

Different origin for mafic and intermediate/felsic lavas from Moorea island (Society, French Polynesia)

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Moorea, a Quaternary volcanic island in the linear Society chain (French Polynesia) is made up of shield (alkali basalt to trachybasalt) capped by intermediate lavas (basaltic trachyandesites, trachyandesites, tephri-phonolites) and alkali trachytes. These intermediate to evolved lavas were emplaced between 1.55 and 1.35 Ma, just after the end of the shield stage which started at 1.72 Ma. The Moorea alkali basaltic suite cannot, however, be easily explained by closed-system fractionation processes because (i) the suite is bimodal in terms of rock abundances (60% mafic lavas and 40% intermediate/felsic ones), and (ii) fractional crystallisation tests fail to account for the transition between these two types.

In order to understand the relationship between basalts and felsic lavas, we determined trace element concentrations, as well as high precision Pb isotope ratios, and Hf, Sr and Nd isotopic compositions of a selection of 18 samples representing the various lava types. Basalts have relatively uniform ²⁰⁶Pb/²⁰⁴Pb (~ 19.2) but variable Nd, Hf and Sr ratios (i.e., ⁸⁷Sr/⁸⁶Sr between 0.7044 and 0.7052). In contrast, the felsic lavas have uniform Nd and Hf isotopic ratios but variable Sr and Pb ratios. The high precision Pb isotopic data define a straight line for the felsic lavas while the basalts form a cluster. Interestingly, the felsic lava straight line does not intersect the basalt cluster.

The composition of the basalts can be explained by conventional models involving partial melting of a garnet peridotite within a plume with EMII characteristics. The composition of the felsic material requires a completely different origin. We suggest that the felsic lavas originate from melting of a basaltic component and not from fractional crystallization of the plume derived basalts. This basaltic component is isotopically heterogeneous but its location is uncertain: it could be located at the base of the oceanic crust below the island or it could be an integral part of the plume.

Schwertmannite transformation to hematite by heating: Implications for pedogenesis, water quality and CO₂/SO₂ export in acid sulfate soil landscapes

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Naturally occurring schwertmannite (Fe₈O₈(OH)_{5.5}(SO₄)_{1.25}), a product of acid sulfate soil oxidation and severe acidification, has been identified as a labile source of iron, sulfate and acidity. Schwertmannite forms surface accumulations on coastal flood plains of eastern Australia that are subject to wild fire events. We report experimental evidence that fire in acid sulfate soil landscapes will convert schwertmannite to hematite (α-Fe₂O₃), consequently reducing the potential acidity store whilst liberating Greenhouse gases. At ≥ 800°C, naturally occurring schwertmannite was transformed completely to hematite. Thermal gravimetric analysis of this transformation process showed that CO₂ and SO₂ evolved simultaneously at relatively low temperatures (200-250°C and 300-340°C respectively). Aqueous dissolution experiments with samples of the initial schwertmannite and the resultant hematite showed that there was a significant decrease in the acidity potential associated with the heating-induced conversion to hematite. The data clearly shows natural fires may convert schwertmannitic surface accumulations to hematite. Hematite surficial layers have been observed previously in these landscapes and this study provides an explanation for their pedogenesis. Theoretical acid loads, based on this research, indicate fire can greatly reduced potential acidity. Relatively low temperature fires in these landscapes can combust schwertmannitic accumulations resulting in the discharge of CO₂ and SO₂. These results have implications for the assessment of acidity and the sustainable management of acid sulfate soil landscapes.