

The role of dissolved water in the compositional evolution of anorogenic magmas

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Phase equilibrium “fractionation” experiments were conducted on natural rocks from the three hy-normative (silica-saturated) suite-types found in hotspot and early continental rift regimes that contain units ranging from basalts to rhyolites (or their plutonic equivalents). The Nandewar suite of NSW Australia was chosen to represent the hawaiiite through rhyolite and comendite of the alkalic series. Fine-grained samples from the Laramie Anorthosite Suite and the Snake River plain volcanic province were used to represent the potassic, Fe-, Ti-, and P-rich units of the “continental tholeiitic series”. Samples from Pinzon and Alcedo, Galapagos represented the ocean island series. This investigation focused on (a) determination of possible conditions under which the units of each suite-type can be produced by fractionation (b) investigation of the possibility of a common tholeiitic parent for the three suite-types.

Experimental results

The hy-normative alkalic trend was replicated at 9 kbar at water contents of 0.4 wt% and higher. Early clinopyroxene domination induces the typical alkali enrichment at constant silica content. Kaersutite dominates the intermediate stages of evolution leading to sodic rhyolite.

The Fe-Ti-P enrichment and early silica depletion of ferrodiorites (jotunites) of the anorthosite massifs and the ferrobasalts of the Snake River Plain are produced in a tholeiitic gabbro at 9 kbar at < 0.4 wt% H₂O. For bulk water contents slightly below this, the silica-depletion trend reverses shortly after this water content is attained by the melt. At pressures of 4.kbar and water contents >0.4 wt%, tholeiitic gabbro produces the typical potassic granite of the anorthosite/rapakivi-type granite complexes. Experiments at 0kbar confirm the tholeiitic ocean island trend.

Investigation of the possibility that these three suite-types could arise from a similar parent but with different water contents and different pressures of crystallisation was accomplished by “cross-over” experiments. Jotunite has been produced from sodic alkalic rocks by reducing the water content below 0.4 wt%. The ocean island tholeiitic trend has been produced from alkalic rocks at low pressure. Intermediate pressures fractionation of sodic hawaiiite above 0.4 wt% H₂O produces potassic granite.

Within each specific range of bulk water content above and below this critical value the liquid compositions that can coexist with an aqueous fluid are now well constrained and can be used to facilitate understanding of the hydrothermal stage of evolution.

Hadean Earth crust: microanalytical investigation of 4.4 to 4.0 Ga zircons from Western Australia

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The oldest identified Earth remnants are 4.4 to 4.0 Ga zircons found within c. 3.0 Ga sediments (Froude et al., 1983; Compston and Pidgeon, 1986; Wilde et al., 2001; Nelson, 2002) and c. 2.7 Ga orthogneisses (Nelson et al., 2000) of the Yilgarn Craton. Their source rocks have not been identified but their trace-element patterns, euhedral zoning and siliceous inclusions suggest crystallization within granitic *sensu lato* melts. Combined SHRIMP U–Th–Pb isotopic, EMA trace-element microanalysis and BSE/CL imaging indicate a range of ²⁰⁷Pb/²⁰⁶Pb dates within each mineral; the oldest provide a minimum age for zircon crystallization, with younger dates not accounted for by zircon rims attributable to radiogenic-Pb loss from μm-scale domains within each grain. Concurrence in ²⁰⁷Pb/²⁰⁶Pb dates within and between zircons favors episodic loss of radiogenic Pb during 4404, 4350, 4276, 4185, 4150, 4005, 3978, 3945 and 3874 Ma events rather than continuous loss during a ≤3750 Ma event. As significant Pb diffusion from zircon will only occur at >900°C, these times may correspond to high-grade thermal metamorphic events related to mantle upwelling or convective overturn episodes.

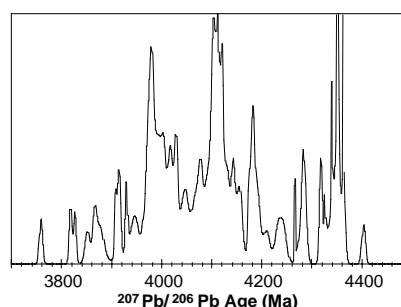


Figure 1. Gaussian probability plot for ≥95% concordant SHRIMP ²⁰⁷Pb/²⁰⁶Pb dates obtained from ≥4.0 Ga zircons (refs. given below).

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