Fission-track thermochronologic analysis in the creeping section of the Atotsugawa Fault, Central Japan

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Fission-track (FT) thermochronologic analysis was performed to detect the ancient thermal anomaly associated with seismic activities in the Atotsugawa Fault, a 70-km long active fault running in the Hida metamorphic rocks in Central Japan. Along this fault, the existence of the creeping section has been presumed based on electro-optical distance measurement, GPS, and seismic prospecting. Present-day seismicity is considerably high but remarkably low in the supposed creeping section of 20 km long and 10 km deep in its central part.

At a fault outcrop with the extent of 15 m long on the Atotsugawa River, six gouge zones of 1-3 cm wide with the fracture zones of 10-15 cm wide on its both sides are found. Apatite and zircon were separated from the outcrop samples collected from both gouge and fracture zones located about 10 cm apart from each other; 12 samples in total. Reference samples were also collected from the no-fracture country rock area.

Dating results were mostly concordant with the age distribution for the granitic rocks in this area reported by the previous works. Most of the apatite ages ranged ~ 40-50 Ma, but an exceptionally young apatite age of 32 Ma was obtained in one gouge zone; this may be attributed to the co-seismic frictional heat. The zircon ages were scattered ~ 120-150 Ma within the very narrow area of 15-m wide outcrop, irrespective of the occurrence of the samples. They might reflect the cooling phases overprinted totally or partly by the secondary heating.

It is hardly possible that co-seismic frictional heat was a single factor for such an irregular pattern in zircon ages. The degree of secondly heating by co-seismic geothermal fluids may have varied at each sample because the permeability was heterogeneous due to the uneven development of cracks. The patterns and the causes of these thermal anomaly will be discussed with the particle size distribution of the gouges and the fine 3-D structure of the fault cores inspected by X-Ray CT imaging of the shallow-drilling samples at the fault outcrop, in relation with the estimation of heat budget and energy generation at the heating events.