Trace element "fingerprinting" tectono-magmatic provenance of igneous zircon

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Attempts to systematically relate zircon trace element (TE) abundances to source rock compositions to determine provenance have been challenging, as diagnostic signatures in zircon from some common tectono-magmatic settings remain elusive. Taking into consideration successful immobile element geochemical fingerprints for lavas, and a compilation of over 5300 recent SHRIMP-RG zircon trace element analyses, new criteria are presented that distinguish mid-ocean ridge (MOR), arc, and ocean island (& plume-proximal MOR) settings. Elemental *ratios* in zircon most effective for fingerprinting tectono-magmatic provenance are systematically related to lava composition from equivalent settings.

Existing discriminations using U/Yb vs Hf or Y differentiate ~90% of MOR from continental zircon. However, they do not effectively distinguish TE-enriched ocean island settings (i.e., Iceland, Hawaii) and continental zircon. Combined U-Nb-Sc-Yb proxies provide more complete distinction of zircon from these settings. Low U/Yb ratios of MOR zircon (typically < 0.1) mirrors their parental magmas and reflect long term incompatible-element-depletion of the MORB mantle. Plume-influenced sources are separated from MOR by higher U/Yb, Nb/Yb, and Nb/Sc. For zircon with U/Yb > 0.1, high Sc/Yb separates arc settings from low-Sc/Yb plume-influenced sources. On a diagram of U/Yb vs Nb/Yb, most MOR and ocean island zircons define a broad "mantle-zircon array", whereas arc zircons are shifted to higher U/Yb at constant Nb/Yb. The trends mimic those observed in basalts.

While we suggest that scandium is useful for provenance studies, its behavior probably reflects contrasting melt fractionation trends between tholeiitic and calc-alkaline systems (especially the role of amphibole) more than differences in primitive magma source. On select plots (e.g., Sc vs. Yb, Ti vs. Sc, Ti vs. Yb) MOR zircons define trends of enrichment that contrast those defined by zircon from arc systems.