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"Routine" versus earthquake-related behavior in Na-K-Mg geothermometry records of Vrancea area (Romania)

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A several-years long geochemical monitoring operation has been initiated in April 2003, addressing a deep-origin groundwater discharge at Slanic Moldova, close to Vrancea seismic area. In order to interpret the evolution of the major cations concentrations, the Na-K-Mg geothermometer diagnosis method has been used. Similarly to results previously obtained worldwide (California; southwest Egypt), an anomalous fluctuation of the so-called "Na-K temperature" (a parameter which is assumed to approximate temperatures existing in a deep origin groundwater reservoir) has been detected on occurrence of a major earthquake (27 October 2004, Mw=5.8-6.0). The earthquake epicenter was positioned at 50 km away from the geochemical sampling site, the focal depth being approximately 95 km.

Generally, Na-K temperature fluctuations may also occur "routinely", as a result of the admixture of various amounts of shallow, meteorically-derived waters, or due to variable degrees of chemical re-equilibration at shallower depths / lower temperatures. It was therefore important to investigate if the variations observed in the data values could be plausibly related to a seismogeneis process. In this respect, an appropriate diagnosis should be provided by a so-called "maturity index": that parameter estimates - by additionally considering the fast-readjusting K/Mg solute ratio - the hydrothermal solution departure from the chemical equilibrium state mirrored by the "Na-K temperature".

By plotting the maturity index versus the Na-K temperature values for the Slanic Moldova spring, two distinct regimes became noticeable: one consisting of highly correlated data-points, occurring as a dense "cluster", and the other one including a series of more poorly correlated data-points, which appeared to "drift away" from the main "cluster".

The "cluster" regime persisted during the entire period (in excess of 3 years) that followed the strongest Vrancea earthquake (27 October 2004, Mw=5.8-6.0) recorded during the monitoring operation. Alternatively, that seismic event had been predated by a continuous, 18 months-long "drift" period; the "drift" phenomenon ended just before the strong earthquake, and no other "drift" regimes were observed on occurrence of the lower magnitude events recorded subsequently.

Those observations seem to indicate that while the "cluster" regime mirrored the "routine" behavior of a deep origin groundwater discharge, the "drift" regime has occurred under certain exceptional circumstances: the latter were most probably connected to the strongest Vrancea earthquake recorded during the monitoring operation.