Pseudotachylyte dating by zircon fission track thermochronology

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Quantitative assessment of heat generation and transfer along faults during or associated with fault movement is of primary importance in understanding the dynamics and geohistory of faulting. Fission track (FT) method is effective in the detection of paleothermal anomaly of deformed and altered fault rocks because temperature is the only environmental factor to cause track fading (Fleischer et al., 1965; Yamada et al., submitted). Annealing kinetics of zircon FTs were given by fitting models to laboratory annealing data (Yamada et al., 1995; Tagami et al., 1998). Futhermore, Murakami et al (2002) designed a new laboratory annealing experiments on zircon FTs for short-term heating at 550-950ºC for 1-100secs. They demonstrated that the FTs in zircon are totally annealed at 950ºC for 1sec, i.e., the temperature-time condition of frictional heating estimated for many faylts. In this study, as examples of detecting frictional heating and dating pseudotachylyte in nature, we report zircon FT data of two pseudotachylyte layers.

Pseudotacylyte of Nojima fault

Nojima fault, located in Awaji Island, Japan, was reactivated during the 1995 Kobe earthquake (Hyogoken-Nanbu earthquake; M7.2). Otsuki et al. (2003) found pseudotachylyte layers in the Nojima fault, in which the detail of physical process during seismic slip was recorded. We carefully separated zircons from ~2-10 mm wide pseudotachylyte layers collected at the Hirabayashi trench of the fault and analyzed them by FT method. The measured ages of the layers (56±5 Ma) were significantly younger than those of surrounding Ryoke granitic rocks (74±3 Ma).

Pseudotacylyte in Asuke Shear Zone

Asuke Shear Zone is located in Aichi Prefecture, Japan. Sakamaki and Takagi (2002) reported pseudotachylyte layers associated mainly with cataclasite along the shear zone. We analyzed zircon separated from a 11cm wide layer by FT method. Preliminary ages of the pseudotachylyte are ~53 Ma, significantly younger than those of surrounding Ryoke granitic rocks (74±4 Ma).

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Biotite dissolution processes and mechanisms: Early stage weathering environment

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The dissolution processes and mechanisms observed in the laboratory are useful for understanding those occurring in nature. The necessary comparisons have not been made, and secondary mineralization such as vermiculitization resulting from biotite dissolution has not been clearly elucidated yet.

Batch dissolution experiments of fresh biotite in granite were carried out at 150°C for 1 to 56 days. The experimentally altered biotite samples were compared with naturally weathered biotite samples mainly by SEM-EDS and TEM to elucidate certain aspects of the weathering processes. The dissolution proceeds from the edges of crystals inward and secondary minerals such as Fe oxide are precipitated mostly at the edges, with a few secondary minerals found on the basal surfaces. A dissolution experiment using a mixture of biotite and muscovite, done at 150°C for 7 days, indicated that hematite crystals formed mostly at the edges of biotite but not on muscovite. This observation suggests that released Fe is precipitated before it diffuses into bulk solution. Because a dissolution rate at the edge is much larger than at the basal surface, precipitation before diffusion of dissolved elements to bulk solution well explains the preferential secondary-mineralization at the edges in the laboratory experiments. SEM-EDS of fresh to slightly weathered biotites revealed that early stage weathering proceeds in the same way as in the laboratory dissolution with the edges being preferentially weathered and secondary minerals being precipitated mostly at the edges. Because of the similarity between the occurrence of secondary minerals in the laboratory experiments and in nature, the laboratory results elucidate the early stage weathering conditions, namely that (1) supersaturation with respect to secondary minerals in a solution occurs around biotite, i.e., the solution is poorly connected to a main flow pathway of water, and (2) once supersaturation is achieved, secondary minerals are precipitated mainly at the edge before some released elements diffuse into the solution. The immobility of water immediately adjacent to primary minerals partly explains the large difference in dissolution rate between the laboratory and natural samples.