THE STUDY ON NATURAL RESOURCES RELATED TO THE MICRO, SMALL, MEDIUM AND HEAVY ENTERPRISES AROUND KYAUKSE AREA, KYAUKSE DISTRICT, MANDALAY REGION

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Abstract

The study area is between Latitude 21° 31' N to 21°47' N and Longitude 96°07' E to 96°17' E, Kyaukse District, Mandalay Region. In fact, this area is located 45 km SSE of Mandalay, occupying parts of UTM map sheets N0.2196-02 & 06. Firstly, field works have been undertaken for systematic sampling of rocks and minerals for the geological study of the research area. Second tasks dealt with the physical and chemical properties of rocks and minerals and their uses. Some geologists have attempted to describe the geology and mineral resources of the present research area and its environs. However, natural resources related to the Micro, Small and Medium Enterprises (MSME) and Heavy Enterprise (HE) have not yet been done. Therefore, the focus point of research works attempts to explore the MSME and HE with the natural resources of industrial raw materials (quartzite, marble, limestone, and dolomitic limestones units), decorative stones as well as road materials and construction materials (Biotite granites, Microgranite, Leucogranite, Hornblende diorites, Hornblendite, Calc phyllite, Schist, Gneiss, Calc-silicate, Quartzite, Marble, and Limestone) of the study area. Besides, ore minerals Copper, Cu (0.01 % to 8.01 %), Iron, Fe (2.52 % to 24 %) Lead, Pb (0.01 % to 5.01 %), Barite, Ba (0.03 % to 10.66 % and Manganese, Mn (0.13 % to 6.11%) around the Kyaukse area are to be studied. Final task has been done for the Environmental Impacts affected by the MSMHE factories, especially production of limestones for cement plant will take the quarry mine life last about 50 years for the Thandawmywet Taung and also 20 years for the Nwalagauk Taung in the future. According to the geological and environmental perspectives, the benefits of research works are to be applied for the production of natural resources of the study area, to fulfill the academic needs of Kyaukse University, and to use the findings in the teaching programs for the Department of Geology.

Keywords: *Natural Resources, Micro, Small, Medium and Heavy Enterprises.*

Introduction

Location, Areal extend and Accessibility

The study area is situated between Latitude 21° 31' N to 21°45' N and Longitude 96°07' E to 96°15' E and it also lies in Kyaukse District in the central part of Myanmar. This area is approximately 10.5 km long in north-south direction and 7 km wide in east-west direction, covering about 73.5 square kilometers. The study area falls in UTM map sheets N0.2196-02 & 06. The research area is well-known for its quarries producing the road metals, industrial minerals, construction materials and decorative stones.

Method of Study

This research has been carried out by using field methods and laboratory investigations. Collecting of fresh representative samples of rocks in the study was selected and prepared to analyze the characters of the rocks. Photographing of necessary minerals, rock types and structures had been done in the field. The laboratory work comprises the representative rock samples primarily for the identification of mineral species and elements content of the rocks. Mineralogy

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of ores and rocks were carried out by using Wavelength Dispersive X –Ray Fluorescence (WDXRF) Spectrometer.

Purpose of Study

Purposes of the investigations are as follow:

To prepare a modified geological map of the research area,

To mention the geology and geochemical of the study area,

To describe the natural resources related to the Micro, Small, Medium, Heavy Enterprises of the study area, and

