AN ABSTRACT OF THE THESIS OF

Gregory A. Brennecka for the degree of Master of Science in Geology presented on March 14, 2006.

Title: Origin and Metal Content of Magmatic Sulfides in Cu-Au Mineralizing Silicic Magmas: Yanacocha, Peru and Yerington, NV

Abstract approved:_____

John H. Dilles

Magmatic sulfides from Yerington, Nevada, and Yanacocha, Peru, were analyzed by laser ablation-inductively coupled mass spectrometry (LA-ICPMS) and electron microprobe to determine copper, gold, and silver concentrations and ratios in order to examine the relationship to the metal content of related magmatic-hydrothermal ores. The magmatic sulfides occur in plutonic rocks of the Yerington batholith, which produced porphyry copper-(molybdenum) ore deposits, and in the andesitic and dacitic volcanic rocks at Yanacocha, which produced high sulfidation epithermal gold (copper) ores. The magmatic sulfides, which range from <1 to 20 micrometers in diameter, consist principally of pyrrhotite and chalcopyrite (with minor pyrite and bornite) with a wide range of copper contents (n=34; <3000 ppm to 36 wt% Cu) in the Yanacocha samples. The magmatic sulfides studied from Yerington (n=9) were exclusively chalcopyrite

composition (~35 wt% Cu), but chalcopyrite-bornite mixtures have been previously described (Dilles, 1984).

A methodology for LA-ICPMS analysis and detection of trace amounts of gold, silver, lead, and other metals was developed and tested for sulfides smaller than 30 micrometers diameter, the minimum for laser ablation. Trace metal contents were corrected for silicate backgrounds and standardized against the copper content of the sulfide. Detection limits of average 10-micrometer diameter sulfides are approximately 0.05 ppm for Au and 0.24 ppm for Ag. The Au content in magmatic sulfides ranged from less than detection limit (n=4) to detectable amounts of 5.4 to 131 ppm (n=5) at Yerington, and from less than detection limit (n=17) to detectable amounts of 0.44 to 494 ppm (n=17) at Yanacocha. Silver concentrations for Yerington and Yanacocha ranged from 29 to 2373 ppm (n=7, n= 2 below detection limit) and 0.36 to 6932 ppm (n=20, n=14 below detection limit), respectively. For samples with detectable gold, the Au/Cu (x10, 000) ratio of magmatic sulfides at Yerington and Yanacocha ranged from 0.15 to 3.75 and from 0.02 to 17.04, respectively. For samples with detectable silver, the Ag/Cu (x1000) ranged from 0.09 to 6.78 for Yerington sulfides and from 0.001 to 32.24 for Yanacocha sulfides. The average Au/Cu ratio of magmatic sulfides from both Yerington and Yanacocha are similar to the average ratio of magmatic sulfide reported for andesite and dacite related to the porphyry Cu (Au) ore deposit in the Bajo de la Alumbrera district of NW Argentina (Halter et al., 2002a). The Au/Cu ratio of magmatic sulfide at Alumbrera is similar to the Au/Cu ratio of the ore deposit, but at both Yerington and Yanacocha the Au/Cu ratio of the magmatic

sulfides differs significantly from Au/Cu ratio of the bulk ore. The magmatic sulfides at both Yerington and Yanacocha have Au/Cu ratios of about 10^{-4}, whereas ores from Yerington have a low average Au/Cu ~2×10^{-7} and those from Yanacocha have a relatively high Au/Cu (estimated at 2×10^{-3}). Au/Cu fractionation is likely to occur both when magmatic sulfides are dissolved into magmatic hydrothermal fluids, and later when these hydrothermal fluids precipitate ore sulfides and gold. Additionally, metals may be contributed to the magmatic hydrothermal fluid from silicate melt as well as sulfide melt. The results of this study suggest that the copper, gold, and silver content and ratios of magmatic sulfides do not directly dictate the metal contents and ratios of related magmatic-hydrothermal ores.

Origin and Metal Content of Magmatic Sulfides in Cu-Au Mineralizing Silicic Magmas: Yanacocha, Peru, and Yerington, Nevada

by

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A THESIS

submitted to

Oregon State University

Presented March 14, 2006
Commencement June, 2006
Master of Science thesis of Gregory A. Brennecka presented on March 14, 2006

in partial fulfillment of
the requirements for the
degree of

Master of Science

APPROVED:

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Gregory A. Brennecka, Author

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