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ADDITIONAL EVIDENCE ON SOME RELATIONSHIP BETWEEN SEISMIC ELECTRIC SIGNALS AND EARTHQUAKE SOURCE PARAMETERS

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A b s t r a c t

We provide recent experimental evidence which further supports the inter-relation between the earthquake source parameters and the selectivity properties of Seismic Electric Signals. The cases of two major earthquakes with magnitudes larger than 6.0, that occurred in Greece during 2004–2005, are presented.

Key words: Seismic Electric Signals, SES selectivity, natural time, earthquake prediction.

SES ACTIVITY AT IOANNINA STATION ON 10 JANUARY 2004

A typical **S**eismic **E**lectric **S**ignals (SES) activity was recorded at Ioannina station (IOA) on 10 January 2004, as depicted in Fig. 1. Out of more than one hundred electric dipoles currently operating there, the following five dipoles are shown: The lower two channels (i.e., the channels No. 7 and 8) correspond to the two short dipoles (of length L = 50 m) installed at site C along the EW and NS direction, respectively (the sites of these electrodes can be found in Fig. 2b of Varotsos *et al*., 1996). The upper three channels (i.e., the channels No. 9, 10 and 11) refer to the three long dipoles L, L' and L-I, the location of which is depicted in Fig. 2a of Varotsos *et al*., (1996). These long dipoles are directed almost NS; this is consistent with the fact that, when com-

paring the two short dipoles in Fig. 1, it is the NS component (i.e., channel 8) which clearly recorded the SES activity, while the EW-component (i.e., channel 7) did not.

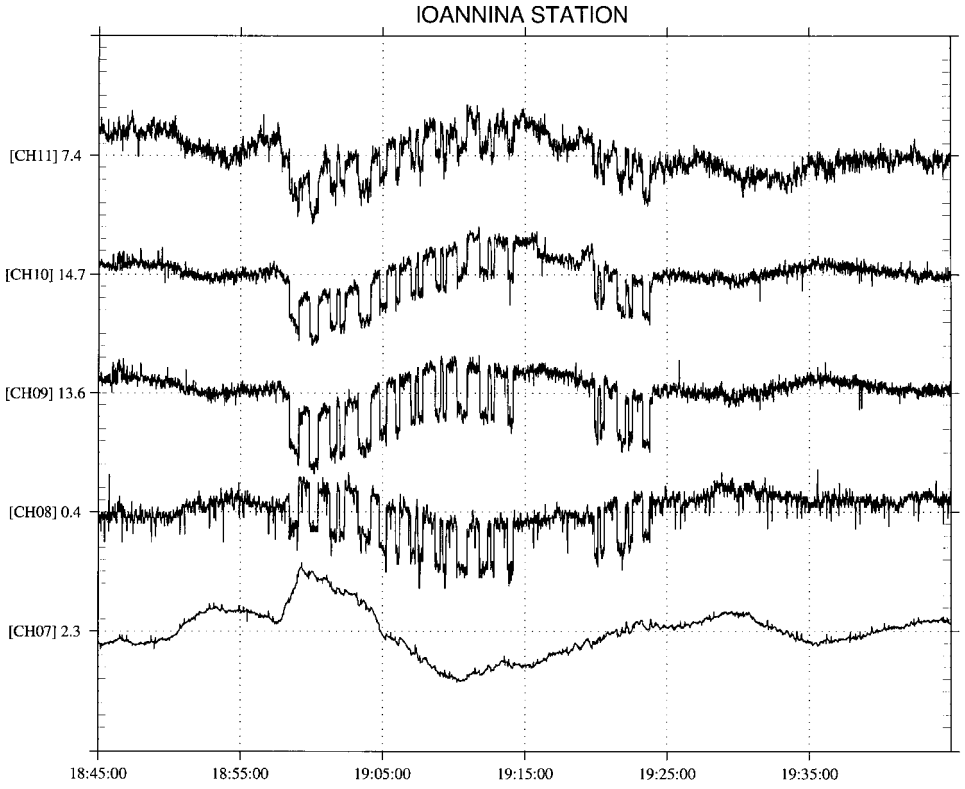

Fig. 1. The SES activity recorded at IOA on 10 January 2004. The ΔV-values (in mV) of the two short dipoles at site C (the lower two channels) and the three long dipoles (the upper three) are shown (see the text).

THE 5.5 EARTHQUAKE IN SOUTHERN GREECE ON 1 MARCH 2004

The previously mentioned SES activity at IOA was followed by an *Ms*(ATH) = 5.5 earthquake (EQ) that occurred at 00:36 GMT on 1 March 2004, with an epicentre at 37.19°N, 22.14°E. The fault plane solution and principal axes parameters of this EQ, as given by the **C**entroid **M**oment **T**ensor (CMT) solution of Harvard (see the site www.seismology.harvard.edu), are listed below

fault plane: strike = 154, dip = 29, slip = –117;

fault plane: strike = 4, dip = 64, slip = –76.

