A Mechanism of Radon Concentration Decline Prior to 1978 Izu-Oshima-Kinkai Earthquake

Tsunomori F. (University of Tokyo), Kuo M.C.T (National Cheng Kung University)

An earthquake of magnitude 7.0 occurred between Izu Peninsula and Izu-Oshima Island in central Japan on January 14, 1978. Precursory changes in a radon concentration in groundwater were observed at the SKE radon-monitoring station located 25 km from the epicenter approximately 3 months prior to the Izu-Oshima-Kinkai Earthquake (Wakita et al., 1980; Wakita, 1981). Because of the similarity between the radon anomaly pattern and volumetric strain changes measured at Irozaki (Figure 1), this radon concentration anomaly is now believed to have predicted the 1978 earthquake (Wakita et al., 1988). In this report, we will discuss about a radon decline mechanism prior to the earthquake.

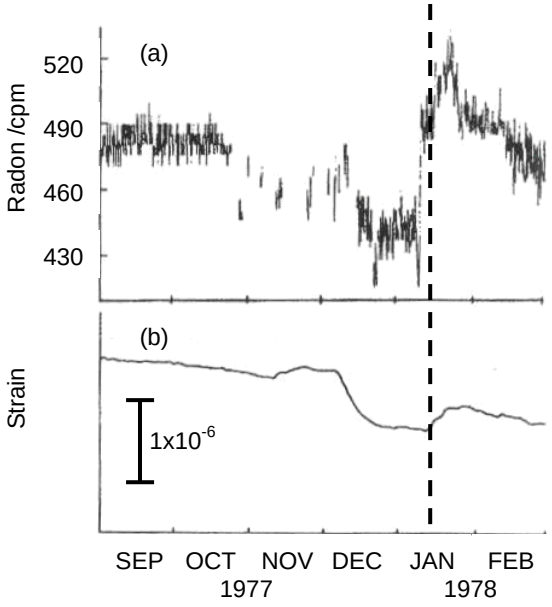

Figure 1 . (a)Groundwater radon concentration change and (b)volumetric change prior to 1978 Izu-Oshima-Kinkai Earthquake. (Wakita, 1988)

According to Andrews (1977), the radon concentration in a porous geologic media is expressed as $C_{Rn} \propto E/\phi$, where E and ϕ are respectively the radon emanation power and the porosity of rocks in such medium. This equation should be improved as $C_{Rn} \propto SE/\phi$, where S is surface area of rocks because radon-222 is supplied through surface of rocks. The emanation power E is regarded as constant because E depends only the concentration of radium-226 ($T_{1/2}$ ~ 1600y). To decrease in radon concentration therefore either S has to decrease or ϕ has to increase.

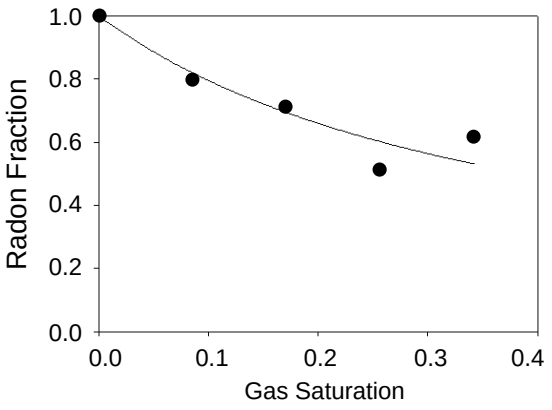

Figure 2. Variation of radon fraction remaining in groundwater with gas saturation at 15 °C using formation brine from the SKE.

Assuming the strain change at an aquifer of SKE station was as same as Irozaki shown in Figure 1(b) (Wakita et al, 1988), dilatancy (porosity increase) was created by approximately 2×10^{-7} strain change on the aquifer from mid-November to mid-December 1977. In this period, if new fractures were generated at dilatancy process the effect of porosity increase on the radon concentration would be canceled. It is therefore presumed that the radon decline prior to the 1978 earthquake is caused by dilatancy at the aquifer without new fracture creation.

In order to evaluate the porosity change, radon-partitioning experiments were carried out to determine the variation of the radon concentration remaining in groundwater with the gas saturation at formation temperature (15 °C) using formation brine from the SKE well (Figure 2). The estimated fracture porosity at the SKE aquifer was approximately 2×10^{-5}.

In conclusion, (1) the radon decline prior to the 1978 earthquake may be caused by dilatancy at the aquifer without new fracture creation, (2) The estimated fracture porosity at the SKE aquifer prior to the earthquake was approximately 2×10^{-5}.