Paper 8

Tectonic implications of Cenozoic magmatism in Southeastern and Eastern Asia

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Cenozoic magmatism post-dates opening of the South China Sea Basin and is associated with fracture intersections in Indochina, Thailand, and China, initiated at ca. 15 Ma BP and 0.5 Ma BP. New geochemical data allow systematic modelling of relationships between melting and lithosphere dynamics in the region. Extrusion tectonics (Tapponnier *et al.*, 1982) predicts rotation of tectonic units along regional strike-slip features such as the Red River and Chao Praya faults and NW-SE opening of the South China Sea in response to the early Tertiary Indo-Eurasian collision. Alternative proposals (e.g. Harder *et al.*, 1992) suggest that extrusion was minimal and rotation of the regional stress field occurred rather than tectonic rotation. In the absence of deep mantle plumes we believe recent melting is best explained by asthenospheric upwelling beneath lithosphere extensional axes at mantle potential temperatures (T_p) of ca. 1280°C. Extension must have been extreme and rapid, and source enrichment necessarily attributed to a shallow recycled crustal source and accreted asthenospheric melt. Post-spreading basalts from pull-apart basins in the South China Sea northern Hainan Island indicate distinctive petrologic relationships: large melt fractions (quartz and olivine tholeiite) beneath extensional east-west fissures and low melt fractions (alkali basalt and basanite) at bounding strike-slip faults. Similar patterns are observed in Vietnam and other parts of Indochina. Petrogenetic conditions have been estimated for Vietnamese and Hainan basalts from experimental data and trace element models. Quartz tholeiites were generated by 12–18% melting of plagioclase/spinel lherzolite at ca. 1250°C. and < 10 kbar pressure. Olivine tholeiites were formed by 10–15% melting of spinel lherzolite (1300°C., 10-15 kbar), and alkali basalts and basanite by 5–8% melting of spinel lherzolite (1350°C, <20 kbar) at or not far below the mechanical boundary layer of lithospheric mantle. These conditions are consistent with thermobarometric estimates from entrained xenoliths. The range and spatial association of primitive melts is consistent with mantle decompression paths beneath pull-apart systems. Isotopic compositions also suggest tholeiites were generated at the base of the lithosphere while alkali basalts tapped a more MORB-like asthenopheric source. Assuming uniform (pure shear) extension stretching factors (ß)>ca. 2.5 are needed for 'normal' mantle T_p. Even if these are unrealistically large, diverse regional orientations suggest major stress redistributions following opening of the South China Sea.

Warta Geologi (Newsletter of the Geological Society of Malaysia), Vol. 18, No. 6, November-December 1992