Geophysical Research Abstracts
Vol. 20, EGU2018-13360, 2018
EGU General Assembly 2018

Sri Lanka: the inverted hinge of Gondwana

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Sri Lanka represents a micro-continent that is composed primarily of Precambrian basement rocks. The Phanerozoic history of the island is poorly constrained since the sedimentary record is restricted to only a small patch of Jurassic strata and some Neogene sediments preserved in NW Sri Lanka. The landscape of Sri Lanka is divided into three distinctive physiographic provinces: lowlands, uplands and highlands. Early workers suggested telescope-like uplift of the central highlands, while most recent studies interpret the high relief as the remnant of a single geomorphic block that was faulted and uplifted prior to 130 Ma. The morphological high was then reduced to the island's interior by polycyclic downwearing or rapid escarpment retreat, potentially reinforced by the weathering contrast between charnockitic and granitic or meta-sedimentary rocks. Here we combine sediment-petrographic, mineralogical and thermochronological data from western Sri Lanka with the stratigraphic record of the adjacent offshore Palk Strait and the juxtaposed Indian Cauvery Basin to develop a model of the regional long-term landscape evolution and, more generally, of medium-scale continental fragments.

The Jurassic deposits of western Sri Lanka consist of poorly sorted feldspatic sandstones and mudstones. Feldspars of four samples are variably altered, detrital micas are corroded and partly replaced by clay minerals, and pore spaces are filled with kaolinite and illite-like clay minerals. XRD and infrared spectroscopic data confirm a homogeneous mineral composition of kaolinite, illite/smectite mixed-layer minerals, quartz and goethite. Porosity determination by X-ray microtomography of a sandstone sample determined a porosity of 5.6% (without clay minerals) and max. 6.5% (partial segmentation of clay minerals into pore space voxels), respectively.

Five detrital apatite fission-track (AFT) sample ages of 222–351 Ma are substantially older than the Jurassic stratigraphic age, and are associated with short mean track lengths (MTL) of 11.4–11.9 μm. Petrographic, mineralogical and AFT data commonly refer to post-Jurassic temperatures of 90°–110°C and considerable sediment compaction. The basement adjacent to the Jurassic strata yields much younger AFT ages of 62–189 Ma and MTL of 11.3–13.6 μm. Thermal history modelling indicates post-Jurassic basement heating to temperatures >100°C followed by rapid early Cenozoic cooling. Thermal histories of both sedimentary and basement rocks are not compatible with any of the predicted landscape evolution scenarios. Instead, they require Jurassic – Cretaceous diffuse crustal extension and burial of the western Sri Lanka lowlands within a 3–5 km thick sedimentary basin. Focussed continental extension and rifting between India and Sri Lanka commenced in the latest Cretaceous, triggered the opening of the Palk Strait and basin inversion on western Sri Lanka, and was compensated isostatically by the uplift of the central highlands.