Zircon fission-track thermochronology of an ancient seismogenic zone in the Shimanto accretionary complex, Southwest Japan

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Quantitative assessment of heat generation and transfer along faults during or associated with the fault movement in subduction zone is of primary importance in understanding the geodynamics and geohistory of faulting, as well as in constraining the thermotectonic evolution and fluid/heat flow of seismogenic zones. Fission-track (FT) thermochronology is effective to assess quantitatively a temporal change of temperature in the past around the fault using the single-grain age and FT length distributions because FTs in minerals are annealed by heating. In this study, FT thermochronologic analysis was performed on zircons separated from an ancient seismogenic zone in the Shimanto accretionary complex, Southwest Japan.

The target of this study is the boundary fault between the Nonokawa Formation and Okitsu Melange. It is suggested that this fault was once located in the seismogenic zone, owing to the occurrence of pseudotachylyte therein which was produced by frictional heating induced melting of host rocks. Although the thermal history of the Shimanto accretionary complex has been studied regionally by previous FT analyses, no FT data have been reported with a particular focus on the seismogenic zone. I carried out zircon FT length and age analyses on 25 sandstone samples collected along a traverse approximately orthogonal to the fault.

For all zircon samples except those nearby the fault on the hanging-wall side, FT lengths are not reduced and single-grain ages predominantly predate the depositional age. This suggests that the zircon FT age is interpreted as the time of last cooling at provenance and thus the rocks did not experience any thermal effect into the zircon partial annealing zone (ZPAZ) after the deposition. In contrast, FTs showed significantly reduced mean lengths and ages for samples less than 10-20 m away orthogonal to the fault on the hanging-wall side. This suggests that the secondary heating up to ZPAZ occurred along the fault after the deposition. It is estimated that the last cooling after the secondary heating took place at about 40-50 Ma, on the basis of the model age calculation using the decomposition of FT length distributions.

The present zircon FT data are consistent with previous thermal analyses in this area. The spatial range of this thermal anomaly is too wide to be explained by the frictional heating, based on a one-dimensional heat conduction calculation using boundary conditions appropriate for the frictional heating as well as the zircon FT annealing model. The ancient thermal anomaly probably represents heat transfer or dispersion via fluids at deep crustal interior because calcite layers and deformed/altered biotite and plagioclase are observed widespread in the thin sections of samples within the thermal anomaly zone.

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