Case Study: Discovery and Geology of the Kham Thong Lai Copper-Gold Deposit, Lao PDR

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The Kham Thong Lai (KTL) deposit is a stratabound porphyry-skarn style copper gold system located approximately 8km ESE from the provincial town of Phonsavan in Xiengkhouang Province, Lao PDR (Fig. 1). It lies within the Mineral Exploration and Production Agreement granted to Phu Bia Mining. The deposit is situated proximal to the confluence area of the northern Loei Fold Belt (LFB) and Truongson Fold Belt (TFB) and lies within a complex and deformed arrangement of magmatic arc and rift volcano-sedimentary rocks and intrusives overlying Khorat type continental clastic sediments. Exploration work within the LFB and TFB has led to the discovery of several ore deposits including Phu Kham Cu-Au, Ban Houayxai Au-Ag, Sepon Cu-Au and Chatree Au-Ag. Orogenic activity associated with the development of the two belts has involved widespread plutonism and volcanic activity throughout the belt regions. It is this magmatism which has played a fundamental role in the formation of the KTL deposit.

Historically, copper at KTL was probably first identified by the local people of the area who referred to the site as Phu Thong, a name which is still in use today and literally translates as Copper Mountain in Laotian. Archaeological finds of bronze artefacts and the discovery of smelting furnaces in Laos confirm that metal production technologies were available and it may be that copper was mined and produced from KTL centuries ago, although this is unconfirmed. In more recent times during the French colonial administration small scale mining was undertaken at KTL from 1951 until 1953.

In 1994 until 1996 Normandy Anglo Asian Pty Ltd, who were the original owners of Phu Bia Mining, undertook regional stream sediment sampling over the Phonsavan area. This work returned broad Au and Cu BLEG anomalies which ultimately led to the rediscovery of the KTL deposit. It was around this time that the name KTL was adopted by Normandy Anglo workers, which in Laotian translates as abundant gold and copper.

Follow-up of this early work comprising geological mapping, gridded soil geochemical sampling and ground and airborne magnetics assisted in locating and defining KTL and directed Normandy Anglo to undertake a scout drilling campaign over the most prospective geochemical targets. This drilling consisted of 31 diamond drill holes, many of which returned significant gold and copper intercepts along

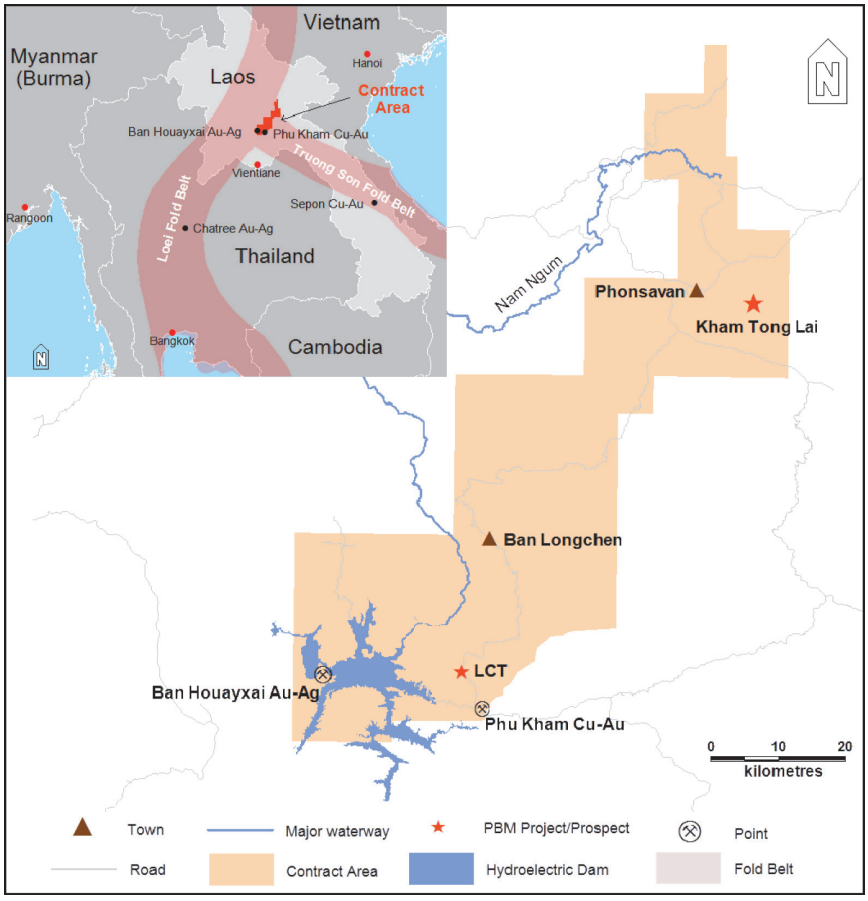

Figure 1. Location Map

1. Phu Bia Mining, Laos *Corresponding author:* peter.leaman@pbm.panaust.com

a 2.3 kilometre long E-W trending zone. At completion Normandy Anglo reported KTL as a significant resource of low-grade copper and gold and concluded that that the metal grades were not high enough to justify further work at that time. Exploration at KTL consequently ceased.

