Economic Mineral Occurrences of Momeik-Mohauk Area, Northern Shan State

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Abstract

The Momeik-Mohauk area is located at the Northern Shan State. It lies at the northern continuation of Mogok Metamorphic Belt, which is occupies a key position of tectonic evolution of Southeast Asia. Due to the complexity of geological processes such as metamorphism (contact and regional), igneous activities, sedimentation and structural deformation etc, are controlled a number of mineralization of study area. In the Momeik-Mohauk area the ore minerals, viz, gold, copper, magnetite, and graphite and gem minerals such as diamond, ruby, sapphire, spinel, topaz, apatite and quartz are observed. In the gold mineralization of Thayetsu area, pyrite-galena-sphalerite-gold-quartz vein, trending NW direction and about 2m wide are intruded in the Kabaing granite and marble unit of MMB. Sample assays include 12, 5, and 0.7 ppm Au. Wall rocks are fosterite-phlogopite-spinel marble and microgranite. Other ore minerals of Momeik area are Graphite, Magnetite, and Azurite. Gem mineralization of study area may be divided into four types such as regional metamorphism, contact metamorphism, pegmatite, and mechanical sedimentary deposit. Gem minerals of study area can be occurred in two main ways. Ruby, sapphire and apatite, etc are occurred as primary deposit, moreover, these and other gems and semiprecious stones including diamond are observed as placer deposit.

Key words: Economic mineralization, Mogok Metamorphic belt, Gold mineralization, Gem mineralization, primary deposit, placer deposit

Introduction

The Momeik area is concerned with the northern continuing Mogok stone tract and involved complex lithology and structures. A number of economical mineralization is occurred in the Momeik area, viz, gem minerals (diamond, ruby, sapphire, spinal, topaz, apatite. quartz, etc…) and ore minerals (gold, copper, magnetite, graphite, etc…).

The geologists have been prospecting in the Momeik area from 1972 onward for primary sources of diamond. Geological mapping, geophysical, geochemical investigations have been carried out by DGSE conjunction with Department of Geology, Yangon University. However, except diamond, detailed investigation of mineralization and minerals of Momeik area have not been reported yet.

Location and Accessibility

The Momeik area is located at the Northern Shan State, lies in the north-western part of the Eastern Highland. The study area situated between latitude 23° 00′ N to 23° 15′ N and longitude 96°15′ to 96° 30′ E (Burma survey map no. 93-A/12). Momeik lies 18 miles northeast of Mogok and Mohauk lies about 18 miles due west of Momeik.

The study area is easily assessable. The study area can be reached by motorcar along Mandalay-Thabeikyin-Momeik car road and Mandalay- Mogok-Momeik car road (Figure 1).

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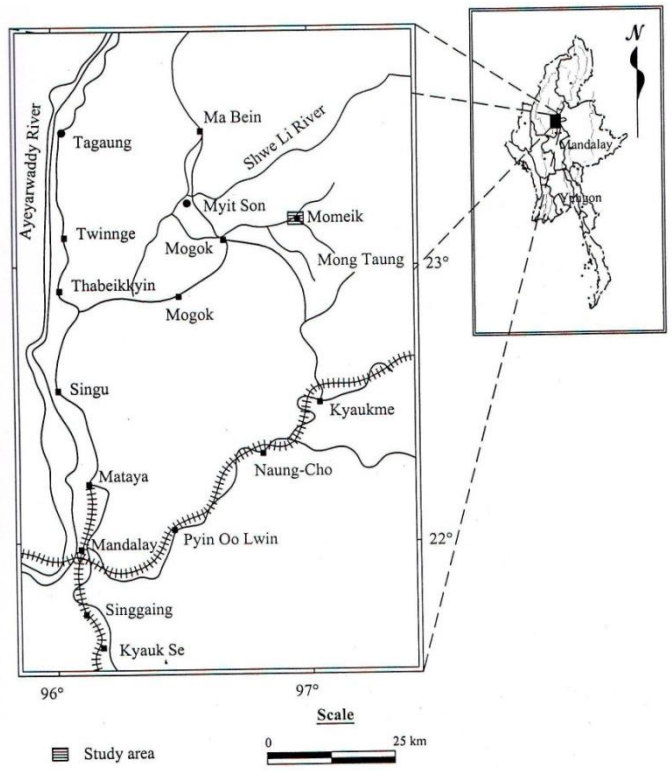

