Gas geochemistry in Pohang, South Korea: Information on the active fault distribution near the EGS site

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An Mw 5.5 earthquake occurred in Pohang, South Korea on November 15, 2017, had a huge influence on Korean society [1]. Despite a lot of controversy on the causality between the earthquake and the enhanced geothermal system (EGS), the location of active faults is insufficiently known. Here we report new results of the geochemical and isotopic analyses of dissolved gases in groundwater in the Heunghae, Yeonil, and Sinkwang areas from the Pohang region. Base on the N_2-Ar-He relationship, all samples from the Heunghae and Yeonil areas show the mantle contribution, except for the Sinkwang area, where all samples are atmospheric. N_2 and CO_2 are the main components of the gas samples, where some of the Heunghae and Yeonil areas contain substantial CH_4. Although $\delta^{15}N\text{-}N_2$ (0.2 to 3.6‰), $\delta^{13}C\text{-}CO_2$ (-27.3 to -16.0‰) and $\delta^{13}C\text{-}CH_4$ (-76.1 to -70.0‰) values indicate that these components are derived from organic substances in sedimentary layer, $^3He/^4He$ ratios (up to 3.83 Ra) represent the significant mantle contribution in the Heunghae and Yeonil areas [2, 3]. Through the distribution of high $^3He/^4He$ ratios, we propose the Heunghae, Namsong, and Jamyeong faults as the passage of mantle-derived fluids and their locations [4]. Computed ^3He fluxes of the Heunghae (120 to 3,000 atoms cm^{-2} sec^{-1}), Namsong (52 to 1,300 atoms cm^{-2} sec^{-1}), and Jamyeong (83 to 2,100 atoms cm^{-2} sec^{-1}) faults are comparable to other major active faults around the world, suggesting either high porosity or high helium flow rates [5]. Therefore, our results attest that there are active faults near the EGS facilities, which supply the foundation for future studies.

[1] Ellsworth *et al.* (2019) *Seismol.Res.Lett.* **90,** 1844-1858. [2] Sano & Marty (1995) *Chem. Geol.* **119,** 265-274. [3] Sano *et al.* (2001) *Chem. Geol.* **171,** 263-271. [4] Umeda & Ninomiya (2009) *G³.* **10.** [5] Kulongoski *et al.* (2013) *Chem. Geol.* **339,** 92-102.