To study the environmental impacts of the research area

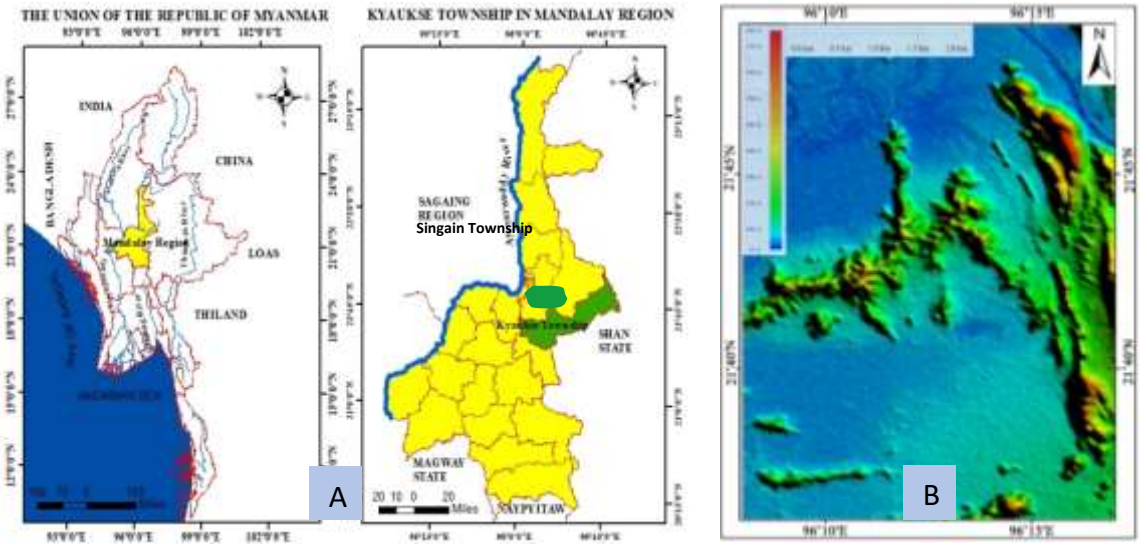


Figure 1.1 (A) Location map and **(B)** Satellite map showing the relief of the study area.

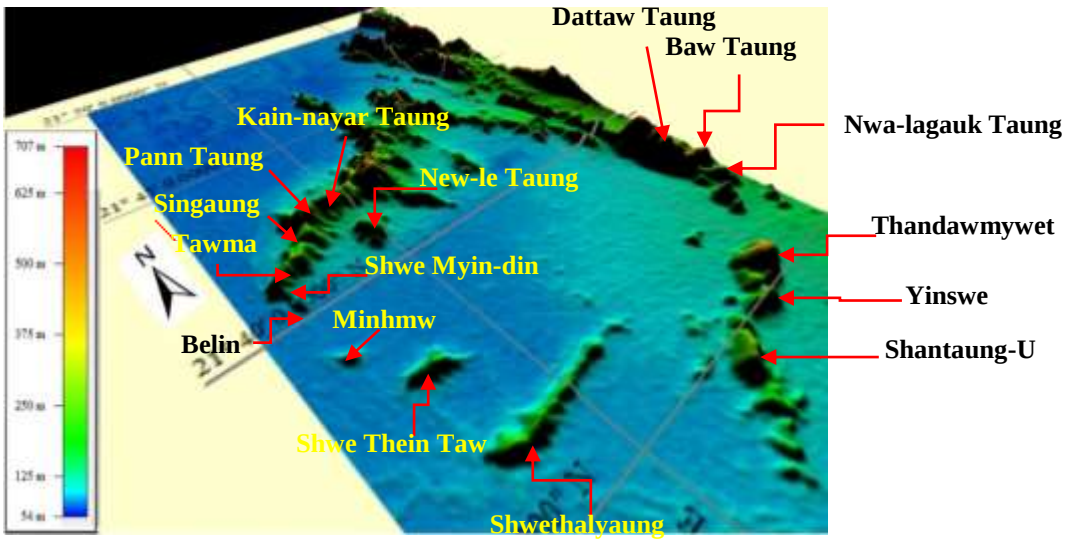


Figure 1.3 DEM (Digital Elevation Model) image showing the physiography of the study area and its environs.

General geology of the study area

The area consists of Upper Paleozoic and Jurassic-Cretaceous sedimentary rocks and their metamorphic equivalents. These rocks are intruded by biotite granites, hornblende diorites, and a few hornblendites. The youngest granite in the Kinda area yielded K/Ar ages of 82 ± 2 m.y and 58 ± 1 m.y (Brook and Snelling, 1976 in Myint Thein, 2004). The biotite-augen gneisses of the Shwethalyaung Hill are regarded as orthogneiss transformed probably from the Mesozoic granite (Myint Thein, 1984). The age of metamorphism affected in this area was probably at the end of Cretaceous (Myint Thein, Bo San and Myint Thein, 1984).