Figure1. Location map of study area

Regional Geological Setting

The Momeik-Mohauk region lies in the northwestern part of Eastern Highland. It is the northern continuation of Mogok Metamorphic Belt. The Mogok series comprising of gneiss, crystalline limestone, calc-sillicate granulites, migmatites and quartzites are found mainly in the northern and southern parts of the valley. This Mogok series is classified as the Archaean rocks in which young granite (dated as 15m.y, Searle and Ba Than Haq 1964), Alaskite-syenite suites, hornblendites, pyroxenites, dunite and serpentines are intruding. Kabaing granite is the biggest intrusive body, being of batholithic dimension. The small bodies of ultrabasic rocks are found near Letha and Htinyutaung village, 10km north of Mogok, at the upper catchments area of Yetagun Chaung. Olivine basalts are also found to the west of Kin Chaung, 15 km NW of Mogok and near the margin of the Momeik valley. (Mya Ko, 1989 and Aung Kyaw Mya, 1984)

To the east of Momeik valley, metamorphic complex and the Chaung Magyi series of Cambrian age composed mainly of slaty shale, gray wackes and phyllites forming the oldest meta-sediments of Myanmar, Bawdwin volcanic series of rhyolitic tuffs, true tuffs of volcanic origin and bands of volcanic breccia, layer of sandstones and feldspathic grits. In the unfossiliferous Chaung Magyi series, the Taung Peng granite (oldest granites in Myanmar) is intruding in several places. Intrusion of basic rocks such as dolerites, and olivine-gabbro, and Taung Peng granites are also observed in many places in Bawdwin area (Chhibber 1934). The Taung Peng granite occurs at the base of this series, covered uncomformably by Chaung Magyi series, while many geologists believe that the granite intruded into this series (Ba Than Haq and Ngaw Cin Paw, 1973).

The Momeik valley is made up of recent alluvial flood plain; low and high terraces with gravel beds. These terraces are characterized by the presence of many ponds. The diamondiferous gravel beds are exposed in an area 2 km north of Mohauk village and nearly 6 km NE of Kyeindaw village, which is 2 km NE of Mogok (Anon, 1993a). Diamonds are

associated with the basal gravels, which are poorly sorted and composed of sub-rounded to rounded pebbles of vein quartz, quartzite, micaceous schist, jasper, black shale, volcanic tuffs, brecciated quartz-tourmaline rock, slaty rocks and well rounded pebbles of gray colored silicified rocks. These gravel beds contain not only diamonds but also small quantities of rubies and sapphires (Tin Tin Win et. al., 1998).

Table 1. Different Rock Types of Momeik Area, (Modified from Ba Than Haq and et. al., 1973)

Rock Unit	**Age**
Sedimentary Rocks	Recent
Alluvium	
Terraces	
Irrawadian Formation	Pliocene
Metamorphic Rocks	Mogok series (Archaean)
7. Marble	
6. Calc-silicate granulites	
5. Calc-gneiss	
4.Quartzites	
3. Unclassified metamorphics	
2. Gneiss and Schist	
1. Garnet gneisses	
Igneous Rocks	
3. Granite	
2. Alaskite-Syenite suite	
1. Basic and Ultrabasic rocks	

The general strikes of the Mogok series, granites and ultrabasic rocks followed the regional trend of NE –SW with the south-easterly dip of 45º to nearly vertical. The rocks are highly folded, faulted, and deformed. The most prominent structural feature is the Momeik-Twinnge fault, which controlled the configuration of present day landforms. On Landsat images it is easily discernible as an east-west trending lineament beginning from south of Twinnge village in the west and stretching eastward up to Kunlon, and passed through the Myanmar-China border. Thus fault is sinistral fault of echelon type. Momeik valley was formed as a graven between the east-west trending parallel faults. (Peel, 1994) The total length of is 300 miles and the offset is estimated at 20 miles. Complementary sets of NE and SW trending minor faults are also present.

