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The sedimentary record of India-Asia collision: an evaluation of new and existing constraints

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The age and degree of diachroneity of India-Asia collision is critical to construction of models of orogenesis and to understanding the causes of spatial variations in Himalayan evolution along strike. The age of collision is quoted between ∼65-34 Ma (Jaeger et al 1989; Aitchison et al 2007) and the degree of dichroneity is considered negligible (Searle et al 1997) to substantial (Rowley 1998). Such discrepancy is, to some extent, the result of the different definitions and methods used to define the collision. Here, we evaluate constraints from the sedimentary record preserved in the suture zone and Tethyan Himalaya where a minimum age to collision has been constrained by determining 1) the timing of cessation of marine facies, 2) first evidence of Asian detritus deposited on the Indian plate and 3) first evidence of mixed Indian-Asian detritus in the sedimentary record.

Extensive previous work has been carried out on the Indus molasse of the Indus Suture zone in Ladakh, India. Here, cessation of marine facies is dated at 50.5 Ma (Green et al. 2008), with the underlying Chogdo Formation considered to show first evidence of mixed Indian and Asian provenance, and be the oldest Formation of Asian-derived provenance to lie in sedimentary contact with the underlying Indian plate (Clift et al 2001, 2002), thus constraining collision at >50.5 Ma. However, our new mapping and provenance analyses on these rocks show that there is no unequivocal evidence of Indian-derived material in the Chogdo Formation, nor that the Chogdo Formation lies in sedimentary contact with the underlying Indian plate (Henderson et al., in review). Thus we question the timing of Indian-Asian collision based on these evidences.

South of the suture zone in India and Tibet, we carried out similar investigations of the youngest Tethyan strata. In Ladakh, Indian plate passive margin limestones of the Paleocene Dibling Fm are overlain by the youngest marine facies of the region, the marine Kong Fm and fluvio-deltaic Chulung La Fm (Garzanti et al 1987). The age of the Kong and Chulung La Formations is disputed, from P5/6 (Fuchs & Willems 1990) to P8 (Garzanti et al 1987) the discrepancy possibly the result of research at different locations. Provenance is considered to be either ophiolitic from the Indian plate (Fuchs & Willems 1990) or containing detritus from the Trans-Himalayan arc of the Asian plate (Garzanti et al 1987; Critelli & Garzanti 1994). Our samples from the Kong Fm contained planktic foraminifera indicating a Middle to Early P6 age (54-56 Ma) and larger benthic foraminifera indicating Middle SBZ8 age (53-54 Ma). U-Pb dating of detrital zircons allows discrimination between Asian provenance (dominated by Mesozoic grains from the Trans-Himalayan arc) and Indian provenance (characterized by Precambrian grains and an absence of Mesozoic grains). Our data from the Kong and Chulung La Fms shows a primary provenance from the Asian plate. Thus collision is constrained by arrival of Asian detritus on the Indian plate by 54 Ma.

In Tingri, Tibet, Indian plate passive margin limestones of the Zephure Shan Fm extend to the early Eocene, overlain by marine facies of the Pengqu Fm. The youngest marine facies have been dated at 34 Ma (Wang et al. 2002), but this age is disputed by other workers who assign an age of 50 Ma (Zhu et al. 2005). Our new biostratigraphic data from the Pengqu Fm show that calcareous nannofossil species are compatible with an age corresponding to Zones NP11-12 (50.6-53.5 Ma). The dominant population of zircons have Cretaceous-Paleocene ages, derived from the Asian plate, thus indicating that contact between India and Asia had occurred by this time.

We therefore conclude that although the Indus Molasse does not provide constraint to the timing of India-Asia collision as previously thought, data from the Tethyan strata show that collision occurred by 54 Ma in the west, with only extremely limited, if any diachroneity eastward.