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High precision olivine analysis using Electron Probe Micro Analyzer

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Concentrations of minor elements Ni and Mn in olivine phenocrysts enable the degree of fractional crystallization to be calculated using bulk volcanic rock geochemistry. This then allows the primary magma compositions of the magma that the olivines have crystallized from to be reconstructed (e.g., Tatsumi et al., 1983; Takahashi, 1986; Machida et al., 2008). Furthermore, high precision Mn and Fe concentrations in olivine allow the contribution from recycled lithosphere to magma genesis to be estimated (Sobolev et al., 2007). Ni and Mn can be routinely analyzed by an Electron Probe Micro Analyzer (EPMA) together with major elements using an accelerating voltage of 15kV and a probe current of 12 nA. However, under these conditions Ni and Mn concentrations have a large uncertainty. In contrast, while a high accelerating voltage (20kV) and probe currents (300 nA) with long counting times (more than 90 seconds on peak) provide precise Ni and Mn data, this set up usually results in over estimations of the major elements. This is related to the choice of primary standard used in the calibration of the EPMA. Rather than using wollastonite for Si, magnesium oxide for Mg, and hematite for Fe, the use of natural olivine standards, such as San Carlos olivine (Jarosewich et al., 1980), allow major and minor elements in olivine to be measured contemporaneously under the conditions for high precision analysis. After applying this analytical protocol to the analysis of olivines in basalts from petit-spot, it is suggested that recycled lithosphere derived-melt contributes generally makes up more than 90% of the source of petit-spot magmas.

Keywords: Electron Probe Micro Analyzer, olivine, petit-spot