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Anomalous change in atmospheric radon concentration induced by crustal movement

IWATA, Daichi[1*] ; NAGAHAMA, Hiroyuki[1] ; MUTO, Jun[1] ; YASUOKA, Yumi[2] ; MIURA, Satoshi[3] ; OHTA, Yusaku[3]

[1]Dept. Geol., Grad. Sch. Sci., Tohoku Univ., [2]Inst. Radioisot. Res., Kobe Pharm. Univ., [3]RCPEVE, Tohoku University

Radon is a radioactive gas which occurs naturally. Radium (^{226}Ra) decays to radon (^{222}Rn), which belongs to uranium series, by emitting an alpha particle. Radon (^{222}Rn) has a half-life of about 3.8 days. Radon (^{222}Rn) is released from the ground and observed as atmospheric radon concentration.

It is known that the anomalous change in atmospheric radon concentration with earthquakes can be observed. For example, prior to the 1995 Kobe earthquake, the anomalous increase in atmospheric radon concentration was observed at Kobe Pharmaceutical University. It is considered that the changes in atmospheric radon concentration related to large earthquakes are caused by the crustal strain resulting in radon exhalation from ground (Yasuoka et al., 2008). In the report of anomalous increase in atmospheric radon concentration before the Kobe earthquake, it is shown that there is a correlation between radon concentration anomaly and variation of crustal strain measured at the Rokko-Takao station of Kyoto University, located about 10 km west of the Kobe Pharmaceutical University. In this case, crustal strain is measured as local crustal strain. If radon exhalation from the ground and atmospheric radon concentration anomaly reflects crustal strain changes, it is expected that there is a correlation between atmospheric radon concentration change and “wide area strain” .

In this study, we compared the atmospheric radon concentration and area strain near the radon observation point. We used data of atmospheric radon concentration measured at the radioisotope institutes of Sapporo Medical University and Fukushima Medical University (Hatanaka et al., 2013). We calculated wide area strain around the two RI institutes by GPS data.

In the result, a correlation can be seen between the anomalous change in atmospheric radon concentration after the 2003 Tokachi oki earthquake (September 26, 2003, Mw 8.0) and the variation of the area strain near the Sapporo Medical University. Moreover, there is a correlation between the variation of the area strain and atmospheric radon concentration anomaly observed around 2008 Ibaraki-ken oki earthquake (May 8, 2008, Mj 7.0), Fukushima-ken oki earthquake (July 19, 2008, Mj 6.9), 2010 Fukushima-ken oki earthquake (March 14, 2010, Mj 6.7) at the Fukushima Medical University.

These results indicated that atmospheric radon concentration is sensitive to variation of area strain of the order of 10^{-7} to 10^{-8}. It is considered that crustal strain change causes the change in flowing condition of radon and radon flux in the ground.

Keywords: atmospheric radon concentration, crustal movement, GPS, area strain