Type deposits of primary gold mineralization in the Central Belt of Peninsular Malaysia

WAN FUAD WAN HASSAN & HERU Sigit PURWANTO

Program Geologi, Universiti Kebangsaan Malaysia
43600 Bangi, Selangor, Malaysia

Abstract: A study of gold mineralization of the Central Belt of Peninsular Malaysia was made, based on fluid inclusion, mineralogy and field observations. The gold mineralizations in the Central Belt can be divided into three types, viz., gold mineralization in quartz veins, gold mineralization in massive sulphides and gold mineralization in skarn. Of the three types, gold mineralization in the quartz veins is the most dominant and being actively mined while the others are limited and of less economic importance. Gold mineralization in quartz veins is distributed from Batu Melintang, Panggung Lalat in Kelantan, through Tersang, Selinsing, Kecau Tui, Penjom and Raub in Pahang to Gunung Ledang in Johor. This mineralization has two styles, viz., gold together with sulphides and gold together with base-metal and carbonate. Fluid inclusion studies indicate that gold-bearing quartz veins in Central Pahang are formed at 50–1,500 m depth, at a temperature range of 100–350°C and salinity of 0.5–4.8 wt% Gold-bearing quartz veins are steeply dipping fault and shear zones trending roughly north-south. Common associated sulphide minerals are pyrite and arsenopyrite white galena, chalcopyrite, sphalerite, tetrahedrite, stibnite and cinnabar are occasionally observed at certain localities. Gold mineralization in massive sulphide is found in Manson’s Lode, Sokor, Kelantan and Tasik Chini in Pahang and its common associated minerals are galena, pyrite, sphalerite, chalcopyrite, pyrrhotite and hematite. This type of gold mineralization was once mined and is regarded as a Kuroko-type massive sulphide, formed in an underwater marine environment. Gold mineralization in skarn is not economically important and has been traced in Sungai Sok, Kelantan. The types of primary gold mineralization in the Central Belt are exemplified.

INTRODUCTION

Most gold deposits are characterized by mineral association, e.g. pyrite, chalcopyrite, arsenopyrite, sphalerite and galena. Gold mineralizations in the Central Belt of Peninsular Malaysia contain sulphide minerals, related to sheared quartz veins and breccia. Gold is present in quartz veins and not observed to be disseminated in wall rocks. Auriferous vein systems are structurally controlled. Among structural controls are: (1) spatial distribution along reverse fault; (2) syn- to late timing relative to the ductile-brittle deformation; (3) lateral fault and sheared zone. In the present study samples from Sokor, Kecau Tui, Tersang, Selingsing, Raub and Penjom were analysed.

GOLD MINERALIZATION IN CENTRAL BELT

The Central belt is the richest gold-bearing belt of Peninsular Malaysia (Fig. 1). In this belt, the distribution of gold mineralizations stretches from Batu Melintang near the Malaysia-Thai border in the north through Sokor, Panggung Lalat and Gua Musang in Kelantan through Selinsing, Kecau Tui, Penjom and Raub in Pahang and ends in Gunung Ledang, Johor. The gold mineralization episode appears to be related to the intermediate intrusives rather than acid Triassic granites. In most cases the host rocks for the mineralizations are volcano-clastics, limestone and metasedimentary rocks.
From the nature of the occurrences gold mineralizations in the Central Belt can be divided into three main types: 1) Gold in quartz veins, 2) Gold in massive-sulphide, and 3) Gold in skarn. Gold in quartz veins is the most widespread, and typical examples are found in Tersang, Selinsing, Kecau Tui, Raub and Penjom. Gold in massive-sulphide is well recognized in Manson’s Lode, Kelantan, while the Lake Chini massive-sulphide in Pahang is probably similar. Gold in skarn is mentioned from Sok base metal prospect (Teoh et al., 1987) while a similar occurrence is found in Mengapur, Pahang in Eastern Belt. Of the three types, presently primary gold is only actively mined from quartz veins.

