Sphalerite mineral chemistry and microthermometry: Implications for the mineralization of the Kay Tanda epithermal gold deposit, Lobo, Batangas, Philippines

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Sphalerite is one of the major base metal sulfides in the Kay Tanda epithermal gold deposit in Lobo, Batangas, southern Luzon, Philippines. Mineralization sequences and paragenesis of the deposit have been studied and they are categorized into six stages. Sphalerite occurs with galena, chalcopyrite and pyrite in the Stage 4 and Stage 6 mineralizations associated with quartz and gypsum-anhydrite, respectively. Sphalerite in the Stage 4 is associated with gold mineralization hosted in hydrothermal breccias and quartz-sulfide veins. Sphalerite occurs as dark brown crystals but appears to be yellowish and transparent in thin section. Chalcopyrite disease is also common in most crystals and some crystals show prominent zoning with primary fluid inclusions along the growth zones. In this study, compositional variation and fluid inclusion characteristics in sphalerite crystals were studied to understand the ore-forming processes of the Kay Tanda epithermal deposit. Compositional zoning of sphalerite crystals with and without growth zones was examined to map the concentration and distribution of Zn, Fe, Mn, Cd, Cu, Sn, In, Ag, Ga and S within the crystals. Fluid inclusion microthermometry of primary liquid-rich liquid-vapor inclusions was done to determine the homogenization temperature and salinity. The FeS contents of Stage 4 sphalerite range from 0.6 to 2.9 mol% with a mode between 1.0 to 1.1 mol% FeS, while the FeS contents of Stage 6 sphalerite range from 0.9 to 2.1 mol% with a mode between 1.3 to 1.4 mol% FeS. Zoned and unzoned sphalerite crystals do not show any compositional variation in any of the analyzed elements except for copper which is correlated to the chalcopyrite disease along the growth zones of the zoned sphalerite. The dark brown color of these low Fe-sphalerite is attributed to the chalcopyrite disease. Homogenization temperatures of fluid inclusions in Stage 4 sphalerite range from 260 ˚C to 370 ˚C with a mode between 290 ˚C to 310 ˚C, while those from Stage 6 sphalerite range from 270 ˚C to 340 ˚C with a mode between 270 ˚C to 290 ˚C. Salinity values from fluid inclusions from Stage 4 sphalerite range from 4 to 8 wt% NaCl equivalent with a mode between 6 to 7 wt% NaCl equivalent, while those from Stage 6 sphalerite range from 4 to 7 wt% NaCl equivalent with a mode between 4 to 5 wt% NaCl equivalent. Homogenization temperature vs salinity diagrams show cooling trend and isothermal mixing trend in Stage 4 sphalerite while a cooling trend on Stage 6 sphalerite. Fluid inclusion data indicates that base-metal ores were deposited from moderate salinity fluids at temperatures higher than typical epithermal deposits. Cooling and isothermal mixing are two possible mechanisms for base metal precipitation. Sulfur fugacity ($\log fS_2$ = -8.9 to -11.6) determined from FeS content at temperatures estimated from microthermometry (T = 533 to 563 K) indicates that the base metal mineralization at Kay Tanda occurred in intermediate sulfidation condition.

Keywords: sphalerite mineral chemistry, sphalerite microthermometry, compositional zoning , sulfur fugacity, intermediate sulfidation epithermal, Lobo, Batangas, Philippines

