PETROGRAPHY AND GEOCHEMISTRY OF CALC-SILICATE ROCKS EXPOSED IN KANTHA-AUNGTHARYA AREA, THABEIKKYIN TOWNSHIP, MANDALAY REGION

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Abstract

The research area, Kantha-Aungtharya area, lies in Thabeikkyin Township, Mandalay Region. The study area falls within the Mogok Metamorphic Belt, lying between Sagaing fault and Shan scarp. It is located about 6.5 km east of Thabeikkyin and 122 km north of Mandalay. Metasedimentary such as marbles and calc-silicate rocks and igneous rock (such as biotite microgranite) units are prominent in this study area. The relatively high Al_2O_3 and fairly high values of $Fe^{3+}$and Fe^{2+}in the calc-silicate rock could be due to (a) impurities containing iron in the sedimentary environment and (b) diffusion of ions from the igneous body. The original material from which the calc-silicates can be formed may be impure dolomitic limestone, marls and limestone.

Keywords: Petrography, Geochemistry, XRF, Calc-silicate Rocks and Kantha-Aungtharya area.

Introduction

Myanmar is situated in an area of complex plate tectonic setting. As a result of plate tectonic evolution, the country has been divided from west to east into four major geotectonic units, the Arakan Coastal Zone, Indo-Burma Range, Inner-Burma Basin and Sino-Burma Ranges, forming the north-south elongated structures. The research area is located in Thabeikkyin Township, Mandalay Region. The main rock units exposed in this area are metamorphic and igneous rocks. The study area is mainly composed of diopside marble interbedded with calc-silicate rocks and marbles, and biotite microgranite. Several gold worksites of the primary gold deposit are situated in the research area. Based on the lithologic characters and mineralogy as well as associated features of metamorphic rock unit, it is apparent that the existence of gold deposits will be encouraging in the area and can probably be explored as primary deposits.

Various workers (geologists) have studied the Mogok Metamorphic Belt of Myanmar. They mentioned their views with respect to geology, metamorphism and tectonism involving in this metamorphic belt. La Touche (1913) described the principal rock types of the area in the Memoir of the Northern Shan State. The term 'Mogok Gneiss' was first introduced. Clegg (1941) suggested that the rocks are considered to be metamorphosed Paleozoic and Mesozoic rock units. He published a geological report for northern Thabeikkyin area and east Ayeyarwaddy. Searle and Haq (1964) described that the Mogok Series comprises stratigraphic groups ranging from Precambrian to Upper Paleozoic. The metamorphism must have been occurred during post Paleozoic and related to the Himalayan Orogeny. Ali Akbar Khan (1985) reported that the metasedimentary rocks were intruded by Tertiary igneous rocks on the geology of Wabyudaung-Ondan area. Myint Naing (1987) studied the geology of Chaunggyi-Zayetkwin area, Thabeikkyin Township. He stated that Lower to Upper Paleozoic metasedimentary rocks were intruded by Late Creteceous to Paleocene igneous rocks. Myint Lwin Thein *et al*., (1990) studied the main rock units of the Mogok-Thabeikkyin-Singu-Madaya area. He described the stratigraphic consideration on marble as well as other metamorphic rock units and associated igneous rocks. Zaw Win Ko (1997) also studied the geology of Kwinthonze-Onzon area. Bertrand *et al*., (1999; 2001 and 2003)

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proposed the Oligocene to Mid-Miocene age of metamorphic rocks of the Mogok Belt. Myo Thant (2002) studied the geology and ore deposits of Kwinthonze-Leikkya area, Thabeikkyin Township. Tin Aung Myint (2009) studied precious and base-metal mineralization in the Chaunggyi-Kandaung-Kwinthonze area, just south of the research area. Zar Oo San (2010) also studied the petrology and genetic aspects of gem minerals in the Kyetsaung Taung-Kyaukkyi area, Thabeikkyin Township. This area lies to the south of the study area. Zaw Win (2015) contributed the petrology and gold mineralization of the Kyaukbalu-Donwe area of Thabeikkyin Township.

