1$) on the Earth) average values $e(i)$ of the integral energy gravitational influences on the Earth of the planets of the Solar System corresponding to the time duration $T_{\text{MOON}}/2$ of the maximal integral energy gravitational influence of the Moon on the Earth. This evaluation is given by the following formula [Simonenko, 2007]:

$$e(i) = s(i) \frac{0.5 T_{\text{MOON}}}{T_g(i)}, \quad (i = 1, 2, 4, 5, 6, 7, 8, 9).\quad (3.117)$$

Using the expression (3.115) for the time $T_g(i)$ of supplying of the cosmic planetary gravitational energy from the inner planets ($i=1, 2$), the expression (3.116) for the time $T_g(i)$ of supplying of the cosmic planetary gravitational energy from the outer planets ($i = 4, 5, 6, 7, 8, 9$) and the expression (3.117) for the relative average values $e(i)$, we calculated the following numerical values [Simonenko, 2007]: $T_g(1) = 57.96$ days and $e(1) = 0.2547$ (which is one order of magnitude smaller than $s(\text{Moon}, \text{second approx.}) = 13.0693$) for the Mercury; $T_g(2) = 291.902$ days and $e(2) = 4.5342$ (which is smaller than $s(\text{Moon}, \text{second approx.}) = 13.0693$) for the Venus; $T_g(4) = 390.0545$ days and $e(4) = 0.0999$ (which is significantly smaller than $s(\text{Moon}, \text{second approx.}) = 13.0693$) for the Mars; $T_g(5) = 199.4705$ days and $e(5) = 2.3182$ (which is smaller significantly than
s(Moon, second approx.) = 13.0693 for the Jupiter; \( T_g(6) = 189.069 \) days and \( e(6) = 0.0809 \) (which is significantly smaller than \( s(Moon, second \ approx.) = 13.0693 \)) for the Saturn; \( T_g(7) = 184.8506 \) days and \( e(7) = 0.001066 \) (which is four orders of the magnitude smaller than \( s(Moon, second \ approx.) = 13.0693 \)) for the Uranus; \( T_g(8) = 183.7653 \) days and \( e(8) = 0.0002594 \) (which is four-five orders of the magnitude smaller than \( s(Moon, second \ approx.) = 13.0693 \)) for the Neptune; \( T_g(9) = 183.3905 \) days and \( e(9) = 1.1671 \times 10^{-8} \) (which is nine orders of the magnitude smaller than \( s(Moon, second \ approx.) = 13.0693 \)) for the Pluto.

We established [Simonenko, 2007] the following order of significance of the planets of the Solar System and the Moon for the cosmic gravitational preparation of the strong earthquakes: the Venus \( (s(2) = 89.640) \), the Jupiter \( (s(5) = 31.319) \), the Moon \( (s(Moon, second \ approx.) = 13.0693) \), the Mars \( (s(4) = 2.6396) \), the Saturn \( (s(6) = 1.036) \), the Mercury \( (s(i) = 1) \), the Uranus \( (s(7) = 0.0133) \), the Neptune \( (s(8) = 0.003229) \) and the Pluto \( (s(9) = 1.4495 \times 10^{-7}) \). We established [Simonenko, 2007] the different order of significance of the planets of the Solar System and the Moon related with the defined relative average values \( e(i) \): the Moon \( (s(Moon, second \ approx.) = 13.0693) \), the Venus \( (e(2) = 4.5342) \), the Jupiter \( (e(5) = 2.3182) \), the Mercury \( (e(1) = 0.2547) \), the Mars \( (e(4) = 0.0999) \), the Saturn \( (e(6) = 0.0809) \), the Uranus \( (e(7) = 0.001066) \), the Neptune \( (e(8) = 0.0002594) \) and the Pluto \( (e(9) = 1.1671 \times 10^{-8}) \). Taking into account the obtained [Simonenko, 2007] numerical values \( e(i) \) for the planets of the Solar System and the numerical value \( s(Moon, second \ approx.) = 13.0693 \) [Simonenko, 2009; 2010] for the Moon, we established [Simonenko, 2009; 2010] the predominant significance of the Moon (along with the minor significance of the Venus, the Jupiter and the Mercury) as the predominant cosmic trigger mechanism of the earthquakes preparing by the combined integral energy gravitational influences on the Earth of the Venus, the Jupiter, the Moon, the Mars and the Mercury.

Taking into account the additional significant results of Subsection 3.3, let us evaluate the relative (normalized on the maximal integral energy gravitational influence of the Mercury \( i = 1 \) on the Earth) average values \( e_S(j) \) (corresponding to the time duration \( T_{MOON} / 2 \) of the maximal integral energy gravitational influence of the Moon on the Earth) of the integral energy gravitational influences on the Earth of the Sun owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j \) \( (j = 5, 6, 7, 8) \). This evaluation is based on the following formula:

\[
e_S(j) = s(Sun - \tau_j, first \ approx.) \frac{0.5 T_{MOON}}{T_g(j)}. \quad (j = 5, 6, 7, 8)
\]

(3.118)

We take into account the time durations of the maximal integral energy gravitational influences on the Earth of the Sun owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j \) \( (j = 5, 6, 7, 8) \) to the focal region of the preparing earthquakes. Taking into account the calculated relative values \( s(Sun - \tau_j, first \ approx.) \) of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j \) \( (j = 5, 6, 7, 8) \) and using the expressions (3.118) and (3.119), we calculate the following numerical values: \( e_S(5) = 313.5305 \) (for the Sun owing to the Jupiter \( \tau_5 \)), \( e_S(6) = 69.3047 \) (for the Sun owing to the Saturn \( \tau_6 \)), \( e_S(7) = 7.4951 \) (for the Sun owing to the Uranus \( \tau_7 \)) and \( e_S(8) = 7.0584 \) (for the Sun owing to the Neptune \( \tau_8 \)).
Taking into account the obtained [Simonenko, 2007] numerical values \(c(i)\) for the planets of the Solar System, the numerical value \(s(\text{Moon, second approx.}) = 13.0693\) [Simonenko, 2009; 2010] for the Moon and the obtained numerical values \(e_j(j)\) for the Sun (owing to the gravitational interaction of the Sun with the outer large planets \(\tau_j, j = 5, 6, 7, 8\), we establish the predominant significance of the Sun (owing to the gravitational interactions of the Sun with the Jupiter \(\tau_5\) and the Saturn \(\tau_6\)) and the Moon as the predominant cosmic trigger mechanism (along with the minor significance of the Sun (owing to the gravitational interactions of the Sun with the Uranus \(\tau_7\) and the Neptune \(\tau_8\)), the Venus, the Jupiter and the Mercury) of the earthquakes preparing by the combined integral energy gravitational influences on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter \(\tau_5\) and the Saturn \(\tau_6\), the Uranus \(\tau_7\) and the Neptune \(\tau_8\)), the Venus, the Jupiter, the Moon, the Mars and the Mercury.

### 3.4.3. The catastrophic planetary configurations of the cosmic seismology

#### 3.4.3.1. The catastrophic planetary configurations related with the maximal (positive) and minimal (negative) combined integral energy gravitational influence on the Earth \(\tau_3\) of the planets of the Solar System

Taking into account the considered planetary and lunar energy gravitational influences on the Earth [Simonenko, 2007; 2009; 2010], we established [Simonenko, 2009; 2010] that the maximal probabilities of a strong earthquakes (induced by the planetary and lunar energy gravitational influences on the Earth) are attained in two catastrophic planetary configurations:

**a)** when the Sun, the Moon, the inner planets (the Mercury and the Venus) and the outer planets (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) are aligned in a straight line with the Earth, and moreover (in the first catastrophic configuration): the inner planets (the Mercury and the Venus) are in close conjunctions with the Earth (and simultaneously in mutual close opposition), the outer planets (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) are in close oppositions with the Earth and the Moon in full moon or in new moon configuration depending on the temporal orientation of the lunar orbit;

**b)** when the Sun, the Moon, the inner planets (the Mercury and the Venus) and the outer planets (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) are aligned in a straight line with the Earth, and moreover (in the second catastrophic configuration): the inner planets (the Mercury and the Venus) are in close oppositions with the Earth, the outer planets (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) are in close conjunctions with the Earth and the Moon in new moon or in full moon configuration depending on the temporal orientation of the lunar orbit.

These two (shown on Fig. 11 and Fig. 12) catastrophic planetary configurations a) and b) are deduced from the global prediction thermohydrogravidynamic principles. The catastrophic planetary configuration a) (shown on Fig. 11) is founded based on the global prediction thermohydrogravidynamic principle (consistent with the generalized differential formulations (1.43) and (1.50) of the first law of thermodynamics of the established cosmic seismology [Simonenko, 2007; 2008; 2009; 2010]) associated with the maximal (positive) combined planetary integral energy gravitational influence on the Earth:

\[
\Delta G_p(t) = \int_{t_0}^{t} dG_p = \text{local maximum for time moment } t^*, \tag{3.120}
\]

where the time moment \(t^*\) is related with the maximal (positive) combined integral energy gravitational influence on the Earth \(\tau_3\) of the planets of the Solar System for the time moment \(t = t^*\):

\[
\Delta G_p(t^*) = \max_{t} \Delta G_p(t) = \max_t \left\{ \sum_{i=1}^{9} \int_{\tau_1}^{t} \int_{\tau_2}^{t} \left[ \frac{\partial y_{1i}}{\partial t} - \rho dV \right] dt \right\}. \tag{3.121}
\]
The catastrophic planetary configuration b) (shown on Fig. 12) is founded based on the global prediction thermohydrogravidynamic principle (consistent with the generalized differential formulations (1.43) and (1.50) of the first law of thermodynamics of the established cosmic seismology [Simonenko, 2007; 2008; 2009; 2010]) associated with the minimal (negative) combined planetary integral energy gravitational influence on the Earth:

\[ \Delta G_p(t) = \int_{t_0}^{t} dG_p = \text{local minimum for time moment } t_* , \]  

(3.122)

where the time moment \( t_* \) is related with the minimal (negative) combined integral energy gravitational influence on the Earth \( \tau_3 \) of the planets of the Solar System for the time moment \( t = t_* \):

\[ \Delta G_p(t_*) = \min_t \Delta G_p(t) = \min_{t_0} \left\{ \sum_{j=1,3} \int_{t_0}^{t} \int \int \int \frac{\partial \psi_{3i}}{\partial t'} \rho \, dV \, dt' \right\} . \]  

(3.123)

Fig. 11. The catastrophic planetary configuration a) characterized by the maximal (positive) combined integral energy gravitational influence on the Earth \( \tau_3 \) of the planets of the Solar System

Fig. 12. The catastrophic planetary configurations b) characterized by the minimal (negative) combined integral energy gravitational influence on the Earth \( \tau_3 \) of the planets of the Solar System

3.4.3.2. The catastrophic planetary configurations related with the maximal (positive) and minimal (negative) combined integral energy gravitational influence on the Earth \( \tau_3 \) of the Sun and the planets of the Solar System

Taking into account the considered planetary [Simonenko, 2007; 2009; 2010] and the additional (considered in Subsection 3.3) very significant solar energy gravitational influences on the Earth (owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j \), \( j = 5, 6, 7, 8 \)), we establish that the global planetary cataclysms (accompanied by the finite change of the space orientation of the Earth’s axis, the irreversible deformation of the Earth’s surface and by the strong catastrophic earthquakes) are attained in two catastrophic planetary configurations (determined by the planetary and solar energy gravitational influences on the Earth) shown on Fig. 13 and Fig. 14, respectively.
Fig. 13. The catastrophic planetary configuration 1 determined by the maximal combined integral energy gravitational influences on the Earth ($\tau_1$) of the Sun (due to the gravitational interactions of the Sun ($\tau_0$) with the Jupiter ($\tau_2$), the Saturn ($\tau_6$), the Uranus ($\tau_7$), and the Neptune ($\tau_8$), the Mercury ($\tau_1$), the Venus ($\tau_2$), the Mars ($\tau_3$) and the Jupiter ($\tau_5$) aligned in a straight line

These two (shown on Fig. 13 and Fig. 14) catastrophic planetary configurations 1 and 2 are deduced from the global prediction thermohydrogravidynamic principles. The catastrophic planetary configurations 1 (shown on Fig. 13) is founded based on the global prediction thermohydrogravidynamic principle (consistent with the generalized differential formulations (1.43) and (1.50) of the first law of thermodynamics of the established cosmic seismology [Simonenko, 2007; 2008; 2009; 2010]) associated with the maximal (positive) combined integral energy gravitational influence on the Earth of the planets of the Solar System and the Sun (owing to the gravitational interaction of the Sun with the outer large planets $\tau_j$, $j = 5, 6, 7, 8$):

$$\Delta G(t) = \int_{t_0}^{t^*} \text{d}G = \text{local maximum for time moment } t^*, \quad (3.124)$$

where the time moment $t^*$ is related with the maximal (positive) combined planetary and solar integral energy gravitational influence on the Earth $\tau_3$ for the time moment $t = t^*$:

$$\Delta G(t^*) = \max \Delta G(t) = \max \left\{ \sum_{i=1}^{9} \int_{t_0}^{t_3} \left( \int \left( \frac{\partial \psi_{3i}}{\partial t'} \right) \text{d}V \right) \text{d}t' + \sum_{j=5,6,7,8} \int_{t_0}^{t_3} \left( \int \left( \frac{\partial \psi^8_j}{\partial t'} \right) \text{d}V \right) \text{d}t' \right\}. \quad (3.125)$$

The catastrophic planetary configuration 2 (shown on Fig. 14) is founded based on the global prediction thermohydrogravidynamic principle (consistent with the generalized differential formulations (1.43) and (1.50) of the first law of thermodynamics of the established cosmic seismology [Simonenko, 2007; 2008; 2009; 2010]) associated with the minimal (negative) combined planetary and solar integral energy gravitational influence on the Earth:

$$\Delta G(t) = \int_{t_0}^{t^*} \text{d}G = \text{local minimum for time moment } t^*, \quad (3.126)$$

where the time moment $t^*$ is related with the minimal (negative) combined planetary and solar integral energy gravitational influence on the Earth $\tau_3$ for the time moment $t = t^*$:

$$\Delta G(t^*) = \min \Delta G(t) = \min \left\{ \sum_{i=1}^{9} \int_{t_0}^{t_3} \left( \int \left( \frac{\partial \psi_{3i}}{\partial t'} \right) \text{d}V \right) \text{d}t' + \sum_{j=5,6,7,8} \int_{t_0}^{t_3} \left( \int \left( \frac{\partial \psi^8_j}{\partial t'} \right) \text{d}V \right) \text{d}t' \right\}. \quad (3.127)$$

Fig. 14. The catastrophic planetary configuration 2 determined by the minimal combined integral energy
gravitational influences on the Earth (τ₃) of the Sun (due to the gravitational interactions of the Sun (τ₆) with the Jupiter (τ₅), the Saturn (τ₆), the Uranus (τ₇), and the Neptune (τ₈)), the Mercury (τ₁), the Venus (τ₂), the Mars (τ₄) and the Jupiter (τ₅) aligned in a straight line.

We can state (according to cosmic geophysics) without any doubt that all previous global planetary cataclysms (accompanied by the finite change of the space orientation of the Earth’s axis, the irreversible deformation of the Earth’s surface and by the strong catastrophic earthquakes) were occurred during a time periods of the satisfactory realization of the catastrophic planetary configurations (shown on Fig. 13 and Fig. 14) of the planets and the Sun aligned approximately in a straight line, when the planets and the Sun are visible (especially, for catastrophic planetary configuration 1 shown on Fig. 13) from the Earth within the narrow angle range (related with one or two zodiacal constellations). Without any doubt, we can state that all future global planetary cataclysms (accompanied by the finite change of the space orientation of the Earth’s axis, the irreversible deformation of the Earth’s surface and by the strong catastrophic earthquakes) will be related with the time periods of the satisfactory realization of the catastrophic planetary configurations (shown on Fig. 13 and Fig. 14) of the planets and the Sun aligned approximately in a straight line.

Thus, taking into account the obtained results of this Subsection 3.4.3 and the founded [2007; 2009; 2010] galactic energy gravitational genesis (considered in Section 2) of the time periodicity of 100 million years [Hofmann, 1990] of the maximal endogenous heating of the Earth (explained by the periodic deformation of the Earth due to the periodic energy gravitational influences on the Solar System of the center of our Galaxy), we solve the major Wegener’s problem (Wegener, 1929) by finding the predominant cosmic energy gravitational influences on the Earth (of the center of our Galaxy and the Solar System) capable of to break up the supercontinent Pangaea and responsible for the subsequent continental drift.

3.5. The generalized thermohydrogravidynamic shear-rotational, classical shear (deformational) and rotational models of the earthquake focal region τ, and the local energy and entropy prediction thermohydrogravidynamic principles determining the fractures formation in the macroscopic continuum region τ

3.5.1. The generalized thermohydrogravidynamic shear-rotational and the classical shear (deformational) models of the earthquake focal region based on the generalized differential formulation of the first law of thermodynamics

Following the works [Simonenko, 2007a; 2007; 2008], we present the foundation of the generalized thermohydrogravidynamic shear-rotational model of the earthquake focal region based on the generalized differential formulation (1.53) of the first law of thermodynamics used for the earthquake focal region. Using the evolution equitation (1.67) of the total mechanical energy of the subsystem τ (the macroscopic continuum region τ) of the Earth, we shall show now that the formation of fractures (modeling by the jumps of the continuum velocity on some surfaces) are related with irreversible dissipation of the macroscopic kinetic energy and the corresponding increase of entropy. We consider at the beginning the analysis of formation of the main line flat fracture (associated with the surface F₁(τ) of the continuum velocity jump) inside of the macroscopic continuum region τ ( bounded by the closed surface ∂τ). The macroscopic continuum region τ may be divided into two subsystem τ₁ and τ₂ by continuing mentally the surface F₁(τ) by means of surface R₁(τ) crossing the surface ∂τ of the macroscopic region τ. The surface of the subsystem τ₁ consists of the surface ( ∂τ₁) (which is the part of the surface ∂τ) and the surfaces F₁(τ) and R₁(τ). The surface of the subsystem τ₂ consists of the surface (∂τ₂) (which is the part of the surface ∂τ) and the surfaces F₁(τ) and R₁(τ).
Using the formulation (1.67), we have the evolution equations for the total mechanical energies of the macroscopic subsystems \( \tau_1 \) and \( \tau_2 \):

\[
\frac{d}{dt}(K_{\tau_1} + \pi_{\tau_1}) = \frac{d}{dt} \iiint_{\tau_1} \left( \frac{1}{2} \mathbf{v}^2 + \psi \right) dV = \\
\iiint_{\tau_1} \text{pdiv} dV + \iiint_{\tau_1} \left( \frac{2}{3} \eta - \eta_v \right) (\text{div} \mathbf{v})^2 dV + \iiint_{\tau_1} 2\nu \epsilon_{ij}^2 dV + \iiint_{\tau_1} (\mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T})) d\Omega_n + \\
+ \iiint_{F_1(\tau)} (\mathbf{v}_1(\tau_1) \cdot (\mathbf{\xi}_1 \cdot \mathbf{T})) d\Sigma_{\mathbf{\xi}_1} + \iiint_{R_1(\tau)} (\mathbf{v}_1(\tau_1) \cdot (\mathbf{\xi}_1 \cdot \mathbf{T})) d\Sigma_{\mathbf{\xi}_1} + \iiint_{\tau_1} \frac{\partial \psi}{\partial t} dV, \\
\tag{3.128}
\]

\[
\frac{d}{dt}(K_{\tau_2} + \pi_{\tau_2}) = \frac{d}{dt} \iiint_{\tau_2} \left( \frac{1}{2} \mathbf{v}^2 + \psi \right) dV = \\
\iiint_{\tau_2} \text{pdiv} dV + \iiint_{\tau_2} \left( \frac{2}{3} \eta - \eta_v \right) (\text{div} \mathbf{v})^2 dV + \iiint_{\tau_2} 2\nu \epsilon_{ij}^2 dV + \iiint_{\tau_2} (\mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T})) d\Omega_n - \\
- \iiint_{F_1(\tau)} (\mathbf{v}_1(\tau_2) \cdot (\mathbf{\xi}_1 \cdot \mathbf{T})) d\Sigma_{\mathbf{\xi}_1} - \iiint_{R_1(\tau)} (\mathbf{v}_1(\tau_2) \cdot (\mathbf{\xi}_1 \cdot \mathbf{T})) d\Sigma_{\mathbf{\xi}_1} + \iiint_{\tau_2} \frac{\partial \psi}{\partial t} dV, \\
\tag{3.129}
\]

where \( \mathbf{\xi}_1 \) is the external unit normal vector of the surface (of the subsystem \( \tau_1 \)) presented by surfaces \( F_1(\tau) \) and \( R_1(\tau) \), and \( \mathbf{\xi}_1 \) is the external unit normal vector of the surface (of the subsystem \( \tau_2 \)) presented also by surfaces \( F_1(\tau) \) and \( R_1(\tau) \). Adding the equations (3.128) and (3.129) (by using the equality \( d\Sigma_{\mathbf{\xi}_1} = d\Sigma_{\mathbf{\xi}_1} \) of the elements of area of surfaces \( F_1(\tau) \) and \( R_1(\tau) \)), we get the evolution equation for the total mechanical energy \( (K_{\tau} + \pi_{\tau}) = (K_{\tau_1} + K_{\tau_2} + \pi_{\tau_1} + \pi_{\tau_2}) \) of the macroscopic region \( \tau \) consisting from subsystems \( \tau_1 \) and \( \tau_2 \) interacting on the surface \( F_1(\tau) \) of the tangential jump of the continuum velocity.
\[
\frac{d}{dt}(K + \pi) = \frac{d}{dt} \int \left( \frac{1}{2} \mathbf{v}^2 + \psi \right) \rho dV = \\
\int \int \int_\tau \rho \nabla \cdot \mathbf{v} dV + \int \int \int_\tau \left( \frac{2}{3} \eta - \eta_v \right) (\nabla \mathbf{v})^2 dV - \int \int \int_\tau 2v(e_{ji})^2 \rho dV + \\
\int_\mathcal{F}_1(t) \int (\mathbf{v} \cdot (n \cdot T)) d\Omega_n + \int_\mathcal{F}_1(t) \int \left( (\mathbf{v}_1(\tau_1) - \mathbf{v}_1(\tau_2)) \cdot (\xi_1 \cdot T) \right) d\Sigma_{\xi_1} + \int_\mathcal{F}_1(t) \int \frac{\partial \psi}{\partial t} \rho dV, 
\]
(3.130)

where \( \mathbf{v}_1(\tau_1) \) is the vector of the continuum velocity on the surface \( \mathcal{F}_1(\tau) \) in the subsystem \( \tau_1 \), \( \mathbf{v}_1(\tau_2) \) is the vector of the continuum velocity on the surface \( \mathcal{F}_1(\tau) \) in the subsystem \( \tau_2 \).

The evolution equation (3.130) takes into account the total mechanical energy \((K + \pi) = (K_{\tau_1} + K_{\tau_2} + \pi_{\tau_1} + \pi_{\tau_2})\) of the macroscopic region \( \tau \) consisting from subsystems \( \tau_1 \) and \( \tau_2 \) interacting on the surface \( \mathcal{F}_1(\tau) \) of the tangential jump of the continuum velocity. The first term in the second row (of the equation (3.130)) describes the evolution of the total mechanical energy of the macroscopic continuum region \( \tau \) due to the continuum reversible compressibility, the second and the third terms in the second row expresses the dissipation of the macroscopic kinetic energy by means of the irreversible continuum compressibility and the velocity shear. The forms of three terms in the second row (of the equation (3.130)) are related with the considered model of the compressible viscous Newtonian continuum. The fourth, fifth and the sixth terms in the third row (of the equation (3.130)) are the universal terms for arbitrary model of continuum characterized by symmetrical stress tensor \( T \). The fourth term express the power

\[
W_{np,\partial t} = \frac{\delta A_{np,\partial t}}{dt} = \int_\mathcal{F}_1(t) (\mathbf{v} \cdot (n \cdot T)) d\Omega_n 
\]
(3.131)

of external (for the continuum region \( \tau \)) non-potential stress forces acting on the boundary surfaces \( \partial \tau \) of the macroscopic continuum region \( \tau \). The fifth term express the power of external (for the continuum region \( \tau \)) forces on different sides of the velocity jumps during the fractures formation on the surfaces \( \mathcal{F}_1(\tau) \). The sixth term in equation (3.130) presents the power of the total mechanical energy added (or lost) as the result of the Newtonian non-stationary gravitational energy influence on the macroscopic continuum region \( \tau \) related with variations of the potential \( \psi \) of the gravity field in the continuum region \( \tau \).

Consider the equation (3.130) for one continuum velocity jump on the non-stationary surfaces \( \mathcal{F}_1(\tau) \) during the time interval \((t, t + \Delta t)\). We calculated [Simonenko, 2007] the energy dissipation during formation of the surface dislocation. Taking into account the form of fifth term on the right-hand side of the evolution equation (3.130), we obtained [Simonenko, 2007] the expression for the work \( \delta A_{np,\mathcal{F}_1(t)} \) (done during the time interval \((t, t + \Delta t)\) by the external (for the continuum region \( \tau \)) non-potential stress forces acting on different sides of the velocity jump on the surface \( \mathcal{F}_1(\tau) \):

\[
\delta A_{np,\mathcal{F}_1(t)} = \int_t^{t + \Delta t} \int_\mathcal{F}_1(t) \left( (\mathbf{v}_1(\tau_1) - \mathbf{v}_1(\tau_2)) \cdot (\xi_1 \cdot T) \right) d\Sigma_{\xi_1} dt, 
\]
(3.132)

which reduces to the following expression (after transposition of integration order):

\[
\delta A_{np,\mathcal{F}_1(t)} = \int_\mathcal{F}_1(t) \int_t^{t + \Delta t} (\mathbf{v}_1(\tau_1) - \mathbf{v}_1(\tau_2)) \cdot (\xi_1 \cdot T) dt d\Sigma_{\xi_1}. 
\]
(3.133)

To test the formula (3.133), we calculated [Simonenko, 2007] the energy \( \delta A_{np,\Delta \Sigma} \), which dissipates during formation of the surface dislocation on the small surface \( \Delta \Sigma \) during the time interval \((t, t + \Delta t)\). Using the theorem about the average value and integrating the internal integral on time, we obtained [Simonenko, 2007] from relation (3.133) for \( \mathcal{F}_1(\tau) = \Delta \Sigma \) the following relation:
\[
\delta A_{np,\Delta \Sigma} = \int \int \left[ (w(\zeta_1, t + \Delta t) - w(-\zeta_1, t + \Delta t)) \cdot <(\zeta_1 \cdot T)> d\Sigma_{\zeta_1}, \right.
\]

(3.134)

where \( <(\zeta_1 \cdot T)> \) is the average value of the stress vector for the element of area \( d\Sigma_{\zeta_1} \) of the two-side surface \( \Delta \Sigma \), \( w(\zeta_1, t + \Delta t) \) and \( w(-\zeta_1, t + \Delta t) \) are the vectors of the continuum displacement on different sides of the element of area \( d\Sigma_{\zeta_1} \) of the two-side surface \( \Delta \Sigma \) in the points characterized by normal unit vectors \( \zeta_1 \) and \( -\zeta_1 \). Using the obvious expression for “linear” time average \( <(\zeta_1 \cdot T)> : \)

\[
< (\zeta_1 \cdot T) > = \frac{1}{2} \left( (p(\zeta_1, t) - p(-\zeta_1, t + \Delta t)) \right)
\]

(3.135)
as the arithmetical average of the values of the stress vectors \( p \) on the different sides from the surface of the jump of the continuum velocity, we obtained [Simonenko, 2007] the expression for the external non-potential stress forces on the two-side surface \( \Delta \Sigma \) of dislocation:

\[
\delta A_{np,\Delta \Sigma} = \frac{1}{2} \int \int \left( (w(\zeta_1, t + \Delta t) - w(-\zeta_1, t + \Delta t)) \cdot (p(\zeta_1, t) + p(-\zeta_1, t + \Delta t)) d\Sigma_{\zeta_1}. \right.
\]

(3.136)

This expression was obtained in the frame of the classical linear approach [Sedov, 1994; p. 544] to formation of surface dislocations in rigid compressible continuum on the small area of surface \( \Delta \Sigma \). It is clear that the suggestion (3.135) is valid only for weak tangential jumps of the continuum displacement. Consequently, we can consider the expression (3.132) as the natural nonlinear generalization of the expression (3.136) for arbitrary surface \( F_1(\tau) \) of dislocation and for strong tangential jumps of the continuum displacement on the surface \( F_1(\tau) \) of dislocation. The work (3.132) of the external (for the continuum region \( \tau \)) non-potential stress forces should be negative. The sufficient energy \( \delta E_{dF_1(\tau)} \) needed for formation of the surface \( F_1(\tau) \) of dislocation is equal to the work of the internal forces in the macroscopic continuum region \( \tau \). The energy \( \delta E_{dF_1(\tau)} \) should be positive and equal to the expression (3.132) with the sign “-”:

\[
\delta E_{dF_1(\tau)} = -\delta A_{np,F_1(\tau)} = -\int_{t}^{t+\Delta t} \left( \int_{F_1(\tau)} \left( (v_1(\tau_1) - v_i(\tau_2)) \cdot (\zeta_1 \cdot T) \right) d\Sigma_{\zeta_1} \right) dt > 0.
\]

(3.137)

The formulae (3.132), (3.136) and (3.137) are obtained (taking into account the generalized differential formulation (1.43) of the first law of thermodynamics) for the model of continuum characterized by the arbitrary symmetrical stress tensor \( T \).

The macroscopic internal shear kinetic energy \( (K_s)_{\tau_1} \) (of the subsystem \( \tau_1 \)), the macroscopic internal rotational kinetic energy \( (K_r)_{\tau_1} \) (of the subsystem \( \tau_1 \)) and the macroscopic kinetic energy of shearr-rotational coupling \( (K_{s,r})_{\tau_1} \) (of the subsystem \( \tau_1 \)) are the significant components of the macroscopic internal shear-rotational kinetic energy \( (K_{s,s})_{\tau_1} \) [Simonenko, 2004; 2005; 2006, 2007a; 2007; 2008]:

\[
(K_{s,r})_{\tau_1} = (K_r)_{\tau_1} + (K_s)_{\tau_1} + (K_{s,r})_{\tau_1}
\]

(3.138)
taken into account (along with the classical internal thermal energy \( U_{\tau_1} \) of the macroscopic continuum region \( \tau_1 \), the macroscopic potential energy \( \Pi_{\tau_1} \) of the macroscopic continuum region \( \tau_1 \) and the macroscopic translational kinetic energy \( (K_c)_{\tau_1} = \frac{1}{2} m_{\tau_1} (V_{\tau_1})^2 \) of the continuum region \( \tau_1 \) (of a mass \( m_{\tau_1} \)) moving as a whole at speed equal to the speed \( (V_c)_{\tau_1} \) of the center of mass of the continuum region \( \tau_1 \)) in the generalized differential formulation (1.43) of the first law of thermodynamics for the macroscopic continuum region \( \tau_1 \).
rotational coupling \((K_{s, r}^{\text{coup}})_{\tau_2}\) (of the subsystem \(\tau_2\)) are the significant components of the macroscopic internal shear-rotational kinetic energy \((K_{s, r})_{\tau_2}\) [Simonenko, 2004; 2005; 2006; 2007a; 2007; 2008]:

\[
(K_{s, r})_{\tau_2} = (K_s)_{\tau_2} + (K_r)_{\tau_2} + (K_{s, r}^{\text{coup}})_{\tau_2}
\]

(3.139)

taken into account (along with the classical internal thermal energy \(U_{\tau_2}\) of the macroscopic continuum region \(\tau_2\), the macroscopic potential energy \(\Pi_{\tau_2}\) of the macroscopic continuum region \(\tau_2\) and the macroscopic translational kinetic energy \((K_t)_{\tau_2}\) of the continuum region \(\tau_2\) (of a mass \(m_{\tau_2}\)) moving as a whole at speed equal to the speed \((V_c)_{\tau_2}\) of the center of mass of the continuum region \(\tau_2\)) in the generalized differential formulation (1.43) of the first law of thermodynamics for the macroscopic continuum region \(\tau_2\).

The macroscopic internal shear kinetic energy \((K_s)_{\tau_1}\) (of the subsystem \(\tau_1\)), the macroscopic internal rotational kinetic energy \((K_r)_{\tau_1}\) (of the subsystem \(\tau_1\)), the macroscopic kinetic energy of shear-rotational coupling \((K_{s, r}^{\text{coup}})_{\tau_1}\) (of the subsystem \(\tau_1\)), the macroscopic translational kinetic energy \((K_t)_{\tau_1}\) (of the subsystem \(\tau_1\)), the macroscopic potential energy \(\Pi_{\tau_1}\) (of the subsystem \(\tau_1\)), the macroscopic internal shear kinetic energy \((K_s)_{\tau_2}\) (of the subsystem \(\tau_2\)), the macroscopic internal rotational kinetic energy \((K_r)_{\tau_2}\) (of the subsystem \(\tau_2\)), the macroscopic kinetic energy of shear-rotational coupling \((K_{s, r}^{\text{coup}})_{\tau_2}\) (of the subsystem \(\tau_2\)), the macroscopic translational kinetic energy \((K_t)_{\tau_2}\) (of the subsystem \(\tau_2\)) and the macroscopic potential energy \(\Pi_{\tau_2}\) (of the subsystem \(\tau_2\)) are the significant energy components taken into account in the presented thermohydrogravidynamic shear-rotational model described by the evolution equation (3.130) for the total mechanical energy \((K_t + \Pi_t)\) of the macroscopic region \(\tau\) consisting from interacting subsystems \(\tau_1\) and \(\tau_2\).

Using of the generalized differential formulation (1.43) of the first law of thermodynamics for the macroscopic continuum region \(\tau\) of the Earth’s crust characterized by practically constant viscosity, we obtained [Simonenko, 2007a; 2007; 2008] the thermodynamic foundation of the classical deformational (shear) model [Abramov, 1997] of the earthquake focal region for the quasi-uniform medium of the Earth’s crust characterized by practically constant viscosity.

3.5.2. The rotational model of the earthquake focal region based on the generalized differential formulation of the first law of thermodynamics

Following the works [Simonenko, 2007a; 2007; 2008], we present the foundation of the rotational model [Vikulin, 2003] of the earthquake focal region for the seismic zone of the Pacific Ring. It was noted [Vikulin, 2003] that the studies of the dislocation models of the focal regions of strong earthquakes showed the bad correspondence with the model of flat endless dislocation in the uniform continuum [Shamsi and Stacey, 1969; Mount and Suppe, 1987; Guo, 1988].

The analysis [Vikulin, 2003; p. 58] showed that the conditions exist to realize the rotational mechanism related with the rotation of the geo-blocks by means of the stress forces related with the Earth rotation in the vicinity of the seismic zone of the Pacific Ring. It was noted [Vikulin, 2003; p. 58] that the rotational mechanism can be more real in compared to the conventional mechanism related with the formation of the main line flat fracture inside of the focal region.
We considered [Simonenko, 2007a; 2007; 2008; 2009; 2010] the energy thermodynamic rotational mechanism [Vikulin, 2003] (of the earthquake focal region) related with formation of the circular continuum velocity jump revealed in the form of circular dislocation after relaxation of the seismic process in the earthquake focal region. The developed and tested mathematical formalism of description of the main line flat fracture was generalized [Simonenko, 2007a; 2007; 2008; 2009; 2010] for the closed surfaces of the continuum velocity jumps.

Following to the rotational model [Vikulin, 2003] of the earthquake focal region, we considered [Simonenko, 2007a; 2007; 2008; 2009; 2010] the separate geo-block \( \tau_{\text{int}} \) of the seismic zone. If the external influences of the non-stationary gravitational forces (on the geo-block \( \tau_{\text{int}} \)) and the non-potential stress forces (on the boundary \( \partial \tau_{\text{i}} \)) exceed the certain critical value then the geo-block may rotate and slip relative to the surrounding fine plastic layer (subsystem) \( \tau_{\text{ext}} \) with the tangential continuum velocity jump on the boundary surface \( \partial \tau_{\text{i}} \) of the geo-block \( \tau_{\text{int}} \). We assumed [Simonenko, 2007a; 2007; 2008; 2009; 2010] that fine plastic layer (subsystem) \( \tau_{\text{ext}} \) is limited by external surface \( \partial \tau \) of the considered thermodynamic system \( \tau \) consisting from the macroscopic subsystems \( \tau_{\text{int}} \) and \( \tau_{\text{ext}} \).

Using the evolution equation (1.67) of the total mechanical energy of the subsystem \( \tau \), we derived [Simonenko, 2007a; 2007; 2008; 2009; 2010] the evolution equations for the total mechanical energy of the macroscopic subsystems \( \tau_{\text{int}} \) and \( \tau_{\text{ext}} \):

\[
\frac{d}{dt}(K_{\tau_{\text{int}}} + \pi_{\tau_{\text{int}}}) = \frac{d}{dt} \int \int \int_{\tau_{\text{int}}} \left( \frac{1}{2} \mathbf{v}^2 + \psi \right) \rho dV = \\
\int \int \int_{\tau_{\text{int}}} \rho \text{div} \mathbf{v} dV + \int \int \int_{\tau_{\text{int}}} \left( \frac{2}{3} \eta - \eta_{\psi} \right) (\text{div} \mathbf{v})^2 dV - \int \int \int_{\tau_{\text{int}}} 2 \mathbf{v} (\mathbf{e}_j)^2 \rho dV + \\
+ \int_{\partial \tau_{\text{i}}} \mathbf{v}_{\text{int}} (\partial \tau_{\text{i}}) \cdot (\mathbf{m} \cdot \mathbf{T}) \, d\Sigma_{\mathbf{m}} + \int \int \int_{\tau_{\text{int}}} \frac{\partial \psi}{\partial t} \rho dV, \tag{3.140}
\]

\[
\frac{d}{dt}(K_{\tau_{\text{ext}}} + \pi_{\tau_{\text{ext}}}) = \frac{d}{dt} \int \int \int_{\tau_{\text{ext}}} \left( \frac{1}{2} \mathbf{v}^2 + \psi \right) \rho dV =
\]

Fig. 16. The macroscopic continuum region \( \tau \) consisting from the subsystems \( \tau_{\text{int}} \) and \( \tau_{\text{ext}} \) interacting on the surface \( \partial \tau_{\text{i}} \) of the geo-block \( \tau_{\text{int}} \).
\[
\begin{align*}
&= \iiint_{\tau} \text{pdivv}dV + \iiint_{\tau} \left( \frac{2}{3} \eta - \eta_v \right) (\text{divv})^2 dV - \iiint_{\tau} 2\mathbf{v}(e_{ij})^2 \rho dV + \\
&+ \iint_{\partial \tau} \left( \mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T}) \right) d\Omega_n - \iint_{\partial \tau} \left( \mathbf{v}_{\text{ext}}(\partial \tau_i) \cdot (\mathbf{m} \cdot \mathbf{T}) \right) d\Sigma_m + \iiint_{\tau} \frac{\partial \psi}{\partial t} \rho dV ,
\end{align*}
\]

(3.141)

where \( \mathbf{m} \) is the external unit normal vector of the surface \( \partial \tau_i \) of the subsystem \( \tau_{\text{int}} \), \( -\mathbf{m} \) is the internal unit normal vector of the surfaces \( \partial \tau_i \), which limits the subsystem \( \tau_{\text{ext}} \) from within, \( \mathbf{n} \) is the external unit normal vector of the surfaces \( \partial \tau \), \( \mathbf{v}_{\text{int}}(\partial \tau_i) \) are the velocity vectors on the inner side of the surface \( \partial \tau_i \) in the subsystem \( \tau_{\text{int}} \), \( \mathbf{v}_{\text{ext}}(\partial \tau_i) \) are the velocity vectors on the outer side of the surface \( \partial \tau_i \) in the subsystem \( \tau_{\text{ext}} \).

Adding the evolution equations (3.140) and (3.141) and using the condition of equality \( d\Sigma_m = d\Sigma_{-m} \) of the area elements of the surface \( \partial \tau_i \), we obtained [Simonenko, 2007a; 2007; 2008; 2009; 2010] the evolution equation for the total mechanical energy of the macroscopic continuum region \( \tau \) consisting from the subsystems \( \tau_{\text{int}} \) and \( \tau_{\text{ext}} \) interacting on the surface \( \partial \tau_i \) of the continuum velocity jump:

\[
\frac{d}{dt}(K_\tau + \pi_\tau) = \frac{d}{dt} \iint_{\tau} \left( \frac{1}{2} \mathbf{v}^2 + \psi \right) \rho dV = \\
\iiint_{\tau} \text{pdivv}dV + \iint_{\partial \tau} \left( \frac{2}{3} \eta - \eta_v \right) (\text{divv})^2 dV - \iiint_{\tau} 2\mathbf{v}(e_{ij})^2 \rho dV + \iint_{\partial \tau} \left( \mathbf{v} \cdot (\mathbf{n} \cdot \mathbf{T}) \right) d\Omega_n + \\
+ \iint_{\partial \tau} \left( (\mathbf{v}_{\text{int}}(\partial \tau_i) - \mathbf{v}_{\text{ext}}(\partial \tau_i)) \cdot (\mathbf{m} \cdot \mathbf{T}) \right) d\Sigma_m + \iint_{\tau} \frac{\partial \psi}{\partial t} \rho dV .
\]

(3.142)

The equation (3.142) is analogous to equation (3.130). The energy needed for formation of the continuum velocities jumps (on the surfaces \( F_i(\tau) \) and \( \partial \tau_i \)) are related with the penultimate terms in the right-hand sides of equations (3.130) and (3.142).

Similarly to expression (3.137), we obtained [Simonenko, 2007a; 2007; 2008; 2009; 2010] the expression for the sufficient energy \( \delta E_{d,\tau_i} \) needed for rotation of the subsystems \( \tau_{\text{int}} \) during the time interval \( \tau, \tau + \Delta \tau \) relative to the surrounding fine plastic layer (subsystem) \( \tau_{\text{ext}} \) (with the tangential continuum velocity jump \( (\mathbf{v}_{\text{int}}(\partial \tau_i) - \mathbf{v}_{\text{ext}}(\partial \tau_i)) \)) on the boundary surface \( \partial \tau_i \) of the geo-block \( \tau_{\text{int}} \):

\[
\delta E_{d,\tau_i} = -\delta A_{np,\tau_i} = \int_{\tau}^{\tau + \Delta \tau} \iint_{\partial \tau_i} \left( (\mathbf{v}_{\text{int}}(\partial \tau_i) - \mathbf{v}_{\text{ext}}(\partial \tau_i)) \cdot (\mathbf{m} \cdot \mathbf{T}) \right) d\Sigma_m dt > 0 .
\]

(3.143)

Taking into account the information [Vikulin, 2003] that the critical continuum stresses (required for rotation of the geo-block \( \tau_{\text{int}} \) weakly coupled with surrounding plastic layer \( \tau_{\text{ext}} \) are less than the critical continuum stresses required to split the mountain rock by forming the main line flat fracture, we concluded [Simonenko, 2007; 2008; 2009; 2010] that the required energy \( \delta E_{d,\tau_i} \) (given by the expression (3.143)) is less than the required energy \( \delta E_{d,F_i(\tau)} \) (given by the expression (3.137)) if the displacements of the rock continuum on different sides of the analyzed different jumps of the continuum displacements (the closed dislocation and the main line flat fracture) have the same order of magnitude and the ratio of the surfaces area of the closed dislocation to the surfaces area of the main line flat fracture is not exceed 10.

This thermodynamic energy consideration showed [Simonenko, 2007; 2008; 2009; 2010] the preferable realization of the rotational motion of the geo-block \( \tau_{\text{int}} \) (under the existence of the surrounding plastic layer around the geo-block \( \tau_{\text{int}} \)) as compared with formation of the of the main line flat fracture.
3.5.3. The local energy and entropy prediction thermohydrogravidynamic principles determining the fractures formation in the macroscopic continuum region \( \tau \) subjected to the combined integral energy gravitational influences of the planets of the Solar System, the Moon and the Sun owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune)

3.5.3.1. The local energy prediction thermohydrogravidynamic principles determining the fractures formation in the macroscopic continuum region \( \tau \) subjected to the combined integral energy gravitational influences of the planets of the Solar System, the Moon and the Sun owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune)

Following the works [Simonenko, 2007a; 2007; 2008; 2009; 2010], we can formulate the local energy prediction thermohydrogravidynamic principle of the fractures formation. The preferable realization of the rotational motion [Vikulin, 2003] (within the seismic zone of the Pacific Ring) and the preferable realization of the shear [Abramov, 1997] and the shear-rotational [Simonenko, 2007] motions (for uniform continuum) resulted to the formulation [Simonenko, 2007a; 2007; 2008; 2009; 2010] of the general principle of the fractures formation: the fracture forms on a surface where the external (combined cosmic and terrestrial for the considered macroscopic continuum region \( \tau \)) energy gravitational influence is sufficient to produce the fracture formation.

The local energy prediction thermohydrogravidynamic principles (determining the fractures formation in the considered macroscopic continuum region \( \tau \) subjected the combined integral energy gravitational influence of the planets of the Solar System, the Moon and the Sun owing to the gravitational interaction of the Sun with the outer large planets) of the cosmic seismology [Simonenko, 2007; 2008; 2009; 2010] can be formulated mathematically as follows:

\[
\Delta G(\tau, t) = \int_{t_0}^{t} dG = \int dt \int dV \frac{\partial \psi}{\partial t} \rho = \text{local maximum for time moment } t^*, \tag{3.144}
\]

and

\[
\Delta G(\tau, t) = \int_{t_0}^{t} dG = \int dt \int dV \frac{\partial \psi}{\partial t} \rho = \text{local minimum for time moment } t_*, \tag{3.145}
\]

which can be reformulated (under the more weak mathematical requirement) as follows:

\[
\Delta G(\tau, t) = \int_{t_0}^{t} dG \geq (\Delta G(\tau))^P_{cr} > 0, \tag{3.146}
\]

and

\[
\Delta G(\tau, t) = \int_{t_0}^{t} dG \leq (\Delta G(\tau))^n_{cr} < 0, \tag{3.147}
\]
where \((\Delta G(\tau))^p\) is the positive critical value of the combined (cosmic and terrestrial) integral energy gravitational influence on the macroscopic continuum region \(\tau\) to produce the fractures inside the macroscopic continuum region \(\tau\), \((\Delta G(\tau))^n\) is the negative critical value of the combined (cosmic and terrestrial) integral energy gravitational influence on the macroscopic continuum region \(\tau\) to produce the fractures inside the macroscopic continuum region \(\tau\).

