Geology, mineralization and mining of the Selinsing gold deposit, West Pahang

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Bukit Selinsing is an elongated hillock trending 350° (measures 800 m by 400 m and is +152 m (+500 ft) high) and is composed of metamorphosed and partially sheared argillites with subordinate tuffaceous arenites, grit and conglomerate which strike between 340° to 350°. Bands of marble have been reported to occur at Bukit Selinsing and chlorite schists have been observed in waste rocks taken out of the old shaft (Mill's Shaft).

The epigenetic hydrothermal gold mineralization of Bukit Selinsing is located within a 50 m to 150 m wide 340° to 350° striking ductile-brittle shear zone which occupies the eastern half of the elongated hillock. The total mapped length of this mineralized zone is in excess of 500 m and continuations of this mineralized zone towards the north (which is known to stretch into the Buffalo Reef area, about 5 km northwards) and south of Bukit Selinsing outside the Selinsing mining lease have been observed.

The rocks in the shear zone is mainly composed of mylonites and a large proportion of it shows distinct s-c fabric. The foliations in these rocks dip mainly from 30° to 85° towards the east though some westward dipping foliations have been mapped. Mapping and petrographic evidence indicates that this shear zone was developed through progressive deformation. The initial deformation was ductile in nature and this caused mylonization of the phyllites, chlorite schists and meta-sediment. Later movements appear to be of brittle nature.

Several phases of silica and gold mineralization were interposed between the various deformation. Some of the quartz veins form porphyroclasts in the mylonite. Field evidence and petrographic studies of oriented sample collected from the field indicate that the shearing movements occur along the strike and along the dip direction. Sinistral movement is detected by one of us (RMY) while essentially normal movement with a minor strike-slip component was detected by another (PJJ).

The gold mineralization takes the form of auriferous quartz filling of fractures parallel, oblique and transverse to the strike of the shear direction of 340° to 350°. Thin mineralized quartz veins which have been deformed were observed to be incorporated into the sheared argillites, tuffaceous host rocks and conglomerates. Deformed quartz lodes are common and they are found as lenses (of up to 5 m thick) occurring obliquely to the strike direction of the shear zone. Small areas with thinner 'stockwork-like' mineralized quartz veins are found within the shear lenses of the more strongly dynamically deformed rocks. Simple planar veins parallel or sub-parallel or oblique/transverse to the strike direction of the shearing are also observed. These veins appear to be one of the latest in the quartz-gold mineralization process. It is noted that not all the vein quartz phases carry

Warta Geologi (Newsletter of the Geological Society of Malaysia), Vol. 21, No. 3, May-June 1995

Au-values even if they are found within the shear zone.

Gold is also found as dissemination in the silicified, pyritized and sericitized mylonites. Auriferous quartz may carry values from 5 g to 25 g/tonne of ore but the disseminated ores generally contain values from 1 g to 3 g/tonne. Mineralogically, the ores are composed overwhelmingly of fine to coarse-grained milky to light grayish quartz with minor pyrites, chalcopyrites, galena and tetrahedrite. The very fine gold particles in the ores (from <1 micron to a few mm) constitutes the main problem for the recovery of the gold from the weathered primary ores mined presently. It is estimated that the recovery using the present mill setup which is more suitable for alluvial-eluvial ores is no more then 60%.

The wall rock alteration accompanying the gold mineralization includes silicification, sericitization and pyritization. Silicification most often accompanied the earlier phase/s of mineralization where much quartz veining and deposition had occurred followed by deformation. Sericitization is pervasive and affected nearly all the rocks within the shear zone. Pyritization is a later phenomenon and may have accompanied one of the later phases of gold-sulphide-silica mineralization.

The Bukit Selinsing gold deposit had been intermittently mined since 1880 to 1939. On record, >31,000 troy ounces of Au had were recovered between 1887 and 1931. Mining resumed in the late 1980's and was targeted on the unworked alluvial ores, old mine tailings and the highly disturbed eluvial ores. With the exhaustion of these ores, the present mining operation is concentrating on the lower grade primary ores which were left behind from the previous mining operations. Ores of >2 g/tonne were selected based on easily observable field criteria such as quartz veining, silicification, pyritization (becomes intensely red when weathered) and sericitization or by field panning of crushed weathered rock sampled ahead of the mining face.

The ores together with the weathered rocks within the shear zone are dug up by hydraulic excavators and transported to the processing plant by trucks and dumped at the head of a hopper. Hard large lump pieces of ores (mainly auriferous quartz) are manually broken to below 15 cm. The ore mixtures are fed with the help of strong jets of water and a tractor-pusher which feed the ores into hopper-feeder of large tube/ball mills (1.5 m by 3 m) which disintegrate the softer materials and grind down the harder ores. The 12 mm under-size product of the mill is then distributed and fed into a 4-lane gold palong.

Cleaning of the palong is done daily or once in 2 or 3 days. The palong concentrates are washed down the trap doors located at the tail part of the palong and pumped up to be distributed onto shaking tables in the processing plant. The table concentrate are manually panned or concentrated by passing through the table a second time. The final concentrate of the gold is then dissolved using aqua regia and then the gold is precipitated using $NaHSO_3$. The filtered gold precipitates are torched with oxy-acetylene flame using borax and $NaHCO_3$ as flux and the gold melt is poured as mini gold bars of about 99.7 to 99.9% purity.

Much of the gold particles in the primary ores is very fine (from <1 micron to a few mm) and this constitutes the main problem for the recovery of the gold from the weathered primary ores mined presently. It is estimated that recovery using the present mill setup which is more suitable for alluvial-eluvial ores is less then 60%. The sandy tailings which were sampled and analysed gave gold content ranging from 1 g to 2 g/tonne. The gold in the tailings is present as very fine liberated particles as well as locked-gold in the generally coarser and difficult to grind vein quartz fraction of the tailings.

The Selinsing Gold Mine shows potential for development into a reasonable large open-pit, low-grade and medium-tonnage mine with proper evaluation and metallurgical studies. Evaluation can be carried out using reverse circulation (RC) drilling with some coring. The samples recovered during the coring and RC drilling can be analyzed for evaluating the ore body, then used for petrological study, followed by metallurgical and gold recovery studies. A cyanidization plant (for example CIP) may be required for effective recovery of the fine fraction of the gold particles and this probably would constitute the most difficult problem as approval for using cyanide in the recovery process from the Mines Department requires stringent environmental mitigation measures.