Stratigraphically, in the study area, the sedimentary units can be divided into two groups: they are Upper Plateau Limestone and Pan Laung Formation. The Pan Laung Formation (Middle Jurassic to Early Cretaceous) overlies unconformably the Permian Triassic Upper Plateau Limestone. The name Pan Laung Formation was introduced by Garson *et. al* (1976). Myint Thein and Win Myint (1988) redefined the term. According to Myint Thein (2004) at the eastern margin of this project area, the formation begins on the Plateau Limestone with a unit of red clastics with basal limestone. Boulder and cobble conglomerate unit which passes upwards into red to purplish red sandstones, siltstones, calcareous mud rocks with Mytilus and argillaceous limestone bearing discycladacean algae. This unit is followed by orthoquartzite and quartzite with interlayers of red purples slates which pass upwards into a sequence of cross-bedded sandy allochemical limestones containing Pseudo cyclammina, Haurania and minute gastropods which form nuclei of ooids and oncoids. The upper part of the formation is dominated by pelitic, psammitic and calcareous rocks.

As the grade of metamorphism increases westwards, the rocks of the Plateau Limestone and the Pan Laung Formation becomes low and medium grade marbles (found in west of Dattaw valley, Thandawmyet, Taungni and Nwalegauk Hills, east of Thin-dwe cannel, Kyauk-hte Hill and eastern tip of the Shwethalyaung Hill, and micaschists, phyllites, marble, and calc-silicate rocks and quartzites respectively. Myint Thein, Bo San and Myint Thein (1984) deciphered the structure of this area, the regional synclinal structure, intruded by a stock of granite near Belin is obvious and it is cut across by a north- south fault passing through the Sunye village. Small folds trending north-south occurred near the Sunye Fault between the Kyauk-hte Hill and Htonbo village. The Plateau Limestone makes an anticlinal flexure at Dattaw Hill area. Geological map of the study area is shown in (figure 2.26)

Rock units succession of the study area

Table 2.1 Succession Rock unit of the study area (After Myint Thein, 1984)

Quaternary

Alluvium

Jurassic-Cretaceous

Panlaung Formation

Upper Pelitic-Calcareous Unit: Phyllites, limephyllites, schists, calc-silicates and some quartzites.

Upper Psammitic- Pelitic Unit: Slates, metawacke, quartzites, phyllites and some calc-silicates.

Psammitic- Calcareous Unit: Clastic limestones, calcareous siltstones and sandstones, marbles, limephyllites and phyllites, calc-silicates and schists.

Lower Psammitic- Pelitic Unit: Red and purple clay-slates, siltstones, sandstones, limestone-conglomerates, silty limestones, mica schists, quartzites and some marbles.

Lower Pelitic-Calcareous Unit: Dark schists, phyllites, limephyllites and banded marbles.

Permian-Trassic

Plateau Limestone: Limestones, dolomitic limestones and marbles (low to medium grade), overlying the rocks of the lime clastics (S3qtz).

Quartzite (Upper Silurian)

Granite (Early Tertiary)

Augen Gneiss (Possibly Up. Cretaceous-Paleocene)

Natural Resources of the Study Area

The present research area is well-known for its quarries producing industrial raw materials, decorative stones, construction materials and road metals (Mines of Burma, 1976 in Maung Thein, 1984). The present research works are focusing on (1) Decorative Stones, Road Metals and Construction Materials (2) Industrial Raw Materials (3) Ore minerals: Copper, Iron, Lead-Barite and Manganese ores with Micro, Small and Medium Enterprise (MSME) and Heavy Enterprise (HE) of the study area.

