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Prediction of the sulphur content of reduced mafic magma at sulfide saturation

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Several 1-atmosphere experimental studies have now been undertaken that permit the prediction of the sulfur content of a reduced mafic magma at the time of sulfide saturation (SCSS, e.g. [1,2,5]). In addition, several studies of S solubility at elevated pressures have been completed that permit an evaluation of the effect of P on the SCSS in anhydrous mafic magmas (e.g. [3,4]). Using 98 experiments with $a_{\text{FeS}} \approx 1$ we have developed expressions that allow the prediction of the SCSS with $R^2 > 0.93$ that depend on T, P, and melt composition only.

The S contents (~1100 ppm) of primitive sulfide-saturated MORB glasses [6] are predicted to within $\pm 4\%$. Predicted sulfur contents of more evolved (high TiO_2 , H_2O , low-T) MORB are lower than observed values. Experimental data are not available at temperatures less than 1200°C , and extrapolation to the low-T and hydrous conditions of the more evolved MORB glasses contributes to the discrepancy. Although primitive MORB liquids derived at depths of ~50 to 65 km are predicted to be S-saturated at their source, experimental data indicate that they will not be S-saturated at the surface [3,4]. Selective assimilation of sulfide in the oceanic crust is proposed as the most likely process to explain the presence of immiscible sulfide blebs in undegassed MORB. Fractional crystallization of primitive MORB magma easily accounts for S concentrations in residual liquids that are far above those required to maintain sulfide saturation. The MORB data clearly illustrate effects related to both sulfide assimilation and fractional crystallization; these processes are also those that are paramount in the generation of massive Ni-Cu sulfide ores and many reef-type PGE deposits in layered intrusions.

References

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High-spatial resolution lithium isotope variation in mantle minerals

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Lithium isotopes are a powerful tracer of recycled material and thus have a great potential for investigating mantle dynamics. Lithium isotopic analyses of bulk mantle minerals, olivines and melts (basalt/glass) from OIB, and olivine, opx, cpx from lherzolite xenoliths, have been made using multi-collector plasma ionisation mass-spectrometry (Finnigan Neptune) at the University of Bristol. The results on the OIB show a substantial range in $\delta^7\text{Li}$ of 8‰ (-2.5 to +6.0), relative to a reproducibility of <0.3‰ (2σ). The results on the lherzolite xenoliths also show a significant but constant isotope fractionation of ~1.5‰ between associated olivine and opx. There is little, or no, isotopic fractionation observed between olivine and associated melt (0.1‰ \pm 0.2‰). Since mantle melting is dominated by olivine (~80% by volume) only slight lithium isotopic fractionation (<0.1%) should occur between a melt and its mantle source. However, isotope fractionation observed between cpx and other mantle minerals is highly variable and may be the result of secondary process.

High-spatial resolution lithium isotope analyses by secondary ionisation mass spectrometry (Cameca ims 1270 & 4f) at the University of Edinburgh were conducted to investigate: a) whether anomalously light lithium isotopic signatures seen in some of the OIB olivines are representative of the mantle source or represent secondary olivine alteration, b) if a possible Li-isotope zonation in OIB olivines can cause uncertainties in using bulk mineral measurements as representative of the pristine whole rock, and c) the apparent disequilibria in lherzolites xenoliths.

Preliminary results on OIB olivines imply complex alteration processes modifying the original Li-isotope signature. In addition, profile measurements on olivine and opx from lherzolite xenoliths show a remarkable core to rim variation in $\delta^7\text{Li}$ of 8‰ relative to a reproducibility of 0.6‰ ($2\sigma_{\text{mean}}$).