Economic Mineral Occurrences of Momeik-Mohauk Area

Gold mineralization of Thayetsu Area

In Thayetsu area, small but important gold mineralization is occurred. It is located at the about three miles south of Mohauk village northern margin side of Mogok Highland. In this area, the marble unit of Mogok Metamorphic Belt is intruded by Kabaing granite. The mineralization zone is northwest striking, a steeply dipping vein at contact of marble and granite, in the main zone, host rocks are fosterite-phlogopite, and sometime spinel bearing marbles and granite. Residual presumably low-grade outcrops show a 2m wide zone of brecciated partly oxidized sulphides with vein quartz stringers, including 20 cm zones of soft reportedly gold rich material (as a result of assayed data 12, 5.4, 0.7 ppm Au contained in samples).

A stockpile of sulphidic ore contain over 50% sulphides, predominantly pyrite and lesser galena, sphalerite, chalcopyrite and silver within a meshwork of irregular white opaque quartz; texture resembles brain coral. Drusy vugs are partly filled by delicate feathery and needle quartz. In the NW extension, foliated biotite granite is wall rock which altered to sericite-quartz with relict biotite. The associated sulphide minerals are pyrite, chalcopyrite, galena, and silver. Therefore, the nature of occurrences of gold and sulphide minerals strongly suggested that mineralization is formed by the hypogene. Moreover, the ore formation is later than the host rock, because the ore bearing quartz veins are intruded in the preexisting host rock of granite. Therefore, it is epigenetic in origin.

Figure 2. Open pit mine of Thayetsu mineralization vein in marble unit

Figure 3. Thayetsu gold mineralized vein is tending NW, show oxidation zone of reddish brown colored limonite overburden and yellowish zone show sulphide zone.

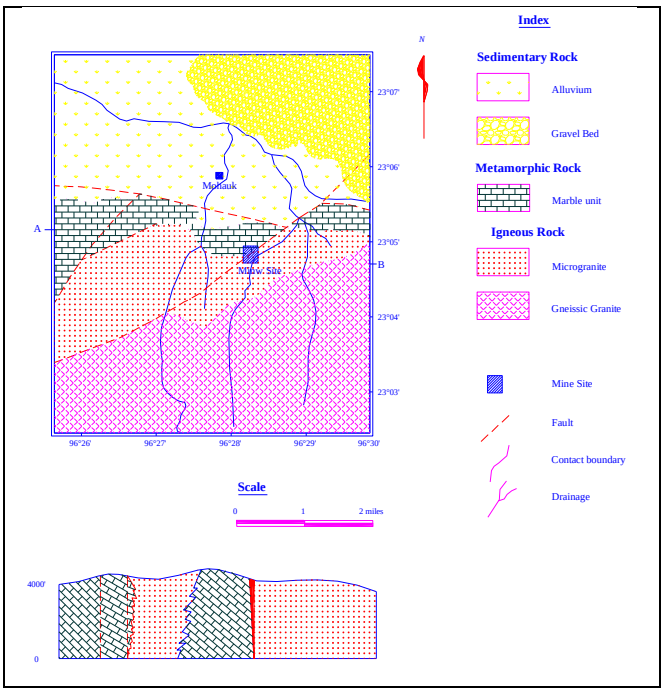

Figure 4. Geological map and Crossed section of Thayetsu area

Other Ore Mineralizations of Momeik Area

In the Momeik area, have various kind of lithology, and several deformation processes such as metamorphism, igneous intrusion and sedimentation. Other ore minerals of the Momeik area are Graphite, Magnetite, and Azurite.