Micro, Small and Medium Enterprises (MSME)

Decorative stones, Road metals and Construction materials

In the study area, exposed metasedimentary units are calc-silicate rock, phyllite, schist, gneiss, quartzite and marble and their age are (199ma - 65ma). Sedimentary unit of limestone (299 ma -199 ma) and intrusive igneous units are granitic rocks, hornblende diorite, hornblendite and dykes and veins units and also their age are (65ma-55.8ma). All of these units are used as Decorative stones, Road Metals and Construction Materials.

In the study area, Belin quarries are well-known from 1915 to 1984, these quarries were worked by private contractors. From 1948 to 1978, Quarry Corporations of the Construction Ministry worked those quarries. From 1979 up to present the Quarry Section of Prison Department has taken over the works (Figure.2.1). The existing quarries are situated in the calc-silicate rocks at south-west of Kyaukkyi Taung in the Belin area. The rocks quarried are mainly calc-silicate rock

with subordinate phyllite, schist, quartzite, marble and granite. They are used as road metals, construction materials and decorative stones. The annual output is estimated as 600,000 cubic feet.

Rock Slab Factory of Belin is famous in the last decade and it stands as a Heavy Enterprise at that time. Because of the easy accessibility, availability of suitable rock types in large amount make quarrying in this area a profitable enterprise. But in recent time, Rock Slab Factory of Belin has been closed down.

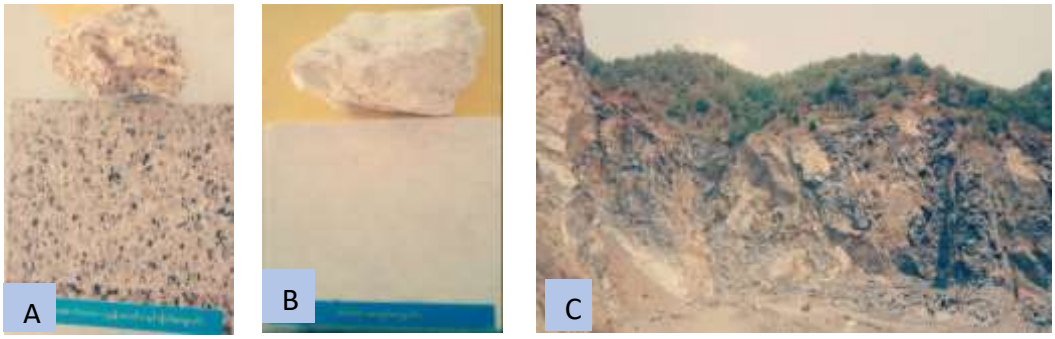
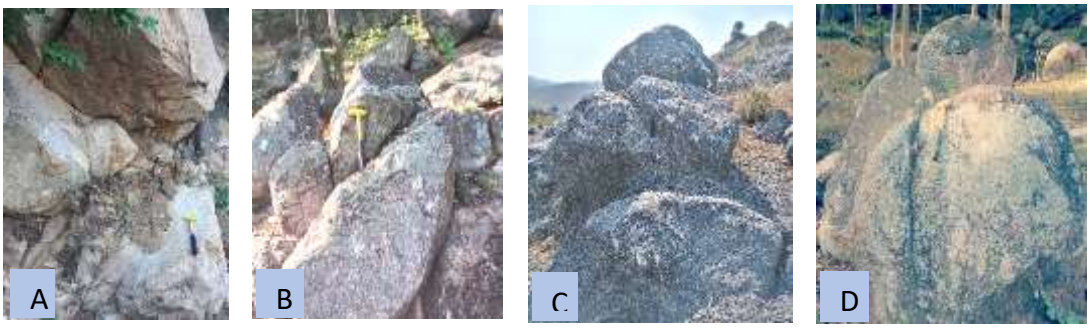


Figure 2.1 (A & B). Granite and Marble slabs are used as decorative stones from Rock Slab Factory of Belin. (C) Calc-silicate rocks, phyllite, and schist exposed at Quarry Section of Prison at Belin area used as road metals.

