Continental subduction vs. collision: What shaped the Himalaya?

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Two major processes appear to have shaped the youngest mountain belts on the Earth– the Himalaya and the Trans-Himalaya mountains: subduction of (i) the Tethyan oceanic lithosphere and (ii) the Indian continental lithosphere. Against the common concepts that the Himalaya originated due to continent-to-continent collision of the India-Asian Plates, recent geological, geophysical and geochronological data from the northern parts of the Himalaya and Trans-Himalayan mountains have been critically evaluated to highlight evolution of these mountains through time.

As the vast Neo-Tethyan Ocean separated the continents of the Indian and Asian Plates, these continents would not have collided initially to start with. It became therefore evident that leading Tethyan oceanic lithosphere in front of the Indian continent initially subducted and melted to produce the calc-alkaline magmatic Shyok-Dras Volcanic Arc, which was subsequently intruded by the Ladakh Batholith. Hence, these mountains did not initially evolve by the collision of continents of the Indian and Asian Plates.

Timing of the first impingement of the Indian and Asia Plates has been better constrained at around 58 Ma by comparing the (i) bulk ages from the Ladakh Batholith (product of partial melting of the Tethyan oceanic lithosphere) with the (ii) subducted continental lithospheric and UHP metamorphosed Indian crust in the Tso Morari, and (iii) biostratigraphy of the youngest marine sedimentation in Zanskar. Thus, the Himalaya first rose and emerged from the deeply exhumed terrain in the Tso Morari only between 53 and 50 Ma. It was followed by sequential imbrication of the Indian continental lithosphere, its subduction at ~45-35 Ma and ~25-15Ma to produce the Eo- and Neo-Himalayan metamorphism and associated exhumation episodes during rise of the Himalayan Mountains from north to the south since 45 Ma.

Current sub-horizontal geometry of the Indian Plate, deciphered by seismic tomography, focal plane mechanism of recent earthquakes, gravity, and magnetotelluric methods, bespeaks continental lithosphere subduction in the Himalaya; this geometry can only be achieved by episodic sub-horizontal push of the Indian Plate towards north.

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