Graphite

Graphite is occurred in the graphite schist of Kyauktaung area, located at the 7 miles northwest of Momeik town (lat-23º 10´ 40´´N and long-96º 37´ 46´´). The graphite vein is about 2m wide and about one mile long, which is trending N 28º E (Fig. 5). It is associated with quartz vein (ThalinnGyaw), so, the mineralization may be related to the hydrothermal deposit.

Under microscopic study of graphite schist, it is contained not only about graphite 40% but also hematite 20%, quartz 20%, mica 5% and other. In polished section, the graphite shows strongly foliated and fibrous form (Fig.6).

Figure 5. Graphite vein exposed in the Molen chaung, Kyauktaung village, trending N 28º E. (Facing 208º)

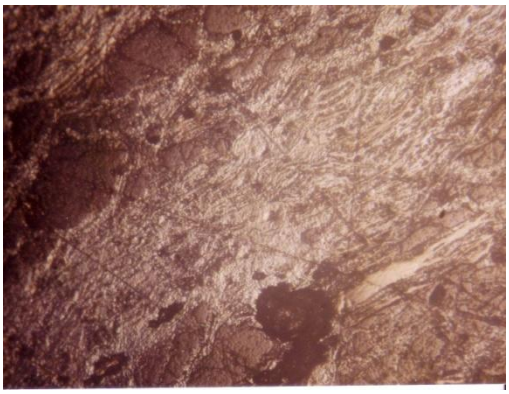

Figure 6. Graphite show strongly foliated and fibrous form (whitish brown) and hematite (dark brown).

Magnetite

Magnetite is found in the Kya-in area, 2 miles south of Bawde village (lat-23º 6' 26" N and 96º 28' 40" E). Volcanic rocks of agglomerated tuff are occurred in this area. The specimen show lava flow structure and bulb texture. A numerous spherical vesicules owing to escape of volatile are observed (Figure 7). Therefore, the deposit of magnetite may be related to the volcanic processes. The crushing ponder of magnetite sample contained about 80% of magnetic minerals and 15 % of volcanic glass and 5% are other.

Azurite

Azurite are occurred in the marble unit of Mogok Metamorphic Belt, located at the Dotehtataung, 3 miles south of Padan Village, lies latitude 23º 8' 35" N and 96º 34' 30" E. Beautiful greenish blue colored minerals are occurred in the vein quartz (Fig.8). Local people used it as sculpture stone.

Figure 7. Magnetite shows lava flow structure and bulb texture.

Figure 8. Azurite mineral bearing quartz vein intruded in the marble (facing-N)

Gem Mineralization of Momeik Area

A number of gem mineralization is occurred in the Momeik area, such as diamond, ruby, sapphire, spinel, topaz, quartz, and apatite.

Mode of Occurrences of Gem Minerals

Gem minerals of Momeik-Mohauk region occurred in two main way,

(1). Primary deposit (in-situ)

(2). Secondary deposit (Placer in the alluvial and eluvial sediments)

(1) Primary deposit

Ruby, sapphire and apatite occurred mainly in the marble of Mogok Metamorphic Belt of study area associated with phlogophite mica and spinel. Sapphire also occurred in igneous rock (syenite) in contact with the metasedimentary rock (marble).

Regional Metamorphism

The mineralization produced by increase of both temperature and pressure. Mogok marble are formed due to regional metamorphism and from these marble are obtain the ruby, apatite and in additional spinel, diopside, sphene and garnet etc.

Contact Metamorphism

Contact metamorphism of Mogok marble occurred by influence of intrusion of syenite. With stronger metamorphism the aluminous (bauxitic?) limestone are converted into emery which consists of corundum, spinal etc...

