Exsolution of Semimetal Liquids from Sulfides: Experimental Study on the Solubility of Te-Bi-As Liquids in Monosulfide Solid Solution Between 1050 °C and 600 °C

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Abstract

Semimetals (e.g., Te, Bi and As) are thought to exsolve immiscible liquids, during the crystallization of magmatic sulfide melts. Previous work has shown that immiscible Te-Bi-As bearing liquids may sequester some highly siderophile elements (HSE), particularly Au, Pd and Pt, which later, with decreasing temperature, form platinum-group minerals (PGM). To determine whether this is a feasible mechanism for HSE fractionation and remobilization, data on the Te, As, Bi content at which such immiscible semimetal liquids form are essential but little is available in the literature. Thus, experiments were performed to measure the semimetal concentration necessary to exsolve the semimetal liquid from the sulfides and its effects on the partitioning of HSE among sulfides, as a function of temperature. Starting materials consisted of sulfides (70 wt.% natural pyrrhotite, 15 wt.% pentlandite and 15 wt.% chalcopyrite) in which 50 ppm of each HSE had been diluted. Semimetals were added individually in concentration of 3 wt.% that provided saturation of semimetals and was used to establish the maximum amount of semimetals that can be contained within a sulfide phase before an immiscible semimetal liquid can exsolve. Materials were sealed in evacuated silica tubes, then fused at 1200 °C for 4 hours. Temperature was reduced (2 °C/h) and different experimental sets were equilibrated at 1050 °C (3.5 days), 900 °C (7 days), 750 °C (14 days) and 600 °C (28 days), finally quenched in water. Run products consisted of monosulfide solid solution (MSS), a Cu-rich sulfide phase (melt or intermediate solid solution, ISS), and a semimetal-rich phase. Analyses (SEM and EDS) show that semimetal liquids segregate and can be found with the Cu-rich liquid (or ISS) or filling cracks within MSS. Preliminary results (LA-ICP-MS analyses) reveal that temperature does not have an extensive effect on the solubility, but the highest semimetal content in MSS was measured for the 900 °C experiments. Current work aims to assess the bulk concentration of semimetals that could result in the formation of immiscible semimetal liquids and affect the fractionation of the HSE.