Location, Size and Accessibility

The Kantha-Aungtharya area lies in Thabeikkyin Township, Mandalay Region. It is located about 6.4 km (4 miles) east of Thabeikkyin and 122 km (76 miles) north of Mandalay. The area is bounded between the coordinates of North Latitude 22° 51' 15" to 22° 58' 00" and the East Longitude 96° 01' 00" to 96° 06' 00" in one-inch topographic maps of 93 B/1. The areal extent is about 8 km (5 miles) from North to South and 8 km (5 miles) from East to West, covering approximately of 64 square kilometers. The study area is easily accessible via motorcar throughout the year. The location map of the research area is shown in Figure 1.

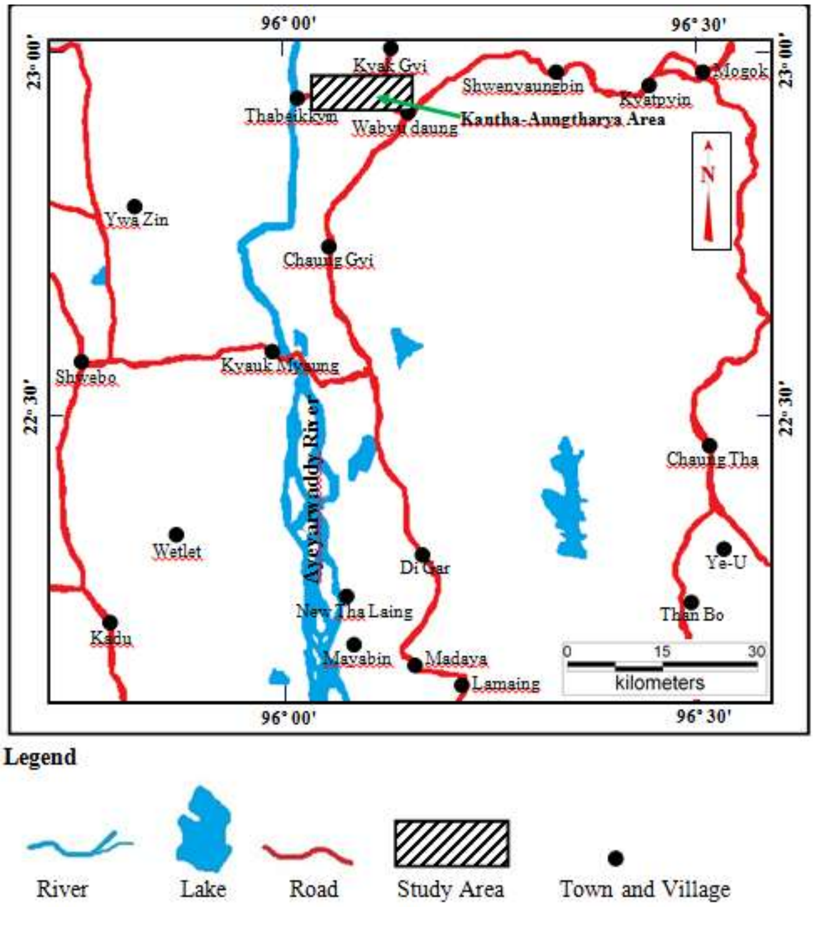

Figure 1 Location map of the study area, Thabeikkyin Township, Mandalay, Region.

Physiography

Geomorphologically, the study area lies on the western border of the Eastern Highlands. Lowland (plain) and rolling hills are common in the research area. The eastern and northern parts are high in relief that gradually lower down towards the west and south. The eastern part is higher than any other parts in the research area and the highest point is about 397m (1304 ft). This part contains massive NE-SW trending ridges covered by dense forest. Late Paleozoic to Mesozoic metasedimentary rock units (mostly marbles) occur in the southern and western part of the research area. Middle Miocene igneous rock Unit (microgranite) is exposed largely in the northern part of the research area. Marble units are also encountered in this part. The interbeds of marbles and calc-silicate rocks are observed in the eastern part of the area. These rock units are sometimes intruded by the microgranite. Marbles are widely exposed where biotite micrograniites are limited in occurrence in the study area. Generally, the drainage pattern of the area shows dendritic nature (Figure 2). Gway Pin Hmaw Chaung is the main stream in the study area. It flows from east to west through the northern part of the research area. The So Gyi Chaung joins the Gway Pin Hmaw Chaung in the northern part of the research area. The So Gyi Chaung runs through the middle part of the study area in south to northwest direction. Finally, Gway Pin Hmaw Chaung flows into the Ayeyarwaddy River. The research area has a subtropical climate and gets fairly high rainfall.

