GEOLOGY, ORE OCCORRENCE AND ORE PROCESSINGOFCOPPER DEPOSITS, MONYWA, SALINGYI TOWNSHIP, SAGAING REGION

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Abstract

In copper processing, many kinds of application methods are using in the world depend on the ore genesis, local environmental regulations and other factors. Among of these methods, in Monywa copper mine area, the electrowinning process is used for the concentrate of copper ore production. Processing of the copper ore involves three stages; Bio-Heap Leaching to dissolve the valuable copper from the ore, solvent extraction to purify and concentrate the copper solution generated by leaching and electrowinning to plate the copper metal into cathode sheet form. Mine reclamation is the process of restoring land that has been mined to a natural or economically usable state. Although the process of mine reclamation occurs once mining is completed, the planning of mine reclamation activities occurs prior to a mine being permitted or started. Electrowinning (EW) process is an environmental friendly way to economically produced high-grade copper from low-grade ore deposit. Kyisintaung and Sabetaung Mines adhere to a strict zero discharge operation and all solution flows are re-circulated to ensure that no effluence is discharged from the mine to outside of lease area. Letpadaung mine produces cathode copper that complies with Landon Market Exchange (LME) Grade-A rating and is more than 99.99% in purity. Therefore, using of Electrowinning (EW) method is slightly better than the other methods.

Introduction

The Monywa Copper District is located 115 km west of the township of Mandalay on the Western side of the Chindwin River Flood plain. Four major copper deposits (Letpadaung, Kyisintaung, Sabetaung and Sabetaung South) occur within an area of 20 square kilometers. Letpadaung and Kyisintaung mines are present production stage, but Sabetaung and Sabetaung South mines are already extracted. There are four major high sulfidation deposits of Miocene age.

Following exploration drilling which began in 1959, production of copper concentrates from a small open pit started at Sabetaung in 1983. Since 1997, when resources total 7 million tons contained copper in 2 billion tons ore. Using leach electro-winning operation, the project has produced over 400,000 t copper cathode from Sabetaung and Sabetaung South.

The district is on the northern margin of Myanmar's dry zone. Most mineralization is structurally-controlled with chalcocite in breccia dykes, in steeply dipping NE-trending sheeted veins, and the Cu grade pipe at Sabetaung is up to 30%.

The highest grade ore at the top of the supergene enrichment zone, within which copper grade, supergene kaolinite and cubic alunite decrease and pyrite increases with depth, in contrast, marcasite(use in jewelry) is mostly occur in shallow depth. Letpadaung and Kyisin hill rise to 322 m and 304 m respectively, Sabetaung was a 180 m hill prior to mining and Sabetaung South was a low rise.

Location

The research area is situated at the West of Chindwin River, Salingyi Township of Sagaing Region. It is about 115 km Northwest of Mandalay and about 30km Southwest of

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Monywa. It lies between North Latitude 22°03′ 1″ to 22°08′ 57″ and East Longitude 95°02′13″to 95°07′ 28″. The research area refers to the one inch topographic map of 84 N/4.

