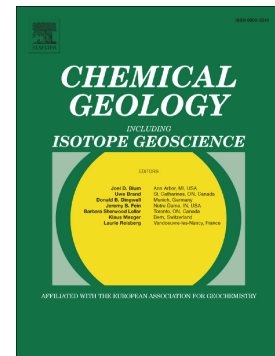


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Silicate-sulfide liquid immiscibility in modern arc basalt (Tolbachik volcano, Kamchatka): Part II. Composition, liquidus assemblage and fractionation of the silicate melt

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Keywords: Sulfide, immiscibility, olivine, magma, melt inclusions, volatiles, island-arc, Tolbachik volcano, geochemistry

ABSTRACT

Olivine-hosted inclusions of silicate and sulfide melts, Cr-spinel and pyroxene were studied to estimate magma composition, temperature, pressure, and fO_2 at the onset and during the silicate-sulfide immiscibility in modern arc basalt from Tolbachik volcano, Kamchatka arc. We demonstrate that the olivine phenocrysts hosting sulfide and silicate melt inclusions belong to the same population. The compositions of the silicate melt inclusions in most primitive olivine (88-91 mol% Fo) represent moderately oxidized (~QFM+1.1) high-MgO (up to 12-12.6 wt%) and high CaO/Al₂O₃ (0.8-1.2) melt that has abundances and ratios of the lithophile trace elements typical of island arc magmas. The initial volatile contents in parental Tolbachik magma are estimated from the melt inclusions and mass-balance considerations to be at least 4.9 wt% H₂O, 2600 ppm S, 1100 ppm Cl, 550 ppm F, and 1200 ppm CO₂. These data are used to calculate the temperature (~1220 °C) and minimum pressure (3 kbar) at which the beginning of crystallization and exsolution of sulfide melt took place. The presence of anhydrite, especially ubiquitous in the crystallized silicate melt associated with sulfide globules, suggest that much higher sulfur abundances prior to degassing and sulfate immiscibility and/or crystallization should be expected. We tentatively considered hydrothermal accumulations of sulfur (elemental, sulfate and sulfide) in the volcanic conduit responsible for local contamination and oversaturation of the Tolbachik magma in sulfur and related sulfide immiscibility. Coexisting sulfide and sulfate can be also interpreted in favor of the magmatic sulfide oxidation and related generation of S-rich fluids. Such fluids are expected to accumulate metals released from decomposed sulfide melts and supply significant epithermal mineralization, including native gold.

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