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Detection of frictional heating of fault motion by the fission track analysis

Masaki Murakami[1], Ryuji Yamada[2], Takahiro Tagami[3]

[1] Earth and Planetary Sci,Kyoto Univ, [2] NIED, [3] Earth and Planetary Sci., Kyoto Univ.

To detect frictional heat owing to activation of earthquake faults is of primary importance in resolving a long-standing state-stress problem because shear stress is implied by the absence of detectable frictionally generated heat. A thermal history analysis using radiometric dating method is one of the most useful approaches to solve this problem because ancient temperature elevation is revealed by using various radiometric dating methods with different closure temperatures. To detect thermal anomaly around a fault, fission track (FT) analysis has the following advantages: (1) Temperature is the only environmental factor to cause track fading (Fleischer et al., 1965). (2) FT ages of sphene, zircon and apatite have relatively low closure temperatures (Harrison and McDougall, 1980; Hurford, 1986) and thus are sensitive to thermal effects. (3) FT length distribution provides additional information for determining a pattern of thermal history (Gleadow et al., 1986). For zircon, Yamada et al. (1995a) and Tagami et al. (1998) performed model fittings using a series of laboratory annealing experiments on zircon FT. The temperature range of the zircon partial annealing zone (ZPAZ) can be calculated by extrapolating the model led annealing kinetics to the heating time. The extrapolation to geological time scale was validated by analyzing rocks that experienced natural longterm annealing (Tagami et al., 1996; Tagami and Shimada, 1996; Tagami et al., 1998). However, there is no data in short time scale to detect frictional heating. Therefore, we carried out a series of laboratory annealing experiments on zircon fision tracks under heating conditions of 740-1000 'C for 1-100 sec. As a result, fission tracks were completely annealed under heating conditions of 858 'C for 10 sec and 924 'C for 1 sec.

Along the Nojima fault at Hirabayashi, Otsuki et al. (2000) found fault rock in which the detail of physical process during seismic slip is recorded. We analyzed zircon separates from trench blocks of Nojima fault by using the fission track method. As a result, the values of ages of pseudotachylyte layers is significantly younger (52Ma) than that of non-pseudotachylyte layer (96Ma). The original rocks of these layers is considered to be the same ryoke granite (Otsuki et al., 2000). Therfore, this result indicates the pseudotachyalyte layer was finally cooled below the ZPAZ.