Gold mineralization in massive-sulphide

Manson’s Lode, Sokor

The deposit is lense-shaped and follow the bedding of volcano-metasedimentary rock. It is expressed on the surface as limonitic and manganiferous gossan. Teoh et al. (1987) described it as a manto-type body. The gold mineralization occurs in the massive sulphide consisting of galena, sphalerite, chalcopyrite, pyrite and pyrrhotite and hematite. Tonnage was estimated at 165,770 tonnes of Pb-Zn sulphide assaying 296.7 g/t Ag and 44.7 g/t Au (Rajah, 1970; Teoh et al., 1987). Bedding of volcano- sedimentary rock is
Gold mineralization in quartz veins

**Kecau Tui**

The Kecau Tui gold mineralization occurred in sheared quartz zone and quartz veins in limestone wall rock. The mineralization is structurally controlled by right lateral fault and sheared zone (200°–220°/70°) and tensional fractures 290°–310°/80°. Wall rock alteration that envelopes the quartz veins is dominated by K-feldspar, muscovite–carbonate. Associated sulphide minerals observed are abundant galena and traces of pyrite, chalcopyrite and a silver-grey sulphide identified by Cheang & Zulkifli (1988) as tetrahedrite. Gold occurs as free gold and in crystal lattices of the tetrahedrite. In this mine gold abundance is unrelated to galena occurrence as gold grains are observed in clean, milky-white, galena-free part of the quartz, and gold is not observed in galena-rich veins.

Fluid inclusion study from quartz veins associated with gold mineralization gave a temperature range 150–300°C with a salinity of 0.7–1.1 wt% and the depth of formation from 50–1,000 m (Table 1). This information gives the type deposit of gold mineralization in Kecau Tui as sheared quartz sulphide and carbonate gold deposits (Fig. 3).

**Tersang**

The gold mineralization in Tersang occurs in sheeted quartz veins trending generally 300°/70° and stock work system (Fig. 3). Mineral associations observed are pyrite, chalcopyrite and arsenopyrite although Lee et al. (1986) mentioned the occurrence of scheelite and cinnabar. The country rocks for gold mineralization in Tersang are volcano-clastic and sedimentary rocks. Wall rock alterations are silicification, argillization and minor chloritization usually near quartz vein. Geochemical analysis of a sample showed high copper (Cu) and minor lead (Pb), zinc (Zn) and silver (Ag). Fluid inclusion analyses of a quartz vein showed gold deposition took place at a temperature range of 200–285°C, salinity 0.9–1.1 wt%, and depth from 200 m to 850 m (Table 2). From the available data, type deposit for Tersang gold mineralization is interpreted as sheeted
Table 2. Fluids inclusion analysis from quartz vein in Tersang (Sample: HFL 08/01).

<table>
<thead>
<tr>
<th>No.</th>
<th>Tm °C</th>
<th>NaCl wt%</th>
<th>D (m)</th>
<th>P (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>211.5</td>
<td>1.077</td>
<td>208.01</td>
<td>19.5</td>
</tr>
<tr>
<td>2</td>
<td>211.5</td>
<td>1.077</td>
<td>208.01</td>
<td>19.5</td>
</tr>
<tr>
<td>3</td>
<td>228.7</td>
<td>0.6</td>
<td>298.14</td>
<td>27.07</td>
</tr>
<tr>
<td>4</td>
<td>238.0</td>
<td>0.6</td>
<td>356.46</td>
<td>32.02</td>
</tr>
<tr>
<td>5</td>
<td>238.0</td>
<td>0.5</td>
<td>356.46</td>
<td>32.02</td>
</tr>
<tr>
<td>6</td>
<td>248.0</td>
<td>0.6</td>
<td>433.22</td>
<td>38.06</td>
</tr>
<tr>
<td>7</td>
<td>285.5</td>
<td>0.6</td>
<td>833.28</td>
<td>69.01</td>
</tr>
</tbody>
</table>

Figure 5. Type deposit model of gold mineralization in Selingsing, Pahang.

