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Attempts to date slip event of crush zones associated with plastic deformations of biotite based on FT thermochronology

SUEOKA, Shigeru[1*] ; SHIMADA, Koji[1] ; ISHIMARU, Tsuneari[1] ; NIWA, Masakazu[1] ; YASUE, Ken-ichi[1] ; UMEDA, Koji[1] ; DANHARA, Tohru[2] ; IWANO, Hideki[2]

[1]Japan Atomic Energy Agency, [2]Kyoto Fission-Track Co., Ltd.

Timings of fault slips are generally constrained by dating displaced geomorphic markers, e.g., terrace surfaces, alluvial deposits, and artificial structures. However, these markers are not always available. Therefore, direct dating of fault materials have been also attempted to determine ages of faulting events; for instance, detecting chronological anomalies derived from frictional heating or crushing (e.g., Ikeya et al., 1982, Science; Murakami and Tagami, 2004, GRL; Yamada et al., 2013, JAES; Ganzawa et al., 2013, JGSJ) and dating hydrothermal veins or clay minerals formed after faulting (e.g., Zwingmann et al., 2004, JSG; Watanabe et al., 2008, Geochem .J.; Siebel et al., 2009, IJES; Yamasaki et al., 2013, Chem. Geol.) were performed (Tagami, 2012, Tectonophys.). However, definitive procedures to determine faulting ages based on such geochronological methods have not been established because thermogenesis and mass transport along fault zones are not simple. More fundamental and case studies are desirable to improve these methods.

We introduce an attempt to date a crush zone associated with plastic deformation of biotite on the basis of fission-track thermochronology. The crash zone is observed in granitic basement rocks and is distributed in the Monju prototype fast breeder reactor site, northwestern part of the Tsuruga peninsula, southwest Japan. The original topography and covering layers were excavated and removed during the construction of the Monju. Crush zones observed in the site are generally shorter than several tens meters and the width is less than several centimeters, producing net-work structures associated with ductile deformations. Along the crush zones, plastically deformed biotite grains are generally observed, which implies the crush zones were slipped under the temperature higher than 150-250 deg. C (e.g., Lin et al., 1999, Tectonophys.; Passchier & Trouw, 2005, " Microtectonics 2nd ed"). The Tsuruga body of the Kōjaku Granite, host rock of the crush zones, intruded at the end of the Cretaceous, cooled down to the ambient temperature within a few million years, and has been free from regional scale secondary heating (Sueoka et al., submitting). By contrast, local heating, such as basaltic intrusions at ˜19 Ma, may have occurred around the crush zones. In this study, we are performing fission-track thermochronometric studies for the crush zones, aiming to determine the timing of fault slips occurred at >150-250 deg. C. Although it is generally known that apatite fission-tracks are annealed at 90-120 deg. C for 10^6-10^7 years, even shorter-term heating, e.g., for several hours to several years of heating, can anneal apatite fission-tracks at >200 deg. C (e.g., Laslett et al., 1987, Chem. Geol.). This temperature range agrees with the temperature at which biotite is plastically deformed. In this presentation, we are going to report the preliminary results of fission-track analyses.

Keywords: fission-track thermochronology, dating of crush zones, plastic deformation of biotite, Kojaku Granite