

## **Exhumation of High Grade Indian Plate Rocks in North Pakistan: Mechanical Implications of a Multi-Phase Process.**

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Although syn-convergent extension has been described from many compressional orogens, evidence that it may partition into multiple discrete phases is less clear, even though extension is predicted as continuing as long as shortening once a critical crustal thickness is attained. Geochronological and structural data from the Indian Plate of North Pakistan and the structurally overlying Kohistan arc, permit construction of a model for Indian Plate exhumation that demands two discrete, short-lived phases of rapid exhumation separated by long periods of erosive exhumation with low unroofing rates. The first exhumation phase shortly followed peak metamorphism at ca. 45 Ma, and brought high grade rocks, including coesite-bearing eclogites, part way back toward the surface. A period of slow cooling in the upper Indian Plate followed until ca. 22 Ma when ductile through to brittle extensional displacement was initiated along N-vergent structures developed along the Indian Plate-Kohistan interface. This extension resulted in ca 300°C cooling at a rate of ca 60°C Ma<sup>-1</sup> in rocks on the MMT footwall.

Both exhumation events can be linked to short-lived phases of ductile thrusting at the, then active, base of the thrust wedge, imbricating the metamorphic complex on the MMT footwall in the former case, and transporting the metamorphic complex south along the Panjal Thrust in the latter. Each event had the effect of thickening the wedge with extensional faulting developed in the upper part of the thickened crust near the brittle-ductile transition as a mechanical consequence of the requirement to maintain the critical taper of the wedge.