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Time series analysis of soil radon in Northern Pakistan: implications for earthquake forecasting

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Abstract

Time series analysis of soil radon data has previously been proposed as a mechanism for earthquake hazard forecasting, but it is not universally accepted as such. Here we perform time series analysis of soil radon along an active fault zone in North Pakistan, in order to investigate pre-earthquake anomalies for a period of July 24, 2014 to April 30, 2015. The methodology includes geochemical analysis of soil, deterministic analysis (Hurst exponent *H*), quantification of meteorological influence and abnormalities of soil radon within the context of earthquake forecasting. In particular, for analyzing abnormalities in radon data, we have used residual signal processing techniques to reduce the regular effect of meteorological factors and a statistical criterion ($\bar{x} \pm 2\sigma$) at a 95% confidence interval. Results of geochemical analysis suggest that any abnormal enhancement in soil radon concentration is not associated with the presence of key radionuclides such as ^{226}Ra, ^{232}Th and ^{40}K. The deterministic analysis of radon and meteorological parameters reveals that *H* belongs to the interval $0.5 \leq H \leq 1$, which indicates a persistent trend with insignificant infrequency and irregularity. Likewise, the influence of meteorological parameters on soil radon is quantified via correlation coefficients suggesting an insignificant impact. Furthermore, temporal variability of residual radon around the time of earthquake activity reveals the presence of six notable anomalous peaks overpassing the statistical criterion during the investigated period. An absence of anomalous residual radon behavior for some earthquake events in the investigated period can be attributed to their low magnitude and high R_E/R_D value. Finally, our results validate earlier findings and recommend the use of radon as a seismic indicator.

Key words: Earthquake Precursors, Radon, Radionuclides, Hurst Exponent, Northern Pakistan

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