

Seismic array analysis of Tornillo-like signals recorded in Tuscany

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With the scientific purpose to monitor the micro-seismicity in the Central Apennines, we recently deployed in Eastern Tuscany (Casentino) a temporary 12 element seismic array, composed exclusively of 3-component seismometers. During the one month of registration we recorded an unexpected high rate of local micro-seismicity with up to 180 events per day.

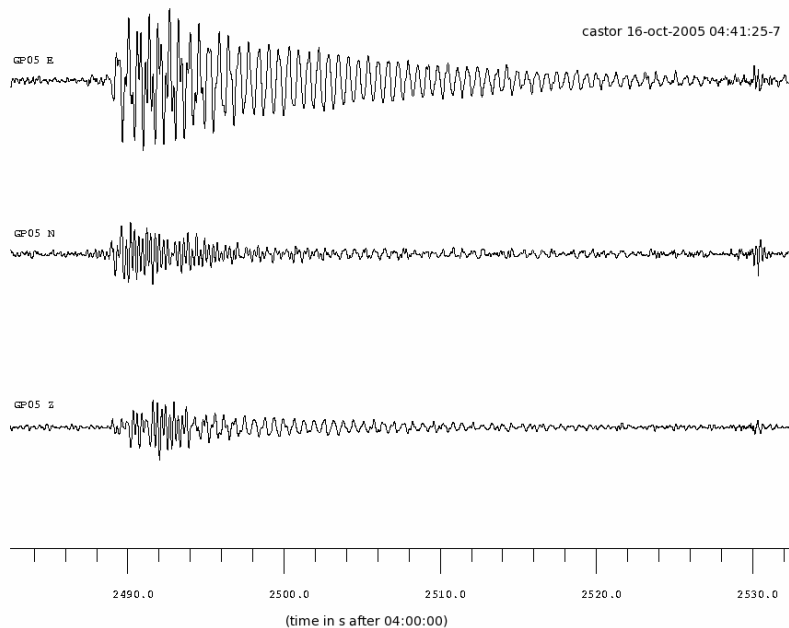


Fig. 1 –E,N,Z-traces of a tornillo-like seismic event recorded by a seismic array in eastern Tuscany

Waveforms surprisingly resembled volcano-seismic events rather than tectonic earthquakes. Distinct P and S-phases with a sharp onset are missing. Seismograms show an emergent onset followed after a few seconds by a weakly attenuated monochromatic coda, similar to “Tornillos” known from active volcanoes like e.g. Galeras. More than 5000 Grapillos (Gas-Related APenninic Tornillos) have been recorded during the one month recording period, showing all similar amplitudes but irregular temporal occurrence. Locations of the Grapillos were determined by automated f-k analysis. Wavefronts reach the array from NW (306°) with a slowness 20 s/deg ($v_{app} \sim 5.32$ km/s), corresponding to an epicentre location 13 km NW respect to the array centre. Source locations seem to remain rather stable for the entire duration of the array installation.

At the end of the experiment some of the array stations were used to set up a small network around the epicentral area. Classical hypocentral determination - using exclusively first onsets - confirmed the epicentres found by f-k analysis and determine for the Grapillos a distinct focal depth of ca. 4 km.

Concerning the origin of the unusual seismic events geothermal and volcanic activity can be excluded “a priori”. However, in the nearby situated Upper Tiber Valley many cold CO₂ springs (Mofettes) can be observed on the surface since decades. Pulsation and transients in gas flux have been observed at known Mofettes and are possibly caused by tectonic transients. However, in the epicentral area currently no gas Mofettes are known. We speculate, that the origin of the “Tornillo”-like seismic signals could be related to transients in an unknown CO₂ reservoir inside the upper crust.

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