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The mineralogy of gold mineralization of the Ajmal Mine, Kechau Tui, Pahang Darul Makmur

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Abstract— The former Ajmal Mine, presently a limestone quarry, shows gold mineralization in its quartz veins. The veins are steeply dipping to the west, are fault related and may occur singly or in multiple as parallel veins in shear zones. The gold bearing veins are sulphide-poor. In some veins gold mineralization is associated with tetrahedrite. Galena-rich patches, carrying almost nothing else, may also be found in the gold bearing quartz veins but it is a late mineral. Texturally gold is fine-grained and is found in the quartz and in the tertrahedrite. Wall-rock alteration is hardly visible and the only type associated is silicification. From the mineralogy and wall-rock alteration it is likely that deposition occurred at a low temperature at a distance from the source of the mineralization.

Keywords: gold mineralization, mineralogy, Ajmal Mine, EPMA, tetrahedrite

INTRODUCTION

Ajmal mine is located in Kechau Tui, a small settlement about 50 km to the north of Kuala Lipis, on the main road leading to Gua Musang (Figure 1). This mine was actively working for gold in the 1980s. It was initially worked alluvial gold but towards the end of 1980s, as the placer gold reserves ran out, it was worked for primary gold using mills to crush the gold-bearing rocks. The primary ore mining venture did not prove to be profitable and after a short while, in 1998, instead of mining for gold, the former Ajmal Mine was turned into a limestone quarry. During the writer's last visit to the quarry in 2003, the gold-bearing quartz veins, with the mine adit at its foot, was still standing but the limestone wall adjacent to it was being slowly quarried.

GEOLOGY OF THE AREA

The Chegar Perah-Merapoh area was originally mapped by Richardson (1950). The lithologic sequence consists of limestone facies from Lower to Middle Permian interbedded with algillaceous units and towards the top is found the volcanics, termed the Pahang Volcanic Series. The sequence was assigned a Permian-Triassic age. Yin (1965) later named the Permo-Triassic calcareous sequence the Gua Musang Formation. The sequence was later intruded by granitic intrusives forming the Bukit Damar and Bukit Tujuh bodies.

Kechau Tui is underlain by limestone of the Gua Musang Formation. Ajmal Mine in particular is underlain by gray limestone of this formation. The sedimentary sequence is generally east-dipping. The limestone was interpreted as having being deposited in a shallow marine environment because of the presence of sedimentary features such as oolite (Kee, 1990; Rohana, 2003),

GOLD MINERALIZATION IN AJMAL MINE

Gold workings are well known in the Kechau Tui area. To the north-west, Sungai Tanum is known to have gold flakes in its river bed in Aur Gading. In 1989, there were two gold mines working the alluvium of the tributaries of

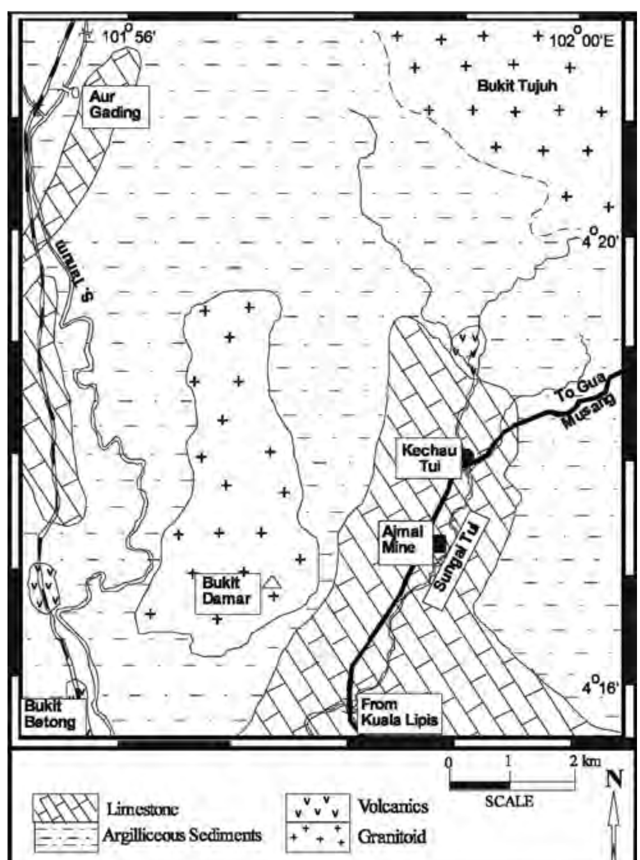

Figure 1: Geology of Kechau Tui area and the location map of Ajmal Mine.

