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Relating changes in radon exhalation to increasing loading in rocks. New insights from rock deformation laboratory experiments.

P. Tuccimei (1), S. Vinciguerra (2), S. Moretti (1), S. Mollo (2), M. Castelluccio (1), and M. Soligo (1)

(1) Universita di Roma Tre, Scienze Geologiche, Roma, Italy (TUCCIMEI@UNIROMA3.IT, 0039-06-57338092), (2) Istituto di Geofisica e Vulcanologia, Roma, Italy

Radon emissions increase is regarded as a valuable geophysical precursor of earthquakes. Radon concentrations are observed in the soil or groundwater and have been related to increasing fracturing of the medium, which increases the exhaling surface area and originates pathways for radon release. In order to investigate the relation between increasing load and changes of radon exhalation rates, a volcanic tuff ("Tufo Rosso a Scorie Nere") from Vico volcano (central Italy) has been investigated in the laboratory. Four samples of 120 (length) x 60 (diameter) mm, have been loaded at constant strain rate, to guarantee a homogeneous deformation of the microstructure, with a strain rate of 0.5 micron / s. Two samples have been loaded up to the failure, while the remaining two have been downloaded, before the onset of dilatancy, when the highest compaction of existing voids space was reached. Radon exhalation rates of rock samples before deformation (step 1), at the end of the compaction phase (step 2) and after rupture, with a partial creep along the failure plain (step 3) have been measured in laboratory by using a solid-state alpha detector, connected to a small accumulation chamber kept at the constant temperature of 60 °C, with the aim to enhance radon exhalation. Measurements have been always performed on groups of two samples to achieve strong signals and being able to discriminate better changes in radon emissions. Analyses were repeated several times in order to verify their reproducibility. A decrease of radon emissions, induced by a stress of about 2 MPa has been measured after step 2, when samples porosity (about 47 %) was reduced from the compaction and formation of new cracks did not start yet. On the contrary, radon release increased after rupture, when the total exhaling surface of test samples was evidently enlarged.