

BAN HOUAYXAI

Exploring and developing mineral deposits in northern Lao PDR: The Ban Houayxai gold-silver deposit

Abstract

The Ban Houayxai project is a narrow vein, structurally controlled gold-silver deposit of Permo-Carboniferous age (285Ma) in the north of the Lao People's Democratic Republic. Mineralised veins are predominantly hosted within intermediate volcanics which have been subject to greenschist facies metamorphism and structurally juxtaposed against a siliciclastic package of probable lower metamorphic grade. The siliciclastic package contains mineralisation hosted within bodies of volcanoclastic siltstone and volcanogenic sandstone. The grade of mineralised veins (quartz + pyrite \pm carbonate \pm base metal) within the Ban Houayxai deposit generally increases with increasing intensity of deformation. Mineralised veins are sparsely distributed, very rare in outcrop and occur within poorly defined zones which can be difficult to identify in drill core.

The Ban Houayxai gold-silver deposit was first identified as a gold prospect during regional stream sediment sampling and follow up surface soil geochemistry in the mid 1990s. The nature of the mineralisation and the complexity of the structure controlling the mineralisation were not established for some time because the initial drilling was largely shallow reverse circulation drilling. As a result, a non optimal drilling orientation was selected which now accounts for approximately 25% of the diamond drill hole dataset. Primary mineralisation below the oxide and transition zones was not investigated until late 2000 but has since been shown to be extremely prospective.

Estimated to contain over 1.4Moz of gold and 8.9Moz of silver at the time of writing, the Ban Houayxai project is the third mineral resource that has been defined within the Contract Area currently held by Phu Bia Mining Ltd in the Lao People's Democratic Republic. The Ban Houayxai project has the potential to produce over 100,000oz of gold per annum, in addition to silver credits, from the oxide and transition components of the deposit over a minimum six year mine life. The Lao People's Democratic Republic remains relatively unexplored for mineral deposits using modern exploration techniques. The lack of exploration combined with the presence of known resources and deposits, particularly copper and gold, is why Lao People's Democratic Republic is regarded as one of the most prospective countries for mineral resources in Southeast Asia.

Introduction

The Ban Houayxai (BHI) Gold (Au) – Silver (Ag) deposit (18°55'N Lat and 102°40'E Long, 750m Elevation) is located in the Lao People's Democratic Republic (Lao PDR), Southeast Asia. Located approximately 100km north of the capital Vientiane (220km by road), the BHI project is 25km west of the Phu Kham Cu-Au mine, now operated by Phu Bia Mining Limited (PBM) (Figure 1). PBM takes its name from the highest mountain in Lao, Phu Bia, while the BHI deposit is named after the nearest village of the same name. The BHI deposit forms a prominent well vegetated relatively narrow 1.8km north-south trending ridge, which is flanked by low lying hills to the east and the west.

The BHI deposit was discovered in the period between 1994 and 1997 by PBM in what was then a joint venture between Normandy Mining Ltd and Anglo American Asian Pty Ltd. Prior to 1994 very little mineral exploration had been undertaken within Lao PDR, including the existing PBM Contract Area. Mineral exploration to date has been limited to minor copper and tin extraction by the French during colonial rule, and regional reconnaissance campaigns by the British Geological Survey and the Vietnamese Geological Survey in the 1980s and early 1990s. The former USSR, in conjunction with the Government of Lao PDR and Lao PDR Department of Geology and Mines, created a department called the Special Enterprise Centre, which during the early 1980s created a 1:500,000 geological map of Lao PDR and investigated several gold anomalies.

PanAust Limited, an Australian publicly listed company, currently owns 90% of the shares in the Lao PDR company PBM while the Government of Lao PDR has recently exercised its option to acquire a 10% interest. PBM has a Mineral Exploration and Production Agreement (MEPA) with the Government of Lao PDR which permits the company to explore for, develop and mine mineral deposits, within the 2,606km² PBM Contract Area, currently the largest metals exploration lease in Lao PDR. The initial PBM Contract Area, which originally covered 500km², was granted to PBM by the Government of Lao PDR on the 26th January 1994 (Wroe 1997).

The BHI Au-Ag deposit is currently the focus of a Feasibility Study that is due to be completed in December 2009 with results to be reported in March 2010. The BHI Feasibility Study, which commenced in March 2009, is assessing the viability of developing and mining the oxide and transition resource of the BHI deposit as an open pit operation with the aim of producing 100,000oz Au per annum over a minimum six year mine life (PanAust Limited 2008). The aim of this paper is to provide a summary of the discovery, development and current geological understanding of the BHI Au-Ag deposit.

Geology

The BHI Au-Ag deposit is hosted within a Permo-Carboniferous volcano-sedimentary basin package that has been subject to polyphase deformation and regional metamorphism (Figure 2). LA-ICPMS U-Pb zircon ages for the volcanics within the BHI deposit have returned age dates of 286±4Ma and 283±4Ma (Manaka 2008). The PBM Contract Area is thought to be located near the interpreted intersection of the Loei and Truongson Fold Belts, which with the Sukhothai Fold Belt, make up a large part of mainland Southeast Asia (Manaka 2008). Each of the three fold belts are characterised by geologically distinct volcanic and plutonic rocks (Khin Zaw et al. 2007). The BHI deposit is presently considered part of the northwest trending Truongson Fold Belt, however additional work is required in the greater Southeast Asia region to better define the geological setting, tectonic framework, and metallogenic potential.