### 3.5.3.2. The local entropy prediction thermohydrogravidynamic principle
determining the fractures formation in the macroscopic continuum region \(\tau\) subjected to the combined integral energy gravitational influences of the planets of the Solar System, the Moon and the Sun owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune)

Taking into account the fundamental physical distinction [Planck, 1930; Prigogine, 1977] between the classical “reversible” macroscopic rotational [de Groot and Mazur, 1962] and “irreversible” macroscopic non-equilibrium kinetic energies [Simonenko, 2004], we deduced (in 2005) the generalized relation [Simonenko, 2006; 2006a]:

\[
\frac{du}{dT} + \frac{de_r(\tau)}{T} - \frac{de_s(\tau)}{T} - \frac{de_{rs}^{\text{coup}}(\tau)}{T} = Tds - pd\vartheta
\]

(3.148)

extending the classical [Gibbs, 1873] relation (for the differential \(ds\) of entropy per unit mass \(S\) of the one-component macrodifferential deformed continuum element with no chemical reactions):

\[
\frac{du}{dT} = Tds - pd\vartheta
\]

(3.149)

by taking into account the total differentials \(de_r(\tau), de_s(\tau)\) and \(de_{rs}^{\text{coup}}(\tau)\) (following the continuum substance of the small macroscopic continuum region \(\tau\)) of the classical macroscopic internal rotational kinetic energy per unit mass \(e_r(\tau)\) [de Groot and Mazur, 1962], the macroscopic internal shear kinetic energy per unit mass \(e_s(\tau)\) [Simonenko, 2004; 2006] and the macroscopic internal kinetic energy of a shear-rotational coupling per unit mass \(e_{rs}^{\text{coup}}(\tau)\) [Simonenko, 2004; 2006]. Based on the established generalizations (1.13) and (3.148), we deduced (in 2005) the generalization [Simonenko, 2006a]:

\[
\frac{ds}{dt} = -\frac{1}{T} \frac{dq}{Tp} \varPi : \text{Grad}v + \frac{1}{T} \frac{de_r(\tau)}{dt} - \frac{1}{T} \frac{de_s(\tau)}{dt} - \frac{1}{T} \frac{de_{rs}^{\text{coup}}(\tau)}{dt}
\]

(3.150)

extending the classical expression (deduced in accordance with the classical Boltzmann’s statistical approach identifying the entropy with the molecular disorder) for the entropy production per unit time in the one-component macro-differential deformed continuum element with no chemical reactions [de Groot and Mazur, 1962]:

\[
\frac{ds}{dt} = -\frac{1}{T} \frac{dq}{Tp} \varPi : \text{Grad}v
\]

(3.151)

by taking into account the classical “reversible” macroscopic rotational \((e_r(\tau))\) and “irreversible” \((e_s(\tau))\) macroscopic non-equilibrium creative kinetic energies [Simonenko, 2004] of the small macroscopic continuum region \(\tau\). Using the established generalized expression (3.150) for the entropy production, we demonstrated [Simonenko, 2006a] the temporal reduction of entropy at the initial stage of irreversible transition [Itsweire et al., 1986] of the freely decaying stratified turbulence to internal gravity waves. Thereby, we revealed [Simonenko, 2006a] the creative constructive role of the established macroscopic non-equilibrium kinetic energies \(e_r(\tau)\) and \(e_{rs}^{\text{coup}}(\tau)\) [Simonenko, 2004]. Simultaneously, we verified [Simonenko, 2006a] the validity of the Prigogine’s foresight that the Boltzmann’s “identification of entropy with molecular disorder could contain only one part of the truth” [Ilya Prigogine – Autobiography, Translation from the French text, 1977]. The fundamental constructive role of the established macroscopic non-equilibrium kinetic energies \(e_s(\tau)\) and \(e_{rs}^{\text{coup}}(\tau)\) was demonstrated [Simonenko, 2007] also by revealing the creative role of the cosmic non-stationary energy gravitational influences reducing the entropy.
of the planet \((\tau + \bar{\tau})\) as a whole after the irreversible relaxation processes in the focal region \(\tau\) of earthquake. This demonstration is related with the established [Simonenko, 2007; 2007a; 2007b] generalization (presented in Subsection 1.7) of the Le Chatelier-Braun principle [Gibbs, 1928] for equilibrium rotating planet \((\tau + \bar{\tau})\).

The developed (in 2006) the generalized thermohydrogravidynamic shear-rotational model [Simonenko, 2007a; 2007b] explained [Simonenko, 2007; 2008; 2009; 2010] the significant increase of the energy flux \(\delta F_{\text{vis,c}} \equiv \delta A_{\text{vis,c}}\) of the geo-acoustic energy [Dolgikh et al., 2007] from the focal region before the prepared earthquake. The classical and generalized expressions ((3.151) and (3.150), respectively, for the entropy production) describe the positive (in accordance with the second law of thermodynamics) irreversible entropy production for continuum characterized by the symmetric pressure tensor \(P = -T = p\delta + \Pi\) and the symmetric viscous-stress tensor \(\Pi\). We obtained (in 2006) the explicit expression for the irreversible viscous-compressible entropy production \(\sigma_{\text{vis,c}}\) for the viscous compressible Newtonian continuum

\[
\sigma_{\text{vis,c}} = \frac{d\mathbf{s}}{dt} = -\frac{1}{T} \Pi : \text{Grad} \mathbf{v} = \frac{e_{\text{dis}}}{T} = \frac{2\nu}{T} (e_{ij})^2 + \frac{(n_v - 2\eta/3)}{Tp} (\text{div} \mathbf{v})^2 > 0.
\]  

The expression (3.152) can be rewritten (based on the established generalization (1.50) of the first law of thermodynamics for the symmetric tensor \(\Pi\)) as follows

\[
\sigma_{\text{vis,c}} = \frac{d\mathbf{s}}{dt} = \frac{1}{T} \Pi : \text{Grad} \mathbf{v} = \frac{1}{Tm_c} \frac{dK_i}{dt} + \frac{1}{Tm_\tau} \frac{d\Pi_i}{dt} + \frac{1}{Tm_\tau} \frac{dG}{dt} > 0
\]  

by taking into account the mass \(m_c\) of the continuum region \(\tau\) at the absolute temperature \(T\), the power \(\delta f_{\text{vis,c}} / dt = (1/m_\tau) \delta A_{\text{vis,c}} / dt\) of the geo-acoustic energy radiated from the unit mass of the focal region \(\tau\) (subjected to the non-stationary gravitational field), the total derivative \((1/m_c) dK_i / dt\) of the macroscopic kinetic energy per unit mass \(e_k(\tau) = K_i / m_c\), the total derivative \((1/m_\tau) d\Pi_i / dt\) of the gravitational potential energy per unit mass \(\Pi_i / m_\tau\), and the total energy power per unit mass \((1/m_\tau) dG / dt\) of the combined (terrestrial and cosmic) non-stationary energy gravitational influence on the continuum region \(\tau\) subjected to the non-stationary gravitational field.

Based on the generalization (1.13) and the evaluation (3.153), we deduced (in 2006) the following condition

\[
\frac{d\delta f_{\text{vis,c}}}{dt} > \frac{1}{2} \left( e_{\text{dis}}(\tau) + \epsilon_{\text{vis,c}}(\tau) + \epsilon_{\text{vis,c}}^{\text{cop}}(\tau) + \psi - \frac{\partial \psi}{\partial \tau}\right) > 0
\]  

for occurrence of a deep earthquakes characterized by the positive power \(\delta f_{\text{vis,c}} / dt > 0\) of the geo-acoustic energy radiated from the unit mass of the focal region \(\tau\). According to the condition (3.154), the criterion

\[
\frac{d}{dt} \left( e_{\text{vis,c}}(\tau) + \epsilon_{\text{vis,c}}(\tau) + \epsilon_{\text{vis,c}}^{\text{cop}}(\tau) + \psi - \frac{\partial \psi}{\partial \tau}\right) = \frac{d}{dt} \left( e_{m}(\tau) - \frac{\partial \psi}{\partial \tau}\right) > 0
\]  

is the “sine qua non” for occurrence of the earthquakes radiating the positive power per unit mass \(\delta f_{\text{vis,c}} / dt > 0\) of the geo-acoustic energy from the focal region \(\tau\) of the Earth. The criterion (3.155) may be considered as the local entropy prediction thermohydrogravidynamic principle consistent with the generalized differential formulation (1.50) of the first law of thermodynamics. The criterion (3.155) imposes the special relationship (for realization of a deep earthquakes) between the variations of the total derivative \(d(e_m(\tau))/dt\) of the mechanical kinetic energy per unit mass \(e_m(\tau) = e_k(\tau) + \psi\) and the local time derivative \(\partial \psi / \partial \tau\) of the potential \(\psi\) of the combined (terrestrial and cosmic) non-stationary gravitational field.

### 3.6. The cosmic energy gravitational genesis of the seismotectonic (and volcanic) activity and the global climate variability induced by the combined non-stationary cosmic energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter

#### 3.6.1. Empirical time periodicities of the seismotectonic activity of the Earth
It was pointed out [Abramov, 1997; p. 72] that the sinusoidal “saw-like” form of the graphic dependence of growth and recession of the seismotectonic activation of the separate geological structure is related with the following empirical time periodicities:

11 years, \hspace{1cm} (3.156)
22 years, \hspace{1cm} (3.157)
44 years, \hspace{1cm} (3.158)
88 years, \hspace{1cm} (3.159)
352 years, \hspace{1cm} (3.160)
704 years, \hspace{1cm} (3.161)
1056 years. \hspace{1cm} (3.162)

It was pointed out [Vikulin, 2003; p. 16] that the strongest earthquakes in the all boundary region of the Pacific Ocean are characterized by the established tendency for recurrence on average once during the following time period [Fedotov, 1965; Davison, 1936; Christensen and Ruff 1986; Barrientos and Kansel, 1990; Jacob, 1984; Shimazaki and Nakata, 1980; Suyehiro, 1984; Clark, Dibble, Fyfe, Lensen and Suggarte, 1965; Johnston, 1965]:

\[
T_r = 100 \pm 50 = 50 \div 150 \text{ years.} \hspace{1cm} (3.163)
\]

It was pointed out [Vikulin, 2003; p. 16] also that the close values for recurrence of the strongest earthquakes were established for different seismic belts of the Earth: 90 \div 140 years for the Caucasus [Tamrazyan, 1962] and 150 years for the Anatolian fault zone [Ambraseys, 1970]. We present the data of the monograph [Vikulin, 2003; p. 17] concerning to the recurrence of the strongest earthquakes in different regions of the of the seismic zone of the Pacific Ring [Vikulin, 1992; 1994; 2003]:

90 \pm 40 = 50 \div 130 \text{ years – Kamchatka,} \hspace{1cm} (3.164)
130 \pm 50 = 80 \div 180 \text{ years – Japan,} \hspace{1cm} (3.165)
110 \pm 50 = 60 \div 160 \text{ years – Peru,} \hspace{1cm} (3.166)
100 \pm 50 = 50 \div 150 \text{ years – Aleutians.} \hspace{1cm} (3.167)

It was pointed out [Vikulin, 2003; p. 17] that for the Japanese chute Nankay (stretched to the Tokyo) are revealed the characteristic time periodicities [Vikulin and Vikulina, 1989] of the strongest earthquakes:

600 years, \hspace{1cm} (3.168)
1200 years. \hspace{1cm} (3.169)

It was revealed the empirical range of the time periodicities [Kyrillov, 1957]:

250 \div 300 \text{ years.} \hspace{1cm} (3.170)

for recurrence of the strongest earthquakes in Turkey.

It was revealed the empirical range of the time periodicities [Turner, 1925]:

240 \div 280 \text{ years} \hspace{1cm} (3.171)

for recurrence of the strongest earthquakes in China. It was earlier revealed also the empirical time periodicity [Мэй Ши-юн, 1960] near:

1000 years \hspace{1cm} (3.172)

for recurrence of the strongest earthquakes in China.

Based on the data presented in the monograph [Vikulin, 2003] concerning to the recurrence of the strongest earthquakes in different regions of the Earth, Dr. A.V. Vikulin made the valid conclusion that the seismic processes have the global nature for the Earth. In the next Subsection we present the explanation [Simonenko, 2007] of the considered empirical time periodicities by the different combinations of the cosmic energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

3.6.2. The time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter

3.6.2.1. The time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the system Sun-Moon
If the configuration of the Sun and the Moon is characterized at any time moment by the maximal combined (instantaneous or integral) energy gravitational influence on the Earth, then the Sun and the Moon will have the recurrence of the same configuration after different integer numbers of circulations \((j_{MOON,3}\) circulations of the Moon around the Earth and \(m_{3,MOON}\) circulations of the Earth around the Sun) to satisfy the following condition [Simonenko, 2007]:

\[
j_{MOON,3} T_{MOON} = m_{3,MOON} T_3. \tag{3.173}
\]

Following the known method [Perelman, 1956], we presented [Simonenko, 2007] the ratio \(T_3/T_{MOON}\) by the following mathematical fraction:

\[
\frac{T_3}{T_{MOON}} = \frac{365.3}{29.5306} = 12 + \frac{109328}{295306} = 12 + \frac{1}{2 + \frac{1}{1 + \frac{1}{2 + \frac{1}{1 + \frac{1}{8 + \frac{458}{1204}}}}}}. \tag{3.174}
\]

Considering the different approximation of the ratio \(T_3/T_{MOON}\), we obtained [Simonenko, 2007] the successive approximations for the time periodicities:

\[
(T_{S-MOON,3})_1 = 3 \text{ years}, \tag{3.175}
\]
\[
(T_{S-MOON,3})_2 = 8 \text{ years}, \tag{3.176}
\]
\[
(T_{S-MOON,3})_3 = 19 \text{ years}, \tag{3.177}
\]
\[
(T_{S-MOON,3})_4 = 27 \text{ years}, \tag{3.178}
\]
\[
(T_{S-MOON,3})_5 = 235 \text{ years}. \tag{3.179}
\]

of recurrence of the maximal (instantaneous and integral) combined energy gravitational influences of the system Sun-Moon on the Earth in the first, second, third, fourth and fifth approximations, respectively. We can verify that the time periodicity

\[
(T_{S-MOON,3})_3 = (T_{S-MOON,3})_1 + (T_{S-MOON,3})_2 = 11 \text{ years} \tag{3.180}
\]

may be considered approximately as the third approximation of recurrence of the maximal (instantaneous and integral) energy gravitational influences of the system Sun-Moon on the Earth.

### 3.6.2.2. The time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Venus

If the configuration of the Earth and the Venus is characterized at any time moment by the maximal (instantaneous or integral) energy gravitational influence on the Earth, then the Earth and the Venus will have the recurrence of the same configuration (in the frame of the real elliptical orbits of the Earth and the Venus) after different integer numbers of circulations \((k_{V,3}\) circulations of the Venus around the Sun and \(m_{3,V}\) circulations of the Earth around the Sun) to satisfy the following condition [Simonenko, 2007]:

\[
k_{V,3} T_V = m_{3,V} T_3. \tag{3.181}
\]

Following the known method [Perelman, 1956], we presented [Simonenko, 2007] the ratio \(T_3/T_V\) by the following mathematical fraction:
\[
\frac{T_1}{T_y} = \frac{365.3}{224.7} = 1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{2 + \frac{1}{280}}}}}.
\]

Considering the different approximation of the ratio \( T_3/T_y \), we obtained [Simonenko, 2007] the successive approximations for the time periodicities [Simonenko, 2007]:
\[
(T_{V,3})_1 = 3 \text{ years,}
\]
\[
(T_{V,3})_2 = 8 \text{ years}
\]
of recurrence of the maximal (instantaneous and integral) energy gravitational influences of the Venus on the Earth in the first and second approximations, respectively. We can verify that the time periodicity
\[
(T_{V,3})_3 = (T_{V,3})_1 + (T_{V,3})_2 = 11 \text{ years}
\]
may be considered as the third approximation of recurrence of the maximal (instantaneous and integral) energy gravitational influences of the Venus on the Earth.

### 3.6.2.3. The time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter

If the configuration of the Earth, the Jupiter and the Sun is characterized at any time moment by the maximal (instantaneous or integral) energy gravitational influences on the Earth, then the Earth, the Jupiter and the Sun will have the recurrence of the same configuration (in the frame of the real elliptical orbits of the Earth and the Jupiter) after different integer numbers of circulations (\( n_{J,3} \) circulations of the Jupiter around the Sun and \( m_{J,3} \) circulations of the Earth around the Sun) to satisfy the following condition [Simonenko, 2007]:
\[
n_{J,3}T_J = m_{J,3}T_H.
\]
Following the known method [Perelman, 1956], we presented [Simonenko, 2007] the ratio \( T_J/T_3 \) by the following mathematical fraction:
\[
\frac{T_J}{T_3} = \frac{4332}{365.3} = 1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{12 + \frac{24}{41}}}}.
\]

Considering the different approximation of the ratio \( T_J/T_3 \), we obtained [Simonenko, 2007] the successive approximations for the time periodicities [Simonenko, 2007]:
\[
(T_{J,3})_1 = 11 \text{ years}
\]
\[
(T_{J,3})_2 = 12 \text{ years}
\]
\[
(T_{J,3})_3 = 83 \text{ years}
\]
of recurrence of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Jupiter and the Sun (owing to the gravitational interaction of the Sun with the Jupiter) in the first, second and third approximations, respectively.

### 3.6.2.4. The time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Mars

If the configuration of the Earth and the Mars is characterized at any time moment by the maximal
(instantaneous or integral) energy gravitational influence on the Earth, then the Earth and the Mars will have
the recurrence of the same configuration (in the frame of the real elliptical orbits of the Earth and the Mars)
after different integer numbers of circulations (\(g_{\text{MARS,3}}\) circulations of the Mars around the Sun
and \(m_{\text{3,MARS}}\) circulations of the Earth around the Sun) to satisfy the following condition [Simonenko,
2007]:

\[
g_{\text{MARS,3}} T_{\text{MARS}} = m_{\text{3,MARS}} T_3. \tag{3.191}
\]

Following the known method [Perelman, 1956], we presented [Simonenko, 2007] the ratio
\(T_{\text{MARS}}/T_3\) by the following mathematical fraction:

\[
\frac{T_{\text{MARS}}}{T_3} = \frac{687.0}{365.3} \approx 1 + \frac{3217}{3653} = 1 + \frac{1}{1 + \frac{1}{7 + \frac{1}{1 + \frac{1}{2 + \frac{1}{1 + \frac{1}{47\ldots}}}}}}. \tag{3.192}
\]

Considering the different approximation of the ratio \(T_{\text{MARS}}/T_3\), we obtained [Simonenko, 2007] the
successive approximations for the time periodicities [Simonenko, 2007]:

\[
(T_{\text{MARS,3}})_1 = 15 \text{ years}, \tag{3.193}
\]

\[
(T_{\text{MARS,3}})_2 = 32 \text{ years}, \tag{3.194}
\]

\[
(T_{\text{MARS,3}})_3 = 47 \text{ years}. \tag{3.195}
\]

of recurrence of the maximal (instantaneous or integral) energy gravitational influences of the Mars on the
Earth in the first, second and third approximations, respectively.

3.6.2.5. The time periodicities of the periodic global seismotectonic (and volcanic) activity and the global climate variability of the Earth induced by the combined different combinations of the cosmic energy gravitational influences of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter

We have shown [Simonenko, 2007] that the periodic recurrence (characterized by the time periodicity \(T_{\text{energy}}\)) of the maximal integral energy gravitational influences on the Earth (defined by the planetary
combination of the system Sun-Moon and the arbitrary combination of the planets: the Venus, the Mars and the Jupiter) leads (according to the generalized differential formulation (1.43) applied for the Earth) to the periodic recurrence of the maximal seismotectonic (and volcanic) activity (characterized by the same time periodicity \(T_{\text{sec}} = T_{\text{energy}}\)) of the geo-spheres of the Earth. We have shown [Simonenko, 2007] that the periodic recurrence (characterized by the time periodicity \(T_{\text{energy}}\)) of the maximal integral energy gravitational influences on the Earth (defined by the combination of the system Sun-Moon and the arbitrary combination of the planets: the Venus, the Mars and the Jupiter, and the Sun owing to the gravitational interaction of the Sun with the Jupiter) leads (according to the generalized differential formulation (1.43) applied for each geo-block of Earth) to the periodic recurrence of the maximal seismotectonic (and volcanic) activity (characterized by the same time periodicity \(T_{\text{sec}} = T_{\text{energy}}\)) of each geo-block of Earth. We have
shown [Simonenko, 2007] that the periodic recurrence (characterized by the time periodicity \(T_{\text{sec}} = T_{\text{energy}}\)) of the maximal seismotectonic (and volcanic) activity of the geo-spheres of the Earth and each geo-block of the Earth (defined by the combination of the system Sun-Moon and the arbitrary combinations of the planets: the Venus, the Mars, the Jupiter, and the Sun owing to the gravitational interaction of the Sun with the Jupiter) leads to the periodic recurrence (characterized by the time periodicity \(T_{\text{sec}} = T_{\text{energy}}\)) of the maximal concentration of the atmospheric greenhouse gases owing to the periodic increase (characterized by the time periodicity \(T_{\text{sec}} = T_{\text{energy}}\)) of the output of the greenhouse gases related with the periodic
seismotectonic-volcanic activation of the Earth. We have shown [Simonenko, 2007] that the periodic increase (characterized by the time periodicity $T_{se} = T_{energy}$) of the average planetary concentration of the atmospheric greenhouse gases leads (as a consequence of the greenhouse effect produced by the gravity-induced periodic tectonic-volcanic activation accompanied by the increase of the atmospheric greenhouse gases) to the periodic global planetary warming related with the increase (characterized by the time periodicity $T_{se} = T_{energy}$) of temperature of the system atmosphere-oceans of the Earth. We have shown [Simonenko, 2007] that the periodic decrease (characterized by the time periodicity $T_{se} = T_{energy}$) of the average planetary concentration of the atmospheric greenhouse gases leads (as a consequence of the decreased greenhouse effect) to the periodic global planetary cooling related with the fall (characterized by the time periodicity $T_{se} = T_{energy}$) of temperature of the atmosphere-oceans system of the Earth. We have shown [Simonenko, 2007] that the time periodicity $T_{energy}$ of the periodic recurrence of the maximal integral energy gravitational influences on the Earth (defined by the combination of the system Sun-Moon and the arbitrary combinations of the planets: the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) corresponds to the following (two) global time periodicities of the Earth’s climate variability [Simonenko, 2007]: the first time periodicity $T_{clim1} = T_{se} = T_{energy}$ (related with the periodic seismotectonic-volcanic activity of the geo-spheres of the Earth and each geo-block of the Earth induced by the cosmic non-stationary combined energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) and the second time periodicity $T_{clim2} = T_{endog} = T_{energy} / 2$ related with the periodic volcanic activity determined by the periodic tectonic-endogenous heating (of the geo-spheres of the Earth, each geo-block of the Earth, and the atmosphere and the oceans of the Earth) induced by the periodic continuum deformation (characterized by the time periodicity $T_{energy}$) owing to the periodic cosmic non-stationary combined energy gravitational influences (characterized by the time periodicity $T_{energy}$) on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

Based on the equivalent generalized differential formulations (1.43), (1.50) and (1.53) [Simonenko, 2007] of the first law of thermodynamics for the Earth and using the obtained successive approximations for the time periodicities of the periodic recurrence of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, we founded [Simonenko, 2007; 2009; 2010] the sets of the global seismotectonic and volcanic periodicities $T_{se}$ (of the global periodic gravity-induced seismotectonic and volcanic activities and the cosmic geological cycles of the thermohydrogravidynamic evolution of the Earth owing to the main cosmic G-factor related to the differential dG of the combined cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) and the global climatic periodicities $T_{clim1}$ (of the periodic global gravity-induced climate variability and the global variability of the quantities of the fresh water and glacial ice resources owing to the G($b$)-factor related to the periodic atmospheric-oceanic warming or cooling as a consequence of the periodic variable (increasing or decreasing) output of the heated greenhouse volcanic gases and the related variable greenhouse effect induced by the periodic variable tectonic-volcanic activity (activization or weakening) due to the G-factor):

$$T_{se} = T_{clim1} = T_{energy} = (T_{S-MOON,j})^{l_{0}} \times (T_{V/3,j})^{l_{2}} \times (T_{MARS,j})^{l_{4}} \times (T_{J,3})^{l_{5}},$$  \hspace{1cm} (3.196)

determined by the successive global periodicities $T_{energy}$ (defined by the multiplications of various successive time periodicities related to the different combinations of the following integer numbers: $i = 1, 2, 3, 4, 5$; $j = 1, 2$; $k = 1, 2, 3$; $n = 1, 2, 3$; $l_{0} = 0, 1$; $l_{2} = 0, 1$; $l_{4} = 0, 1$; $l_{5} = 0, 1$) of recurrence of the maximal combined energy gravitational influences on the Earth of the different combined combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. The global seismotectonic and volcanic periodicities $T_{se}$ (of the global periodic seismotectonic and volcanic activity)
and the global climatic periodicities $T_{\text{clim}}$ (of the global periodic climate variability) are related with the periodic recurrence of the maximal combined integral energy gravitational influences on the Earth induced by the different combinations of the cosmic non-stationary energy gravitational influences of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

Using the equivalent generalized differential formulations (1.43), (1.50) and (1.53) [Simonenko, 2007] of the first law of thermodynamics for the Earth and the obtained successive approximations for the time periodicities of the periodic recurrence of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, we founded [Simonenko, 2007; 2009; 2010] the set of the global volcanic and climatic periodicities $T_{\text{clim}} = T_{\text{endog}} = T_{\text{energy}} / 2$ (of the periodical global tectonic-endogenous heating determining the periodical global volcanic activity and the related local climate variability and the global variability of the quantities of the fresh water and glacial ice resources and the cosmic geological cycles of the thermohydrogravidynamic evolution of the Earth owing to the $G(a)$-factor related to the tectonic-endogenous heating contributing to the differential increase $d\Omega_{j}$ of the internal thermal energy $U_{j}$ of the Earth $\tau_{j}$ as a consequence of the periodic continuum deformation of the Earth $\tau_{3}$ due to the $G$-factor):

$$T_{\text{clim2}} = T_{\text{energy}} / 2 = (T_{\text{S-Moon},3})^{j} \times (T_{V,j})^{j} \times (T_{\text{Mars},3})^{j} \times (T_{\text{J},j})^{j} / 2,$$

(3.197)
determined by the successive global periodicities $T_{\text{energy}}$ (defined by the multiplications of various successive time periodicities related to the different combinations of the following integer numbers: $i = 1, 2, 3, 4, 5; j = 1, 2; k = 1, 2, 3; n = 1, 2, 3; l_{0} = 0,1; l_{2} = 0,1; l_{4} = 0,1; l_{5} = 0,1$) of recurrence of the maximal combined energy gravitational influences on the Earth of the different combined combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. The global volcanic and climatic periodicities $T_{\text{clim}} = T_{\text{endog}} = T_{\text{energy}} / 2$ (of the global periodic volcanic and climatic variability) are related with the periodic recurrence of the maximal combined integral energy gravitational influences on the Earth induced by the different combinations of the cosmic non-stationary energy gravitational influences of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

By comparing the global seismotectonic, volcanic and climatic time periodicities (obtained from the expression (3.196)) with the empirical time periodicities of the seismotectonic activity of the Earth submitted in Subsection 3.6.1 we established [Simonenko, 2007] that the empirical time periodicities (of the seismotectonic activity of the Earth) may be satisfactorily approximated by the expression (3.196) with the different combinations of the various integer numbers.

The calculated time periodicity 24 years (given by $3 \times 8$ years determined by the combination of the system Sun-Moon and the Venus) is close to empirical time periodicity 22 years given by (3.157).

The calculated time periodicity 45 years (given by $3 \times 15$ years determined by the combination of the system Sun-Moon, the Venus and the Mars) is close to the empirical time periodicity 44 years given by (3.158).

The empirical time periodicity 88 years (given by (3.159)) is equal to the same time periodicity 88 years (given by $8 \times 11$ years determined by the combination of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter). Since the ratio 88 years/$T_{\text{Mars}}=46.786$ in close to 47, we concluded [Simonenko, 2009; 2010] that the time periodicity 88 years is determined also by the Mars.

The calculated range of the time periodicities 88 ÷ 96 years (given by $8 \times (11 \div 12)$ years determined by the planetary combination of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) gets into the ranges of the empirical time periodicities: the range $T_{1} = 100 \pm 50$ years (given by (3.163)), the range $90 \pm 40$ years (given by (3.164)), the range $130 \pm 50$ years (given by (3.165)), the range $110 \pm 50$ years (given by (3.166)) and the range $100 \pm 50$ years (given by (3.167)).

The calculated time periodicity 96 years (given by $3 \times 32$ years determined by the combination of the system Sun-Moon, the Venus and the Mars) gets into the ranges of the empirical time periodicities: the
range $T_r = 100 \pm 50$ years (given by (3.163)), the range $90 \pm 40$ years (given by (3.164)), the range $130 \pm 50$ years (given by (3.165)), the range $110 \pm 50$ years (given by (3.166)) and the range $100 \pm 50$ years (given by (3.167)).

The calculated range of the time periodicities $99 \div 108$ years (given by $3 \times 3 \times (11 \div 12)$ years determined by the combination of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) gets into the ranges of the empirical time periodicities: the range $T_r = 100 \pm 50$ years (given by (3.163)), the range $90 \pm 40$ years (given by (3.164)), the range $130 \pm 50$ years (given by (3.165)), the range $110 \pm 50$ years (given by (3.166)) and the range $100 \pm 50$ years (given by (3.167)).

The calculated range of the time periodicity 120 years (given by $8 \times 15$ years determined by the combination of the system Sun-Moon, Venus and the Mars) gets into the ranges of the empirical time periodicities: the range $T_r = 100 \pm 50$ years (given by (3.163)), the range $90 \pm 40$ years (given by (3.164)), the range $130 \pm 50$ years (given by (3.165)), the range $110 \pm 50$ years (given by (3.166)) and the range $100 \pm 50$ years (given by (3.167)).

The calculated time periodicity 135 years (given by $3 \times 3 \times 15$ years determined by the combination of the system Sun-Moon, the Venus and the Mars) gets into the range of the empirical time periodicities $T_r = 100 \pm 50$ years (given by (3.163)).

The calculated time periodicity 152 years (given by $152 = 19 \times 8$ determined by the combination of the system Sun-Moon and the Venus) gets into the ranges of the empirical time periodicities: the range $130 \pm 50$ years (given by (3.165)) and the range $110 \pm 50$ years (given by (3.166)).

The calculated range $165 \div 180$ years (given by $15 \times (11 \div 12)$ years determined by the combination of the system Sun-Moon, the Mars, Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) gets into the range of the empirical time periodicities $130 \pm 50$ years (given by (3.165)).

The calculated time periodicity 249 years (given by $249 = 3 \times 83$ years determined by the combination of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) is near the lower value of the range of the empirical time periodicities $250 \div 300$ years (given by (3.170)) and gets into the range $240 \div 280$ years of the empirical time periodicities (given by (3.171)).

The calculated time periodicity 285 years (given by $19 \times 15$ years determined by the combination of the system Sun-Moon and the Mars) is close to the upper value of the range $240 \div 280$ years of the empirical time periodicities (given by (3.171)).

The calculated time periodicity 285 years (given by $19 \times 15$ years determined by the combination of the system Sun-Moon and the Mars) gets into the range of the empirical time periodicities $250 \div 300$ years (given by (3.170)).

The calculated range of the time periodicities $264 \div 288$ years (given by $3 \times 8 \times (11 \div 12)$ years determined by the combination of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) gets approximately into the range of the empirical time periodicities $240 \div 280$ years (given by (3.171)).

The calculated time periodicity 352 years (given by $32 \times 11$ years determined by the combination of the system Sun-Moon, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) is equal to the empirical time periodicity 352 years (given by (3.160)).

The empirical time periodicities 704 years [Abramov, 1997] (given by (3.161)), 1056 years [Abramov, 1997] (given by (3.162)), 600 years [Vikulin and Vikulina, 1989] (given by (3.168)), 1200 years [Vikulin and Vikulina, 1989] (given by (3.169)) and 1000 years [Мэй Ши-юн, 1960] (given by (3.172)) were also well approximated [Simonenko, 2007; 2008; 2009; 2010] by the different combinations of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

Finally, the established [Simonenko, 2007] global seismotectonic, volcanic and climatic periodicity of 4320 years (given by $3 \times 8 \times 15 \times 12$ years determined by the recurrence of the maximal combined energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) represents the fundamental basis of Hindu cosmological time cycles.
3.6.3. Cosmic energy gravitational genesis of the strongest Japanese earthquakes

We demonstrated [Simonenko, 2007; 2009; 2010] the cosmic energy gravitational genesis of the strongest \(M \geq 7.9\) Japanese earthquakes.

To confirm the proposed cosmic energy gravitational genesis of the strongest \((M \geq 7.9)\) Japanese earthquakes, we present in Table 1 the time periods \(T_1\) (given in years) of recurrence of the strongest Japanese earthquakes [Vikulin, 2003; p. 17] and the obtained [Simonenko, 2007; 2009; 2010] corresponding time periodicities (given in years) induced by the given (in Table 1) corresponding planetary combinations.

Taking into account the time periodicity 83 years (given by (3.190)), the year 1927 AD of the Jupiter’s opposition with the Earth, the time periodicity 88 years \(= 8 \times 11\) years (given by (3.159) and determined by the system Sun-Moon, the Venus, the Jupiter, the Mars and the Sun owing to the gravitational interaction of the Sun with the Jupiter) and the year 1923 AD of the strongest Japanese earthquake in the Tokyo region, we predicted [Simonenko, 2009; 2010] “the time range 2010 ÷ 2011 AD (1927+83 ÷ 1923+88) of the next sufficiently strong Japanese earthquake near the Tokyo region”.

<table>
<thead>
<tr>
<th>Region</th>
<th>Magnitude M of the strongest Japanese earthquakes</th>
<th>Date of the strongest Japanese earthquake</th>
<th>The time periods (T_1) (given in years) of recurrence of the strongest Japanese earthquakes</th>
<th>Corresponding time periodicities (given in years) determined by the following planetary combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokyo region</td>
<td>7.9</td>
<td>1.01.1605</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.2</td>
<td>31.12.1703</td>
<td>98</td>
<td>88 ÷ 96 = 8 \times (11 ÷ 12) – Sun-Moon-Venus-Jupiter- Sun (due to Jupiter) – Mars</td>
</tr>
<tr>
<td></td>
<td>8.2</td>
<td>1.09.1923</td>
<td>220</td>
<td>209 ÷ 228 = 19 \times (11 ÷ 12) – Sun-Moon-Jupiter- Sun (due to Jupiter)</td>
</tr>
<tr>
<td>Southwest from Tokyo</td>
<td>8.6</td>
<td>20.09.1498</td>
<td>107</td>
<td>96 = 3 \times 32 – Sun-Moon-Venus-Mars</td>
</tr>
<tr>
<td></td>
<td>7.9</td>
<td>31.01.1605</td>
<td>107</td>
<td>120 = 8 \times 15 – Sun-Moon-Venus-Mars</td>
</tr>
<tr>
<td></td>
<td>8.4</td>
<td>28.10.1707</td>
<td>102</td>
<td>96 = 3 \times 32 – Sun-Moon-Venus-Mars</td>
</tr>
<tr>
<td></td>
<td>8.4</td>
<td>23.12.1854</td>
<td>147</td>
<td>152 = 19 \times 8 – Sun-Moon-Venus</td>
</tr>
<tr>
<td></td>
<td>8.0</td>
<td>7.12.1944</td>
<td>90</td>
<td>88 ÷ 96 = 8 \times (11 ÷ 12) – Sun-Moon-Venus-Jupiter- Sun (due to Jupiter)</td>
</tr>
</tbody>
</table>

3.6.4. The evaluated mean time periodicities 94620 years and 107568 years of the global climate variability (related with the $G(a)$ - factor and $G(b)$ - factor determined by the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) and the mean time periodicities 100845 years and 121612.5 years of the global climate variability related with the $G(b)$ - factor (determined by the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter).

It is well known [Bol’shakov, 2003; p. 82] that 50% of the climatic variability during Pleistocene [Hays, Imbrie and Shackleton, 1976] is related with the time periodicities 106000 years, 94000 years and 122000 years; 25% of the climatic variability during Pleistocene [Hays, Imbrie and Shackleton, 1976] is related with the time periodicities 40000 years, 41000 years and 43000 years; 10% of the climatic variability during Pleistocene [Hays, Imbrie and Shackleton, 1976] is related with the time periodicities 23000 years, 24000 years.

Based on the generalized differential formulation (1.43) of the first law of thermodynamics applied for the Earth, we developed the fundamentals of the thermohydrogravidymanic theory of the paleoclimate [Simonenko, 2007] of the Earth and proposed [Simonenko, 2007] the partial solution of the problem of the 100000-year climate periodicity [Berger, 1999] during Pleistocene by taking into account the $G(a)$ - factor and $G(b)$ - factor determined by the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

It was noted [Bol’shakov, 2003; p. 82] that the spectrum [Hays et al., 1976] of the variations of the summer insolation on 60° northern latitude of the Earth during last 468000 years (calculated based on the Milankovitch theory [Milankovitch, 1938]) does not contain the main time periodicity 100000 years of the climatic variability during the last 1000000 years. It was concluded [Imbrie et al., 1993; p. 730] that the foundation of the 100000-year climate periodicity is not possible in the frame of the Milankovitch theory [Milankovitch, 1938] since the variations of the radiation (related with the variations of the eccentricity of the Earth’s orbit) are very small to control adequately the change of the Earth’s climate.

According to the estimation [Bol’shakov, 2003; p. 28] based on the numerical data [Berger and Loutre, 1991] of the variation of the eccentricity $e$ of the Earth’s orbit during the last 2000000 years and the Milankovitch dependence $(1 - e^2)^{-0.5}$ [Milankovitch, 1938] of the average (annual) solar energy flux related with the eccentricity $e$ of the Earth’s orbit, the variations of the average (annual) solar energy flux are not exceeded 0.16%. It was also concluded [Bol’shakov, 2003; p. 100] that the Milankovitch theory [Milankovitch, 1938] cannot predict the climate variability related with the 100000-year periodicity. It was presented [Bol’shakov, 2003; p. 100-101] the explicit contradiction of the Milankovitch theory [Milankovitch, 1938]: the glacial epochs (according the empirical data [Hays et al., 1976]) during the last 500000 years correspond to the minimal values of the eccentricity of the Earth’s orbit [Bol’shakov, 2003; p. 100], but the Milankovitch theory (in which the glacial epochs are associated with the minimal values of the solar radiation related with the minimal values of the eccentricity of the Earth’s orbit) predict four (from five) glacial epochs during the last 750000 years [Bol’shakov, 2003; p. 100, Fig. 23] corresponding to the maximal values of the eccentricity of the Earth’s orbit taken from the work [Berger, 1988, Fig. 9]. It was concluded [Bol’shakov, 2003; p. 114] that the genesis of the 100000-year climate periodicity is not explained. The analogous conclusion was made [Berger, 1999, p. 312; Elkibbi and Rial, 2001]. Thus, we see that the solution of the problem of the 100000-year climate periodicity during Pleistocene [Berger, 1999; Bol’shakov, 2003; p. 100] cannot be obtain in the frame of the Milankovitch theory [Milankovitch, 1938].

We founded the near 100000 years Earth’s climate periodicities in the frame of the thermohydrogravidymanic theory [Simonenko, 2007] using the conclusion that for the time periodicity $T_{\text{energy}}$ of the periodic recurrence of the maximal integral energy gravitational influences on the Earth (defined by the combination of the system Sun-Moon and the arbitrary combination of the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) we have two global time periodicities of the Earth’s climate variability: the time periodicity $T_{\text{tec}} = T_{\text{energy}}$ (related with the
periodic tectonic-volcanic activity of the geo-spheres of the Earth and each geo-block of the Earth induced by the cosmic non-stationary combined energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) and time periodicity $T_{\text{endog}} = T_{\text{energy}} / 2$ related with the periodic tectonic-endogenous heating (of the geo-spheres of the Earth, each geo-block of the Earth, the atmosphere and the oceans of the Earth) and related global volcanic activity induced by the periodic continuum deformation (characterized by the time periodicity $T_{\text{energy}}$) owing to the periodic cosmic non-stationary combined energy gravitational influence (characterized by the time periodicity $T_{\text{energy}}$) on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

Considering the time periodicity 19 years of the maximal combined integral energy gravitational influence on the Earth of the system Sun-Moon (in the third approximation), the time periodicity 8 years of the maximal integral energy gravitational influence on the Earth of the Venus (in the second approximation), the time periodicity 15 years of the maximal integral energy gravitational influence on the Earth of the Mars (in the first approximation) and the time periodicity 83 years of the maximal integral energy gravitational influence on the Earth of the Jupiter (in the third approximation) and the Sun owing to the gravitational interaction of the Sun with the Jupiter, we obtained [Simonenko, 2007] the time periodicity

$$T_{\text{clim2}} = T_{\text{endog}} = T_{\text{energy}} / 2 = 0.5 \times 19 \times 8 \times 15 \times 83 \text{ years} = 94620 \text{ years}$$

(3.198)

of the global climate variability of the Earth related with the periodic tectonic-endogenous heating (of the geo-spheres of the Earth, each geo-block of the Earth, the atmosphere and the oceans of the Earth) and related global volcanic activity induced by periodic continuum deformation (characterized by the time periodicity $T_{\text{energy}}$) owing to the periodic cosmic non-stationary combined energy gravitational influences (characterized by the time periodicity $T_{\text{energy}}$) on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

Considering the time periodicity 27 years of the maximal combined integral energy gravitational influence on the Earth of the system Sun-Moon (in the fourth approximation), the time periodicity 3 years of the maximal integral energy gravitational influences on the Earth of the Venus (in the first approximation), the time periodicity 15 years of the maximal integral energy gravitational influences on the Earth of the Mars (in the first approximation) and the time periodicity 83 years of the maximal integral energy gravitational influences on the Earth of the Jupiter (in the third approximation) and the Sun owing to the gravitational interaction of the Sun with the Jupiter, we obtained [Simonenko, 2007] the time periodicity

$$T_{\text{tec}} = T_{\text{clim1}} = T_{\text{energy}} = 27 \times 3 \times 15 \times 83 \text{ years} = 100845 \text{ years}$$

(3.199)

of the Earth’s periodic seismotectonic (and volcanic) activity and the global climate variability of the Earth induced by the combined cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

Considering the time periodicity 27 years of the maximal combined integral energy gravitational influence on the Earth of the system Sun-Moon (in the fourth approximation), the periodicity 3 years of the maximal integral energy gravitational influence on the Earth of the Venus (in the first approximation), the periodicity 32 years of the maximal integral energy gravitational influence on the Earth of the Mars (in the second approximation) and the periodicity 83 years of the maximal integral energy gravitational influence on the Earth of the Jupiter (in the third approximation) and the Sun owing to the gravitational interaction of the Sun with the Jupiter, we obtained [Simonenko, 2007] the time periodicity

$$T_{\text{clim2}} = T_{\text{endog}} = T_{\text{energy}} / 2 = 0.5 \times 27 \times 3 \times 32 \times 83 \text{ years} = 107568 \text{ years}$$

(3.200)

of the global climate variability of the Earth related with the periodic tectonic-endogenous heating (of the geo-spheres of the Earth, each geo-block of the Earth, the atmosphere and the oceans of the Earth) and related global volcanic activity induced by periodic continuum deformation (characterized by the time periodicity $T_{\text{energy}}$) owing to the periodic cosmic non-stationary combined energy gravitational influences (characterized by the time periodicity $T_{\text{energy}}$) on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

Considering the time periodicity 235 years of the maximal combined integral energy gravitational influence on the Earth of the system Sun-Moon (in the fifth approximation), the time periodicity 3 years of the maximal integral energy gravitational influences on the Earth of the Venus (in the first approximation),
the time periodicity 15 years of the maximal integral energy gravitational influences on the Earth of the Mars (in first approximation) and the range of the time periodicities (11 ÷ 12) years of the maximal integral energy gravitational influences on the Earth of the Jupiter (in the first and second approximations) and the Sun owing to the gravitational interaction of the Sun with the Jupiter, we obtained [Simonenko, 2007] the range of the time periodicities

$$T_{\text{tor}} = T_{\text{diam}} = T_{\text{energy}} = 235 \times 3 \times 15 \times (11 \div 12) \text{ years} = 116325 \div 126900 \text{ years} \quad (3.201)$$

of the global periodic seismotectonic (and volcanic) activity and the global climate variability of the Earth induced by the combined integral cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. The average value 121612.5 years (of the calculated range 116325 ÷ 126900 years of the time periodicities given by (3.201)) is very close to the empirical time periodicity 122000 years [Hays, Imbrie and Shackleton, 1976] of the climatic variability during Pleistocene. The value 124000 years (corresponding to the strong local maximum of the amplitude-frequency spectrum [Berger and Loutre, 1991] of the variations of the eccentricity of the Earth’s orbit during the last 2 millions years) gets into the predicted theoretical range (3.201) of the time periodicities 116325 ÷ 126900 years [Simonenko, 2007].

