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Characterisation of amang minerals from the Klian Intan area, Upper Perak

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Abstract: Samples of amang were collected from Rahman Hydraulic Tin Mine, Klian Intan, Upper Perak, and its adjacent areas, for both physical and chemical characterisation. Results show that the amang from the Klian Intan area contain mainly arsenopyrite, pyrite, cassiterite, wolframite, rutile, zircon, and iron oxides. The main iron oxide present is hematite, which shows botryoidal texture and zoning. Goethite and gangue minerals replaced some of the hematite grains. Some of the arsenopyrite grains were replaced by covellite and scorodite, while the pyrite is mainly associated with quartz and wolframite. There are still valuable amounts of cassiterite in the amang from the Klian Intan area. Some of the cassiterite grains show exsolutions of tapiolite. Some are associated with sphalerite, pyrite, and wolframite. EPMA study has identified several new minerals, which have not been recorded yet in the Klian Intan amang. These include wittichenite (Cu_3BiS_3), bournonite ($PbCuSbS_3$), boulangerite ($Pb_5Sb_4S_{11}$), and possibly tsugaruite ($Pb_4As_2S_7$) and trippkeite ($CuAs_2O_4$).

Abstrak: Sampel–sampel amang telah dikutip dari Lombong Bijih Timah Rahman Hydraulic, Klian Intan, Ulu Perak, dan kawasan-kawasan yang berdekatan dengannya untuk pencirian sifat fizikal dan kimia. Keputusan menunjukkan bahawa amang dari kawasan Klian Intan mengandungi arsenopirit, pirit, kasiterit, wolframit, rutil, dan oksida-oksida besi. Okisida besi utama yang hadir ialah hematite, yang mempamerkan tekstur bergugus dan penzonan. Goethit dan mineral-mineral gang telah menggantikan sesetengah butiran hematite. Sebilangan daripada butiran arsenopirit telah digantikan oleh covellit dan scorodit sementara pirit pula didapati berasosiasi dengan quartz dan wolframit. Terdapat kuantiti kasiterit yang bernilai di dalam amang dari kawasan Klian Intan. Sesetengah butiran kasiterit yang hadir menunjukkan exsolusi tapiolit. Ada juga yang berasosiasi dengan sfalerit, pirit, dan wolframit. Kajian EPMA telah mengenalpasti beberapa mineral berat, yang belum direkod di dalam amang Klian Intan. Ini termasuk witichenit (Cu_3BiS_3), bournonit ($PbCuSbS_3$), boulangerit ($Pb_5Sb_4S_{11}$), dan kemungkinan tsugaruit ($Pb_4As_2S_7$) and trippkeite ($CuAs_2O_4$).

INTRODUCTION

Amang is a local term used for the middling by-product from treatment plants of tin mines. It is the heap of heavy minerals left behind in the tin mining areas after tin mining activities. Klian Intan, an active tin mining area, has good prospects as an amang minerals reservoir, which can generate further economic interests besides the tin ore, if the characteristics of the amang minerals and their relationships are well studied.

This paper characterises the amang minerals, both physically and chemically, from the Klian Intan area. Previous investigations on the geology, mineralogy, geochemistry and mining activities in the area include Scrivenor (1928), Jones (1970), Oh (1974), Leong (1984) and Nizarulikram (1992).

MATERIAL AND METHODS

Samples of amang were collected from the Rahman Hydraulic Tin Mine Sdn. Bhd. and its adjacent areas (Figure 1). Samples collected were concentrated first by hand panning before being mounted in araldite and polished.

Well-polished samples were then studied under the ore microscope and then analysed using Electronprobe Microanalyser (EPMA) for both physical and chemical characterisation of the amang minerals. These include the usage of the secondary electron image (SE) for the study of the morphology of the mineral grains, the backscattered electron image (BSE) to differentiate the minerals with different compositions, and X-ray mapping on the various amang samples for mineral identification and to determine the percentages of the various minerals present.