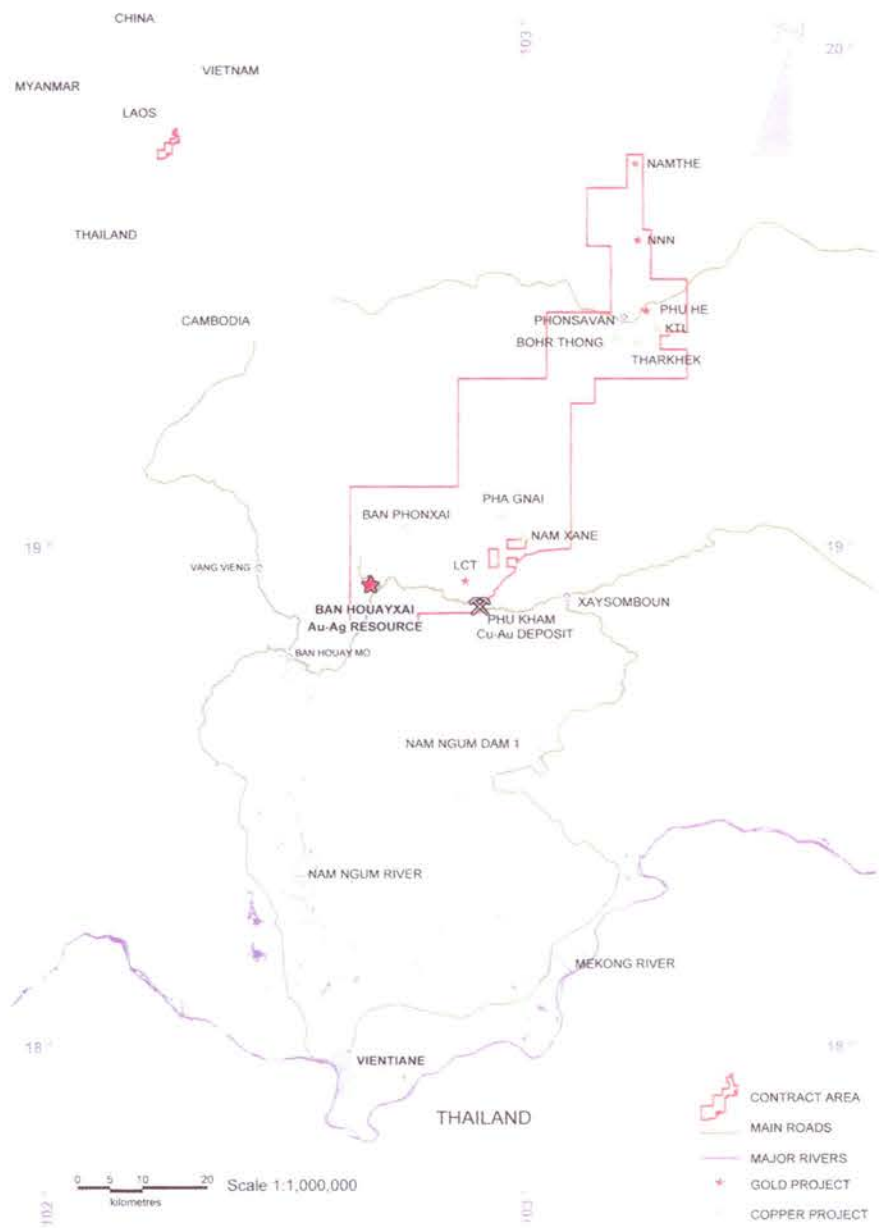


Figure 1: Location map showing Ban Houayxai Deposit and PBM contract area

BAN HOUAYXAI

The weak to moderately foliated dark green volcanic package, which also contains units of volcanoclastic siltstone and carbonaceous shale, is dominated by fine grained poorly welded ignimbrites and tuffs. Lesser porphyritic andesitic flows exist as indicated by the presence of subhedral feldspar phenocrysts (1-3mm) and relict quartz-carbonate filled amygdales (1-3mm). The ignimbrites and tuffaceous units generally contain an abundance of what are interpreted to be relict glass and crystal shards which have been noted to exhibit a pseudofiamme texture, as per the classification of McPhie, Doyle and Allen (1993 p30). Small lithic fragments (3-5mm) are also present within the ignimbrites and tuffaceous units. All volcanic units exhibit a moderate to well developed chloritic groundmass which is interpreted to be the result of greenschist facies metamorphism. The sedimentary units within the volcanic package are generally massive volcanoclastic siltstones with occasional thin beds (3-10mm) and very rare accretionary lapilli. The thickness of individual siltstone units may vary from several metres up to one hundred metres. Correlating individual volcanic and sedimentary units of the volcanic package has proven quite difficult, largely because of overprinting deformation.

The volcanic package is interpreted to have been fault emplaced by a low angle normal fault (F1) as indicated by the juxtaposition of greenschist facies metamorphics against a siliciclastic sedimentary package. The siliciclastic are interpreted to have been subjected to very low, undeterminable at the time of writing, metamorphic grades (Figure 3). Holcombe (2009) has interpreted F1 to potentially represent a regional scale detachment fault.

The siliciclastic sedimentary package is dominated by a pale brown to green arenitic sandstone in which subrounded to rounded pebbles and cobbles are regularly distributed throughout a sandy matrix. The increasing abundance and size of polymictic clasts result in relatively thin lenses of poorly sorted conglomerate within the greater arenitic sandstone. Bedding is a common feature of the siliciclastic although younging direction indicators are very rare. The varying intersection angles of bedding and foliation in outcrop indicate a complex fold system within the siliciclastic package which may in part be influenced by proximity to local faulting (i.e. drag folds). The orientation of foliation within all units is generally 50-60° to the north.

A distinctive member of the siliciclastic package is a dark grey arkosic sandstone which has been inundated by narrow and irregular medium to coarse grained feldspar-quartz dykes (several centimetres to several metres). The dykes are generally moderate to strongly porphyritic in their appearance with the moderate to strongly foliated sericitic groundmass indicating the dykes are likely to be syntectonic (Holcombe 2008). Foreign phenocrysts are regularly identified within the matrix of the arkosic sandstone indicating that the dykes have broken up during their emplacement. The distribution of these dykes effectively defines the prominent north-south trending ridge which contains the BHI deposit.

The F1 fault, which juxtaposes the volcanic package against the siliciclastic package, is offset by a low angle (40-50°) undulating north dipping thrust, F2. The F2 thrust is a relatively continuous structure at the deposit scale with a zone of strong cleavage development in the immediate hanging wall. The F2 thrust appears to be also responsible for the emplacement of a distinctive chlorite-rich volcanic breccia unit in which sub-angular lithic fragments (10-150mm) become strongly aligned within the prominent shear fabric (Figure 3). (This volcanic breccia is a volcanic unit that can be correlated at the deposit scale given its characteristic textural features. It also lacks veining and is effectively barren of mineralisation). There is good evidence to suggest multiple F1 and F2 surfaces and/or splays (i.e. the apparent dismembering of F1); F1 and F2 as described here are the dominant structures that can be mapped at surface and in cross section.

Both F1 and F2 are offset by F3 faults which are west-northwest subvertical north block down structures varying texturally from angular breccia to gouge dominant depending on which lithology they intersect. The F3 structures are considered to be relatively high level (Holcombe pers comm.) and are generally surrounded by a lead halo. A cluster of F3 structures, representing an inferred structural corridor, occur in the southeast of the deposit (Figure 2). Mesoscopic north-south striking subvertical F4 structures, only identified in drill core, are not thought to have impacted significantly on the geometry of the deposit.

A relatively large body of limestone and a package of moderately to strongly foliated red siltstones and sandstones bounds the deposit to the west and east respectively. The relationship of these units to the volcanics and siliciclastics is yet to be determined. It is uncertain whether the contacts of these units represent a structural or stratigraphic contact.

Mineralisation

Attempts have been made by previous workers to classify the BHI deposit as epithermal in style (i.e. Manaka 2008). However, with a lack of diagnostic vein textures and mineralogy and further work required, the BHI deposit is termed here a structurally controlled narrow vein Au-Ag deposit.

