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Crustal stress monitoring in the Cephallonia Island (Western Greece) on the basis of a multi-parametric approach

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Both ground-based and space-borne techniques were applied since 2001 for monitoring crustal deformations in the Cephallonia Island, seated in the most seismically active area of the Hellenic Ionian Sea. Ground deformation studies based on Differential GPS (DGPS) and Differential Interferometric SAR (DInSAR) analyses were carried out on all Central Ionian Islands. In particular, local GPS networks were installed in Cephallonia (2001), Ithaca (2004) and Zakynthos (2005). The Cephallonian network was re-measured five times while Zakynthos' once as of July 2006. The studies yielded detailed information about both local and regional deformation occurring in the area. In Cephallonia, DInSAR analysis (1995 to 1998) pointed out ground deformation up to 28 mm in small segments of the island. DGPS measurements in the period 2001 to 2006 revealed a clockwise rotation of the island with respect to Aenos Mount, a station located at almost the island center. The horizontal component of deformation generally ranged from 6-34 mm, with the largest values occurring at the western and northern parts of the island. Considering the vertical deformation, two periods are distinguished: the first one (2001 to 2003) is consistent with anticipated

motions associated with the main geological and tectonic features of the island. The second one (2003 to 2006) has been tentatively attributed to *dilatancy* in which relatively small uplift (20-40 mm) has occurred along the S/SE sides of the island, while larger values ($>$50 mm) are measured at its western part (Paliki Peninsula). These large magnitudes of uplift over an extensive area ($>$50 km), together with an accelerated Benioff strain determined by analysing of the seismicity in a broader region, are consistent with *dilatancy*. This effect has begun some time after September 2003, and is probably centred in the area between Zakynthos and Cephallonia. If this interpretation is correct, it may foreshadow the occurrence of a strong earthquake(s) in the aforementioned region during 2008.

A validation of such inference has been investigated by means of time series of Acoustic Emission (AE) data at high (*200 kHz, HF AE*) and low (*25 kHz, LF AE*) frequencies collected in a ground station installed in February 2003 at the centre of Cephallonia Island. Such point-like AE records exhibit high temporal resolution and provide:

(i) relative time variation of the applied stress intensity, envisaging the amount of stress that affects some crustal portion, on a scale size, which depends on the specific tectonic setting;

(ii) the state of fatigue of stressed crustal slab, which is characterised by the typical time series of the released AE signals. Such aspect was examined by applying the fractal analysis to the AE records temporal sequence. This can provide information about the temporal evolution of the system in terms of increasing fatigue, eventually addressed toward a catastrophic event (e.g. the seismic shock).

The preliminary results concerning the *HF AE* show a clear annual variation, whose regularity envisages some likely astronomical modulation. Such annual variation results during 2004 clearly in phase with other *HF AE* time series collected in the Italian peninsula. It proves, therefore, a planetary phenomenon, which appears as a periodic stress wave regularly crossing the Mediterranean area. As far as the *LF AE* data are concerned, a conspicuous crisis of crustal stress seems to cross the broader area of Cephallonia, appearing just like one well defined “soliton” lasting from about April 2004 through the beginning of 2005. Some other perturbation could have been more recently started. The entire area appears involved in some remarkable seismic activity during such “soliton” crossing.

In addition, this multi-parametric study utilizes ancillary information obtained by analyzing digital topographic data (DEM) and soil exhalation measured by monitoring Radon (Rn) well content in a gauge nearby the AE station.