

Low-pressure fractionation of undersaturated alkaline lavas from Cape Verde Islands

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Sub-aerial flows of olivine nephelinites and melilitites (Mg#: 70-73; Ni: 430-560 ppm) from Cape Verde Islands (Sal and Santiago) underwent post eruptive fractional crystallization resulting in granular segregates ('pegmatitoids') of ijolitic to melilititic composition (Mg#: 42-64; Ni: 40-60 ppm). These segregations form discrete clots to sinuous veinlets at the base of the flows, developing in to coarse-grained bands at the central part of the outcrops. Their paragenesis, partially common to the host lavas, includes variable amounts of Ti-augite (Wo₅₅₋₂₈En₄₀₋₆Fs₆₆₋₉), rimmed by aegirine-augite/aegirine, + nepheline + melilite + Ti-magnetite + apatite + aegirine-augite (~WFe₆₁Ae₃₉) + perovskite + rhonite + carbonates + yellowish glass. Late perovskite (average wt%: Nb₂O₅ = 1.22; Ce₂O₃ = 1.92; La₂O₃ = 0.43; TiO₂ = 51.85; CaO = 37.96) in rosary, cruciform or fishbone structures, along well-defined lineaments down cleavage planes and micro-fractures stand out in the 'pegmatitoid' domains. Its orientation in the host minerals strongly suggests crystallization from secondary fluid inclusions under the influence of Ti rich fluids. The host rocks are composed of olivine (%Fo = 82-88) and Ti-augite (Wo₅₅₋₅₁En₄₀₋₃₂Fs₁₂₋₉), essential to accessory nepheline and melilite, Ti-magnetite (%Usp ≈ 42-64), apatite, small crystals of perovskite, and rarely biotite and amphibole. Pyroxenes define a fractionation trend from host rocks to granular segregates with decreasing Mg# and Al₂O₃ and increasing SiO₂, Na₂O and FeO. Also, whole rock chemistry shows that, when compared with parent rocks, 'pegmatitoids' are highly depleted in Mg, Cr and Ni, largely due to olivine extraction, and are enriched in incompatible elements like Zr, Cu, Nb, Ba, La, Yb, Hf, Th, Pb and U. Incompatible elements and REE contents for the segregations show similar patterns to the parental rocks, typical of alkaline OIB, but with higher enrichment degree ($\Sigma\text{REE}_{\text{peg}} = 561$ to 964 ; $\Sigma\text{REE}_{\text{host}} = 338$ to 551). This data indicates that the 'pegmatitoid' granular segregations resulted from low-pressure *in situ* crystallization of residual liquids from fractional crystallization of undifferentiated melts of nephelinitic and melilititic composition. However, the abundant fluid and perovskite inclusions in some minerals suggest the influence of late-magmatic fluids into partially crystallized magma. Decreasing fO₂ conditions are deduced from increase in ulvospinel percentage in magnetite with differentiation.

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Contribution of deep groundwater to weathering budget in a rapidly eroding mountain belt, Taiwan

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Weathering processes occurring in the soil zone and shallow bedrock are supposed to provide most of the dissolved load in rivers. However, river chemistry combines weathering products resulting from surface processes such as soil production and erosion, as well as those coming from deeper processes occurring within the underlying bedrock. A straightforward quantification of those different contributions remains difficult from punctual samplings and may require time series samplings. Analysis of a 7-yr time series of water samples from a well-drained, rapidly eroding catchment in Taiwan, the Liwu River, shows that three water reservoirs with distinct weathering signatures systematically contribute to the dissolved load. Whereas the contributions from surface and shallow groundwater increase at high discharge, the deep groundwater component becomes a predominant water source at low discharge and therefore for 75% of time. The longer residence time of water in the deep reservoir enhances silicate weathering implying that deep groundwater provides a large part of the silicate weathering flux because about 50% of the total chemical flux is carried at low discharge. Deep weathering fluxes may therefore be an important component of the global silicate weathering flux even in high rainfall and rapidly eroding environments. This highlights that weathering reactions in soil and shallow reservoirs only provide part of the total dissolved load and studies that focus on the controlling parameters of chemical weathering must take into account weathering fluxes coming from deeper reservoirs.