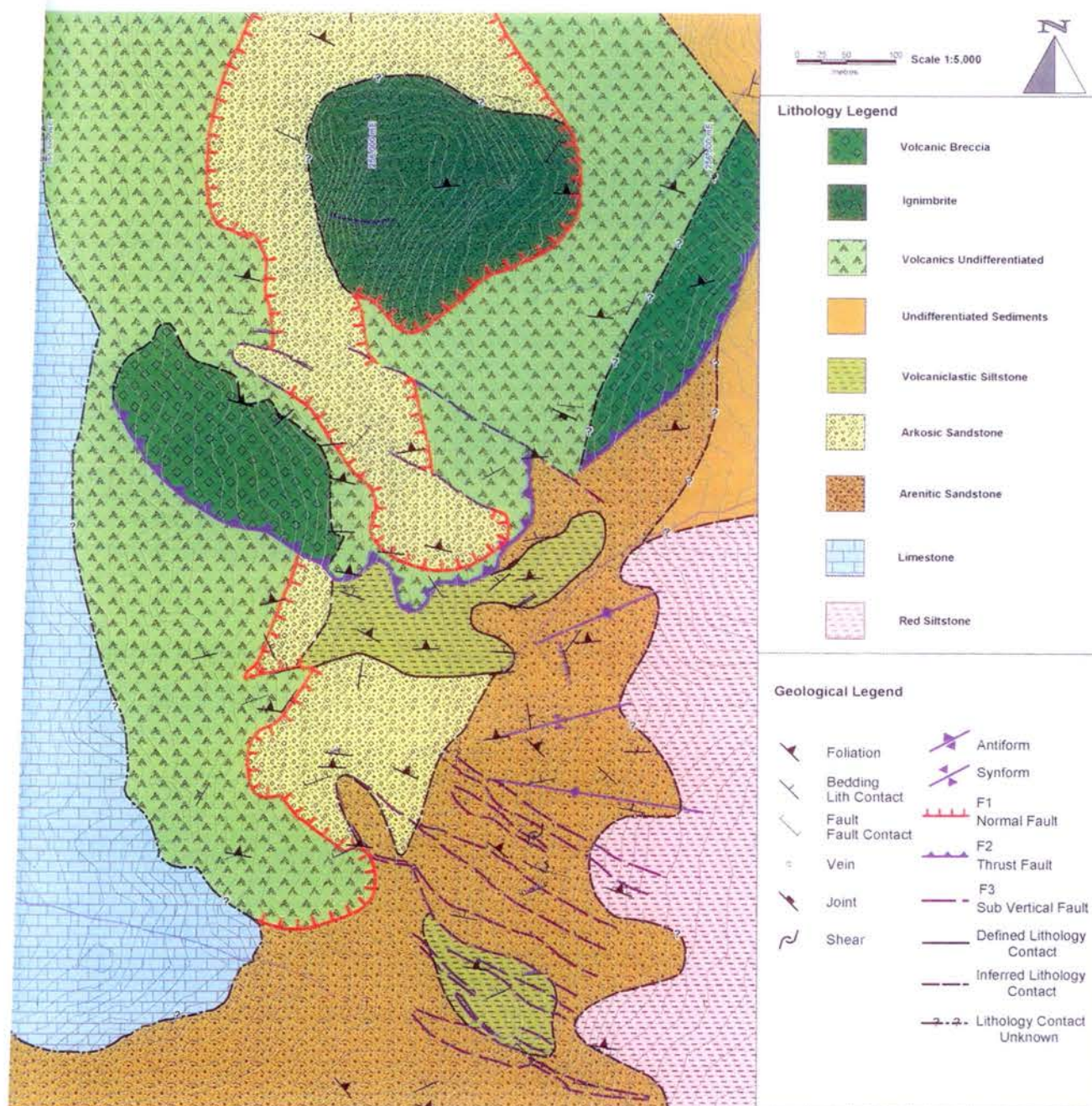


Figure 2: Geological surface map of the BHI deposit (August 09)

There are two styles of mineralisation currently recognised within the BHI deposit;

- Vein hosted Au-Ag
- Sediment hosted Au-Ag

Mineralised veins (quartz + pyrite ± carbonate ± base metals ± electrum) are predominantly hosted within the intermediate volcanics, and to a lesser extent within the arkosic sandstone, where they are sparsely distributed within poorly defined zones of variable width (metres to tens of metres). There appears to be a general relationship between increasing grade of the veins and increasing deformation. The highest grades (10-70g/t Au and 50-700g/t Ag) generally occur within what is termed Quartz Vein Breccia, although these veins are relatively narrow (0.5-1m), and possibly steeper (80-90°) in orientation, compared with the broader moderately north dipping vein zones which are generally also much lower grade (0.5-10g/t Au and 1-20g/t Ag). The vein packages are typically dominated by what are termed Undifferentiated Quartz Veining (5-10mm) which, although mainly consisting of milky coloured quartz, may contain relatively small discontinuous pods of carbonate along the centreline. Textural features of the more deformed veins include internal brecciation, two-tone coloured quartz (milky white and grey)

BAN HOUAYXAI

and the presence of an overprinting network of hairline quartz veinlets. A stereonet analysis of Undifferentiated Quartz Veining orientations in orientated drill core suggests that there are two orientations; north-northwest and north-northeast. Both vein sets are moderately dipping ($45-55^\circ$) to the north and mineralised although the latter appears to be marginally higher in grade (Figure 4). Mineralised veins are believed to be extensional in nature and formed in response to normal faulting (F1) (Holcombe 2008).

Sulphides within the mineralised veins are weakly disseminated; pyrite is dominant with pale brown sphalerite, galena, chalcopyrite and arsenopyrite generally occurring as rare accessories. Electrum (100 to 800 μ m) is the dominant form of mineralisation occurring as inclusions in pyrite and as free grains (Manaka 2008). Native gold is interpreted in some veins based on visible mineralogy and the Au:Ag ratio for the interval. Native silver (50 to 200 μ m), although not common, forms as inclusions in pyrite and also as free grains while stephanite has been confirmed by microprobe (Manaka 2008).

The mineralisation phases and control within the interpreted sediment hosted mineralisation are not as well established as those within the mineralised veins. Sediment hosted mineralisation has only recently been recognised as a potential mineralisation style within the BHI deposit. The most prominent form of sediment hosted mineralisation occurs within silica-clay altered volcanoclastic siltstone that appears to be a member of the siliciclastic package. Disseminated pyrite is very fine grained and generally very low in abundance (0.5%), rare galena and sphalerite have been also observed. The mineralisation within the silica-clay altered volcanoclastic siltstone is relatively high grade (1-5g/t Au and 10-30g/t Ag) and generally very continuous. The apparent in situ brecciation of the silica-clay altered volcanoclastic siltstone appears to have upgraded the mineralisation within this unit (i.e. in the southeastern extent of the deposit area) and the relationship between grade and deformation may be similar to that of the vein hosted mineralisation.

