Protracted and complex fluid histories the norm in orogenic-type gold deposits as revealed by LA ICP-MS sulfide mapping

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Hydrothermal ore deposits are the culmination of many processes, commencing with generation of fluids, metal transport and mineral precipitation. This process can involve mixing of fluids, in addition to metals sourced from different reservoirs. The convention of inferring elemental enrichment and associations using bulk methods is limited with such data, although ore petrology provides insight into elemental paragenesis. The advent of in situ LA-ICP-MS analysis provides the means to readily analyse many elements at various detection limits wt. % to ppb) and apply spatial resolution (10s µm) in a way not possible previously. Application of this procedure to pyrite and arsenopyrite has increased in recent years and with it the realization of a complex chemistry in ore systems. Here LA-ICP-MS data from a wide variety of orogenic-type gold settings is used to illustrate the power of the method and assess generalizations in regards to deposit formation based on: 1) elemental mapping; 2) generating an elemental paragenesis for the mapped sulfides; 3) conversion of the data to time slice domains (TSD) or semi-quantitative concentrations which provides 10s of thousands of analyses in small domains to assess elemental trends and processes; and 4) statistical treatment of such data. Application of the latter protocol to deposit samples reveals a general paragenesis of: 1) early enrichment of Co, Ni, As ± Au, Ag, Cu, Te, In, Sb, Se, Mo; 2) later overgrowths or fracture controlled Bi, Sb, Te, Pb, Zn, Au, Ag; and 3) a late Ti, Mo and W stage. Relevant to Au are: 1) its increase through the paragenesis from 10s to 100s ppm; 2) late occurrence as VG with lower Au:Ag ratios; and 3) variable elemental associations. These data indicate a protracted elemental paragenesis, remobilization of early Au by later fluids, and coupled dissolution-precipitation reactions as important processes in these deposits.