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Seismicity, gravity anomalies and lithospheric structure of the Andaman arc, NE Indian Ocean

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ABSTRACT

The Andaman arc in the northeastern Indian Ocean defines nearly 1100 km long active plate margin between the India and Burma plates where an oblique Benioff zone develops down to 200 km depth. Several east-trending seismologic sections taken across the Andaman Benioff Zone (ABZ) are presented here to detail the subduction zone geometry in a 3-D perspective. The slab gravity anomaly, computed from the 3-D ABZ configuration, is a smooth, long-wavelength and symmetric gravity high of 85 mGal amplitude centering to the immediate east of the Nicobar Island, where, a prominent gravity "high" follows the Nicobar Deep. The Slab-Residual Gravity Anomaly (SRGA) and Mantle Bouguer Anomaly (MBA) maps prepared for the Andaman plate margin bring out a double-peaked SRGA "low" in the range of −150 to −240 mGal and a wider-cum-larger MBA "low" having the amplitude of −280 to −315 mGal demarcating the Andaman arc–trench system. The gravity models provide evidences for structural control in propagating the rupture within the lithosphere. The plate margin configuration below the Andaman arc is sliced by the West Andaman Fault (WAF) as well as by a set of sympathetic faults of various proportions, often cutting across the fore-arc sediment package. Some of these fore-arc thrust faults clearly give rise to considerably high post-seismic activity, but the seismic incidence along the WAF further east is comparatively much less particularly in the north, although, the lack of depth resolution for many of the events prohibits tracing the downward continuity of these faults. Tectonic correlation of the gravity-derived models presented here tends to favour the presence of oceanic crust below the Andaman–Nicobar Outer Arc Ridge.

1. Introduction

The Sumatra mega-thrust earthquake of 26 December 2004 (M_w ~9.3) and its chain of aftershocks ruptured nearly 1300 km long segment of the plate margin along the Andaman and Sumatra trench-arc region (Ammon et al., 2005; Ishii et al., 2005). Such an abnormally large seismic activity has brought to fore, the seismicity of the Indonesia arc system and its extension into the Andaman–Nicobar region. The segment of Andaman–Sumatra arc is characterized by oblique motion between the Indo-Australia and Burma–Sunda plates with predominantly thrust motion in the trench/fore-arc region and strike-slip motion in the back-arc region. The latter motion is mainly taken up by the ridge-transform system in the Andaman Sea and along the Sumatran fault in mainland Sumatra. The ridge-transform motion in Andaman Sea is believed to continue further north into Burma to connect to the Shan–Sagaing fault; together they form an important transitional tectonic link between the Eastern Himalaya to the north and the Sunda arc to the south (Fig. 1).

All sizeable earthquakes in the Andaman region relate to subduction of the Indian plate presently occurring up to intermediate depths, though, noticeably, no large earthquake of $M \geq 8.0$ has so far been reported from this region, the largest was 1881 M_w ~7.9 event in the historical records (Ortiz and Bilham, 2003). However, the proximity of the Sumatran mega-earthquake of 26 December 2004, and the rupturing produced by this earthquake in the Andaman arc provide ample reason to cast a re-look into ABZ for delineation of its salient details, particularly, the variations in the configuration of the Benioff zone along and across the arc, active faults, current deformation of the accretionary wedge and anomalous subsurface mass distribution resulting from plate subduction. Characteristics of the rupture zone due to the Sumatran 2004 mega-thrust event and the co-seismic slip propagation northward in the Andaman–Nicobar Islands region have been studied in some detail from the seismic as well as geodetic measurements (Ammon et al., 2005; Lay et al., 2005; Banerjee et al., 2005; Catherine et al., 2005; Earnest et al., 2005; Jade et al., 2005; Gahalaut et al., 2006; Chlieh et al., 2007) and suggest significant variation in the rupture pattern along the arc. Multi-wave speed tomography carried out by Kennet and Cummins (2005)

