Geophysical Research Abstracts,
Vol. 10, EGU2008-A-05386, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-05386
EGU General Assembly 2008

The Evolution, Transportation and Variation in Time of Rn-222 Within Rocks in a Desert Region

H.Zafrir

Geological Survey of Israel, 30 Malkhei Israel St., Jerusalem, 95501, Israel, (zafrir@gsi.gov.il)

The basic assumption underlying monitoring of Radon within rocks is the capability of Radon to emanate to the porous media and be available for further transport by diffusion via the pore content (geo-gas) or to a convective migration, to a limited range (half life = 3.8 days).

To this end, the association between the temporal variations of Radon is investigated versus other geophysical variables: pressure, temperature, precipitation, humidity, groundwater level, gravity, and geodynamic changes.

Monitoring Radon in an arid region was achieved by installing Radon sensors along the Dead Sea Transform, similar to the Amram Tunnel near Eilat. It enables to set apart those variables that are not active in the area like precipitation, and keeping part of them stable.

The Tunnel is a deep dead-end, confined horizontal shaft within quartz porphyry (172 meter span and 75-150 meters below surface) with well defined environmental conditions as: stable indoor humidity and temperature ($28\pm0.3^{\circ}$C), low CO_2 content and very dry porous media, situated high above the local water table.

Monitoring Radon by gamma counting together with environmental parameters, since 2004 to 2007, at sampling rate of several minutes, provided the following results.

Seasonal and daily Observations within the tunnel:

- No correlation occurred between Radon and atmospheric pressure

- No connection occurred between Radon and the stable tunnel temperature
- Clear correlation occurred between the Radon at tunnel interior depth and the temporal variation of the external temperature
- Reduction of Radon intensities by a factor of 2-5 occurred during the winters
- During summer the Radon within the tunnel follows the daily external temperature with a delay of about 10 hours, consistently
- The Fourier spectrum of summer Radon and temperature is identical. Furthermore, the multi-day and the seasonal variations of the Radon emanation during summer & winter also delineate the same interconnection with the external temperature
- During winter, while the external temperature is lower than the tunnel internal temperature the Radon diurnal variations fade away - as indicated by the winter FFT.

Particular Observations outside the tunnel:

- Outside the tunnel at shallow depth of 7 meter, there is also a clear daily correlation between Radon and the temperature with a delay of about 2-3 hours, consistently
- The multi-day and the seasonal Radon variations are affected by environmental condition as wind that may distort the interconnection with the external temperature.

The conclusions based on the Radon Transport model are:

- The temporal variation of the Radon in the Amram tunnel is caused by a convection geo-gas current. Pressure gradient of several tens Pa is sufficient to get pore-air velocity of a few meters per hour
- The aerostatic absolute pressure in the subsurface and outside is the same and therefore cannot produce an advection that can account for the Radon anomalies
- On the other hand, there is a pressure difference (above the aerostatic) between the outside air and the inside air of the tunnel caused by the difference in temperature between the outdoor air and the indoor air, similar to Stack effect

- This indicates that the diurnal variation of the Radon concentration at Amram tunnel is caused by the interplay of the ambient temperature gradient at the outside rock air interface
- The delay of 10 hours per 100 m (in average) occurs as a result of the time it takes to transport the Radon through the fracture rock porous media towards the daily hot ground surface. At night when the ground surface is cooled the advective transport of the Radon is back to tunnel
- The time lag between the Radon and temperature maxima - 2 hours for the 7 meters shallow sensor at and 10 hours for the 100 meter tunnel sensor, caused by the time it takes to transport the Radon pulse through the fracture rocks
- Furthermore, the multi-day and the seasonal variation of the radon emanation also delineate the same interconnection with the ambient temperature
- But the non-linear relation between the intensity of the Radon anomalies and the ambience temperature with a reduction of the Radon emission by a factor of 2-5 during the winters (November-March) cannot be explained by Stack equation. It may be explained by the Radon transport dependent on temperature within the porous media, like a thermal noise