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Thematic Article

Behavior of gases in the Nojima Fault Zone revealed from the chemical composition and carbon isotope ratio of gases extracted from DPRI 1800 m drill core

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Abstract An 1800 m borehole was drilled into the Nojima Fault Zone at Ogura, Awaji Island, Hyogo prefecture, Japan. The chemical compositions and isotope ratios of gases extracted from the drill core were investigated. Major components were carbon dioxide (CO_2) and methane (CH_4). Microcracks in granodiorite outside the fracture zone were occupied mainly by CO_2, and this CO_2 is interpreted to have generated biogenically at shallow depths based on the measured C value of Ð17 to Ð22. The CO_2 gas was probably transported with underground water to deeper portions to Þll microcracks in the basement granodiorite with CO_2. However, the pores in the fracture zone are occupied predominantly by CH_4. The ratio of CH_4 to ethane (C_2H_6), 80 to100, and C of CH_4, Ð40 to Ð52, suggest that CH_4 and C_2H_6 formed by the thermal decomposition of organic materials at temperatures above 75 C. We interpret that they originated at depths from organic materials and migrated upwards through the fault zone. It is interpreted that the concentration of CO_2 in the fracture zone has decreased by the replacement with CH_4 and/or by the consumption of CO_2 in fault clay minerals. Although hydrogen (H_2) and helium (He) were minor components of the gases from cores, they increased in quantity in the fracture zone. High concentration of H_2 in the fracture zones is consistent with the idea that H_2 was generated by radical reactions on the fresh surface of fractured rocks during the earthquake. The $^3He/^4He$ ratio of 0.723 Ra in the fracture zones suggests that He is of radiogenic origin; that is, it is not from the mantle.

Key words: earthquake fault, earthquake geochemistry, fault drilling, fault gas, Hyogo-ken Nanbu earthquake (Kobe earthquake), Nojima Fault, underground gas.

INTRODUCTION

Hyogo-ken Nanbu earthquake (Kobe earthquake) occurred on January 17, 1995 in the HanshinÐAwaji area of Japan. In the northern part of Awaji Island, surface fault ruptures formed close to or almost parallel to the Nojima active fault (Fig. 1; e.g. Lin et al. 1995). Aftershock distribution suggests that the Nojima Fault is the surface trace of the earthquake source fault (Disaster Prevention Research Institute 1995). Several boreholes were drilled into the Nojima Fault Zone in order to study the fault zone at various depths. A 1800 m deep drilling was conducted by Disaster Prevention Research Institute, Kyoto University, at Ogura, approximately 10 km to the south-west of the epicenter near the fault (DPRI 1800 m drilling; Ando 2001). The location of the drilling site is shown in Fig. 1. We used core specimens for investigating the natural gases and their behavior in the fault zone.

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