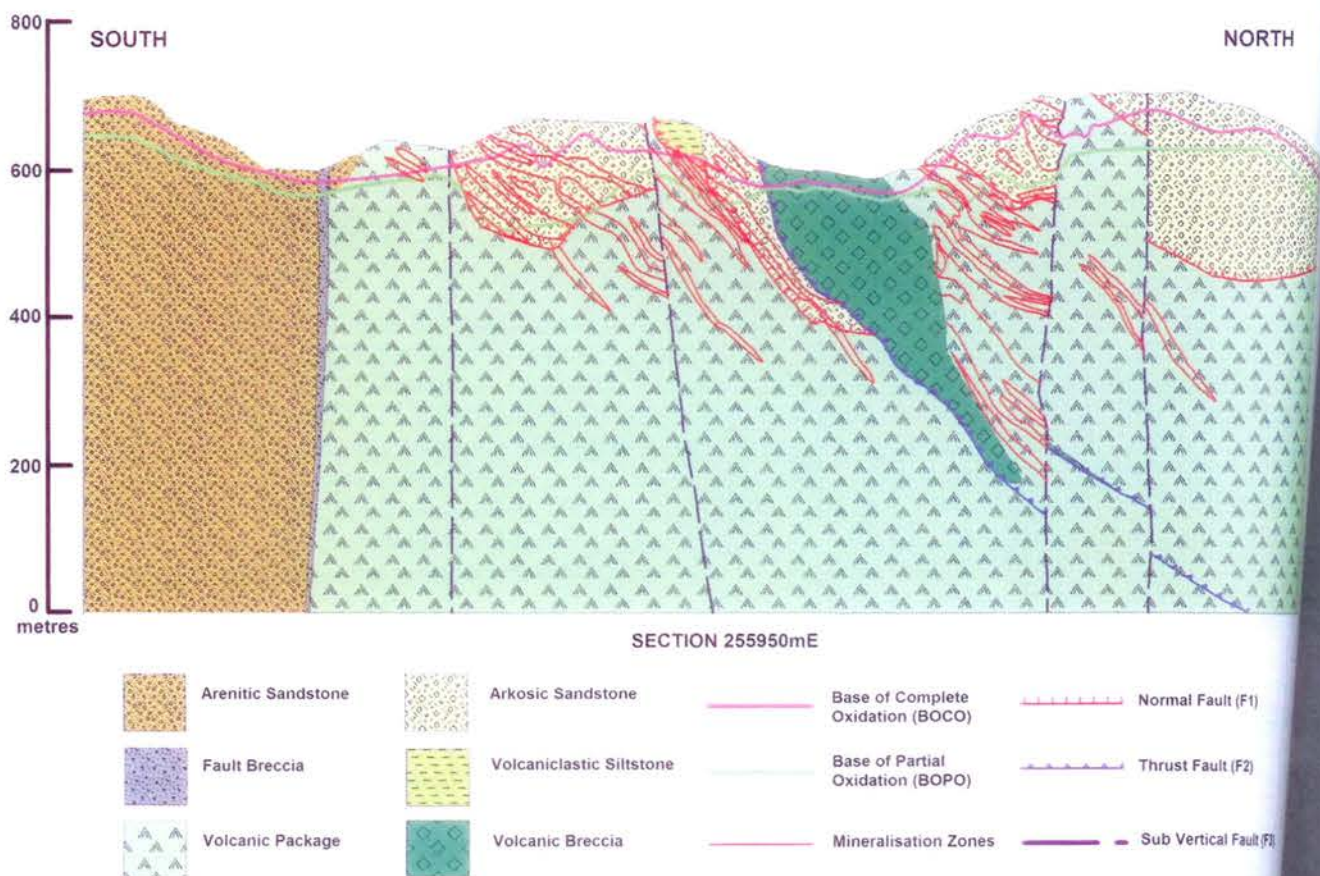


Figure 3: Geological cross section (255950mE) through the BHI deposit

A secondary mineralisation target is the colluvium which has been shed from the prominent north-south trending ridge containing the BHI deposit. The colluvium profile, which is best developed in the low lying valley to the west of the deposit, varies from 1-10m in thickness and has consistently returned grades above 0.5g/t Au during drilling although single sample values of up to 146g/t Au (HRC184) have been reported. The colluvium is yet to comprise any part of the BHI resource, however given the size of the area and potential for shallow mineralisation, the colluvium but is likely to be investigated with ongoing exploration.

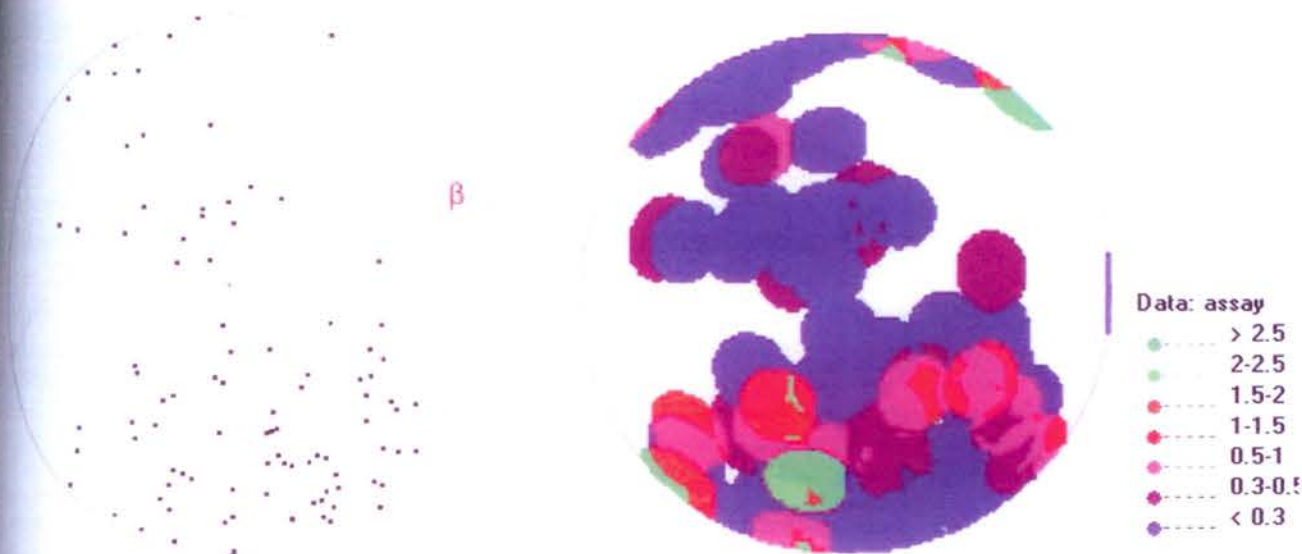


Figure 4: Equal area projection of poles to undifferentiated quartz veins for the highest two categories (3 and 4) of orientation reliability as per the PBM orientation classification system. The stereonet on the left is poles to vein orientation only while the stereonet on the right is a contoured mean classification plot where the Au assay value from the interval in which the vein occurs has been assigned to the vein which has been measured

Exploration history

A chronological overview of the discovery and exploration of the BHI deposit is provided below.

1994-1997: Discovery

The BHI deposit was identified as a gold anomaly by BLEG (-1mm) sampling during a regional stream sediment survey undertaken in the mid 1990s by PBM, then a joint venture between Normandy Mining Limited and Anglo American Asia Pty Ltd (Wroe 1997). In addition to the BHI gold anomaly a number of other gold, copper, lead and zinc anomalies were identified within the PBM Contract Area through a combination of BLEG sampling and -80# stream sediment sampling. The BHI gold anomaly was defined by two BLEG samples collected in single tributaries on either side of the prominent topographic ridge. The BLEG sample to the east reported 13.2ppb Au and 23ppb Ag while the sample to the west returned 99.8ppb and 183ppb Ag. Samples within the BLEG dataset greater than 20ppb Au were considered highly anomalous while values less than 2ppb Au were deemed background (Patterson 2004). BLEG samples were analysed for Au, Ag and Cu while the stream sediment samples were analysed for Cu, Pb, Zn, Ag, As, Sb, Fe, Mn, Ba and Hg (Wroe 1997).

Based on the BLEG results, ridge and spur soil auger sampling (50m spaced point samples to an approximate depth of 0.5m) was completed over the ridge from which the anomalous tributaries drained (Wroe 1997). The soil program defined a broad 1.1 x 1.3km area of anomalous gold in soil using a contour value of 0.1ppm; a total of 606 soil samples were collected with a peak value of 1.04g/t Au and 20 samples above 0.5g/t Au (Johnson 2002). In addition to Au, Wroe (1997) reported that anomalously high Pb and As were also geochemical features of the BHI soil anomaly. One hundred and eighty rock samples (grab) were collected during the discovery period with 53 samples returning greater than 0.1g/t Au. However, with the exception of a single highly anomalous 20g/t Au outcrop sample, the majority of rock chip samples were less than 0.5g/t Au (only 6 samples were above 0.5g/t Au with no sample greater than 1.5g/t).

During the period October-December 1997 PBM tested the surface geochemical anomaly (Au, As and Pb) at the BHI prospect with 9 vertical scout diamond drill holes (HSD01-HSD09) using a small man portable rig capable of BQ coring. Five of the 9 drill holes within the surface geochemical anomaly, including the first hole HSD01, returned gold values >1g/t Au (up to 10.1g/t Au). The best intersection of the program was reported within HSD03 which returned 100m (0-100m) @ 0.74g/t Au and 5.63g/t Ag including 41.5m (8.7-50.2m) @ 1.23g/t Au and 5.04g/t Ag. On the basis of these results additional scout drilling was recommended by Wroe (1997).

