Unlocking the Giant Ladolam Gold Deposit: New Insights into Its Pyrites

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Gold mineralization at Ladolam, with its 59 Moz Au resource (www.newcrest.com.au), occurs principally as auriferous pyrite and accessory marcasite. Other base metal sulfides and sulfosalts are also present. Metallurgical test work undertaken as part of the original Ladolam feasibility study showed that direct cyanidation of finely ground ore yielded less than 30% gold extraction, and coarse gold is extremely rare. Early studies also highlighted contrasting Au values with different pyrite morphologies, including "barren" blocky pyrite and multiple "higher-value," more ornate textured variants. After a number of oxidative test work campaigns in the original feasibility studies, whole ore pressure oxidation was selected for Ladolam.

Newcrest, working together with CODES, University of Tasmania, completed a study of microscale pyrite chemistry across the Ladolam deposit. This data was gathered in a well-established paragenetic framework (from multiple research projects in collaboration with university-based researchers), with the aim of determining the spatial distribution of pyrite "types" across the deposit to allow development of alternative processing options to segregate and discard lower-value pyrite ore. Over 1.5 million laser ablation micro assays (each of 39 elements) confirm that higher Au grades are associated with a spectrum of chemically complex pyrite variations.

Pyrites were grouped into chemically distinct "pyrite classes." When individual pyrite chemistry maps (via laser ablation-ICP-MS) are visualized with these pyrite classes, the varied and complex chemistry of the Ladolam pyrite is apparent. Classification of pyrite maps by material type failed to reveal either textural or chemical characteristics that are restricted to any singular material class. That is, both epithermal- and porphyry-related alteration domains contain nearly all the pyrite classes across a multitude of morphological and textural types.

"Pyrite genesis" of the pyrite phases has been interpreted using the variation in elemental concentrations measured within the crystals. Elevated Te, Pb, and Ag in the pyrite has been interpreted to have formed during the porphyry phase of the deposit formation. The presence of high levels of As and Tl are interpreted as pyrite of a lower-temperature epithermal origin. While Au is observed in pyrites of each genetic type, the epithermal-related pyrite typically contains higher concentrations of Au.

Analysis of the "pyrite value" proportions indicated for each pyrite grain, averaged into grade range intervals and classified by alteration domain, has allowed pyrite value models to be generated which enable the proportion of high-value reactive pyrite to be estimated across the deposit, which can be used to optimize the processing options at Lihir. Ores with higher amounts of high-value, reactive pyrite are likely to oxidize more rapidly and may require a lower residence time within the autoclaves. Hence, autoclave residence times (oxidation levels) may be able to be varied based on the proportions of "valuable" pyrite.

This knowledge has challenged accepted thinking on the treatment of Lihir ore types. A change in pressure oxidation management has increased capacity, with the net impact being increased gold production at a lower unit cost.