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Geodynamic radon signals and signatures along the Dead Sea Transform (Israel) – results for 1994-2004

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Radon is being monitored at three arrays of stations located in a 200 km sector along the western boundary fault of the Dead Sea Transform (DST). Measurements are conducted in the geogas of the unsaturated zone of different rock units - Precambrian igneous and metamorphic basement rocks, Cretaceous syenite and sub-recent unconsolidated gravel. Alpha and gamma detectors, placed at depths of 1.5 to tens of meters, gather radon and ancillary information at a high time resolution ($<$ 1 hour). Long time series (up to +10 years) display systematic and recurring signatures and signals, enabling to discern several variation patterns: 1) Multi-year (MY); 2) Seasonal; 3) Multi-day (MD), and 4) Diurnal Radon Signals (DRS).

Establishing the geodynamic nature of the signatures and signals is based on three approaches:

Negation of atmospheric influence - demonstrating that the variation of the radon in geogas is basically unrelated to variations in the local ambient atmospheric conditions. This is shown by searching for correlation and fit in the time and frequency domains.

Analyzing radon signatures in the geological, spatial, time and frequency domains. Systematic relations are observed among signals from different stations within an array at spatial scales of 0.1 to 20 km. Time series of radon exhibit temporal correlation, among stations in the local arrays. Several modes of correlation occur, based on the time scale of the radon signal – MY, MD, DRS.

Systematic time-offsets of the signals, confirmed by cross-correlation analysis, are observed among stations within an array. In the case of DRS different patterns of daily cyclic signals, derived by FFT analysis, are associated with geologic and tectonic elements.

Establishing correlation with geophysical phenomena, and specifically by correlation to seismic patterns. Using a 10 year long time series from a single monitoring site at the NW Dead Sea, statistically significant correlations with earthquakes in an associated tectonic segment of the DST is demonstrated independently for three different time scales of variation – MY, MD, and DRS.

Such relations imply subsurface geophysical driving processes, influencing the release of radon from its source rock and/or affecting the advection/conduit system transporting the radon from source at depth to the detector. Furthermore, the results determine radon as a sensitive proxy of subtle transients in the geodynamic activity in the upper crust. This sets radon as a leading tool for investigations in the field of geodynamic prediction research.