The empirical time periodicities (related with the problem of the 100000-year climate periodicity during Pleistocene [Berger, 1999]) and the founded time periodicities established in the frame of the thermohydrogravidynamic theory [Simonenko, 2007a; 2007; 2008] of the Earth’s paleoclimate

<table>
<thead>
<tr>
<th>The empirical time periodicities of the Earth’s climatic variability</th>
<th>[Hays, Imbrie and Shackleton, 1976]: 94000 years</th>
<th>[Muller and MacDonald, 1995]: 100000 years</th>
<th>[Hays, Imbrie and Shackleton, 1976]: 106000 years</th>
<th>[Hays, Imbrie and Shackleton, 1976]: 122000 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>The founded time periodicities of the Earth’s global climate variability established in the frame of thermohydrogravidynamic theory [Simonenko, 2007]</td>
<td>[Simonenko, 2007; p. 148]: 94620 years</td>
<td>[Simonenko, 2007; p. 148]: 100845 years</td>
<td>[Simonenko, 2007; p. 148]: 107568 years</td>
<td>[Simonenko, 2007; p. 148]: average periodicity 121612.5 years</td>
</tr>
<tr>
<td>The established physical genesis of the time periodicities of the Earth’s global climate variability revealed in the frame of the thermohydrogravidynamic theory [Simonenko, 2007] of the Earth’s paleoclimate</td>
<td>The global periodic Earth’s tectonic-endogenous heating related with the periodic continuum deformation (and related global volcanic activity) induced by the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun</td>
<td>The global periodic Earth’s atmospheric-oceanic warming as a consequence of the greenhouse effect produced by the gravity-induced (owing to the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun</td>
<td>The global periodic Earth’s tectonic-endogenous heating related with the periodic continuum deformation (and related global volcanic activity) induced by the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun</td>
<td>The global periodic Earth’s atmospheric-oceanic warming as a consequence of the greenhouse effect produced by the gravity-induced (owing to the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun</td>
</tr>
<tr>
<td>the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter</td>
<td>Sun owing to the gravitational interaction of the Sun with the Jupiter</td>
<td>system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter</td>
<td>gravitational interaction of the Sun with the Jupiter</td>
<td>periodic global tectonic-volcanic activization accompanied by increased output of the atmospheric greenhouse gases</td>
</tr>
</tbody>
</table>

The recurrence of the maximal tectonic (and volcanic) activity of the Earth (characterized by the range of the time periodicities $116325 \div 126900$ years) must lead to the recurrence of the maximal concentration of the atmospheric greenhouse gases characterized by the same time periodicities $116325 \div 126900$ years) owing to the periodic increase of production of the atmospheric greenhouse gases related with tectonic-volcanic activization of the Earth. The periodic increase of the atmospheric greenhouse gases concentration (characterized by the range of the time periodicities $116325 \div 126900$ years) must lead to the periodic climate variability related with the atmospheric-oceanic warming as a consequence of the greenhouse effect.

The established [Simonenko, 2007] cosmic energy gravitational genesis of the range (3.201) of the time periodicities $116325 \div 126900$ years (corresponding to the empirical time periodicity 122000 years [Hays, Imbrie and Shackleton, 1976] of the global climate variability) is explained in the frame of the thermohydrogravdynamic theory [Simonenko, 2007] by considering the combined energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

We present in Table 2 the empirical time periodicities [Muller and MacDonald, 1995; Hays, Imbrie and Shackleton, 1976] of the Earth’s global climatic variability (related with the problem of the 100000-year climate periodicity during Pleistocene [Berger, 1999]) and the calculated time periodicities in the frame of the thermohydrogravdynamic theory [Simonenko, 2007].

The empirical time periodicity 94000 years [Hays, Imbrie and Shackleton, 1976] during Pleistocene is in good agreement with the calculated [Simonenko, 2007] time periodicity 94620 years ($0.5 \times 19 \times 8 \times 15 \times 83$ years) of the Earth’s global climatic variability related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

Taking this agreement into account, we revealed [Simonenko, 2007] the cosmic energy gravitational genesis (related with the combined cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) of the periodic Earth’s tectonic-endogenous heating and related global volcanic activity (characterized by the time periodicity 94620 years) induced by the periodic continuum deformation owing to the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

The established cosmic energy gravitational genesis of the time periodicity 100845 years ($27 \times 3 \times 15 \times 83$ years) [Simonenko, 2007] is in agreement with the experimental data [Pinxian et al., 2003; p. 2524-2535], which revealed the time periodicity 100000 years of the climatic variability. The established cosmic energy gravitational genesis of the time periodicity 100845 years [Simonenko, 2007] is also in agreement with the experimental data [Pinxian et al., 2003; p. 2536-2548], which revealed the same time periodicity 100000 years of the variability of the carbon concentration in the Earth’s sedimentary rocks. The empirical time periodicity 100000 years [Muller and MacDonald, 1995] during Pleistocene is in good agreement with the calculated time periodicity 100845 years [Simonenko, 2007] of the Earth’s climatic variability related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. Taking into account this agreement, we revealed [Simonenko, 2007] the cosmic energy gravitational genesis (related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the
gravitational interaction of the Sun with the Jupiter) of the periodic atmospheric-oceanic global planetary warming and cooling (characterized by the time periodicity 100845 years) as a consequence of the greenhouse effect produced by the gravity-induced periodic global tectonic-volcanic activation accompanied by the increased output of the atmospheric greenhouse gases.

The empirical time periodicity 106000 years [Hays, Imbrie and Shackleton, 1976] during Pleistocene is in good agreement with the calculated [Simonenko, 2007] time periodicity 107568 years (0.5 × 27 × 3 × 32 × 83 years) of the Earth’s global climatic variability related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. Taking into account this agreement, we revealed [Simonenko, 2007] the cosmic energy gravitational genesis (related with the combined cosmic planetary non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) of the periodic Earth’s global tectonic-endogenous heating and related global volcanic activity (characterized by the time periodicity 107568 years induced by the periodic continuum deformation owing to the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter).

The empirical time periodicity 122000 years [Hays, Imbrie and Shackleton, 1976] during Pleistocene is in good agreement with the calculated [Simonenko, 2007] average time periodicity 121612.5 years (235 × 3 × 15 × (11+12) × 0.5 years) of the Earth’s global climatic variability related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. Taking this agreement into account, we revealed [Simonenko, 2007] the cosmic energy gravitational genesis (related with the combined cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) of the periodic global atmospheric-oceanic warming (characterized by the average time periodicity 121612.5 years) as a consequence of the greenhouse effect produced by the gravity-induced periodic global tectonic-volcanic activation accompanied by the increased output of the atmospheric greenhouse gases.

Using the presented (in Table 2) calculated time periodicities of the Earth’s global climatic variability, we calculated [Simonenko, 2007] the average theoretical time periodicity 106160 years, which is in good agreement with the empirical time periodicity 106000 years corresponding to the main maximum of the spectrum [Hays, Imbrie and Shackleton, 1976] of the combined isotopic-oxygen variations based on the empirical data RC11 - 120 and E49 - 18.

Using the presented (in Table 2) empirical time periodicities of the Earth’s global climatic variability, we calculated [Simonenko, 2007] the average empirical time periodicity 105500 years, which is in fairly good agreement with the empirical time periodicity 106000 years corresponding to the main maximum of the spectrum [Hays, Imbrie and Shackleton, 1976] of the combined isotopic-oxygen variations based on the empirical data RC11 - 120 and E49 - 18. The calculated [Simonenko, 2007] average theoretical time periodicity 106160 years is in fairly good agreement with the empirical predominant time periodicity of 105000 years [Gorbarenko et al., 2011] characterizing the Okhotsk Sea productivity and lithological proxies stacks during the last 350 kyr.

The agreement of the obtained average theoretical global time periodicity 106160 years [Simonenko, 2007] with the empirical time periodicity 106000 years [Hays, Imbrie and Shackleton, 1976] confirmed [Simonenko, 2007] the validity of the established cosmic planetary energy gravitational genesis (related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) of the revealed time periodicities (in the frame of the thermohydrogravodynamic theory [Simonenko, 2007a; 2007; 2008]) of the Earth’s global climatic variability. The agreement of the obtained average theoretical global time periodicity 106160 years [Simonenko, 2007] with the empirical time periodicity 105000 years [Gorbarenko et al., 2011] is the additional confirmation of the validity of the established cosmic planetary energy gravitational genesis (related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) of the revealed [Hays, Imbrie and Shackleton, 1976] time periodicities of the Earth’s global climatic variability.
3.6.5. Cosmic energy gravitational genesis of the modern short-term time periodicities of the Earth’s global climate variability determined by the combined cosmic factors:

- **G-factor** related with the combined cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Mercury, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter;

- **G(a)-factor** related to the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor;

- **G(b)-factor** related to the periodic atmospheric-oceanic warming or cooling as a consequence of the periodic variable (increasing or decreasing) output of the heated greenhouse volcanic gases and the related variable greenhouse effect induced by the periodic variable tectonic-volcanic activity (activization or weakening) due to the G-factor;

- **G(c)-factor** related to the periodic variations of the solar activity owing to the periodic variations of the combined planetary non-stationary energy gravitational influence on the Sun

Using the evaluations [Simonenko, 2009; 2010] of the relative maximal instantaneous energy gravitational influences of the planets of the Solar System on the Sun and using the established [Simonenko, 2009; 2010] time periodicities of the solar activity induced by the energy gravitational influences on the Sun of the planets of the Solar System, we established [Simonenko, 2009; 2010] the following short-term time periodicities (of the solar activity induced by the planetary energy gravitational influences on the Sun):

\[
0.96359 \div 1.2302 \text{ years} \quad (3.202)
\]
determined by the combined energy gravitational influence of the Mercury, the Venus and the Earth on the Sun;

\[
5.5359 \div 7 \text{ years} \quad (3.203)
\]
determined by the combined energy gravitational influence of the Mercury, the Venus and the Earth on the Sun;

\[
11 \div 13.008 \text{ years} \quad (3.204)
\]
determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Earth and the Mars on the Sun;

\[
19.9945 \div 29.4525 \text{ years} \quad (3.205)
\]
determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Earth and the Mars on the Sun;

\[
33 \div 35.73 \text{ years} \quad (3.206)
\]
determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Earth and the Mars on the Sun;

\[
47.36 \div 53 \text{ years} \quad (3.207)
\]
determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Earth and the Mars on the Sun;

\[
58.905 \div 63.3564 \text{ years} \quad (3.208)
\]
determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Earth and the Mars on the Sun;

\[
83 \div 88.4095 \text{ years} \quad (3.209)
\]
determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Earth and the Mars on the Sun;

\[
106.7177 \div 118.58 \text{ years} \quad (3.210)
\]
determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Earth and the Mars on the Sun.

Taking into account these short-term time periodicities (founded in Subsection 6.2.9 of the monographs [Simonenko, 2009; 2010]) of the solar activity; the modern short-term time periodicities (founded in Subsection 4.3.2.10 of the monographs [Simonenko, 2009; 2010]) of the global climate variability induced by the non-stationary energy gravitational influences on the Earth of the Mercury, the Venus, the Moon, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter; the time periodicities (founded in Subsections 4.4.5.3 and 4.4.5.4 of the monographs [Simonenko, 2009; 2010]) of the Earth’s periodic global climate variability induced by the different combinations of the cosmic non-stationary energy gravitational influences of the system Sun-Moon, the Venus, the Mars, the Jupiter and
the Sun owing to the gravitational interaction of the Sun with the Jupiter; we evaluated [Simonenko, 2009; 2010] the following ranges of the main modern short-term time periodicities of the Earth’s global climate variability:

\[0.96359 \div 3 \text{ years}\] (3.211)  
consistent approximately with the empirical range \([1 \div 3] \text{ years}\) of the time periodicities [Li et al., 2001; Krokhn, 2004; Ponomarev et al., 2007] of the global climate variability;

\[3 \div 7 \text{ years}\] (3.212)  
consistent with the same empirical range \([3 \div 7] \text{ years}\) of the time periodicities [Thompson and Wallace, 1998; Wang and Ikeda, 2000; Gong et al., 2003; Ogi and Tachibana, 2006; Oort and Yienger, 1996; White and Cayan, 2000; Diaz et al., 2001; Fu and Teng, 1993; Ponomarev et al., 1999a; Ponomarev et al., 1999b; Ponomarev et al., 2007] related with the ENSO climate variability;

\[(7 \div 15) \text{ years}\] (3.213)  
consistent approximately with the evaluated empirical range \(8 \div 15 \text{ years}\) [Ponomarev et al., 2007] of the quasi-decadal climate variability [Nakamura et al., 1997; Tourre et al., 2001; Auad, 2003; Qiu, 2003; Ponomarev et al., 2003a; 2003b; 2003c; Polonsky et al., 2004];

\[16 \div 19 \text{ years}\] (3.214)  
consistent approximately with the evaluated empirical [Ponomarev et al., 2007] quasi-twenty-year climate variability of the Pacific Ocean and the continental marginal Pacific areas [Latif and Barnett, 1994; Minobe, 1997; Tourre et al., 2001; Auad, 2003];

\[19.9945 \div 29.4525 \text{ years}\] (3.215)  
consistent with the evaluated empirical range \(20 \div 30 \text{ years}\) [Ponomarev et al., 2007] of the climate variability for the Asian continental (adjacent to the Far Eastern seas) and Pacific marginal areas;

\[32 \div 36 \text{ years}\] (3.216)  
consistent approximately with the evaluated [Dmitrieva and Ponomarev, 2012] empirical time periodicity 37 years characterizing the South-Eastern tropical area, Kuroshio Current region (including East China an Japan/East Seas), central and northeastern Pacific;

\[16 \div 36 \text{ years}\] (3.217)  
consistent approximately with the evaluated [Ponomarev et al., 2007] empirical range \(15 \div 35 \text{ years}\) of the time periodicities of the global climate variability [Yamagata and Masumoto, 1992; Trenberth and Hurrel, 1994; Latif and Barnett, 1994; Miller et al., 1994; Delworth et al., 1994; Zhang et al., 1997; Mantua et al., 1997; Minobe and Mantua, 1999; Tourre et al., 2001; Auad, 2003; Ponomarev et al., 2003a; 2003b; 2003c];

\[41.5 \div 54 \text{ years}\] (3.218)  
consistent approximately with the evaluated (based on the wavelet analysis) interdecadal cycle of approximately 50 years [Goncharova, Gorbarenko, Shi, Bosin, Fischenko, Zou and Liu, 2012] characterizing the regional climate variability of the Japan Sea, and in good agreement with the estimated (based on the spectral Fourier analysis) time periodicity 48 years [Kalugin and Darin, 2012] obtained from the studies of sediments from Siberian and Mongolian lakes;

\[57 \div 63.3564 \text{ years}\] (3.219)  
in good agreement with the estimated (based on the spectral Fourier analysis) time periodicity 60 years [Monin and Sonechkin, 2005];

\[76 \div 96 \text{ years}\] (3.220)  
in good agreement with the estimated (based on the spectral Fourier analysis) time periodicity 88 years [Kalugin and Darin, 2012] obtained from the studies of sediments from Siberian and Mongolian lakes;

\[99 \div 124.5 \text{ years}\] (3.221)  
consistent approximately with the evaluated [Ponomarev et al., 2007] quasi-hundred-year time periodicity of the global climate variability [Auad, 2003; Miller and Schneider, 2000; Webster and Yang, 1992; Li et al., 2001; Nakamura et al., 2002; Global-regional linkages in the Earth system, 2002; Overland et al., 1999; Vasilevska et al., 2003; Savelieva et al., 2004], and in good agreement with the estimated (based on the spectral Fourier analysis) time periodicity 109 years [Kalugin and Darin, 2012] obtained from the studies of sediments from Siberian and Mongolian lakes, and consistent approximately with the evaluated (based on the wavelet analysis) interdecadal cycle of approximately 100 years [Goncharova, Gorbarenko, Shi, Bosin, Fischenko, Zou and Liu, 2012] characterizing the regional climate variability of the Japan Sea.

The combination of the founded ranges (3.218) and (3.219) gives the explanation of the evaluated empirical range \(50 \div 70 \text{ years}\) of the time periodicities [Minobe, 1997] of the global climate variability in the northern region of the Pacific Ocean and for the Northern America.

The range (3.216) of the global climatic time periodicities \(32 \div 36 \text{ years}\) is determined by the range (3.206) of the time periodicities \(33 \div 35.73 \text{ years}\) of the solar activity (induced by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Mars and the Earth on the Sun) and mainly
the range of the global climatic (and seismotectonic) time periodicities $33 \div 36$ years ($3 \times (11 \div 12)$ years) [Simonenko, 2007] related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. The established time periodicity 35 years [Hattory, 1977] of the seismotectonic activity of various regions of the seismic zone of the Pacific Ring is in good agreement with the mean value 34.5 years of the established range of the global climatic (and seismotectonic) time periodicities $33 \div 36$ years [Simonenko, 2007]. The mean value 34.5 years (of the established range of the global climatic (and seismotectonic) time periodicities $33 \div 36$ years [Simonenko, 2007]) is also in good agreement with the evaluated [Dmitrieva and Ponomarev, 2012] empirical time periodicity 37 years characterizing the South-Eastern tropical area, Kuroshio Current region (including East China and Japan/East Seas), central and northeastern Pacific. These good agreement (of the independent studies [Hattory, 1977; Simonenko, 2007; Dmitrieva and Ponomarev, 2012]) confirms the validity of the thermohydrogravidynamic theory [Simonenko, 2007; 2009; 2010] of the seismotectonic, volcanic and climatic evolution of the Earth.
3.7. The cosmic energy gravitational genesis of the seismotectonic (and volcanic) activity and the
global climate variability induced (owing to the G-factor, \(G(a)\)-factor and \(G(b)\)-factor)
by the combined non-stationary cosmic energy gravitational influences on the Earth of the
system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun (owing to the gravitational
interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune)

3.7.1. The time periodicities of the maximal (instantaneous and integral) energy gravitational
influences of the Sun on the Earth owing to the gravitational interaction of the Sun
with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune)

Taking into account the results of Subsection 3.3 (revealing the very significant energy gravitational
influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large
planets of the Solar System), it is necessary to deduce (using the generalized differential formulation \((1.50)\)
of the first law of thermodynamics and the related results of Subsections 3.3 for the Earth) the
time periodicities of the maximal (instantaneous and integral) energy gravitational influences of the Sun on the
Earth owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn,
the Uranus and the Neptune).

3.7.1.1. The time periodicities of the maximal (instantaneous and integral) energy
gravitational influences on the Earth of the Jupiter and the Sun owing to the gravitational
interaction of the Sun with the Jupiter

Using the results of Subsections 3.3.1 and 3.6.2.3, we have the successive approximations for the
time periodicities [Simonenko, 2007] \((T_{1,3})_1 = 11\) years, \((T_{1,3})_2 = 12\) years and \((T_{1,3})_3 = 83\) years (given
by \((3.188)\), \((3.189)\) and \((3.190)\), respectively) of recurrence of the maximal (instantaneous and integral)
energy gravitational influences on the Earth of the Jupiter [Simonenko, 2007] and the Sun (owing to the
gravitational interaction of the Sun with the Jupiter) in the first, second and third approximations,
respectively.

3.7.1.2. The time periodicities of the maximal (instantaneous and integral) energy
gravitational influences on the Earth of the Saturn and the Sun owing to the gravitational
interaction of the Sun with the Saturn

Let us obtain (in the frame of the real elliptical orbits of the Earth and the Saturn) the first, second and
third approximations for the time periodicities characterizing the maximal (instantaneous and integral)
energy gravitational influences on the Earth of the Saturn and the Sun owing to the gravitational interaction
of the Sun with the Saturn. If the configuration of the Earth, the Saturn and the Sun (considered as the closed
system) is characterized at any time moment by the maximal (instantaneous or integral) combined energy
gravitational influences on the Earth of the Saturn and the Sun (owing to the gravitational interaction of the
Sun with the Saturn), then the Earth, the Saturn and the Sun will have the recurrence of the same
(approximately) configuration after different integer numbers of circulations \((I_{SAT,3})\) circulations of the
Saturn around the combined mass center of the Sun and the Saturn and \(m_{3,SAT}\) circulations of the Earth
around the combined mass center of the Sun and the Saturn) to satisfy the following condition:

\[
I_{SAT,3} T_{SAT} = m_{3,SAT} T_3 .
\]  

Following the known method [Perelman, 1956], we present the ratio \(T_{SAT}/T_3\) by the following mathematical
fraction:

\[
m_{3,SAT}/I_{SAT,3} = \frac{T_{SAT}}{T_3} = \frac{10759}{365.3} = 29 + \frac{1}{2 + \frac{1}{4 + \frac{347}{265}}}.
\]
Considering the first approximation of the ratio \( \frac{T_{SAT}}{T_3} \) given by the rational number 
\[ \frac{m_{3,SAT}}{l_{SAT,3}} = 29, \]
we have from condition (3.222) the first approximation:
\[ T_{SAT} \approx 29 T_3 \quad (3.223) \]
denoting that 29 circulations of the Earth (around the combined mass center of the Sun and the Saturn) correspond approximately to 1 circulation of the Saturn around the combined mass center of the Sun and the Saturn. The first approximation gives the first approximate time periodicity \( (T_{SAT,3})_1 = 29 \) years of the maximal (instantaneous or integral) combined energy gravitational influences (in the first approximation) on the Earth of the Saturn and the Sun owing to the gravitational interaction of the Sun with the Saturn.

Considering the second approximation of the ratio \( \frac{T_{SAT}}{T_3} \) given by the following rational number
\[ \frac{m_{3,SAT}}{l_{SAT,3}} = 59, \]
we have from condition (3.222) the second approximation:
\[ 2T_{SAT} \approx 59 T_3 \quad (3.224) \]
denoting that 59 circulations of the Earth (around the combined mass center of the Sun and the Saturn) correspond approximately to 2 circulations of the Saturn around the combined mass center of the Sun and the Saturn. The second approximation (3.224) gives the second approximate time periodicity \( (T_{SAT,3})_2 = 59 \) years of the maximal (instantaneous or integral) combined energy gravitational influences (in the second approximation) on the Earth of the Saturn and the Sun owing to the gravitational interaction of the Sun with the Saturn.

Considering the third approximation of the ratio \( \frac{T_{SAT}}{T_3} \) given by the following rational number
\[ \frac{m_{3,SAT}}{l_{SAT,3}} = 265, \]
we have from condition (3.222) the third approximation:
\[ 9T_{SAT} \approx 265 T_3 \quad (3.225) \]
denoting that 265 circulations of the Earth (around the combined mass center of the Sun and the Saturn) correspond approximately to 9 circulations of the Saturn around the combined mass center of the Sun and the Saturn. The third approximation (3.225) gives the third approximate time periodicity \( (T_{SAT,3})_3 = 265 \) years of the maximal (instantaneous or integral) combined energy gravitational influences (in the third approximation) on the Earth of the Saturn and the Sun owing to the gravitational interaction of the Sun with the Saturn.

Thus, we found the time periodicities:
\[ (T_{SAT,3})_1 = 29 \text{ years}, \quad (3.226) \]
\[ (T_{SAT,3})_2 = 59 \text{ years}, \quad (3.227) \]
\[ (T_{SAT,3})_3 = 265 \text{ years} \quad (3.228) \]
of recurrence of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Saturn and Sun (owing to the gravitational interaction of the Sun with the Saturn) in the first, second and third approximations, respectively.

3.7.1.3. The time periodicity of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Uranus and the Sun owing to the gravitational interaction of the Sun with the Uranus

Let us obtain (in the frame of the real elliptical orbits of the Earth and the Uranus) the first approximation for the time periodicities characterizing the maximal (instantaneous or integral) energy gravitational influences on the Earth of the Uranus and the Sun owing to the gravitational interaction of the Sun with the Uranus. If the configuration of the Earth, the Uranus and the Sun (considered as the closed system) is characterized at any time moment by the maximal (instantaneous or integral) combined energy gravitational influences on the Earth of the Uranus and the Sun (owing to the gravitational interaction of the Sun with the Uranus), then the Earth, the Uranus and the Sun will have the recurrence of the same
configuration (approximately) after different integer numbers of circulations \((w_{U,3}, \text{circulations of the Uranus around the combined mass center of the Sun and the Uranus and } m_{3,\text{U}}, \text{circulations of the Earth around the combined mass center of the Sun and the Uranus})\) to satisfy the following condition:

\[
w_{U,3} T_U = m_{3,\text{U}} T_3 .
\]

Following the known method [Perelman, 1956], we present the ratio \(T_U / T_3\) by the following mathematical fraction:

\[
m_{3,\text{U}} / w_{U,3} = \frac{T_U}{T_3} = \frac{30685}{365.3} = 83 + \frac{1}{1 + \frac{1825}{2}}.
\]

Considering the first approximation of the ratio \(T_U / T_3\) given by the rational number \(m_{3,\text{U}} / w_{U,3} = 84\), we have from condition (3.229) the first approximation:

\[
T_U \approx 84 T_3
\]

denoting that 84 circulations of the Earth (around the combined mass center of the Sun and the Uranus) correspond approximately to 1 circulation of the Uranus around the combined mass center of the Sun and the Uranus. The first approximation gives the first approximate time periodicity \((T_{U,3})_1 = 84\) years of the maximal (instantaneous or integral) combined energy gravitational influences (in the first approximation) on the Earth of the Uranus and the Sun owing to the gravitational interaction of the Sun with the Uranus. Thus, we found the following time periodicity:

\[
(T_{U,3})_1 = 84, \quad \text{years},
\]

of recurrence of the maximal (instantaneous and integral) combined energy gravitational influences on the Earth of the Uranus and Sun (owing to the gravitational interaction of the Sun with the Uranus) in the first approximation.

3.7.1.4. The time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Neptune and the Sun owing to the gravitational interaction of the Sun with the Neptune

Let us obtain (in the frame of the real elliptical orbits of the Earth and the Neptune) the first, second and third approximations for the time periodicities characterizing the maximal (instantaneous or integral) energy gravitational influences on the Earth of the Neptune and the Sun owing to the gravitational interaction of the Sun with the Neptune. If the configuration of the Earth, the Neptune and the Sun (considered as the closed system) is characterized at any time moment by the maximal (instantaneous or integral) combined energy gravitational influences on the Earth of the Neptune and the Sun (owing to the gravitational interaction of the Sun with the Neptune), then the Earth, the Neptune and the Sun will have the recurrence of the same (approximately) configuration after different integer numbers of circulations \((p_{N,3}, \text{circulations of the Neptune around the combined mass center of the Sun and the Neptune and } m_{3,\text{N}}, \text{circulations of the Earth around the combined mass center of the Sun and the Neptune})\) to satisfy the following condition:

\[
p_{N,3} T_N = m_{3,\text{N}} T_3 .
\]

Following the known method [Perelman, 1956], we present the ratio \(T_N / T_3\) by the following mathematical fraction:

\[
m_{3,\text{N}} / p_{N,3} = \frac{T_N}{T_3} = \frac{60189}{365.3} = 164 + \frac{1}{1 + \frac{1}{1 + \frac{1}{3 + \frac{156}{233}}}}.
\]

Considering the first approximation of the ratio \(T_N / T_3\) given by the rational number...
\[ m_{3,N}/p_{N,3} = 165 \], we have from condition (3.232) the first approximation:

\[ T_N \approx 165 T_3 \]  \hspace{1cm} (3.233)
denoting that 165 circulations of the Earth (around the combined mass center of the Sun and the Neptune) correspond approximately to 1 circulation of the Neptune around the combined mass center of the Sun and the Neptune. The first approximation gives the first approximate time periodicity \( (T_{N,1})_1 = 165 \) years of the maximal (instantaneous or integral) combined energy gravitational influences (in the first approximation) on the Earth of the Neptune and the Sun owing to the gravitational interaction of the Sun with the Neptune.

Considering the second approximation of the ratio \( T_N/T_3 \) given by the following rational number

\[ m_{3,N}/p_{N,3} = 164 + \frac{1}{1 + \frac{1}{3}} = \frac{659}{4}, \]

we have from condition (3.232) the second approximation:

\[ 4T_N \approx 659 T_3 \]  \hspace{1cm} (3.234)
denoting that 659 circulations of the Earth (around the combined mass center of the Sun and the Neptune) correspond approximately to 4 circulations of the Neptune around the combined mass center of the Sun and the Neptune. The second approximation (3.234) gives the second approximate time periodicity \( (T_{N,2})_2 = 659 \) years of the maximal (instantaneous or integral) combined energy gravitational influences (in the second approximation) on the Earth of the Neptune and the Sun owing to the gravitational interaction of the Sun with the Neptune.

Considering the third approximation of the ratio \( T_N/T_3 \) given by the following rational number

\[ m_{3,N}/p_{N,3} = 164 + \frac{1}{1 + \frac{1}{3} + \frac{1}{5}} = \frac{2142}{13}, \]

we have from condition (3.232) the third approximation:

\[ 13T_N \approx 2142 T_3 \]  \hspace{1cm} (3.235)
denoting that 2142 circulations of the Earth (around the combined mass center of the Sun and the Neptune) correspond approximately to 13 circulations of the Neptune around the combined mass center of the Sun and the Neptune. The third approximation (3.235) gives the third approximate time periodicity \( (T_{N,3})_3 = 2142 \) years of the maximal (instantaneous or integral) combined energy gravitational influences (in the third approximation) on the Earth of the Neptune and the Sun owing to the gravitational interaction of the Sun with the Neptune.

Thus, we found the time periodicities:

\[ (T_{N,1})_1 = 165 \] years,  \hspace{1cm} (3.236)
\[ (T_{N,2})_2 = 659 \] years,  \hspace{1cm} (3.237)
\[ (T_{N,3})_3 = 2142 \] years  \hspace{1cm} (3.238)
of recurrence of the maximal (instantaneous and integral) combined energy gravitational influences on the Earth of the Neptune and Sun (owing to the gravitational interaction of the Sun with the Neptune) in the first, second and third approximations, respectively.
3.7.1.5. The fundamental global time periodicities (related to the combined planetary, lunar and solar non-stationary energy gravitational influences on the Earth) of the Earth’s periodic global seismotectonic (and volcanic) activity and the global climate variability induced by the different combinations of the cosmic non-stationary energy gravitational influences of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

Using the equivalent generalized differential formulations (1.43), (1.50) and (1.53) [Simonenko, 2007] of the first law of thermodynamics for the Earth and the calculated time periods of the periodic recurrence of the maximal integral energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars and the Jupiter, we calculated [Simonenko, 2007] the set of the gravity-induced time periodicities (3.196) of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability related with the periodic recurrence of the maximal combined integral energy gravitational influences on the Earth induced by the different combinations of the cosmic non-stationary energy gravitational influences of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune. Taking into account the very significant non-stationary energy gravitational influence (established in Subsection 3.3) on the Earth of the Sun owing to the gravitational interaction of the Sun with the Jupiter and using the same successive approximations for the time periodicities [Simonenko, 2007] \((T_{1,3},) = 11 \text{ years}, \quad (T_{1,3},) = 12 \text{ years and } (T_{1,3},) = 83 \text{ years} \) (given by (3.188), (3.189) and (3.190), respectively) of recurrence of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Jupiter [Simonenko, 2007] and the Sun (owing to the gravitational interaction of the Sun with the Jupiter in the first, second and third approximations, respectively), we have expanded in Subsection 3.6.2 the previous results (taking into account the very significant energy gravitational influence on the Earth of the Sun owing to the gravitational interaction of the Sun with the Jupiter) of the monographs [Simonenko, 2007; 2009; 2010] by establishing the time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. We expand in this Subsection the results of the Subsection 3.6.2 by establishing the fundamental global time periodicities (related to the combined planetary, lunar and solar non-stationary energy gravitational influences on the Earth) of the Earth’s periodic global seismotectonic (and volcanic) activity and the global climate variability induced by the different combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

It was founded [Simonenko, 2007; 2009; 2010] that the time periodicities of the Earth’s global climate variability are determined by the combined cosmic factors: G-factor related with the combined cosmic non-stationary energy gravitational influences on the Earth, \(G(a)\)-factor related to the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor, \(G(b)\)-factor related to the periodic atmospheric-oceanic warming or cooling as a consequence of the periodic variable (increasing or decreasing) output of the heated greenhouse volcanic gases and the related variable greenhouse effect induced by the periodic variable tectonic-volcanic activity (activation or weakening) due to the G-factor, \(G(c)\)-factor related to the periodic variations of the solar activity owing to the periodic variations of the combined planetary non-stationary energy gravitational influence on the Sun. We consider in this Subsection the combined \(G\), \(G(a)\) and \(G(b)\) cosmic factors related with the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

We take into account the established successive approximations for the commensurable [Alfvén and Arrhenius, 1976] time periodicities of recurrence of the maximal (instantaneous and integral) energy gravitational influences on the Earth: \(\{T_{S\text{MOON},3}\} = 3 \text{ years (i = 1), 8 years (i = 2), the Metonic cycle of 19 years (i = 3), 27 years (i = 4)} \) for the system Sun-Moon [Simonenko, 2007; 2009; 2010]; \(\{T_{V\text{MOON},3}\} = 3 \text{ years (j = 1), 8 years (j = 2)} \) for the Venus [Simonenko, 2007; 2009; 2010];
\{(T_{MARS,3})_k\} = 15 \text{ years (} k = 1), \ 32 \text{ years (} k = 2), \ 47 \text{ years (} k = 3) \text{ for the Mars [Simonenko, 2007; 2009; 2010]; } \{(T_{J,3})_n\} = 11 \text{ years (} n = 1), \ 12 \text{ years (} n = 2), \ 83 \text{ years (} n = 3) \text{ for the Jupiter [Simonenko, 2007; 2009; 2010] and for the Sun owing to the gravitational interaction of the Sun with the Jupiter; } \{(T_{SAT,3})_m\} = 29 \text{ years (} m = 1), \ 59 \text{ years (} m = 2), \ 265 \text{ years (} m = 3) \text{ for the Saturn and for the Sun owing to the gravitational interaction of the Sun with the Saturn; } \{(T_{U,3})_q\} = 84 \text{ years (} q = 1) \text{ for the Uranus and for the Sun owing to the gravitational interaction of the Sun with the Uranus; } \{(T_{N,3})_r\} = 165 \text{ years (} r = 1), \ 659 \text{ years (} r = 2), \ 2142 \text{ years (} r = 3) \text{ for the Neptune and for the Sun owing to the gravitational interaction of the Sun with the Neptune.}

Based on the generalized formulation (1.50) of the first law of thermodynamics used for the Earth as a whole, we found (taking into account the established [Simonenko, 2007] cosmic G-factor and G(\(b\))-factor) the fundamental sets of the fundamental global seismotectonic and volcanic time periodicities \(T_{tec,3}\) (of the periodic global seismotectonic and volcanic activities owing to the G-factor) and the fundamental global climatic periodicities \(T_{clim1,3}\) (of the periodic global climate variability and the global variability of the quantities of the fresh water and glacial ice resources owing to the G(\(b\))-factor):

\[
T_{tec,3} = T_{clim1,3} = T_{energy,3} = \frac{L.C.M. \{ (T_{S,3})_i (T_{V,3})_j (T_{MARS,3})_k (T_{J,3})_n (T_{SAT,3})_m (T_{U,3})_q (T_{N,3})_r \}}{2}
\]

(3.239)

determined by the successive global fundamental periodicities \(T_{energy,3}\) (defined by the least common multiples \(L.C.M.\) of various successive time periodicities related to the different combinations of the following integer numbers: \(i = 1, 2, 3, 4; \ j = 1, 2; \ k = 1, 2, 3; \ n = 1, 2, 3; \ m = 1, 2, 3; \ q = 1; \ r = 1, 2, 3; \ l_0 = 0, 1; \ l_2 = 0, 1; \ l_4 = 0, 1; \ l_5 = 0, 1; \ l_6 = 0, 1; \ l_7 = 0, 1; \ l_8 = 0, 1\) of recurrence of the maximal combined energy gravitational influences on the Earth of the different combined combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

Based on the generalized formulation (1.50) of the first law of thermodynamics used for the Earth as a whole, we found (taking into account the established [Simonenko, 2007] cosmic G-factor and G(\(a\)) and G(\(b\))-factors) the fundamental set of the fundamental global climatic periodicities

\[
T_{clim2,3} = T_{endog,3} = T_{energy,3} = \frac{L.C.M. \{ (T_{S,3})_i (T_{V,3})_j (T_{MARS,3})_k (T_{J,3})_n (T_{SAT,3})_m (T_{U,3})_q (T_{N,3})_r \}}{2}
\]

(3.240)

(of the periodic global climate variability and the global variability of the quantities of the fresh water and glacial ice resources related with the periodic tectonic-endogenous heating and related global volcanic activity) determined by the G(\(a\)) and G(\(b\))-factors related to the different combined combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

3.7.1.6. The thermohydrogravidynamic solution of the fundamental problem of the origin of the major 100-kyr glacial cycle (during Pleistocene) determined by the non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune

A simple Milankovitch origin of the 100-kyr glacial cycle “is ruled out” [Imbrie, Berger et al., 1993] “because the eccentricity-driven 100-kyr radiation cycle is much too small and its phase too late to force the corresponding climate cycle directly”. We present in Subsection 3.6.4 the results of the previous evaluation [Simonenko, 2007; 2009; 2010] of the mean time periodicities 94620 years and 107568 years of the global climate variability determined by the G(\(a\))-factor and G(\(b\))-factor (related with the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun.
the Sun owing to the gravitational interaction of the Sun with the Jupiter) and the mean time periodicities 100845 years and 121612.5 years of the global climate variability determined by the $G(b)$-factor (related with the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter). Taking into account the established (in Subsection 3.3) significance of the non-stationary energy gravitational influences on the Earth of the Sun owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune, we present in this Subsection the thermohydrogravidynamic solution of the fundamental problem [Imbrie, Berger et al., 1993] of the origin of the major 100-kyr glacial cycle during the Milankovitch chron [Berger, 1994].

The major 100-kyr glacial cycle is determined by the non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune. We obtain from formula (3.239) (for $l_0=1$, $l_6=1$, $l_4=0$, $l_5=1$, $l_6=1$, $l_7=1$, $l_8=0$) the following fundamental global periodicities $T_{tec,f} = T_{clim1,f}$ (in the range 79–121 kyr) of the periodic global seismotectonic and volcanic activities (owing to the $G$-factor) and the periodic global climatic variability and the global variability of the quantities of the fresh water and glacial ice resources (owing to the $G(b)$-factor) determined by the combined planetary and solar non-stationary energy gravitational influences on the Earth (of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn and the Uranus):

$$T_{tec,f} = T_{clim1,f} = L.C.M.\{3,8,11,59,84\} = L.C.M.\{8,3,11,59,84\} = L.C.M.\{8,8,11,59,84\} = 109032 \text{ years},$$

(3.241)

which is in good agreement with the predominant Mann’s (1967) period of 109 kyr [Berger, 1988] in spectrum of geological data for the Missourian rocks;

$$T_{tec,f} = T_{clim1,f} = L.C.M.\{19,8,12,29,84\} = 92568 \text{ years},$$

(3.242)

$$T_{tec,f} = T_{clim1,f} = L.C.M.\{27,8,12,59,84\} = 89208 \text{ years}$$

(3.243)

and

$$T_{tec,f} = T_{clim1,f} = L.C.M.\{27,3,12,29,84\} = 87696 \text{ years},$$

(3.244)

which are located near the empirical [Imbrie, Mix and Martinson, 1993] predominant period of 91 kyr (in spectra of the oxygen isotopic composition $\delta^{18}O$ records).

The obtained fundamental global periodicities $T_{tec,f} = T_{clim1,f}$ (in the range 79–121 kyr owing to the $G$ and $G(b)$-factors) result to the mean fundamental global seismotectonic, volcanic and climatic periodicity of

$$<T_{tec,f}> = <T_{clim1,f}> = 94626 \text{ years},$$

(3.245)


We obtain from the formula (3.240) (for $l_0=1$, $l_6=1$, $l_4=0$, $l_5=1$, $l_6=1$, $l_7=1$, $l_8=0$) the following fundamental global climatic periodicities $T_{clim2,f}$ (in the range 79–121 kyr) of the periodic global climate variability and the global variability of the quantities of the fresh water and glacial ice resources (owing to the $G(a)$ and $G(b)$-factors) determined by the combined non-stationary energy gravitational influences on the Earth (of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn and the Uranus):

$$T_{clim2,f} = 0.5 \cdot L.C.M.\{3,3,83,29,84\} = 101094 \text{ years},$$

(3.246)

which is in good agreement with the empirical periodicity near 100 kyr in variations of the measured deep-sea sediment oxygen isotopic composition $\delta^{18}O$ [Muller and MacDonald, 1996; Shackleton, 2000] and in variations of the atmospheric $CO_2$ [Pisias and Shackleton, 1984; Shackleton, 2000];

$$T_{clim2,f} = 0.5 \cdot L.C.M.\{19,8,12,59,84\} = 94164 \text{ years},$$

(3.247)

which is in good agreement with the empirical periodicity of 94 kyr [Hays et al., 1976] corresponding to
the predominant maximum of the calculated spectrum of the estimated summer sea-surface temperatures $T$ in the southern Indian Ocean during the past 468 kyr; and
\[
T_{clim2,T} = 0.5 \cdot L.C.M. \{27,3,11,29,84\} = 120582 \text{ years}, \tag{3.248}
\]
which is located between the empirical periodicities of 119 kyr and 122 kyr [Hays et al., 1976] corresponding to the predominant maxima of the calculated spectra of the percentage of *Cycladophora daviesiana*.

The established fundamental global climatic periodicities $T_{clim2,T}$ (in the range $79 \div 121$ kyr owing to the $G(a)$ and $G(b)$-factors) result to the mean fundamental global climatic periodicity
\[
\langle T_{clim2,T} \rangle = 105280 \text{ years}, \tag{3.249}
\]
which is in good agreement with the empirical [Gorbarenko et al., 2011] climatic periodicity 105 kyr  (3.250)
(corresponding to the predominant maxima of the calculated spectra of the productivity and lithological stacks of the deep-sea sediment records for the Okhotsk Sea during the last 350 kyr) and with the empirical [Hays et al., 1976] climatic periodicity 106 kyr  (3.251)
corresponding to the predominant maximum of the calculated spectrum of the measured oxygen isotopic composition $\delta^{18}O$ of planktonic foraminifera.

Based on the founded fundamental global climatic periodicities (in the range $79 \div 121$ kyr) $T_{clim1,f}$ and $T_{clim2,f}$, we derive the mean combined fundamental global climatic periodicity $\langle T_{clim,f} \rangle$ (determined by the combined non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn and the Uranus)
\[
\langle T_{clim,f} \rangle = 99.953 \text{ kyr}, \tag{3.252}
\]
which is in good agreement with the empirical major 100-kyr glaciation cycle [Kukla, 1977; Imbrie, Berger et al., 1993] characterizing the Milankovitch chron [Berger, 1994].

We obtain from formula (3.239) (for $l_o=1$, $l_2=1$, $l_4=0$, $l_5=1$, $l_6=1$, $l_7=1$, $l_8=1$) the fundamental global seismotectonic, volcanic and climatic periodicity (of the periodic global seismotectonic and volcanic activities (owing to the $G$-factor) and the periodic global climate variability and the global variability of the quantities of the fresh water and glacial ice resources (owing to the $G(b)$-factor) determined by the combined planetary and solar non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune)
\[
T_{secl,f} = T_{clim1,f} = L.C.M. \{3,3,12,29,84,2142\} = 124236 \text{ years}, \tag{3.253}
\]
which is located between the estimated predominant 123818-yr [Berger, 1978] and 125-kyr [Berger, 1999] periods of variations of the orbital Earth’s eccentricity.

We obtain from formula (3.240) (for $l_o=1$, $l_2=1$, $l_4=0$, $l_5=1$, $l_6=1$, $l_7=1$, $l_8=1$) the fundamental global climatic periodicity
\[
T_{clim2,f} = 0.5 \cdot L.C.M. \{3,8,12,29,84,2142\} = 0.5 \cdot L.C.M. \{8,3,12,29,84,2142\} = 124236 \text{ years} \tag{3.254}
\]
of the periodic global climate variability and the global variability of the quantities of the fresh water and glacial ice resources (owing to the $G(a)$ and $G(b)$-factors) determined by the combined non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune.

The founded fundamental global climatic periodicities $T_{clim1,f} = 124236$ yr (owing to the $G(b)$-factor) and $T_{clim2,f} = 124236$ yr (owing to the $G(a)$ and $G(b)$-factors) determine the combined fundamental global climatic periodicity (determined by the combined non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune)
\[
T_{clim,f} = 124236 \text{ years}, \tag{3.255}
\]
which is in good agreement with the climatic period of 125 kyr characterizing the Croll chron [Berger,
Thus, the generalized thermohydrogravidynamic theory [Simonenko, 2007; 2009; 2010] of the paleoclimate generalizes the Milankovitch’s (1930) theory of the paleoclimate (taking into account the variability of solar insolation related to the periodic variations of the eccentricity of the Earth’s orbit due to the G-factor) by taking into account the additional established cosmic G(a), G(b) and G(c)-factors. The presented thermohydrogravidynamic solution of the fundamental problem of the origin of the major 100-kyr glacial cycle (determined during Pleistocene by the non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn and the Uranus) shows that the Thermohydrogravidynamics (Cosmic Physics) of the Solar System represents the reliable thermohydrogravidynamic theory destined to play an important role for the stable evolutionary development of humankind in the present and forthcoming epochs of the critical surrounding cosmic, seismotectonic, volcanic and climatic conditions of the human existence on the Earth.

3.8. The analysis of the global seismicity and volcanic activity of the Earth from the biblical Flood (occurred in 2104 BC according to the orthodox biblical chronology) to found the forthcoming range 2020 ÷ 2061 AD of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696 ÷ 708 years of the history of humankind

3.8.1. The foundation of the ranges of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{lcc,t} = T_{clim,1,t} = 696 ÷ 708$ years and $T_{lcc,t} = T_{clim,2,t} = 348 ÷ 354$ years determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn:

To evaluate the behavior of the global seismicity and volcanic activity of the Earth from the biblical Flood (occurred in 2104 BC according to the orthodox biblical chronology) to the beginning of the 21st century AD, we deduced [Simonenko, 2012] from formula (3.239) (for $l_0 = 1$, $l_2 = 1$, $l_4 = 0$, $l_5 = 1$, $l_6 = 1$, $l_7 = 0$, $l_8 = 0$ ) the ranges of the following fundamental global seismotectonic, volcanic and climatic periodicities (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn):

$T_{lcc,t} = T_{clim,1,t} = (L.C.M.\{3, 8, 12, 29\} ÷ L.C.M.\{3, 3, 12, 59\}) = 696 ÷ 708$ years \( (3.256) \)

and

$T_{lcc,t} = T_{clim,2,t} = (L.C.M.\{3, 3, 12, 29\} ÷ 0.5L.C.M.\{3, 3, 12, 59\}) = 348 ÷ 354$ years. \( (3.257) \)

Considering the time periodicity $(T_{S-MOON,3})_1 = 3$ years (or $(T_{S-MOON,3})_2 = 8$ years) of the maximal combined energy gravitational influence on the Earth of the system Sun-Moon in the first (or second) approximation, the time periodicity $(T_{V,3})_2 = 8$ years (or $(T_{V,3})_1 = 3$ years) of the maximal energy gravitational influences on the Earth of the Venus in the second (or first) approximation, the time periodicity $(T_{J,3})_2 = 12$ years (in the second approximation) of the maximal energy gravitational influences on the Earth of the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the time periodicity $(T_{SAT,3})_1 = 29$ years (in the first approximation) of the maximal energy gravitational influences on the Earth the Sun owing to the gravitational interactions of the Sun with the Saturn, we obtained [Simonenko, 2012] from formula (3.239) (for $l_0 = 1$, $l_2 = 1$, $l_4 = 0$, $l_5 = 1$, $l_6 = 1$, $l_7 = 0$, $l_8 = 0$ ) (as the lower boundary of the founded range (3.256) [Simonenko, 2012]) the fundamental global seismotectonic, volcanic and climatic periodicity (of the Earth’s periodic global seismotectonic and volcanic activity and the global climate variability)
\[ T_{\text{tec},f} = T_{\text{clim},f} = L.C.M. \{3, 8, 12, 29\} = L.C.M. \{8, 3, 12, 29\} = 3 \times 2 \times 4 \times 29 \text{ years} = 696 \text{ years} \quad (3.256a) \]
determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.