RESULTS AND DISCUSSIONS

From the petrograpic study, it was found that the Klian Intan area amang samples contain mainly arsenopyrite, pyrite, cassiterite, iron oxides, wolframite, rutile and zircon as the early phase minerals. Quartz, fluorite, covellite and scorodite, occur as secondary replacement minerals of the earlier phase minerals. The later phase minerals include quartz and fluorite, while covellite and scorodite occur as secondary replacement minerals of the earlier phase minerals. Point counting of polished sections of amang samples from the Klian Intan area show that the Klian Intan amang contain about 34% pyrite, 26% iron oxides, 19% arsenopyrite, 14% gangue minerals, 3% wolframite, 2% cassiterite, 1% rutile and 1% zircon.

The Klian Intan amang is iron-rich. The amang samples contain in the range of 12% to 43% iron oxides. The main iron mineral present is hematite. The hematite grains show botryoidal texture (Figure 2) and zoning due to replacement (Figure 3). They are subhedral to euhedral in form and from 0.1 mm (millimetre) to 0.45 mm in size. Inclusions of arsenopyrite are also found in the hematite. Goethite has replaced some of the hematite grains, while gangue minerals such as quartz and fluorite have in filled fractures in the hematite.

The arsenopyrite and pyrite are present as euhedral and well-polished minerals. Arsenopyrite was replaced mainly by covellite (Figure 4) and scorodite, while the pyrite is mainly associated with quartz and wolframite.

Zircon and rutile are present in minor quantities (about 1%) in the amang samples from the Klian Intan area. The zircon exists mainly as inclusions in other minerals, while the rutile is either in single grains or associated with hematite.

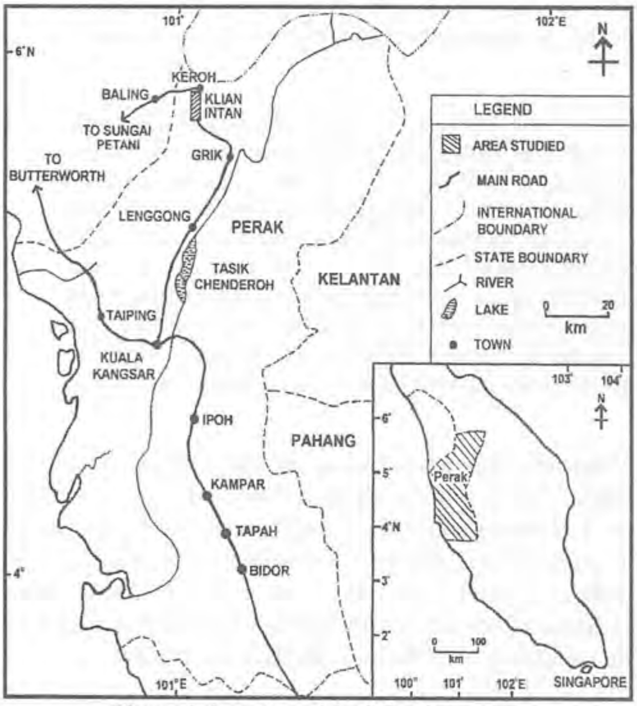

Figure 1. Location of the Klian Intan area.

The amang at Klian Intan still contains valuable quantities of cassiterite, which have not been recovered by the treatment plant. The cassiterite grains present are euhedral and vary in size from fractions of 1 mm to 2 mm. They are dark-brown in colour. Some of the cassiterite have tapiolite exsolutions (Figure 5). Sphalerite, pyrite and quartz are found associated with the cassiterite grains.

From this study, several new minerals that have not been recorded yet in the Klian Intan amang have been identified. These include wittichenite (Cu_3BiS_3), bournonite ($PbCuSbS_3$), boulangerite ($Pb_5Sb_4S_{11}$), and possibly tsugaruite ($Pb_4As_2S_7$), and trippkeite ($CuAs_2O_4$). The presence of rooseveltite ($BiAsO_4$) has previously been reported in the amang of the Klian Intan area (Cheng & Teh, 2003).

