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Timing and Rates of Neogene Exhumation During Orogen-Parallel Extension in the Central Alps

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Different structural levels of the crust, recording both brittle and ductile deformation, are often juxtaposed across major low-angle normal faults. However, there is a controversy regarding whether the observed field relationships are the result of a single continuous process or of two separate events, with the later brittle detachment exhuming a fossil ductile shear zone from depth. These potential models have been investigated with detailed geochronology on the Simplon Fault, located in the Central Alps. This well exposed low-angle detachment developed as the result of orogen-parallel extension that has affected the Alps since at least the Oligocene. This normal fault zone developed during continued convergence, resulting in a complex interplay between large-scale backfolds, mylonites, and the brittle detachment. Different geochronological methods are used to constrain the temporal and spatial evolution of the Simplon fault system and quantify the amount of exhumation involved. We present new apatite and zircon fission tracks ages and 40Ar/39Ar ages on white mica and biotite. Samples used are structurally controlled and come from mylonites developed under different metamorphic grades. In the high grade mylonites, 40Ar/39Ar dating of recrystallized muscovites yield cooling ages indicating shear zone activity from 20 to 14 Ma. 40Ar/39Ar formation ages of new white micas that grew synkinematically in the mylonites varies from 14 Ma in the SE to 10 Ma in the NW, indicating a lateral and temporal evolution of distributed deformation within the Simplon Fault. Zircon and apatite fission track ages indicate a slower cooling through the brittle transition at around 8-12 Ma but continuing until 5Ma. 40Ar/39Ar dating of biotite overprinted by the axial plane schistosity of the backfolds constrains this event to ca. 10-13Ma, which corresponds approximately to the time of transition to brittle fracture on the Simplon Fault. Overall the new data argue for a single continuous transition from ductile shearing to a more localized zone of brittle deformation over a period of ca. 15 Ma during the Neogene, while the Alpine convergence was still active. 2D numerical thermo-kinematic models (Pecube, Braun 2003) coupled with a formal inversion algorithm (Neighbourhood Algorithm) are used to quantify the relative displacement and rates of exhumation related to the Simplon Fault.