Recrystallization of Metastable Arsenian Pyrite as a Source of Metals for Metamorphic Fluids

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Sedimentary pyrite is the primary host for several chalcophile elements, e.g., As, Au, Ag, Sb. Decomposition of pyrite to pyrrhotite has been proposed as source of Au and As for metamorphic fluids which form orogenic gold deposits. Here we demonstrate that trace element-rich pyrite is likely metastable and its recrystallization to metamorphic pyrite with low trace element content can be another mechanism of release of chalcophile elements during metamorphism.

Arsenian pyrite (2–4 wt % As) from the Konkera gold deposit (Burkina Faso) has textures indicating decomposition to low As pyrite and arsenopyrite during low grade metamorphism. The textures were probably formed when a reaction front propagated through the arsenian pyrite leaving a fine-grained aggregate of low-As pyrite (0.2 wt % As), arsenopyrite, and gold. Microprobe measurements suggest that the reaction was isochemical. The textures can be interpreted as a dissolution-precipitation process resulting in decomposition of a metastable arsenian pyrite to a stable assemblage.

Metamorphosed sulfide deposits tend to contain an assemblage of low As pyrite and arsenopyrite pyrite but high As pyrite (>2 wt % As) is most common in unmetamorphosed hydrothermal deposits where arsenopyrite is a rare phase (e.g., Carlin trend, USA; Ladolam, Lihir island, PNG). The combined datasets suggests that the equilibrium solubility of As in pyrite is between 0.2 and 1 wt %, and higher concentrations represent a metastable solid solution which can un-mix to low-As pyrite and arsenopyrite during low grade metamorphism. Crystallization of metastable arsenian pyrite is possibly related to rapid pyrite growth and is likely controlled by surface processes.

The metastability of arsenian pyrite can result in pyrite recrystallization during regional metamorphism to stable pyrite with a low content of trace elements. Therefore, we suggest that chalcophile elements can be released without transformation of pyrite to pyrrhotite. The release of trace elements by transformation of sedimentary pyrite to metamorphic pyrite is likely to occur at lower PT conditions than transformation of pyrite to pyrrhotite and hence might be responsible for deposits at the lower temperature end of the spectrum of orogenic deposits.