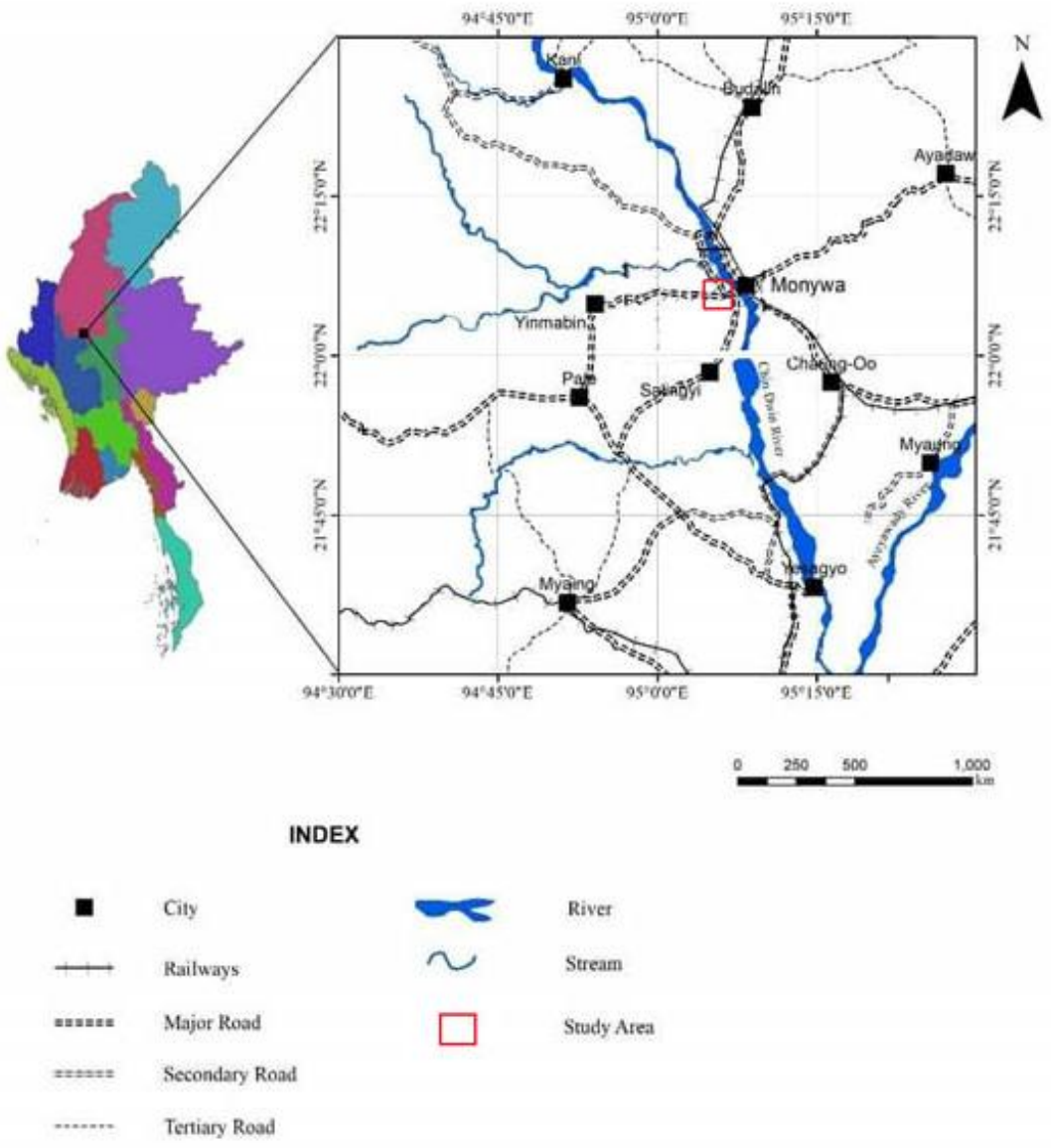

Figure 1 Location map of the study area

Topography and Drainage

The Research area lies within Monywa Copper district as a part in Salingyi Township, Sagaing Region. Sabetaung, Sabetaung South and Kyisintaung are continuous while Letpadaung lies 7 km far from the Southeast of Kyisintaung range. The highest mountains are Letpadaung (about 0.33km), Kyisintaung (about 0.31km) and Sabetaung (about 0.18km) are the dome shaped hills heaped up on the flat land. Elevation in the mine area reported as above sea level 500 m.

There is a Yama Chaung in the northern part of the research area. This stream is a major tributary to the Chindwin river and flows from West to East. The drainage density is generally coarse. The stream and their tributaries show mainly dendritic patterns. In some area radial pattern are noted.