The element suite assayed during the scout program was Au, Ba, Bi, Cu, Fe, Hg, Mn, Mo, Pb, Sb, Ti, Zn, Ag and As by methods unknown. The peak Ag value for the scout drilling program was 134g/t with a number of weak to moderate Ag numbers being returned for mineralised Au samples. The economic potential of Ag at the prospect appears not to have been fully considered at the time. In a summary provided by Johnson (2002), for work per-

respect to or scout diamond drilling data. At the end of 1997 the joint venture operators of PBM, Normandy Mining Ltd and Anglo American Asia Pty Ltd, abandoned exploration activity.

2002: Exploration

PBM resumed activity at the BHI deposit in 2002, however the Lao company was now being operated as a joint venture arrangement, formed in 2001, between Pan Mekong Exploration Ltd (80%), a fully owned subsidiary of Pan Australian Resources Limited (later to become PanAust Limited) and Newmont South East Asia (20%).

Nineteen RC holes (HRC001-HRC019) were completed in May-July 2002, 17 being vertical and 2 inclined at -60° toward the east and west (holes abandoned), to a nominal depth of 60m on east-west traverses on an approximate 50m x 50m spacing. The holes were deemed infill/extension holes around the previous scout holes, testing the original soil geochemical anomaly and the potential for oxide mineralisation (Johnson 2002). Seventeen of the 19 RC holes returned mineralised intersections above the cut off value of $\geq 0.3\text{g/t Au}$ with many holes ending in mineralisation. Gold was the only element assayed for during the program.

Deposit and reconnaissance geological mapping was undertaken in conjunction with rock chip (channel) sampling; the first known geological map was produced from this mapping aided by air photo (black and white) interpretation. The geological mapping utilised vehicle access development and subsequent outcrop exposure. A north-northwest trending target zone was identified with an interpreted strike length of 1300m and approximate width of 350m (Johnson 2002). Mineralisation was interpreted by Johnson (2002) as being related to the intrusion of quartz-feldspar porphyry which was deemed to share similarities in orientation to the target zone. Johnson (2002) identified mineralisation to be hosted in stockwork and low angle veining, both of which were noted to be relatively low in abundance. A disseminated style of mineralisation within sericite-silica altered volcanic marginal to porphyry occurrences was interpreted. The possibility of supergene enrichment and the presence of mineralised material within the colluvium to the west were identified (Johnson 2002). An epithermal style system was postulated as a deposit model although it was acknowledged by Johnson (2002) that the quartz textures within veins were not necessarily diagnostic of an epithermal environment.

2003-2004: Exploration

In June 2003 the first two diamond holes since 1997 were completed by PBM under an ongoing joint venture arrangement between Pan Mekong Exploration Ltd (80%) and Newmont South East Asia (20%). The shallow diamond holes were dedicated metallurgical holes with all core sampled. The holes were orientated -70°/090°; this orientation appears to have been selected based on the north-northwest target zone identified by Johnson (2002).

Exploration activity was increased at the start of the 2003 dry season (October – April). An additional 46 RC holes (HRC020-HRC076) were completed on a dedicated 25m x 25m grid in the area of greatest drilling density to further investigate the potential of oxide gold mineralisation. With the exception of a single 100m hole, no vertical hole was drilled deeper than 60m during this program, Au was the only element assayed for.

Some shallow vertical step out holes were completed, however the majority of the drilling was within the previously identified zone of oxide mineralisation. At that stage PBM was focused on establishing an oxide gold inventory across a number of prospects within the southern portion of the Contract Area. The BHI deposit was considered just one of a number satellite oxide targets that would form part of the Phu Bia Gold Project. It was planned that oxide material from the satellite operations would be treated at a central heap leach facility located at the Phu Kham deposit which contained a substantial (oxide) gold cap (Pan Australian Resources 2004).

Three shallow 20m diamond holes HDD003-HDD005 (2 vertical and 1 inclined -60/000) were completed in January 2004 for additional metallurgical test work. A geological review was completed by Tate (2004) who concluded that the style of mineralisation was a combination of stockwork vein and dissemination which, in conjunction with interpreted porphyry style alteration, reflected the distal expression of an unusual porphyry copper-gold type system. In addition to a dominant steep north dipping foliation, Tate (2004) identified a possible thrust at the deposit scale and postulated that the veining may have formed in response to movement on that structure.

A maiden resource estimate was completed for gold only given that silver had not been assayed for. A mining licence was approved over the BHI deposit area on completion of the Phu Bia Gold Project Feasibility Study in July 2004 (PanAust Limited 2008). No further approvals were required, other than the acceptance by the Government of Lao PDR of a Feasibility Study and Environmental Social Impact Assessment (ESIA) (PanAust Limited 2008).

2006: Scoping study

Minimal exploration activity was undertaken in the dry season of 2004/2005 while the company focussed on developing the Phu Kham Cu-Au deposit. In 2005, Pan Mekong Exploration Ltd exercised its option to acquire the remaining 20% interest in PBM from Newmont South East Asia. As a result Pan Australian Resources, through Pan Mekong Exploration Ltd, became the 100% owner of PBM, with the Government of Lao PDR having the right to acquire a 10% interest (Pan Australian Resources Limited 2006).

The focus of the company shifted somewhat in 2006 and the BHI oxide resource was considered for the first time as a potential standalone operation. As a result, a drilling program consisting of 151 vertical RC holes (HRC077-HRC227) were undertaken between April and July 2006. The aim of the program was to improve confidence in the existing indicated and inferred oxide resource while also testing the extent of the oxide and transition mineralisation at limited distances along strike. This drilling program would ultimately form the basis for a revised geological model and Scoping Study, which was undertaken late in 2006. Previously untested soil anomalism was targeted on the west flank of the deposit with limited success. A small program of 8 RC holes (HRC228-HRC235) completed late in 2006 confirmed that the soil anomalism and earlier drilling results had in fact intersected mineralised colluvium. Gold, by 50g fire assay and AAS finish, was the only element analysed. A 0.2g/t trigger was used for determination of cyanide soluble Au and Cu using an agitated cyanide leach and AAS finish.

Buoyed by encouraging drilling results and an increase in confidence and size of the resource, the BHI Scoping Study considered three potential production scenarios for the BHI deposit (PanAust Limited 2008);

- Mining the BHI deposit as a satellite operation and transporting ore to the existing heap leach operation at Phu Kham;
- Building a new, stand alone heap leach operation to treat the BHI ore locally; and
- Building a new Carbon in Pulp or Leach (CIP/CIL) processing plant and Tailings Storage Facility (TSF) in close proximity to the BHI deposit.

2006-2007: Exploration

Following a review of the drilling data gathered in the first half of 2006 and the completion of the BHI Scoping Study it was decided that the 2006-2007 dry season (October-April) would be dedicated to testing the potential of the primary mineralisation beneath the oxide-transition resource with 6 relatively deep (200-300m) diamond drill holes (HDD006-HDD011). For the first time since the 1997 scout drilling campaign that drill holes were routinely analysed for elements other than Au, namely Ag, Cu, Pb and Zn.

The revised geological model retained the concept of a structural control on the distribution of mineralisation with a west dipping, north-south striking sub-vertical fault, approximating the orientation of the prominent north-south trending ridge, and offset by a number of northeast striking faults (Tate, 2006). In light of the geological model all drilling was orientated -60°/090° which was perpendicular to the interpreted and most prominent controlling structure. Each drill hole of the initial 6 hole program intersected significant mineralisation (individual two metre samples returned values of up to 71.2g/t Au (HDD007)), which supported the growing concept of a broad low grade mineralised envelope encompassing high grade mineralised shoots (Tucker, 2007). The results of the limited assay suite suggested that there was potentially significant Ag present within the oxide, transition and primary zones. Issues were identified with the PBM orientated core and data collection procedures during this time which affected the integrity of structural and geological data in early diamond drilling (Cairns 2006).

