

### **Cobaltite-Pyrite-Pyrrhotite Association: Triassic Metasedimentary Rocks in the South Kitakami Belt, Japan**

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Pyrite framboids coated with cobaltite in sulfide-rich nodules are confirmed from the pelitic and psammitic slate of the Upper Triassic Isatoma Formation in the Ishinomaki district, southernmost part of the South Kitakami Belt, Japan. The nodules are a few cm (~3 cm) in size and included in low-grade metamorphic products of prehnite-pumpellyite facies. The rocks contain grains of quartz, albite, K-feldspar, apatite, epidote, pumpellyite/prehnite, magnetite and titanite with minor rutile in matrix minerals of chlorite, illite and biotite. The main sulfide minerals included in the nodules and disseminated in the rocks are pyrite, cobaltite, and pyrrhotite, with trace pentlandite, galena, and electrum. The framboidal pyrites (~5  $\mu\text{m}$ ) are commonly coated with cobaltite. Minute electrum grains (~2  $\mu\text{m}$ ) appear next to the compact anhedral pyrite and cobaltite grains in the nodules, surrounded by albite, K-feldspar, titanite, and pumpellyite. Carbonaceous materials are identified as seams and/or nodules, associated with chlorite and biotite in the samples. A bulk rock composition of the nodules-bearing sample shows significant enrichment of As, Co, Ni, Cr, Cu, and Zn. The chemical compositions of anhedral compact pyrites determined by EMPA show a strong negative correlation ( $R^2=0.992$ ) between  $\text{Fe}+\text{Co}+\text{Ni}+\text{Mo}$  versus  $\text{As}+\text{S}$ . Also, a strong negative correlation between As and S ( $R^2=0.996$ ) in compact cobaltite shows the substitution of As for S. These results suggest that diagenetic framboidal and compact pyrite is the main metal source for Isatoma Formation. Cobaltite, coating framboidal pyrite, may have formed by adsorption of cobalt and arsenic in a reducing environment during the diagenesis, and compact cobaltite as well as electrum due to the recrystallization of pyrite and transformation from pyrite to pyrrhotite during the metamorphism.