Attention should be drawn to the following point: On 13 September 1986, a destructive *Ms*(ATH) = 6.0 EQ occurred in the broad area of Kalamata, which has been preceded by clear SESs at Keratea (KER) station. However, the EQ on 1 March 2004, which more or less occurred in the same broad area – was preceded by an SES activity recorded at a different station, i.e., IOA. This might be due to the fact that different faults have been activated in these two EQs, but this point merits further investigation.

SES ACTIVITY AT PIRGOS STATION ON 14 MARCH 2004

The following information has been issued on 14 March 2004. Two very clear SES activities have been recorded at Pirgos (PIR) station on 14 March 2004. As an example, one of them is depicted in Fig. 2. It is interesting to check whether these SES activities will be followed by EQs at the Hellenic arc that obey the findings of Uyeda *et al*. (1999), according to which EQs with thrust source mechanism were predicted by

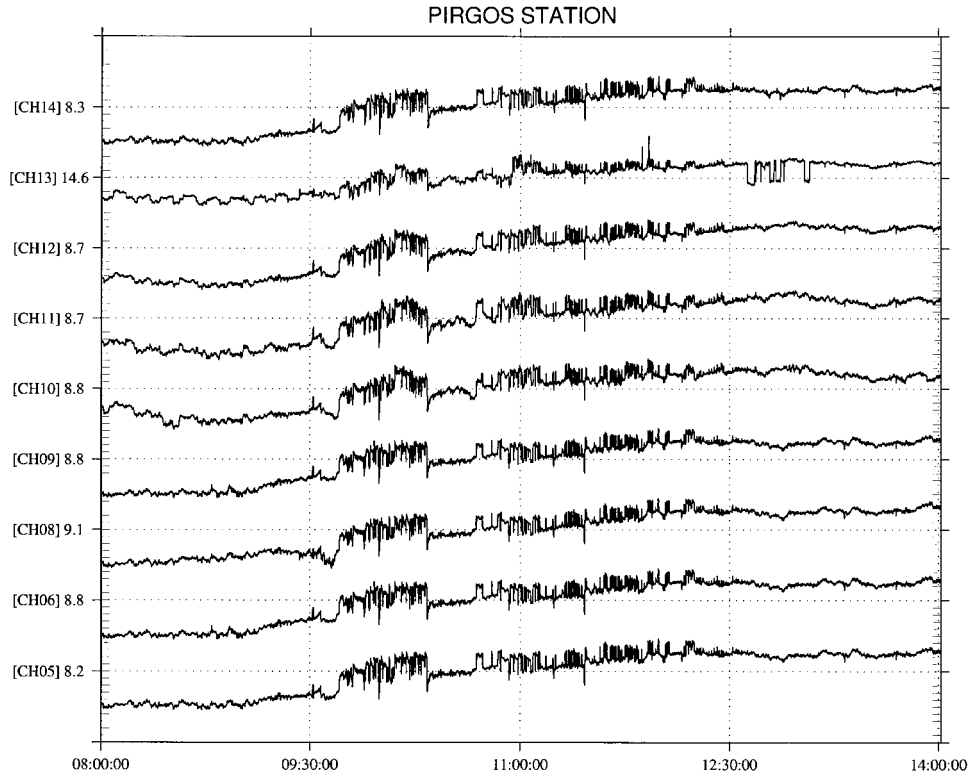

Fig. 2. One SES activity (out of two) recorded at PIR on 14 March 2004. The ΔV-values (in mV) of nine long dipoles are shown.

SES recorded at IOA station, while EQs predicted by SES recorded at PIR were (mostly) strike-slip-type with varying degree of normal component.

THE EARTHQUAKES IN 2004 THAT FOLLOWED THE PREVIOUS SES ACTIVITIES AT PIRGOS

Almost three days later, i.e., on 17 March 2004 an *Ms*(ATH) = 6.5 EQ occurred with an epicentre at 34.46°N, 23.26°E. The CMT solution according to Harvard is listed below

fault plane: strike = 82, dip = 80, slip = 177;

fault plane: strike = 172, dip = 87, slip = 10, and *Mw* = 6.0.

Being of strike-slip-type, this earthquake source mechanism is more or less compatible with the aforementioned conclusion of Uyeda *et al*. (1999).