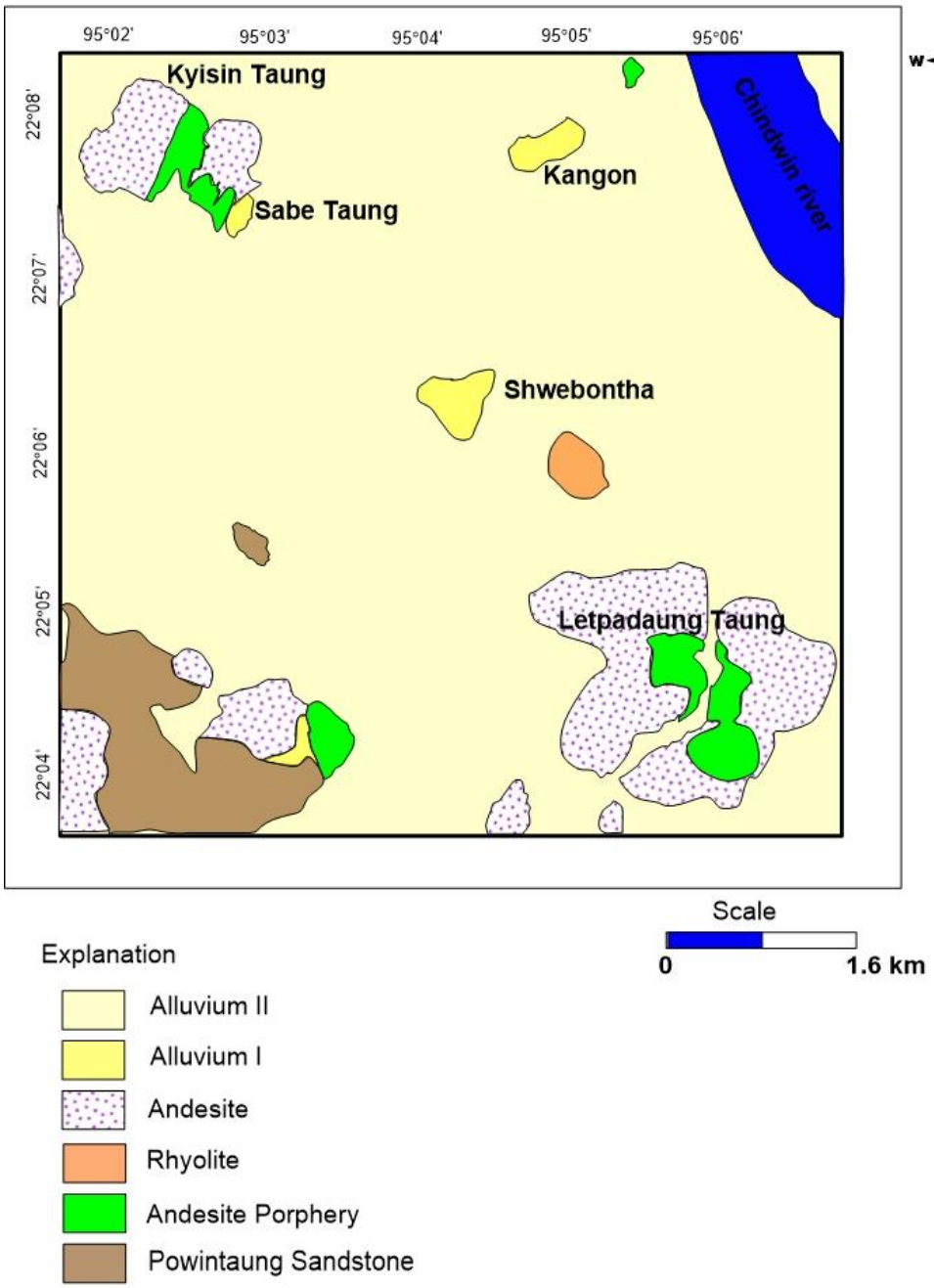

Figure 2 Geological map of Monywa Copper area

Rock Sequence of the Research Area

Monywa high sulphidation Copper deposit occurs in Magyigon Formation, unconformably rest on Salingyi basement complex of Cretaceous age and does not crop out in the mine area.In this area, sedimentary rocks are intruded by igneous rocks. The oldest rocks in the mine area are pillow basalts, basalts, flow breccias, granite, gabbros and granodiorite which are Mesozoic age.

The Miocene age of the Magyigone Formation and Powintaung Formation are intruded by andesite porphyries of both pre-mineralization and post-mineraliztion.

Rock sequence of the research area (After Mitchell, 2011)

Sedimentary Rock

QUATERNARY	Alluvium
PLIOCENE	(Kangon Sands &Kanthit Gravels)
	Sandstone-Shale
	Cross Bedded and Massive Coarse Sandstone
MIDDLE MIOCENE	Magyigon Formation
	PowinTaung SSTS
LOWER MIOCENE	Minzu East Conglomerate
	Igneous Rock
UPPER PLIOCENE	Basalt and Olivine Basalt
MIDDLE MIOCENE	Andesite Porphyry Pre-mineralization & Post
	Mineralization
MESOZOIC	Pillow Basalts, Basalts flow Breccia, Granite,
	Gabbros, Granodiorite

Distribution of Rock Unit

Sedimentary rock

Powintaung Formation

The oldest rock in the mine area is chiefly sandstone of Eocene to Lower Miocene age. The Damapala Formation described in the Japanese report is considered to be the upper most member of this formation. The sandstone is composed chiefly of well-sorted sub-rounded to rounded, translucent to transparent quartz fragments, commonly cemented by clay and carbonate. Bedding nature is noted in many places. The thickness is 300m (Bender 1983).

