Brittle fault dating –looking through a clutter of ages

*Horst Zwingmann[1], Takahiro Tagami[1], Neil Mancktelow[2], Giulio Viola[3], Seiko Yamasaki[4], Andreas Mulch[5]

1.Department of Geology and Mineralogy, Kyoto University, 606-8502 Kyoto, Japan, 2.Department of Earth Sciences, ETH Zurich, 8092 Zurich, Switzerland, 3.Geological Survey of Norway, 7491 Trondheim, Norway and Department of Geology and Mineral Resources Engineering, NTNU, 7491 Trondheim, Norway, 4.Geological Society of Japan, AIST, Tsukuba, Ibaraki, 305-8567, Japan, 5.Institute of Geoscience, Goethe University Frankfurt, 60438 Frankfurt, Germany and Biodiversity and Climate Research Centre (BiK-F) and Senckenberg Research Institute, 60325 Frankfurt, Germany

There have been numerous case studies in the last few years that successfully constrained the timeframe of brittle faulting through dating of clay-size fault gouge fractions. However, the radiogenic isotope systematics of fault rocks are complex due to the intimate mixture of minerals of different origins such as detrital phases, potentially from a variety of sources, as well as authigenic/synkinematic minerals. Consequently, it is often difficult to unambiguously interpret measured ages. Special sample preparation techniques involving freeze-thaw disaggregation to avoid overcrushing and extensive size separation to reduce the amount of detrital phases can address these issues [1]. Progressive size reduction down to submicron size fractions (<0.1 μm) increases the proportion of authigenic clay phases in the clay component and minimizes contamination suggesting that the most reliable isotopic ages for authigenic clay minerals are obtained for the finest size fractions.

Brittle fault illite K-Ar age data and δD from several studies in Europe, Scandinavia and Japan will be presented. All study areas are located within igneous or metamorphic rocks collected from tunnel or drill core samples, which offer a unique advantage as no detrital illite is present in the host rock, thus reducing potential contamination and weathering sources. The age data were obtained using a simplified and standarized method described by Zwingmann *et al.* (2010) [2]. Ages range from the Mesoproterozoic (1240±26 Ma) for the Finland to the Neogene (6.0±2.1 Ma) for the European Alps study. Fault gouges in Japan scatter around the Paleogene –early Eocene.

The illite ages decrease with grain size, and are consistent with the cooling history of host rocks as bracketed by Ar-Ar, AFTA and ZFTA ages. The data indicates that the fault-rock samples formed within the stability field of illite and the main temperature field of brittle deformation (< ~ 300°C). The internal consistency of the illite K-Ar ages of fault gouges from samples, as well as their consistency with independent constraints from field relationships and existing geochronological data, demonstrate the potential of this simplified method for providing reliable data to constrain absolute timing of brittle deformation.

[1] Liewig *et al*., 1987. *AAPG Bulletin* 71, 1467-1474.

[2] Zwingmann *et al.* 2010. Geology, v. 38, no 6, 487-490; doi10.1130/G30785.1

Keywords: brittle faults, illite clay dating and tracing, K-Ar and hydrogen stable isotopes