We deduce from formula (3.239) (for \( l_1 = 1, l_2 = 1, l_4 = 1, l_5 = 1, l_6 = 1, l_7 = 0, l_8 = 0 \)) the fundamental global seismotectonic, volcanic and climatic periodicity (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn)

\[ T_{\text{tec},f} = T_{\text{clim},f} = T_{\text{energy},f} = L.C.M. \{3, 3, 15, 12, 59\} = 3 \times 5 \times 4 \times 59 \text{ years} = 3540 \text{ years}, \quad (3.258) \]
which transforms into the classical Babylonian “sar” of 3600 years under the final practical transformation \( 59 \rightarrow 60 \) for the time periodicity \( (T_{\text{SAT},3})_2 = 59\) years.

Considering the time periodicity or \((T_{\text{S-MOON},3})_2 = 8\) years of the maximal combined energy gravitational influence on the Earth of the system Sun-Moon in the second approximation, the time periodicity \((T_{\text{V},3})_2 = 8\) years of the maximal energy gravitational influences on the Earth of the Venus in the second approximation, the time periodicity \((T_{\text{J},3})_2 = 12\) years (in the second approximation) of the maximal energy gravitational influences on the Earth of the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter, the time periodicity \((T_{\text{SAT},3})_1 = 29\) years (in the first approximation) of the maximal energy gravitational influences on the Earth the Sun owing to the gravitational interactions of the Sun with the Saturn, and the time periodicity \((T_{\text{MARS},3})_1 = 15\) years of the maximal of the maximal energy gravitational influences on the Earth of the Mars (in the first approximation), we obtain from formula (3.239) (for \( l_0 = 1, l_2 = 1, l_4 = 1, l_5 = 1, l_6 = 1, l_7 = 0, l_8 = 0 \)) the fundamental global seismotectonic, volcanic and climatic periodicity (of the Earth’s periodic global seismotectonic and volcanic activity and the global climate variability)

\[ T_{\text{tec}} = T_{\text{clim}} = T_{\text{energy}} = L.C.M. \{8, 8, 15, 12, 29\} = 2 \times 4 \times 3 \times 5 \times 29 \text{ years} = 5 \times 696 \text{ years} = 3480 \text{ years} \quad (3.258a) \]
determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

The practical transformation \( 59 \rightarrow 60 \) in the expression \( L.C.M. \{3, 3, 15, 12, 59\} \) (of (3.258)) produces the following fundamental global seismotectonic, volcanic and climatic periodicities:

\[ T_{\text{tec},f} = T_{\text{clim},f} = L.C.M. \{3, 3, 15, 12, 60\} = 60 \text{ years} \quad (3.259) \]

and

\[ T_{\text{tec},f} = T_{\text{clim},f} = 0.5 \cdot L.C.M. \{3, 8, 15, 12, 60\} = 60 \text{ years} \quad (3.260) \]


We deduce also (under the final transformation \( 59 \rightarrow 60 \)) the fundamental global seismotectonic, volcanic and climatic periodicity (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn)

\[ T_{\text{tec},f} = T_{\text{clim},f} = T_{\text{energy},f} = L.C.M. \{3, 8, 15, 12, 60\} = 120 \text{ years}, \quad (3.261) \]
which is in good agreement with the mean periodicity of recurrence of the strongest earthquakes in different regions (especially for Japan and Peru) of the seismic zone of the Pacific Ring [Vikulin, 2003].
3.8.2. The evidence of the founded ranges of the fundamental global seismotectonic and volcanic time periodicities

\[ T_{\text{sec,f}} = T_{\text{clim1,f}} = 696 \div 708 \text{ years} \quad \text{and} \quad T_{\text{sec,f}} = T_{\text{clim2,f}} = 348 \div 354 \text{ years} \]

based on the statistical analysis of the historical eruptions of the Katla and the Hekla volcanic systems in Iceland

3.8.2.1. The generalized formulation of the weak law of large numbers

We shall use the generalization [Simonenko, 2005] of the classical special formulation [Nicolis and Prigogine, 1989] of the weak law of large numbers for the statistical analysis of the historical eruptions of the Katla and the Hekla volcanic systems. The generalization [Simonenko, 2005] of the classical special formulation [Nicolis and Prigogine, 1989] of the weak law of large numbers takes into account the coefficients of correlations \( \rho(x_i, x_k) \neq 0 \) between the random variables \( X_i \) and \( X_k \) of the infinite set of random variables \( X_1, X_2, \ldots, X_n, \ldots \) characterized by the same variance \( \sigma^2 = \frac{(x_i - a)^2}{n} \) and the same statistical mean \( a = \bar{X}_i \) of the random variables \( X_1, X_2, \ldots, X_n, \ldots \). It was proved [Simonenko, 2005] mathematically that the limit of probability

\[
\lim_{n \to \infty} \Pr \left( \left| \frac{\sum_{i=1}^{n} x_i}{n} - a \right| < \varepsilon \right) = 1
\]

is satisfied (for any \( \varepsilon > 0 \)) if the following condition:

\[
\lim_{n \to \infty} \frac{\sigma^2}{n} \sum_{i,k=1}^{n} \rho(x_i, x_k) = 0
\]

is satisfied for the coefficients of correlations \( \rho(x_i, x_k) \).

Let us formulate the conditions of creation of the various possible pair combinations \( ((t_2)_i, (t_1)_i) \) of different previous \( (t_1)_i \) and subsequent \( (t_2)_i \) dates of real volcanic eruptions. We take the dates \( (t_1)_i \) and \( (t_2)_i \) from the experimental sequence \( \{T_k\} = T_1, T_2, \ldots, T_N \) of different dates of real volcanic eruptions, where \( T_1 \) is the initial date of real volcanic eruption, \( T_N \) the final date of real volcanic eruption. We form the various possible pair combinations \( ((t_2)_i, (t_1)_i) \) \( (i=1, 2, 3, \ldots, n) \) of two dates \( (t_1)_i \) and \( (t_2)_i \) taken from the experimental sequence \( \{T_k\} = T_1, T_2, \ldots, T_N \) of different dates of real volcanic eruptions. To obtain the experimental evidence of the founded ranges of the fundamental global volcanic periodicities \( T_{\text{sec,f}} = T_{\text{clim1,f}} = 696 \div 708 \) years, we take into account all possible pair combinations \( ((t_2)_i, (t_1)_i) \) satisfying the imposed conditions

\[
\left| (t_2)_i - (t_1)_i \right| - 696 \leq 88 \text{ years},
\]

\[
\left| (t_2)_i - (t_1)_i \right| - 708 \leq 88 \text{ years}.
\]

Considering the various possible pair combinations \( ((t_2)_i, (t_1)_i) \) of two dates \( (t_1)_i \) and \( (t_2)_i \) under imposed conditions (3.264) and (3.265), we obtain the random variable \( X_i \equiv (\Delta t)_i = (t_2)_i - (t_1)_i \) characterizing by the mean value

\[
\langle \Delta t \rangle = \frac{1}{n} \sum_{i=1}^{n} (\Delta t)_i,
\]

which must be very close to the statistical mean \( a = \bar{X}_i \equiv (\Delta t) \) for sufficiently large number \( n \) according to the proved [Simonenko, 2005] formulation (3.262) if the condition (3.263) is satisfied for the coefficients of correlations \( \rho(x_i, x_k) \). We assume that the condition (3.263) is satisfied.
3.8.2.2. The statistical analysis of eruptions of Katla volcano

The real dates of Katla volcano eruptions are given by the following experimental sequence [Thordarson and Larsen, 2007]:

\( \{T_k\}_1 = T_1, T_2, \ldots, T_N = 920, 934, 938, 1179, 1245, 1262, 1357, 1416, 1440, 1500, 1580, 1612, 1625, 1660, 1721, 1755, 1823, 1860, 1918, 1955, 1999, 2011 \) AD.

Taking into account the imposed condition (3.264), we obtain from this experimental sequence [Thordarson and Larsen, 2007] the following pair combinations \( \{(t_1)_i, (t_2)_i\)_i (between the Katla volcano eruptions): (2011, 1245) characterized by \( \Delta t = t_2 - t_1 = 766 \) years, (2011, 1262) characterized by \( \Delta t = t_2 - t_1 = 749 \) years, (2011, 1357) characterized by \( \Delta t = t_2 - t_1 = 654 \) years, (1999, 1245) characterized by \( \Delta t = t_2 - t_1 = 754 \) years, (1999, 1262) characterized by \( \Delta t = t_2 - t_1 = 737 \) years, (1999, 1357) characterized by \( \Delta t = t_2 - t_1 = 642 \) years, (1955, 1179) characterized by \( \Delta t = t_2 - t_1 = 776 \) years, (1955, 1245) characterized by \( \Delta t = t_2 - t_1 = 710 \) years, (1955, 1262) characterized by \( \Delta t = t_2 - t_1 = 693 \) years, (1918, 1179) characterized by \( \Delta t = t_2 - t_1 = 739 \) years, (1918, 1245) characterized by \( \Delta t = t_2 - t_1 = 681 \) years, (1860, 1245) characterized by \( \Delta t = t_2 - t_1 = 615 \) years, (1823, 1179) characterized by \( \Delta t = t_2 - t_1 = 644 \) years, (1721, 938) characterized by \( \Delta t = t_2 - t_1 = 783 \) years, (1660, 934) characterized by \( \Delta t = t_2 - t_1 = 726 \) years, (1660, 938) characterized by \( \Delta t = t_2 - t_1 = 722 \) years, (1625, 920) characterized by \( \Delta t = t_2 - t_1 = 691 \) years, (1625, 934) characterized by \( \Delta t = t_2 - t_1 = 687 \) years, (1612, 920) characterized by \( \Delta t = t_2 - t_1 = 692 \) years, (1612, 934) characterized by \( \Delta t = t_2 - t_1 = 678 \) years, (1612, 938) characterized by \( \Delta t = t_2 - t_1 = 674 \) years, (1580, 920) characterized by \( \Delta t = t_2 - t_1 = 660 \) years, (1580, 934) characterized by \( \Delta t = t_2 - t_1 = 646 \) years, and (1580, 938) characterized by \( \Delta t = t_2 - t_1 = 642 \) years. Taking into account of these \( n=28 \) numerical values of \( \Delta t \), we obtain the mean experimental time periodicity (between the Katla volcano eruptions)

\[
\langle \Delta t \rangle_{\text{exp}} = \frac{1}{28} \sum_{i=1}^{n} (\Delta t)_i = 697.6785 \text{ years},
\]

entering into the founded range of the fundamental global seismotectonic and volcanic time periodicities \( T_{\text{osc}} = T_{\text{sim}} = 696 \pm 708 \) years [Simonenko, 2012] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

Taking into account the imposed condition (3.265), we obtain the following pair combinations \( \{(t_1)_i, (t_2)_i\)_i (between the Katla volcano eruptions): (2011, 1245) characterized by \( \Delta t = t_2 - t_1 = 766 \) years, (2011, 1262) characterized by \( \Delta t = t_2 - t_1 = 749 \) years, (2011, 1357) characterized by \( \Delta t = t_2 - t_1 = 654 \) years, (1999, 1245) characterized by \( \Delta t = t_2 - t_1 = 754 \) years, (1999, 1262) characterized by \( \Delta t = t_2 - t_1 = 737 \) years, (1999, 1357) characterized by \( \Delta t = t_2 - t_1 = 642 \) years, (1955, 1179) characterized by \( \Delta t = t_2 - t_1 = 776 \) years, (1955, 1245) characterized by \( \Delta t = t_2 - t_1 = 710 \) years, (1955, 1262) characterized by \( \Delta t = t_2 - t_1 = 693 \) years, (1918, 1179) characterized by \( \Delta t = t_2 - t_1 = 739 \) years, (1918, 1245) characterized by \( \Delta t = t_2 - t_1 = 681 \) years, (1860, 1245) characterized by \( \Delta t = t_2 - t_1 = 615 \) years, (1823, 1179) characterized by \( \Delta t = t_2 - t_1 = 644 \) years, (1721, 938) characterized by \( \Delta t = t_2 - t_1 = 783 \) years, (1660, 934) characterized by \( \Delta t = t_2 - t_1 = 726 \) years, (1660, 938) characterized by \( \Delta t = t_2 - t_1 = 722 \) years, (1625, 920) characterized by \( \Delta t = t_2 - t_1 = 691 \) years, (1625, 934) characterized by \( \Delta t = t_2 - t_1 = 687 \) years, (1612, 920) characterized by \( \Delta t = t_2 - t_1 = 692 \) years, (1612, 934) characterized by \( \Delta t = t_2 - t_1 = 678 \) years, (1612, 938) characterized by \( \Delta t = t_2 - t_1 = 674 \) years, (1580, 920) characterized by \( \Delta t = t_2 - t_1 = 660 \) years, (1580, 934) characterized by \( \Delta t = t_2 - t_1 = 646 \) years, and (1580, 938) characterized by \( \Delta t = t_2 - t_1 = 642 \) years. Taking into account of these \( n=28 \) numerical values of \( \Delta t \), we obtain the mean experimental time periodicity (between the Katla volcano eruptions)

\[
\langle \Delta t \rangle_{\text{exp}} = \frac{1}{28} \sum_{i=1}^{n} (\Delta t)_i = 697.6785 \text{ years},
\]

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934) characterized by $\Delta t = t_2 - t_1 = 678$ years, (1612, 938) characterized by $\Delta t = t_2 - t_1 = 674$ years, (1580, 920) characterized by $\Delta t = t_2 - t_1 = 660$ years, (1580, 934) characterized by $\Delta t = t_2 - t_1 = 646$ years and (1580, 938) characterized by $\Delta t = t_2 - t_1 = 642$ years. Taking into account of these $n = 27$ numerical values, we obtain the mean experimental time periodicity (between the Katla volcano eruptions)

$$\left\langle \Delta t \right\rangle_{708} = \frac{1}{27} \sum_{i=1}^{27} (\Delta t)_i = 700.7407 \text{ years}$$

(3.268)

entering into the founded range of the fundamental global seismotectonic and volcanic time periodicities $T_{tec, f} = T_{clim, f} = 696 \pm 708 \text{ years}$ [Simonenko, 2012] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

The mean value 699.2096 years of the calculated mean experimental time periodicities (3.267) and (3.268) (of the considered eruptions of Katla volcano) is very close to the mean value 702 years the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec, f} = T_{clim, f} = 696 \pm 708 \text{ years}$ [Simonenko, 2012]. We can see that the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec, f} = T_{clim, f} = 696 \pm 708 \text{ years}$ [Simonenko, 2012] contains the calculated mean experimental time periodicities (3.267) and (3.268) of the considered eruptions of Katla volcano [Thordarson and Larsen, 2007]. This agreement confirms the established cosmic energy gravitational genesis [Simonenko, 2007] of the global seismotectonic, volcanic and climatic activity of the Earth.

### 3.8.2.3. The statistical analysis of eruptions of Hekla volcano


Taking into account the imposed condition (3.264), we obtain from this experimental sequence [Thordarson and Larsen, 2007] the following pair combinations $((t_1)_i, (t_1)_j)$ of two dates $(t_1)_i$ and $(t_2)_j$ (between the Hekla volcano eruptions): (2000, 1222) characterized by $\Delta t = t_2 - t_1 = 778$ years, (2000, 1300) characterized by $\Delta t = t_2 - t_1 = 700$ years, (2000, 1341) characterized by $\Delta t = t_2 - t_1 = 659$ years, (2000, 1389) characterized by $\Delta t = t_2 - t_1 = 611$ years, (1991, 1222) characterized by $\Delta t = t_2 - t_1 = 769$ years, (1991, 1300) characterized by $\Delta t = t_2 - t_1 = 691$ years, (1991, 1341) characterized by $\Delta t = t_2 - t_1 = 650$ years, (1980, 1206) characterized by $\Delta t = t_2 - t_1 = 774.5$ years, (1980, 1222) characterized by $\Delta t = t_2 - t_1 = 758.5$ years, (1980, 1300) characterized by $\Delta t = t_2 - t_1 = 680.5$ years, (1980, 1341) characterized by $\Delta t = t_2 - t_1 = 639.5$ years, (1970, 1206) characterized by $\Delta t = t_2 - t_1 = 764$ years, (1970, 1222) characterized by $\Delta t = t_2 - t_1 = 748$ years, (1970, 1300) characterized by $\Delta t = t_2 - t_1 = 670$ years, (1970, 1341) characterized by $\Delta t = t_2 - t_1 = 629$ years, (1947, 1206) characterized by $\Delta t = t_2 - t_1 = 741.5$ years, (1947, 1222) characterized by $\Delta t = t_2 - t_1 = 725.5$ years, (1947, 1300) characterized by $\Delta t = t_2 - t_1 = 647.5$ years, (1913, 1158) characterized by $\Delta t = t_2 - t_1 = 755$ years, (1913, 1206) characterized by $\Delta t = t_2 - t_1 = 707$ years, (1913, 1222) characterized by $\Delta t = t_2 - t_1 = 691$ years, (1913, 1300) characterized by $\Delta t = t_2 - t_1 = 613$ years, (1878, 1104) characterized by $\Delta t = t_2 - t_1 = 774$ years, (1878, 1158) characterized by $\Delta t = t_2 - t_1 = 720$ years, (1878, 1206) characterized by $\Delta t = t_2 - t_1 = 672$ years, (1878, 1222) characterized by $\Delta t = t_2 - t_1 = 656$ years, (1845, 1104) characterized by $\Delta t = t_2 - t_1 = 687$ years, (1845, 1206) characterized by $\Delta t = t_2 - t_1 = 639$ years, (1845, 1222) characterized by $\Delta t = t_2 - t_1 = 623$ years, (1767, 1104)
characterized by $\Delta t = t_2 - t_1 = 663$ years and $(1767, 1158)$ characterized by $\Delta t = t_2 - t_1 = 609$ years.

Taking into account of these $n=32$ numerical values of $\Delta t$, we obtain the mean experimental time periodicity (between the Hekla volcano eruptions)

$$\langle \Delta t \rangle_{696} = \frac{1}{32} \sum_{i=1}^{32} (\Delta t)_i = 693.328 \text{ years}, \quad (3.269)$$

which is near the lower boundary (696 years) of the founded range of the fundamental global seismotectonic and volcanic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708 \text{ years}$ [Simonenko, 2012] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

Taking into account the imposed condition (3.265), we obtain the following pair combinations $((t_{11}), (t_{12}), (t_{13}), (t_{14}))$ of two dates $(t_i)$ and $(t_j)$ (between the Hekla volcano eruptions): (2000, 1222) characterized by $\Delta t = t_2 - t_1 = 778$ years, (2000, 1300) characterized by $\Delta t = t_2 - t_1 = 700$ years, (2000, 1341) characterized by $\Delta t = t_2 - t_1 = 659$ years, (1991, 1222) characterized by $\Delta t = t_2 - t_1 = 769$ years, (1991, 1300) characterized by $\Delta t = t_2 - t_1 = 691$ years, (1991, 1341) characterized by $\Delta t = t_2 - t_1 = 650$ years, (1980.5, 1206) characterized by $\Delta t = t_2 - t_1 = 774.5$ years, (1980.5, 1222) characterized by $\Delta t = t_2 - t_1 = 758.5$ years, (1980.5, 1300) characterized by $\Delta t = t_2 - t_1 = 680.5$ years, (1980.5, 1341) characterized by $\Delta t = t_2 - t_1 = 639$ years, (1970, 1206) characterized by $\Delta t = t_2 - t_1 = 764$ years, (1970, 1222) characterized by $\Delta t = t_2 - t_1 = 748$ years, (1970, 1300) characterized by $\Delta t = t_2 - t_1 = 670$ years, (1970, 1341) characterized by $\Delta t = t_2 - t_1 = 629$ years, (1947.5, 1206) characterized by $\Delta t = t_2 - t_1 = 741.5$ years, (1947.5, 1222) characterized by $\Delta t = t_2 - t_1 = 725.5$ years, (1947.5, 1300) characterized by $\Delta t = t_2 - t_1 = 647.5$ years, (1913, 1158) characterized by $\Delta t = t_2 - t_1 = 755$ years, (1913, 1206) characterized by $\Delta t = t_2 - t_1 = 707$ years, (1913, 1222) characterized by $\Delta t = t_2 - t_1 = 691$ years, (1878, 1104) characterized by $\Delta t = t_2 - t_1 = 774$ years, (1878, 1158) characterized by $\Delta t = t_2 - t_1 = 720$ years, (1878, 1206) characterized by $\Delta t = t_2 - t_1 = 672$ years, (1878, 1222) characterized by $\Delta t = t_2 - t_1 = 656$ years, (1845, 1104) characterized by $\Delta t = t_2 - t_1 = 741$ years, (1845, 1158) characterized by $\Delta t = t_2 - t_1 = 687$ years, (1845, 1206) characterized by $\Delta t = t_2 - t_1 = 639$ years, (1845, 1222) characterized by $\Delta t = t_2 - t_1 = 623$ years and (1767, 1104) characterized by $\Delta t = t_2 - t_1 = 663$ years. Taking into account of these $n=29$ numerical values, we obtain the mean experimental time periodicity (between the Hekla volcano eruptions [Thordarson and Larsen, 2007])

$$\langle \Delta t \rangle_{708} = \frac{1}{29} \sum_{i=1}^{29} (\Delta t)_i = 701.8447 \text{ years} \quad (3.270)$$

entering into the founded range of the fundamental global seismotectonic and volcanic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708 \text{ years}$ [Simonenko, 2012] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn. The mean value 697.5863 years of the calculated mean experimental time periodicities (3.269) and (3.270) (of the considered eruptions of Hekla volcano) is in very good agreement with the mean value 702 years the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708 \text{ years}$ [Simonenko, 2012].

The analogous statistical analysis of the historical eruptions of the Katla and the Hekla volcanic systems in Iceland [Thordarson and Larsen, 2007] confirms also the founded range of the fundamental global seismotectonic and volcanic time periodicities $T_{tec,f} = T_{clim2,f} = 348 \div 354 \text{ years}$ determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

Thus, the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim1,f} = 696 \div 708 \text{ years}$ [Simonenko, 2012] (determined by the combined
predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn) contains the calculated mean experimental time periodicities (3.267) and (3.268) (of the considered eruptions of Katla volcano [Thordarson and Larsen, 2007]), the calculated mean experimental time periodicity (3.270) (of the considered eruptions of Hekla volcano [Thordarson and Larsen, 2007]), the experimental time periodicity 704 years [Abramov, 1997] of the global seismotectonic activity of the Earth, and the evaluated (based on the wavelet analysis) time periodicity of approximately 700 years [Goncharova, Gorbarenko, Shi, Bosin, Fischenko, Zou and Liu, 2012] characterizing the regional climate variability of the Japan Sea. This agreement confirms the established cosmic energy gravitational genesis [Simonenko, 2007] of the global seismotectonic, volcanic and climatic activity of the Earth.

3.8.3. The cosmic energy gravitational genesis of the predominant short-range time periodicities (7i/6 years and 6j/5 years determined by small integers i and j) of the Chandler’s wobble of the Earth’s pole and sea water and air temperature variations

3.8.3.1. The cosmic energy gravitational genesis of the predominant time periodicities of the Chandler’s wobble of the Earth’s pole and the global climate variability induced by the combined non-stationary energy gravitational influence on the Earth of the Venus, the Mercury and the Moon

The fundamentals of the solution of the Chandler’s problem [Chandler, 1892] are presented in the monographs [Simonenko, 2007; 2008; 2009; 2010]. The cosmic energy gravitational genesis of the Chandler’s wobble of the Earth (related with the Chandler’s wobble of the Earth’s pole) was explained [Simonenko, 2007; 2008; 2009; 2010] by the combined non-stationary energy gravitational influence of the Sun, the Venus, the Mercury, the Moon and the Jupiter. The cosmic energy gravitational genesis of the Chandler’s wobble of the Earth’s pole was founded [Simonenko, 2007; 2008; 2009; 2010] based on the generalized differential formulation (1.43) of the first law of thermodynamics for the Earth subjected to the non-stationary energy gravitational influences of the Mercury, the Venus, the Moon and the Jupiter. We founded [Simonenko, 2009; 2010] the total average first approximate range of the time periodicities (of the Chandler’s wobble of the Earth’s pole):

\[ T_{\text{lim},1} = (T_{ch})_1 \approx 6/5 \text{ yr} = 1.2 \text{ years} \quad \text{and} \quad T_{\text{lim},2} = (T_{ch})_2 \approx 7/6 \text{ yr} = 1.1666666... \text{years} \]

induced by the combined non-stationary energy gravitational influence of the Venus, the Mercury and the Moon on the Earth. We obtained [Simonenko, 2011] that the average of the range (3.271) is given by the value

\[ (405 + 447.25)/(2 \cdot 365.25) = 1.166666667 \text{ yr} = \frac{14}{12} \text{ yr} = \frac{7}{6} \text{ yr}, \]

which gives the following previously established values: the mean experimental period of 14/12 yr = 14 months (Chandler, 1892) of the Chandler’s wobble of the Earth’s pole, and the time periodicity of 7 yr [Simonenko, 2009; 2010] of the established intensification of the Chandler’s wobble of the Earth’s pole. The analysis [Simonenko, 2009; 2010] showed that the time periodicities

\[ (T_{M,V,MOON,3}(T_{ch}))_1 \approx 6 \text{ yr}, \quad (T_{M,V,MOON,3}(T_{ch}))_2 \approx 7 \text{ yr} \]

are related with the established intensification of the Chandler’s wobble of the Earth’s pole due to the combined non-stationary energy gravitational influence of the Venus, the Mercury and the Moon on the Earth. It was founded [Simonenko, 2011] that the time periodicities (3.273) correspond to the following time periodicities

\[ (T_{ch})_1 \approx 6/5 = 1.2 \text{ yr}, \quad (T_{ch})_2 \approx 7/6 \text{ yr} = 1.1666666... \text{yr} \]
characterizing the main maxima of the calculated [Simonenko, 2011] frequency spectra $S_x(f)$ and $S_y(f)$ of the documented [Kotlyar and Kim, 1994] variations of the experimental coordinates $x$ and $y$ of the Earth’s pole.

Fig. 17. The calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a) and $S_y(f)$ (b) of the documented [Kotlyar and Kim, 1994] variations of the experimental coordinates $x$ and $y$ of the Earth’s pole during 1897-1969 AD

The calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a) and $S_y(f)$ (b) (presented on Fig. 17 for 1897-1969 AD) demonstrate the main maxima for $(T_{ch})_1 \approx 6/5 = 1.2\text{ yr}$ and 1 yr.

The calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a) and $S_y(f)$ (b) (presented on Fig. 18 for 1897-1989 AD) demonstrate the main maxima for $(T_{ch})_1 \approx 6/5 = 1.2\text{ yr}$ and 1 yr.

The calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a) and $S_y(f)$ (b) (presented on Fig. 19 for 1969-1989 AD) demonstrate the main maxima for $(T_{ch})_2 \approx 7/6 = 1.1666666... \text{ yr}$ and 1 yr.

The calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a) and $S_y(f)$ (b) (presented on Fig. 20 for 1969-2010 AD) demonstrate the main maxima for $(T_{ch})_1 \approx 6/5 = 1.2\text{ yr}$ and 1 yr.

According to the thermohydrogravidynamic theory [Simonenko, 2007; 2008; 2009; 2010] of the global climate evolution (taking into account the cosmic $G(b)$-factor related with the atmospheric-oceanic warming as a consequence of the greenhouse effect produced by the periodic tectonic-volcanic activation accompanied by increased output of the atmospheric greenhouse gases) induced by the cosmic non-stationary energy gravitational influences on the Earth, the same time periodicities

$$T_{clim1,1} = (T_{ch})_1 \approx 6/5 = 1.2\text{ yr}, \quad T_{clim1,2} = (T_{ch})_2 \approx 7/6 = 1.1666666... \text{ yr}$$

must characterize the global climate variability induced by the combined non-stationary energy gravitational influence of the Venus, the Mercury and the Moon on the Earth.
Fig. 18. The calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a) and $S_y(f)$ (b) of the documented [Kotlyar and Kim, 1994] variations of the experimental coordinates $x$ and $y$ of the Earth’s pole during 1897-1989 AD.

Fig. 19. The calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a) and $S_y(f)$ (b) of the documented [Kotlyar and Kim, 1994] variations of the experimental coordinates $x$ and $y$ of the Earth’s pole during 1969-1989 AD.
To prove this deduction of the thermohydrogravidynamic theory [Simonenko, 2007; 2008; 2009; 2010], we present in Subsection 3.8.3.2 the combined analysis of the Chandler’s wobble of the Earth’s pole [Simonenko, 2011] and the variations of sea water and air temperature for the coastal station Possy et of the Japan Sea [Simonenko, Gayko and Sereda, 2012].

### 3.8.3.2. The combined analysis of the Chandler’s wobble of the Earth’s pole and the variations of sea water and air temperature during 1969-2010 AD for the coastal station Possyet of the Japan Sea

Let us fulfill the combined analysis of the Chandler’s wobble of the Earth’s pole [Simonenko, 2011] and the variations [Simonenko, Gayko and Sereda, 2012] of sea water and air temperature during 1969-2010 AD for the coastal station Possyet of the Japan Sea. We see that the calculated [Simonenko, Gayko and Sereda, 2012] spectra $S_{T,W}(f)$ and $S_{T,A}(f)$ of the sea water temperature variations (Fig. 21a) and the air temperature variations (Fig. 21b) have the coincided and nearly coincided local maxima for the following predominant experimental time periodicities: 0.9999 years (for the sea water and air temperature variations), 1.4999 years (for the sea water temperature variations) and 1.49995 years (for the air temperature variations), 2.3332 years (for the sea water temperature variations) and 2.333 years (for the air temperature variations), 3.2306 years (for the sea water temperature variations) and 3.2307 years (for the air temperature variations), and 8.3997 years (for the sea water and air temperature variations).

The calculated spectrum $S_{T,W}(f)$ (presented on Fig. 21a for the time range 1969-2010 AD) of variations of sea water temperature demonstrates the predominant experimental time periodicities $T_{W,exp,i}$, which are in a very good agreement with the following periodicities

$$T_{W,2,i} = i(T_{ch})_2 = i7/6 \text{ years} \equiv i7/6 \text{ yr}, \ i = 1, 2, 4, 18,$$

i.e., the predominant experimental time periodicities $T_{W,exp,i}$ of variations of sea water approximately equal to

$$T_{W,exp} \approx T_{W,2,i} = i(T_{ch})_2 = i7/6 \text{ yr}, \ i = 1, 2, 4, 18.$$
Fig. 21. The calculated spectrum $S_{T,W}(\mathbf{f})$ (a) of variations of sea water during 1969-2010 for the coastal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]. The calculated spectrum $S_{T,A}(\mathbf{f})$ (b) of variations of air temperature during 1969-2010 AD for the coastal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]

Table 3a shows a very good agreement between the predominant experimental time periodicities $T_{W,exp,i}$ of variations of the sea water temperature (during 1969-2010 AD for the coastal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]) and the time periodicities $T_{W,2,i} = i(T_{ch})_2 = i7/6$ yr for $i=1, 2, 4, 18$.

<table>
<thead>
<tr>
<th>$i$</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{W,2,i}$ in yr</td>
<td>1.1666…</td>
<td>2.333…</td>
<td>4.666…</td>
<td>20.999</td>
</tr>
<tr>
<td>$T_{W,exp,i}$ in yr</td>
<td>1.1666</td>
<td>2.3332</td>
<td>4.666</td>
<td>20.999</td>
</tr>
</tbody>
</table>

Table 3a shows a very good agreement between the predominant experimental time periodicities $T_{W,exp,i}$ of variations of the sea water temperature (during 1969-2010 AD for the coastal station Possyet of the Japan Sea) and the time periodicities $T_{W,2,i} = i(T_{ch})_2$ for $i=1, 2, 4, 18$. The predominant experimental time periodicity $T_{W,exp,1} = 1.1666$ yr is in a very good agreement with the periodicity $T_{W,2,1} = (T_{ch})_2 = 7/6$ yr $= 1.1666…$ yr obtained from the formula (3.276) for the integer $i=1$. The predominant experimental time periodicity $T_{W,exp,2} = 2.3332$ yr is in a very good agreement with the periodicity $T_{W,2,2} = 2(T_{ch})_2 = 7/3$ yr $= 2.333…$ yr obtained from the formula (3.276) for the integer $i=2$. The predominant experimental time periodicity $T_{W,exp,4} = 4.666$ yr is in a very good agreement with the periodicity $T_{W,2,4} = 4(T_{ch})_2 = 14/3$ yr $= 4.666…$ yr obtained from the formula (3.276) for the integer $i=4$. The predominant experimental time periodicity $T_{W,exp,18} = 20.999$ yr is in a very good agreement with the periodicity $T_{W,2,18} = 18(T_{ch})_2 = 21$ yr obtained from formula the (3.276) for the integer $i=18$.

The calculated spectrum $S_{T,W}(\mathbf{f})$ (presented on Fig. 21a for the time range 1969-2010 AD) of variations of sea water temperature demonstrates the predominant experimental time periodicities $T_{W,exp,i}$, which are in a very good agreement with the following periodicities
\[ T_{W,1,j} = j(T_{ch})_1 = j6/5 \text{ yr, } j = 1, 7, \]  
\[ T_{W,\text{exp},j} \approx T_{W,1,j} = j(T_{ch})_1 = j6/5 \text{ yr, } j = 1, 7. \]  

i.e., we have the following relations for the sea water

\[ T_{W,\text{exp},j} \approx T_{W,1,j} = j(T_{ch})_1 = j6/5 \text{ yr, } j = 1, 7. \]  

The predominant experimental time periodicities \( T_{W,\text{exp},j} \) of variations of the sea water temperature (during 1969-2010 AD for the coastal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]) and the time periodicities \( T_{W,1,j} = j(T_{ch})_1 = j6/5 \text{ yr, } j = 1, 7 \)

<table>
<thead>
<tr>
<th>( j )</th>
<th>1</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_{W,1,j} \text{ in yr} )</td>
<td>1.2</td>
<td>8.4</td>
</tr>
<tr>
<td>( T_{W,\text{exp},j} \text{ in yr} )</td>
<td>1.2352</td>
<td>8.3997</td>
</tr>
</tbody>
</table>

Table 3b shows a very good agreement between the predominant experimental time periodicities \( T_{W,\text{exp},j} \) of variations of the sea water temperature (during 1969-2010 AD for the coastal station Possyet of the Japan Sea) and the periodicity \( j \text{exp},W,T \) for \( j = 1, 7 \). The predominant experimental time periodicity \( T_{W,\text{exp},1} = 1.2352 \text{ yr} \) is in a very good agreement with the periodicity \( T_{W,1,1} = (T_{ch})_1 = 1.2 \text{ yr} \) obtained from the formula (3.278) for the integer \( j = 1 \). The predominant experimental time periodicity \( T_{W,\text{exp},7} = 8.3997 \text{ yr} \) is in a very good agreement with the periodicity \( T_{W,1,7} = 7(T_{ch})_1 = 8.4 \text{ yr} \) obtained from the formula (3.278) for the integer \( j = 7 \).

\[ T_{A,\text{exp},j} \text{ in yr} \]
\[ 1.1666\ldots \quad 2.333\ldots \quad 14 \]

<table>
<thead>
<tr>
<th>( j )</th>
<th>1</th>
<th>2</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_{A,\text{exp},j} \text{ in yr} )</td>
<td>1.1351</td>
<td>2.3332</td>
<td>13.9995</td>
</tr>
</tbody>
</table>

Table 4a shows a very good agreement between the predominant experimental time periodicities \( T_{A,\text{exp},j} \) of variations of air temperature (during 1969-2010 AD for the coastal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]) and the time periodicities \( T_{A,2,j} = i(T_{ch})_2 = i7/6 \text{ yr for } i=1, 2, 12 \)

\[ T_{A,2,i} \text{ in yr} \]
\[ i = 1, 2, 12 \]

\[ T_{A,\text{exp},j} \approx T_{A,2,j} = i(T_{ch})_2 = i7/6 \text{ yr, } i = 1, 2, 12. \]  

The calculated spectrum \( S_{T,A}(f) \) (presented on Fig. 21b for the time range 1969-2010 AD) of variations of the air temperature demonstrates the predominant experimental time periodicities \( T_{A,\text{exp},j} \), which are in a very good agreement with the following periodicities

\[ T_{A,2,i} = i(T_{ch})_2 = i7/6 \text{ yr, } i = 1, 2, 12, \]  

i.e., we have the following relations for the air

\[ T_{A,\text{exp},j} \approx T_{A,2,j} = i(T_{ch})_2 = i7/6 \text{ yr, } i = 1, 2, 12. \]  

Table 4a shows a very good agreement between the predominant experimental time periodicities \( T_{A,\text{exp},j} \) of variations of the air temperature (during 1969-2010 AD for the coastal station Possyet of the Japan Sea) and the time periodicities \( T_{A,2,i} = i(T_{ch})_2 = i7/6 \text{ yr for } i=1, 2, 12 \). The predominant experimental time periodicity \( T_{A,\text{exp},1} = 1.1351 \text{ yr} \) is in a very good agreement with the periodicity
The predominant experimental time periodicity $T_{A,exp,2} = 2.3332 \text{ yr}$ is in a very good agreement with the periodicity $T_{A,2,2} = 2(T_{ch})_2 = 7/3 \text{ yr} = 2.333\ldots \text{yr}$ obtained from the formula (3.280) for the integer $i=2$.

The predominant experimental time periodicity $T_{A,exp,12} = 13.9995 \text{ yr}$ is in a very good agreement with the periodicity $T_{A,2,12} = 12(T_{ch})_2 = 14 \text{ yr}$ obtained from the formula (3.280) for the integer $i = 12$.

**Table 4b**

The predominant experimental time periodicities $T_{A,exp,j}$ of variations of the air temperature (during 1969-2010 AD for the coastal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]) and the time periodicities $T_{A,1,j} = j(T_{ch})_1 = j6/5 \text{ yr}$, $j = 1, 5, 7$

<table>
<thead>
<tr>
<th>J</th>
<th>1</th>
<th>5</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{A,1,j}$ in yr</td>
<td>1.2</td>
<td>6</td>
<td>8.4</td>
</tr>
<tr>
<td>$T_{A,exp,j}$ in yr</td>
<td>1.1999</td>
<td>5.9998</td>
<td>8.3997</td>
</tr>
</tbody>
</table>

The calculated spectrum $S_{T,A}$ (f) (presented on Fig. 21b for the time range 1969-2010 AD) of variations of the air temperature demonstrates the predominant experimental time periodicities $T_{A,exp,j}$, which are in a very good agreement with the following periodicities

$$T_{A,1,j} = j(T_{ch})_1 = j6/5 \text{ yr}, \ j = 1, 5, 7,$$

i.e., we have the following relations for the air

$$T_{A,exp,j} \approx T_{A,1,j} = j(T_{ch})_1 = j6/5 \text{ yr}, \ j = 1, 5, 7. \quad (3.282)$$

Table 4b shows a very good agreement between the predominant experimental time periodicities $T_{A,exp,j}$ of variations of the air temperature (during 1969-2010 AD for the coastal station Possyet of the Japan Sea) and the time periodicities $T_{A,1,j} = j(T_{ch})_1 = j6/5 \text{ yr}$ for $j=1, 5, 7$. The predominant experimental time periodicity $T_{A,exp,1} = 1.1999 \text{ yr}$ is in a very good agreement with the periodicity $T_{A,1,1} = (T_{ch})_1 = 1.2 \text{ yr}$ obtained from the formula (3.282) for the integer $j=1$. The predominant experimental time periodicity $T_{A,exp,5} = 5.9998 \text{ yr}$ is in a very good agreement with the periodicity $T_{A,1,5} = 5(T_{ch})_1 = 6 \text{ yr}$ obtained from the formula (3.282) for the integer $j=5$. The predominant experimental time periodicity $T_{A,exp,7} = 8.3997 \text{ yr}$ is in a very good agreement with the periodicity $T_{A,1,7} = 7(T_{ch})_1 = 8.4 \text{ yr}$ obtained from the formula (3.282) for the integer $j=7$.

The combined Fig. 22 demonstrates the calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a) and $S_y(f)$ (b) of the documented [Earth Orientation Centre data] variations of the experimental coordinates $x$ and $y$ of the Earth’s pole during 1969-2010 AD. The combined Fig. 22 demonstrates also the calculated spectrum $S_{T,W}$ (f) (c) of variations of sea water during 1969-2010 AD for the coastal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]. The combined Fig. 22 demonstrates also the calculated spectrum $S_{T,A}$ (f) (d) of variations of air temperature during 1969-2010 AD for the coastal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]. The calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a), $S_y(f)$ (b), $S_{T,W}$ (f) (c) and $S_{T,A}$ (f) (d) have the same slope of -2 demonstrating the single cosmic energy gravitational genesis of the Chandler’s wobble of the Earth’s pole and sea water and air temperature variations for the coastal station Possyet of the Japan Sea.
Fig. 22. The calculated [Simonenko, 2011] frequency spectra $S_x(f)$ (a) and $S_y(f)$ (b) of the documented [Earth Orientation Centre data] variations of the experimental coordinates $x$ and $y$ of the Earth’s pole during 1969-2010 AD. The calculated spectrum $S_{WT}(f)$ (c) of variations of sea water during 1969-2010 AD for the costal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]. The calculated spectrum $S_{TA}(f)$ (d) of variations of air temperature during 1969-2010 AD for the costal station Possyet of the Japan Sea [Simonenko, Gayko and Sereda, 2012]

Thus, the previous theoretical results [Simonenko, 2007, 2008, 2009, 2010], the spectral studies [Simonenko, 2011] of the Chandler’s wobble of the Earth’s pole, and the spectral analysis [Simonenko, Gayko and Sereda, 2012] of the experimental variations of sea water and air temperature (during 1969-2010 AD for the costal station Possyet of the Japan Sea) confirm the cosmic energy gravitational genesis of the predominant short-range periodicities $(7i/6 \text{ yr and } 6j/5 \text{ yr}$ determined by small integers $i$ and $j$) of the Chandler’s wobble of the Earth’s pole and sea water and air temperature variations for the costal station Possyet of the Japan Sea.
3.8.4. The evidence of the founded range of the fundamental global periodicities

\[ T_{\text{tec},f} = T_{\text{clim},f} = 696 \pm 708 \text{ yr} \]  (of the global seismotectonic and volcanic activities and the climate variability of the Earth) obtained from the established links between the great natural cataclysms in the ancient history of humankind from the final collapse of the ancient Egyptian Kingdom and the biblical Flood to the increase of the global seismicity and the global volcanic activity in the beginning of the 20th century and the modern increase of the global seismicity and the volcanic activity in the end of the 20th century and in the beginning of the 21st century

We present in Subsection 3.8.4 the evidence of the founded [Simonenko, 2012] range of the fundamental global periodicities \( T_{\text{tec},f} = T_{\text{clim},f} = 696 \pm 708 \text{ yr} \) (of the global seismotectonic and volcanic activities and the climate variability of the Earth) based on the established links between the great natural cataclysms in the ancient history of humankind from the final collapse of the ancient Egyptian Kingdom and the biblical Flood to the increase of the global seismicity and the global volcanic activity in the beginning of the 20th century [Richter, 1969] and the modern increase of the global seismicity and the volcanic activity in the end of the 20th century [Abramov, 1997] and in the beginning of the 21st century [Simonenko, 2007; 2009; 2010].

3.8.4.1. The great natural cataclysms in the history of humankind from the final collapse of the ancient Egyptian Kingdom (near 2190 BC) and the biblical Flood (occurred in 2104 BC according to the orthodox Jewish and Christian biblical chronology)

We have the documented time 63 BC of “the greatest earthquake ever experienced” [Cassius Dio Cocceianus, Dio's Roman history] destroyed many cities of the ancient Pontus located in Asia Minor. The ancient Minoan empire declined as a consequence of the great Minoan volcanic eruptions at islands Thera [Bolt et al., 1978] and Crete [Marinatos, 1939]. The “conventionally accepted” [LaMarche and Hirschboeck, 1984; p. 126] date of 1500 ÷ 1450 BC of the volcanic eruption at Thera (Santorini) is based on the archaeological evidence [Lamb, 1977]. Archaeologists [Sivertsen, 2009] and geophysicists [Bolt et al., 1978] placed usually the Minoan volcanic eruption at island Thera (Santorini) near 1500 BC. This volcanic eruption had the global planetary evidences revealed worldwide [LaMoreaux, 1995]. Especially, Stanley and Sheng reported [Stanley and Sheng, 1986] the evidence for the presence of ash ejected from the explosion of Santorini in sediment cores recovered in the eastern Nile Delta of Egypt. Weisbue [Weisbued, 1985] pointed out that some biblical scholars have suggested that the Israelites’ exodus from Egypt took place a date closer to 1450 BC (i.e., near the date 1450 BC of the last major eruption of Thera (Santorini) [LaMoreaux, 1995]), whereas LaMoreaux [LaMoreaux, 1995; p. 174] dated it to about 1440 BC, while others have maintained that the exodus took place around 1200 BC.

Despite the global planetary consequences [LaMoreaux, 1995] of the great Minoan volcanic eruption, the exact date of the eruption has not been determined. Marinatos [Marinatos, 1939] dated the great Minoan volcanic eruption to about 1400 BC, whereas Hammer et al. concluded [Hammer et al., 1987] that the eruption of Thera occurred in the range 1665 ÷ 1625 BC. The eruption catalogue of Simkin et al. [Simkin et al., 1981] gives the range of dates 1490 ÷ 1450 BC for Santorini eruption. Betancourt suggested [Betancourt, 1987] the range 1700 ÷ 1640 BC as the most probable date of the eruption of Thera. Running the radiocarbon analysis of samples from Akrotini, Hubberten et al. concluded [Hubberten et al., 1989] that the catastrophic eruption of Thera occurred most probably in the same range 1700 ÷ 1640 BC giving “the exact time of the great eruption seem to agree a date of about 1670 BC” [Antonopoulos, 1992; p. 158], whereas Antonopoulos [Antonopoulos, 1992; p. 155] dated it to about the range 1600 ÷ 1500 BC (“1550 BC plus or minus 50 years”). Friedrich et al. [Friedrich et al., 2006] argued: “Precise and direct dating of the Minoan eruption of Santorini (Thera) in Greece, a global Bronze Age time marker, has been made possible by the unique find of an olive tree, buried alive in life position by the tephra (pumice and ashes) on Santorini”.