With the success of the initial 6 holes testing the primary zone another 9 holes (HDD012-HDD020) were completed in the same orientation (-60°/090°) during the second half of the 2007/2008 dry season (January-April). All holes intersected significant Au and Ag mineralisation and provided continuity in the existing geological and mineralisation model.

Ridge and spur soil auger sampling was undertaken in late 2006 in an area that was later to become the BHI North prospect. The soil geochemical anomaly identified the potential for Au and Ag mineralisation given the similarities in values to soil auger samples collected as part of the BHI ridge and spur soil auger program while subsequent RC drilling confirmed this. Limited work has been undertaken since late 2006 and the BHI North prospect remains largely underexplored.

2007-2008: Pre-feasibility study

In late September 2007, following the wet season (May-September), diamond drilling recommenced to infill the existing 100 metre (east-west) by 200 metre (north-south) drill pattern in the primary zone to a nominal 100m x

BAN HOUAYXAI

100m spacing. Seventeen diamond drill holes (HDD021-HDD037) were completed in the orientation -60°/090°. This drilling indicated sufficient continuity of mineralisation within the primary zone at the 100m x 100m drill spacing and was the trigger for PBM to proceed with a Pre Feasibility Study on the viability of developing the BHI deposit, including the primary zone, as a standalone mining and processing operation.

During the construction of drill pads and access tracks as part of this infill program a zone, of sub-vertical north dipping veins was exposed; veins within the zone were observed to be striking approximately east-west. Sampling of these veins, in conjunction with routine channel rock chip sampling, returned grades of up to 195g/t Au and 1210 g/t Ag. This was the first time high grade mineralisation had been observed in surface exposure and marked a significant turning point in the understanding of the BHI deposit.

To test the hypothesis that the east-west orientated vein system was the main host for mineralisation three diamond drill holes, HDD038, HDD039 and HDD041, were drilled to the southeast (-60°/135°). All holes intersected significant Au and Ag mineralisation (up to several metres exceeding 1g/t Au). In light of these intersections, and in an effort to gather an understanding of the greater structural framework within the PBM Contract Area, a specialised structural consultant was engaged in February 2008 to complete a preliminary structural analysis of the BHI deposit.

Following a review of historical data, drill core and existing outcrop exposures, it became apparent that the easterly orientated drill holes had effectively been drilled along strike and not perpendicular to the orientation of the mineralisation (approximately east-west, with a moderate to steep northerly dip). In addition to determining the orientation of mineralisation Holcombe (2008) made a number of other structural observations which were significant in advancing the understanding of the BHI deposit;

- The main controlling structures within the BHI deposit strike east-west with a moderate to shallow northerly dip;
- The strong topographic relief within the project area has a significant effect on the surface map pattern of the shallowly dipping structures;
- There is no major north-south structure within the deposit which would justify drilling east orientated holes;
- The mineralised veins are associated with distributed shear around an early Permian basin forming fault (and subsidiary faults); and
- Vectors for mineralisation are proximity to normal faults, commonly marked by foliation development.

The remainder of the 2007/2008 dry season (October-May) was spent drilling south orientated drill holes (-60°/180°), commencing with HDD047, in an effort to complete a uniform wide spaced southerly orientated drill pattern across the area still considered prospective for primary mineralisation.

A new three dimensional geological and mineralisation model was produced in August 2008 reflecting the revised structural interpretation. The revised geological model and subsequent resource estimate, which for the first time included Ag following a re-assay program of historical pulps in storage (36.0Mt @ 1.2g/t Au and 7.7g/t Ag; Table 1), formed the basis for the BHI Pre Feasibility Study. The BHI Pre Feasibility Study which was completed in October 2008 and concluded that the most viable means of developing the BHI deposit as a profitable standalone open pit mining operation was to focus on the oxide and transition component of the resource which could sustain production of >100,000oz Au per annum over a minimum mine life of at least 6 years (PanAust Limited 2008).

A wide spaced soil grid over the deposit and surrounding area (200m spaced north-south lines with sample points spaced at 50m east-west along those lines) was completed in March of the 2007/2008 dry season. The aims of the soil program were to;

- Test the results of the soil program undertaken by previous workers given that there was limited information available on various aspects of the program in particular analytical techniques and QAQC;
- Establish the geochemical footprint of the deposit;
- Identify any additional prospective areas within the immediate area.

The March 2008 soil program identified a previously unknown area of Au anomalism approximately 400m to the southeast of the existing resource (Figure 5). Two lines of wide spaced 70m deep RC drill holes, drilled at -60°/135° (HRC236-HRC270), were completed on the eastern flank of the BHI deposit to follow up the previously untested

areas defined by soil anomalism. Significant mineralisation was intersected in the final holes of that program in the southeast with HRC268 and HRC270 intersecting 58m (14-72m) @ 0.99g/t Au (8.4g/t Ag) and 72m (0-72m) @ 0.94g/t Au (6.0g/t Ag) respectively.

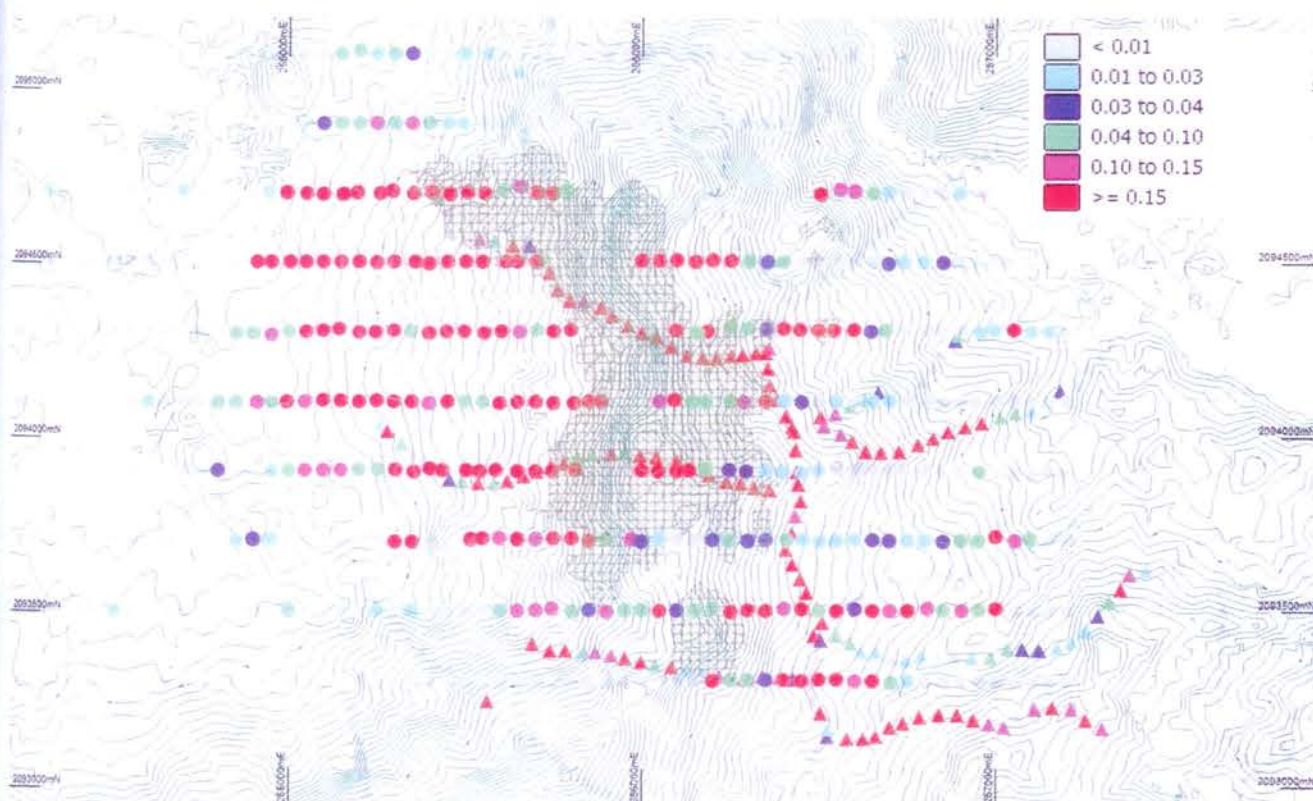


Figure 5: Geochemical footprint, as defined by Au in soils, of the BHI Au-Ag deposit (triangles: Historical and circles: 2008 programme)

