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断層-地震発生帯における炭素とヘリウム
carbon and helium in faulted-seismogenic areas

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Carbon and helium have been discharging for a long time from the Earth's mantle to the atmosphere through volcanic and hydrothermal activity. In addition they are derived from faulted-seismogenic areas. It is obvious that volcanic fluxes are originated in magma source even though they may be partly contaminated by crustal material. In contrast, it is difficult to estimate how deep they are derived in non-volcanic and tectonically active regions. Irwin & Barnes [1] reported that CO_2-rich springs occur worldwide along major zones of seismicity. They further suggested that much of the CO_2 is derived from the mantle and that other important sources are the metamorphism of marine carbonate-bearing sedimentary rocks and the degradation of organic material. Carbon isotopes may provide information of the origin. When the delta13C value of spring gas in faulted-seismogenic area shows -6permil, it is explained by either mantle carbon or a mixing of marine carbonate (0permil) and sedimentary organic matter (-30permil). Thus it is difficult to estimate the origin of carbon. If the data are combined with helium isotopes, however, we can deconvolve the mantle contribution quantitatively [2]. There are several evidences of mantle carbon and helium degassing from active fault. Kennedy et al. [3] suggested the mantle helium flux in the San Andreas fault system located at boundary between the Pacific and North American plate. The bottom may extend the upper mantle. Significant CO_2 discharges were observed at the same time. A part of CO_2, up to 3.3% may be derived from the mantle [4]. Similar discharges have been observed in the North and East Anatolian fault zones [5,6]. These are examples of steady-state degassing from active fault. Non steady-state, catastrophic degassing of carbon and helium were reported in the 1995 Kobe earthquake, even though they are originated in shallow crust [7,8]. On the other hand, increase of helium isotopes in bottom seawater in the trench region after the 2011 Tohoku-oki earthquake suggested substantial input of mantle helium [9]. There may be a fluid flow induced by the earthquake, which would carry helium and methane from the mantle wedge to the trench through the entire plate boundary.

Reference [1] Irwin & Barnes, 1980. *JGR* **85**, 3115-3121. [2] Sano & Marty, 1995. *Chem Geol* **119**, 265-274. [3] Kennedy et al., 1997. *Science* **278**, 1278-1281. [4] Kulongoski et al., 2013. *Chem Geol* **339**, 92-102 [5] de Leeuw et al., 2010. *App Geochem* **25**, 524-539. [6] Italiano et al., 2013. *Chem Geol* **339**, 103-114. [7] Sano et al., 1998. *Chem Geol* **150**, 171-179. [8] Famin et al., 2008. *EPSL* **265**, 487-497. [9] Sano et al., 2014. *Nature Commun* **5**, 3084.
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