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HIMALAYAN ECLOGITES, PAKISTAN: AN UPDATE

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The finding of eclogites in the Himalaya, and especially the realization that they are of UHP type, has forced a dramatic change of view regarding the nature of India-Asia collision and the style of subsequent tectonometamorphism. Important details constraining the timing of collision such as: the change in rate of plate motion; the age of the youngest marine sediments in the suture zone; the age of the final magmatism in the arc; initiation of denudation and sedimentation or change in oxygen isotope signal of benthic foraminifera (caused by the disruption of circum-equatorial ocean circulation) were unaffected by the new results. However, tectonic models requiring a shallow angle of subduction to produce the long-recognised inverted metamorphic sequences, recently rejuvenated in a series of papers promoting a channel flow mechanism, are put into question. New field and petrographic studies of eclogites reveal important details critical to the understanding of the evolution of the collision.
The new fieldwork shows a much wider distribution of eclogites than previously realised. The eclogites sit as part of a continental sequence (basement gneiss, meta-granite, metasedimentary cover) thus emphasizing the fact that it is the Indian Plate that was subducted to UHP conditions. The age of UHP metamorphism (dating of coesite-bearing zircon), combined with dating of retrograde and even final shallow-depth cooling (by fission track methods) indicates both rapid subduction and exhumation at rates of several cm / a. This short-term ‚dunk' to mantle depths is reflected very clearly in the fine-grained nature of most preserved eclogites. Garnet grains are mostly 0.2 - 0.5 mm in diameter but are still compositionally zoned. Clearly, the number of nuclei, and their size, is a direct reflection of the rapid overstep of the reaction boundary and the short time for the whole of the growth process. The fine-grained nature of these eclogites may be one of the reasons it took so long to identify them. The information from eclogites in Pakistan is perfectly compatible with what is known from NW Indian UHP eclogites and confirms that the subduction-controlled processes of the India-Asia collision probably lasted until about 40 Ma by which time these units had undergone amphibolite and greenschist facies overprints and were at shallow depths. This part of the history of the India-Asia collision is totally separate in style from the subsequent thickening-related Barrovian followed by HT metamorphism. The change from steep to low-angle subduction, as already pointed out with the discovery of coesite eclogites in 1998, is most likely related to a slab breakoff process that may be thus critical in allowing the subsequent shallow-angle underthrusting of the leading edge of the Indian Plate to cause crustal thickening. In this sense, deep continental subduction, UHP metamorphism and slab breakoff are necessary precursors for the channel flow mechanism and thus explain the time gap between the eclogite facies metamorphism in the NW Himalaya (the first part of India to collide) and the crustal-type metamorphism in the central part of the Himalaya.