Association of gold and hydrothermal pyrite in the metamorphic-hosted gold mineralization at the Awak Mas deposit and the Luk Ulo prospect, Indonesia

*Renaldi Suhendra[1], Ryohei Takahashi[1], Andrea Agangi[1], Muhammad Zain Tuakia[2], Hinako Sato[1]

1. Akita University, 2. National Research and Innovation Agency (BRIN), Indonesia

Gold of the Awak Mas and Luk Ulo metamorphic-hosted Au mineralization is strongly associated with hydrothermal pyrite as visible (microscopic-scale) and invisible gold, respectively. To better understand their relationship and mode of occurrence of gold, we investigated texture and trace element compositions of hydrothermal pyrite. We utilized petrography and SEM-EDS analyses for textural and mineral identification, and electron probe micro analyzer (EPMA) and laser ablation (LA)-ICP-MS for quantitative mineral chemistry analysis.
The gold in the hydrothermal pyrite occurs as 1) solid solution, 2) nano-particles, and 3) micro-inclusions. The hydrothermal pyrite of the Luk Ulo gold prospect is characterized by euhedral to rounded shapes, presence of sulfides-sulfosalt inclusions, and has chemical zoning. It is classified into arsenic-poor (av. 235 ppm As) and arsenic-rich or arsenian pyrite (av. 22100 ppm As). The results of this study are consistent with those of many other previous studies on pyrite. Arsenic substitutes for S, while metals (Co, Ni, Sb, Cu, Pb, Hg, Ag, and Au) substitute for Fe in the crystal structure of pyrite. The contents of trace elements in the arsenian pyrite are significantly higher (up to four times) with average of 2800 ppm Sb, 500 ppm Pb, 400 ppm Cu, 187 ppm Hg, 29.8 ppm Ag, and 0.61 ppm Au compared to those in the arsenic-poor pyrite. Gold in both types of pyrite occurs mainly as a solid solution, while its content is significantly lower in As-poor pyrite. Furthermore, EPMA and LA-ICP-MS spot analyses also documented few occurrences of gold nano-particles randomly distributed in the arsenic-poor pyrite.
On the other hand, hydrothermal pyrite in the Awak Mas gold deposit is mostly euhedral, sulfide-sulfosalt inclusion-rich, relatively depleted in trace elements, and has no significant chemical zoning. Likely due to low As content in pyrite (av. 70.42 ppm As), the other metals were not favorably incorporated in the pyrite crystal structure during its formation. Consequently, metals were precipitated as micro inclusions in hydrothermal pyrite as sulfides, oxides, and/or native elements (native Au and Bi). We consider that the As-poor pyrite in the Awak Mas gold deposit was due to an oxidized hydrothermal fluid in which oxidized As^{2+} was relatively dominant rather than reduced As^{-} and As^{3-}. The oxidized hydrothermal fluid, in addition to elevated sulfur fugacity, led to the favorable condition for the As-rich hydrothermal fluid to form enargite and luzonite ($Cu^{+2}{}_3As^{+2}S^{-2}{}_4$) rather than arsenian pyrite. The deposition of Au and other metals from the hydrothermal fluids was promoted by the sulfidation of Fe-rich host rocks such as meta-hematitic mudstone, chlorite metavolcanic rocks, and chlorite muscovite schist.

Keywords: Hydrothermal pyrite, The Awak Mas gold deposit, The Luk Ulo metamorphic complex