Pegmatite

With progressive crystallization, the late residual liquid of granite is made up principally of low melting silicates and considerable water, along with other low melting compounds and volatiles and a relative concentration of many of the substances that enter into mineral deposit of igneous origin. In addition to water, the volatile substance consist of phase rich in boron, florine, chlorine, sulphur, phosphorus and other rare elements. The volatile substances aid crystallization by decreasing the viscous of magma and by lowering the freezing point of minerals. This is an aqueo-igneous stage, a transition between a strictly igneous stage and hydrothermal stage, learning more to the igneous and is referred to as pegmatitic stage (Bateman, 1965)

The pegmatite deposits are found at 12 miles from northwest of Momeik Town and also called "Athattayar Taw". Native people are worked in this area for Topaz (Ahtattayar) and Quartz (smoky quartz, citrine, etc.) crystals. Such deposits are characterized by crystallization at relatively low temperature; large crystal size (due to the case of diffusion made possible by presence of fluid, and a preponderance of mineral rich in volatiles or late stage elements.

(2) Secondary deposit

The occurrences of gem are confined to particular rock and particular place. However, loose gem minerals with other minerals are transported and deposited in adjacent valley. The gem bearing gravels of Pleistocene age were deposited along stream valley. Apart from the placer deposits in which many of semi-precious stones also occurred such as spinal, topaz, zircon, etc. The concentration of heavy minerals such as tourmaline, sphene, etc., in sediment will be a measure or indicator of the probability of encountering corundum and heavy gem minerals.

Figure 9. Topaz mine site, here topaz crystal and quartz crystal are extracted from weathering pegmatite vein.

Figure 10. Mohauk placer deposit mine site, ruby, sapphire and other semiprecious stones found in these gravel deposit and often found diamonds.

Mechanical sedimentary deposit

Deposits that have arisen through sedimentation, the agency of weathering with transportation, resulted from pre-existing deposits. The main gem bearing detrital sedimentary deposits are,

(1). Gem bearing gravel and sand (locally known as "byon") in river valley
Eg. , at Bawde, Mohauk, Pathin, Kyiendaw area

(2). Fissure-filling deposit (also called "Letkya byon")
Eg, at Athattayar Taw near 12mile village

(3). Cavern-and-sinkhole-filled deposit (lu)
Eg, at Yantaung near the Kyauktaung village

Most of ruby, sapphire and other semi-precious stone are minded in the placer deposits of study area by local people. Moreover, significant quantities of diamonds are occurred in these gravel beds of Momeik-Mohauk region.

Gemmological Account of the Study Area

Diamond

The alluvial diamonds discovered in gravel beds of Mohauk, Bawde, Pathin, Kyiendaw, and Magyibin area in addition to the ruby and sapphire. In these areas, three layers of gem bearing gravel beds are occurred. The surface layer of gravel bed has thickness of 0.5

to 2 ft called "Apaw byon", while the lower layer, lying at 4 ft below the surface has a thickness of 2 to 4 ft known as "Khar byon". The lowest layer lying at about 45 ft beneath the surface, diamonds are not found in this layer.

The diamond bearing gravel beds are composed of rounded pebbles of quartz, quartzite, schist, jaspers, and volcanic tuffs ranging in size from 1 inche to 4 inches in diameter. The alluvial diamond of study area characterized by its light yellow to brown color (often white, yellowish green color also occurred) with the black inclusions of carbon. Crystals is octahedral forms and perfect raised triangular facets. Most of these are partly worn that they are irregular shaped. The diamonds recovered from Mohauk ranging in weight from 0.3 to 7 carats (Figure 11).

Ruby

In the study area, rubies are found in both placer deposits (byon) and primary deposits (Gekyaw). The placer deposits of ruby found in the gravel beds of Momeik-Mohauk region associated with sapphire, spinal and other semi-precious stones. The primary deposit of ruby occurred in the phlogophite marble of U-gin taung and Yan taung near the Kyauk taung village about 7 miles Northwest of Momeik town.

