

Coupled Au and As partitioning between hydrothermal fluid and pyrite

C. KUSEBAUCH^{1*}, S. A. GLEESON^{1,2}, M. OELZE¹

¹German Research Center for Geoscience, GFZ Potsdam, Telegrafenberg, 14473 Potsdam, Germany,

(*correspondence: c.kusebauch@gfz-potsdam.de)

²Free University Berlin, Institute for Geosciences, Malteser Str. 74-100, 12249 Berlin, Germany

Arsenian pyrite is the major host of Au in Carlin type gold deposits (CTGD) and forms by interaction of hydrothermal fluids rich in H₂S with Fe bearing carbonates (e.g., siderite, ankerite, Fe-rich dolomite) of the CTGD wall rocks. Gold in these deposits is either structurally bound together with As or occurs as nm sized nuggets in pyrite. Although, much about this ore system is known from natural observations (e.g., fluid characteristics, metal origin and transport), information on the partitioning behaviour of trace elements (i.e., As and Au) between ore forming fluid and ore stage pyrite is lacking.

To better understand the partitioning and, therefore, the depositional process of Au in CTGD, we performed hydrothermal experiments at conditions typical for these deposits (i.e., 200°C, 0.05molal H₂S, fluid dominated). Partitioning was studied by adding trace amounts of As (0-100ppm) and Au (0.05-10ppm) to the experimental H₂S-rich fluid, which interacts with siderite (FeCO₃) to form pyrite (FeS₂) via a coupled dissolution-precipitation reaction. Concentration of As and Au of newly formed pyrite was measured using LA-ICPMS to calculate Nernst partition coefficients ($D=c_{py}/c_{fl}$).

Experimentally derived D values for As vary between 300 and 1600 showing a high compatibility of As in the pyrite structure and a major substitution of As⁻¹ on the S⁻² position similar to natural CTGD pyrite. Gold also partitions strongly into the pyrite having D values ranging from 30 to 1200 as a function of As in pyrite with increasing D values for Au towards high As concentrations.

We conclude from this observation that not only the maximum concentration of dissolved Au in pyrite depends on the As but also the partitioning of Au between fluid and pyrite. This dependency can be explained by a coupled adsorption process of As and Au onto the surface of growing pyrite. Results of this study provide, on one hand, a sound quantification of partition coefficients for Au and As in CTGD and, show on the other hand, the importance of As for the formation of these deposits.