The origin of oceanic granites: a view from zircon of the Troodos ophiolite, Cyprus

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In the Troodos ophiolite of Cyprus, like in ophiolites elsewhere, plagiogranitic intrusions abundantly occur at the sheeted dyke-gabbro transition zone. The genesis of plagiogranites in general and the Troodos plagiogranites in particular has been the source of long standing controversy. Extreme fractional crystallization of mantle-derived mafic melts was suggested based on the similarities of incompatible element ratios between plagiogranites and oceanic lavas. Nonetheless, plagiogranites occur mostly near the interface of hydrothermal and magmatic oceanic systems and in some ophiolites yield lower than mantle $\delta^{18}O$(Zrn) values, suggesting an origin by partial melting of hydrothermally-altered mafic crust. In Troodos, plagiogranites perfectly extend and complement geochemical trends of both tholeiitic and boninitic lava series, but crustal anatexis is evident by the occurrence of migmatites at the roof of a gabbro intrusion. Here we apply SIMS U-Pb and O isotope and trace element analysis to 73 zircons from five plagiogranite intrusions in Troodos. Our results confirm that the main phase of tholeiitic magmatism in Troodos took place at 92 – 91 Ma. An earlier phase of incompatible element-enriched magmatism is identified at 94.3 ± 0.5 Ma. Boninitic magmatism in Troodos overlapped the main tholeiitic phase, at about 91 Ma. Average $\delta^{18}O$(Zrn) values in the Troodos plagiogranites range between 4.18 and 4.75 ‰. The lower values in this range are significantly lower than those expected in equilibrium with mantle-derived melt (≥4.7‰), indicating substantial contribution, up to ~40% in some intrusions, of hydrothermally altered deep-seated oceanic crust. The inferred crustal assimilation suggests the existence of a shallow axial magma chamber, typical of fast spreading MOR settings, within the Troodos slow-spreading ridge environment. This apparent contradiction may be reconciled by episodically intense magmatism within an otherwise slow, magmatically-deprived spreading axis.