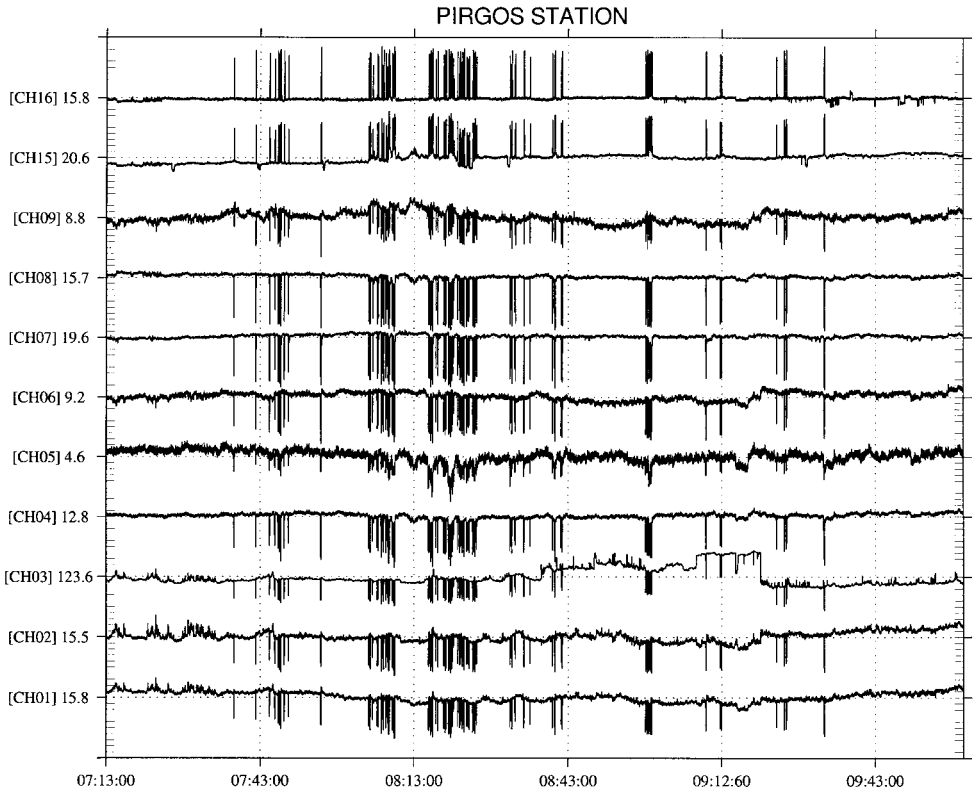

Fig. 3. The SES activity recorded at PIR on 17 October 2004. The ΔV-values (in mV) of eleven long dipoles are depicted.

Beyond the above EQ, a series of five EQs subsequently occurred, i.e., on 30 May and 31 May in the sea area south of Zakynthos (i.e., around 37.1°N, 21.5°E). The two strongest of them occurred at 06:59 GMT on 30 May and 06:30 GMT on 31 May with M = 5.4 and M = 5.2 (according to the University of Patras, while Athens observatory announced *Ms*(ATH) = 5.1 and 5.0, respectively).

SES ACTIVITY AT PIRGOS STATION ON 17 OCTOBER 2004

On 22 October 2004 the following information was forwarded: A clear SES activity was recorded at PIR on 17 October 2004, which is depicted in Fig. 3. The features of this SES activity are more or less similar to those of the signals recorded on 14 March 2004, mentioned above. We recall that the latter activity was followed by strong EQs in southern Greece (western Crete) and in western Greece (Zakynthos sea area of PIR). Hence, it is interesting to see whether in the present case the same seismic areas will become activated.

THE EARTHQUAKES THAT FOLLOWED THE SES ACTIVITY AT PIRGOS ON 17 OCTOBER 2004

Actually the following two strong EQs occurred:

– First, at 06:22 GMT on 4 November 2004, *Ms*(ATH) = 5.5 EQ occurred with an epicentre at 35.86°N, 23.23°E (i.e., between southern Peloponese and western Crete);

– Second, at 01:05 GMT on 31 January 2005, *Ms*(ATH) = 6.2 EQ occurred with an epicentre at 37.41°N, 20.11°E (Zakynthos sea area).

The source mechanism of the first EQ is more or less similar to the one of the EQ on 17 March 2004, mentioned above. Hence, it is compatible with the conclusions of Uyeda *et al*. (1999). As for the second EQ, the CMT solution according to Harvard is listed below

fault plane: strike = 344, dip = 16, slip = 117;

fault plane: strike = 136, dip = 76, slip = 83.

A further investigation on whether this source mechanism is consistent with the findings of Uyeda *et al*. (1999) is still in progress. In another paper (Teisseyre *et al*., 2004) it was found, basing on the numerical simulations of the Seismic Electric Signals, that the character and existence of such signals depend on the source fault structure. Furthermore, the natural time domain analysis (Varotsos *et al*. 2001; 2002; 2003a, b) of this SES activity as well as that of the subsequent seismicity are currently investigated in detail and the results will be shortly presented elsewhere.

MAIN CONCLUSION

Two major EQs with magnitudes *Ms*(ATH) = 6.5 and 6.2 (17 March 2004 and 31 January 2005), were preceded by the SES activities recorded at PIR that have been recognized well in advance. Further studies on these two cases are still in progress.

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