Magyigon Formation

The Magyigon formation lies conformably over the Powintaung formation. It consists of sandstone, clasts of dacite, andesite porphyries, quartz and various pyroclastics units. The pyroclastic units are dominantly crystal-rich, lithic-tuffs of dacitic composition. The age of this formation is Upper Miocene to Pliocene.

Kangon Formation

The Pleistocene Quaternary rocks (Kangon Formation) can be divided into two members, the Lower member of poorly consolidated to essentially unconsolidated sands and gravels. The Upper is unconsolidated mud, which are cemented with porous calcium carbonated.

Igneous rock

Pre-mineral Andesite and Dacite Porphyry

It occurs as a stock forming the core of Kyisintaung hills and dykes of stocks at Letpadaung. The Andesite Porphyry has phenocryst population composed of 10-30 percent plagioclase feldspars, minor quartz and rare alkali feldspar. Where quartz phenocrysts and alkali feldspar content are visible, is called Dacite. This unit is the major host rock to hypogene and supergene copper mineralization.

Figure 3 Small dykes of Pre-Mineral andesite porphyry in Letpadaung

Post-mineral Andesite and Dacite Porphyry

It has a composition similar to the Pre-mineral Andesite Porphyry, more abundance of large fresh Biotite and Hornblende.

Figure 4 Whitish coloured Post-Mineral andesite porphyry in Letpadaung mine area

Pyroclastic rocks

They called Mine Pyroclastics units is the second most abundant rock types at Sabetaung and Kyinsintaung project area. These rocks are common next to andesite porphyry at the Monywa Copper District.

Hydrothermal breccia

It is the most important rock type for its association with copper mineralization. It occurs as dykes and cut the pre-mineral rocks. The breccia clasts are varied from angular to well-rounded mineralized andesite/dacite porphyry clasts. Among the northern corner of the Letpadaung, a number of phretomagmatic breccia zones occur.

Ore Mineralogy

Alunite ($KAl_3 (SO_4)_2 (OH)_6$)

Alunite is occurred in Silica Alunite Zone that as pervasive replacement of the host rock groundmass by silica and complete alunitization of plagioclase feldspar. Alunite replacing the feldspars generally occurs as bright pink, translucent crystal. It widely occurs at Letpataung Taung mine area. Associated minerals are pyrite and gangue minerals. It widely occurs at LetpataungTaung mine area. Associated minerals are pyrite and gangue minerals.

Hematite (Fe_2O_3)

Hematite has variable color and lustre depending on its habit. It has a trigonal crystal system. It ranges from metallic lustre and steel or silvery grey to black color. All forms of hematite have a characteristic reddish-brown streak.Hematite is the most important ore of iron and is also a common alteration mineral.

