American Mineralogist, Volume 102, pages 966–974, 2017

SPECIAL COLLECTION: FROM MAGMAS TO ORE DEPOSITS

Sperrylite saturation in magmatic sulfide melts: Implications for formation of PGE-bearing arsenides and sulfarsenides

Liping Bai[1,*], Sarah-Jane Barnes[1], and Don R. Baker[2]

[1]Sciences de la Terre, Université du Québec à Chicoutimi, Québec G7H 2B1, Canada
[2]Earth and Planetary Sciences, McGill University, Montreal, Québec H3A 0E8, Canada

Abstract

Sperrylite ($PtAs_2$) is one of most common Pt minerals, but the processes whereby it forms are not clearly established. Most commonly it is associated with the major-component base metal sulfide minerals (pyrrhotite, pentlandite, and chalcopyrite), which are believed to have crystallized from magmatic sulfide melts. Hence, sperrylite is thought to have formed by crystallization from a sulfide melt or by exsolution from sulfide minerals. However, sperrylite is also found associated with silicate and oxide minerals where it is thought to have formed by crystallization from the silicate magma. To investigate the conditions under which sperrylite could crystallize from a magmatic sulfide melt we investigated sperrylite saturation in Fe-Ni-Cu-S sulfide melts under controlled f_{O_2} and f_{S_2} at 910–1060 °C and 1 bar. The As and Pt concentrations in the sulfide melt at sperrylite saturation increase from 0.23–0.41 to 2.2–4.4 wt% and from 0.36–0.65 to 1.9–2.8 wt%, respectively, as the iron concentration in the sulfide melt decreases from 50 to 36 wt% at 910–1060 °C. We show that transitional metal concentrations, particular iron and nickel, as well as sulfur and oxygen fugacities influence As and Pt concentrations in the sulfide melt at sperrylite saturation. These intensive variables appear to effect sperrylite solubility by influencing the oxidation state of As in the sulfide melt. The measured concentrations of As and Pt in sperrylite-saturated sulfide melts produced in our experiments are much higher than that in most natural sulfides, implying that arsenides and sulfarsenides will not reach saturation in natural magmatic sulfide melts at high temperatures unless the magma has been contaminated with an exceptionally As-rich rock. This suggests that the observed arsenides and sulfarsenides in natural sulfide ores were not formed by crystallization from unfractionated sulfide melts at high temperatures above 900 °C, but might form at low temperatures below 900 °C.

Keywords: Sperrylite, PGE, magmatic sulfide melt, arsenide, sulfarsenide