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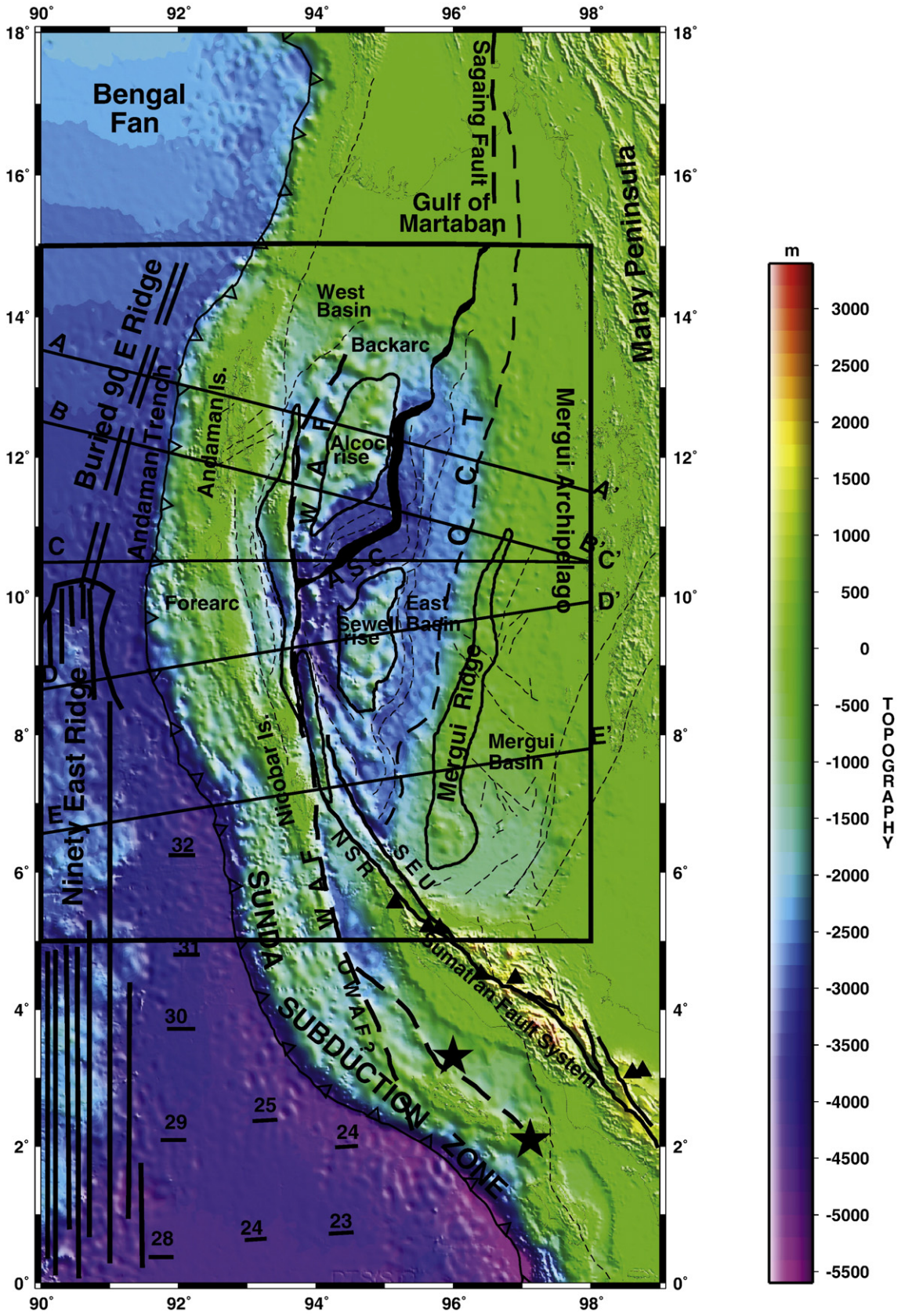

Fig. 1. Shaded relief map of the Andaman arc showing various tectonic elements related to subduction of the Indian plate and opening of the Andaman Sea. Tectonic elements are adopted from Curray (2005). OCT— Ocean–continent transition, WAF— West Andaman Fault, NSR— North Sumatra Ridge, ASC— Andaman Spreading Center, SEU— Seulimeum strand of Sumatran fault, OWAF— Old West Andaman Fault. Filled triangles indicate location of volcanoes; Bold stars are the location of recent mega-thrust earthquakes (26 December 2004 and 28 March 2005) in offshore Sumatra. Numbered lines in the offshore indicate magnetic anomaly identifications (after Liu et al., 1983). Rectangle represents the study area; Profiles AA′ to EE′ are the gravity traverses used for delineating lithospheric structure.