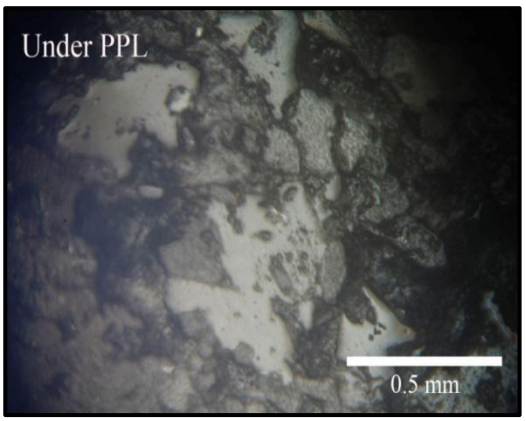

Figure 5 Photomicrograph showing alunite in andesites

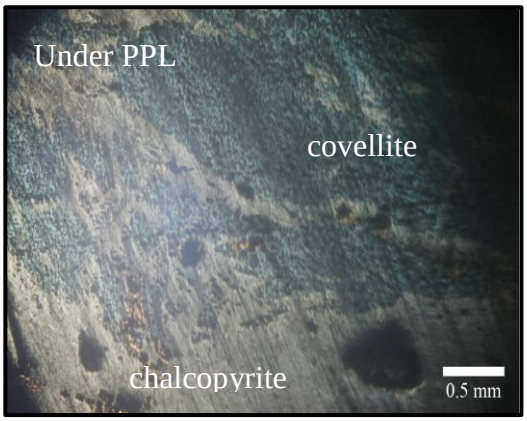

Figure 6 Photomicrograph showing covellite in andesites

Brochantite($Cu_4 SO_4 OH_6$)

Brochantite has monoclinic system. It is associated with malachite, azurite and cuprite. It shows slight in shades of bluishes green. It has vitreous lustre, sometime pearly. It can be prismatic or acicular needle-like crystals. Pleochroism of brochantite is weak. Commonly associated mineral is pyrite.

Covellite(Cu S)

Covellite has a characteristic deep indigo-blue color. It has a dark grey to black streak, a micaceous cleavage, and is very soft.covellite is a common supergene mineral associated with porphyry copper deposits.

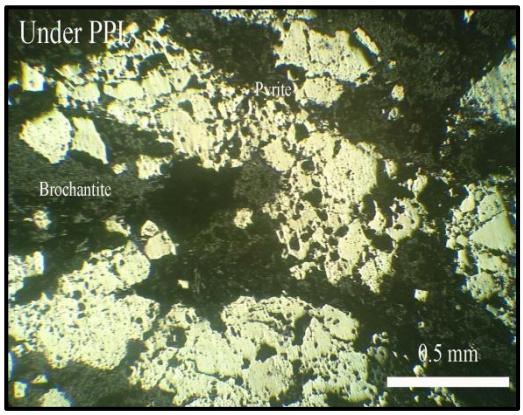

Figure 7 Photomicrograph showing brochantite in pyroclastic rock

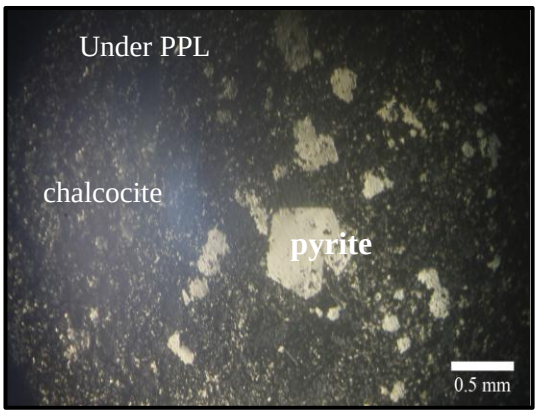

Figure 8 Photomicrograph showing chalcocite in andesite

Enargite(Cu_3 As S_4)

Enargite is a copper arsenic sulfide mineral. It has grayish black to black colour.Enargites are intimately intergrowth with pyrite, chalcopyrite, and covellite.

Chalcocite (Cu_2 S)

Chalcocite is usually subhedral. It is shows light grey colour, metallic lustre, indistinct cleavage and coarse grained. The high copper content makes chalcocite an important copper ore. (Primary) Hypogene of chalcocite has metallic lustre and massive in nature. Supergene chalcocite is fine grained and commonly appears sooty in polished section.