Sungai Tui a few kilometers to the north of Ajmal Mine (Kee, 1990). Ajmal Mine was originally an alluvial mine working the alluvial ground of Sungai Tui. The pinnacled limestone bedrock offers many potholes that acted as traps where rich gold concentrates were obtained.

The primary gold mineralization in the area seems to be related to the igneous intrusions in the area. To the east is a small granite pluton named Bukit Damar and to the north-east is the Bukit Tujuh granite. The igneous intrusions were thought to have been emplaced in the Triassic-Jurassic period.

Primary gold mineralization in Ajmal Mine occurs as gold-bearing quartz veins transecting the Permian limestone bedrocks. The veins are generally steeply dipping to the west (at about 70^o) and fault-related. Some exist as single, 20-30 cm thick veins while others may exist as thin (a few cm) parallel veins in a shear zone (Figure 2). The faults strike approximately N-S and NE-SW.

There are two types of mineralized veins in this mine, viz., i) sulphide rich, gold poor quartz veins and ii) sulphide poor gold bearing quartz veins. The main gold mineralization occurs in N-S trending sulphide-poor veins. The sulphide in the sulphide-poor veins consists mainly of an olive-grey minerals later identified as tetrahedrite, galena and traces of chacopyrite and sphalerite. Gold is found in these veins, as little specks of free gold, in the white quartz away from the main galena mass and also as little specks in the tetrahedrite. In parts, there may also be patches of galena in these veins but the galena is a late mineral. The gold was deposited earlier in the quartz, and later, together with tetrahedrite.

The second type is the galena-rich quartz veins. Weathered galena appears as black material in the white quartz. Fresh surfaces show galena as medium grained, shining silvery gray scaly mineral that occurs by itself. There may also be specks of gold grains in these quartz veins but it occurs in the white quartz away from the galena. The galena rarely occurs with other sulphides. A close examination may also show the presence of a fine-grained off-white carbonate mineral together with the quartz. This carbonate, which effervesces on contact with acid, and is clean and fine-grained, probably brought together with quartz by the mineralizing solution. Micro-veinlets of galena may cut both the quartz and the carbonate indicating that galena is a later mineral.

Gold itself appears as minute specks in the quartz and in the tetrahedrite sulphide, but is rarely present in the galena-rich part. It seems that early gold was deposited together with the early quartz in the veins. A second generation of gold was brought together with tetrahedrite. The galena bearing late solution seems to have been depleted in gold.

MICROSCOPIC STUDY

Native gold is observed in two occurrences, viz. in white quartz and in the tetrahedrite. In both, gold is more common in the tetrahedrite-bearing quartz veins rather than the galena-rich variety. Sulphides consist of two major components, viz. galena and tetrahedrite. Galena seems to appear at a later stage in the mineralization, and does not carry much gold, other than some small gold specks observed in the galena-rich part. In the same vein, whenever there is galena, gold specks may appear in the white quartz but not in the galena-rich part.

Polished section study shows galena as the main sulphide in the galena-rich sample and other sulphides are rarely found. In the tetrahedrite-rich sections, tetrahedrite is the main mineral together with some chalcopyrite and sphalerite engulfed by galena. Tetrahedrite boundaries in contact with the galena are rounded, convex-outwards, indicating that it has been corroded by galena and that tetrahedrite is the earlier mineral. Gold somehow appears in the tetrahedrite only and rarely in the galena.

In the quartz, gold occurs as free disseminated grains along microfractures. Its grain size is fine, seldom exceeding 1 mm. In the tetrahedrite gold appears as minute grains normally less than 1 mm maximum dimension. It appears as anhedral blebs between tetrahedrite grains and as a later mineral to tetrahedrite, as it occupies spaces between tetrahedrite grains, in places replacing parts of the earlier mineral boundary (Figure 3). Tetrahedrite in turn is an earlier mineral than galena.

