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Ore Paragenesis, Fluid Inclusion and Sulfur Isotope Systematics of the Balatoc Breccia and Vein Orebodies, Acupan Epithermal Deposit, Philippines

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The Acupan epithermal deposit is characterized by NE-trending epithermal veins transecting the Balatoc Diatreme and the Virac Granodiorite. Mineralization hosted by the Balatoc Diatreme occurs as veins and breccias. The veins transform to stockwork at the eastern portion, while the breccias, called GW orebodies, occur along the margins of the diatreme. This study characterizes the mineralization of the Balatoc epithermal veins and breccia-hosted GW orebodies using ore-gangue mineralogy, fluid inclusion characteristics, and sulfur isotope systematics.

The breccia and vein mineralization within the Balatoc Diatreme has five stages, distinguished by the dominant gangue mineral: gray quartz (Stage I), white quartz (Stage II), clear quartz (Stage III), calcite (Stage IV), and gypsum (Stage V). Stage I is the main gold mineralization stage. It is characterized by gray quartz with pyrite + marcasite + arsenopyrite + electrum + sphalerite \pm chalcopyrite. Stage II is typified by white quartz associated with pyrite + electrum + chalcopyrite. Stage III is composed of clear quartz hosting pyrite + stibnite + chalcopyrite + galena + sphalerite + electrum (\pm pyrite + marcasite + arsenopyrite). Stages IV and V are associated with calcite and gypsum, respectively, hosting trace amounts of pyrite and sphalerite.

Microthermometry of the fluid inclusions hosted by Stage I and Stage II vein quartz revealed homogenization temperatures (T_h) ranging from 220°-240°C and 260°-320°C, respectively. Calculated salinity values range from 1.7-8.7 wt % NaCl equiv for Stage I and 2.1-13 wt % NaCl equiv for Stage II. The fluid inclusions hosted in Stage III quartz breccia cement have homogenization temperature ranging from 290°-300°C and salinity ranging from 1.05-6.01 wt % NaCl equiv. A boiling trend is recognized for the stages associated with the epithermal veins (Stages I and II), while an isothermal mixing trend is prominent for Stage III mineralization in the GW breccia orebodies.

Measured $\delta^{34}\text{S}$ values of pyrite and sphalerite from Stage I to Stage IV veins and breccias narrowly range from 0.8 to 1.5‰, which suggests that H_2S is the dominant sulfur species. On the other hand, the $\delta^{34}\text{S}$ values measured from the pyrite of Stage V breccia orebody range from -1.6 to -1.5‰, indicating the partitioning of the heavier isotopes to the gypsum sulfate. This depicts a shift from reducing to oxidizing conditions in the latter part of the mineralization.