Evaluation of coseismic fluid-rock interactions in fault zones based on trace element and isotope analyses of fault rocks

T. Ishikawa[1]

[1]Kochi Instute for Core Sample Research, JAMSTEC, Japan (t-ishik@jamstec.go.jp)

Frictional heating in a fault zone during earthquake slip affects the slip behavior itself. Increased temperature on a fault can induce dynamic fault weakening by processes such as pressurization of interstitial fluid by thermal expansion, known as thermal pressurization, and melt lubrication. Recent studies revealed that geochemical analyses of fault rocks combined with geological, mineralogical, structural, and geophysical observations can provide useful means for elucidating such slip weakening processes.

In the case of the Chelungpu fault in Taiwan, which slipped during the 1999 Mw 7.6 Chi-Chi earthquake, the slip-zone rocks [1, 2] showed marked decreases of Li, Rb, Cs and 87Sr/86Sr and an increase of Sr relative to adjacent host sedimentary rocks [3]. Model calculations revealed that these trace element and isotope spectra were produced by coseismic fluid-rock interactions at >350°C, which may have caused a dynamic decrease of friction along the fault through thermal pressurization [3]. The slip zone rocks from a major reverse fault in the Boso Emi accretionary complex at 1–2 km depth [4] also show similar evidence for coseismic fluid-rock interactions at high temperatures [5]. For the slip zone rocks from the Shimanto accretionary complex in Kure area, which represent rocks of ancient megaspray fault at 2.5–5.5 km depth [6], geochemical signals derived from high-temperature fluids overlap with those from melting, indicating coseismic fluid-rock interactions followed by frictional melting [7]. These results demonstrate that high-temperature fluid-rock interactions widely occur during seismic slip and geochemical characteristics of the fault rocks are useful indicators of such coseismic events. Geochemical characteristics of the fault rocks recovered from the Nankai Trough and the Japan Trench will also be discussed.

[1] Ma *et al* (2006) *Nature* **444**, 473-476 [2] Hirono *et al* (2006) *GRL* **33**, L15303 [3] Ishikawa *et al* (2008) *Nature Geosci.* **1**, 679-683 [4] Hirono *et al* (2005) *Tectonophys.* **397**, 261-280 [5] Hamada *et al* (2011) *JGR* **116**, B01302 [6] Mukoyoshi *et al* (2006) *EPSL* **245**, 330-343 [7] Honda *et al* (2011) *GRL* **38**, L06310