Characteristics of Porphyry Copper-Gold Mineralization in the Grasberg Mine, Papua, Indonesia

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The Grasberg-Ertsberg district is located in the west of the remote highlands of the Sudirman Mountain in the province of Papua, Indonesia. The district is well-known copper-gold mine area as “Grasberg mine” in the world. In this district, Pliocene intrusive rocks host copper and gold mineralization. These intrusive rocks are named “Grasberg Igneous Complex” (GIC), which is composed of Kali Intrusion (KI), Main Grasberg Intrusion (MGI) and Dalam Intrusion (DI). The purpose of this study is to clarify characteristics of ore forming fluid and copper-gold mineralization, especially in the western part of MGI hosted porphyry mineralization in the Grasberg district.
In this study, all samples used is collected from a drill core, AM-30-08H-05. It penetrates KI and DI through MGI. Petrography revealed that Cu bearing mineralization style can be divided into three types: Cu(-Fe) sulfides vein type in quartz vein, Cu(-Fe) sulfides veinlet type and disseminated Cu(-Fe) sulfides type. Chalcopyrite is major ore mineral in vein type and veinlet type. In these types, bornite is often distributed in or by the chalcopyrite, therefore it could be explained by exsolution from intermediate solid solution and bornite solid solution. In disseminated Cu(-Fe) sulfides, chalcopyrite and bornite is major and primary Cu bearing minerals. They are often co-existing, therefore they also seemed to be exsoluted from intermediate solid solution and bornite solution. However, the other Cu bearing minerals (chalcocite, covellite, digenite) sometimes form foliated texture with chalcopyrite and bornite, clearly indicating that those Cu bearing minerals are formed by replacement from bornite. In addition, rim of bornite is sometimes replaced by chalcocite, covellite and digenite, suggesting interaction with ground water after primary mineralization. Native gold is precipitated in chalcopyrite vein in quartz vein and in disseminated chalcopyrite. In chalcopyrite vein, native gold is precipitated with bornite and merenskyite, which is determined by SEM-EDX as $Pd_{1.0}Te_{2.0}$. Merenskyite is newly identified in the western part of GIC, while it has already reported in northern and southern part of GIC. Merenskyite is a common in ultramafic rocks related to PGE mineralization (e.g., merensky reef in Bushveld Igneous Complex). Precipitation of merenskyite in this area suggests the presence and contribution of primitive mafic magma. The fact merenskyite can be observed widely in MGI, the contribution may cover the whole MGI.
Since clear cross-cutting relationship among quartz veins is not observed in this research, SEM-Cathodoluminescence observation is conducted for identifying quartz crystal growth pattern in quartz vein, hosting chalcopyrite vein. Luminescence contrast anomaly can be recognized in quartz vein, suggesting that there are two different occurrence of quartz veins which are early quartz vein and later quartz vein. Only late quartz vein is associated with chalcopyrite vein. Fluid inclusion microthermometry in early quartz vein was conducted. Homogenization temperature of fluid inclusion in early quartz is over 600 degree Celsius with high salinity (61.32 wt%). These results are harmonious with previous research, suggesting weak or none of Cu and Au mineralization is associated with early quartz vein, however late quartz vein introduced intensive copper-gold mineralization.

Keywords: Grasberg Mine, Porphyry Copper Deposit, Mineralization

