K-Ar dating for fault gouges within the Arima-Takatsuki Tectonic Line, southwest Japan

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Determining the timing of brittle fault deformation is important to assess active faults. In general, cross-cutting relationships of age-known strata is used to constrain indirectly the faulting history, but suitable field relationships are not always evident in outcrops. Numerous studies have successfully constrained the timing of brittle deformation by direct dating of fault gouges in recent years. For this method, careful sample preparation as well as sample charactarization are required to unambiguously interpret measured ages [1].

We measured K-Ar ages for clay-rich fault gouges within the Arima-Takatsuki Tectonic Line (ATTL), which is a major active fault zone in southwest Japan. Samples were collected around a segment that juxtaposed Cretaceous granite against Cretaceous rhyolitic tuff; two samples from the main fault core, three samples from a vein in the tuff zone and two samples from a subsidiary fault in the granite. The seven samples were separated into three grain-size fractions (<0.1, <0.4, <2 μm) and characterized by SEM, TEM and XRD.

SEM investigation on the surface of whole-rock chips indicate authigenic fiberous illites in all samples. TEM investigation of separated fractions confirm fibers in all samples, especially in gouges within the tuff zone.

K-Ar ages decrease with grain size suggesting enrichment of recently grown authigenic illite in these finer fractions. The age data can be devided into two main groups: (1) 23-39 Ma and (2) 48-70 Ma, suggesting that a hydrothermal event related to brittle deformation occurred in at least two stages. The younger group includes gouges from the main fault core and the subsidiary fault vein in granite, and the older group comprises gouges in the vein within the tuff. The younger age range is consistent with the stability field of illite and the temperature field of brittle deformation (<300°C) estimated from reported apatite/zircon FT ages of host Rokko Granite. However, K-Ar dating cannot be applied to measure authigenesis of K-free low-temperature clay (smectite), the reported youngest age is older than the historical last displacement within the ATTL fault zone.

[1] Yamasaki et al. (2013) Chem. Geol., 351, 168-174.