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Novel determination of radon-222 velocity in deep subsurface rocks, and the feasibility to using radon as an earthquake precursor

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Abstract

An enhanced radon monitoring system was designed in order to study shallow versus deep subsurface processes affecting the appearance of radon anomalies. The method is based on the assumption that the climatic influence is limited since its energy decreases with the decrease in thickness of the geological cover whereby its effect is reduced to a negligible value at depth.

Hence, lowering gamma and alpha detectors into deep boreholes and monitoring their temporal variations relative to a reference couple at shallow depths of 10-40 m eliminates the ambient thermal and pressure-induced contribution from the total radon time series. It allows highlighting the residual portion of the radon signals that might be associated with the geodynamic processes. The primary technological key is the higher sensitivity of the gamma detectors - in comparison to the solid-state alpha detectors, which are also suitable for threading into narrow boreholes in parallel to the narrow gamma detector (Zafrir et al., 2013*).

The unique achievements of the novel system that was installed at the Sde Eliezer site close to the Hula Valley western border fault (HWBF) in northern Israel are:

a) Determination, for the first time, of the radon movement velocity within rock layers at depths of several tens of meters, namely, 25 m per hour on average;

b) Distinguishing between the diurnal periodical effect of the ambient temperature and the semi-diurnal effect of the ambient pressure on the radon temporal spectrum;

c) Identification of a radon random pre-seismic anomaly preceding the Nuweiba, M 5.5 earthquake of 27 June 2015 that occurred within Dead Sea Fault Zone.

* Zafrir, H**.,** Barbosa, S.M. and Malik, U., 2013. Differentiation between the effect of temperature and pressure on radon within the subsurface geological media, *Radiat. Meas.*, 49, 39-56. doi:10.1016/j.radmeas.2012.11.019.