



Experiments on volatile contents of large igneous province basalts

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Volatile degassing of melts erupted during large igneous province (LIP) events are supposed to have major effects on the climatic system of the Earth. Melt inclusions trapped in olivines can provide information on the volatile content of the parental magma and thus on the degassing potential. Samples of submarine picritic basalts dredged at the Kerguelen plateau (Weis et al., 2002) contain approximately 35% olivine and 1% clinopyroxene phenocrysts sized up to 5mm in diameter and 50 μ m scaled Cr enriched spinels. The interstitial microcrystalline matrix contains olivine, clinopyroxene and plagioclase.

Electron microprobe analysis (EMA) show two compositional ranges of olivine with different forsterite contents (Fo₈₄ and Fo₇₉) indicating two different crystallisation stages in different pressure zones in agreement with (Borisova et al., 2002). Glass inclusions trapped in olivines have an alkali basaltic composition poor in MgO and are far from equilibrium with the surrounding olivine. The Fe-Mg partition coefficient between glass and olivine varies between 0.096 and 0.179. Roeder and Emslie (1970) suggest that the coefficient should be near 0.3 while the modelling by Toplis (2004) predicts a partition coefficient of 0.27. However, the observed deviation is suggested to be the result of crystallisation of olivine component from the melt inclusion during eruption and cooling. Therefore, hand-picked olivines with melt inclusions sized up to 200 μ m were filled in an Au₈₀Pd₂₀-capsule and welded shut. The capsule was run in an internally heated argon pressure vessel (IHPV) at the formation conditions which are supposed to be 400 MPa and 1200 °C (Borisova et al., 2002) for 10 minutes using a "rapid quench" device (Berndt et al., 2002) to quench the melt inclusions. EMA demonstrates re-equilibration of the melt inclusions, indicated by the Fe-Mg distribution coefficient near 0.3. First estimations of trace elements lead to the assumption that

the degree of melting of the mantle source is low.

Sulfur, chlorine and fluorine contents in the melt inclusions determined by EMA are 1100, 420 and 350ppm, respectively. H₂O content determined by IR spectroscopy is ranging between 0.14 and 0.35wt%. Surprisingly, no CO₂ was detected. The oxygen fugacity (fO_2) has been estimated using the oxidation state of sulfur in the glass inclusions using EMA. Variations in the wavelength of SK_α radiation are directly related to changes in the oxidation state of sulfur because of the higher bond energies associated with oxidized S⁶⁺ species compared to S²⁻. These higher bond energies are reflected in the shorter wavelength of SK_α X-rays from S⁶⁺ (Carroll and Rutherford, 1988). Both, untreated and re-equilibrated glass inclusions contain S²⁻ suggesting that (1) the relatively high intrinsic oxygen fugacity of the IHPV (~QFM+4) does not change the oxidation state of sulfur and (2) the log fO_2 of the melt is about QFM.

Phase equilibria experiments are in progress for developing quantitative indicators for volatile contents in basaltic systems using equilibration compositions of solid solutions and trace element partition coefficients. Ca partitioning between olivine and melt is found to be dependent on water content, as shown by Libourel (1999). Other methods to constrain volatile contents could be the Ni content in olivine and Cr in clinopyroxenes.

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