Geophysical Research Abstracts
Vol. 21, EGU2019-14983, 2019
EGU General Assembly 2019

Contribution of rocks fracturing to the radiogenic helium budget in a seismic region

Dario Buttitta (1), Antonio Caracausi (1), Lauro Chiaraluce (2), Rocco Favara (1), Maurizio Gasparo Morticelli (3), and Attilio Sulli (3)

(1) Istituto Nazionale di Geofisica e Vulcanologia, sezione di Palermo, Palermo, Italy, (2) Istituto Nazionale di Geofisica e Vulcanologia, sezione di Roma, Roma, Italy, (3) Università di Palermo, Dipartimento di Scienza della Terra e del Mare, Via Archirafi, 22, Palermo, Italy

Changes of physical properties of rocks can modify the release and transfer of volatiles through the crust. The fracturing of rocks under physical stress, with the consequent generation of new surfaces because of dilatancy, can produce episodic release of the accumulated radiogenic volatiles (Bauer 2016; Honda et al. 1982). In fact, radioactive decay of U and Th continuously produces helium (He), so its amount stored into minerals and rocks progressively increases over the geological time. The rock deformation creates new fracture networks that improve the release of the trapped volatiles (e.g. He).
In our study, we investigated how tectonic deformation can control the release and transfer of crustal fluids in north-central Italy by using He. So, we compared He that is stored in natural gas reservoirs feeding mud volcanoes with He that is produced in the crust and the role of local seismicity in increasing the release of He from the rock. We investigated fluids that are emitted at Regnano-Nirano mud volcanoes and these fluids are methane-dominated and He is in traces (tens of ppmv). These gases suffer of very low air contamination and He isotopic signature indicates its radiogenic origin (R/Ra =0.01-0.03; Ra is the He isotope signature in air). Based on a reconstruction of the volume of the gas reservoirs we ascertained that the amount of He in the natural reservoirs cannot be sustained by a diffusive degassing through the entire crust. It means that we have to invocate additional processes to explain the He-excess into the reservoirs respect to the diffusive degassing. Previous investigations (Bonini, 2007) show that vertical migration of fluids feeds the gas reservoirs. So, we investigated if the deep and shallow local seismicity can really support the extra He in the reservoirs.
According to the approach proposed by Sano et al. (1998), we computed the volume of rock affected by deformation due to each local earthquake and the related increase of He flux (Caracausi and Paternoster 2015). If we extrapolate the current frequency and magnitude of earthquakes over time to the age of the gas trap formation, we can calculate the total volumes of radiogenic He produced and released due to seismicity. The volume of fractured rocks per year is from 2.4 to 70 km3 and it can explain from 1% to 3% of He in the reservoir each year. This variability depends on the local seismicity (the earthquakes hypocenters and magnitude) and the method that is used to compute the recurrence–time of earthquakes (FixedMc-MaxCurvature). So, the recent seismicity can explain the He-excess that is stored in the reservoirs. These results strongly support that the transport of volatiles through the crust is episodic with short intervals of rapid transport and longer timescales of very slow fluid transport and the seismicity is a major process in controlling this transfer.

References
Bauer et., (2016). No. SAND2016-1483C.
Bonini M. (2007).JGR (Solid Earth)
Caracausi and Paternoster, (2015).JGR (Solid Earth).
Honda et al., (1982).EarthPlanet.Sci.Lett.
Sano et al., (1998).Chem.Geol.
Torgersen, T. and O'Donnell, J. (1991).GeophysicalResearchLetters