Wittichenite was first discovered by Kobell in 1853 in Mine Neugluck, Witten, Germany (Criddle & Stanley, 1979). According to Ramdohr (1969), the mineral is orthorhombic and opaque, but having dark grey metallic lustre. In the Klian Intan area, the wittichenite is intergrown with arsenopyrite (Figure 6).

Bournonite was named after the French crystallographer and mineralogist Jacques Louis de Bournon (Bakakin & Godovikov, 1980). Bournonite is a complex sulphide with lead, antimony, sulphur, and copper as major elements; and small quantities of arsenic, silver, iron, zinc, manganese, and nickel. In Klian Intan, bournonite is found associated with trippkeite.

Boulangerite was first discovered in 1837 in Molieres town, Gard, France (Palache & Berman, 1942). It is named after a French mineralogist, Charles Louis Boulanger. In Klian Intan, the mineral is anhedral in shape and about 120 um in size. It contains small quantities of arsenic and bismuth.

Tsugaruite is a new Pb-As sulphosalt from Yunosawa Mine, Aomori Prefecture, northern Japan (Shimizu *et* al., 1998). It is opaque with a metallic lustre and lead-grey streak. In polished sections, in plane-polarised light, tsugaruite is weakly bireflectant and weakly pleochroic

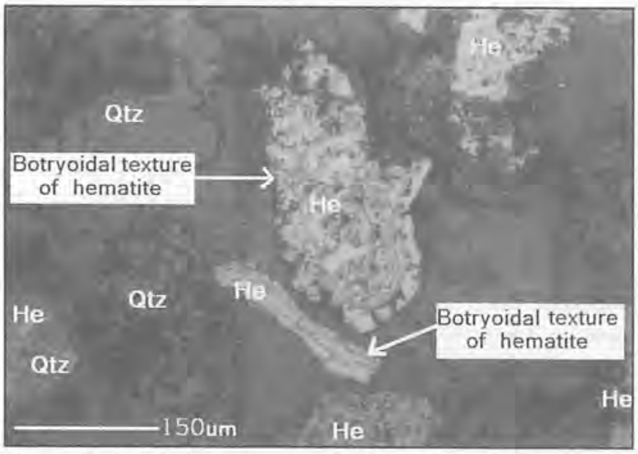

Figure 2. Polished section sample shows botryoidal texture in hematite (He) grains. Also present are quartz (Qtz) grains. Rahman Hydraulic Tin Mine, Klian Intan. Plane polarised light.

Figure 3. Replacement zoning in hematite (He) grain. Also present are quartz (Qtz) grains. Rahman Hydraulic Mine, Klian Intan. Plane polarised light.

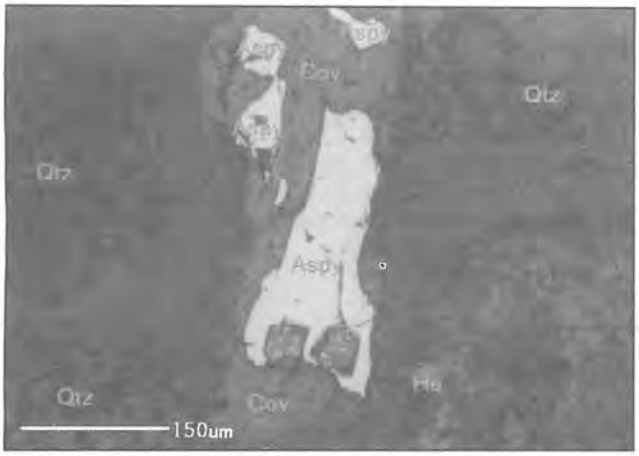

Figure 4. Replacement of arsenopyrite (Aspy) by covellite (Cov). Also present are quartz (Qtz) grains. Rahman Hydraulic Tin Mine, Klian Intan. Plane polarised light.

