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ESR dating of the Shimotsuburai and Hoozan faults in the Itoigawa-Shizuoka Tectonic Line Active Fault System

FUKUCHI, Tatsuro[1*] ; TANAKA, Mami[1] ; KITTA, Takuto[1] ; IMAI, Noboru[2]

[1]University of Yamanashi, [2]AIST

The Shimotsuburai fault, which is located in the south part of the Itoigawa-Shizuoka Tectonic Line (ISTL) Active Fault System, displaces the lower terrace deposits formed at about 20 kaBP. The trenching survey at the Tozawa outcrop revealed that the latest fault movement occurred at 1,550 +or- 70 yBP - 2,350 +or- 60 yBP (Toda et al., 2000). Along the fault plane of the Shimotsuburai fault, black injection veins are distributed forming complex networks and a part of the black veins is injected into the fault gouge or lower terrace deposits. Kano et al. (2004) proposed that this black intrusion veins are crushing-originated pseudotachylyte formed at 30-40m or less in depth at the time of the latest fault movement. On the other hand, the Hoozan fault is distributed about 6km west of the Simotsuburai fault. At the Dondokozawa outcrop, fault gouge is hardly recognized besides cataclasite and mylonite. This suggests that the Hoozan fault may not have moved since its formation in Neogene to early Quaternary, and that the main activity of the ISTL may have shifted to the Simotsuburai fault (Koyama, 1990). The Gofukuji fault located at the northwest extension of the Hoozan and Shimotsuburai faults may cause a Magnitude 8-class large earthquake, and besides its activity may have increased after the 2011 Tohoku-oki earthquake (M9.0). When the Gofukuji fault moves in the future, it is unclear whether or not its southeast extension would also move operating together. It is important to exactly assess the activity of the Hoozan fault as well as the Shimotsuburai fault. We thus carried out XRD (X-ray diffraction) and ESR (electron spin resonance) dating of fault rocks collected from the Shimotsuburai and Hoozan faults.

As a result of XRD analysis, smectite is detected from the Shimotsuburai fault gouge at the Tozawa outcrop, and smectite and a chlorite/smectite (C/S) mixed layer mineral from the black injection vein just on the fault plane, while besides illite chlorite and C/S are respectively detected from the black and gray gouges of the Hoozan fault at the Ishiutoro-gawa outcrop. In general, the formation depth of clay minerals tends to increase in order of smectite, C/S, chlorite and illite. Therefore, the result from the XRD analysis suggests that the Hoozan fault was much more active at deeper positions. As a result of ESR dating, strong signals of the Al and Ti centers are detected from quartz in the Shimotsuburai fault gouge and black injection vein however these centers show the tendency of saturation implying that the resetting by frictional heating did not work. Since the Al and Ti centers can be completely reset at about 300-350 degree C (Fukuchi, 2004), the result from the ESR dating shows that the frictional heat temperature did not rise so much at the time of the latest fault movement. On the other hand, the quartet signals intrinsic to montmorillonite are detected from the gray gouge of the Hoozan fault, and give the age of 2.8-3.2 +or- 0.4 Ma. The chlorite/smectite mixed layer is considered to be formed at about 130-200 degree C (Yoshimura, 2001), so that its formation age may be estimated as 2.2-3.3 Ma assuming the upheaval rate of 2 mm/y and the geothermal gradient of 30 degree C/km. This formation age is consistent with the ESR age obtained from the gray gouge.

References

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