

Hydrothermal Mineral Assemblage of the Southwest Prospect, in the Vicinity Sto. Tomas II (Philex) Porphyry Cu-Au Deposit, Baguio District, Philippines

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Overprinting relationship between intrusive rocks, diatreme-breccias and mineralized porphyry-type veinlets are documented in the Southwest prospect was recently discovered along the contact of the basement Pugo metavolcanics and conglomerates of the Zigzag formation, overlain by dacitic tuff termed as the Keratophyre (KTP). The prospect is located at the southwestern periphery of the Sto. Tomas II orebody, a 60-year old porphyry Cu-Au mine being operated by Philex Mining Corporation (PMC). At least four intrusive rocks were recognized. In chronological order, they are the: (1) coarse-grained biotite quartz diorite (ODP –Old Diorite Porphyry), (2) fine-grained quartz diorite porphyry (EMD -Early Mineralization Diorite), (3) medium-grained porphyritic hornblende quartz diorite (LD –Late Diorite) and (4) hornblende andesite porphyry (DP –Diorite Porphyry). Meanwhile, at least five breccia facies were identified: (1) Phreatomagmatic Breccia facies 1 or PMBx1, (2) Phreatomagmatic facies 2a or PMBx2a, (3) Phreatomagmatic Breccia facies 2b or PMBx2b, (4) Early Mineralization Diorite Breccia or EMDbx and (5) Diorite Porphyry Breccia or DPBx. The PMBx facies are polymictic breccias with chaotic mixture of clasts set in a matrix composed of rock flour of earlier formed rocks and juvenile tuffaceous matrix. They are sub-vertical pipes that flare upwards and may represent diatreme breccias (Sillitoe, 1985, Baker et al., 1986, Lawless and White, 1990). On the other hand, EMDbx and DPBx are intrusion breccias that were formed during the emplacement of their intrusive equivalents (Sillitoe, 1985). Porphyry-type veinlets are observed overprinting ODP, EMD and PMBx1, while at the same time, quartz vein fragments are included in the latter. These veinlets are also commonly found along the contacts between LD and the PMBx1. PMBx2a and PMBx2b crosscut all the earlier intrusions and breccias. Spatial and temporal associations suggest syn-mineralization timing of the EMD, PMBx1 during porphyry-type quartz veining, while LD and some of the porphyry-type veinlets associated with the LD suggest a late-mineralization timing.

Intense potassic alteration is characterized by secondary biotite-quartz-magnetite-anhydrite-chalcopryite-bornite. It is exhibited by EMD and andesitic clasts of Pugo Metavolcanics occurring as clasts in the diatreme breccias. It is also well-developed in the EMD at the deeper central portion of the prospect, in the matrix of the adjacent EMDbx and PMBx1. Secondary biotite is present as fine disseminations in the groundmass and as polygrain aggregates completely altering former ferromagnesian minerals, such as hornblende. It is often accompanied with quartz, anhydrite, magnetite and copper iron sulfides. Occasional K-feldspar, chlorite, illite and epidote are present in the assemblage. Associated sheeted quartz and granular quartz veinlets indicated a wide range of liquid-vapor homogenization temperature ($T_h(L-V)$) from 436°C to 578°C and 461°C to >720°C, respectively, and salinities from 41 to 43 wt% NaCl_{equivalent} and 37 to 43 wt% NaCl_{equiv.} This alteration is overprinted by illite-chlorite-carbonate-magnetite±K-feldspar alteration with abundant chalcopryite and bornite. It pervasively overprinted the quartz stockwork zone hosted in the PMBx1 adjacent to the EMD at the central deeper portion of the prospect. Associated banded quartz veinlets indicated $T_h(L-V) > 720^\circ\text{C}$ and salinities ranging from 55 to 70 wt% NaCl_{equiv.} The shallower portions dominated by the later breccias were altered by chlorite-illite-pyrite±chalcopryite with associated quartz-gypsum cement. Lastly, propylitic

alteration is exhibited by LD. It is characterized by chlorite-epidote-calcite \pm illite. Associated crystalline quartz-chlorite veinlets indicated lower Th(L-V) 246°C and lower salinity of 40 wt% NaCl_{equivalent}. K-Ar ages determined on the secondary biotite of the EMD sample that exhibited intense hydrothermal biotitization typical at the potassic core in Southwest and on the hornblende grains of LD that showed no hydrothermal alteration are both 3.5Ma. This indicates that the hydrothermal biotitization prevalent in the potassic alteration in EMD and the emplacement of the LD could have happened in a single magmatic-hydrothermal event. This may also indicate that the timing between the potassic alteration and intrusion are close in Southwest, and also constrained an older age than the mineralization at the Sto. Tomas II orebody (Imai, 2001, Waters et al., 2011).

Keywords: Baguio district, Southwest prospect, Sto. Tomas II orebody, potassic alteration, overprinting porphyry-type veinlets, diatreme breccias