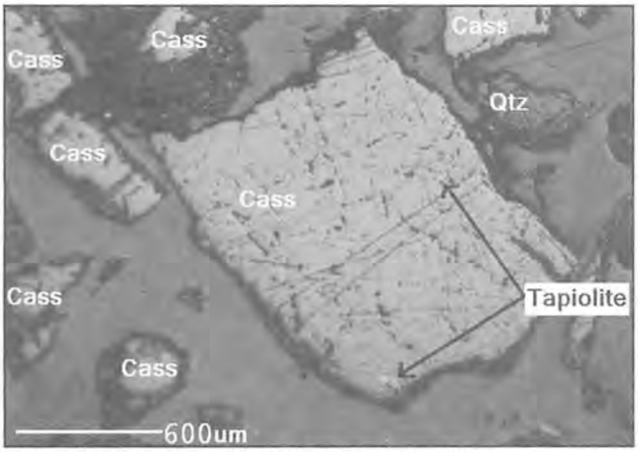

Figure 5. Exsolutions of tapiolite in cassiterite (Cass). Also present are quartz (Qtz) grains. Rahman Hydraulic Mine, Klian Intan. Plane polarised light.

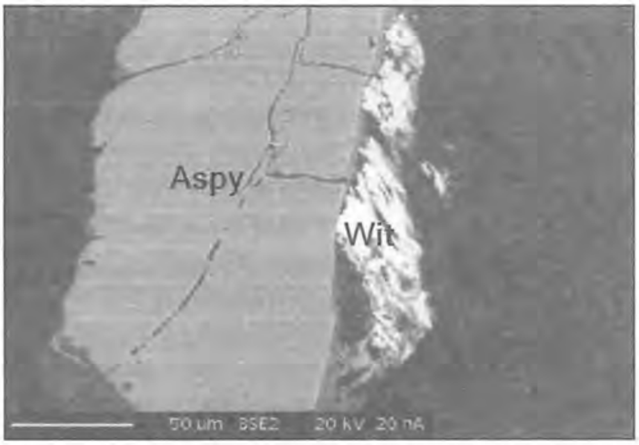

Figure 6. BSE image shows intergrowth relationship between wittichenite (Wit) and arsenopyrite (Aspy), Rahman Hydraulic Mine, Klian Intan.

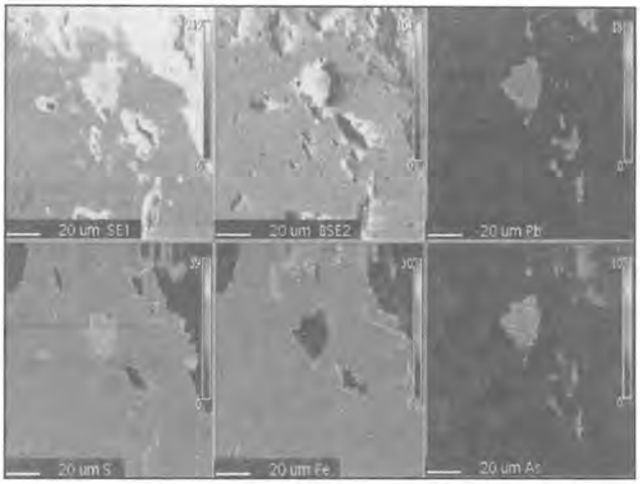

Figure 7. X-ray map showing tsugaruite ($Pb_4As_2S_7$) present as inclusions in pyrite (FeS_2). Pyrite is the dominant mineral here. Rahman Hydraulic Mine, Klian Intan.

from white with a greenish tint to grey white with a greenish tint. In the Klian Intan area, tsugaruite is present as inclusions in pyrite (Figure 7).

CONCLUSIONS

Petrographic studies show that amang from the Klian Intan area contains arsenopyrite, pyrite, zircon, rutile, cassiterite, wolframite, and iron oxides. The EPMA has proven to be a good analytical tool in revealing several new minerals, which have not been recorded yet in the Klian Intan amang, namely wittichenite (Cu_3BiS_3), bournonite ($PbCuSbS_3$), boulangerite ($Pb_5Sb_4S_{11}$), and probably tsugaruite ($Pb_4As_2S_7$), and trippkeite ($CuAs_2O_4$).

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