Geophysical Research Abstracts
Vol. 12, EGU2010-11191-1, 2010
EGU General Assembly 2010

Detrital Zircon U-Pb and Hf-isotope Constrains on Basement Ages, Granitic Magmatism, and Sediment Provenance in the Malay Peninsula

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The Malay Peninsula forms the western part of central Sundaland in SE Asia. Sundaland comprises Indochina, the Thai-Malay Peninsula, Sumatra, Java, Borneo, and the shallow shelf between these landmasses. It is a composite region of continental crustal fragments that are separated by sutures that represent remnant ocean basins and volcanic arcs. The Malay Peninsula includes two of these fragments – East Malaya and Sibumasu – separated by the Bentong-Raub Suture Zone. The latter is a Palaeo-Tethyan ocean remnant. Granitoids of the Malay Peninsula are the major sources of detrital zircon in Sundaland. East Malaya is intruded by Permian-Triassic Eastern Province granitoids interpreted as products of Palaeozoic subduction of oceanic crust beneath the East Malaya Volcanic Arc. Sibumasu is intruded by Triassic Main Range Province granitoids interpreted as syn- to post-collisional magmatism following suturing to East Malaya. Locally, there are minor Late Cretaceous plutons.
Basements of Sibumasu and East Malaya are not exposed and their ages are poorly constrained. The exact timing of the collision between these fragments is also contentious. In order to resolve these uncertainties, 752 U-Pb analyses from 9 samples were carried out on detrital zircons from modern rivers draining the Malay Peninsula and, of these, 243 grains from 6 samples were selected for Hf-isotope analyses.
U-Pb zircon ages show that small numbers of Neoarchean-Proterozoic grains are consistently present in all samples, but do not form prominent populations. Permian-Triassic populations are dominant. Only one sample contains a small Jurassic population probably sourced from the area of Thailand and most likely recycled from fluvial-alluvial Mesozoic 'red-beds'. Late Cretaceous populations are locally abundant.
Hf-isotope crustal model ages suggest that basement beneath the Malay Peninsula is heterogeneous. Some basement may be Neoarchean but there is no evidence for basement older than 2.8 Ga beneath the Malay Peninsula. Both Sibumasu and East Malaya basements are Paleoproterozoic, but of different ages.
$^{176}Hf/^{177}Hf_i$ ratios suggest that Permian-Triassic zircons were sourced from three major magmatic suites: (a) Permian crust-derived granitoids, (b) Early-Middle Triassic granitoids with a mixed mantle- and crust-derived source, and (c) Late Triassic crust-derived granitoids. This suggests three major Permian-Triassic episodes of magmatism in the Malay Peninsula. Two of these episodes (a and b) occurred in the Eastern Province. This suggests a multi-phase evolution of the East Malaya Volcanic Arc. Crust-derived zircon Hf-isotope signatures are unusual for a continental margin arc and may indicate contamination from older crust beneath the East Malaya fragment. A Late Permian-Early Triassic gap in magmatism and subsequent change of zircon source may indicate a micro-collision around 260-270 Ma (e.g. with an island arc or a seamount on the Paleo-Tethys oceanic crust). U-Pb ages and Hf-isotope composition of zircons sourced from the Main Range Province granitoids suggest that Sibumasu-East Malaya collision occurred by Late Triassic, but it is not clear when exactly this collision initiated.
Different Hf-isotope signatures of Triassic zircons can be used as indicators of sediment provenance from the Malay Peninsula. Crust-derived signatures are diagnostic of Triassic zircons from the Main Range Province source, whereas mixed crust- and mantle-derived signatures of similar age zircons indicate Eastern Province source.