Infrared Imaging of Geothermal Activity Within the Lienetz Open-Pit, Lihir Au Mine, PNG; Influence of Faults and Porphyry- and Epithermal-Style Breccias on Modern-Day High-Temperature Fluid Flow

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The Lihir gold deposit in Papua New Guinea is the largest known alkalic gold deposit in the world (57 Moz Au resource; Newcrest, 2013) and is one of the best examples of a telescoped epithermal-porphyry system. Lihir's spectacular gold endowment has been related to a catastrophic volcanic sector-collapse event (Carman, 1994; Sillitoe, 1994); however, new lithological, structural, and alteration mapping in the Lienetz ore zone at Lihir has unraveled a more complex history of brecciation and faulting.

Lienetz contains volcanic, magmatic and hydrothermal breccia complexes that were emplaced along largely steep NE-, ENE- and lesser NW-striking faults. The two main brecciation events related to gold mineralization consist of a low-grade (i.e., <1 g/t Au) biotite-anhydrite-cemented matrix-rich magmatic-hydrothermal breccia with low pore space (i.e., <10 %), and a high-grade (i.e., >1 g/t Au), pyrite-cemented, adularia-altered hydrothermal breccia with high pore space (i.e., >10%). The early magmatic-hydrothermal breccia underwent partial solution collapse due to anhydrite dissolution. In the upper-levels of the magmatic-hydrothermal breccia, open-space cavities were created by solution collapse and partly sealed by high-grade epithermal gold mineralization with associated bladed anhydrite and quartz.

In the Lienetz open pit, active geothermal hazards and mining limits access to some benches; nonetheless, lithological boundaries and faults were mappable, in part with the use of infrared (IR) thermal images. IR images of open pit benches highlight steep NE-striking faults, with local listric splays and upward-flaring geometries that bound parts of the pyrite-adularia-cemented breccia. The pyrite-adularia–cemented breccia and anhydrite-biotite-cemented breccia are largely juxtaposed by these faults.

Preliminary results of imaging indicate that some faults currently act as permeable conduits that localize nearby geothermal activity, and others as impermeable barriers to convective heat transfer. The same NE-striking faults are expressed in the broader Lihir volcanic amphitheatre and control the macroscale geothermal system. Elevated temperatures (>40°C; Villaguerte et al., 2007) that are broadly dispersed within the porous pyrite-adularia–cemented breccia are indicative of enhanced permeability therein.