2009: Feasibility

A decision was made in February 2009 to complete a Feasibility Study on developing the oxide and transition component of the BHI Au-Ag deposit in line with the conclusions of the 2008 BHI Pre Feasibility Study.

One hundred and thirty drill holes, diamond (HDD074-HDD141; 75%) and reverse circulation (HRC271-HRC332; 25%), were completed as part of the BHI Feasibility drilling program. The aim of BHI Feasibility drilling program was to complete a nominal 50m x 50m grid pattern within the oxide and transition zones across the optimal pit defined as part of the BHI Pre Feasibility Study, thereby increasing the confidence in the resource within this area. Although the oxide and transition zones were the ultimate target of the drilling program, selective diamond drill holes were drilled into the primary zone across the deposit to test the mineralisation potential given the success of deeper diamond holes during the period 2006-2008.

All drill holes were orientated -60°/180° to achieve the best intersection of the moderate north dipping mineralised vein set. A key geological observation that came from systematic analysis of all drill holes by the project geologists was the general rule that vein hosted mineralisation appeared to increase with increasing deformation of the vein. This observation became more valid when brecciated volcanoclastic siltstone in the southeast of the deposit, which was identified during the 2008 program, returned some of the highest, consistent grades and widths within the entire deposit (e.g. HDD138 106m @ 2.15g/t Au, 34.6g/t Ag).

Additional structural analysis was completed following the successful work completed during the BHI Pre Feasibility Study. In conjunction with surface remapping, and better definition of the lithology and vein types (enhanced by the change from two metre sampling to one metre sampling), a revised three dimensional geological model was produced. The model incorporated a detailed topographic survey which was deemed absolutely necessary for the accuracy of the resource estimate given the very steep topography. In an effort to expand on classical exploration methods an orientation survey was undertaken using PIMA to investigate potential alteration assemblages otherwise masked by the intensive chlorite, the results of this survey were pending at the time of writing.

An aspect which greatly assisted the BHI Feasibility drilling program and contributed to the revised geological model, was the updating in March 2009 of the PBM Geology Department field technical and data collection pro-

BAN HOUAYXAI

cedures. As a result surface and drilling data became more detailed, easier to collect and of better quality than previous exploration programs undertaken across any of the prospects within the PBM Contract Area.

The new geological model, completed in September 2009, indicated that the BHI deposit still remains open for vein hosted oxide, transition and primary mineralisation to the west and northwest and at depth. The model also indicated continuity of mineralisation within the primary zone. The location of additional mineralised intersections within the primary zone supports the need for additional systematic drilling across the deposit and current drill planning is focussed on the primary zone target.

Resources

The most recent resource estimate for the BHI Au-Ag deposit (August 2008) was classified and reported in accordance with the JORC code (2004). A summary of the resource estimate is presented in Table 1.

Drilling in the central area of the oxide zone is on a nominal 25m x 25m grid spacing with the majority of the Measured resource component falling within this area. Drill hole spacing in the primary zone generally ranges from 50m to 100m and at depth the spacing between holes is in the order of 80m to 120m. The majority of the Measured and Indicated resource is currently constrained to the oxide and transitional zones while most of the primary resource is classified as Inferred.

Table 1: BHI Resource estimate (PanAust 2008). A revised estimate, as part of the BHI Feasibility Study was in progress at the time of writing

Mineral resources	Category	Tonnes (Mt)	Gold grade (g/t)	Silver Grade (g/t)	Gold in-situ (000 oz)	Silver in-situ (000 oz)
	Measured	6.0	1.0	6.1	190	1,200
	Indicated	10.7	1.0	8.2	340	2,800
	Inferred	5.6	1.1	4.4	190	800
	Sub Total	22.3	1.0	6.7	740	4,800
	Measured	-	-	-	-	-
	Indicated	0.3	1.3	7.2	10	70
	Inferred	13.4	1.5	9.4	660	4,100
	Sub Total	13.7	1.5	9.4	670	4,170
	Measured	6.0	1.0	6.1	190	1,200
	Indicated	11.0	1.0	6.1	350	2,870
	Inferred	19.0	1.4	7.9	850	4,900
	Total	36.0	1.2	7.7	1,410	8,970

Leasing and government

PBM commercial rights and obligations for operating in Laos are dictated by the Mining Exploration and Production Agreement (MEPA). Under this agreement PBM has enjoyed a long, fair, and profitable partnership with the government and people of Lao PDR. The original MEPA was settled in 1994, but has undergone several amendments since then, which address changes to the land tenure area through relinquishment/acquisition, and revisions to tax and royalty payments. Highlights of the existing MEPA include:

- Land tenure currently more than 2600km2 and a right to exchange land-for-land in future relinquishment/acquisition deals
- The duration of the MEPA will exist for 30 years following the establishment of each new mine.
- Right to minerals includes gold, silver, and all base metals (copper, lead, zinc, nickel, and tin), but excludes iron ore and hydrocarbons
- 1% import duty, exempt export duty
- Exempt from business turnover tax / VAT / similar taxes
- 25% corporate income tax, 8 year loss carried forward

- 10% Expat income tax, expats recruitment as required
- International accounting system allowed
- Dispute resolution by UNCITRAL Arbitration Rules
- MEPA overrides any new laws

PBM enjoys unprecedented support for its operations in Laos, including establishment of a private ferry crossing for haulage across the Mekong River to Thailand, exemption to existing road weight limits, and in-principal approval to open new mines, (e.g. Ban Houayxai). The Government of Lao PDR has the right to obtain up to 10% share of PBM through investment, and at the time of writing is in discussions with PBM to exercise this right and begin contributions.

Nam Ngum 2 Dam

An immediate issue facing the BHI project is the inundation of the Nam Ngum 2 Dam which is scheduled to commence in mid 2010. A challenge facing PBM exploration in the southwest quadrant of the Contract Area is the relocation of local villages due to the inundation of the Nam Ngum 2 Dam. The relocation of some 16 villages will affect the existing casual employees, which represent a significant proportion of the trained workforce. The creation of the Nam Ngum 2 Dam will leave the prominent north-south trending ridge, containing the BHI deposit, as a promontory within the dam lake with both adjacent valleys inundated to 375mRL at high water. The high water mark has been taken into account in all future planning for the BHI project and ongoing exploration activity. The Nam Ngum 2 Dam will also separate BHI from the BHI North prospect. The BHI North prospect has shown encouraging evidence for gold and silver mineralisation in shallow RC drilling and surface soil sampling, both of which require follow up prior to inundation. The development of the Nam Ngum 3 power station and the Nam Ngum 2 Dam are projects of national interest that will result in the development of hydropower for domestic use and international sale.