Polished section study under electron microanalyser (EPMA) revealed the presence of new minerals not recognized under an ore microscope. The common mineral recognized in the section is galena. The olive-grey mineral described by Cheang (1988) as tetrahedrite, is a Cu-Sb sulphide, poor in As, and was correctly identified as tetrahedrite. Less common minerals observed in minute amount are the telurides, probably petzite, and unrecognized Pb-As sulpho-salts (Figure 4).

WALL-ROCK ALTERATION

Wall-rock alteration is hardly visible. One would expect development of new minerals at the vein quartz-limestone contact and to see calc-silicate minerals, but no such development occurs. At the vein quartz-limestone contact, there is a narrow transition zone where the white colour of quartz is gradually changed to gray colour of limestone. An XRD analysis of a sample taken at the contact shows dolomite as the main mineral followed by quartz and calcite (Norhasfiza, 2003). The only wall-rock alteration one might expect is silicification with the addition of fine quartz to the limestone. The absence of well-defined wall rock alteration is indicative of low temperature of the hydrothermal mineralizing fluid.

DISCUSSION

Gold mineralization in Ajmal Mine is significantly different from that of Penjom or Rusila (Gunn, 1994; Heru Sigit, 2002) in mineralogy as it contains less arsenopyrite and pyrite. In the latter phase of deposition Ajmal gold-

Figure 2: Gold bearing quartz veins in Ajmal Mine.

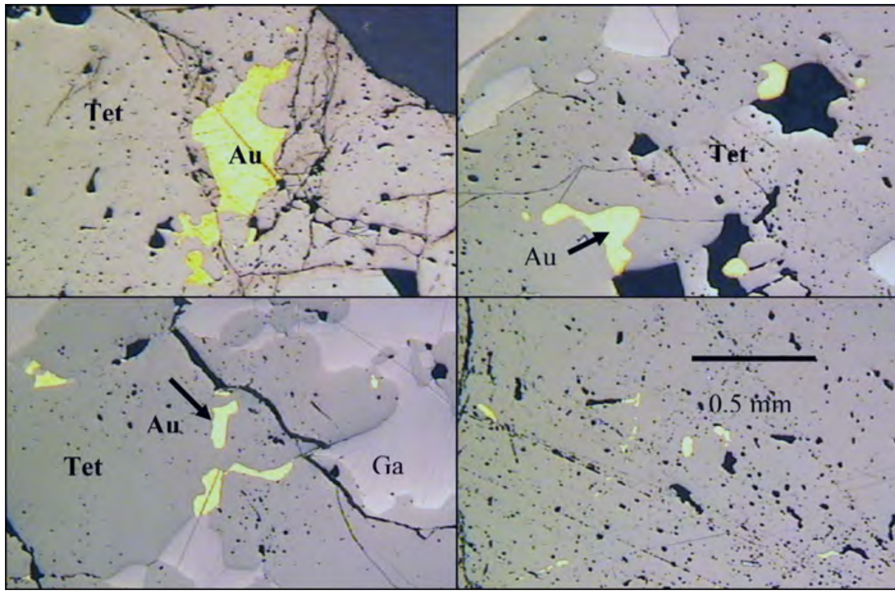

Figure 3: Photomicrographs of polished sections of gold in tetrahedrite, uncrossed nicols. Au is gold, Tet is tetrahedrite, Ga is galena.

