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Oxidation state of hydrothermal fluids in the Grasberg porphyry Cu-Au ± Mo deposit, Indonesia

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The Grasberg porphyry Cu-Au ± Mo deposit in Indonesia is one of the largest and highest grade Cu-Au deposits in the world. The deposit is hosted within the Pliocene Grasberg Igneous Complex (GIC) that consists of the pre-mineral Dalam Intrusion Complex, intra-mineral Main Grasberg Intrusion (MGI), Early Kali Intrusion (EKI), and post-mineral Late Kali Intrusion (LKI). Present research focuses on the three drill cores that penetrate the upper part of the intrusions for more than 1,000 m vertically. We are investigating the oxidation state of the hydrothermal fluids based on core logging, magnetic susceptibility (MS) measurement, petrography, and mineralogy. Magnetite in rocks with high MS is of secondary origin that occurs with or without biotite±K-feldspar±quartz in the form of veinlets, as disseminated grains, around or within hornblende or biotite, and in pseudomorphs. The MS decreases with depth gradually, and slightly increases in the bottom part of the drill cores, where the least altered LKI that contains primary magnetite is observed as phenocrysts and inclusions within primary silicate minerals. In contrast, the MS has a negative correlation with anhydrite. There are three stages of anhydrite, i.e., i) anhydrite as phenocrysts and inclusions within primary silicate minerals, observed in the least altered MGI and LKI; ii) anhydrite with a biotite±K-feldspar±quartz±magnetite±chalcopyrite±bornite assemblage as veins and in pseudomorphs; and iii) anhydrite that occurs as veins with or without quartz±chalcopyrite±bornite, often with sericite halos. Those indicate that anhydrite formation occurred during magmatic, potassic, and phyllic stages, respectively. The presence of magmatic anhydrite but sulfides in the unaltered GIC indicates that the oxygen fugacity is above the sulfide-sulfur oxide buffer. Hydrothermal magnetite, which forms early in the potassic stage, is interpreted to provide buffering of SO_2-H_2S.