The “radiocarbon wiggle-matching” dating analysis of the olive tree revealed [Friedrich et al., 2006] that the eruption occurred during the range 1627 ÷ 1600 BC with 95.4% probability. The authors [Friedrich
et al., 2006] argued: “It is a century earlier than the date derived from traditional Egyptian chronologies”. The studies [LaMarche and Hirschboeck, 1984] of the tree frost rings of the bristlecone pine in California revealed the frost damage (related with the period of global cooling) between 1628 and 1626 BC. Based on revealed frost-ring damage, LaMarche and Hirschboeck dated [LaMarche and Hirschboeck, 1984] tentatively the cataclysmic eruption of Santorini (Thera) to 1828 ÷ 1626 BC. This estimate 1828 ÷ 1626 BC is based on the accepted hypothesis “that major eruptions are likely to be closely followed by notable frost events – at better than the 99.9% confidence level”. Baillie [Baillie, 1989] stated that an Irish oak minimum-growth period is the real evidence of a large volcanic eruption (accompanied by volcanic veil of fine ash and aerosols) that began in 1628 BC. LaMoreaux has stated [LaMoreaux, 1995]: “It is believed that this is an earlier time when Thera began its period of volcanic activity. This could represent the first of a series of large eruptions which left two major calderas that have occurred at Thera. A final large eruption and collapse took place in 1450 BC, which agrees with archaeological evidence”.

Antonopoulos indicated [Antonopoulos, 1992; p. 158] that it is important to remember that the date about 1550 BC “is the date of the beginning of the eruption and not of the widespread destruction in Crete”. It is very important for subsequent analysis to take into account the additional information related with the date about 1550 BC [Antonopoulos, 1992; p. 158]: “It is also the date when the Thera volcano became active again after a long period of quiescence and ejected the coarser pumice which form the lowest layer in the tephra deposits. The effects of this phase of the eruption were probably confined only to Thera. It did not result in the formation of the caldera, but all settlements on the island were obliterated, and all the inhabitants were either killed or driven away. Thus, since just a few skeletons and valuables have been found, it seems as if the inhabitants had enough warning to collect some of their belongings and evacuate”.

Finally, LaMoreaux stated [LaMoreaux, 1995]: “The eruptions of Thera (Santorini) between 1628 and 1450 BC constituted a natural catastrophe unparalleled in all history. The last major eruption in 1450 BC destroyed the entire Minoan Fleet at Crete at a time when the Minoans dominated the Mediterranean world”. LaMoreaux has believed [LaMoreaux, 1995] that “over the period from 1628 to 1450 BC Thera experienced a number of very explosive volcanic events”.

As we can see from the first point of view, the exact date of the eruption of Thera (Santorini) is the subject of controversy. We intent to solve this controversy in this Subsection by establishment of the non-controversial exact dates of the different distinct eruptions of Thera (Santorini).

It is well known that the ancient Egyptian Kingdom declined near 2190 BC as a consequence of the long-lasting catastrophic drought related with the extraordinary decrease of the depth of the Nile. The decline of the ancient Egyptian Kingdom coincided with the small ice age in Europe. The recurrence of the next catastrophic drought occurred in Egyptian Cairo in 1200 AD during the Arabic conquest of the Egypt.

According to the orthodox Jewish and Christian biblical chronology [Genesis, 7:11], the Flood occurred in the Jewish year 1656 (which is 2104 BC) as a consequence of the rainstorm during the 40 days [Genesis, 7:12]. We have the intermediate mean date 2147 BC between the biblical Flood (2104 BC) and the final collapse of the ancient Egyptian Kingdom (2190 BC) related with the long-lasting catastrophic drought.

Reconstructing the ancient history of the humankind in his “Egypt’s Place in Universal History”, Von Bunsen [Von Bunsen, 1848, pp. 77-78, 88] revealed the marks of the planetary disaster, related with the dramatic change of the landscape of the Central Asia in 10555 BC. Considering the ancient history of the humankind in his “Fingerprints of the Gods” [Hancock, 1997], Graham Hancock revealed the Egyptian marks of the planetary disaster in 10450 BC. It was suggested [Simonenko, 2009; 2010] that the Bunzen’s and Hancock’s estimations are related with the same planetary disaster during the time range 10555 BC ÷ 10450 BC in the ancient history of the humankind. Taking into account the documented times (10555 BC [Von Bunzen, 1848] and 10450 BC [Hancock, 1997]), we can evaluate the mean date 10502.5 BC of the planetary disaster in the Central Asia and Egypt.

We get the time duration 10439.5 years (10502.5 - 63) between the greatest [Cassius Dio Cocceianus, Dio's Roman history] earthquake (63 BC) destroyed the ancient Pontus (located in Asia Minor) and the obtained mean date 10502.5 BC of the planetary disaster in the Central Asia [Von Bunsen, 1848, pp. 77-78, 88] and Egypt [Hancock, 1997]. The obtained time duration 10439.5 years is approximately equal to the time period 10440 years (3 × 3480 years) consisting of 3 time periods of 3480 years given by the fundamental global seismotectonic, volcanic and climatic periodicity (3.258a) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn. The obtained time duration 10439.5 years confirms the stated hypothesis [Ilyichev and Cherepanov, 1991, p. 1371] about the recurrence of the super-earthquakes characterized by the average approximate time periodicity of 10000 years. The considered above catastrophic droughts, great earthquakes and great volcanic eruptions in the
history of the humankind are the climatic and geophysical mutually related links of the one evolutionary chain determined by the combined cosmic non-stationary energy gravitational influence on the Earth of the Sun, the Moon and the planets of the Solar System. The founded (in Subsection 3.8.1) range of the fundamental global seismotectonic, volcanic and climatic periodicities \( T_{\text{seis}} = T_{\text{clim}} = 696 \div 708 \) years (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn) gives the opportunity to discover one clear viewpoint in the frame of the established cosmic geophysics [Simonenko, 2007] towards these planetary catastrophes.

### 3.8.4.2. Linkage of the last major eruption of Thera (1450 BC) and the greatest earthquake destroyed the ancient Pontus (63 BC)

Let us analyze the great natural cataclysms in the ancient history of the humankind to verify the established time periodicities (3.256a) and (3.258a) of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability of the Earth induced by the combined cosmic non-stationary energy gravitational influences of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

Using the time difference 1387 years \( (1450 - 63) \) between the date 1450 BC [LaMoreaux, 1995] of last major eruption of Thera and the greatest earthquake in the ancient Pontus (63 BC), we get the ratio:

\[
\frac{(1450 - 63) \text{ years}}{696 \text{ years}} = \frac{1387}{696} = 1.9928, \quad (3.284)
\]

which shows that we have approximately 2 time periods of 696 years (given by (3.256a)) between these cataclysms. Using the classical date 1500 BC [Bolt et al., 1978; Sivertsen, 2009] of the eruption of Thera (Santorini), we get the ratio:

\[
\frac{(1500 - 63) \text{ years}}{696 \text{ years}} = \frac{1437}{696} = 2.0646, \quad (3.285)
\]

which is slightly larger than the previous estimation (3.284).

The closeness of the ratios (3.284) and (3.285) to the integer number 2 confirms the founded cosmic energy gravitational genesis of the fundamental global seismotectonic, volcanic and climatic periodicity (3.256a) [Simonenko, 2012] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn. Taking into account that the estimation (3.284) is closer to the integer number 2 than the estimation (3.285), we can conclude that the date 1450 BC [LaMoreaux, 1995] is more probable than the classical date 1500 BC [Bolt et al., 1978; Sivertsen, 2009] of the eruption of Thera (Santorini).

### 3.8.4.3. Linkage of the greatest earthquake destroyed the ancient Pontus (63 BC), the earthquake destroyed the ancient Greek Temple of Artemis (614 AD) and the great frost event (628 AD) related with the atmospheric veil (recorded in Europe in 626 AD) induced by the great unknown volcanic eruption

The ancient Greek city Ephesus (later a major Roman city on the west coast of Asia Minor) was destroyed by an earthquake occurred in 614 AD. The Ephesus was famed owing to the Temple of Artemis, one of the Seven Wonders of the Ancient World. Using the time difference 677 years \( (614 + 63) \) between the major earthquake destroyed the Temple of Artemis (614 AD) and the greatest earthquake in the ancient Pontus (63 BC), we get the ratio:

\[
\frac{(614 + 63) \text{ years}}{696 \text{ years}} = \frac{677}{696} = 0.9727, \quad (3.286)
\]

which shows that we have approximately 1 time period of 696 years between these earthquakes.

Using the time difference 689 years \( (626 + 63) \) between the greatest earthquake destroyed the ancient Pontus (63 BC) and great unknown volcanic eruption (apparently, Rabaul’ [LaMarche and Hirschboeck, 1984] eruption, whose atmospheric veil was recorded in Europe in 626 AD [Stothers and Rampino, 1983]
and resulted to the great frost events in 628 AD [LaMarche and Hirschboeck, 1984], we get the ratio:

$$\frac{(626 + 63) \text{ years}}{696 \text{ years}} = \frac{689}{696} = 0.9899,$$

which shows that we have approximately 1 time period of 696 years (given by (3.256a)) between the greatest earthquake destroyed the ancient Pontus (63 BC) and great unknown volcanic eruption.

The closeness of the ratios (3.286) and (3.287) to the integer number 1 confirms the founded cosmic energy gravitational genesis of the fundamental global seismotectonic, volcanic and climatic periodicity (3.256a) [Simonenko, 2012] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

### 3.8.4.4. Linkage of the greatest earthquake destroyed the ancient Pontus (63 BC) and the great earthquakes occurred in England (1318 AD and 1343 AD), Armenia (1319 AD), Portugal (1320 AD, 1344 AD and 1356 AD) and Japan (1361 AD)

Using the time differences 1381 years (1318 + 63) and 1382 years (1318 + 63) between the great earthquakes [Vikulin, 2008] occurred in England (1318 AD) and Armenia (1319 AD), respectively, and the greatest earthquake in the ancient Pontus (63 BC), we get the ratio:

$$\frac{(1318 + 63) \text{ years}}{696 \text{ years}} = \frac{1381}{696} = 1.9842,$$

which shows that we have approximately 2 time periods of 696 years (given by (3.256a)) between these great earthquakes in the ancient Pontus (63 BC) and in England (1318 AD) and Armenia (1319 AD). Using the time difference 1406 years (1343 + 63) between the great earthquake in England (1343 AD) and the greatest earthquake of the ancient Pontus (63 BC), we get the ratio:

$$\frac{(1343 + 63) \text{ years}}{696 \text{ years}} = \frac{1406}{696} = 2.0201,$$

which shows that we have approximately 2 time periods of 696 years (given by (3.256a)) between these great earthquakes.

Using the mean date 1330.5 AD between the great earthquakes in England (1318 AD and 1343 AD) and the greatest earthquake in the ancient Pontus (63 BC), we get the ratio:

$$\frac{(1330.5 + 63) \text{ years}}{696 \text{ years}} = \frac{1393.5}{696} = 2.0021,$$

which shows that the great earthquakes in England (1318 AD and 1330.5 AD) occurred approximately after 2 time periods of 696 years (given by (3.256a)) from the date 63 BC of the greatest earthquake in the ancient Pontus.

Using the mean date 1332 AD between the great earthquakes in Portugal (1320 AD and 1344 AD) and the greatest earthquake in the ancient Pontus (63 BC), we get the ratio:

$$\frac{(1332 + 63) \text{ years}}{696 \text{ years}} = \frac{1395}{696} = 2.0043,$$

which shows that the great earthquakes in Portugal (1320 AD and 1344 AD) occurred approximately after 2 time periods of 696 years (given by (3.256a)) from the date 63 BC of the greatest earthquake in the ancient Pontus.

Using the time difference 1424 years (1361 + 63) between the great earthquake in Japan (1361 AD) and the greatest earthquake in the ancient Pontus (63 BC), we get the ratio:

$$\frac{(1361 + 63) \text{ years}}{696 \text{ years}} = \frac{1424}{696} = 2.0459,$$

which shows that we have approximately 2 time periods of 696 years (given by (3.256a)) between these great earthquakes.

The closeness of the ratios (3.290), (3.291) and (3.292) to the integer number 2 (for England, Portugal and Japan) confirms the founded cosmic energy gravitational genesis of the fundamental global seismotectonic, volcanic and climatic periodicity (3.256a) [Simonenko, 2012] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.
3.8.4.5. Linkage of the final collapse of the ancient Egyptian Kingdom 
(occurred near 2190 BC), the biblical Flood (occurred in 2104 BC 
according to the orthodox Jewish and Christian biblical chronology) 
and the last major eruption of Thera (1450 BC)

We have the intermediate mean date 2147 BC ((2190+2104)/2) between the final collapse of the 
ancient Egyptian Kingdom (near 2190 BC) and the biblical Flood (2104 BC). Using the time difference 697 
years (2147- 1450) between the intermediate mean date 2147 BC and the last major eruption of Thera (1450 
BC) [LaMoreaux, 1995], we get the corresponding ratio:
\[
\frac{(2147 - 1450) \text{ years}}{696 \text{ years}} = \frac{697}{696} = 1.0014, \quad (3.293)
\]
which shows that we have approximately 1 time period of 696 years between the intermediate mean date 
2147 BC (between the final collapse of the ancient Egyptian Kingdom (near 2190 BC) and the biblical Flood 
(2104 BC)) and the last major eruption of Thera (1450 BC).

Using the classical date 1500 BC [Bolt et al., 1978; Sivertsen, 2009] of the eruption of Thera 
(Santorini), we get the corresponding ratio:
\[
\frac{(2147 - 1500) \text{ years}}{696 \text{ years}} = \frac{647}{696} = 0.9295. \quad (3.294)
\]
Since the estimation (3.293) is closer to the integer number 1 than the estimation (3.294), we can conclude 
onece again that the date 1450 BC [LaMoreaux, 1995] is the more probable date for the last major eruption of Thera 
than the classical date 1500 BC [Bolt et al., 1978; Sivertsen, 2009] of the eruption of Thera 
(Santorini).

The closeness of the ratios (3.293) and (3.294) to the integer number 1 confirms the founded cosmic 
energy gravitational genesis of the fundamental global seismotectonic, volcanic and climatic periodicity 
(3.256a) [Simonenko, 2012] determined by the combined predominant non-stationary energy gravitational 
influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the 
gravitational interactions of the Sun with the Jupiter and the Saturn.

3.8.4.6. Linkage of the planetary disasters in the Central Asia (10555 BC) 
and in the ancient Egyptian Kingdom (10450 BC), and the greatest 
earthquake destroyed the ancient Pontus (63 BC)

Using the time duration 10439.5 years (10502.5 - 63) between the greatest [Cassius Dio 
Coccianus, Dio's Roman history] Pontic earthquake (63 BC) in Asia Minor and the obtained mean 
estimation 10502.5 BC ((10555+10450)/2) of the planetary disaster (10555 BC) in the Central Asia [Von 
Bunsen, 1848, pp. 77-78, 88] and the planetary disaster (10450 BC) in ancient Egyptian Kingdom [Hancock, 
1997], we get the ratio
\[
\frac{(10502.5 - 63) \text{ years}}{696 \text{ years}} = \frac{10439.5}{696} = 14.9992 \approx 15, \quad (3.295)
\]
confirming the fundamental global seismotectonic, volcanic and climatic periodicity (3.256a) determined 
by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-
Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter 
and the Saturn.

We get also the ratio
\[
\frac{(10502.5 - 63) \text{ years}}{3480 \text{ years}} = \frac{10439.5}{3480} \approx \frac{10440}{3480} = \frac{3 \times 3480}{3480} = 3, \quad (3.296)
\]
confirming the fundamental global seismotectonic, volcanic and climatic periodicity (3.258a) determined 
by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-
Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with 
the Jupiter and the Saturn.

Thus, the obtained ratios (3.284), (3.285), (3.286), (3.287), (3.288), (3.289), (3.290), (3.291), 
(3.292), (3.293), (3.294), (3.295) (which can be approximated by various integer numbers for different
regions of the Earth) confirm the fundamental global seismotectonic, volcanic and climatic periodicity (3.256a) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

3.8.4.7. Linkage of the previous great eruptions of Thera (Santorini) (between 1628 and 1450 BC), the greatest (in the United States in the past 150 years up to 1872) earthquake in Owens Valley, California (1872 AD), the eruptions of Santorini in 1866 and 1925 AD and the great eruption of Krakatau in 1883 AD

We present in Subsection 3.8.4.7 the linkage of the previous great eruptions of Thera (Santorini) (between 1628 and 1450 BC [LaMoreaux, 1995]), the greatest (in the United States in the past 150 years up to 1872) earthquake in Owens Valley, California (1872 AD), the eruptions of Santorini in 1866 and 1925 AD and the great eruption of Krakatau in 1883 AD.

Papazachos (see also [Antonopoulos, 1992]) considered [Papazachos, 1989] the largest eruptions (accompanied by tsunamis) of the Santorini volcano, which occurred (during the last five centuries) in 1457, 1573, 1560, 1866 and 1925 AD. We can interpret the eruptions of Santorini in 1866 and 1925 AD and the eruption of Krakatau in 1883 AD as terrible manifestation (in the 19th and 20th centuries) of the time periodicity of 3480 years = $5 \times 696$ years given by (3.258a). The mean date 1874.5 AD between the eruptions of Santorini (1866 AD) and Krakatau (1883 AD) is close to the date 1872 AD of the greatest (in the United States in the past 150 years up to 1872) earthquake in Owens Valley, California. The date 1925 AD of the eruption of Santorini is close to the year 1923 AD of the strongest Japanese earthquake in the Kanto region (and in Torbat-e Heydariyeh, Iran; Sichuan, China; Kamchatka, USSR; Humbolt County, California, USA).

Using the mean date 1613.5 BC of the obtained range 1627 ÷ 1600 BC of the first Santorini’s eruption (based on the “radiocarbon wiggle-matching” dating analysis [Friedrich et al., 2006] with 95.4% probability), we get the time duration 3479.5 years from this mean date 1613.5 BC and the eruption of Santorini in 1866 AD. We get the ratio of the obtained time duration 3479.5 years to the time periodicity of 3480 years

$$\frac{(1613.5 + 1866) \text{ years}}{3480 \text{ years}} = \frac{3479.5}{3480} = 0.999856, \quad (3.297)$$

which is very close to the integer number 1. It means that the eruption of Santorini in 1866 AD is related with the first minor eruption of Santorini in the obtained range 1627 ÷ 1600 BC [Friedrich et al., 2006]. Really, considering the eruption of the Santorini in 1866 AD, we can obtain the corresponding date $t_p (1866 \text{ AD})$ of previous eruption related with the founded time periodicity 3480 years given by (3.258a). To do this, we have the obvious equation

$$t_p (1866 \text{ AD}) + 3480 \text{ years} = 1866 \text{ years},$$

which gives the following date of the first minor eruption of Santorini:

$$t_p (1866 \text{ AD}) = 1866 \text{ years} - 3480 \text{ years} = 1614 \text{ BC} \quad (3.298)$$

in agreement with the mean date 1613.5 BC of the obtained range 1627 ÷ 1600 BC [Friedrich et al., 2006] of the Santorini’s eruption.

Antonopoulos associated [Antonopoulos, 1992; p. 166] “the eruption at Thera with the analogous Krakatau eruption” occurred in 1883 AD. We can interpret the great eruption of Krakatau in 1883 AD as the manifestation of the periodic increase of the global seismicity and volcanic activity related with the founded time periodicity 3480 years given by (3.258a). Really, considering the eruption of Krakatau in 1883 AD, we can obtain the time duration 3496.5 years between the great eruption of Krakatau in 1883 AD and the mean date 1613.5 BC of the obtained range 1627 ÷ 1600 BC of the first Santorini’s eruption (based on the “radiocarbon wiggle-matching” dating analysis [Friedrich et al., 2006]). We get the ratio of the obtained time duration 3496.5 years to the time periodicity of 3480 years

$$\frac{(1613.5 + 1883) \text{ years}}{3480 \text{ years}} = \frac{3496.5}{3480} = 1.0047, \quad (3.299)$$

which is very close to the integer number 1, denoting that the eruption of Thera (Santorini) in the obtained range 1627 ÷ 1600 BC [Friedrich et al., 2006] is related with the great eruption of Krakatau in 1883 AD.
Using the mean value 1613.5 BC of the obtained range 1627 ÷ 1600 BC of the first minor eruption of Santorini [Friedrich et al., 2006], we get the time duration 3485.5 years from this mean date 1613.5 BC and the greatest (in the United States in the past 150 years up to 1872) earthquake in Owens Valley, California (1872 AD). We get the ratio of the obtained time duration 3485.5 years to the time periodicity of 3480 years

\[
\frac{(1613.5 + 1872) \text{ years}}{3480 \text{ years}} = \frac{3485.5}{3480} = 1.00158, \tag{3.300}
\]

which is very close to the integer number 1. It denotes that the greatest earthquake in Owens Valley, California (1872 AD) is related with the first Santorini’s eruption in the obtained range 1627-1600 BC [Friedrich et al., 2006]. The obtained closeness of the estimations (3.296), (3.297) and (3.300) to the integer number 1 confirms the founded fundamental global seismotectonic, volcanic and climatic periodicity (3.258a) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

Considering the greatest (in the United States in the past 150 years up to 1872) earthquake in Owens Valley, California (1872 AD), we can obtain (based on the founded time periodicity 3480 years given by (3.258a)) the corresponding date \( t_p (1872 \text{ AD}) \) of previous maximal planetary seismic and volcanic activity from the obvious relation

\[
t_p (1872 \text{ AD}) + 3480 \text{ years} = 1872 \text{ years},
\]

which gives the following date of previous maximal planetary seismic and volcanic activity:

\[
t_p (1972 \text{ AD}) = 1872 \text{ years} - 3480 \text{ years} = 1608 \text{ BC}, \tag{3.301}
\]

entering to the obtained range 1627-1600 BC [Friedrich et al., 2006] of the eruption of Santorini.

Considering the eruption of Santorini in 1925 AD, we can obtain the corresponding date \( t_p (1925 \text{ AD}) \) of previous eruption related with the founded time periodicity 3480 years given by (3.258a). To do this, we have the obvious relation

\[
t_p (1925 \text{ AD}) + 3480 \text{ years} = 1925 \text{ years},
\]

which gives the following date of the second minor eruption of Santorini:

\[
t_p (1925 \text{ AD}) = 1925 \text{ years} - 3480 \text{ years} = 1555 \text{ BC}, \tag{3.302}
\]

in a good agreement with the mean value 1550 BC [Antonopoulos, 1992; p. 155] of the established range 1600 ÷ 1500 BC of the Santorini’s eruption.

### 3.8.4.8. Linkage of the eruption of Tambora (1815 AD) and the Thera (Santorini) eruption in the range 1700 ÷ 1640 BC

We present in Subsection 3.8.4.8 the linkage of the eruption of Tambora (1815 AD) and the Thera (Santorini) eruption in the range 1700 ÷ 1640 BC [Betancourt, 1987; Hubberten et al., 1989].

The eruption of Thera (Santorini) was the great natural cataclysm. However, in terms of the erupted volume, it ranks smaller [Pyle, 1996] than the eruption of the Tambora occurred in 1815 AD. Considering the eruption of the Tambora occurred (1815 AD), we can obtain (based on the founded time periodicity 3480 years given by (3.258a)) the corresponding date \( t_p (1815 \text{ AD}) \) of the previous great world eruption from the obvious relation

\[
t_p (1815 \text{ AD}) + 3480 \text{ years} = 1815 \text{ years},
\]

which gives the following date of the previous great world eruption:

\[
t_p (1815 \text{ AD}) = 1815 \text{ years} - 3480 \text{ years} = -1665 \text{ years} = 1665 \text{ BC}, \tag{3.303}
\]

which is very close to the mean date 1670 BC of the suggested range 1700 ÷ 1640 BC [Betancourt, 1987; Hubberten et al., 1989] of the eruption of Thera (Santorini). The date 1665 BC is very close to the average date of 1675 BC [LaMarche and Hirschboeck, 1984] based “on grain from storage jars from the destruction level” [Batancourt and Weinstein, 1976]. This agreement confirms the founded fundamental global seismotectonic, volcanic and climatic periodicity (3.258a) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.
3.8.4.9. Linkage of the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 19th century and in the beginning of the 20th century
and the eruption of Thera (Santorini) between 1600 and 1500 BC

We present in Subsection 3.8.4.9 the linkage of the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 19th century and in beginning of the 20th century [Richter, 1969] and the eruption of Thera (Santorini) between 1600 and 1500 BC [Antonopoulos, 1992].

The former President of the Seismological Society of America made in 1969 the statement [Richter, 1969] about the increase of the global seismicity recorded in the range 1896 ÷ 1906 AD up to 1969:

“One notices with some amusement that certain religious groups have picked this rather unfortunate time to insist that the number of earthquakes is increasing. In part they are misled by the increasing number of small earthquakes that are being catalogued and listed by newer, more sensitive stations throughout the world. It is worth remarking that the number of great [that is, 8.0 and over on the Richter scale] earthquakes from 1896 to 1906 (about twenty-five) was greater than in any ten-year interval since”.

The seismologists Seweryn J. Duda and Markus Baith revealed [Duda, 1965; Baith and Duda, 1979] the range 1900 ÷ 1920 AD characterized by the maximal energy release per year for the whole time period up to 1977. The eruption of Santorini occurred in 1925 AD, i.e. near the end of the established range 1900 ÷ 1920 AD. Considering the range 1900 ÷ 1925 AD as the range of the maximal global seismic activity in the end of the 19th century and in the beginning of the 20th century (along with the eruption of Santorini in 1925 AD), we can obtain (based on the founded time periodicity 3480 years given by (3.258a)) the corresponding time range \( t_p (1896 ÷ 1925 \text{ AD}) \) of the previous maximal global seismic and volcanic activities from the obvious relation

\[
t_p (1896 ÷ 1925 \text{ AD}) + 3480 \text{ years} = 1896 ÷ 1925 \text{ years},
\]

which gives the following range of the corresponding previous maximal global seismic and volcanic activities:

\[
t_p (1896 ÷ 1925 \text{ AD}) = 1584 ÷ 1555 \text{ BC}
\]

(3.305)

entering to the established range 1600 ÷ 1500 BC [Antonopoulos, 1992; p. 155] of eruption of Santorini. This agreement confirms the founded fundamental global seismotectonic, volcanic and climatic periodicity (3.258a) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

Thus, we have revealed the evident linkages between the different distinct eruptions of the Thera (Santorini) dated in the following ranges: 1700÷1640 BC [Betancourt, 1987; Habberten et al., 1989], 1628÷1626 BC [LaMarche and Hirschboeck, 1984], 1627÷1600 BC [Friedrich et al., 2006], 1600÷1500 BC [Antonopoulos, 1992], 1628÷1450 BC [LaMoreaux, 1995] and the eruptions of the Tambora (1815 AD), the Santorini (1866 AD and 1925 AD) and the Krakatau (1883 AD). Based on the fundamental global seismotectonic, volcanic and climatic periodicity (3.258a) and taking into account the eruptions of the Tambora (1815 AD), the Santorini (1866 AD and 1925 AD) and the Krakatau (1883 AD), we have shown the real possibility of different distinct eruptions of Thera (Santorini): near 1665 BC (in accordance with the range 1700÷1640 BC [Betancourt, 1987; Habberten et al., 1989]), near 1613.5 BC (in accordance with the range 1627÷1600 BC [Friedrich et al., 2006]) and in the range 1584÷1555 BC (in accordance with the range 1600÷1500 BC [Antonopoulos, 1992]). Consequently, we can consider the possibility of the final major catastrophic eruption near 1450 BC [LaMoreaux, 1995].
3.8.4.10. Linkage of the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 20th century and the eruption of Hekla (1300 AD) in Iceland and the great earthquake (1303 AD) in China

We present in Subsection 3.8.4.10 the linkage of the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 20th [Abramov, 1997] century and the eruption of Hekla (1300 AD) [Thordarson and Larsen, 2007] in Iceland and the great earthquake (1303 AD) in China [Vikulin, 2008].

Considering the date (1300 AD) of the eruption of Hekla (1300 AD) [Thordarson and Larsen, 2007] in Iceland and the date (1303 AD) of great earthquake in China [Vikulin, 2008] and using the founded range (3.256) of the fundamental global periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708\ yr$ (of the global seismotectonic and volcanic activities and the climate variability of the Earth determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn), we can evaluate, respectively, the following ranges of the next possible seismotectonic and volcanic activities of the Earth

$$1300\ years + 696\ years \div 1300\ years + 708\ years = 1996 \div 2008\ AD,$$  \hspace{1cm} (3.306)

$$1303\ years + 696\ years \div 1303\ years + 708\ years = 1999 \div 2011\ AD,$$  \hspace{1cm} (3.307)

The lower boundaries of these ranges are related with the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 20th [Abramov, 1997] century. The upper boundary (2008 AD) of the range (3.306) is coincided with the predicted [Simonenko, 2007] date (2008 AD) of the next great Chinese earthquake. The upper boundary (2011 AD) of the range (3.307) is coincided with the predicted [Abramov, 1997] date (2011 AD) of next strong earthquake in the Kanto region. The upper boundary (2011 AD) of the range (3.307) is coincided with the upper boundary (2011 AD) of the predicted [Simonenko, 2009; 2010] time range (2010 ÷ 2011 AD) of the next sufficiently strong Japanese earthquake near the Tokyo region.

3.9. The forthcoming range 2020 ÷ 2061 AD of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696 ÷ 708 years of the history of humankind and the related subsequent subranges (2023±3 AD, 2040.38 ± 3 AD and 2061±3 AD) of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth

Based on the established links between the different natural cataclysms in the history of humankind and using the founded range (3.256) of the fundamental global seismotectonic, volcanic and climatic periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708\ yr$ of the global seismotectonic, volcanic and climatic activities of the Earth, we evaluated [Simonenko, 2012] the forthcoming range

$$2020 \div 2061\ AD$$  \hspace{1cm} (3.308)

of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696 ÷ 708 years of the history of humankind. We give below the details of this evaluation [Simonenko, 2012].

Considering the date (63 BC) of the greatest earthquake destroyed the ancient Pontus, we can evaluate (based on the founded time periodicity 696 years given by (3.256a) and the obvious calculation) the date of the next approximate peak of the maximal global seismotectonic, volcanic and climatic activity of the Earth (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn)

$$- 63\ years + 3 \times 696\ years = 2025\ AD.$$  \hspace{1cm} (3.309)

Considering the date (63 BC) of the greatest earthquake destroyed the ancient Pontus, we can evaluate (based on the founded time periodicity 696 years given by (3.256a)) the approximate date of the first nearest peak of the maximal global seismotectonic, volcanic and climatic activity of the Earth (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn)

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which is very close to the date 626 AD of the recorded atmospheric veil in Europe [Stothers and Rampino, 1983] and the resulted great frost events in 628 AD [LaMarche and Hirschboeck, 1984]. This satisfactory agreement shows that these geophysical events are closely correlated.

Considering the date (63 BC) of the greatest earthquake destroyed the ancient Pontus, we can evaluate (based on the founded time periodicity 696 years given by (3.256a)) the approximate date of the next second peak of the maximal global seismotectonic, volcanic and climatic activity of the Earth (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn)

\[ -63 \text{ years} + 2 \times 696 \text{ years} = 1329 \text{ AD}, \]  

which is in good agreement with the mean date (1330.5 AD) of great earthquakes in England (occurred in 1318 AD and 1343 AD [Vikulin, 2008]). It means that these great earthquakes in the ancient Pontus (63 BC) and in England (1318 AD and 1343 AD) can be considered as the closely related events for evaluation of the forthcoming range of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century AD during the past 696 + 708 years of the history of humankind.

Considering the date (1318 AD) of the great earthquake in England and the founded range (3.256) of the fundamental global periodicities \( T_{\text{tec},f} = T_{\text{clim},f} = 696 + 708 \text{ yr} \) (of the global seismotectonic and volcanic activities and the climate variability of the Earth determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn), we can evaluate the following range of the next possible strong earthquake in England

\[ 1318 \text{ years} + 696 \text{ years} + 1318 \text{ years} + 708 \text{ years} = 2014 \div 2026 \text{ AD}, \]  

which gives the mean date 

\[ (2014 + 2026 \text{ AD})/2 = 2020 \text{ AD}. \]  

of the initial phase of the rapid increase of the global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century.

We can see that the upper value (2026 AD) of the range (3.312) is near the evaluation (3.309) of the approximate date of the next peak of the maximal global seismotectonic, volcanic and climatic activity of the Earth (determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn) in the 21st century. Consequently, we can evaluate (based on (3.309), (3.312) and (3.313)) the first more narrow subrange of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century

\[ 2020 \div 2026 \text{ AD} = 2023 \pm 3 \text{ AD} \]  

determined by the time periodicity \( \{T_{S,\text{MOON,3}}\} = 3 \text{ years of recurrence of the maximal (instantaneous and integral) combined energy gravitational influences on the Earth of the system Sun-Moon and the Venus}. \)

To evaluate the duration of the next subrange of the increased global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century, it is necessary to consider the dates (in the range 1300–1389 AD) of the volcanic eruptions [Thordarson and Larsen, 2007] in Iceland on the Hekla (1300 AD, 1341 AD and 1389 AD) and the Katla (1357 AD) volcanic systems, and the dates (in the range 1300–1389 AD) of the great earthquakes [Vikulin, 2008] in China (1303 AD), England (1318 AD and 1343 AD), Armenia (1319 AD), Portugal (1320 AD, 1344 AD and 1356 AD), Austria (1348 AD) and Japan (1361 AD). We evaluate the mean time value of these volcanic eruptions and great earthquakes as follows

\[ (1300 + 1341 + 1389 + 1357 + 1303 + 1318 + 1343 + 1319 + 1320 + 1344 + 1356 + 1348 + 1361)/13 = \]

\[ = 1338.38 \text{ years} = 1338.38 \text{ AD}. \]  

Using the mean time value (3.315) and the founded range (3.256) of the fundamental global periodicities \( T_{\text{tec},f} = T_{\text{clim},f} = 696 + 708 \text{ years} \) (of the global seismotectonic and volcanic activities and the climate variability of the Earth determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn), we can evaluate the second subrange of the increased global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century.
century as follows

\[ 1338.38 \text{ years} + 696 + 708 \text{ years} = 2034.38 \div 2046.38 \text{ AD}, \quad (3.316) \]

which is characterized by the increased peak intensity of the global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century near the following mean time of the subrange (3.316):

\[ (2034.38 + 2046.38) / 2 \text{ years} = 2040.38 \text{ years} = 2040.38 \text{ AD}, \quad (3.317) \]

Based on the mean time (3.317), we obtain the more narrow second subrange of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century

\[ 2040.38 \text{ years} \pm 3 \text{ years} = 2037.38 \div 2043.38 \text{ AD}, \quad (3.318) \]

determined by the time periodicity \( \{T_{5, \text{MOON}}\}_{1} = 3 \text{ years} \) of recurrence of the maximal (instantaneous and integral) combined energy gravitational influences on the Earth of the system Sun-Moon and the Venus.

Reconstructing the ancient history of the humankind in his “Egypt’s Place in Universal History” [Von Bunzen, 1848], Bunzen revealed the marks of the planetary disaster related with the dramatic change of the landscape of the Central Asia in 10555 BC. Considering the ancient history of the humankind in his “Fingerprints of the Gods” [Hancock, 1997], Graham Hancock revealed the Egyptian marks of the planetary disaster in 10450 BC. We assumed [Simonenko, 2009; 2010] that the Bunzen’s (10555 BC) and Hancock’s (10450 BC) estimations are related with the same (or, the distinct events of the same) planetary disaster during the time range 10555 BC ÷ 10450 BC in the ancient history of the humankind. Taking into account the global time periodicity (of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability) 12540 years [Simonenko, 2007; p. 136] of recurrence of the maximal seismotectonic and volcanic activity and the global climate variability and considering the documented dates (10555 BC [Von Bunzen, 1848] and 10450 BC [H Hancock, 1997] revealed in the Central Asia and Egypt, respectively) as a manifestations of the same global cataclysm (accompanied by a super-earthquakes), we can evaluate the possible time range of recurrence of these disasters:

- (10555 years ÷ 10450 years) + 12540 years = 1985 years ÷ 2090 years = 1985 ÷ 2090 AD. \quad (3.319)

The founded (in Subsection 3.9) forthcoming range 2020 ÷ 2061 AD [Simonenko, 2012] (of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696 ÷ 708 years of the history of humankind) is the more accurate and narrow estimation of the obtained range 1985 ÷ 2090 AD. However, taking into account the closeness of estimations (presented in Subsection 3.8.4.6) (3.295) and (3.296) to integers 15 and 3, respectively, we can conclude that the obtained mean estimation 10502.5 BC (of the planetary disaster (10555 BC) in the Central Asia [Von Bunzen, 1848, pp. 77-78, 88] and the planetary disaster (10450 BC) in ancient Egyptian Kingdom [Hancock, 1997]) can be considered as the more probable date related with the same planetary disaster in the ancient history of the humankind. Using the obtained mean estimation 10502.5 BC ((10555+10450)/2) of the planetary disaster (10555 BC) in the Central Asia [Von Bunzen, 1848, pp. 77-78, 88] and the planetary disaster (10450 BC) in ancient Egyptian Kingdom [H Hancock, 1997], we can evaluate the more probable date of recurrence of these disaster:

- (10502.5 years) + 12540 years = 2037.5 years = 2037.5 AD, \quad (3.320)

which enter into the second obtained subrange 2037.38 ÷ 2043.38 AD (given by (3.318)) of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century. It means that the second obtained subrange 2037.38 ÷ 2043.38 AD will be the more dangerous and destructive for the humankind in the 21st century.

Considering the date (63 BC) of the greatest earthquake destroyed the ancient Pontus and the founded time periodicity 708 years given by the upper value in the founded range (3.256) of the fundamental global periodicities \( T_{\text{ecf}} = T_{\text{clim}, f} = 696 + 708 \text{ yr} \) of the global seismotectonic and volcanic activities and the climate variability of the Earth determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn), we can evaluate the third next subrange of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century

\[ -63 \text{ years} + (3 \times 708 \text{ years}) + 3 \text{ years} = 2061 \pm 3 \text{ years} = 2058 \pm 2064 \text{ AD} \quad (3.321) \]

determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn. The time periodicity \( \{T_{5, \text{MOON}}\}_{1} = 3 \text{ years} \) (of recurrence of the maximal (instantaneous and integral) combined energy gravitational influences on the Earth of the system Sun-Moon
and the Venus) determines the width of the subrange (3.321).

Thus, taking into account the founded range (3.256) of the fundamental global periodicities
$T_{\text{tec.f}} = T_{\text{clim1.f}} = 696 \div 708 \text{ yr}$ [Simonenko, 2012] of the global seismotectonic and volcanic activities and
the climate variability of the Earth determined by the combined predominant non-stationary energy
gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to
the gravitational interactions of the Sun with the Jupiter and the Saturn, we evaluate (inside the established
range $2020 \div 2061 \text{ AD}$ [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities
of the Earth during the past $696 \div 708$ years of the history of humankind) the subsequent subranges
(2023$\pm$3 AD given by (3.314), 2040.38 $\pm$ 3 AD given by (3.318) and 2061$\pm$3 AD given by (3.321))
of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in
the 21st century. Consequently, the worldwide safety precautions are needed to prepare in advance for these
increased peaks of the global seismotectonic, volcanic and climatic intensification of the Earth in the 21st
century.
4. THE SYNTHESIS OF MAIN RESULTS AND CONCLUSIONS

We have founded in this monograph the cosmic energy gravitational genesis of the increase of the seismic and volcanic activity of the Earth in the end of the 20th century [Abramov, 1997] and in the beginning of the 21st Century AD [Simonenko, 2007]. To do this, the Thermohydrogravidynamics of the Solar System [Simonenko, 2007; 2007a; 2008] and the Fundamentals of the Thermohydrogravidynamic Theory of Cosmic Genesis of the Planetary Cataclysms [Simonenko, 2009; 2010] are extended by taking into account the additional non-stationary energy gravitational influences on the Earth of the Sun owing to the gravitational interactions of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune. The presented extended thermohydrogravidynamic theory of cosmic genesis of the planetary cataclysms is based on the established generalized formulation [Simonenko, 2007a; 2007] of the first law of thermodynamics for moving rotating deforming compressible heat-conducting stratified macroscopic continuum region \( \tau \) subjected to the non-stationary Newtonian gravitational field.

Using the classical continuum-mechanical theoretical approach [Batchelor, 1967], we have presented in Subsection 1.1 the generalized expression (in non-equilibrium thermodynamics [Simonenko, 2004; 2006]) for the macroscopic kinetic energy of a small continuum region. We have generalized [Simonenko, 2004; 2006] the classical expression [de Groot and Mazur, 1962] in classical non-equilibrium thermodynamics for the macroscopic kinetic energy per unit mass of a small macroscopic continuum region (considered in a stratified three-dimensional shear flow) by taking into account the irreversible shear component of the hydrodynamic velocity field related with the rate of strain tensor \( \varepsilon_{ij} \). The macroscopic kinetic energy (of the small macroscopic continuum region) is presented as a sum of the macroscopic translational kinetic energy and three Galilean invariants: the classical macroscopic internal rotational kinetic energy [de Groot and Mazur, 1962], the established macroscopic internal shear kinetic energy [Simonenko, 2004; 2006] and the established macroscopic internal kinetic energy of shear-rotational coupling [Simonenko, 2004; 2006] with small correction. The obtained formula (1.13) for the macroscopic kinetic energy per unit mass \( \varepsilon_{4s} \) and its particular form (1.24) for homogeneous continuum regions of spherical and cubical shapes generalize the classical de Groot and Mazur expression (1.1) in classical non-equilibrium thermodynamics [de Groot and Mazur, 1962; Gyarmati, 1970] by taking into account the established [Simonenko, 2004; 2006; 2007] macroscopic internal shear kinetic energy per unit mass \( \varepsilon_{s, \text{irr}} \), which expresses the kinetic energy of irreversible dissipative shear motion, and also the established [Simonenko, 2004; 2006] macroscopic internal kinetic energy of shear-rotational coupling per unit mass \( \varepsilon_{\text{coup}} \), which expresses the kinetic energy of local coupling between irreversible dissipative shear and reversible rigid-like rotational macroscopic fluid motions. The presented expression (1.13) confirms the postulate [Evans, Hanley and Hess, 1984] that the velocity shear \( (\varepsilon_{ij} \neq 0) \) represents an additional energy source taking into account in the Evans, Hanley and Hess’s postulated formulation of the first law of thermodynamics for non-equilibrium deformed states of fluid motion.

We have presented the established conceptions [Simonenko, 2004; 2006; 2007a; 2007]: the macroscopic internal shear kinetic energy (expressing the kinetic energy of the non-equilibrium shear motion near the mass center of the small macroscopic continuum region); the macroscopic internal kinetic energy of shear-rotational coupling (expressing the kinetic energy of the nonlinear coupling between the equilibrium rigid-like rotational motion and the non-equilibrium shear motion near the mass center of the small macroscopic continuum region); the macroscopic internal kinetic energy of the small macroscopic continuum region (expressing the macroscopic kinetic energy in the \( K' \) - coordinate system related with the mass center of the continuum region); the macroscopic internal shear-rotational kinetic energy (defined as the sum of the macroscopic internal rotational kinetic energy, the macroscopic internal shear kinetic energy and the macroscopic internal kinetic energy of shear-rotational coupling). The established analytical formulae for the macroscopic kinetic energy (per unit mass), the macroscopic internal shear kinetic energy (per unit mass), the macroscopic internal rotational kinetic energy (per unit mass), the macroscopic internal kinetic energy of shear-rotational coupling (per unit mass), the macroscopic internal kinetic energy (per unit mass) are presented in tensorial forms for the small macroscopic continuum region considered in a stratified shear three-dimensional flow. The analytical formulae for the established energies are derived from the mathematical analysis of the relative fluid motion (in the Euclidean space) considered in the inertial Cartesian coordinate system \( K \) within the frame of the classical continuum-mechanical theoretical approach [Batchelor, 1967].

We have established [Simonenko, 2004] that the macroscopic internal kinetic energy may be approxi-
mated for a small continuum region as the sum of the macroscopic internal shear kinetic energy, the macroscopic internal kinetic energy of shear-rotational coupling and the classical de Groot and Mazur macroscopic internal rotational kinetic energy [de Groot and Mazur, 1962].

We have presented the evidence [Simonenko, 2006] that the established proportionality [Simonenko, 2004] \( \varepsilon_s \propto \varepsilon_{\text{dis}} \) of the macroscopic internal shear kinetic energy per unit mass \( \varepsilon_s = \frac{1}{2} \beta (e_{ij})^2 \) (for homogeneous continuum regions of spherical and cubical shapes) and the kinetic energy dissipation rate per unit mass \( \varepsilon_{\text{dis}} = 2 \nu (e_{ij})^2 \) in an incompressible viscous Newtonian continuum (characterized by the kinematic viscosity \( \nu \)) may be considered as the real foundation of the remarkable association [Prigogine and Stengers, 1984; Nicolis and Prigogine, 1989] between a structure and an order (and, hence, the related kinetic energy), on the one hand, and the irreversible dissipation, on the other hand, for the dissipative structures in viscous Newtonian fluids.

