New Tectonic Insights into the Burma-Andaman-Sumatra Subduction Zone

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ABSTRACT

The Burmese arc on the eastern margin of the Indian plate is a complex region where the plate tectonic scenario has been enigmatic for a long time. Based on focal mechanism data and stress inversion studies it appears that in comparison to worldwide subduction zones, the Burmese arc is a unique zone where an eastward subducted lithospheric slab exists but the subduction process has come to an end. Instead, an overturned lithospheric configuration has been attained due to resistance to slab penetration at the 410 km mantle discontinuity, in course of the clockwise rotation of the Sundaland and westward migration of the arc. This feature is also evidenced by images of seismic tomography in this region. Normally, such resistance to a sinking slab is common at the 660 km discontinuity which represents a density phase change with a negative Pressure-Temperature slope, where as the 410 km discontinuity with a positive slope facilitates sinking of the lithosphere. However, in the Burmese arc it appears that a unique resistance has been encountered at the 410 km discontinuity, possibly governed by very low plate velocity and slab width. There could also be implications for anomalous physical and chemical properties in both the slab and the mantle underneath. Further, detachment of the Indian slab at the base of the lithospheric contact zone is proposed as a special case of gravitational loading leading to reverse faulting, associated with slab detachment away from the dip direction.

Further south, lies another complex tectonic region – the Andaman-Sumatra arc which witnessed the devastating tsunamigenic earthquake of magnitude 9.1 on 26 December 2004. This was quickly followed by another one further south on 28 March 2005 (M8.6), a unique occurrence of two great earthquakes in such close spatial proximity and succession. A comparative study of seismicity and GPS data corresponding to these two earthquakes located close to a quadruple plate junction suggests that the first one was confined to the India-Burma plate boundary, where as the second one was triggered on the adjoining segment of the Australia-Sunda plate boundary. We suggest the possibility of a lithospheric split separating differentially subducting India and Australia plates that acts as a stress barrier at the junction. Analysis of the world's greatest earthquakes in the past century (magnitude 8.5 – 9.5) indicates a strong correlation with locations of plate junctions. In general, it appears that triple and quadruple plate junctions in convergent zones are capable of sustaining much larger stress build-up, and hence, are potential targets for future great earthquakes, a hypothesis that gains strength from 2D Finite Element Modeling study.