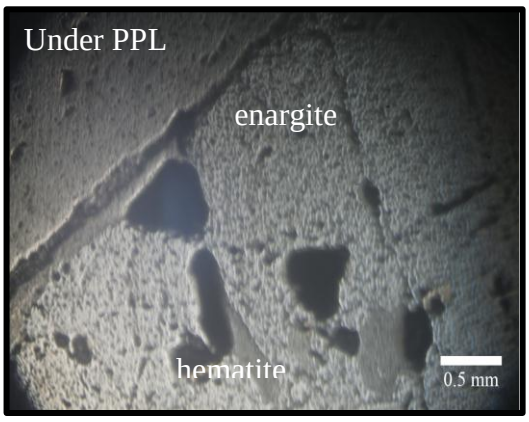

Figure 9 Photomicrograph showing enargite in andesite

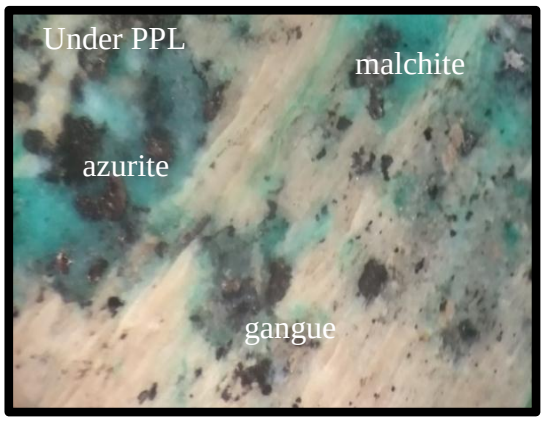

Figure 10 Photomicrograph showing azurite in andesite

Supergene High Grade Ore (Chalcocite)

Chalcocites are regarded as supergene high grade ore. It has two kinds of Primary (Hypogene) and Secondary (Supergene) zones. It is mainly occurred in Sabetaung mine area.

Azurite ($Cu_3 (CO_3)_3 (OH)_2$)

The color of Azurite is blue and lighter blue streak are distinctive. The lustre is vitreous to dull depending on crystal habit. In polished section, it is grey and has strong anisotropism. Azurite occurs as less fibrous and thicker aggregates than malachite.

Malachite ($Cu_2 CO_3 (OH)_2$)

The mineral occurs in association with one or many other copper minerals, such as native copper, chalcopyrite and azurite. Typically, it occurs as crystalline aggregates and commonly growth-zoned.

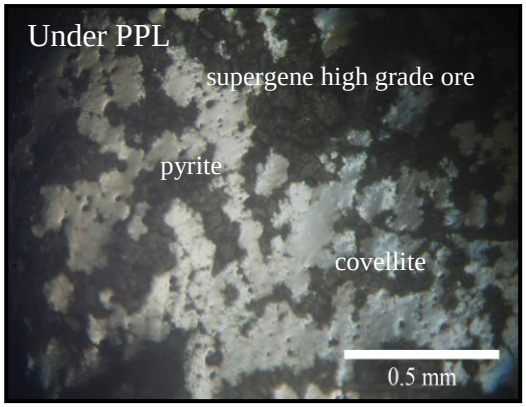

Figure 11 Photomicrograph showing Supergene high grade ore in andesite.

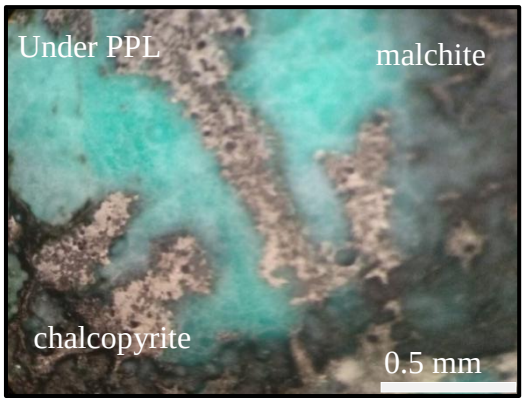

Figure 12 Photomicrograph showing malachite in andesite

Copper mineral processing of Monywa Cu Mine

Copper processing is a complicated process that begins with mining of the ore (less than 1% copper) and ends with sheets of 99.99% pure copper.

Crushing

In the research area, the processing of Letpadaungtaung mine is start to crushing. Primary crushers and the coarse ore bins may be located at the mine, where the mine and mill operation are separated. Primary crusher can crush 12000 tonnage per one hour. Secondary crushers and the fine ore bins are usually at the mill, along with blending or custom facilities where more than one kind of ore is mined or received. The fine ore is ground in ball or rod mills to a size small enough to liberate the ore minerals, then classified in various kinds of machines of machines to insure that the feed to the mill is uniform.

Heap leaching

The method is similar to the leaching method, except sulphuric acid is used to dissolve copper from its ores. The acid is recycled from the solvent extraction circuit and reused on the leach pad.