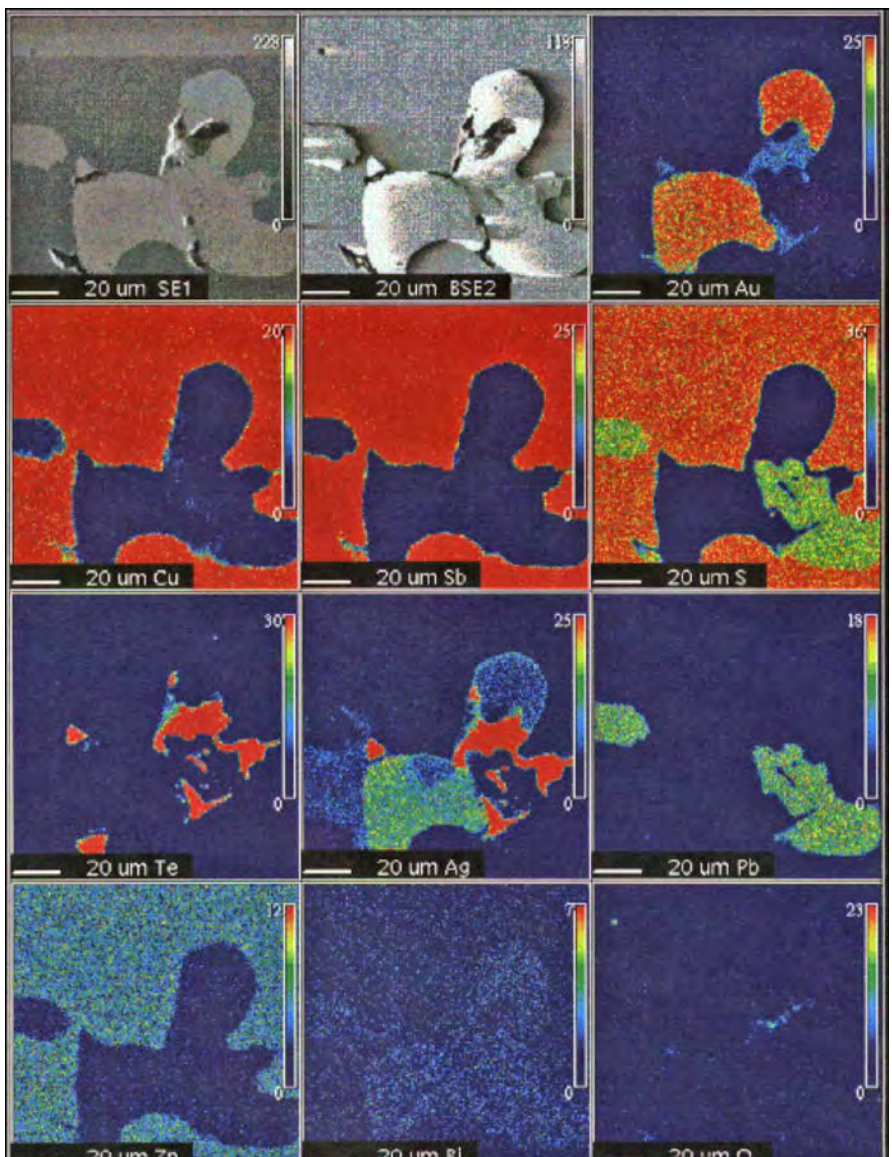

Figure 4: Electron Probe Microprobe Analysis (EPMA) of Ajmal Mine gold ore. Note the presence of Au and Ag of native gold, Te-Ag-Au in petzite. Native gold is associated with tetrahedrite (Cu-Sb-S) and galena (Pb-S).

bearing quartz veins are invaded by galena-bearing solutions which carry no gold. Mineralogical differences reflect the differences of the source content, temperature and chemistry of the hydrothermal solution. But as a class, the gold mineralization in the Ajmal Mine is not different from those of Penjom, Lubuk Mandi and many other primary gold mineralizations in the Peninsula.

Absence of well-define wall-rock alteration suggests a low temperature of deposition and the aqueous nature of the mineralizing solution. At low temperature there would be less interaction between the reactive calcareous rock and the aqueous solution and only a weak silicification was recognized.

The olive-gray sulphide was correctly identified as tetrahedrite by Cheang (1988). The EPMA image of the present analysis indicates Sb as the major component and only traces of As to justify it as tetrahedrite and the inclusion of its As end-member is unnecessary.

There is plenty of a carbonate mineral in the hydrothermal solution as evidenced by the presence of carbonate together with the white quartz in the gold-bearing vein. This carbonate is identified as dolomite by XRD (Norhasfiza, 2003). Its role in mineralization was not fully emphasized until recently, e.g. by Lowenstern (2001) who suggested that the presence of CO_2 aid the process of metallogenesis including gold.

CONCLUSION

The gold mineralization in the Ajmal Mine is a variation of the primary gold mineralization style found in Peninsular Malaysia. Fine-grained native gold is found in clean quartz veins in association with tetrahedrite and some galena, chalcopyrite and sphalerite and petzite. The late phase of mineralization carrying galena is poor in gold.

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