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Sub seawater monitoring of Radon at IUI, Elat, Israel – geophysical implications

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Radon is monitored at shore and near offshore environs at the western border of the Gulf of Elat (Aqaba), at the Inter University Institute (IUI) in Elat. Monitoring is implemented using gamma detectors at a 15-minute resolution at four locations: a) at depths of around 1.8 meters below seawater in a hole dug in the shore gravel, about 15 meters from the shoreline; b) 3 meters under sea level at the far end of the IUI pier; c) Beyond the pier at a water depth of 30 meters; d) in the air at the end of the pier some 3 meters above seawater and 70 meters from the shoreline. The Measured Signal (MS) is composed of periodic Daily Radon (DR), non-periodic Multi Day (MD) and periodic Seasonal Radon (SR) signals. The primary features of the temporal variation of radon are:

- Exceptionally high levels of radon and very large temporal variations are encountered in the shore gravel (a).
- Applying gamma spectrometry in the shore gravel (a) confirms that detected variation is due to radiation from radon in the water.
- Periodic Daily Radon signals are observed by all submerged detectors (a-c). In the shore gravel (a) they are extremely prominent and the daily variation (=daily amplitude) exhibits a linear relation to the average daily level.
- Non-periodic Multi Day variations occur in the shore gravel (a) and in the seawater about 1 meter above sea bottom, at a depth of 3 meters (b) at the pier and at a depth of 30 meters (c).

- Similar MD and DR signals are recorded above sea, in the atmosphere around IUI (d). Collimation tests using Pb shielding indicate that the signal originates to a large extent from the shore sector.

Spectral analysis (FFT) of the MS from all locations shows that the diurnal band is dominated by diurnal constituents indicative of tidal influence. The primary indicator is the M2 (Principal lunar) constituent around 1.93 cycles/day. At this stage it is not known whether the diurnal tidal signature observed in the radon is due to the effect of change in the sea level, sea tide forcing of the sub-sea system or local solid earth tide.

In general the radon level in the seawater (a-c) is not supported by radium in the water, indicating a sub seawater influx. A flux of radon flowing from the subsurface into the seawater and the local atmosphere is indicated by the high radiation levels in the air of the shore sector and the tidal signature of its DR, which cannot be generated in the air.

These observations are the first of radon signals in the marine environment. The implications of the occurrence at IUI are: a) A large radon flux probably exists along further sectors of the major western active boundary fault of the Elat deep; b) Clarifying the nature of the nature of the tidal components in the DR signal is central to the understanding of the specific processes involved – sea level, sea tide, or solid earth tide; This will help constrain the driver(s) of other signals (MD) which may be reflecting geodynamic transients (MD signals). C) Comparison with nearby radon signal patterns in the on-land geological environment (2km, Elat Granite; Steinitz et al. JGR, 2007) should help understand the overall rules governing the variation of radon in the upper crust.