Based on the postulates of thermodynamics, continuum mechanics and hydrodynamics, we have presented in Subsection 1.2 the equivalent generalized differential formulations (1.43), (1.50) and (1.53) (given for the Galilean frame of reference) of the first law of thermodynamics [Simonenko, 2007a; 2007; 2008] for non-equilibrium shear-rotational states of the deformed finite one-component individual continuum region (characterized by the symmetric stress tensor \( T \)) moving in the non-stationary Newtonian gravitational field. The equivalent generalized differential formulations (1.43), (1.50) and (1.53) are valid for moving rotating deforming heat-conducting stratified macroscopic continuum region \( \tau \) subjected to the non-stationary Newtonian gravity). The generalized differential formulation (1.50):

\[
dU_\tau + dK_\tau + d\pi_\tau = \delta Q + \delta A_{\text{np},\tau} + dG
\]

(1.50)

by taking into account (along with the classical infinitesimal change of heat \( \delta Q \) and the classical infinitesimal change of the internal energy \( dU_\tau \equiv dU \)) the infinitesimal increment of the macroscopic kinetic energy \( dK_\tau \), the infinitesimal increment of the gravitational potential energy \( dG \), the generalized expression [Simonenko, 2007a; 2007] for the infinitesimal work \( \delta A_{\text{np},\tau} \) done on the continuum region \( \tau \) by the surroundings of \( \tau \), the infinitesimal amount \( dG \) of energy (given by the expression (1.52)) added (or lost) as the result of the Newtonian non-stationary gravitational energy influence on the continuum region \( \tau \) during the infinitesimal time interval \( d\tau \). The equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics may be considered as the same differential formulations (1.43), (1.50) and (1.53) of the first law of thermohydrogravidadynamics for the continuum region \( \tau \). The presented generalized expression [Simonenko, 2007a; 2007] for infinitesimal work \( \delta A_{\text{np},\tau} \) (done on the continuum region \( \tau \) by the surroundings of \( \tau \)) generalizes the classical [Gibbs, 1873] expression

\[
\delta A_{\text{np},\tau} = - \delta W = - pdV
\]

by taking into account (for Newtonian continuum) the infinitesimal work \( \delta A_\psi \) (given by expression (1.62)) of the acoustic forces and the infinitesimal work \( \delta A_s \) (given by expression (1.63)) of the viscous forces acting during the infinitesimal time interval \( d\tau \) on the boundary surface \( \partial \tau \) of the individual continuum region \( \tau \) bounded by the continuum boundary surface \( \partial \tau \).

Based on the equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics and the obtained expression (1.68) for the gravitational energy power \( W_{\text{gr}}(\tau) \), we have presented in Subsection 1.4 the established [Simonenko, 2007a; 2007] gravitational energy mechanism of the gravitational energy supply into the continuum region \( \tau \) owing to the local time increase of the potential \( \Psi \) of the gravitational field inside the continuum region \( \tau \) subjected to the non-stationary Newtonian gravitational field. We have presented the evidence that the revealed gravitational mechanism [Simonenko, 2007a; 2007] of the gravitational energy supply into the continuum region \( \tau \) is consistent with the empirical finding [Abramov, 1997; p. 60] that the anomalous variations of the gravity field on the background of the Moon-Sun induced variations go in front of the earthquakes. Based on the equivalent generalized differential
formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics, we have presented the conclusion [Simonenko, 2007] about the significant increase of the energy flux $\delta F_{\text{vis},c}$ (given by expression (1.70)) of the geo-acoustic energy from the focal region $\tau$ before the earthquake in a good agreement with the results of the detailed experimental studies [Dolgikh et al., 2006].

Using the established [Simonenko, 2004; 2006] generalized expression (1.6) for the total macroscopic kinetic energy $(K_\tau)_\alpha$ of each subsystem $\alpha$, we have presented in Subsection 1.6 the deduction [Simonenko, 2007] of the conditions of the thermodynamic equilibrium in the closed thermohydrogravidynamic system. We have considered in Subsection 1.6.1 the equilibrium state of the closed thermodynamic system in classical statistical physics [Landau and Lifshitz, 1976]. We have presented in Subsection 1.6.2 the conservation law [Simonenko, 2007] of the total energy for the closed thermohydrogravidynamic system $\tau$ in the frame of the continuum model. We have considered in Subsection 1.6.3 the classical statistical properties of the thermodynamically equilibrium subsystem in the classical statistical physics [Landau and Lifshitz, 1976]. We have presented in Subsection 1.6.4 the definition of entropy (of the thermodynamic system in the classical statistical physics [Landau and Lifshitz, 1976]) related with the Galilean principle of relativity. We have formulated in Subsection 1.6.5 the condition of the thermodynamic equilibrium for the closed thermohydrogravidynamic system considered in the coordinate system $K'_{\text{sys}}$ of the mass center $C_{\text{sys}}$ of the thermohydrogravidynamic system under imposed conservation laws of the total energy and the total angular momentum. We have presented in Subsection 1.6.6 the generalized expression [Simonenko, 2007] for the angular momentum of the subsystem $\tau_\alpha$ (macroscopic continuum region $\tau_\alpha$) for the non-equilibrium thermodynamic state. We have presented in Subsection 1.6.7 the condition (1.117) of the thermodynamic equilibrium [Simonenko, 2007] for the closed thermohydrogravidynamic system (consisting of $N$ thermohydrogravidynamic subsystems) considering in the inertial coordinate system $K'_{\text{sys}}$, related with the mass center $C_{\text{sys}}$ of the thermohydrogravidynamic system. We have presented in Subsection 1.6.8 the conditions of the thermodynamic equilibrium [Simonenko, 2007] of the closed thermohydrogravidynamic system consisting of $N$ thermohydrogravidynamic subsystems considered in the arbitrary inertial coordinate system $K$. We have presented in Subsection 1.6.8.1 the condition (1.121) of the thermodynamic equilibrium (of the closed thermohydrogravidynamic system) describing the relative movements of the mass centers of all subsystems. We have presented in Subsection 1.6.8.2 the conditions (1.125) and (1.118) of the thermodynamic equilibrium [Simonenko, 2007] of the closed thermohydrogravidynamic system relative to the macroscopic non-equilibrium kinetic energies of the subsystems $\tau_\alpha$. We have presented the evidence [Simonenko, 2007] that the disturbing cosmic energy gravitational influences (acting on the planets of the Solar System) can induce the irregular variations of the angular velocities of internal rotation of the planets of the Solar System.

Taking into account the shear-rotational thermodynamic states of the considered macroscopic system $\tau$, we have presented in Subsection 1.7 the generalization [Simonenko, 2007a; 2007] of the Le Chatelier–Braun principle [Landau and Lifshitz, 1976] on the closed equilibrium rotating thermohydrogravidynamic systems $(\tau + \bar{\tau})$ consisting of two subsystems: macroscopic continuum region $\tau$ (the subsystem in the viscous compressible continuum, which can be the focal region of the earthquakes) and some large subsystem $\bar{\tau}$ complementing the subsystem $\tau$ to obtain the closed thermohydrogravidynamic system $(\tau + \bar{\tau})$. We have presented the evaluation [Simonenko, 2007a; 2007] of the relaxation processes in the closed rotational thermohydrogravidynamic systems $(\tau + \bar{\tau})$ in terms of the total entropy of the rotational thermohydrogravidynamic systems $(\tau + \bar{\tau})$ after the deformational influence on the subsystem $\tau$. We have presented the evidence [Simonenko, 2007a; 2007] that the entropy $S$ of the thermohydrogravidynamic system is reduced up to the same value $S|_y$ (which is less than the value $S_0$ characterizing the equilibrium state of the thermohydrogravidynamic system) as a result of the external momentary deformational influence on the subsystem $\tau$ (especially, induced by the cosmic gravitation) related with the added macroscopic internal shear kinetic energy $(K_y)_\tau$, when the component $y = y_i = (M_i)_{\tau}$ of the angular momentum $M_i$ does not change directly as a result of sharp change $(K_y)_\tau > 0$ relative to the equilibrium zero value. Generalizing the Le Chatelier-Braun’s principle on the rotational thermohydrogravidynamic systems, we have presented the evidence [Simonenko, 2007a; 2007] that the total entropy of the closed thermohydrogravidynamic system is increased up to the value $S|_{F_{\text{vis},c}}$, which is less than the value $S_0$ and is larger than the value $S|_y$. 

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(S_o > S_{t_{0}} > S_{\tau}) as a result of the irreversible relaxation processes (in the thermohydrogravidynamic system) diminishing the result of the deformation influence on the subsystem \( \tau \) related with the added macroscopic internal shear kinetic energy \( (K_{s})_{\alpha} > 0 \) to the subsystem \( \tau \). Taking into account that the external influence on the subsystem \( \tau \) of the Earth \((\tau + \tilde{\tau})\) can realize the increasing cosmic gravitational field (by means of the term \( W_{\text{gr}}(\tau) \) given by the expression (1.68) in the generalized differential formulation of the first law of thermodynamics (1.53)), we have presented the evidence [Simonenko, 2007] that the resulting reduction (up to the value \( S_{\tau} \), which is less than the value \( S_{o} \) characterizing the equilibrium state of the rotational Earth) of the entropy \( S \) of the Earth \((\tau + \tilde{\tau})\) reveals the creative role of the external cosmic energy gravitational influences on the Earth.

We have presented in Subsection 1.8 the subsequent generalization (1.155) of the first law of thermodynamics (for moving rotating deformed compressible heat-conducting stratified individual macroscopic region \( \tau \) of turbulent electromagnetic plasma subjected to the non-stationary Newtonian gravity and the non-stationary electromagnetic field) extending the established generalized differential formulation (1.50) by taking into account (along with the infinitesimal change \( dU_{\tau} \) of the internal energy \( U_{\tau} \) of turbulent plasma without the emitted fast neutrons in the individual region \( \tau \), the increment \( dK_{\tau} \) of the macroscopic kinetic energy \( K_{\tau} \) of turbulent plasma in the individual region \( \tau \)) the following additional terms: the useful energy production \( P(t)dt \) of fast neutrons (emitted during time interval \( dt \) due to the thermonuclear reaction between two nuclei of deuterium or between nuclei of deuterium and tritium in a high temperature plasma) characterized by the positive released energy power \( P(t) \) (which should be directed from the individual region \( \tau \) to sustain the controlled thermonuclear process), the differential change \( dE_{e,m,\tau} \) of electromagnetic energy \( E_{e,m,\tau} \) inside the individual region \( \tau \) of plasma, the energy flux \( \delta F_{e,m} \) of electromagnetic energy radiated across the boundary surface \( \partial \tau \) of the individual region \( \tau \), the differential heating \( \delta Q_{e,m} \) due to the differential work of electrodynamic forces (resulted to the Joule heating owing to the plasma current) and due to the dissipated electromagnetic waves inside the individual region \( \tau \), and the differential amount of energy \( c^{2}dm_{\tau} > 0 \) released (as a consequence of the thermonuclear burning mechanism proposed by Dr. Hans Bethe in 1939 for the Sun) due to the thermonuclear reaction related to the conversion of the differential amount of mass \( dm_{\tau} \) (a small difference between the initial and final reactive components of the thermonuclear reaction inside the individual region \( \tau \)) into energy. The generalized formulation (1.155) of the first law of thermodynamics (for moving rotating deformed compressible heat-conducting stratified individual macroscopic region \( \tau \) of turbulent electromagnetic plasma subjected to the non-stationary Newtonian gravity and the non-stationary electromagnetic field) is presented for the urgent practical realization of the controlled thermonuclear reactions [Kapitza, 1978] to enhance the energy power of humankind before the forthcoming range \( 2020 \div 2061 \text{AD} \) [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century during the past \( 696 \div 708 \) years of the history of humankind.

We have presented in Section 2 the fundamentals of the cosmic geology [Simonenko, 2007; 2008]. We have presented in Subsection 2.1 the expressions [Simonenko, 2007] for the total energy \( E_{\tau} \) and the total angular momentum \( M_{\tau_{0}} \) of the planet \( \tau_{0} \) (and the satellite of the planet) taking into account the internal thermohydrogravidynamic structure of the planet \( \tau_{0} \) (and the satellite of the planet). Considering the Solar System as the open thermohydrogravidynamic system containing the set of separate thermohydrogravidynamic subsystems (the planets \( \tau_{n} \) and the satellites of the planets) and disregarding the presence of atmospheres and hydrospheres (of the planets and the satellites of the planets), we have presented the expressions (2.17) and (2.18) [Simonenko, 2004a; 2007; 2008] for the total energy and the total angular momentum for the Solar System consisting of \( N \) cosmic material objects (the Sun, the planets, the satellites of the planets, the midget planets, known asteroids and comets of the Solar System). Using the expressions (2.17) and (2.18), we have presented the evidence [Simonenko, 2004a; 2007; 2008] of the mutual energy transformations between the accumulated internal energies (of the accumulated internal energies of deformation, compression and strain of the continuum of the planets) and the macroscopic internal rotational [de Groot and Mazur, 1962; Gyarmati, 1970] and the macroscopic internal non-equilibrium kinetic energies.
[Simonenko, 2004] of the planets. We have demonstrated the evidence [Simonenko, 2004a; 2007; 2008] that the mutual energy transformations can result to the evolutionary change of the directions (and axes) of rotation of the planets and the satellites (of the planets) of the Solar System.

Taking into account the system of the expressions (2.19) and (2.20), respectively, of the total energy and the total angular momentum of the subsystem \( \tau \) (the subsystem of the planet \((\tau + \overline{\tau})\) without the surrounding subsystem \(\overline{\tau}\) (the atmosphere or the atmosphere and hydrosphere)) of the planet \((\tau + \overline{\tau})\), we have presented the evidence [Simonenko, 2004a; 2007; 2008] of the mutual energy transformations between the accumulated internal energy \(U_\tau\) of the subsystem \(\tau\) and the macroscopic internal rotational kinetic energy \((K_\tau)_\sigma\) of the subsystem \(\tau\) of the planet \((\tau + \overline{\tau})\), the macroscopic internal shear kinetic energy \((K_s)_\sigma\) and the macroscopic internal kinetic energy of shear-rotational coupling \((K_{s,r})_{\sigma}\) of the subsystem \(\tau\) of the planet \((\tau + \overline{\tau})\) during the seismotectonic relaxation of the planet \((\tau + \overline{\tau})\). These energy transformations gave the real evidence [Simonenko, 2007a; 2007; 2008] to consider the seismotectonic relaxation of the planet \((\tau + \overline{\tau})\) as the global planetary process [Vikulin, 2003].

In Subsection 2.2. we have presented the non-catastrophic models [Simonenko, 2007a; 2007; 2008] of the thermohydrogravidynamic evolution of the total energy of the subsystems \((\tau\text{ and }\overline{\tau})\) of the planet \((\tau + \overline{\tau})\) subjected to the cosmic non-stationary energy gravitational influences of the Solar System and our Galaxy. Using the generalized differential formulation (2.21) of the first law of thermodynamics (taking into account the additional term related with the space-time density \(\epsilon_\tau\) of heating due to the disintegration of the radio-active elements inside the planet \((\tau + \overline{\tau})\) of the Solar System and the human industrial activity), we have presented in Subsection 2.2.1 the non-catastrophic model [Simonenko, 2007] of the thermohydrogravidynamic evolution of the total energy \(E_\tau(t)\) of the subsystem \(\tau\) of the planet \((\tau + \overline{\tau})\) bounded by the external boundary surface \(\partial\tau\), on which the subsystem \(\tau\) interacts with the subsystem \(\overline{\tau}\) representing the atmosphere or atmosphere and hydrosphere of the planet \((\tau + \overline{\tau})\). We assumed [Simonenko, 2007] that the planet \((\tau + \overline{\tau})\) evolves during some time period without formation of the new planetary tectonic fractures in the subsystem \(\tau\) surrounded by the subsystem \(\overline{\tau}\) (the atmosphere or the atmosphere and hydrosphere).

We have presented the integral expression (2.22) for the time evolution of the total energy \((E(t))_\tau\) of the subsystem \(\tau\) of the planet \((\tau + \overline{\tau})\) in the absence of the new catastrophic planetary tectonic fractures in the subsystem \(\tau\) surrounded by the subsystem \(\overline{\tau}\) (atmosphere or atmosphere and hydrosphere). Based on the expression (2.22), we have presented the evidence [Simonenko, 2007a; 2007; 2008] that the time evolution of the total energy \((E(t))_\tau\) of the subsystem \(\tau\) is determined by the dynamic and thermal energy exchanges on the boundary surface \(\partial\tau\), by the time change of the potential \(\Psi\) of the gravitational field in the subsystem \(\tau\) of the planet \((\tau + \overline{\tau})\), by the thermal heating in the subsystem \(\tau\) owing to disintegration of the radio-active elements. We have presented the evidence [Simonenko, 2007a; 2007; 2008] that the regulation of the macroscopic internal rotational kinetic energy \((K_\tau(t))_\sigma\) and the angular velocity \(\omega(t)\) of rotation of the subsystem \(\tau\) of the planet \((\tau + \overline{\tau})\) is determined (under thermodynamically equilibrium regime of rotation of the subsystem \(\tau\) characterizing by constant angular velocity \(\omega(t)\) for all continuum region \(\tau\) and by \((K_s(t))_\sigma = 0\) and \((K_{s,r}(t))_\sigma = 0\)) by the time change of the potential \(\Psi\) of the gravitational field in the subsystem \(\tau\) and also by the dynamic energy exchange [Dolgikh, 2000] on the boundary surface \(\partial\tau\) between the atmosphere-hydrosphere (representing the subsystem \(\overline{\tau}\)) and the subsystem \(\tau\) containing the lithosphere and all geo-spheres of the planet \((\tau + \overline{\tau})\). This conclusion is in agreement with the documented [Endrecon, 1958] phenomenon of the partial solar determination of the rotational regime of the Earth by means of atmospheric and oceanic circulations. We have presented also the evidence [Simonenko, 2007a; 2007; 2008] that the long-term changes of the angular velocity of the Earth’s rotation are defined by changes of thermal heating owing to disintegration of the radio-active elements and by cyclic changes of the solar radiation activity, which change the distributions of the average circulations of the atmosphere and the oceans and the corresponding fields of the thermohydrodynamic parameters near the lithosphere of the Earth.

Based on the expression (1.63) for the differential work \(\delta A_s\) of the viscous Newtonian forces (related with the combined effect of the velocity shear and the molecular kinematic viscosity), we have presented the evi-
evidence [Simonenko, 2007a; 2007; 2008] that the energy exchange between the atmosphere-hydrosphere (the oceans and the atmosphere) and the lithosphere of the Earth is possible only under the presence of the medium acoustic compressibility (i.e., $\text{div } \mathbf{v} \neq 0$) and the medium deformations (i.e., $e_{\alpha\beta} \neq 0$) in the boundary regions of fluid (in the oceans), air (in the atmosphere) and the lithosphere of the Earth. We have presented the evidence [Simonenko, 2007a; 2007; 2008] that it is necessary to use the real information about the oscillations of the lithosphere [Dolgikh, 2000] for modeling of the energy exchanges between atmosphere-hydrosphere and the lithosphere of the Earth by means of the term $\delta A_p$ (alongside with the terms $\delta A_{p\text{,}e}$ in the expression (1.60) for the differential work $\delta A_{np,e}$).

Using the expression (2.22), we have presented the evidence [Simonenko, 2007a; 2007; 2008] that the compression of the subsystem $\tau$ of the planet $(\tau + \bar{\tau})$ accompanied by the increase of the gravitational potential $\Psi$ in the fixed point of space must induce the increase of the internal thermal energy and the corresponding heat flux from the kernel of the planet in accordance with the Milanovsky’s conclusion [Милановский, 1979] that the geological eras of the intensive increase of the heat flux correspond to the eras of general compression of the Earth. We have presented in Subsection 2.2.1 the evidence [Simonenko, 2007a; 2007; 2008] of the galactic energy gravitational genesis (related with the circulation of the Solar System around the center of our Galaxy) of each cycle (the compression, the stretching and the more lasting reduction of the tectonic motions) of the geological eras of the Earth during the latest 570 million years.

Using the generalized differential formulation (1.53) of the first law of thermodynamics (with the additional source of heat $e_{\alpha}$ in the subsystem $\bar{\tau}$) for the total combined subsystem $\bar{\tau}$ (atmosphere or atmosphere and hydrosphere) in the frame of the thermohydrogravidynamic theory, in Subsection 2.2.2 we have presented the deduction [Simonenko, 2007a; 2007; 2008] of the evolution equation (2.24) for the total energy $E_{\bar{\tau}}$ of the subsystems $\bar{\tau}$ taking into account the dynamic and thermal energy exchanges on the boundary surface $\partial \tau$ dividing the subsystems $\tau$ and $\bar{\tau}$, the time change of the potential $\Psi$ of the gravitational field in the subsystem $\bar{\tau}$ of the planet $(\tau + \bar{\tau})$ and the total fluxes of heat (related with the electromagnetic radiation of the Sun) on the external boundary surface $\partial(\tau + \bar{\tau})$ of the planet $(\tau + \bar{\tau})$.

Based on the generalized differential formulation (1.53) of the first law of thermodynamics taking into account all above listed energy factors for the subsystems $\tau$ and $\bar{\tau}$ of the planet $(\tau + \bar{\tau})$, in Subsection 2.2.3 we have presented the deduction [Simonenko, 2007a; 2007; 2008] of the evolution equation (2.25) for the total energy $E_{(\tau + \bar{\tau})}$ of the planet $(\tau + \bar{\tau})$ consisting from the subsystems $\tau$ and $\bar{\tau}$ interacting on the boundary surface $\partial \tau$. The deduced (from the evolution equation (2.25)) expression (2.26) for the evolution of the total energy $(E(t))_{(\tau + \bar{\tau})}$ is considered [Simonenko, 2007a; 2007; 2008] the long-term energy sources, which define (for the planet $(\tau + \bar{\tau})$) the amazing wealth of the collective processes in the Solar System [Гор'кавый и Фридман, 1994] excepting the striking heating.

We have presented in Subsection 2.3 the synthesis of the cosmic geology [Simonenko, 2007; 2008] taking into account the convection in the lower geo-spheres of the planet (of the Earth), the density differentiation, the translational, rotational and deformational movements of the tectonic plates, the creation of the new planetary tectonic fractures induced by the energy gravitational influences of the Solar System and our Galaxy. Using the generalized differential formulation (2.21) of the first law of thermodynamics, we have presented in Subsection 2.3.1 the fundamentals of the thermohydrogravidynamic N-layer model [Simonenko, 2007; 2008] of the non-fragmentary geo-spheres of the planet (of the Earth) of the Solar System. Based on the founded [Simonenko, 2007; 2008] evolution equation (2.30) of the total energy $E_{\tau}$ of the subsystem $\tau$ (consisting of N successively embedded to each other subsystems (geo-spheres) $\tau_{N}, \tau_{N-1}, \ldots, \tau_{2}, \tau_{1}$) of the planet $(\tau + \bar{\tau})$, we have presented in Subsection 2.3.1 the expression (2.31) for the necessary power $W_{\text{er}}(\Delta \Sigma_{\tau})$ (in particular, of the external energy gravitational influence), which is sufficient to break the crystalline root of the considered continental and oceanic planetary tectonic formations (characterized [Абрамов и Молев, 2005, p. 245] by the mantle penetrated deep roots) in one section characterized by the area $\Delta \Sigma_{\tau}$. We have presented the evidence [Simonenko, 2007; 2008] that the translational mobility of the upper subsystem $\tau_{1} = \tau_{\text{ext}}$ of the Earth (also as a separate tectonic plates and geo-blocks of the subsystem
\( \tau_1 = \tau_{\text{ext}} \) is greatly restricted by the deep roots of the continental and oceanic planetary formations (for two data [Abramov and Molev, 2005; p. 245; Pavlenkova, 2007] about the roots of continents). We have presented the evidence [Simonenko, 2007; 2008] (for two data [Abramov and Molev, 2005; p. 245; Pavlenkova, 2007; p. 107] about the roots of continents) that it is easier to realize (by action of the external cosmic gravitational field) the assumed [Pavlenkova, 1995] rotation of the mantle (as a whole) relative to the fluid kernel with the slippage on the boundary of the fluid kernel and the mantle of the Earth than to split the mantle of the Earth by means of the new global tectonic fracture breaking the mantle into two equal parts in the different sides of the main secant plane intersecting the centre of the Earth. Using the evolution equation (2.32) for the sum \( K_1 + \pi_1 \) of the total macroscopic kinetic energy \( K_1 \) and the total macroscopic potential (gravitational) energy \( \pi_1 \) of the subsystem \( \tau \) (of the Earth or the planet of the Solar System), we have presented the evidence [Simonenko, 2007; 2008] that the revealed time period 100 million years [Hofmann, 1990] of the maximal endogenous activity of the Earth [Morozov, 2007; p. 496] has the galactic energy gravitational genesis related with the periodic changes (characterized by the time period near 200 million years) of the potential of the gravitational field (of the Solar System and our Galaxy) influencing on the Earth considered as the cosmic material object moving (in the frame of the Solar System) around the center of our Galaxy.

Based on the generalized differential formulation (2.21) of the first law of thermodynamics, we have presented in Subsection 2.3.2 the thermohydro gravidynamic translational-shear-rotational N-layer tectonic model [Simonenko, 2007; 2008] of the fragmentary geo-spheres of the planet (\( \tau + \tau \)) (of the Earth) of the Solar System. We have presented the evolution equation (2.36) of the total energy of the geo-sphere \( \tau_i = \tau_{\text{ext}} \) (the first upper layer of the subsystem \( \tau \) of the planet (\( \tau + \tau \))). The evolution equation (2.36) represents the thermohydro gravidynamic model [Simonenko, 2007; 2008] of the translational-shear-rotational tectonics of moving rotating deforming compressible heat-conducting stratified macroscopic geo-blocks \( \tau_{ij} \) \((j = 1, 2, \ldots, N_j)\) surrounded by the coupled viscous plastic layers and subjected to the cosmic non-stationary Newtonian energy gravitational influences and heating related with disintegration of the radio-active elements (in the geo-sphere \( \tau_{\text{ext}} \)).

We have presented in Subsection 2.3.3 the universal energy thermohydro gravidynamic approach [Simonenko, 2007; 2008] intended to explain the formation of the planetary fractures in the frame of the generalized differential formulation (2.21) of the first law of thermodynamics and the thermohydro gravidynamic translational-shear-rotational N-layer tectonic model (presented in Subsection 2.3.2) of the fragmentary (consisting of geo-blocks) geo-spheres of the Earth (the planet of the Solar System). Based on the generalized differential formulation (2.21) of the first law of thermodynamics and the mathematical inductive method, we have presented the deduction of the evolution equations (2.39), (2.41) and (2.42) [Simonenko, 2007; 2008] describing the evolution of the total energy of the geo-block \( \tau_{ij} \) (of the first upper layer (geo-sphere) \( \tau = \tau_{\text{ext}} \) of the subsystem \( \tau \) of the planet (\( \tau + \tau \))) under formation of the integer number of various (uncrossed between itself) breaking fracture surfaces. Using the deduced evolution equations (2.39), (2.41) and (2.42), we have presented the established [Simonenko, 2007; 2008] energy sources of the destruction (formation of the fractures) in the geo-block \( \tau_{ij} \): the total non-stationary gravitational fields (the external, cosmic and the internal, terrestrial), the internal heat related with the disintegration of the radio-active elements, the heat flux from the upper boundary of the situated below second layer (subsystem) \( \tau_2 \) and the work of stress forces on the surface of the geo-block \( \tau_{ij} \). By considering in Subsection 2.3.3 the established [Simonenko, 2007; 2008] exceptionally significant role of the external cosmic non-stationary gravitational field for formation of the tectonic fractures, we have presented the evidence [Simonenko, 2007; 2008] of the Khain’s suggestion that the movements along the weakened planetary fractures “can occur owing to the influence of the astronomical factors” [Khain, 1958; p. 138].

We have presented in Section 3 the development of the established cosmic geophysics [Simonenko, 2007; 2008]. We have presented in Subsection 3.1 the evaluation [Simonenko, 2007; 2008; 2009; 2010] of the instantaneous and integral energy gravitational influences on the Earth of the inner planets (the Mercury and the Venus) and the outer planets (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) of the Solar System.

We have presented in Subsection 3.1.1 the derived [Simonenko, 2009; 2010] analytical expression (3.6) for the instantaneous energy gravitational influences on the Earth of the inner and the outer planets in
the second approximation of the elliptical orbits of the planets of the Solar System. We have presented the evidence [Simonenko, 2009; 2010] that the obtained evaluations [Simonenko, 2007; 2008] (presented in Subsection 3.1.2 based on the first approximation of the circular orbits of the planets) of the relative maximal planetary instantaneous energy gravitational influences on the Earth (of the planets of the Solar System) may be considered as the first sound approximation.

We have presented in Subsection 3.1.2 the evaluation [Simonenko, 2007; 2008] of the relative maximal planetary instantaneous energy gravitational influences on the unit mass of the Earth at the mass center \( C_3 \) of the Earth and at the surface point \( D_3 \) of the inner and the outer planets in the first approximation of the circular orbits of the planets. Considering the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \) of the gravitational potential \( \psi_{3M}(C_3, \text{int}) \) created by the Mercury at the mass center \( C_3 \) of the Earth) as a scale of the instantaneous energy gravitational influence of the planets of the Solar System on the Earth (in the considered first approximation of the circular orbits of the planets), we have presented in Subsection 3.1.2 the obtained [Simonenko, 2009; 2010] numerical sequence of the non-dimensional relative maximal powers of the planetary instantaneous energy gravitational influences on the Earth (on the unit mass of the Earth at the mass center \( C_3 \) of the Earth): \( f(2, C_3) = 37.69807434 \) (for the Venus), \( f(5, C_3) = 7.41055774 \) (for the Jupiter), \( f(1, C_3) = 1 \) (for the Mercury), \( f(4, C_3) = 0.67441034 \) (for the Mars), \( f(6, C_3) = 0.24601009 \) (for the Saturn), \( f(7, C_3) = 0.00319056 \) (for the Uranus), \( f(8, C_3) = 0.00077565 \) (for the Neptune) and \( f(9, C_3) = 3.4813 \times 10^{-8} \) (for the Pluto). Considering the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3M}(D_3, \text{int}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3M}(D_3, \text{int}) \) of the gravitational potential \( \psi_{3M}(D_3, \text{int}) \) created by the Mercury at the surface point \( D_3 \) of the Earth) as a scale of the instantaneous energy gravitational influence of the planets of the Solar System on the Earth (in the considered first approximation of the circular orbits of the planets), we have presented in Subsection 3.1.2 slightly corrected [Simonenko, 2009; 2010] numerical sequence (of the previously obtained numerical values [Simonenko, 2007; 2008]) of the non-dimensional relative maximal powers of the planetary instantaneous energy gravitational influences on the Earth (on the unit mass of the Earth at the surface point \( D_3 \) of the Earth): \( f(2, D_3) = 37.70428085 \) (for the Venus), \( f(5, D_3) = 7.40926122 \) (for the Jupiter), \( f(1, D_3) = 1 \) (for the Mercury), \( f(4, D_3) = 0.67420160 \) (for the Mars), \( f(6, D_3) = 0.24596865 \) (for the Saturn), \( f(7, D_3) = 0.00319004 \) (for the Uranus), \( f(8, D_3) = 0.00077552 \) (for the Neptune) and \( f(9, D_3) = 3.4807 \times 10^{-8} \) (for the Pluto). Using the obtained numerical values \( f(i, D_3) \) and \( f(i, C_3) \) (for \( i = 1, 2, 4, 5, 6, 7, 8, 9 \)), we have presented in Subsection 3.1.2 the conclusion [Simonenko, 2009; 2010] that the small difference of the combined maximal instantaneous energy gravitational influences of the planets of the Solar System on the points \( C_3 \) and \( D_3 \) of the Earth can explain the following related geophysical phenomena: the small oscillatory motion of the rigid kernel of the Earth relative to the fluid kernel of the Earth; the small oscillation of the Earth’s pole (i.e., the Chandler’s wobble of the Earth’s pole [Chandler, 1892]); the small oscillations [Vikulin, 2003] of the boundary of the Pacific Ocean (i.e., the seismic zone of the Pacific Ring); the oscillations [Dolgikh, 2000], rotations [Vikulin, 2003] and deformations [Abramov, 1993; 1997] of the geo-blocks weakly coupled with the surrounding plastic layers in all seismic zones of the Earth and the formation of fractures related with the strong earthquakes and the planetary cataclysms.

We have presented in Subsection 3.1.3 the evaluation [Simonenko, 2007] of the relative maximal planetary integral energy gravitational influences on the Earth in the approximation of the circular orbits of the planets of the Solar System. Based on the equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics used for the Earth, we have presented in Subsection 3.1.3 the following order of signification of the inner planets (the Mercury and the Venus) and the outer planets (the Mars, the Jupiter, the Saturn, the Uranus, the Neptune and the Pluto) of the Solar System [Simonenko, 2007]: the Venus \( (s(2) = 89.6409) \), the Jupiter \( (s(5) = 31.319) \), the Mars \( (s(4) = 2.6396) \), the Saturn \( (s(6) = 1.036) \), the Mercury \( (s(1) = 1) \), the Uranus \( (s(7) = 0.0133) \), the Neptune \( (s(8) = 0.003229) \) and
the Pluto \( s(9) = 1.4495 \cdot 10^{-7} \) in respect of the relative non-dimensional values \( s(t) \) of the maximal planetary integral energy gravitational influences (normalized on the maximal integral energy gravitational influence of the Mercury on the Earth) on the Earth. We have presented the evidence [Simonenko, 2007] of the predominant combined planetary integral energy gravitational influence on the Earth of the Venus and the Jupiter. The combined maximal planetary integral energy gravitational influence on the Earth of the Mars, the Saturn and the Mercury is one order of the magnitude smaller than the maximal integral energy gravitational influence of the Jupiter. The maximal combined planetary integral energy gravitational influences on the Earth of the Uranus, the Neptune and the Pluto are two, three and seven orders of the magnitude, respectively, smaller than the maximal integral energy gravitational influence of the Mercury on the Earth.

We have presented in Subsection 3.2 the evaluation [Simonenko, 2009; 2010] of the relative maximal instantaneous and integral energy gravitational influence of the Moon on the Earth as compared with the maximal planetary instantaneous and integral energy gravitational influences on the Earth (of the planets of the Solar System). We have presented in Subsection 3.2.1 the evaluation [Simonenko, 2009; 2010] of the relative maximal instantaneous energy gravitational influence of the Moon on the Earth in the second approximation of the elliptical orbits of the Earth and the Moon around the combined mass center \( C_{3, \text{MOON}} \) of the Earth and the Moon. Considering the maximal positive value \( \max \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \) (of the partial derivative \( \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int}) \) of the gravitational potential \( \psi_{3M}(C_3, \text{int}) \) created by the Mercury moving around the mass center \( O \) of the Sun along the hypothetical circular orbit) as a scale of the instantaneous energy gravitational influence of the planets of the Solar System and the Moon on the Earth, we have presented the foundation the non-dimensional numerical value \( f_{\text{MOON}}(C_3, \text{second approx.}) = 19.44083 \), which means that the power of the maximal instantaneous energy gravitational influence of the Moon (on the unit mass of the Earth at the mass center \( C_3 \) of the Earth) is \( 19.44083 \) times larger than the power of the maximal instantaneous energy gravitational influence (on the unit mass at the mass center \( C_3 \) of the Earth) of the Mercury moving around the mass center \( O \) of the Sun along the hypothetical circular orbit. Taking into account the calculated non-dimensional maximal planetary instantaneous energy gravitational influences [Simonenko, 2007] and maximal lunar instantaneous energy gravitational influence [Simonenko, 2009; 2010] on the unit mass of the Earth at the mass center \( C_3 \) of the Earth: \( f(2, C_3) = 37.69807434 \) (for the Venus), \( f_{\text{MOON}}(C_3, \text{second approx.}) = 19.44083404 \) (for the Moon), \( f(5, C_3) = 7.41055774 \) (for the Jupiter), \( f(1, C_3) = 1 \) (for the Mercury), \( f(4, C_3) = 0.67441034 \) (for the Mars), \( f(6, C_3) = 0.24601009 \) (for the Saturn), \( f(7, C_3) = 0.00319056 \) (for the Uranus), \( f(8, C_3) = 0.00077565 \) (for the Neptunne) and \( f(9, C_3) = 3.4813 \cdot 10^{-8} \) (for the Pluto), we have evaluated [Simonenko, 2009; 2010] the following order of significance (in the frame of the considered second approximation of the elliptical orbits of the Earth and the Moon around the combined mass center \( C_{3, \text{MOON}} \) of the Earth and the Moon) of the Moon and the planets of the Solar System: the Venus, the Moon, the Jupiter, the Mercury, the Mars, the Saturn, the Uranus, the Neptune and the Pluto in respect of the maximal planetary and lunar instantaneous energy gravitational influences on the unit mass of the Earth at the mass center \( C_3 \) of the Earth.

We have presented in Subsection 3.2.2 the evaluation [Simonenko, 2009; 2010] of the maximal integral energy gravitational influence of the Moon on the Earth in the approximation of the elliptical orbits of the Earth and the Moon around the combined mass center \( C_{3, \text{MOON}} \) of the Earth and the Moon. Based on the equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics used for the Earth, we have presented in Subsection 3.2.2 the foundation [Simonenko, 2009; 2010] that maximal positive integral energy gravitational influence of the Moon on the Earth is \( s(\text{Moon, second approx.}) = 13.0693 \) times larger than the maximal positive integral energy gravitational influence of the Mercury on the Earth. Considering the aspect of the cosmic planetary gravitational preparation of the Earth’s geological catastrophes and the strong earthquakes, we have established the Venussian \( s(2) = 89.6409 \) [Simonenko, 2007], the Jupiter’s \( s(5) = 31.319 \) [Simonenko, 2007] and the Moon’s \( s(\text{Moon, second approx.}) = 13.0693 \) [Simonenko, 2009; 2010] energy gravitational predominance in
supplying of the cosmic planetary and lunar gravitational energy to the focal region of the preparing earthquakes. The Venus, the Jupiter and the Moon form the predominant planetary and lunar integral energy gravitational influence on the Earth. The combined maximal integral energy gravitational influence on the Earth of the Mars ($s(4) = 2.6396$) [Simonenko, 2007], the Saturn ($s(6) = 1.036$) [Simonenko, 2007] and the Mercury ($s(1) = 1$) [Simonenko, 2007] is one order of the magnitude smaller than the maximal integral energy gravitational influence of the Jupiter. The combined maximal integral energy gravitational influence on the Earth of the Uranus ($s(7) = 0.0133$) [Simonenko, 2007], the Neptune ($s(8) = 0.003229$) [Simonenko, 2007] and the Pluto ($s(9) = 1.4495 \cdot 10^{-7}$) [Simonenko, 2007] is two orders of the magnitude smaller (i.e., negligible) than the maximal integral energy gravitational influence of the Mercury.

We have presented in Subsection 3.3 the evaluation of the energy gravitational influence of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune) of the Solar System. We have presented in Subsection 3.3.1 the evaluations of the relative characteristic maximal positive instantaneous energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets of the Solar System. We have presented in Subsection 3.3.1 the evaluations of the characteristic maximal positive instantaneous energy gravitational influences of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planets of the Solar System) as compared with the maximal planetary instantaneous energy gravitational influences on the Earth of the planets of the Solar System. The evaluations of the relative characteristic maximal positive instantaneous energy gravitational influences of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planets of the Solar System) are obtained in the approximation of the elliptical orbit of the Earth $\tau_j$ around the combined mass center $C(S,j)$ of the Sun and the outer large planets $\tau_j$ ($j = 5, 6, 7, 8$). Considering the maximal positive value $\max \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int})$ (of the partial derivative $\frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int})$ of the gravitational potential $\psi_{3M}(C_3, \text{int})$) created by the Mercury (moving around the mass center O of the Sun along the hypothetical circular orbit) at the mass center $C_3$ of the Earth) as a scale of the energy gravitational influence of the Sun (owing to the outer large planets $\tau_j$ ($j = 5, 6, 7, 8$) of the Solar System) on the Earth, we have calculated the following ratios $f_{\text{SUN,M}}(j, C_3, \text{char.})$ (given by the expression (3.96) for $j = 5, 6, 7, 8$): $f_{\text{SUN,M}}(5, C_3, \text{char.}) = 884.935424$ (for the Sun owing to the gravitational interaction of the Sun with the Jupiter), $f_{\text{SUN,M}}(6, C_3, \text{char.}) = 194.923355$ (for the Sun owing to the gravitational interaction of the Sun with the Saturn), $f_{\text{SUN,M}}(7, C_3, \text{char.}) = 21.27951$ (for the Sun owing to the gravitational interaction of the Sun with the Uranus) and $f_{\text{SUN,M}}(8, C_3, \text{char.}) = 20.833557$ (for the Sun owing to the gravitational interaction of the Sun with the Neptune). These numerical values $f_{\text{SUN,M}}(j, C_3, \text{char.})$ ($j = 5, 6, 7, 8$) are calculated based on the characteristic maximal positive values char. $\max. \frac{\partial}{\partial t} \psi_{3M}(C_3, t)$ (given by the expression (3.92) for $j = 5, 6, 7, 8$) and the maximal positive value $\max \frac{\partial}{\partial t} \psi_{3M}(C_3, \text{int})$ (given by the expression (3.93)). Taking into account the calculated numerical values $f_{\text{SUN,M}}(j, C_3, \text{char.})$ ($j = 5, 6, 7, 8$), we have established the following order of significance of the outer large planets of the Solar System: the Jupiter ($\tau_j$), the Saturn ($\tau_6$), the Uranus ($\tau_7$) and the Neptune ($\tau_7$) in respect of the evaluated characteristic maximal positive instantaneous energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets of the Solar System.

We have presented in Subsection 3.3.2 the evaluations of the maximal positive integral energy gravitational influences of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planets) in the first approximation of the circular orbits of the planets of the Solar System. Based on the equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics used for the Earth, we have presented in Subsection 3.3.2 the foundation of the relations (3.106), (3.108) and (3.109) for the maximal positive integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets $\tau_j$ ($j = 5, 6, 7, 8$). Considering the maximal
positive integral energy gravitational influence \( \max \Delta E_j (\text{Sun} - \tau_j, 0, 0, t, 0) \) (given by the expression (3.109)) of the Sun on the Earth (owing to the gravitational interaction of the Sun with the outer large planet \( \tau_j, j = 5, 6, 7, 8 \)) and the maximal positive integral energy gravitational influence \( \max \Delta E_j (\tau_j, 0, 0, t, 0) \) (given by the expression (3.48)) of the Mercury on the Earth, we have calculated the following relative values (ratios) \( s(\text{Sun} - \tau_j, \text{first approx.}) \) (defined by the relation (3.110) for \( j = 5, 6, 7, 8 \)) of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j (j = 5, 6, 7, 8) \): \( s(\text{Sun} - \tau_5, \text{first approx.}) = 4235.613239 \) (for the maximal integral energy gravitational influence of the Sun owing to the gravitational interaction of the Sun with the Jupiter), \( s(\text{Sun} - \tau_4, \text{first approx.}) = 887.4442965 \) (for the maximal integral energy gravitational influence of the Sun owing to the gravitational interaction of the Sun with the Saturn), \( s(\text{Sun} - \tau_3, \text{first approx.}) = 8337322.93 \) (for the maximal integral energy gravitational influence of the Sun owing to the gravitational interaction of the Sun with the Uranus) and \( s(\text{Sun} - \tau_2, \text{first approx.}) = 87.8477601 \) (for the maximal integral energy gravitational influence of the Sun owing to the gravitational interaction of the Sun with the Neptune). Taking into account the calculated relative values \( s(\text{Sun} - \tau_j, \text{first approx.}) \) of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j (j = 5, 6, 7, 8) \), we have established the following order of signification of the outer large planets \( \tau_j (j = 5, 6, 7, 8) \) of the Solar System: the Jupiter \( s(\text{Sun} - \tau_5, \text{first approx.}) = 4235.613239 \), the Saturn \( s(\text{Sun} - \tau_6, \text{first approx.}) = 887.4442965 \), the Uranus \( s(\text{Sun} - \tau_7, \text{first approx.}) = 8337322.93 \) and the Neptune \( s(\text{Sun} - \tau_8, \text{first approx.}) = 87.8477601 \) in respect of the presented evaluation of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j (j = 5, 6, 7, 8) \).

Thus, considering the aspect of the cosmic gravitational preparation of the strong earthquakes, we have demonstrated in Subsection 3.3 the predominance of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the Jupiter \( s(\text{Sun} - \tau_5, \text{first approx.}) = 4235.613239 \), with the Saturn \( s(\text{Sun} - \tau_6, \text{first approx.}) = 887.4442965 \), with the Uranus \( s(\text{Sun} - \tau_7, \text{first approx.}) = 8337322.93 \) and with the Neptune \( s(\text{Sun} - \tau_8, \text{first approx.}) = 87.8477601 \) along with the established [Simonenko, 2007; 2009] Venusian \( s(2) = 89.6409 \) and the Jupiter’s \( s(5) = 31.319 \) planetary energy gravitational predominance and the established [Simonenko, 2009; 2010] significant maximal integral energy gravitational influence of the Moon \( s(\text{Moon}, \text{second approx.}) = 13.0693 \) on the Earth.

Thus, taking into account the previously established planetary [Simonenko, 2007] and lunar [Simonenko, 2009; 2010] numerical values and also the calculated relative values \( s(\text{Sun} - \tau_j, \text{first approx.}) \) of the maximal integral energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets \( \tau_j (j = 5, 6, 7, 8) \), we have established in Subsection 3.3 the following order of significance of the cosmic bodies of the Solar System: the Sun (owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune), the Venus, the Jupiter, the Moon, the Mars, the Saturn, the Mercury, the Uranus, the Neptune and the Pluto in respect of the evaluated integral energy gravitational influences of these cosmic bodies on the Earth.

We have presented in Subsection 3.4 the confirmation of the real cosmic energy gravitational genesis of the strong earthquakes and the global planetary cataclysms. We have presented in Subsection 3.4.1 the confirmation [Simonenko, 2007; 2009; 2010] of the real cosmic energy gravitational genesis of preparation of earthquakes. Using the approximate expression (3.51) for the maximal positive integral energy gravitational influence \( E_g (\tau_2, D_3, m_1) \) of the Venus \( i = 2 \) on the macroscopic continuum region \( \tau \) of mass \( m_1 \) near the surface point \( D_3 \) of the Earth, we have presented in Subsection 3.4.1 the evidence [Simonenko, 2007] of the real cosmic energy gravitational genesis of the preparation of earthquakes. Based on the
equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics used for the Earth’s macroscopic continuum region \( \tau \) (the focal region of the preparing earthquake), we have shown [Simonenko, 2007] that the regular changes of the rotational regime of the Earth are related with the regular discharges of the accumulated potential energy (in the focal region of earthquakes) supplying by the cosmic energy gravitational influences of the planets of the Solar System, the Sun and the Moon.

