Geophysical Research Abstracts
Vol. 20, EGU2018-5266, 2018
EGU General Assembly 2018

Two years of geochemical monitoring along the Alto Tiberina Fault (Italy): new inferences on fluids and seismicity in central Apennines

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Crustal faults are complex natural systems whose mechanical properties evolve over time. Hence the understanding of the multi-scale chemical-physical processes, which control rock deformation, faulting and seismicity, requires investigating processes at the boundaries between different research fields and the availability of long term series of data.

With this aim it was created the TABOO near fault observatory within the inner sector of the northern Apennines (Italy)to permanently monitor at high resolution a relatively small and actively deforming area (120km x 120km) by a multidisciplinary approach (Chiaraluce et al., 2014).

In this area it is documented the existence of a 60km long extensional fault named Alto Tiberina Fault (ATF) that is recognized being an high seismicity structure even if there were not large historical events unambiguously associated with this fault. In contrast a set of synthetic and antitethic high angle faults generated moderate seismic events. The region is also characterized by high pressure fluids (mainly CO_2) at depth and very high flux CO_2 emissions (up to 5800 t/yr) on the surface in absence of any evidences of volcanism. The fluid over-pressure is proposed as one of the main triggering mechanisms of Apennine earthquakes (Chiodini et al., 2004). Recently, we deployed a network of 4 automatic permanent stations along the ATF to monitor the soil CO_2 flux. Periodically we also collect fluids released in the region to investigate a) the origin of outgassing volatiles, b) the role of the tectonic discontinuities in the transfer of volatiles towards the surface.

The geochemical network was in place also during the seismic sequence that hit the central Italy in 2016. We observed a variation of the CO_2 fluxes in all the sites before the main faulting episodes (MW>5.9) of the seismic sequences. We recognized the increase even if the sites are located up to 140km away from the main shocks epicentres. The increase of the soil CO_2 flux that anticipated the higher magnitude earthquakes from one week to one month, was observed firstly at the southernmost station (100 km from the epicentre) and then to the northernmost ones (140 km from the epicentre), mimicking sort of migrating pulse at about 1km/day. Moreover, the volatiles that we periodically collected, have shown that the increase of soil CO_2 flux was not coupled to variations of the chemistry of the fluids emitted from the main vents in the region.

This study indicates that crustal deformation associated with earthquakes preparatory processes, controls the gas transfer on regional scale along the Apennine and it also give new insights on the depth of the faults systems that are active to the transfer of volatiles towards the surface and are sensitive to deformation at regional scale.

References

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