The rubies of Momeik area show generally irregular form, sometime show hexagonal prism form. The colors of stones show various shades of red (Figure 12).

Sapphire

Sapphires also occurred in the two types of deposits, placer and in-situ. In placer deposit of gravel beds, sapphires are found associated with ruby, spinal, etc. The alluvial sapphire is small in size. The in-situ sapphires are discovered in the highly altered syenite rock of Chaungzauk area. In Legyi area, the fissure-filling deposit (Letkya byon) of sapphires is occurred associated with moonstone (hmyay). The sapphires of study area are characterized by impure blue to light blue color and hexagonal dypyramid form and massive (Figure 13).

Spinel

Spinels are occurred in the marbles and placer deposits throughout the study area. It showed perfect octahedral forms, but loose crystals of spinel from placer deposits show rounded and sub-rounded form. Raised triangle and triangular pits are sometime found on octahedral faces. The grain-size varies from a few mm to 10mm in diameter. The color varies from deep red to pink (Figure 14). Local people gather spinels from gravel in the Mohauk, Bawde, Pathin, Kyeindaw, Magyibin area association with ruby, sapphire and other semiprecious stones.

Topaz

Topaz are mainly occur as fissure-filling deposit (Called Letkya byon) driven from the weathering pegmatite vein located at the Topaz mine site "Athattayar Taw" 12 miles northwest of Momeik town. Topaz crystal shows orthorhombic system and long prismatic form. The color of Topaz is very variable, ranging from water-clear colorless crystal through yellow and delicate shades of light green and light blue. The vertical striation and mirror faces cleavages and specific gravity are distinguishing features of Topaz. The size of Topaz crystal ranging from a few mm to above 20cm (Figure 15), they are associated with quartz crystals.

Apatite

Apatite occurred in the phlogopite marble. It is extracted from Myasein taung 15miles NW of Momeik. It occurred along contact of granite and marble unit. It is shows greenish blue

color with vitreous luster. They are associated with phlogopite mica boards (Figure 16). Many of these crystals are fractured not suitable to cut for use as faceted gem stone.

Figure 11. Diamonds of Momeik area, Photographed by Tin Tin Win (2001) x 25

Figure 12. Ruby crystal in the marble unit of U-gin Taung, Momeik area.

Figure 13. Sapphires in highly alters syenite of Chaungzauk area, Momeik Township.

Figure 14. Spinels occur in the Momeik gravel bed

Figure 15. Topaz crystal occurs in the Momeik area

Figure 16. Apatite in marble associated with phlogopite mica board of Myasein Taung area, Momeik Township.

Summary and Conclusion

Momeik-Mohauk area is concerned with the Northern continuation of Mogok Metamorphic Belt. Mogok Metamorphic Belt is occupies the key position of tectonic evolution of the Myanmar/Southeast Asia.

Due to the complexity of geological processes such as metamorphism (contact and regional), igneous activities, sedimentation and structural deformation etc, are controlled a number of mineralization of study area. In the Momeik-Mohauk area the ore minerals, viz, gold, copper, magnetite, and graphite and gem mineral such as diamond, ruby, sapphire, spinel, topaz, apatite and quartz are observed.

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မြက၊ (၁၉၈၉)၊ ရှမ်းပြည်နယ်မြောက်ပိုင်း၊ မိုးမိတ်–မိုးဟောက်သေ၊ အထူးကျောက်မျက်ပင်းရင်းသိုက် လေ့လာရှာဖွေရေးလုပ်ငန်း အစီရင်ခံစာ၊ ဘဝရ စာ ၅–၁၁။

အောင်ကျော်မြ၊ (၁၉၈၄) မိုးမိတ်–မိုးကုတ်ဒေသ၊ ဘူမိရူပနည်းဖြင့် အထူးကျောက်မျက်ရှာဖွေမှု အစီရင်ခံစာ။ ဘဝရ စာ ၇ ၁၀။