

## Nanoscale mineralogy of Ag in sulfides from Cu deposits in northern Chile: Implications for ore genesis, exploration, and metallurgical recovery

M. REICH<sup>1\*</sup>, S.L. CHRYSOULIS<sup>2</sup> AND C. PALACIOS<sup>1</sup>,

<sup>1</sup>Dept. of Geology, University of Chile, Santiago, Chile  
(\*correspondence: mreich@ing.uchile.cl)

<sup>2</sup>Advanced Mineral Technology Laboratory (AMTEL), London, Ontario, Canada

Little is known about the mineralogical form of occurrence of “invisible” precious metals in stratabound (“manto-type”) Cu deposits in northern Chile, where Ag can be enriched up to thousands of ppm. A few studies report bulk analyses of sulfide concentrates revealing that Ag is hosted by primary and secondary Cu and Fe sulfides such as chalcopyrite, bornite, pyrite, chalcocite, digenite, and covellite. However, no comprehensive set of data is available regarding the relative distribution, speciation, solubility, and limits of incorporation of Ag (and other trace metals) in the sulfides. This information is of utmost importance to determine: (a) the saturation state of the parent ore-forming hydrothermal solutions with respect to Ag (b) the ability of different sulfides to extract economically important amounts of precious metals from solution during Cu ore deposition.

Preliminary bulk (INAA) data from the Mantos Blancos deposit show that maximum amounts of Ag are present in mineral separates of chalcocite and covellite (1057 and 812 ppm, respectively), followed by bornite (510 ppm) and chalcopyrite (336 ppm). Bulk analyses allow constraining the ranges of concentration in different sulfides, but they do not provide information about the mineralogical form of Ag (solid-solution versus nanoparticulate), the distribution of Ag in the sulfide grains, and the spatial relation between Ag and other trace metals.

Therefore, we are analyzing the trace metal content of sulfides *in situ*, using secondary-ionization mass spectrometry (SIMS) along with high-resolution transmission electron microscopy (HRTEM). The speciation of Ag in different sulfides is determined (Ag<sup>+</sup>, Ag<sup>0</sup>, Ag<sub>2</sub>S, (Ag, Au)) as well as its close association with other trace metals such as Au, Sb, Se, and Te. The precise determination of the mineralogical form of precious metals in their sulfide host(s) is a key factor to improve our understanding of the distribution of precious metals in the ore body and its relation with ore-forming processes. In addition, by knowing the mineralogical form and distribution of the incorporated metals, new exploration guidelines and more cost-efficient metallurgical extraction strategies can be developed.

## Whole rock and single grain provenance analysis of Early Paleozoic sandstones from northern Peru and Southern Bolivia

C.R. REIMANN<sup>1\*</sup>, H. BAHLBURG<sup>1</sup>, J. BERNDT<sup>2</sup> AND E. KOOIJMAN<sup>2</sup>

<sup>1</sup>Geological-Palaentological Institute, University of Muenster, Germany

(\*correspondence: reimannc@uni-muenster.de)

<sup>2</sup>Institut fuer Mineralogie, University of Muenster, Germany

The Ordovician sedimentary basins of the northern central Andes (southern Peru, northern Bolivia) developed in a back-arc position, with the arc on the Arequipa Massif in the west and the Amazon craton in the east. This plate-tectonic setting appears to have changed into a passive margin in the Early Devonian. As there are only very few outcrops of intrusive and extrusive Early Paleozoic rocks, detailed information considering the plate-tectonic evolution and the duration of Early Paleozoic magmatism can mainly be found in the coeval and younger siliciclastic strata. In a provenance study we address these problems by geochemical analysis of Ordovician (Sandia/Amutara Fm.) and Devonian (Cabanillas Gr.) sandstones, exposed across southern Peru and northern Bolivia. A particular emphasis is placed on single grain analysis of tourmalines and rutiles, and U-Pb LA-ICP-MS isotope geochemistry of detrital zircons.

Whole-rock REE-patterns in sandstones of both intervals reflect an upper continental crust composition. The major part of the detritus is well recycled. Over 70% of tourmalines and rutiles show a chemical composition typical of a meta-sedimentary origin. Thus, the majority of the detritus has undergone at least one resedimentation event before final deposition. We conclude that the Ordovician and Devonian basins were only to a minor degree influenced by immature detritus, indicative of an active margin plate-tectonic setting.

The detrital zircons from the Ordovician sandstones are well rounded to subhedral. C. 50% have a magmatic origin. The U-Pb LA-ICP-MS zircon data show an age distribution with the most distinctive peak between 0.5-0.7Ga (Brasiliano event), and smaller peaks at 1-1.3Ga, 1.4-1.5Ga and 1.5-1.8Ga. The detrital zircons from the Devonian sandstones are mostly subhedral to euhedral and >70% are of magmatic origin. The most prominent peak lies between 0.4-0.5Ga (Famatinian event). These zircons were derived from a western source on the Arequipa Massif, the only place where respective intrusives occur. The oldest (476.93±33Ma) and youngest zircons (406.5±11.4Ma) from this Famatinian peak are narrowing down the duration of Early Paleozoic arc magmatism to the Early Ordovician to very Early Devonian.