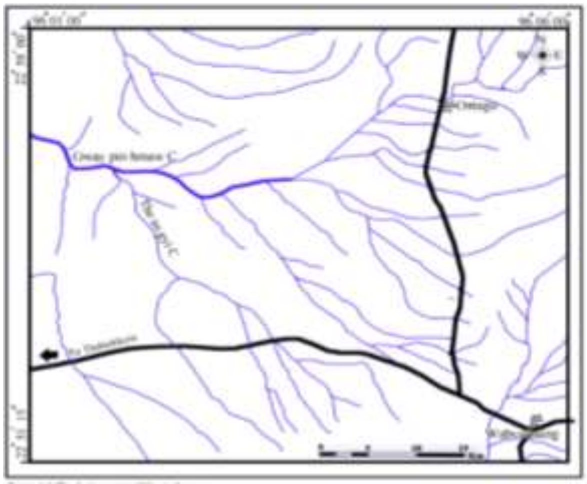

Figure 2 The drainage map of the research area

Purposes of Research

1) To identify the petrological characteristics of the Calc-silicate rocks unit and their distributions in the study area
2) To investigate the geochemical signatures and suggest the paragenesis of these rocks.

Methods of Study

1) The research methods mainly include two parts: detailed field investigation and laboratory works.
2) The GPS and Brunton compass are used to locate the lithologic contact and collect rock samples.
3) The major and trace elemental composition of rocks and mineralized rocks and veins was analyzed by X-Ray Fluorescence (XRF) under pressed pellets using a RIGAKU RIX-3100 (Series VR 25006) X-ray Fluorescence spectrometer. The LOI (loss of ignition) data were measured at 1000ºC for all samples to be analyzed by XRF. XRF analyses were carried out at the laboratory of Economic Geology, Department of Earth Resources Engineering, Kyushu University.

Petrography

Nature of exposure and distribution

Calc-silicate rocks are widespread in the research area. Good exposures of these rocks are located north of Chan-tha village (N 22° 53' 04.5" and E 96° 04' 47.4"). They usually form distinctive ridges striking parallel to the east-west foliation. Generally, they are medium- to coarse-grained, well-banded meta-sediment with distinct mineralogical layering (Figure 3a). Layering varies in thickness between 2mm and 2cm.

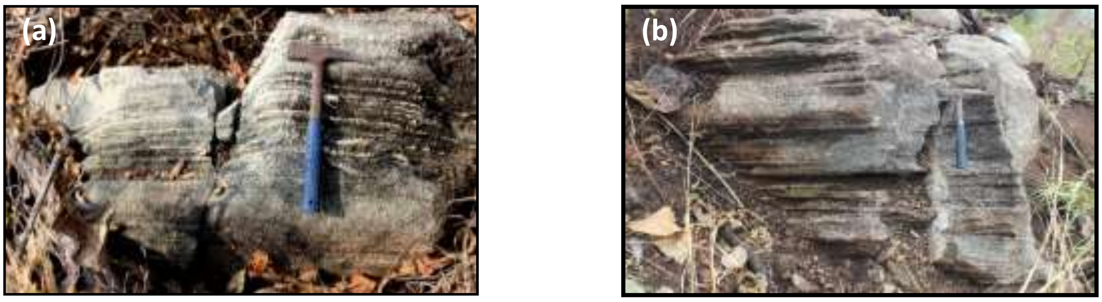

Figure 3 (a) The banded calc-silicate rock showing distinctive quartz-rich layers (white) and diopside rich layers (green) and (b) typical rib and furrow structures of calc-silicate rock

In outcrop, the calcium-rich layers are often more deeply weathered leaving the more resistant silica layers to stand out. By the differential weathering rib and furrow structure are also observed on weathered surface (Figure 3b). The calc-silicate layers dip steeply 70-85 degree to the north-northwest and show evidence of multiple deformations with small folds striking east-west (Figure 4).

Figure 4 The calc-silicate rock showing drag folds as the evidence of plastic deformations.

