Groundwater helium anomaly reflects strain change during the 2016 Kumamoto earthquake in Southwest Japan

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Geochemical monitoring of groundwater and soil gas emission pointed out precursor and/or coseismic anomalies of noble gases such as helium, argon and radon associated with earthquakes [1, 2], but there was lack of plausible physico-chemical basis. A laboratory experiment of rock fracturing and noble gas emission was conducted, but there is no quantitative connection between the laboratory results and observation in field [3, 4]. We report here deep groundwater helium isotope anomalies related to the 2016 Kumamoto earthquake, which is an inland crustal earthquake with a strike-slip fault and a shallow hypocenter (10 km depth) close to highly populated areas in Southwest Japan. The observed helium isotope changes, soon after the earthquake, are quantitatively coupled with co-seismic volumetric strain changes estimated from a fault model, which can be explained by experimental studies of helium degassing during compressional loading of rock samples in a laboratory [5]. Based on the observation, groundwater helium is considered as effective strain gauge. This suggests the first quantitative linkage between geochemical and seismological observations and may open the possibility to develop a new monitoring system to detect a possible strain change prior to a hazardous earthquake in regions where conventional borehole strain meter is not available.

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