Geochronology and thermochronology of fault zones: an overview

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Thermal signatures as well as timing of fault motions can be constrained by thermochronological analyses of fault-zone rocks (e.g., Tagami, 2012). Fault-zone materials suitable for such analyses are produced by tectocic and geochemical processes, such as (1) mechanical fragmentation of host rocks, grain-size reduction of fragments and recrystallization of grains to form mica and clay minerals, (2) secondary heating/melting of host rocks by frictional fault motions, and (3) mineral vein formation as a consequence of fluid advection associated with fault motions. The geothermal structure of fault zones are primarily controlled by the following three factors: (a) regional geothermal structure around the fault zone that reflect background thermo-tectonic history of studied province, (b) frictional heating of wall rocks by fault motions and resultant heat transfer into surrounding rocks, and (c) thermal influences by hot fluid advection in and around the fault zone. Thermochronological methods widely applied in fault zones are K-Ar ($^{40}Ar/^{39}Ar$), fission-track (FT), and U-Th methods. In addition, OSL, TL, ESR and (U-Th)/He methods are applied in some fault zones, in order to extract temporal imformation related to low temperature and/or very recent fault activities. Here I briefly review the thermal sensitivity of individual thermochronological systems, which basically controls the response of each method against faulting processes. Then, the thermal sensitivity of FTs is highlighted, with a particular focus on the thermal processes characteristic to fault zones, i.e., flash and hydrothermal heating. On these basis, representative examples as well as key issues, including sampling strategy, are presented to make thermochronologic analysis of fault-zone materials, such as fault gouges, pseudotachylytes and mylonites, along with geological, geomorphological and seismological implications. Finally, the thermochronologic analyses of the Nojima fault are overviewed, as an example of multidisciplinary investigations of an active seismogenic fault system.

References:
T. Tagami, 2012. Thermochronological investigation of fault zones. Tectonophys., 538-540, 67-85, doi:10.1016/j.tecto.2012.01.032.

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