Diopside grains are anhedral to subhedral and rounded. The grain size ranges from 0.2 mm to 1.5 mm in diameter. Diopside porphyroblasts are seen along the mosaic of quartz and calcite grains. The relief is high, pale green and greenish pink in thin section. They are randomly oriented (Figures 5a &b).

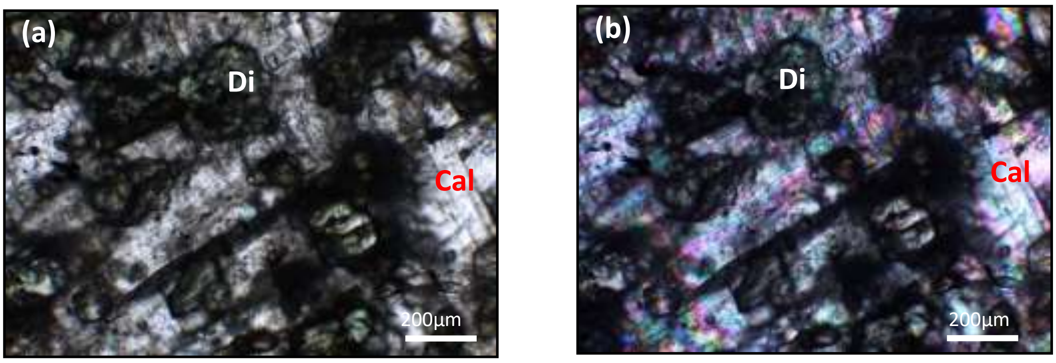

Figure 5 Photomicrograph showing randomly oriented diopside grains (a) under PPL (b) under XN. Di=Diopside and Cal= Calcite

Calcite appears as xenoblastic to idioblastic grains. They can be easily recognizable under microscope. Most calcite grains reach up to 2mm in diameter.

Sphene is greyish brown in color. It shows very high relief. Color and pleochroism are more distinct. Lozenge-shaped sphene occurs as idioblastic grains (Figures 6a & b). It occurs at the contact of diopside.

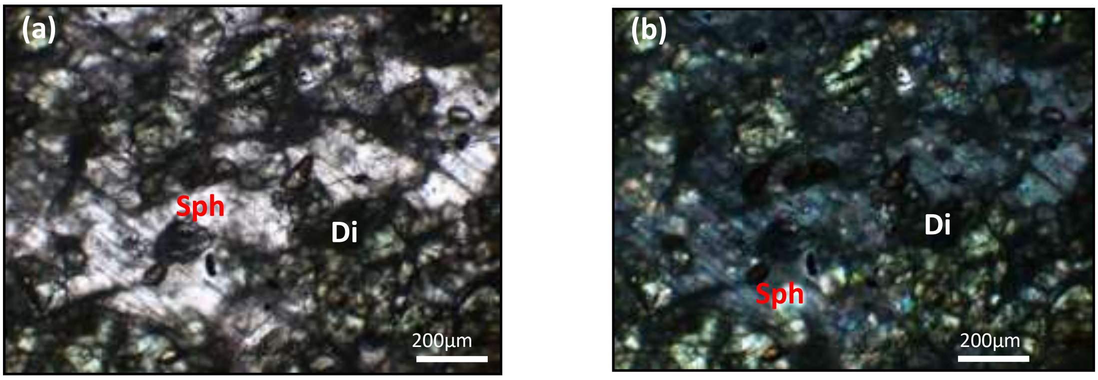

Figure 6 Photomicrograph showing disseminated granulus of sphene in calc-silicate rock (a) under PPL (b) under XN. Di=Diopside, Sph=Sphene

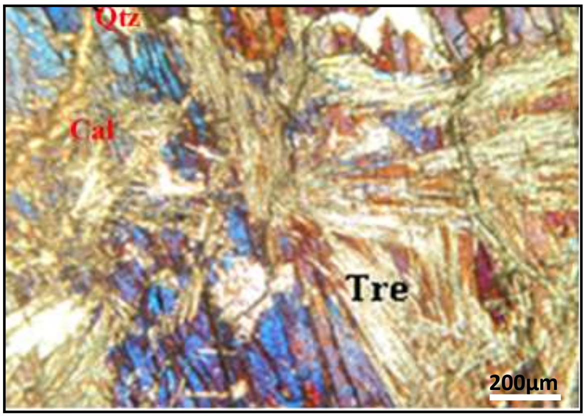

Figure 7 Photomicrograph showing fibrous aggregate of tremolite in calc-silicate rock, (Under XN), Tre = Tremolite, Cal = Calcite and Qtz = Quartz