Figure 6: Inundation plan of the Nam Ngum 2 Dam within the immediate area surrounding the BHI project

BAN HOUAYXAI

Staffing

At the peak of field activity during the 2009 Feasibility drilling program, and with 5 drill rigs in operation, the Exploration Camp housed 160 people, including PBM employees and associated contractors. The operation supported a total workforce of over 220 with up to 60 employees commuting from local villages on a daily basis (Table 2). PBM strives to, and encourages its contractors to employ and train local residents in various aspects of the daily field operations. This arrangement has proven successful over the years of operation at not only the project but also across various projects/prospects within the PBM Contract Area. One of the many advantages of having a nearby established mining operation, such as the Phu Kham Cu-Au mine, is the exposure to resources and training to further develop local employees and exploration projects. The PBM workforce has a female contingent comprising 32% of the total workforce, of which two thirds are from local villages (19% of the total PBM workforce). PBM sees it as very important to promote equal opportunity for employment within its exploration projects and source employees, from the immediate local communities where there is limited employment opportunity particularly for females.

Table 2: Staffing at the BHI exploration camp

BHI camp staffing – current	
Local Lao employees	65% of total PBM employees
Other Lao employees	30% of total PBM employees
Expatriates	5% of total PBM employees

Unexploded ordnance (UXO)

The Lao National Unexploded Ordnance Programme (UXO LAO) regards Lao PDR as the most bombed nation per capita, in the world. It is estimated that approximately two million tonnes of ordnance were dropped by US States bombing missions during the period 1964-1973 in an effort to combat North Vietnamese forces. Of the ordnance dropped by these missions it is estimated by UXO LAO that approximately 30% did not explode. In addition to air bombing numerous episodes of military ground fighting also occurred within various areas of Lao PDR during this little known period of the Vietnam War.

UXO poses a problem, not only for exploration activity, but more importantly for the daily life of the Laotian people in various areas across the PBM Contract Area. The BHI deposit is no exception and UXO clearance by specialised contractor clearance teams is regularly required as it is in many of the prospect areas in which PBM operates. In an effort to assist the local villages within the vicinity of active prospect areas, PBM clears contaminated ground of UXO as a service to the community. This often has many socio-economic benefits including the resumption of agricultural activity and the construction of schools and community centres that may not have been possible without UXO clearance.

Conclusions

The following conclusions are drawn from the case study of the BHI Au-Ag deposit presented above, many of which will be important in the search for additional mineral deposits within the PBM Contract Area;

- The primary component of the BHI deposit remains highly prospective for Au-Ag mineralisation but will require deeper close spaced diamond drilling to establish continuity. The definition of the BHI Au-Ag resource has provided a good indication of potential deposit scale within the PBM Contract Area.
- Stream sediment sampling and soil sampling are very good surface geochemistry techniques in exploring for mineralised deposits in the mountainous terrain of northern Laos PDR. Systematic soil sample grids are cost effective and a proven method for establishing the geochemical footprint of a mineralised system. Gold, silver, arsenic and lead are pathfinder elements associated with the style of mineralisation identified at the BHI deposit. An earlier identification of the high grade area in the southeast of the BHI deposit may have completely changed the dynamics of the BHI project during initial evaluation thereby fast tracking exploration and development.
- Surface mapping, even of advanced prospects/deposits, is paramount in establishing all aspects

of geological control which was shown to be the case at BHI. The development of strategic access tracks, particularly along topographic contours, is a very good way of exposing in mountainous areas such as BHI.

- The financial outlay of diamond core drilling and multi element analysis may initially appear expensive however it can be very beneficial in reducing exploration expenditure as the project evolves by means of optimal drill spacing, drill orientation and better targeting through an understanding of the geology and mineralised system.
- A drilling program is only as good as the data produced from developing sound technical procedures and encouraging a technical ethos. The geological database and field technical procedures are evolving entities that require ongoing maintenance and improvement. Likewise, the importance of historical reporting and drilling information should never be overlooked when assessing the potential of a prospect/deposit.
- It could be argued, with the BHI deposit as an example, that conceptual thinking, drawn from genetically classifying deposits, actually inhibits exploration rather than advancing progress. A considerable amount of work remains in establishing the tectonic setting and metallogenic potential in Laos PDR and Southeast Asia as a region.

Acknowledgements

Shaun Versace, Shaun Richardson, Dan Brost and George Brech reviewed this paper and provided constructive feedback.

References

- Cairns, C.P., 2006. Observations on Orientated Core and Geotechnical Logging, Internal memorandum, unpublished, Ban Houayxai Geology Base.
- Holcombe, R.J., 2008. Phu Bia Projects, Laos Structural Appraisal February-March 2008, A report prepared for Phu Bia Mining Ltd, unpublished, Ban Houayxai Geology Base.
- Holcombe, R.J., 2009. Ban Houayxai, Laos Structural Appraisal June 2009, A report prepared for Phu Bia Mining Ltd, unpublished, Ban Houayxai Geology Base.
- Johnson, A.C., 2002. Ban Houayxai Gold Deposit Stage 1 Drill Program (May-July 2002) Report on Mapping Channel Sampling and Drill Hole Sampling Results, Internal report, unpublished, Ban Houayxai Geology Base.
- JORC, 2004. Australasian Code for Reporting of Exploration Results, Mineral Resources and Mineral Reserves, The Joint Ore Reserves Committee of The Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia (JORC).
- Khin Zaw, Meffre, S. and higher degree students 2007. Metallogenic relations and deposit-scale studies, Final Report, Geochronology, metallogenesis and deposit styles of Loi Fold Belt in Thailand and Laos PDR, ARC Linkage Project, CODES Centre of Excellence in Ore Deposits University of Tasmania.
- Lao National Unexploded Ordnance Programme (UXO LAO) 2008. Lao National Unexploded Ordnance Programme (UXO LAO), Vientiane, viewed 20 September 2009, <<http://www.uxolao.org>>.
- Manaka, T. 2008. Geological setting and mineralisation characteristics of the Long Chieng Track and Ban Houayxai deposits, Lao PDR, MSc. thesis, CODES Centre of Excellence in Ore Deposits University of Tasmania.
- McPhie, J. Doyle, M. and Allen, R. 1993. Volcanic textures: a guide to the interpretation of textures in volcanic rocks, Tasmania: Printing Authority of Tasmania.
- Pan Australian Resources, 2004. Pan Australian Resources Annual Report, Brisbane: Pan Australian Resources.
- PanAust Limited, 2008. Annual Report 2008, Brisbane: PanAust Limited.
- PanAust Limited, 2008. Phu Bia Mining Limited Ban Houayxai Gold Silver Project Pre-Feasibility Study Execu-

BAN HOUAYXAI

tive Summary, Internal Report, unpublished, Ban Houayxai Geology Base.

Patterson, J., 2004. Phu Bia Contract Area Summary of Previous Exploration and Recommendations for Further Work, Internal report, unpublished, Ban Houayxai Geology Base.

Tate, N.M., 2006. Ban Houayxai Geology Model Review, A report prepared for Phu Bia Mining Ltd, unpublished, Ban Houayxai Geology Base.

Tucker, B.A., 2007. Assay Results – Ban Houayxai DD Drilling Program, Internal memorandum, unpublished, Ban Houayxai Geology Base.

Wroe, J.A., 2007. Summary Technical Report for the Phonsavan Contract Area (January 1st 1994-31st December 1997), Internal report, unpublished, Ban Houayxai Geology Base.