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Mineralogical and copper isotopic characteristics of various types of native copper mineralization

Micro-Raman spectroscopy was used to identify mineral species in various types of native copper deposits from Japan. Five reference products of clay minerals, including kaolinite (JCSS1101b), dickite (JCSS1301), pyrophyllite (JCSS2101), montmorillonite (JCSS3101), and saponite (JCSS3501) were also analyzed to optimize analytical conditions and to obtain reference spectra of clay minerals [1]. Primary chalcopyrite, secondary copper-bearing minerals (cuprite, malachite, and langite), and montmorillonite were identified with Raman analyses of supergene native copper. Magmatic native copper occurs in fresh olivine from an orogenic peridotite massif [2]. Micro-Raman measurements indicated that there were no serpentine and clay minerals around the native copper. In contrast, micro-Raman results revealed that native copper from serpentinized peridotite was associated with primary pentlandite and secondary malachite, oxide minerals, and carbonate minerals. The copper isotopic values ($\delta^{65}Cu = [(^{65}Cu/^{63}Cu)_{sample}/ (^{65}Cu/^{63}Cu)_{NIST\text{-}SRM976}\text{-}1] \times 1000$) of the supergene native copper ($\delta^{65}Cu$ = 1.4 to 1.7‰ [3]) and the associated secondary copper-bearing minerals ($\delta^{65}Cu$ = 2.2−3.1‰) were significantly heavier than those of the primary chalcopyrite (−0.3 to 0.2‰) from the same deposit. Copper isotopic ratios of the magmatic native copper are in a relatively narrow range (0.0 to 0.1‰) [2]. The native copper from the serpentinized peridotite had negative $\delta^{65}Cu$ values (-0.7 to -0.4‰), whereas the associated secondary malachite had positive $\delta^{65}Cu$ values (1.0 to 1.2‰). There were significant differences in $\delta^{65}Cu$ values between native copper and associated copper-bearing minerals. Therefore, pre-identification of minerals associated with native copper using micro-Raman spectroscopy is important to understand intrinsic isotopic signatures of these samples.

References

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