Introduction

We report the occurrence of inclusions of a (Ag,I)-rich mineral, most probably iodargyrite, in supergene chalcocite from the Mantos de la Luna argentiferous stratabound Cu deposit in the Coastal Range of northern Chile. Iodargyrite (AgI) is highly insoluble and its occurrence is restricted to Ag-bearing deposits in extremely arid environments such as desert areas of Nevada, Arizona, New Mexico, Kazakhstan, Australia, and Chile [1, 2]. We explore the close association of iodargyrite and chalcocite in supergene zones and provide new constraints on the nature and source of the waters involved in supergene enrichment of Cu deposits in the Atacama region.

Samples and methods

Silver-bearing chalcocite samples were taken from the supergene enrichment zone of the argentiferous Mantos de la Luna deposit. This deposit, located 30 km south of Tocopilla, consists of three small orebodies (Bloques Norte, Central, and Sur) that occur within a monoclinical volcanic sequence (N10ºE, 30ºE dip). The orebodies are delimited by the NWW and EW trending Sur and Albornoz faults, respectively [3]. At Mantos de la Luna, Cu mineralization occurs preferentially in the lower levels of amygdaloidal and porphyritic horizons. Mineral paragenesis is simple and composed exclusively of Ag-bearing supergene chalcocite (digenite), atacamite, and chrysocolla. The fine-grained aggregates of chalcocite and minor covellite occur disseminated and in veinlets, and are locally replaced by the oxide alteration assemblage (atacamite and chrysocolla).
contrast to other stratabound Cu deposits of the Coastal Range (e.g. Susana-Lince and Buena Esperanza), hypogene sulfides are not observed in this deposit, and extraction is exclusively reduced to the thick (~300 m) supergene/oxide zone.

Chalcocite samples from Mantos de la Luna were analyzed using a Cameca SX-100 electron microbe analyzer (EMPA) at Electron Microprobe Analytical Laboratory (EMAL) of the University of Michigan. The analytical conditions were: accelerating voltage of 20 kV and a beam current of 20-40 nA.

**Analytical Results and Discussion**

EMPA observations reveal the presence of discrete, micron-sized (1-10 µm) inclusions of a Ag iodide mineral in supergene chalcocite. The inclusions were identified as iodargyrite by means of EDS and WDS elemental mapping. The Ag concentrations in the inclusions vary from 1.0-67.6 wt% and they are contaminated by Cu and S from chalcocite. The small size and the beam-sensitivity of the Ag-I inclusions precluded the precise description of its chemical formula. However, the Ag and I elemental maps strongly correlate with the inclusions, whereas the WDS maps of Cu and S correlate well with the chalcocite sulfide host [4].

The occurrence of iodargyrite inclusions in supergene chalcocite suggests the involvement of iodine-rich waters during supergene enrichment at the Mantos de la Luna Cu deposit. Considering the fact that the occurrence of iodargyrite is restricted to extremely arid environments [1], our observations strongly suggest the prevalence of hyperarid conditions during the latest stages of supergene enrichment of the Mantos de la Luna argentiferous Cu deposit in northern Chile. This suggests that supergene enrichment processes of Cu deposits in the hyperarid Atacama Desert are dynamic in nature and do not exclusively require the presence of meteoric water [4]. Further studies are needed not only to address the isotopic signature (and age) of iodine-rich waters involved in supergene enrichment of these deposits (e.g. deep formation waters), but also to constrain the origin of iodine in the extensive nitrate deposits occurring in the eastern flank of the Coastal Range.

**Acknowledgements**

Financial support for this study was provided to Martin Reich by the Chilean Fund for Science and Technology, Fondecyt Grant # 11070088. We thank Jorge Pizarro at Compañía Minera Mantos de la Luna for logistical assistance in the field and Carl Henderson at University of Michigan for his valuable help with EMPA measurements.
References


