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Dating of faults using low temperature thermochronology - a case study from the passive margin of SW Sri Lanka

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The precise dating of extensional tectonics and the associated brittle deformation in the upper crustal level (5-2 km) can give important markers for e.g., landscape models, palaeo-reconstructions and especially basin analyses. Accurate constraints of the geohistory and dynamics of faulting improve the knowledge of rift kinematics and the associated sedimentary filling of basins. Dating of faulting is often problematic especially in non-marine and non volcanic extensional settings where in most cases not enough datable syn-extensional time markers are available. The low temperature sensitivity of combined apatite FT and (U-Th-Sm)/He methods from ca. 120-40 °C must be extremely valuable for direct dating of brittle structures in the upper crust. Along faults conductive and convective heat is transported from hotter to colder crustal levels which can cause partial or total annealing of the low-temperature thermochronmeters. Here, we focus on direct dating of samples directly taken from fault walls in SW Sri Lanka. Results from brittle undeformed basement rocks are compared with samples from high-angle normal and strike-slip faults. Apatite fission track ages from brittle undeformed rocks range between ca. 220 Ma and 95 Ma, and samples from the fault walls (sample thickness <3 cm) revealed apatite fission track ages between ca. 145 Ma and 90 Ma. At higher elevation levels (>200 m), faulting pre-dates and near sea-level it is contemporaneous with cooling related to the general basement exhumation. Single grain apatite (U-Th-Sm)/He ages span between ca. 150 Ma and 40 Ma and mainly reflect the post-tectonic cooling history. Inverse modelled time-temperature paths of low temperature thermochronological data are compared with numerical modelled synthetic cooling paths for different fault parameters. All synthetic paths show a significant turn over from fast to no cooling when the fault temperature reaches equilibrium with the surrounding rocks. This can be recognised in all fault related inverse modelled time-temperature paths and gives a minimum age for thermal overprint along the fault planes. The data indicates phases of brittle deformation during the ca. 160-95 Ma episode, which are related to extensional tectonics in SW Sri Lanka during the break-up of the Gondwana supercontinent. Combined with structural data they indicate different palaeo-stress regimes during the late Jurassic/early Cretaceous and the late Cretaceous, when Sri Lanka separated from East Antarctica and successively moved away from Madagascar.