Selingsing

Mineralization in Selingsing occurs in right lateral fault zone, about 10–20 m wide trending 185°/80°. The dominant thickness of quartz veins in the fault and sheared zones range from 2 cm to 20 cm. The sulphide minerals in the vein are mainly pyrite with traces of chalcopyrite and galena. A narrow alteration envelope is dominated by K-feldspar, albite or muscovite (sericitation). Wall rock alterations are silification, argillization and chloritization. Gold mineralization was not observed in the wall or country rock. Fluid inclusion in quartz veins associated with gold mineralization shows a salinity range of 0.5–1.1 wt%, formation temperature range of 150–290°C and depth of formation at 100–850 m (Table 4). Based on above data gold deposit in Selingsing is of sheared quartz sulphide type (Fig. 3).

Penjom

In Penjom gold mineralization occurs in quartz vein, sheared and lateral fault zones in bedrocks composed of volcanic and sedimentary rocks which in some places are carbonaceous. The volcano-clastics and sedimentary sequence is cut by microgranite and dacite intrusion, known locally as felsite. Major structural trends are aligned in N-S (355°–005°) and NE-SW (035°–045°) and controlled the gold mineralization.

Intensive alteration observed around the quartz veins, intrusive rock and fault zone are silification, argillation and chloritization. Two styles of gold mineralizations are reported, viz., quartz sulphide and carbonate-base metal type. The quartz-sulphide type is associated with coarse pyrite and arsenopyrite (Kidd, 1988) whereas the carbonate-base metal type contains galena, sphalerite and carbonate mineral in the quartz veins. The carbonate-base metal type is the main gold mineralization event and it overprinted the earlier quartz-sulphide mineralization. Fluid inclusion analysis of a quartz vein associated with gold mineralization shows a salinity range of 1.8–4.8 wt%, temperature range of 190–270°C and depth range of 100–700 m. Based on the data obtained, the type deposit of gold mineralization in Penjom is interpreted as sheared quartz vein sulphide and carbonate gold deposits (Fig. 6).

Raub

The gold mineralization in Raub occurs in quartz shear zone, sheeted quartz vein and quartz breccia. The most dominant is the quartz shear zone, 20–200 cm wide with quartz sheets of 2–15 cm thick. The sulphide minerals in the quartz vein are pyrite, arsenopyrite, stibnite, scheelite and traces of chalcopyrite and cerussite. There is a narrow alteration envelope developed is dominated by K-feldspar, albite or muscovite (sericitation). Reconnaissance fluid inclusion study of a Raub vein sample showed the hydrothermal solution involved has a salinity range of 0.5–1.6 wt% NaCl, with a temperature range of 180–330°C and depth of formation range of 100–1,500 m. Based on the quartz veins are controlled by reverse fault generally trending 120°/50° and 360°/80° trending lateral fault (Richardson, 1939).
Wall rock alterations recognized are silification, argillization and chloritization. Based on the above data gold deposit in Raub area is interpreted as quartz sulphide type (Fig. 6), however Richardson (1939) suggested that the mineralization is somewhat related to the nearby Late Triassic Kajang granite.

**CONCLUSION**

Field observations and mineralogical studies in most of the localities indicates that gold is present in quartz veins (sheeted, sheared and brecciated) in association with volcanic intrusion and sulphide minerals. Gold mineralization is structurally controlled and accompanied by intensive wall-rock alterations. Temperature for gold mineralization in the Central Belt ranges about 150–350°C, with formation depth 100–700 m and fluid salinity of 0.5–4.8 wt% NaCl. Type deposits are usually quartz veins sulphide and carbonate gold deposits (Penjom, Raub, Selingsing, Tersang dan Kecau Tui). The type of deposit in Sokor is volcanic massive sulphide.

**ACKNOWLEDGEMENT**

We wish to record our appreciation to Project IRPA 02-02-02-0020 for the financial support in the study, and the Head of Geology Program, Universiti Kebangsaan Malaysia for the use of the facilities.

**REFERENCES**


Richardson, J.A., 1939. Geology and mineral resources of the neighbourhood of Raub, Pahang, Federated Malay States, with an account of the geology of the Raub Australia Gold Mine. Geol. Surv., FMS.