Sulfides and noble metals in primitive arc basalts

M. ZELENSKI[1], V.S. KAMENETSKY[1]

[1]Institute of Experimental Mineralogy, Chernogolvka, 142432, Russia (correspondence: volcangas@gmail.com)

Sulfide globules entrapped in primitive olivine phenocrysts (Mg# 86-92) from arc basalts (Tolbachik volcano, Kamchatka, Russia) preserve the compositions of primary magmatic sulfide melts. The globules have high concentrations (up to 38 mol%) of CuS and NiS that indicates low sulfide supersaturation in magma, when the diffusion fluxes of FeS, NiS and CuS into growing globules are comparable. The phase composition of sulfides depends on the quenching rate during the eruption and varies from homogeneous through intergrowths of MSS and ISS to fully crystallized globules containing FeS, $CuFeS_2$, $CuFe_2S_3$, Cu_5FeS_4, $(Fe,Ni)_9S_8$ and Fe_3O_4. Trace elements (PGE, Ag, Te, Au, Pb and Bi) are present in solid solution in sulfide phases and as micron-sized “nuggets” scattered randomly within sulfide matrices or at phase boundaries and outer surfaces of the globules. Concentrations of PGE in sulfides follow a log normal distribution over five orders of magnitude from 0.29 to > 20,000 ppm Au + PGE. Correlations between noble metal abundances suggest diffusive equilibration between sulfide and silicate melts. However some anomalous concentrations suggest entrapment of Au–PGE-rich particles (solid or liquid) from magma. This is further supported by very high Pd of 2% in two sulfide globules, associated with fine Pd particles disseminated in co-trapped silicate melt. Tolbachik sulfide globules have mean composition resembling those of major PGE-sulfide ore deposits (e.g., Norilsk, Sudbury, Platreef and Merensky Reef). The sulfide-silicate immiscibility in the Tolbachik parental melt occurred at ~1220 °C, ≥ 3 kbar and QFM+ 1.1.