We have presented in Subsection 3.4.2 the evidence of the integral energy gravitational influence on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter \( \tau_5 \) and the Saturn \( \tau_6 \)) and the Moon as the predominant cosmic trigger mechanism of the earthquakes preparing by the combined integral energy gravitational influence on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter \( \tau_5 \) and the Saturn \( \tau_6 \), the Uranus \( \tau_7 \) and the Neptun \( \tau_8 \)), the Venus, the Jupiter, the Moon, the Mars and the Mercury. Taking into account the obtained [Simonenko, 2007] numerical values \( e(i) \) for the planets of the Solar System, the numerical value \( s(Moon, \text{second approx.})=13.0693 \) [Simonenko, 2009; 2010] for the Moon and the calculated (in Subsection 3.4.2) numerical values \( e_{5,6}(j) \) for the Sun (owing to the gravitational interaction of the Sun with the outer large planets \( \tau_1, j=5,6,7,8 \)), we have established in Subsection 3.4.2 the predominant significance of the Sun (owing to the gravitational interactions of the Sun with the Jupiter \( \tau_5 \) and the Saturn \( \tau_6 \)) and the Moon as the predominant cosmic trigger mechanism (along with the minor significance of the Sun (owing to the gravitational interactions of the Sun with the Uranus \( \tau_7 \) and the Neptune \( \tau_8 \)), the Venus, the Jupiter and the Mercury) of the earthquakes preparing by the combined integral energy gravitational influences on the Earth of the Sun (owing to the gravitational interactions of the Sun with the Jupiter \( \tau_5 \) and the Saturn \( \tau_6 \), the Uranus \( \tau_7 \) and the Neptune \( \tau_8 \)), the Venus, the Jupiter, the Moon, the Mars and the Mercury.

We have presented in Subsection 3.4.3 the catastrophic planetary configurations of the established cosmic seismology [Simonenko, 2007]. We have presented in Subsection 3.4.3.1 the foundation of the established catastrophic planetary configurations [Simonenko, 2009; 2010] related with the maximal (positive) and minimal (negative) combined integral energy gravitational influence on the Earth \( \tau_3 \) of the planets of the Solar System. We have presented in Subsection 3.4.3.2 the foundation of the new catastrophic planetary configurations related with the maximal (positive) and minimal (negative) combined integral energy gravitational influence on the Earth \( \tau_3 \) of the Sun (mainly, owing to the gravitational interactions of the Sun with the Jupiter \( \tau_5 \) and the Saturn \( \tau_6 \), the Uranus \( \tau_7 \) and the Neptune \( \tau_8 \)) and the planets of the Solar System.

We have presented in Subsection 3.5 the generalized thermohydrogravidynamic shear-rotational [Simonenko, 2007; 2009; 2010], classical shear (deformational) [Короновский и Абрамов, 2000] and rotational [Vikulin, 2003] models of the earthquake focal region \( \tau \), and the established local energy and entropy prediction thermohydrogravidynamic principles determining the fractures formation in the macroscopic continuum region \( \tau \). We have presented in Section 3.5.1 the thermodynamic foundation of the generalized thermohydrogravidynamic shear-rotational [Simonenko, 2007; 2009; 2010] and the classical shear (deformational) [Короновский и Абрамов, 2000] models of the earthquake focal region based on the generalized differential formulations (1.43) and (1.53) of the first law of thermodynamics. Using the evolution equation (1.67) (deduced from the generalized differential formulations (1.43) and (1.53) of the first law of thermodynamics) of the total mechanical energy of the macroscopic continuum region \( \tau \) (of the compressible viscous Newtonian continuum), we have presented in Subsection 3.5.1 the thermodynamic foundation of the classical deformational (shear) model [Короновский и Абрамов, 2000] of the earthquake focal region for the quasi-uniform medium of the Earth’s crust characterized by practically constant viscosity. Based on the generalized differential formulation (1.43) of the first law of thermodynamics for the macroscopic continuum region \( \tau \), we have presented the generalized thermohydrogravidynamic shear-rotational model [Simonenko, 2007a; 2007] of the earthquake focal region by taking into account the classical macroscopic rotational kinetic energy [de Groot and Mazur, 1962; Gyarmati, 1970], the macroscopic non-equilibrium kinetic energies [Simonenko, 2007], the internal (terrestrial) energy gravitational influences and the external (cosmic) energy gravitational influences on the focal region \( \tau \) of the preparing earthquakes. Using the evolution equation (3.142) (deduced from the generalized differential formulations (1.43) and (1.53) of the first law of thermodynamics) of the total mechanical energy of the macroscopic continuum region \( \tau \) (consisting from the subsystems \( \tau_{int} \) and \( \tau_{ext} \) interacting on the surface \( \partial \tau_i \) of the geo-block \( \tau_{int} \)), we have presented in Subsection
3.5.2 the evidence [Simonenko, 2007] of the physical adequacy of the rotational model [Vikulin, 2003] of the earthquake focal region for the seismic zone of the Pacific Ring. We have formulated in Subsection 3.5.3.1 the local energy prediction thermohydrogravidynamic principles (3.144) and (3.145) determining (according to the generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics [Simonenko, 2007]) the fractures formation in the macroscopic continuum region $\tau$ subjected the combined integral energy gravitational influence of the planets of the Solar System, the Moon and the Sun owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune). We have formulated in Subsection 3.5.3.2 the local entropy prediction thermohydrogravidynamic principle (3.155) determining (according to the generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics [Simonenko, 2007] and according to the generalized differential expression (3.150) [Simonenko, 2006a] for the entropy production per unit time in the one-component macrodifferential deformed continuum element with no chemical reactions) the fractures formation (and related positive power $\delta f_{\text{vis-c}} / dt > 0$ (given by (3.154)) of the geo-acoustic energy radiated from the unit mass of the focal region $\tau$ of earthquake) in the macroscopic continuum region $\tau$ subjected the combined integral energy gravitational influence of the planets of the Solar System, the Moon and the Sun owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune).

We have presented in Subsection 3.6 the real confirmation [Simonenko, 2007] of the cosmic energy gravitational genesis of the seismotectonic (and volcanic) activity and the global climate variability induced by the combined non-stationary cosmic energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. We have presented in Subsection 3.6.1 the empirically established [Turner, 1925; Мей Ши-юн, 1960; Tamrazyan, 1962; Fedotov, 1965; Филипинс, 1965; Davison, 1936; Ambroseys, 1970; Christensen, Ruff 1986; Barrientos and Kansel, 1990; Jacob, 1984; Shimazaki and Nakata, 1980; Suyehiro, 1984; Clark, Dibble, Fyfe, Lensen and Suggarte, 1965; Johnston, 1965; Abramov, 1997; p. 72; Vikulin and Vikulina, 1989; Vikulin, 2003; p. 16-17] time periodicities of the seismotectonic activity of the Earth.

Using the equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics used for the Earth, we have presented in Subsection 3.6.2 (in the frame of the real elliptical orbits of the Earth and the Moon, the Venus, the Mars and the Jupiter) the successive approximations of the obtained time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the system Sun-Moon [Simonenko, 2007], the Venus [Simonenko, 2007], the Mars [Simonenko, 2007], the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter. We have presented in Subsection 3.6.2.1 the successive approximations of the time periodicities [Simonenko, 2007] of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the system Sun-Moon. We have presented in Subsection 3.6.2.2 the successive approximations of the time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Venus. We have presented in Subsection 3.6.2.3 the successive approximations of the time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter. We have presented in Subsection 3.6.2.4 the successive approximations of the time periodicities of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Mars.

Based on the equivalent generalized differential formulations (1.43), (1.50) and (1.53) of the first law of thermodynamics used for the Earth, we have presented in Subsection 3.6.2.5 the successive approximations of the obtained [Simonenko, 2007] time periodicities (3.196) of the periodic global seismotectonic (and volcanic) activity and the global climate variability of the Earth (and related cosmic geological cycles of the thermohydrogravidynamic evolution of the Earth owing to the $G(a)$-factor and the $G(b)$-factor) induced by the combined different combinations of the cosmic energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter, the Mars and the Sun owing to the gravitational interaction of the Sun with the Jupiter. The time periodicities (3.196) are determined by the successive global periodicities $T_{\text{energy}}$ (defined by the multiplications of various successive time periodicities related to the different combinations of the following integer numbers: $i = 1, 2, 3, 4, 5$; $j = 1, 2$; $k = 1, 2, 3$; $n = 1, 2, 3$; $l_0 = 0, 1$; $l_2 = 0, 1$; $l_4 = 0, 1$; $l_6 = 0, 1$) of recurrence of the maximal combined energy gravitational influences on the Earth of the different combined combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. We have presented in Subsection 3.6.2.5 the successive approximations of the obtained [Simonenko, 2007] time periodicities (3.197) of the periodic global tectonic-
endogenous heating related with the periodic global volcanic activity and related global climate variability and the global variability of the quantities of the fresh water and glacial ice resources and the cosmic geological cycles of the thermohydrogravidynamic evolution of the Earth owing to the $G(a)$-factor. The time periodicities (3.197) are determined by the successive global periodicities $T_{\text{energy}}/2$ (defined by the multiplications of various successive time periodicities related to the different combinations of the following integer numbers: $i = 1, 2, 3, 4, 5; j = 1, 2; k = 1, 2, 3; n = 1, 2, 3; l_0 = 0.1; l_2 = 0.1; l_4 = 0.1; l_3 = 0.1$) of recurrence of the maximal combined energy gravitational influences on the Earth of the different combined combinations of the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter. We have presented in Subsection 3.6.2.5 the evidence [Simonenko, 2007; 2009; 2010] that the empirical time periodicities [Turner, 1925; Мэй Ши-юн, 1960; Tamrazyan, 1962; Fedotov, 1965; Филлипас, 1965; Davison, 1936; Ambraseys, 1970; Christensen, Ruff 1986; Barrientos and Kansel, 1990; Jacob, 1984; Shimazaki and Nakata, 1980; Suyehiro, 1984; Clark, Dibble, Fyfe, Lensen and Suggarte, 1965; Johnston, 1965; Abramov, 1997; p. 72; Vikulin and Vikulina, 1989; Vikulin, 2003; p. 16-17] of the seismotectonic activity of the Earth (submitted in Subsection 3.6.1) may be satisfactory approximated by the time periodicities (3.196) characterized by different combinations of the various integer numbers.

We have presented in Subsection 3.6.3 the evidence [Simonenko, 2007] of the cosmic energy gravitational genesis of the strongest (M ≥ 7.9) Japanese earthquakes [Vikulin, 2003] near the Tokyo region and south-west from Tokyo. The predicted [Simonenko, 2009; 2010] “time range 2010 ÷ 2011 AD (1927 + 83 ÷ 1923 + 88) of the next sufficiently strong Japanese earthquake near the Tokyo region” (determined by the system Sun-Moon, the Venus, the Jupiter, the Mars and the Sun owing to the gravitational interaction of the Sun with the Jupiter) was confirmed by occurrence of the strong Japanese earthquake on 11 March, 2011. The occurrence of the strong Japanese earthquake on 11 March, 2011 may be considered as the real confirmation of the proposed [Simonenko, 2007; Simonenko, 2009; 2010] cosmic energy gravitational genesis of the strongest Japanese earthquakes.

We have presented in Subsection 3.6.4 the evidence [Simonenko, 2007] of the mean time periodicities 94620 years and 107568 years of the global climate variability (related with the $G(a)$ - factor [Simonenko, 2007; 2009; 2010] and $G(b)$ - factor [Simonenko, 2007; 2009; 2010] determined by the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) and the mean time periodicities 100845 years and 121612.5 years of the global climate variability related with the $G(b)$ - factor (determined by the cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter).

We revealed [Simonenko, 2007] the cosmic energy gravitational genesis (related with the combined cosmic non-stationary energy gravitational influence on the Earth of the Sun, the Moon, the Venus, the Mars and the Jupiter) of the periodic Earth’s tectonic-endogenous heating (characterized by the time periodicity 94620 years) induced by the periodic continuum deformation owing to the combined cosmic non-stationary energy gravitational influence on the Earth of the Sun, the Moon, the Venus, the Mars and the Jupiter. We have defined more precisely in Subsection 3.6.4 that the empirical time periodicity 94000 years during Pleistocene [Hays, Imbrie and Shackleton, 1976] is in good agreement with the founded [Simonenko, 2007] time periodicity 94620 years ($0.5 \times 19 \times 8 \times 15 \times 83$ years) of the Earth’s global climatic variability related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter. The founded [Simonenko, 2007] time periodicity 94620 years ($0.5 \times 19 \times 8 \times 15 \times 83$ years) of the Earth’s global climatic variability is determined (according the Table 2) by the global periodic Earth’s tectonic-endogenous heating related with the periodic continuum deformation (and related global volcanic activity) induced by the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

We revealed [Simonenko, 2007] the cosmic energy gravitational genesis (related with the combined cosmic non-stationary energy gravitational influence on the Earth of the Sun, the Moon, the Venus, the Mars and the Jupiter) of the periodic atmospheric-oceanic global planetary warming and cooling (characterized by the time periodicity 100845 years) as a consequence of the greenhouse effect produced by the gravity-induced periodic tectonic-volcanic activation accompanied by increase of the atmospheric greenhouse gases (especially, the carbon dioxide CO$_2$) concentration. The established cosmic energy gravitational gene-
sis [Simonenko, 2007] of the time periodicity 100845 years is in good agreement with the experimental data [Pinxian et al., 2003; p. 2524-2535], which revealed the time periodicity 100000 years of the climatic variability, and also with the experimental data [Pinxian et al., 2003; p. 2536-2548], which revealed the same time periodicity 100000 years of the variability of the carbon concentration in the Earth’s sedimentary rocks.

We have defined more precisely in Subsection 3.6.4 that the empirical time periodicity 100000 years during Pleistocene [Muller and MacDonald, 1995] is in good agreement with the founded [Simonenko, 2007] time periodicity 100845 years (27 × 3 × 15 × 83 years) of the Earth’s global climatic variability related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter. The founded [Simonenko, 2007] time periodicity 100845 years (27 × 3 × 15 × 83 years) of the Earth’s global climatic variability is determined (according the Table 2) by the global periodic Earth’s atmospheric-oceanic warming as a consequence of the greenhouse effect produced by the gravity-induced (owing to the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) periodic global tectonic-volcanic activization accompanied by increased output of the atmospheric greenhouse gases.

We revealed [Simonenko, 2007] the cosmic energy gravitational genesis (related with the combined cosmic non-stationary energy gravitational influence on the Earth of the Sun, the Moon, the Venus, the Mars and the Jupiter) of the periodic Earth’s global tectonic-endogenous heating (characterized by the time periodicity 107568 years induced by the periodic continuum deformation owing to the combined cosmic non-stationary energy gravitational influence on the Earth of the Sun, the Moon, the Venus, the Mars and the Jupiter. We have defined more precisely in Subsection 3.6.4 that the empirical time periodicity 106000 years during Pleistocene [Hays, Imbrie and Shackleton, 1976] is in good agreement with the founded [Simonenko, 2007] time periodicity 107568 years (0.5 × 27 × 3 × 32 × 83 years) of the Earth’s global climatic variability related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter. The founded [Simonenko, 2007] time periodicity 107568 years (0.5 × 27 × 3 × 32 × 83 years) of the Earth’s global climatic variability is determined (according the Table 2) by the global periodic Earth’s tectonic endogenous heating related with the periodic continuum deformation (and related global volcanic activity) induced by the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

We revealed [Simonenko, 2007] the cosmic energy gravitational genesis (related with the combined cosmic non-stationary energy gravitational influence on the Earth of the Sun, the Moon, the Venus, the Mars and the Jupiter) of the periodic atmospheric-oceanic warming (characterized by the average time periodicity 121612.5 years) as a consequence of the greenhouse effect produced by the gravity-induced periodic global tectonic-volcanic activization accompanied by increase of the atmospheric greenhouse gases (especially, the carbon dioxide CO₂ concentration. We have defined more precisely in Subsection 3.6.4 that the empirical time periodicity 122000 years during Pleistocene [Hays, Imbrie and Shackleton, 1976] is in good agreement with the founded [Simonenko, 2007] average time periodicity 121612.5 years (235 × 3 × 15 × (11+12)× 0.5 years) of the Earth’s global climatic variability related with the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter. The founded [Simonenko, 2007] average time periodicity 121612.5 years of the Earth’s global climatic variability is determined (according the Table 2) by the global periodic Earth’s atmospheric-oceanic warming as a consequence of the greenhouse effect produced by the gravity-induced (owing to the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter) periodic global tectonic-volcanic activization accompanied by increased output of the atmospheric greenhouse gases.

We have presented in Subsection 3.6.5 the evidence [Simonenko, 2007; 2009; 2010] of the cosmic energy gravitational genesis of the modern short-term time periodicities of the Earth’s global climate variability determined by the combined cosmic factors: G-factor related with the combined cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Mercury, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter; G(a)-factor related to the tectonic-endogenous heating of the Earth as a consequence of the periodic continuum deformation of the Earth due to the G-factor; G(b)-factor related to the periodic atmospheric-oceanic warming or cooling as a consequence of the periodic variable (increasing or decreasing) output of the heated greenhouse volcanic
gases and the related variable greenhouse effect induced by the periodic variable tectonic-volcanic activity (activation or weakening) due to the G-factor; G(\(c\))-factor related to the periodic variations of the solar activity owing to the periodic variations of the combined planetary non-stationary energy gravitational influence on the Sun. We have presented in Subsection 3.6.5 the following evaluated [Simonenko, 2009; 2010] successive ranges of the short-term time periodicities of the solar activity: 0.96359 ÷ 1.2302 years (determined by the combined energy gravitational influence of the Mercury, the Venus and the Earth on the Sun), 5.5359 ÷ 7 years (determined by the combined energy gravitational influence of the Mercury, the Venus and the Earth on the Sun), 11 ÷ 13.008 years (determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Earth and the Mars on the Sun), 19.9945 ÷ 29.4525 years (determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Saturn and the Venus on the Sun), 33 ÷ 35.73 years (determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus, the Mars and the Earth on the Sun), 47.36 ÷ 53 years (determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Venus and the Earth on the Sun), 58.905 ÷ 63.3564 years (determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Saturn and the Venus on the Sun), 83 ÷ 88.4095 years (determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Saturn, the Venus and the Earth on the Sun) and 106.7177 ÷ 118.58 years (determined by the combined energy gravitational influence of the Jupiter, the Mercury, the Saturn and the Mars on the Sun). We have presented in Subsection 3.6.5 the following evaluated [Simonenko, 2009; 2010] and experimentally confirmed (by different authors mentioned in Subsection 3.6.5) successive ranges of the main modern short-term time periodicities of the Earth’s global climate variability (determined by the variability of the solar activity and determined by the variability of the combined cosmic non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Mercury, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter): [0.96359 ÷ 3] years, (3 ÷ 7) years, (7 ÷ 15) years, [16 ÷ 19] years, [19.9945 ÷ 29.4525] years, [32 ÷ 36] years, [16 ÷ 36] years, [41.5 ÷ 54] years, [57 ÷ 63.3564] years, [76 ÷ 96] years and [99 ÷ 124.5] years.

We have presented in Subsection 3.7 the evidence of the cosmic energy gravitational genesis of the seismotectonic (and volcanic) activity and the global climate variability induced (owing to the G-factor, G(\(a\))-factor and G(\(b\))-factor) by the combined non-stationary cosmic energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun (owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune). We have presented in Subsection 3.7.1 the evaluations of the time periodicities of the maximal (instantaneous and integral) energy gravitational influences of the Sun on the Earth owing to the gravitational interaction of the Sun with the outer large planets (the Jupiter, the Saturn, the Uranus and the Neptune). We have presented in Subsection 3.7.1.1 the time periodicities (\(T_{1,3}\)) = 11 years, (\(T_{2,3}\)) = 12 years and (\(T_{3,3}\)) = 83 (in the first, second and third approximations, respectively) years of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter. We have presented in Subsection 3.7.1.2 the evaluations of the time periodicities (\(T_{\text{S\text{a\text{t}}}3}\)) = 29 years, (\(T_{\text{s\text{a\text{t}}}3}\)) = 59 years and (\(T_{\text{s\text{a\text{t}}}3}\)) = 265 years (in the first, second and third approximations, respectively) of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Saturn and the Sun owing to the gravitational interaction of the Sun with the Saturn. We have presented in Subsection 3.7.1.3 the evaluation of the time periodicity (\(T_{\text{U\text{a\text{r}}}3}\)) = 84 years (in the first approximation) of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Uranus and the Sun owing to the gravitational interaction of the Sun with the Uranus. We have presented in Subsection 3.7.1.4 the evaluations of the time periodicities (\(T_{\text{N\text{a\text{r}}}3}\)) = 165 years, (\(T_{\text{N\text{a\text{r}}}3}\)) = 659 years and (\(T_{\text{N\text{a\text{r}}}3}\)) = 2142 years (in the first, second and third approximations, respectively) of the maximal (instantaneous and integral) energy gravitational influences on the Earth of the Neptune and the Sun owing to the gravitational interaction of the Sun with the Neptune. We have presented in Subsection 3.7.1.5 the foundation of the fundamental global time periodicities (3.239) and (3.240) of the Earth’s periodic global seismotectonic (and volcanic) activity and the global climate variability (related to the combined planetary, lunar and solar non-stationary energy gravitational influences on the Earth) induced by the different combinations of the cosmic non-stationary energy gravitational influences of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interaction of the Sun with the Jupiter, the Saturn, the Uranus and the Neptune. Based on the generalized formulation (1.50) of the first law of thermodynamics used for the Earth as a whole, we have found (taking into account the established [Simo-
Based on the presented statistical analysis of the historical eruptions [Thordarson and Larsen, 2007] of the Katla and the Hekla volcanic systems in Iceland. We have presented in Subsection 3.8.2.1 the generalized formulation [Simonenko, 2005] of the Katla and the Hekla volcanic systems. Based on the generalized formulation [Simonenko, 2005] of the weak law of large numbers, we have presented in Subsection 3.8.2.2 the statistical analysis of the historical eruptions [Thordarson and Larsen, 2007] of Katla volcano.

We have shown in Subsection 3.8.2.2 that the founded theoretical range of the fundamental global ...
seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ years [Simonenko, 2012] contains the calculated mean experimental time periodicities $\langle \Delta t \rangle_{exp} = 697.6785$ years (given by (3.267)) and $\langle \Delta t \rangle_{708} = 700.7407$ years (given by (3.268)) of the considered historical eruptions of Katla volcano [Thordarson and Larsen, 2007]. We have shown in Subsection 3.8.2.2 that the mean value 699.2096 years of the calculated mean experimental time periodicities (3.267) and (3.268) (of the considered eruptions of Katla volcano) is very close to the mean value 702 years the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ years [Simonenko, 2012]. We have shown in Subsection 3.8.2.3 that the mean value 697.5863 years of the calculated mean experimental time periodicities (3.269) and (3.270) (of the considered eruptions of Hekla volcano) is in very good agreement with the mean value 702 years the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ years [Simonenko, 2012]. The obtained (in Subsections 3.8.2.2 and 3.8.2.3) agreements of the experimental and theoretical volcanic time periodicities confirm the established cosmic energy gravitational genesis [Simonenko, 2012] of the founded range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ years determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

The founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ years [Simonenko, 2012] contains the experimental time periodicity 704 years [Abramov, 1997] of the global seismotectonic activity of the Earth. The founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ years [Simonenko, 2012] contains also the evaluated (based on the wavelet analysis) time periodicity of approximately 700 years [Goncharova, Gorbarenko, Shi, Bosin, Fischenko, Zou and Liu, 2012] characterizing the regional climate variability of the Japan Sea. These additional agreements confirm the validity of the founded theoretical range of the fundamental global seismotectonic, volcanic and climatic time periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ years [Simonenko, 2012] determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn.

We have presented in Subsection 3.8.3 the evidence [Simonenko, 2011] of the cosmic energy gravitational genesis of the predominant short-range time periodicities $(7i/6$ years and $6j/5$ years determined by small integers $i$ and $j$) of the Chandler’s wobble of the Earth’s pole [Chandler, 1892] and sea water and air temperature variations [Simonenko, Gayko and Sereda, 2012]. We have presented in Subsection 3.8.3.1 the evidence [Simonenko, 2011] of the cosmic energy gravitational genesis of the predominant time periodicities $T_{clim,1} = (T_{ah,1}) \approx 6/5$yr $= 1.2$ years and $T_{clim,2} = (T_{ah,2}) \approx 7/6$yr $= 1.1666666...$ years of the Chandler’s wobble of the Earth’s pole and the global climate variability induced by the combined non-stationary energy gravitational influence on the Earth of the Venus, the Mercury and the Moon. We have presented in Subsection 3.8.3.2 the combined analysis of the Chandler’s wobble of the Earth’s pole [Simonenko, 2011] and the variations of sea water and air temperature during 1969-2010 for the coastal station Possyet [Simonenko, Gayko and Sereda, 2012] of the Japan Sea. Based on the previous theoretical results [Simonenko, 2007, 2008, 2009, 2010], the spectral studies [Simonenko, 2011] of the Chandler’s wobble of the Earth’s pole, and the spectral analysis [Simonenko, Gayko and Sereda, 2012] of the experimental variations of sea water and air temperature (during 1969-2010 AD for the coastal station Possyet of the Japan Sea), we have confirmed the cosmic energy gravitational genesis of the predominant short-range periodicities $(7i/6$ yr and $6j/5$ yr determined by small integers $i$ and $j$) of the Chandler’s wobble of the Earth’s pole and sea water and air temperature variations for the coastal station Possyet [Simonenko, et al., 2012] of the Japan Sea.

We have presented in Subsection 3.8.4 the additional evidence of the founded [Simonenko, 2012] range of the fundamental global periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ yr (of the global seismotectonic and volcanic activities and the climate variability of the Earth) based on the established links between the great natural cataclysms in the ancient history of humankind from the final collapse of the ancient Egyptian Kingdom and the biblical Flood to the increase of the global seismicity and the global volcanic activity in the beginning of the 20th century [Richter, 1969] and the modern increase of the global seismicity and the volcanic activity in the end of the 20th century [Abramov, 1997] and in the beginning of the 21st century [Simonenko, 2007; 2009; 2010]. We have considered in Subsection 3.8.4.1 the great natural cataclysms in the
history of humankind from the final collapse of the ancient Egyptian Kingdom (near 2190 BC) and the biblical Flood (occurred in 2104 BC according to the orthodox Jewish and Christian biblical chronology).

We have presented in Subsection 3.8.4.2 the evidence (confirming the founded range of the fundamental global periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ yr [Simonenko, 2012]) of the linkage of the last major eruption of Thera (1450 BC) [LaMoreaux, 1995] and the greatest earthquake destroyed the ancient Pontus (63 BC) [Cassius Dio Cocceianus, Dio's Roman history].

We have presented in Subsection 3.8.4.3 the evidence (confirming the founded range of the fundamental global periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ yr [Simonenko, 2012]) of the linkage of the greatest earthquake destroyed the ancient Pontus (63 BC), the earthquake destroyed the ancient Greek Temple of Artemis (614 AD) and the great frost event (628 AD) [LaMarche and Hirschboeck, 1984] related with the atmospheric veil (recorded in Europe in 626 AD [Stothers and Rampino, 1983]) induced by the great unknown volcanic eruption (apparently, Rabaul′ [LaMarche and Hirschboeck, 1984] eruption).

We have presented in Subsection 3.8.4.4 the evidence (confirming the founded range of the fundamental global periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ yr [Simonenko, 2012]) of the linkage of the greatest earthquake destroyed the ancient Pontus (63 BC) and the great earthquakes [Vikulin, 2008] occurred in England (1318 AD and 1343 AD), Armenia (1319 AD), Portugal (1320 AD, 1344 AD and 1356 AD) and Japan (1361 AD).

We have presented in Subsection 3.8.4.5 the evidence (confirming the founded range of the fundamental global periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ yr [Simonenko, 2012]) of the linkage of the final collapse of the ancient Egyptian Kingdom (occurred near 2190 BC), the biblical Flood (occurred in 2104 BC according to the orthodox Jewish and Christian biblical chronology) and the last major eruption of Thera (1450 BC) [LaMoreaux, 1995].

We have presented in Subsection 3.8.4.6 the evidence (confirming the founded range of the fundamental global periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ yr [Simonenko, 2012]) of the linkage of the planetary disasters in the Central Asia (10555 BC) [Von Bunsen, 1848, pp. 77-78, 88] and in the ancient Egyptian Kingdom (10450 BC) [Hancock, 1997], and the greatest earthquake destroyed the ancient Pontus (63 BC).

We have presented in Subsection 3.8.4.7 the evidence (confirming the founded fundamental global periodicity $T_{tec,f} = T_{clim,f} = 5 \times 696$ years = 3480 years given by (3.258a)) determined by the combined predominant non-stationary energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter and the Saturn) of the linkage of the previous great eruptions of Thera (Santorini) (between 1628 and 1450 BC [LaMoreaux, 1995]), the greatest (in the United States in the past 150 years up to 1872) earthquake in Owens Valley, California (1872 AD), the eruptions of Santorini [Papazachos, 1989] in 1866 and 1925 AD and the great eruption of Krakatau in 1883 AD.

We have presented in Subsection 3.8.4.8 the evidence (confirming the founded fundamental global periodicity $T_{tec,f} = T_{clim,f} = 5 \times 696$ years = 3480 years given by (3.258a)) of the linkage of the eruption of Tambora (1815 AD) and the Thera (Santorini) eruption in the range 1700÷1640 BC [Betancourt, 1987; Habberten et al., 1989].

We have presented in Subsection 3.8.4.9 the evidence (confirming the founded fundamental global periodicity $T_{tec,f} = T_{clim,f} = 5 \times 696$ years = 3480 years given by (3.258a)) of the linkage of the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 19th century and in beginning of the 20th century [Richter, 1969] and the eruption of Thera (Santorini) between 1600 and 1500 BC [Antonopoulos, 1992].

We have revealed (based on combined analysis presented in Subsections 3.8.4.1, 3.8.4.2, 3.8.4.3, 3.8.4.4, 3.8.4.5, 3.8.4.6, 3.8.4.7, 3.8.4.8 and 3.8.4.9) in Subsection 3.8.4.9 the evident linkages between the different distinct eruptions of the Thera (Santorini) dated in the following ranges: 1700÷1640 BC [Betancourt, 1987; Habberten et al., 1989], 1628÷1626 BC [LaMarche and Hirschboeck, 1984], 1627÷1600 BC [Friedrich et al., 2006], 1600÷1500 BC [Antonopoulos, 1992], 1628÷1450 BC [LaMoreaux, 1995] and the eruptions of the Tambora (1815 AD), the Santorini (1866 AD and 1925 AD) and the Krakatau (1883 AD). Based on the fundamental global seismotectonic, volcanic and climatic periodicity (3.258a) and taking into account the eruptions of the Tambora (1815 AD), the Santorini (1866 AD and 1925 AD) and the Krakatau (1883 AD), we have founded the real possibility of different distinct eruptions of Thera (Santorini): near 1665 BC (in accordance with the range 1700÷1640 BC [Betancourt, 1987; Habberten et al., 1989]), near 1613.5 BC (in accordance with the range 1627÷1600 BC [Friedrich et al., 2006]) and in the range
1584±1555 BC (in accordance with the range 1600±1500 BC [Antonopoulos, 1992]). We have shown in Subsection 3.8.4.9 that we can consider the possibility of the final major catastrophic eruption near 1450 BC [LaMoreaux, 1995].

We have presented in Subsection 3.8.4.10 the evidence (confirming the founded range of the fundamental global periodicities $T_{tec,f} = T_{clim,f} = 696 \div 708$ yr [Simenenko, 2012]) of the linkage of the increase of the global seismicity (along with the increase of the volcanic activity) in the end of the 20th century [Abramov, 1997] and the eruption of Hekla (1300 AD) in Iceland [Thordarson and Larsen, 2007] and the great earthquake (1303 AD) in China [Vikulin, 2008].

We have presented in Subsection 3.9 the evidence of the forthcoming range 2020±2061 AD [Simenenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century during the past 696±708 years of the history of humankind. We have presented in Subsection 3.9 the evidence of the related subsequent subranges (2023±3 AD, 2040.38±3 AD and 2061±3 AD) of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century during the past 696±708 years of the history of humankind. It is clear that the additional fundamental studies (in the frame of the established cosmic geology and cosmic geophysics [Simenenko, 2007]) are needed to be not in some partial ignorance concerning to the behavior of the global seismicity of the Earth during the founded range 2020±2061 AD [Simenenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century.

Evaluating the negative consequences of the underground nuclear explosions (especially, the violation of the Earth’s water and seismotectonic processes leading to the established [Simenenko, 2007; 2009; 2010] decrease of the natural warning omens associated with the prepared earthquakes), we proved [Simenenko, 2007; 2009; 2010] that the underground nuclear explosions (during the established [Simenenko, 2007] modern activation of the seismotectonic and water-related processes of the Earth in the beginning of the 21st century) can initiate the small planetary cataclysm on the Eurasian continent accompanied by the super-earthquakes. Appealing to the world community and to the United Nations, we identified [Simenenko, 2007; 2009; 2010] the continuing underground nuclear explosions (produced by Northern Korea in 2006 and 2009 during the modern seismotectonic planetary activization [Simenenko, 2007]) as the very dangerous crime against the humankind. In this regard, the statement that “the furthest underground nuclear explosions and the furthest proliferation and development of the military technologies of production of the nuclear weapon in the world are disagree with the ethics of survival of the Eurasian nations in the third millennium” [Simenenko, 2010; p. 272] is still very actual for the humankind in the beginning of the 21st century.

We have presented in this monograph the final synthesis of the Cosmic Geology and the Cosmic Geophysics to create in advance the urgent technologies of the long-term deterministic predictions of the strong earthquakes, the planetary cataclysms, the Earth’s climate and the Earth’s fresh water resources in order to sustain the stable evolutionary development, the survival, greatness and cosmic dignity of the humankind in the 21st century before the founded forthcoming range 2020±2061 AD of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696±708 years of the history of humankind.
REFERENCES


Betancourt P.P. Dating the Aegean Late Bronze Age with radiocarbon // Archaeometry. 1987. No. 29.
P.45-49.


Gibbs J.W. The collected works of J. Willard Gibbs: In 2 vol. Vol. 2. N.Y. etc.: Longmans, Green,


Kapitza P.L. Plasma and the controlled thermonuclear reaction: Nobel lecture in physics // Institute for Physical problems of the USSR Academy of Sciences, Moscow, USSR.


Miller A.J., Scheiner N. Interdecadal climate regime dynamics in the North Pacific Ocean: Theories,


Ponomarev V.I., Kaplunenko D.D., Krokhin V.V., Ishida H. Seasonality of climate change in the


Tamrazyan G.P. About periodicity of seismic activity during the last one and half-two thousand years (as an example for Armenia) // Izv. AN SSSR. Fizika Zemli. 1962. No. 1. P. 76–85. In Russian.


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THE SURVIVAL OF THE EURASIAN NATIONS IN THE 21ST CENTURY

Sergey V. Simonenko

Introduction

The developments of the human civilizations are the most mysterious and difficultly predictable phenomena. Considering the history of the human civilizations, one can conjecture that the survivals of civilizations depend on the political and the natural environmental (seismotectonic, volcanic and climatic) conditions. Can the world community (and especially, the scientific community) give the exact prediction of the development of the modern human civilization in the near future?

It is well known that the ancient Egyptian Kingdom declined near 2190 BC as a consequence of the long catastrophic drought related with the extraordinary decrease of the depth of the Nile. The decline of the ancient Egyptian Kingdom coincided with the small ice age in Europe. The recurrence of the next catastrophic drought occurred in Egyptian Cairo in 1200 AD during the Arabic conquest of the Egypt.

The ancient European civilization on islands Tira and Crete collapsed as a consequence of the founded (in Subsection 3.8.4.9) different distinct eruptions of Thera (Santorini): near 1665 BC (in accordance with the range 1700÷1640 BC [Betancourt, 1987; Habberten et al., 1989]), near 1613.5 BC (in accordance with the range 1627÷1600 BC [Friedrich et al., 2006]) and in the range 1584÷1555 BC (in accordance with the range 1600÷1500 BC [Antonopoulos, 1992]). These volcanic eruptions decreased the mean planetary temperature of the Earth leading to the bad harvests worldwide.

It is well known that the ancient Mayas’ civilization destructed in the beginning of the ninth century AD as a consequence of the long catastrophic drought leading to the disappearance of the fresh water resources in the lakes and artificial reservoirs intended for collection of the rain-water. The destruction of the Mayas’ civilization coincided with the extremely cold weather of the European history.

The cosmic geophysics [Simonenko, 2007; 2009; 2010] gives the opportunity to discover one clear sight towards these planetary catastrophes. Analyzing the seismic belts around the Pacific Ocean, the Japanese seismologist Hattory concluded [Hattory, 1977] that the characteristic time of the seismic cycle was approximately 35 years for different seismic zones. This average seismic periodicity 35 years was explained by the average value 34.5 year of the evaluated time range $33 \div 36 = 3 \times (11 \div 12)$ years [Simonenko, 2007; 2009] of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability induced by the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter.

The established time periodicity 35 years [Hattory, 1977] of the seismotectonic activity of various regions of the seismic zone of the Pacific Ring is in good agreement with the mean value 34.5 years (of the established range $33 \div 36 = 3 \times (11 \div 12)$ years [Simonenko, 2007; 2009]) of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability. The mean value 34.5 years (of the established range $33 \div 36$ years [Simonenko, 2007]) is also in good agreement with the evaluated [Dmitrieva and Ponomarev, 2012] empirical time periodicity 37 years characterizing the South-Eastern tropical area, Kuroshio Current region (including East China and Japan/East Seas), central and northeastern Pacific. These good agreement (of the independent studies [Hattory, 1977; Simonenko, 2007; Dmitrieva and Ponomarev, 2012]) is the real confirmation of the validity of the thermohydrogravidynamic theory [Simonenko, 2007; 2009; 2010] of the seismotectonic, volcanic and climatic evolution of the Earth.

We have the time duration 3390 years (2190÷1200) between the catastrophic drought in the ancient Egyptian Kingdom (2190 BC) and the catastrophic drought in 1200 AD occurred in the Egyptian Cairo. The time duration 3390 years gets into the evaluated time range $3135 \div 3420 = 19 \times 15 \times (11 \div 12)$ years [Simonenko, 2007; p. 134] of the time periodicities of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability explained (in Subsection 3.6.2.5) by the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter.

We have the time duration 400 years between the catastrophic droughts related with the destruction of the ancient Mayas’ civilization and with the terrible hunger in Egyptian Cairo in 1200 AD. The time duration 400 years is very close to the time periodicity 405 years $= 27 \times 15$ years [Simonenko, 2007; p. 144] of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability determined the
combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon and the Mars. The revealed satisfactory correspondences of the evaluated time durations between the catastrophic droughts and the founded time periodicities [Simonenko, 2007; p. 132] of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability are in good agreement with the stated conclusion [Simonenko, 2007; p. 150] that these time periodicities must characterize the time variability of the quantity of the fresh water in lakes, artificial reservoirs and rivers of the Earth’s continents. The revealed satisfactory correspondences are in good agreement with the cosmic geophysics [Simonenko, 2007] considering the catastrophic droughts as manifestations of the seismotectonic and volcanic activity of the Earth.

The stated hypothesis [Ilyichev and Cherepanov, 1991; p. 1371] about the recurrence of the super-earthquakes characterized by the average approximate time periodicity of 10000 years was confirmed by the foundation of the range (10032÷10944) years [Simonenko, 2007; p. 140] of the time periodicities of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability determined by the combined cosmic non-stationary energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter and the Sun owing to the gravitational interactions of the Sun with the Jupiter. Using the average value 10488 years of the founded range (10032÷10944) years [Simonenko, 2007; p. 140] and taking into account the documented time 10555 BC of the planetary disaster revealed in the Central Asia [Von Bunsen, 1848; p. 77-78, 88], we evaluate the time 67 BC (10488-10555=-67) of the super-earthquake in the Central Asia, which is very close to the documented time 63 BC of “the greatest earthquake ever experienced” [Cassius Dio Cocceianus] destroyed many cities of the ancient Pontus located in the Minor Asia. Among other things, this greatest Pontic earthquake (63 BC) led to the suicide of Mithridates VI of Pontus (the king of Pontus also known as Eupator Dionysius remembered as the most formidable enemy of the Roman Republic during the Mithridatic Wars) and to the final defeat of Pontus in 63 BC.

The mentioned above catastrophic events (catastrophic droughts, great volcanic eruptions, planetary disasters and super-earthquakes) in the ancient history of the humankind show that it is very important for elites and governments of the Eurasian nations to anticipate ahead of time the natural planetary cataclysms to realize the preventive precautionary measures for the evolutionary development in the 21st century. Taking into account the founded forthcoming range 2020÷2061AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696 ÷ 708 years of the history of humankind, we analyze the joint survival of the Eurasian nations in the 21st century.

Taking into account the modern increase of the seismotectonic and volcanic activity of the Earth [Simonenko, 2007; p. 151], we concluded [Simonenko, 2007; 2009; 2010] that the subsequent underground nuclear explosions on the Eurasian continent may initiate the super-earthquake characterized [Simonenko, 2007; p. 92] by the destructive slippage along the “Atlantiok” zone [Abramov, 1997; p. 74] penetrating the Eurasian continent from the Japan Sea to the Eurasian continent and Iceland. We can state that the more reasonable variant of survival of the Eurasian nations in the 21st century is related with the rapid ratification of the CTBT in the near future by the Eurasian states (the Democratic People’s Republic of Korea, Indonesia, Iran, Israel, Egypt, Pakistan, India and China), whose ratification is necessary for the CTBT to go into force.

Taking into account the founded forthcoming range 2020÷2061AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696 ÷ 708 years of the history of humankind, we appeal to the elites and governments of the Eurasian nations (ratified the CTBT) to consider the possibility [Simonenko, 2010] of the subsequent integration of the Eurasian nations in the frame of the Eurasian Association (EAA) intended for the joint survival of the Eurasian states in the 21st century.

We accentuate the nonproliferation of the weapons of mass destruction on the Eurasian continent during the modern critical time period of the human existence on the Earth related with the founded forthcoming range 2020÷2061AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696 ÷ 708 years of the history of humankind. The final rapid ratification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) is argued to support the geopolitical equilibrium and stability in the world required for survival of the Eurasian nations in the 21st century. The establishment of the Eurasian Association (EAA) of the Eurasian states (ratified the CTBT) in a realistic perspective can facilitate the entry into force of the CTBT. Whether such responses prevail over the shorter-term modern problems of the Eurasian states depend on the awareness of the critical moment of the seismotectonic, volcanic and climatic conditions on the Earth [Simonenko, 2007; 2009; 2010, 2012].
The real cosmic seismotectonic, volcanic and climatic time periodicities and impending threats for the human existence on the Earth in the 21st century

Based on the founded cosmic geology [Simonenko, 2007; p. 71-92], we founded the 100 million years galactic time periodicity [Simonenko, 2007; p. 84] of the galactic hot ages of the maximal thermal heating [Hofmann, 1990; p. 340-341] of the Earth as a result of the Earth’s periodic compressions and deformations induced by the periodic non-stationary galactic energy gravitational influences of our Galaxy on the Earth moving in the frame of the Solar System around the center of our Galaxy with the time period of 200 million years. We revealed the galactic energy gravitational genesis [Simonenko, 2007; p. 68] of each cycle (the compression, stretching and more long-lasting reduction of the tectonic motions) of the geological eras of the Earth during the latest 570 million years.

The evaluated (in the frame of the cosmic geophysics [Simonenko, 2007]) range (116325±126900) years [Simonenko, 2007; p. 146] of the time periodicities (of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability) contains the empirical time periodicity 122000 [Hays et al., 1976] of the global climate variability during Pleistocene. The average time periodicity 121612.5 years [Simonenko, 2007; p. 146] of the evaluated range (116325±126900) years is in good agreement with the empirical time periodicity 122000 years [Hays et al., 1976] of the global climate variability during Pleistocene. The founded [Simonenko, 2007; p. 138-150] main average time periodicities 94620 years, 100845 years, 107568 years and 121612.5 years (determined by the combined cosmic non-stationary integral energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter) are in good agreement with the following empirical climate time periodicities: 94000 years [Hays et al., 1976], 100000 years [Muller and MacDonald, 1995; p. 107-108; Pinxian et al., 2003; p. 2553], 106000 years [Hays et al., 1976] and 122000 years [Hays et al., 1976] during Pleistocene. The revealed time periodicity 100000 years [Muller and MacDonald, 1995; p. 107-108] of the climate variability and the corresponding time variability of the carbon concentration in the Earth’s sedimentary rocks [Pinxian et al., 2003; p. 2553] confirms the founded cosmic energy gravitational genesis of the corresponding time periodicity 100845 years [Simonenko, 2007; p. 148] of recurrence of the maximal seismotectonic and volcanic activity and the global climate variability related with the atmospheric-oceanic warming (due to the greenhouse effect created by the periodic tectonic-volcanic activations) produced by the cosmic non-stationary combined energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter.

Using the presented (Table 2 in Subsection 3.6.4) calculated time periodicities of the Earth’s global climatic variability, we calculated [Simonenko, 2007] the average theoretical time periodicity 106160 years, which is in good agreement with the empirical time periodicity 106000 years corresponding to the main maximum of the spectrum [Hays, Imbrie and Shackleton, 1976] of the combined isotopic-oxygen variations based on the empirical data RC11 - 120 and E49 - 18. The calculated [Simonenko, 2007] average theoretical time periodicity 106160 years is in fairly good agreement with the empirical predominant time periodicity of 105000 years [Gorbarenko et al., 2011] characterizing the Okhotsk Sea productivity and lithological proxies stacks during the last 350 kyr. These good agreement (of the independent experimental and theoretical studies [Hays, Imbrie and Shackleton, 1976; Simonenko, 2007; Gorbarenko et al., 2011] is the additional confirmation of the validity of the thermohydrogravodynamic theory [Simonenko, 2007; 2009; 2010] of the seismotectonic, volcanic and climatic evolution of the Earth.

The founded range (58162.5±63450) years [Simonenko, 2007; p. 146] of the time periodicities of the global climate variability (determined by the combined cosmic non-stationary integral energy gravitational influence on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [Simonenko, 2007] and the Sun owing to the gravitational interaction of the Sun with the Jupiter) contains the revealed (during Pleistocene) empirical mean climate time periodicity 59000 years [Pletnev and Sukhanov, 2006; p. 701] based on the 210-m core in borehole near Honshu Island.

The stated hypothesis [Ilyichev and Cherepanov, 1991; p. 1371] about the recurrence of the super-earthquakes characterized by the average approximate time periodicity of 10000 years was confirmed by the foundation of the additional (along with the mentioned above) global time periodicity (of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability) 12540 years [Simonenko, 2007; p. 136] of recurrence of the maximal seismotectonic and volcanic activity and the global climate variability determined by the combined cosmic non-stationary integral energy gravitational influence on the Earth of the
Establishing the predominant solar, planetary (the Venusian and the Jupiter’s) and the lunar energy gravitational influences on the Earth, we founded the cosmic energy gravitational genesis [Simonenko, 2007; 2009] of the Chandler’s wobble [Chandler, 1892; p. 97-107] of the Earth’s pole (and the detected oscillations [Vikulin, 2003; p. 76] of the boundary of the Pacific Ocean representing the seismic zone of the Pacific Ring) induced by the Sun (exciting the periodicity of 1 year) and the Venus, the Jupiter, the Moon and the Mercury (exciting the Chandler’s periods of 405-447.25 days [Simonenko, 2009; 2010, p. 105]).

