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Behavior of gold in a magma at sulfide-sulfate transition: Revisited

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Abstract

We have investigated experimentally the partitioning of Au between solid and liquid sulfide phases and basaltic melts at 200 MPa, at redox conditions close to the sulfide-sulfate transition, over temperatures between 1050 and 1200 °C, which span the monosulfide solid solution (MSS) - sulfide liquid (SuL) solidus. The measured MSS/basalt partition coefficient of Au ($D_{Au}^{MSS-sil}$) is about 100–200, whereas the partition coefficient of sulfide liquid/basalt ($D_{Au}^{SuL-sil}$) is approximately 10 times larger at 2200. Although we find that temperature, pressure, and oxygen fugacity (f_{O_2}) exert relatively weak controls on Au partitioning, they exert major indirect influences on Au behavior by controlling the identity of the condensed sulfide phase and by affecting S solubility. These observations have important implications for the behavior of Au in the processes of partial melting in the mantle and magma crystallization in the crust. The occurrence of natural magmas with elevated concentrations of Au and presumably other highly siderophile and chalcophile elements requires predominance of MSS over SuL in the source or/and oxidizing conditions close to or above the sulfide-sulfate transition in the magma.

Keywords: Gold, sulfur, sulfide, solubility, partitioning, enrichment, magma, basalt