In 2001 PanAust, then operating as Pan Australian Resources NL, took an 80% stake in the Phu Bia Contract Area in Laos. The remaining 20% of PBM was later acquired by PanAust from Newmont in 2005. Between 2004 and 2005 PanAust commenced a review of all previous work completed at KTL by its former owner. PanAust geologists also re-logged the Normandy Anglo drill core and remapped the prospect area. Based on this work PanAust recognised potential in the project and a decision was made to conduct further exploration work, which included gridded soil sampling, trenching and ground and airborne geophysics. Encouraging results consequently led to the resumption and continuation of exploration drilling from 2006 onwards. To date a total of 290 drillholes have been completed by PanAust, defining an indicated and inferred mineral resource (at 0.25% Cu cut-off) of 89 MT @ 0.44% Cu, 0.18g/t Au and 1.7g/t Ag containing approximately 390,000 tonnes of copper, 515,100oz of gold and 4,864,400oz of silver. The majority of the stated mineral resource is primary mineralisation.

The host sequence at KTL consists of an E-W trending, moderate south dipping, weak to moderately foliated sedimentary package of Late Carboniferous–Early-Permian age which contains alternating sequences of strongly deformed interbedded siltstone, sandstone, micritic limestone and carbonaceous shales of passive shallow marine and volcaniclastic origin. The volcano-sedimentary sequence is intruded by rift related calc-alkali stocks that occur as elongated bodies and lobes showing a west to northwest trend. Late quartz-feldspar rhyodacite porphyry dykes intrude both the diorite and host sediments.

At district scale the Phonsavan area lies at the margin of a south verging fold-thrust belt of probable late Permo-mid Triassic age. Evidence of the fold-thrust system is observed at KTL as localised brittle-ductile and ductile shear in the core. Statistical analysis of shear data indicates the shear fabric dips moderately south. Late WNW and NE structures also occur and appear to have formed after the timing of mineralisation. This faulting is responsible for disruption and truncation of the deposit but not to a significant extent, based on recent modeling.

Alteration styles within the host geology are complex and comprise diverse and localised alteration packages associated with different lithologies. Diorite and microdiorite intrusions exhibit propylitic (chlorite/carbonate/± epidote) alteration of varying intensity with strong development associated with stockwork zones and increasing in intensity toward skarn contacts. Weak to strong phyllic alteration is also widespread and occurs as sericite-silica-pyrite alteration within the diorite and sediments. Stockwork vein associated sulphide phases within intrusive bodies are also associated with weak to strong sericite-silica alteration. No significant potassic alteration is associated with the KTL deposit and only minor secondary biotite is observed in the core. Prograde altered calc-silicate skarns contain mainly garnet and pyroxene and typically show an outward progression from diorite to brown-red garnet skarn to green-yellow garnet skarn to marble to limestone. Massive magnetite skarn occurs when the host rock has undergone complete replacement of the original mineral assemblage by magnetite.

Base and precious metal mineralisation at KTL is considered to be coeval with stock emplacement. Re-Os age dating from vein hosted molybdenite returned an age of 289.4 ± 1.0 Ma. Mineralisation occurs as several styles. Low to moderate grade Cu-Mo-Au mineralisation is typically hosted in multi-phase stockworks and sheeted quartz-sulphide veins, and as disseminated and aggregate mineralisation within and proximal to intrusive stocks. High grade Cu-Au is associated with banded and semi-massive to massive sulphides hosted within prograde and more typically retrograde altered calc-silicate and magnetite-pyrrhotite-pyrite exo-skarn. Skarn hosted mineralisation is more common and significantly higher in grade within exoskarn compared with endoskarn, the latter typically comprising mainly garnet skarn varieties. Dominant sulphide minerals for both styles are pyrite, chalcopyrite and pyrrhotite with less common molybdenite, bornite, sphalerite and galena. Secondary copper within the supergene profile is weakly developed throughout the deposit and occurs mostly in the form of malachite with lesser chalcocite and rare chrysocolla.

The deposit is at the pre-feasibility evaluation stage with additional drilling to upgrade the resource base.