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Preliminary results on variations of radon concentration associated with rock deformation in a uranium mine

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Time–series of radon concentration and environmental parameters were recently recorded in a uranium mine gallery, located in the Maritime Alps (NW Italy). The mine was bored in metarhyolites and porphyric schists mainly composed by quartz, feldspar, sericite and fluorite. U–bearing minerals are generally concentrated in veins heterogeneously spaced and made of crystals of metaautunite and metatorbernite. Radon air concentration monitoring was performed with an ionization chamber which was placed at the bottom of the gallery. Hourly mean values of temperature, pressure, and relative humidity were also measured. External data of atmospheric temperature, pressure and rainfall were also available from a meteorological station located nearby, at a similar altitude of the mine. The analysis of the time series recorded showed variation of radon concentration, of large amplitude, exhibiting daily and half–daily periods, which do not seem correlated with meteorological records. Searching for the origin of radon concentration changes and monitoring their amplitude as a function of time can provide important clues on the complex emanation process. During this process, radon reaches the air– and water–filled interstices by recoil and diffusion, where its migration is directed towards lower concentration regions, following the local gradient. The radon emanation from the rock matrix could also be controlled by stress changes acting on the rate of migration of radon into fissures, and fractures. This may yield emanation boosts due to rock extension and the consequent crack broadening, and emanation decrease when joints between cracks close. Thus, besides interaction and mass transfer with the external atmospheric environment, one possible explanation for the periodic changes in radon concentrations in the investigated mine, could be the variation of rock deformation related to lunar–solar tides. The large variation of concentration could be also due to the fact that the mine is located next to the Ligurian Sea coast. When the sea tides change the water level at the shore, this might produce additional pressure which increases the deformations (sea loading). This paper presents the preliminary results of an experiment, which is in progress in the uranium mine. During the experiment, several geophysical parameters are monitored together with radon concentration. After appropriate insulation in order to prevent radon escape through normal atmospheric circulation, the gallery was equipped with three radon detectors, four passive dosimeters, an array of unpolarisable electrodes for measurements of self-potential variations and a microgravimeter for monitoring of the tidal effect. We expect that changes in the mechanical state can be accompanied by changes in the electric potential. Since the latter variation can be related also to changes in the natural magnetic field, measurements with a three components fluxgate magnetometer are also being carried out. The recorded signals will be analysed according to standard procedures, such as spectral analysis and cross-correlation, aimed at discriminating the periodic components and the governing physical processes.