Recurrent radon minima and crustal-strain transients precursory to earthquakes in Taiwan

M. C. T. Kuo

Department of Mineral and Petroleum Engineering, National Cheng Kung University, Tainan, Taiwan
E-mail: mctkuobe@mail.ncku.edu.tw

For the first time, three anomalous decreases in radon concentration have been recorded prior to the large earthquakes of magnitude M_W 6.8, M_W 6.2, M_W 5.9, and M_W 6.0 that occurred on December 10, 2003, April 1 and 15, 2006, and January 25, 2007, respectively, within a 75 km radius from the Antung D1 monitoring well in eastern Taiwan. The recurrent precursory minima in radon concentration observed at the Antung hot spring demonstrate that the radon minimum decreases as the earthquake magnitude increases and as the distance between the hypocenter and the Antung hot spring decreases. Reproducible observations at the Antung hot spring suggest that radon concentrations in ground water, under suitable geological conditions, can be a sensitive tracer of strain changes in the crust preceding an earthquake. The Antung hot spring is situated in a fractured block of tuffaceous-sandstone surrounded by ductile mudstone. Given these geological conditions, the dilation of brittle rock mass occurred at a rate faster than the recharge of pore water and gas saturation developed in newly created cracks preceding the above mentioned earthquakes. Radon partitioning into the gas phase can explain the anomalous decreases of radon precursory to the earthquakes. The 2003 Chengkung earthquake of magnitude (M) 6.8 was the strongest earthquake near the Chengkung area in eastern Taiwan since 1951. The distance from the epicenter to the Antung D1 monitoring well was only about 20 kilometers. For the first time, transient crustal-strain signals prior to the 2003 M_W 6.8 Chengkung earthquake have been calculated using the radon transient during the rock dilation stage, which can be correlated reasonably with the coseismic strain change calculated based on the dislocation fault model using the data recorded by nearby strong-motion stations and a GPS network.

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