Probing fault zone heterogeneity on the Nojima fault: Constraints from zircon FT analysis of borehole and trench samples

Takahiro Tagami[1]; Masaki Murakami[2]

[1] Earth and Planetary Sci., Kyoto Univ.; [2] Earth Planetary Sci., Univ. Tokyo

Quantitative assessment of heat generation and transfer associated with a fault motion is critically important to constrain the thermal budget of orogeny as well as to estimate the shear stress that controls the energy budget of earthquakes. These thermal signatures also provide a tool for constraining the ages of faults. In the present contribution, we summarize our recent results of the zircon fission-track (FT) thermochronologic analysis of the Nojima fault, which was activated during the 1995 Kobe earthquake (Hyogoken-Nanbu earthquake; M7.2)[Tagami et al., 2001; Murakami et al., 2002; Murakami and Tagmai, 2004; Tagami and Murakami, 2005, 2006; Tagami et al., in prep.]. Rock samples were collected from the University Group 500 m (UG-500) borehole, Geological Survey of Japan 750 m (GSJ-750) borehole, the fault trench at Hirabayashi, and nearby outcrops. In the two boreholes that penetrate the fault at depth, zircon FTs were partially annealed in the samples nearby the fault. The age of onset of cooling from the zircon partial annealing zone (ZPAZ) was estimated by the inverse modeling of FT data using the Monte Trax program; i.e., ca. 4 Ma within ca. 3 m (in the hanging wall only) from the fault plane in the UG-500, and ca. 31-38 Ma within ca. 25 m from the fault in the GSJ-750. On the basis of one-dimensional heat conduction modeling as well as the general positive correlation between the FT annealing and deformation/alteration of borehole rocks, those cooling ages in both boreholes probably represent ancient thermal overprints by heat dispersion or transfer via fluids in the fault zone. Calculation of in-situ heat dispersion indicates the resulted temperature increase of ca. 1 degree C, if the frictional heat is homogeneously and instantaneously dispersed via fluids to a 3 m-wide zone. Because such a small temperature increase does not advance significantly the zircon FT annealing, it is likely that the thermal overprints were caused by migration of hot fluids along the fault zone from deep crustal interior. For the fault trench samples, zircon FTs of the 2 -10 mm thick pseudotachylyte layer were totally annealed and subsequently cooled through ZPAZ at ca. 56 Ma, which is interpreted as the time of (final stage) of pseudotachylyte formation. It is suggested, therefore, that the present Nojima fault was formed in the Middle Quaternary by reactivating an ancient fault initiated at ca. 56 Ma at mid-crustal depth.

References

Tagami et al., 2001, The Island Arc, 10, 457-464.
Murakami et al., 2002, Geophys. Res. Lett., 29, doi: 10.1029/2002GL015679.
Murakami and Tagmai, 2004, Geophys. Res. Lett., 31, doi: 10.1029/2004GL020211.
Tagami and Murakami, 2005, Amer. Assoc. Petrol. Geol. Memoir, 85, 269-285.
Tagami and Murakami, 2006, Tectonophysics, resubmitted.