

Nano-scale trace element zoning in Au related pyrite – towards a detailed understanding of deposit formation

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Trace element content of pyrite has long been of interest of people investigating the formation of Au deposits. This is because one of the deposition mechanisms for Au is the precipitation of pyrite that removes the HS⁻ that are ligands that allow the Au to remain in solution. Pyrite can bind a large number of elements into its structure, therefore examining the trace element content of the pyrite can provide information on the composition of the Au bearing fluids.

Much of the current research involves laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) to provide the compositions of trace elements in the pyrite. While this is indeed a useful technique it cannot fully explain how the trace elements are held within the pyrite so a number of assumptions are required to explain the observed trace element contents. An example of this is As(-I) is thought to increase the incorporation of elements similar to Fe like Ni and Co into the pyrite structure while As(III) is thought to increase the incorporation of large cations like Au⁺ or Pb²⁺ because for every two As³⁺ cations a void in the structure is required for charge balance. However, this has rarely been tested with techniques that can measure the coordination chemistry of the ions. Further the laser ablation analysis does not give conclusive information on whether the trace elements are indeed held within pyrite or within evenly distributed nano-inclusions.

Here we test the assumptions commonly made in the interpretation of LA-ICPMS analyses using a combination of micro focused synchrotron based absorption and XRF techniques to identify changes in the redox state of As and Se across nm scale spatial resolution with fine zoning in pyrite from the Jinchang gold deposit, southeastern Tibet. Our new insights provide a detailed understanding of the redox state of these elements in pyrite and how the speciation and spatial distribution of the elements change during formation of the pyrite. We then use a combination of transmission electron spectrometry and atom probe tomography to determine whether these elements are held within the pyrite, as nano-inclusions or within the pyrite structure.

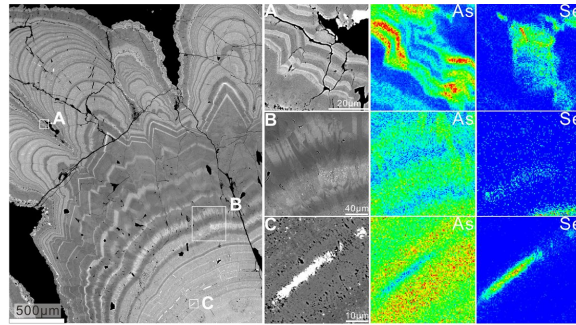


Figure 1: High resolution SEM backscatter images with As and Se compositions from synchrotron based XANES mapping.