Tremolite is observed as an accessory mineral. Tremolite laths are sub-idioblastic. It shows moderate to high relief. It is colorless in thin section. Darker color and stronger pleochroism are associated with higher iron content (William, 2013). Tremolite shows up to the middle second order white interference color. It occurs as the acicular pattern. It forms fibrous aggregates (Figure 7).

Geochemistry of Calc-Silicate Rocks

Calc-silicate rocks owe their origin mainly from contact metamorphism when magma intrudes into colder region and the adjacent rocks are heated. If the heat content of the magma is high, there will be a temperature rise in the bordering country rocks lasting long enough to cause mineral reactions to start and proceed to completion.

The following minerals were identified in thin section calcite, quartz, tremolite, garnet, diopside, forsterite and iron oxide. Representative samples of calc-silicate rock were selected and prepared for geochemical analysis, using X-ray fluorescence (XRF).

In rock samples of the study area, SiO_2 occupies (46.61%) a significant proportion of the rock. This high proportion is not unrelated to the high immobility of the Si^{4+} ion. CaO is the second most abundant element (23.15%) from the result of analysis. This abundance is to be expected since Ca^{2+} ion is very mobile and goes into reaction easily. The relatively high Al_2O_3 (14.12%) may be due to the mobility of an Al^{3+} ion. Al^{3+} ion may have migrated from the acid igneous rocks which metamorphose the carbonates. Due to diffusion and metasomatism, the ions have transferred into the carbonate. The low content of magnesium (3.05%) may have resulted also from leaching of the dolomitic limestone. TiO_2 value (<1%) is quite low. The low value should be expected due to the limited or small abundance of Ti-bearing minerals in the rock. Fairly high values of Fe^{3+} and Fe^{2+} in the rock could be possibly due to (a) impurities containing iron in the sedimentary environment and (b) diffusion of ions possibly come from the igneous body. The presence of high oxygen fugacity in the environment may have resulted in the oxidation of the Fe ions.

The original material from which the calc-silicates can be formed may be impure dolomitic limestone, marls and limestone. However, these carbonates can be found deposited under the same environment. Generally, limestone and dolomite are very common in fresh water lake or marine environments.

Experiment has shown that Tremolite is mainly stable at temperatures below 400°C at the fluid pressure of 2 kilobars (Helmut, *et al*., 1976; Shaw, 1960; Knorring, 1958). Tremolite + Calcite + Quartz will not be stable at temperatures greater than 400°C. Diopside +Calcite +Quartz are stable at temperature higher than 400°C and fluid pressure of about 2 kilobars. Therefore, for calc-silicate minerals, it may be concluded that they are direct result of contact metamorphism of impure siliceous dolomitic limestone in the study area.

Conclusions

Based on the available data from field investigation and resultant data from the analyses, the following conclusions are summarized:

The Kantha-Aungtharya area lies in Thabeikkyin Township, Mandalay Region. It is located about 6.5 km east of Thabeikkyin and 122 km north of Mandalay. The research area falls within the Mogok Metamorphic Belt. Metasedimentary rocks such as marbles and calc-silicate rocks and igneous rock (such as biotite microgranite) units are prominent in this study area. Calc-silicate rocks owe their origin mainly to contact metamorphism when magma intrudes into colder region, the adjacent rocks are heated. The relatively high Al_2O_3 may be due to the mobility of a Al^{3+}ion. Al^{3+}ion may have migrated from the acid igneous rocks which metamorphose the carbonates. Fairly high values of $Fe^{3+}$and Fe^{2+}in the calc-silicate rock could be due to (a) impurities containing iron in the sedimentary environment and (b) diffusion of ions from the igneous body. respectively

Calc-silicate minerals, it may be concluded that they are direct result of contact metamorphism of impure siliceous dolomitic limestone in the study area.

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