Based on the founded cosmic geophysics [Simonenko, 2007; p. 93-155], we established the short-term and long-range time periodicities [Simonenko, 2007; 2009; 2010] of the seismotectonic and volcanic activizations, the climate variabilities and the variabilities of the fresh water resources and the glacial ice of the mountain, Arctic and Antarctic glaciers of the Earth owing to the fundamental energy gravitational influences of the Sun and the Moon, the Venus, the Mars and the Jupiter. The founded time periodicities [Simonenko, 2007; 124-150] of the seismotectonic activity were confirmed by the empirical time periodicities of the strong earthquakes worldwide during the long time period of the first and the second millennia [Abramov, 1997; Vikulin, 2003].

Unfortunately, the predicted [Simonenko, 2007; p. 154-155] Chinese 2008 earthquakes had not been detected by means of the preventive precursors and natural warning omens owing to the violation of the natural seismotectonic and volcanic processes related with the realized Chinese underground nuclear explosions. The powerful 7.8-magnitude (on Richter scale) Sichuan 2008 earthquake with the epicenter in the VENCHUAN region was the largest destructive seismological cataclysm after 1949 and excels the Tangshan 1976 earthquake.

We established [Simonenko, 2007] the cosmic energy gravitational genesis of the strongest Japanese earthquakes [Vikulin, 2003] by revealing the satisfactory correspondence of the empirical time periods of recurrence of the strongest Japanese earthquakes and the time periodicities determined by different Sun-Moon and planetary combinations. Taking into account the time periodicity 83 years (of recurrence of the maximal energy gravitational influences of the Jupiter on the Earth), the year 1927 AD of the Jupiter’s opposition with the Earth, the time periodicity 88 years (of recurrence of the maximal combined energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [Simonenko, 2007; 2009; 2010] and the Sun owing to the gravitational interaction of the Sun with the Jupiter) and the year 1923 AD of the last strongest Japanese earthquake in the Tokyo region, we founded [Simonenko, 2009; 2010] in advance the time range 2010÷2011 AD (1927+83 ÷ 1923+88) of the next sufficiently strong Japanese earthquake near the Tokyo region. The previous independent prediction of the strong earthquake in 2011 AD for the Kanto region was given by Prof. V.A. Abramov in 1997 AD [Abramov, 1997].

The powerful 6.6-magnitude (on Richter scale) Japanese earthquake (that occurred on March 14, 2010) near Tokyo (with the epicenter in the Fukushima Prefecture) gets into the predicted time range 2010÷2011 AD [Simonenko, 2009; Simonenko, 2010]. The powerful 6.8-magnitude (on Richter scale) Japanese earthquake (that occurred on March 11, 2011) near Tokyo gets also into the predicted time range 2010÷2011 AD [Simonenko, 2009; Simonenko, 2010].

The time periodicity 88 years (of the global seismotectonic and volcanic activity and the global climate variability related with recurrence of the maximal combined energy gravitational influences on the Earth of the system Sun-Moon, the Venus, the Mars, the Jupiter [Simonenko, 2007; 2009; 2010] and the Sun owing to the gravitational interaction of the Sun with the Jupiter) is in good agreement with the estimated (based on the spectral Fourier analysis) climatic time periodicity 88 years [Kalugin and Darin, 2012] obtained from the studies of sediments from Siberian and Mongolian lakes. These good agreement (of the independent experimental and theoretical studies [Abramov, 1997; Simonenko, 2007; 2009; 2010; Kalugin and Darin, 2012] is the additional confirmation of the validity of the thermohydrogravodynamic theory [Simonenko, 2007; 2009; 2010] of the seismotectonic, volcanic and climatic evolution of the Earth.

According to the cosmic geophysics [Simonenko, 2007; p. 93-155; 2009], the founded forthcoming range 2020÷2061 AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth (during the past 696÷708 years of the history of humankind) is related with the modern increase of the seismotectonic and volcanic activity [Abramov, 1997; Simonenko, 2007; 2009; 2010] and the global atmospheric-oceanic warming. This conclusion is consistent with the established [Keylis-Borok and Malinovskaya, 1964; p. 3019-3024] regularity related with the general increase of the seismotectonic activity before the strong earthquakes.

The considered (in Subsection 3.8.4) events in the ancient history of the humankind show that the catastrophic droughts, great volcanic eruptions, the planetary disasters and the super-earthquakes in the
history of humankind are the climatic and geophysical mutually related links of the one evolutionary chain determined by the combined cosmic non-stationary energy gravitational influence on the Earth. We appeal to the world community to understand the modern increase of the seismotectonic and volcanic activity of the Earth, the global atmospheric-oceanic warming and the reduction of the Earth’s fresh water resources as the preventive precursors of the forthcoming super-earthquakes during the founded forthcoming range 2020−2061AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth during the past 696 ± 708 years of the history of humankind in the 21st century. The first dangerous and destructive increased peak of the global seismotectonic and volcanic activities and the climate variability of the Earth is evaluated (in Subsection 3.9) during the forthcoming subrange 2020−2026 AD (given by (3.314)).

The elites and governments of the Eurasian nations (ratified the CTBT) have the sufficient time to consider the possibility of the subsequent integration of the Eurasian nations before the first subrange 2020−2026 AD of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century.

Inadmissibility of the nuclear explosions on the Eurasian continent during the founded forthcoming range 2020−2061 AD of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century

On December 6, 2006, General Assembly of the United Nations adopted a resolution underlining the necessity of the rapid signing and ratification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) accepted on the fiftieth Session of the United Nations General Assembly in 1996. Taking into account the modern increase of the seismotectonic and volcanic activity of the Earth, we founded the necessity [Simonenko, 2007; p. 155] of the total United Nations’ prohibition against the furthest underground nuclear explosions breaking the fragile [Ilyichev and Cherepanov, 1991; p. 1367] lithosphere of the Earth. It was conjectured [Simonenko, 2007; p. 155] that the new underground nuclear explosions on the Eurasian continent can lead to the initiation of the possible small global planetary cataclysm during the modern increase of the seismotectonic and volcanic activity of the Earth, when the fragile Earth’s crust (saturated by ample water penetrating through the tectonic fractures and cracks) is subjected to the very strong combined energy gravitational influence of the Solar System and our Galaxy. The new underground nuclear explosions may initiate the possible super-earthquakes characterized [Simonenko, 2007; p. 92] by the destructive slippage along the “Atlantok” zone [Abramov, 1997; p. 74] penetrating the Eurasian continent from the Japan Sea to the England and Iceland. The awakened world volcanoes and the recent strong destructive earthquakes occurred in China (2008), Italy (2009), Haiti (2010), Chile (2010), New Zealand (2010), and Japan (2011) confirmed the founded increase [Simonenko, 2007; p. 151] of the modern seismotectonic and volcanic activity of the Earth. The detected oscillations [Vikulin, 2003; p. 75-76] of the boundary of the Pacific Ocean and Alpine-Himalayas’ belt with the annual and Chandler’s periods are the natural forerunners of the most destructive consequences of the future small global planetary cataclysm in the seismic belts of the Pacific Ocean, the European and Asian regions.

It is clear that total United Nations prohibition and tough measures against the new nuclear explosions may be achieved only by facilitating the entry into force of the CTBT in the near future before the first subrange 2020−2026 AD of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century. The CTBT has so far been signed by 177 states and ratified by 138 countries. However, of the 44 states whose ratification is sufficient for the CTBT to go into force, 9 states have still not ratified the CTBT, including the Democratic People’s Republic of Korea, Indonesia, Iran, Israel, Egypt, Pakistan, India, China and the United States. If the world society cannot prevent the subsequent development of the military nuclear technologies and underground nuclear explosions on the Eurasian continent then it will lead to the chain reaction of proliferation of the military nuclear technologies in the world assisting to the initiation of the possible small global planetary cataclysm in the 21st century on the Eurasian continent. It is inadmissible risk for the United Nations to permit the subsequent proliferation and development of the military technologies of production of the nuclear weapon in the world. The new underground nuclear explosions (apart from the underground nuclear explosions realized in 2006 and 2009 by the Democratic People’s Republic of Korea) will increase the international political problems and will assist to the initiation of the possible small global planetary cataclysm in the 21st
century on the Eurasian continent. It is clear that the key to solution of the problem of non-proliferation of the military nuclear technologies and nuclear disarmament in the 21st century is related with a sequence of simultaneous combined ratifications: by the United States and China, by India and Pakistan, by Israel, Egypt and Iran, and one-sided ratifications: by Indonesia and by the Democratic People’s Republic of Korea. The survival of the Eurasian nations in the 21st century demands the final rapid ratification of the CTBT in the near future (before the first subrange $2020 \div 2026$ AD of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century) by means of the sequence of the following ratifications: by the Democratic People’s Republic of Korea; by Indonesia; by Iran, Israel and Egypt; by Pakistan and India; and by China and the United States.

The entry into force of the CTBT may be achieved only by the combined efforts of the political powers of the world community and especially by the combined efforts of the Russia (ratified the CTBT), Great Britain (ratified the CTBT), France (ratified the CTBT), the United States and China as the permanent representatives of the Security Council of the United Nations. The entry into force of the CTBT is one of the most essential preconditions for the survival of the Eurasian and world nations in the 21st century.

Taking into account the modern activization of the seismotectonic and volcanic activity of the Earth, the atmospheric-oceanic warming, the melting of the Arctic ice and the mountain glaciers and the reduction of the world fresh water resources, it is reasonably for the elites and governments of the Eurasian nations (ratified the CTBT) to discuss in advance (before the first subrange $2020 \div 2026$ AD of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century) the subsequent integration of the UE, Russia and others countries of the Commonwealth of Independent States (CIS) in the frame of the Eurasian Association (EAA) of the sovereign states facilitating the entry into force of the CTBT for the joint survival of the Eurasian nations on the Eurasian continent in the 21st century.

Instead of the political confrontation related with the senseless NATO’s eastward expansion in the modern historical period of the critical environmental seismotectonic, climatic and volcanic conditions on the Earth [Simonenko, 2007; p. 149], the basic precondition of the survival of the UE’s, Russian and CIS’ nations (ratified the CTBT) is the rapid attainment of the favorable political conditions for joint practical actions intended for development of the extraordinary measures to diminish the destructive consequences during the founded forthcoming range $2020 \div 2061$ AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century during the past $696 \div 708$ years of the history of humankind. The additional (apart from the underground nuclear explosions realized by the Democratic People’s Republic of Korea in 2006 and 2009) underground nuclear explosions on the Eurasian can initiate the increased peak of the global seismotectonic and volcanic activities and the climate variability of the Earth before the first predicted (in Subsection 3.9) subrange $2020 \div 2026$ AD of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century.

In this regard, the more reasonable variant of the survival of the Eurasian and world nations in the 21st century is related with the final rapid ratification of the CTBT in the near future by the Eurasian states (the Democratic People’s Republic of Korea, Indonesia, Iran, Israel, Egypt, Pakistan, India and China) to not permit the new underground nuclear explosions, which may initiate the possible super-earthquakes on the Eurasian continent along the “Atlantiok” zone [Abramov, 1997; p. 74] penetrating the Eurasian continent from the Japan Sea to the Eurasian continent and Iceland.

**Summary and conclusions**

We have considered the founded real cosmic seismotectonic, volcanic and climatic time periodicities [Simonenko, 2007; 2009; 2010; 2012] and impending threats [Simonenko, 2012] for the human existence on the Earth in the 21st century. Based on the founded global time periodicity (of the Earth’s periodic seismotectonic and volcanic activity and the global climate variability) 12540 years [Simonenko, 2007; p. 136] of recurrence of the maximal seismotectonic and volcanic activity and the global climate variability of the Earth and using the obtained mean adequate estimation $10502.5$ BC of the planetary disaster ($10555$ BC) in the Central Asia [Von Bunsen, 1848, pp. 77-78, 88] and the planetary disaster ($10450$ BC) in ancient Egyptian Kingdom [Hancock, 1997], we have evaluated (in Subsection 3.9) the probable date (of recurrence of the same disaster) $2037.5$ AD, which enter into the second obtained subrange $2037.38 \div 2043.38$ AD (given by (3.318) in Subsection 3.9) of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century. We have conjectured (in Subsection 3.9) that the modern increase of the seismotectonic and volcanic activity of the Earth, the global atmospheric-oceanic
warming and the reduction of the Earth’s fresh water resources may be considered as the preventive precursors of the possible small global planetary cataclysms on the Eurasian continent during the founded forthcoming range $2020 \div 2061 \text{AD}$ [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth (and on the Eurasian continent) in the 21st century during the past $696 \div 708$ years of the history of humankind.

By considering the problem of the survival of the Eurasian nations in the 21st century, we have revealed the necessity of awareness of the community of interests of the Eurasian nations during the modern planetary seismotectonic and volcanic activation of the Earth before the forthcoming range $2020 \div 2061 \text{AD}$ [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth. In this regard, it is reasonably to discuss by the elites and governments of the Eurasian nations (ratified the CTBT) the conditions for the subsequent integration of the Eurasian nations to facilitate the entry into force of the CTBT for the joint survival in the 21st century. The difficulties can be reduced if conscious efforts will be made by the governments of the Eurasian nations (ratified the CTBT) to stimulate the positive responses pointed to consolidation of the Eurasian nations.

In this regard, it is important for governments of the Eurasian nations to take conscious controlling policies appropriate for the modern increase of the seismotectonic and volcanic activity of the Earth, the global atmospheric-oceanic warming and the reduction of the Earth’s fresh water resources. In realization of this, good co-ordination is needed between the Eurasian governments. Governments of the Eurasian nations can develop ahead of time the extraordinary measures to diminish the destructive consequences during the founded forthcoming range $2020 \div 2061 \text{AD}$ [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth. The additional (apart from the underground nuclear explosions realized by the Democratic People’s Republic of Korea in 2006 and 2009) underground nuclear explosions on the Eurasian continent can initiate the very strong seismic activity before the first (evaluated in Subsection 3.9) dangerous and destructive increased peak $(2020 \div 2026, \text{AD})$ of the global seismotectonic and volcanic activities and the climate variability of the Earth. In determining geopolitical priorities of the Eurasian nations in the 21st century, governments of the Eurasian nations should re-examine the balance between the national political interests and the general human (and reasonable) strategy intended for the joint survival in the 21st century on the Eurasian continent. The more reasonable variant of the survival of the Eurasian nations in the 21st century can be realized by the final rapid ratification of the CTBT in the near future by the Democratic People’s Republic of Korea, Indonesia, Iran, Israel, Egypt, Pakistan, India and China. The security of life of the Eurasian nations in the 21st century rightly depends on the awareness of governments of the Eurasian states (still not ratified the CTBT) the conscious balance between of the own political interests and general political strategy for the joint survival of the Eurasian nations in the 21st century.

The world economic crisis and the anticipations [Kupchan, 2003; Khannam, 2008; Starobin, 2009; Zakaria, 2009] of a return to multipolar world and the decline of American hegemonic dominance stimulated new doubts [Stiglitz, 2010; Lelong and Cohen, 2010] about the capacities of the United States to provide the leadership for the global economic stability and advancement of the world. At the same time, the anticipations of the American decline have generated the reasonable skepticism [Ikenberry and Inoguchi, 2010] argued by “the three global advantages of a large open market, the world’s reserve currency, and overwhelming military power with global reach”. The deep arguments were presented also [Norrof, 2010] for continuing American hegemonic leadership. The development of new multipolar power centers, especially the rise of China [Jacques, 2009; Inoguchi, 2009] in Asia, requires the sufficient time for creation “new principles and logics – for the organization of regional and international order” [Ikenberry and Inoguchi, 2010]. In recent years of development of the new principles and logics of the new multipolar international order, some countries have attempted to create nuclear weapon.

The Democratic People’s Republic of Korea (North Korea) was evaluated [Benard and Leaf, 2010] as the world’s most dangerous regime, which used the deep division (concerning to the assessment and the corresponding responses on the modern world’s threats related with proliferation of the weapons of mass destruction) between the permanent members (the United States, the United Kingdom, France, Russia and China) of the UN Security Council.

The North Korea conducted the second underground nuclear explosion on 25 May 2009. This nuclear test was evaluated by the leaders of all democratic countries as the direct and reckless challenge for the international community to counter the subsequent proliferation of the weapons of mass destruction. Unfortunately, however, the reasonable recent efforts by the United States were failed in collecting of all permanent members of the UN Security Council for adequate UN’s measures against the North Korea. Now
the world community seeing the obvious intention of North Korea to develop in the near future the nuclear weapon.

We see that the development of multipolarity reveals the obvious uncoordinated tendentious centrifugal intentions of the main multipolar power centers related with non-proliferation control. The subsequent development of the multipolarity will produce the additional structural complexity of the multipolar power centers to control the non-proliferation of the military nuclear technologies worldwide in the 21st century. Therefore, it is necessary to ratify the Comprehensive Nuclear-Test-Ban Treaty (CTBT) by the Eurasian states (still not ratified the CTBT) before the first predicted (in Subsection 3.9) subrange 2020\(\pm\)2026 AD of the increased peak global seismotectonic and volcanic activities and the climate variability of the Earth in the 21st century.

The new underground nuclear explosions and the subsequent proliferation and development of the military technologies of production of the nuclear weapon in the world are disagree with the ethics of survival of the Eurasian nations in the 21st century.

References


Inoguchi T. World order debates in the twentieth century: through the two-level game and the second image (reversed) // The Chinese Journal of International Politics. 2010. No. 3(2). P. 155-188.


FROM THE SCIENTIFIC EDITOR

Images recognition by multidimensional intervals
G.Sh. Tsitsiashvili
Распознавание образов с помощью многомерных интервалов
Г.Ш. Цициашвили


Однако применительно к задачам горного дела возникала ситуация, когда единственный признак (несколько признаков), характеризующий объекты первого класса - проявления горного давления, не может прогнозироваться с помощью единственного отрезка. Иными словами есть проявления, имеющие предвестников, а есть проявления, которые не имеют предвестников. В этой ситуации единственный отрезок на множестве признаков уже не характеризует все проявления, пропуская те из них, накануне которых возникает явление так называемого молчания. В настоящей работе метод интервального распознавания учитывает особенности описанной ситуации. Он базируется на построении не одного отрезка или интервала, а нескольких непересекающихся интервалов, внутри которых на множестве признаков содержатся точки, характеризующие объекты первого класса. Тем самым объекты первого класса разбиваются на классы, для каждого из которых распознавание производится отдельно. Если исходная выборка на каждом шаге пополняется новым объектом, то тогда возникает последовательность классификаций объектов первого класса, которую можно характеризовать как иерархическую классификацию.

Пусть первый класс объектов характеризуется набором вещественных чисел

\[ B = \{ b_j, 1 \leq j \leq m \} \]

авторой класс объектов набором вещественных чисел

\[ A = \{ a_l, 1 \leq l \leq n \}; -\infty, \infty \in A \]

Принято, что число \( n \) много меньше \( n \). Пусть вещественные числа \( e \), \( d \) удовлетворяют неравенству \( c \leq d \). Определим интервал \( (c, d] \) условием \( (c, d] = \{ f : c < f \leq d \} \), если \( c < d \). Если же \( c \geq d \), то полагаем, что интервал \( (c, d] \) состоит из единственно точки \( c = d \). Построим следующее правило распознавания объекта \( b \) набора \( B \). Каждому числу \( b \in B \) сопоставим два числа

\[ k(b) = \max \{ a : a \in A ; \ a \leq b \} \]

\[ r(b) = \min \{ a : a \in A ; \ a \geq b \} \]
В результате вокруг каждого числа $b \in B$ построен интервал $(l(b), r(b))$.

Лемма 1. Если $b_i, b_j \in B$, то интервалы $(l(b_i), r(b_i)), (l(b_j), r(b_j))$ либо совпадают, либо не пересекаются.

Доказательство. Пусть между точками $b_i, b_j$ на вещественной оси нет точек набора $A$, тогда по построению интервалы $(l(b_i), r(b_i)), (l(b_j), r(b_j))$ совпадают. Наоборот, если между точками $b_i, b_j$ на вещественной оси имеются точки набора $A$, тогда по построению интервалы $(l(b_i), r(b_i)), (l(b_j), r(b_j))$ не пересекаются. Таким образом, точки набора $b$ разбиваются на классы (эквивалентности) по их принадлежности совпадающим интервалам. Лемма доказана.

Предположим теперь, что множество $A$ состоит из $n$ объектов, причем каждый объект $i$ характеризуется $l$-мерным вектором $x_i = (a^1, ..., a^l)$. Аналогично считаем, что множество $E$ состоит из $m$ объектов, причем каждый объект $j$ характеризуется $l$-мерным вектором $b_j = (b^1_j, ..., b^l_j)$. Определим интервал $k(b_j) = \max \{a^1_i: a^1_i \leq b^1_j, 1 \leq i \leq n\},#$

Po этим интервалам построим $l$-мерный интервал, являющийся их прямым произведением $\bigwedge_{i=1}^l (k(b^i_j), r(b^i_j))$.

Лемма. Если $1 \leq i \neq j \leq m$, то $l$ -мерные интервалы $\bigwedge_{i=1}^l (k(b^i_j), r(b^i_j))$ либо совпадают, либо не пересекаются.

Доказательство. Действительно, по построению для любого $t, 1 \leq t \leq l$, одномерные интервалы $(k(b^t_j), r(b^t_j))$ либо совпадают, либо не пересекаются. Если эти одномерные интервалы при всех $t, 1 \leq t \leq l$, совпадают, то совпадают и их прямые произведения $\bigwedge_{i=1}^l (k(b^i_j), r(b^i_j))$. В противном случае хотя бы при одном $t$ эти интервалы не пересекаются и значит не пересекаются их прямые произведения. Таким образом, вектор набора $b$, разбиваются на подмножества (классы эквивалентности) по их принадлежности к совпадающим $l$ -мерным интервалам. Лемма доказана.

Предположим теперь, что на вход нашей распознающей системы поступают $l$-мерные вектора $(c^1, c^2, ..., c^n) \in A$, причем каждый из этих векторов принадлежит либо множеству $A$, либо множеству $E$. Пусть на шаге $m$ в систему введено два $l$-мерных вектора $(c^1, c^2, ..., c^m) \in A$. Предположим, что $n_0$ - первый шаг, на котором $(c^1_{n_0}, c^2_{n_0}, ..., c^n_{n_0}) \in B$, тогда строится первый $l$-мерный интервал, содержащий $(c^1_{n_0}, c^2_{n_0}, ..., c^n_{n_0})$.

Далее пусть на шаге $n > n_0$ вектор $(c^1_{n}, c^2_{n}, ..., c^n_{n}) \in A$. Тогда если он не принадлежит ни одному из уже построенных интервалов, то система этих интервалов сохраняется. Если же $(c^1_{n}, c^2_{n}, ..., c^n_{n}) \in A$, то принадлежит одному из уже существующих интервалов, то тогда этот ин-
ошибал разбивается на подинтервалы по известному правилу. Пусть теперь на шаге $n \rightarrow n_0$ вектор 
$\left( r_{n_1}, ..., r_{n_k} \right) \in B$. Тогда если он не принадлежит ни одному из уже построенных интервалов, то 
строится новый интервал, содержащий этот вектор. В противном случае система интервалов на дан-
ном шаге сохраняется.

Замечание. В результате такого построения на шаге $n \rightarrow n_0$ образуется либо новый интервал, со-
держащий $\sum_{i=1}^{k} (r_{n_1}, ..., c_{i(n_1, l)})$, либо вектор $\sum_{i=1}^{k} (r_{n_1}, ..., c_{i(n_1, l)})$ попадает в одну из ком-
понент разбиения. Тем самым данные вектора подчиняются описанной выше иерархической класси-
фикации.

Список литературы

1. Цициашвили Г.Ш., Болотин Е.И. Разработка быстрого алгоритма распознавания образов в прило-
жении к задачам прогнозирования // Информатика и системы управления. 2010. № 2. С. 25-27.
2. Болотин Е.И., Цициашвили Г.Ш., Гольчева И.В. Некоторые аспекты и перспективы факторного 
прогнозирования эпидемического проявления очагов клещевого энцефалита на основе многомерного 
3. Болотин Е.И., Цициашвили Г.Ш., Бурухина И.Г., Гольчева И.В. Возможности факторного прогно-
зирования заболеваемости клещевым энцефалитом в Приморском крае // Паразитология. 2002. Т. 36, 
4. Болотин Е.И., Цициашвили Г.Ш. Пространственно временнве прогнозирование функционирования 
5. Шатишина Т.А., Цициашвили Г.Ш., Радченкова Т.В.Опыт использования метода интервального 
распознавания для прогноза экстремальной ледовитости Татарского пролива (Японское море) // Ме-
теорология и гидрология. 2006. № 10. С. 65-72.
6. Горяинов, А.А., Шатишина Т.А., Цициашвили Г.Ш., Лысенко А.В., Радченкова Т.В. Климатические 
причины снижения запасов амурских лососей в 20-м столетии // Дальневосточный регион - Рыбное 
хозяйство. 2007. № 1,2 (6,7). С. 94-114.
7. Болотин Е.И., Цициашвили Г.Ш., Федорова С.Ю., Радченкова Т.В. Факторное временневе прогно-
зирование критических уровней инфекционной заболеваемости // Экология человека. 2009. № 10. C. 
23-29.
8. Болотин Е.И., Цициашвили Г.Ш., Федорова С.Ю. Теоретические и практические аспекты фактор-
ного прогнозирования инфекционной заболеваемости // Экология человека. 2010. № 7. С. 42-47.
9. Болотин Е.И., Ананьев В.Ю., Цициашвили Г.Ш. Прогнозирование инфекционной заболеваемости: 
новые подходы // Здоровье населения и среда обитания. 2010. №5. С. 15-19.
We present the analysis of the air temperature $T(t)$ dynamics for the considered stations and for different months. By using the method of the smallest squares, we evaluate the coefficients $a, b$ of the linear mean temperature dependences $\tau(t)=at+b$ and fluctuations

$$s = \frac{1}{n} \sum_{t=1}^{n} (T(t) - \tau(t))^2,$$

where $n$ is the period of observation. We consider the ratio $a/s$ characterizing the mean dependences and then select the stations and months for large and small ratio $a/s$. We analyze then the temperature oscillations for different extreme situations: the small values of $a/s$ (Table 1) and the large values of $a/s$ (Table 2). The analyzed (in Tables 1 and 2) time periodicities were evaluated ([1], p. 227) by taking into account the following cosmic factors: a) the Earth’s tectonic-endogenous heating ([1], p. 149) related with the periodic continuum deformation induced by the cosmic non-stationary energy gravitational influences on the Earth in the frame of the generalized differential formulation of the first law of thermodynamics ([1], p. 23), b) the Earth’s atmospheric-oceanic warming ([1], p. 149) (as a consequence of the natural greenhouse effect) produced by the gravity-induced periodic tectonic-volcanic activization accompanied by the increase of the atmospheric greenhouse gases concentration.

Based on the thermohydrogravidynamic theory, it was founded ([1], pp. 135-136) the recurrence of the maximal combined energy gravitational influences on the Earth of the Sun, the Moon and the Venus characterized by the time periodicity near 3 years (in the first approximation), that must lead (by taking into account the factor b) to the strong mean temperature time dependences characterized by the same time periodicity near 3 years.

Based on the experimental data about the range of the Chandler’s periods (of the Chandler’s wobble of the Earth’s pole) during the time range 1970-1991, it was founded the statistical average time periodicity 4.91 years (of the maximal combined energy gravitational influence on the Earth of the Mercury, the Venus and the Moon) which must give (as a consequence of the factor b) to the strong mean temperature time dependences characterized by the same time periodicity near 5 years.

Based on the experimental data about the range of the Earth’s periodic seismotectonic (and volcanic) activity and the global climate variability (as a consequence of the factor b) induced by the combined non-stationary energy gravitational influence on the Earth of the Mercury, the Moon and the Jupiter (taking into account the factor a), the time periodicity 6 years was also founded ([1], p. 112) as a consequence of the combined energy gravitational influences (the factor b) of the Mercury, the Venus and the Moon on the Earth (in the second approximation). It was shown ([1], p. 113) the recurrence of the maximal combined energy gravitational influences on the Earth of the Mercury, the Venus and the Moon has the time periodicity 7 years (in the third approximation), that must lead to (by taking into account the factor b) to the strong mean temperature time dependences characterized by the same time periodicity of 7 years.

Based on the thermohydrogravidynamic theory, it was founded ([1], p. 109) the short-term time periodicity near 12 years (in the first approximation) of intensification of the Chandler’s wobble of the Earth’s pole and related Earth’s periodic seismotectonic (and volcanic) activity and the global climate variability (as a consequence of the factor b) induced by the combined non-stationary energy gravitational influence on the Earth of the Mercury, the Moon and the Jupiter.

Based on the thermohydrogravidynamic theory, it was founded ([1], p. 226) the total range $11 \div 13.008$ years of the time periodicities of the solar activity induced by the combined energy gravitational influences on the Sun of the Jupiter, the Mercury, the Venus, the Earth and the Mars.

We calculated [2] (Tables 1, 2) the Fourier coefficients of the differences $T(t) - \tau(t)$ during the time range 1980-2009 for the considered periodicities 2, 3, 5, 6, 7, 10 years. We also calculate the mean value of the marked coefficients (which are larger than the critical value 0.15) for each time periodicity.

The presented analysis of the revealed [2] time ranges and distinct time periodicities of the temperature variations of the atmosphere and hydrosphere of the Earth confirm the hypothesis about the predominant
time periodicities 5 years and 6 years (for obvious multimodal character of highly fluctuating time temperature dependences) and 7 years (for small multimodal character related with strong mean temperature dependences). The present study gives the confirmation of this hypothesis based on the data about the air temperature fluctuations for stations of the Far East during the time range 1980-2009.

But now it is interesting to analyze how errors of linear trend calculations influence on Fourier coefficients. For this aim we suggest and then use modified method of the coefficients calculation. It is based on the following considerations. Suppose that the function \( x(t) \) is defined in integer points \( t=1,\ldots,T+m+1: \)

\[
x(t) = \sum_{j=0}^{m} a_j t^j + \sum_{k=1}^{\infty} c_k \exp \left( \frac{2\pi i k t}{T} \right),
\]

where \( i \) is the imaginary unit. Calculate Fourier coefficients \( c_k = r_k + ij_k \) and their absolute values \( s_k, k = 1,\ldots,T-1, \) without \( a_j, j = 0,\ldots,m, \) calculations.

Introduce the functions

\[
\Delta_0 x(t) = x(t), \quad \Delta_{j+1} x(t) = \Delta_j x(t+1) - \Delta_j x(t), \quad j = 0,\ldots,m, \quad t = 1,\ldots,T,
\]

then

\[
\Delta_{m+1} x(t) = \sum_{k=1}^{T} c_k \left[ \exp \left( \frac{2\pi i k t}{T} \right) - 1 \right] \exp \left( \frac{2\pi i k t}{T} \right), \quad t = 1,\ldots,T,
\]

and so

\[
c_k = r_k + ij_k = \sum_{k=1}^{T} \frac{\Delta_{m+1} x(t) e^{\frac{2\pi i k t}{T}}}{T \left[ e^{\frac{2\pi i k}{T}} - 1 \right]}.
\]

Denote

\[
\left[ \left( \cos \frac{2\pi k}{T} - 1 \right) - i \sin \frac{2\pi k}{T} \right]^{m+1} = A_k + iB_k
\]

where \( A_k, B_k \) are real numbers:

\[
A_k = \rho_k^{m+1} \cos(m+1)\varphi_k, \quad B_k = \rho_k^{m+1} \sin(m+1)\varphi_k,
\]

\[
\rho_k = \sqrt{\left( \cos \frac{2\pi k}{T} - 1 \right)^2 + \left( \sin \frac{2\pi k}{T} \right)^2}, \quad \varphi_k = \arctg \frac{\sin \frac{2\pi k}{T}}{\cos \frac{2\pi k}{T} - 1}.
\]

Then we obtain

\[
r_k = \sum_{t=1}^{T} \frac{\Delta_{m+1} x(t) \left( A_k \cos \frac{2\pi k t}{T} + B_k \sin \frac{2\pi k t}{T} \right)}{T \left[ \left( \cos \frac{2\pi k}{T} - 1 \right)^2 + \left( \sin \frac{2\pi k}{T} \right)^2 \right]^{m+1}}.
\]

\[
j_k = \sum_{t=1}^{T} \frac{\Delta_{m+1} x(t) \left( A_k \sin \frac{2\pi k t}{T} - B_k \cos \frac{2\pi k t}{T} \right)}{T \left[ \left( \cos \frac{2\pi k}{T} - 1 \right)^2 + \left( \sin \frac{2\pi k}{T} \right)^2 \right]^{m+1}}.
\]

\[
s_k = \sqrt{r_k^2 + j_k^2}, \quad k = 1,\ldots,T-1.
\]

Analogously suppose that the function \( x(t) \) is defined in integer points \( t=1,\ldots,T+m+1: \)

\[
x(t) = \sum_{j=0}^{m} a_j t^j + \varepsilon(t),
\]

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where $\varepsilon(t), t = 1, ..., T + m + 1,$ are independent random variables with $M \varepsilon(t) = 0$, $D \varepsilon(t) = \sigma^2$. We are to estimate the parameter $\sigma^2$. It is obvious that

$$\Delta_{m+1} x(t) = \Delta_{m+1} \varepsilon(t)$$

where

$$\Delta_{m+1} \varepsilon(t) = \sum_{k=0}^{m+1} \varepsilon(t + k) (-1)^{m+1-k} C_k^{m+1},$$

consequently

$$M \Delta_{m+1} \varepsilon(t) = 0, \quad D \Delta_{m+1} \varepsilon(t) = F_{m+1} \sigma^2, \quad F_{m+1} = \sum_{k=0}^{m+1} (C_k^{m+1})^2$$

and so almost surely

$$\frac{\sum_{t=1}^T (\Delta_{m+1} x(t))^2}{TF_{m+1}} \rightarrow \sigma^2, \quad T \rightarrow \infty.$$ 

Table 1. Fourier coefficients (calculated by modified method) of the deviation $T(t) - \tau(t)$ for the time periodicities 2, 3, 5, 6, 7, 10, 11, 12 years for the small values of $a/s$.

<table>
<thead>
<tr>
<th>Stations, Months</th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nemuro, Apr.</td>
<td>0.200</td>
<td>0.192</td>
<td>0.100</td>
<td>0.189</td>
<td>0.039</td>
<td>0.049</td>
<td>0.128</td>
<td>0.187</td>
</tr>
<tr>
<td>Nemuro, May</td>
<td>0.078</td>
<td>0.218</td>
<td>0.045</td>
<td>0.149</td>
<td>0.327</td>
<td>0.149</td>
<td>0.110</td>
<td>0.081</td>
</tr>
<tr>
<td>Abashiri, July</td>
<td>0.055</td>
<td>0.070</td>
<td>0.331</td>
<td>0.250</td>
<td>0.084</td>
<td>0.086</td>
<td>0.357</td>
<td>0.391</td>
</tr>
<tr>
<td>Asahikawa, July</td>
<td>0.153</td>
<td>0.104</td>
<td>0.244</td>
<td>0.323</td>
<td>0.135</td>
<td>0.098</td>
<td>0.185</td>
<td>0.321</td>
</tr>
<tr>
<td>Wakkamai, July</td>
<td>0.122</td>
<td>0.058</td>
<td>0.396</td>
<td>0.197</td>
<td>0.018</td>
<td>0.098</td>
<td>0.510</td>
<td>0.261</td>
</tr>
<tr>
<td>Suttsu, July</td>
<td>0.222</td>
<td>0.215</td>
<td>0.105</td>
<td>0.318</td>
<td>0.026</td>
<td>0.085</td>
<td>0.183</td>
<td>0.323</td>
</tr>
<tr>
<td>Taejon, July</td>
<td>0.069</td>
<td>0.143</td>
<td>0.204</td>
<td>0.189</td>
<td>0.128</td>
<td>0.082</td>
<td>0.170</td>
<td>0.168</td>
</tr>
<tr>
<td>Aomori, Aug.</td>
<td>0.294</td>
<td>0.283</td>
<td>0.691</td>
<td>0.597</td>
<td>0.291</td>
<td>0.562</td>
<td>0.109</td>
<td>0.220</td>
</tr>
<tr>
<td>Asahikawa, Aug.</td>
<td>0.291</td>
<td>0.301</td>
<td>0.635</td>
<td>0.585</td>
<td>0.297</td>
<td>0.474</td>
<td>0.127</td>
<td>0.240</td>
</tr>
<tr>
<td>Sapporo, Aug.</td>
<td>0.252</td>
<td>0.281</td>
<td>0.585</td>
<td>0.551</td>
<td>0.344</td>
<td>0.327</td>
<td>0.113</td>
<td>0.224</td>
</tr>
<tr>
<td>Suttsu, Aug.</td>
<td>0.356</td>
<td>0.273</td>
<td>0.593</td>
<td>0.573</td>
<td>0.339</td>
<td>0.243</td>
<td>0.059</td>
<td>0.213</td>
</tr>
<tr>
<td>Urakava, Aug.</td>
<td>0.328</td>
<td>0.375</td>
<td>0.612</td>
<td>0.564</td>
<td>0.357</td>
<td>0.358</td>
<td>0.098</td>
<td>0.189</td>
</tr>
<tr>
<td>Hakodate, Aug.</td>
<td>0.200</td>
<td>0.192</td>
<td>0.100</td>
<td>0.189</td>
<td>0.039</td>
<td>0.049</td>
<td>0.128</td>
<td>0.187</td>
</tr>
</tbody>
</table>

We also calculate the mean value of the marked coefficients (which are larger than the critical value 0.285) for each time periodicity.

<table>
<thead>
<tr>
<th>Stations, Months</th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taejon, Jan.</td>
<td>0.711</td>
<td>0.244</td>
<td>0.288</td>
<td>0.132</td>
<td>0.123</td>
<td>0.154</td>
<td>0.143</td>
<td>0.183</td>
</tr>
<tr>
<td>Izuhara, Feb.</td>
<td>0.319</td>
<td>0.118</td>
<td>0.056</td>
<td>0.104</td>
<td>0.361</td>
<td>0.045</td>
<td>0.479</td>
<td>0.249</td>
</tr>
<tr>
<td>Kagoshima, Feb</td>
<td>0.225</td>
<td>0.283</td>
<td>0.062</td>
<td>0.107</td>
<td>0.559</td>
<td>0.059</td>
<td>0.605</td>
<td>0.075</td>
</tr>
<tr>
<td>Abashiri, Mar.</td>
<td>0.180</td>
<td>0.257</td>
<td>0.127</td>
<td>0.075</td>
<td>0.196</td>
<td>0.034</td>
<td>0.159</td>
<td>0.243</td>
</tr>
<tr>
<td>Tokio, Mar.</td>
<td>0.160</td>
<td>0.444</td>
<td>0.047</td>
<td>0.408</td>
<td>0.156</td>
<td>0.078</td>
<td>0.059</td>
<td>0.148</td>
</tr>
<tr>
<td>Kagoshima, Aug.</td>
<td>0.045</td>
<td>0.142</td>
<td>0.046</td>
<td>0.069</td>
<td>0.096</td>
<td>0.063</td>
<td>0.194</td>
<td>0.030</td>
</tr>
<tr>
<td>Vlad-k, Sep.</td>
<td>0.166</td>
<td>0.078</td>
<td>0.065</td>
<td>0.100</td>
<td>0.018</td>
<td>0.017</td>
<td>0.163</td>
<td>0.083</td>
</tr>
<tr>
<td>Kagoshima, Sep.</td>
<td>0.180</td>
<td>0.101</td>
<td>0.176</td>
<td>0.183</td>
<td>0.172</td>
<td>0.062</td>
<td>0.167</td>
<td>0.047</td>
</tr>
<tr>
<td>Izuhara, Oct.</td>
<td>0.051</td>
<td>0.158</td>
<td>0.263</td>
<td>0.120</td>
<td>0.107</td>
<td>0.091</td>
<td>0.286</td>
<td>0.137</td>
</tr>
<tr>
<td>Fukuoka, Oct.</td>
<td>0.032</td>
<td>0.152</td>
<td>0.266</td>
<td>0.041</td>
<td>0.010</td>
<td>0.039</td>
<td>0.128</td>
<td>0.121</td>
</tr>
</tbody>
</table>
Consequently modified method decreases values of Fourier coefficients for small periods and so large periods with 12, 11, 10, 7, 6, 5 years become more important. It is interesting to say that the marked periodicities are not enough to obtain pikes at the curve of temperature dynamics.

The authors thank S.V. Simonenko for his suggestion to include periods 11, 12 years into our research.

References

ABOUT AUTHOR

Dr. Sergey Victorovich Simonenko, physicist, researcher, geologist, geophysicist, oceanographer, hydrologist. The author has graduated from the Moscow Physical-Technical Institute, the Faculty of Aerophysics and Space Explorations (the speciality – thermodynamics and aerodynamics, the specialization – physics of oceans). In 2000 he has been appointed as a Leading Scientist of the V.I. Il’ichev Pacific Oceanological Institute, Far Eastern Branch of the Russian Academy of Sciences. In 2008 Dr. Simonenko has been inducted as an Honorary Director General of the International Biographical Centre, Cambridge, England. In 2009 he has been inaugurated as a Vice-President of the Recognition Board of the World Congress of Arts, Sciences and Communications, Cambridge, England. In 2010 he has been appointed as a Lifetime Deputy Governor of the American Biographical Institute Research Association. In 2010 he has been inducted into the Inner Circle of the International Biographical Centre “in recognition of his services to Humankind with the most Important and Vital Good (“Thermohydrogravidynamics of the Solar System”) for Survival, Greatness and Cosmic Dignity of Humankind on Earth” (IBC, Cambridge, England, 2010).


Dr. Simonenko has been awarded by the IBC Awards (presented on his website: www.drserygevysimonenkokohondgibc.ru): the Pinnacle of Achievement Award “for the exceptional achievements in the arena of the turbulence problem solution” (2008); the Da Vinci Diamond “in recognition of an outstanding contribution to: solutions of turbulence & Chandler’s problems” (2008); the Lifetime Achievement Award “in recognition of an outstanding contribution to: physics of turbulence and cosmic geophysics” (2008).

Dr. Simonenko has been awarded by the following medals: the IBC Silver Medal “2000 Outstanding Intellectuals of the 21st Century” (Inscription: “GREAT BRITAIN to S V Simonenko Physicist”) in 2006; the IBC Silver Medal “Outstanding Scientists of the 21st Century” (Inscription: “GREAT BRITAIN to Dr S V Simonenko Physicist”) in 2007; the IBC Silver Medal “2000 Outstanding Intellectuals of the 21st Century” (Inscription: “To Dr. S.V. Simonenko Creator of Cosmic Geophysics”) in 2008; the IBC Lifetime Achievement Award Golden Medal (Inscription: “Presented to Dr S V Simonenko the Founder of Turbulence and Solar System Physics 2008”) in 2008; the IBC Commemorative Medal “Top Two Hundred of the IBC” (Inscription: “GB TO DR. SERGEY V. SIMONENKO HonDG IBC”) in 2008; the IBC Silver Medal “2000 Outstanding Scientists” (Inscription: “Dr. S.V. Simonenko the Founder of Cosmic Geology”) in 2008, the ABI Gold Medal for Russia (in the name of Russian people and Russia) in 2009; the ABI Medal “Great Minds of the 21st Century” (Inscription: “Dr. Sergey V. Simonenko 2009”) in 2009; the OIA’s Official Medal related with lifetime induction into the Noble Order of International Ambassadors and appointed personal title “The Honorable” (Inscription: “The Hon. Dr. Sergey V. Simonenko H.E.”) in 2009; the IBC Silver Medal “2000 Outstanding Intellectuals of the 21st Century” (Inscription: “Dr. S.V.
By publishing of this monograph, Dr. Sergey V. Simonenko has initiated the Sergey V. Simonenko Global World-wide Prognostication Project intended for the global world-wide predictions of the forthcoming catastrophic seismotectonic processes of the Earth during the founded range 2020÷2061 AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century. The main object of the Global World-wide Prognostication Project is to make more precise the obtained subsequent subranges (2023±3 AD, 2040.38±3 AD and 2061 ±3 AD) of the increased peaks of the forthcoming range 2020÷2061 AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century.

By publishing the previous fundamental monographs [Simonenko, 2004; 2005; 2006a; 2006; 2007a; 2007; 2008; 2009; 2010] (recognized by the world community by means of the related international awards presented on the website: dsergeyvsimonenkohondgibc.ru), the author has presented the real evidence of his potential ability to be the real head of the Global World-wide Prognostication Project. For rapid realization of the Global World-wide Prognostication Project, the author can accept the financial support in the official form from the International Organizations: the United Nations, UNESCO, the Scientific and Governmental Institutions world-wide. All possible (scientific and financial) contributions to the Sergey V. Simonenko Global World-wide Prognostication Project will be officially documented on the author’s website: www.dsergeyvsimonenkohondgibc.ru and used for the subsequent development of the Project.

Although the author believes into the final satisfactory realization of the Project (before 2020 AD by the personal author’s efforts in the frame of the Russian Academy of Sciences and the Ministry of Education and Science of the Russian Federation), the speed of realization of the Project may be not sufficient for the world community and the mentioned above International Organizations for the adequate control of the global world-wide natural processes during the range 2020÷2061 AD [Simonenko, 2012] of the maximal seismotectonic, volcanic and climatic activities of the Earth in the 21st century. All possible official proposals to support the Sergey V. Simonenko Global World-wide Prognostication Project should be send on the author’s E-mail (sergeyvsimonenko@yahoo.com) briefly in the clear form.

The author announces officially in advance that he cannot accept the financial support from the independent anonymous persons since the Project is the matter of great concern related (not with the author’s financial happiness) with the stable evolutionary development of the humankind during the forthcoming range 2020÷2061 AD [Simonenko, 2012]. Thereby, the author cannot admit that the additional scientific results (related with the corrected prognostication of the global seismicity in the range 2020÷2061 AD) will be the means of commerce. All scientific results obtained in the frame of the Sergey V. Simonenko Global World-wide Prognostication Project will be immediately published and accessible on the author’s website: www.dsergeyvsimonenkohondgibc.ru in the open access for the world community.
Sergey Victorovich Simonenko


Scientific monograph

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