K-Ar dating of fault movement in clay rich gouge: an example from the Alpine Fault at Gaunt Creek and Waikukupa River, South Island, New Zealand

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The occurrence of synkinematic and authigenic clay minerals, in particular illite, is a common feature in neotectonic fault gouges. Numerous attempts have been made to date fault gouges [see summary in Zwingmann et al., 2010]. We present new age data for synkinematic illite growth in two fault gouges from surface exposures of the Alpine Fault at Gaunt Creek and Waikukupa River, South Island, New Zealand. The Alpine Fault in the South Island of New Zealand marks the Australian-Pacific plate boundary. An amphibolite-facies mid-crustal ductile shear zone (mylonite series rocks) in the Pacific Plate hanging wall is exhumed along a current brittle fault marked by cataclasite and fault gouge.

Size separation combined with mineral characterization (SEM, TEM, XRD, LPS) enables to identify suitable samples for isotopic dating. Investigations of two <2 micron illite gouge separates from fault gouge samples collected from surface exposures at Gaunt Creek and Waikukupa River yield K-Ar ages of resp. 4.1 ±0.4 and 1.9 ±0.2 Ma, corresponding to the late Pliocene. K-Ar illite ages are consistent with well-defined field constraints and within error similar to c. 1 to 2.5 Ma 40Ar/39Ar ages for micas from hanging wall metapelites and amphibolites and to published K-Ar mica and near-zero apatite fission track ages. The corresponding illite and mica ages suggest that hanging wall rocks were rapidly exhumed and cooled c. 1 –4 Ma ago with coeval exhumation resulting to extensive hydration in the brittle part of the Alpine Fault documented by illite authigenesis. Argon diffusion modeling supports the cooling timeframe. The ages of fault gouge illite provide absolute time constraints on the youngest, retrograde, neotectonic movements on this part of the Australian-Pacific plate boundary. This study highlights the potential of isotopic dating of synkinematic illite to determine upper crustal deformation events.

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