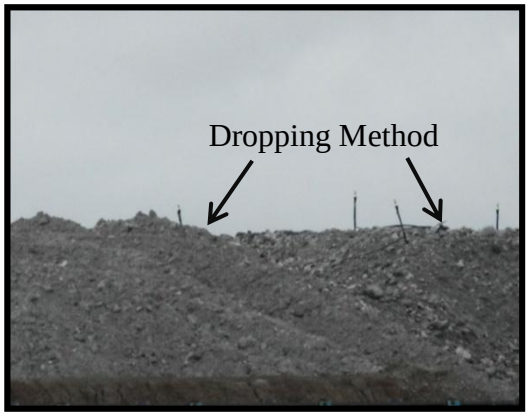

Figure 13 Heap is leaching by dropping methods

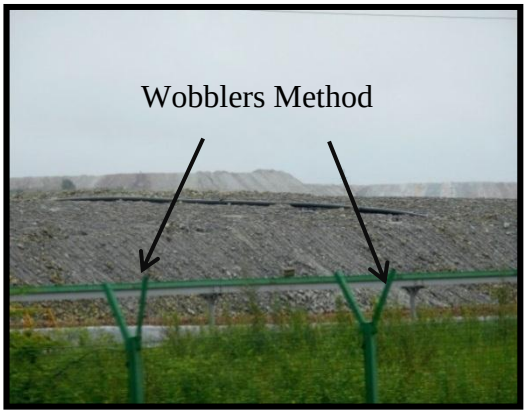

Figure 14 Heap is leaching by wobblers methods

Solvent extraction

The leach liquor is pumped from the leaching circuit through polishing filters into the extraction section of the solvent extraction plant. The extraction section of the solvent extraction plant consists of a number of mixer-settlers in series.

Electrowinning and final product

Electrowinning is the electrodeposition of metals from their ores that referred to as leaching. The electrowinning of copper is an electrolytic process that uses electricity to recover dissolved copper from solution as copper plate, also known as "cathode". The process of electrorefining copper involves an impure copper anode and an inert cathode. An electric current is applied across the anode and cathode which causes the copper to dissolve from the anode to be then plated onto the cathode as pure copper metal.

Figure 15 Tank House for electro winning Process

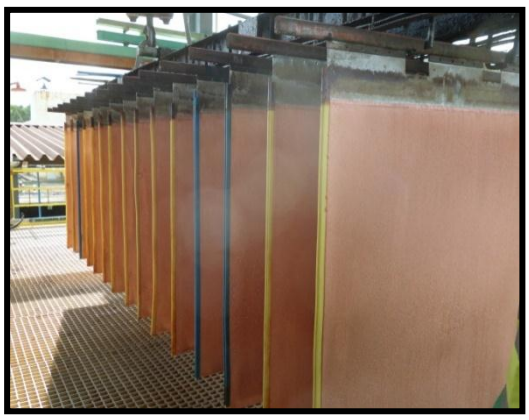

Figure 16 Extracted copper plate from Tank House

Conclusions

The study area lies within Monywa Copper district as a part in Salingyi Township, Sagaing Region. Four major copper deposits (Letpadaung, Kyisintaung, Sabetaung and Sabetaung South) occur within an area of 20 square kilometers.

Letpadaung and Kyisintaung mines are present production stage, but Sabetaung and Sabetaung South mines are already extracted. Monywa copper deposits occur in Magyigon Formation with the age of Middle Miocene age. It is mainly composed of sandstone, rhyollite, dacite and andesite, pyroclastic rocks and hydrothermal breccia dykes. The ore mineral assemblages in the study area are alunite, hematite, brochantite, covellite, enargite, chalcocite and supergene high grade ore.

In copper processing, many kinds of applicable methods are using in the world depend on the ore genesis, relationship of host rock and morphology of ore occurrences, local environmental regulations and other factors. Among of these methods, the electrowinning process is used in Monywa copper mine area. Solvent Extraction to purify and concentrate the copper solution is generated by leaching and Electrowinning to plate the copper metal into cathode sheet form.

Electrowinning (EW) process is an environmentally friendly way to economically produce high-grade copper from low-grade ore deposits. Monywa Cu mine adheres to a strict zero discharge operation and all solution flows are

re-circulated to ensure that no effluence is discharged from the mine to outside of lease area. These mines produce cathode copper that complies with Landon Market Exchange (LME) Grade-A rating and is more than 99.99% in purity. Therefore, using of Electrowinning (EW) method is better than other methods for Cu mineral processing.

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