Biotite granites exposed at Singaung, Pann and Kyaukyi Taungs are used as decorative stones. These marbles are metamorphosed part of the Plateau Limestone Unit. At the eastern end of the Shwethalyaung Hill, exposed white marble, has been quarried and gneiss from this hill also quarried for use as road metals and decorative stones. Compact greenish-gray calc-silicates with micaceous quartzite quarries situated in the study area are Shwemyindin Taung, Kyaukyi Taung, Belin Taung, Nwa-le Taung and near Ngazu and Patta villages. Patta village rocks are known as "Patta Kyauk (Patta Rock)" (Figure 2.2). They are used as road metals as well as construction materials and decorative stones. Local people are still work at Small Enterprise there.

Figure 2.2 (A, B, C & D) Calc-silicates with micaceous quartzite (Patta Kyauk) occur at quarry of Shwemyindin Taung are used as decorative stones.

Granite, Hornblende Diorite and Hornblendite exposed near Tawma village are also being quarried for decorative stones, construction materials and road metals (Figure.2.3 A, B, C, D).



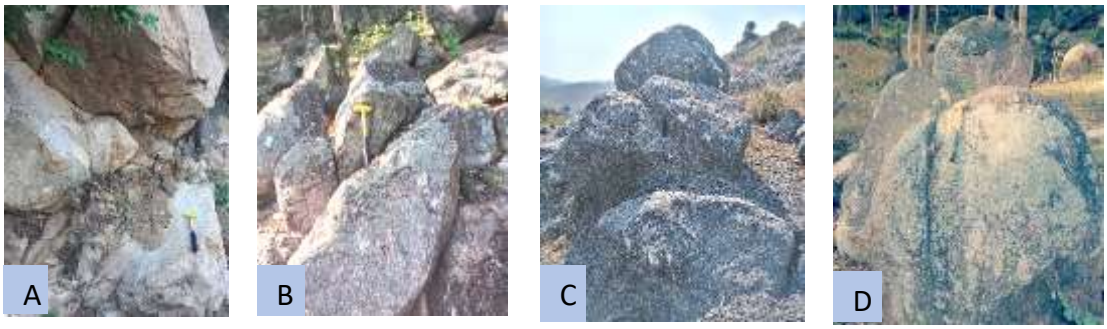


Figure 2.3 (A & B) Leucogranite, Microgranite and Biotite granite exposed at Tawma Taung are used as decorative stones, (C & D) Boulder natures of Hornblendite, Hornblende Diorite units cropped out near Mogaung village are used as decorative stones.

Schists and phyllites units of the research area are also being quarried for decorative stones. Local name of these rocks is called as "Shwelar-Ngwelar decorative stones" in the study area (Figure 2.3 A, B, C, D). Cutting machine for rock slab is shown in (Figure 2.4 A & B). These decorative stones are still popular among the enterprises of Micro and Small in the research area. Sale for current prices is as shown in Table 2.1.

Figure 2.3 (A, B, C, D) Packages of Shwelar-Ngwelar decorative stones.

Figure 2.4 (A, B) Hand cutting machine for decorative stones (Shwelar-Ngwelar Slab)

Table. 2.1 Current prices for Shwelar-Ngwelar decorative stones

Sr. No	Rock Slide Numbers	Package	Size in Box	Price (Kyats)
1	160	1	6″× 1.25″	12000
2	450	1	8″× 4″	98000
3	2880	1	4″× 1.25″	280000
4	1800	1	4″×2″	280000
5	1200	1	4″×2″	95000

In the study area, sand from the Pan Laung River, Zawgyi River, Myitnge River and Ayeyarwady River are used in construction of roads and buildings. Sand of Ayeyarwady River is the best quality. Current price for a pile of sand is 45000 kyats for sand of Ayeyarwady River (Figure 2.5).

Figure 2.5 Sand of Ayeyarwady River is used as construction for roads and buildings.

Rock powder of brecciated limestones and dolomitic limestones and limestones of this area are used in manufacturing of handmade bricks /sun-dried bricks. The size of the brick is (11″×5″×4″) and current price for brick is 200 kyats/ per piece (Figure 2.6).

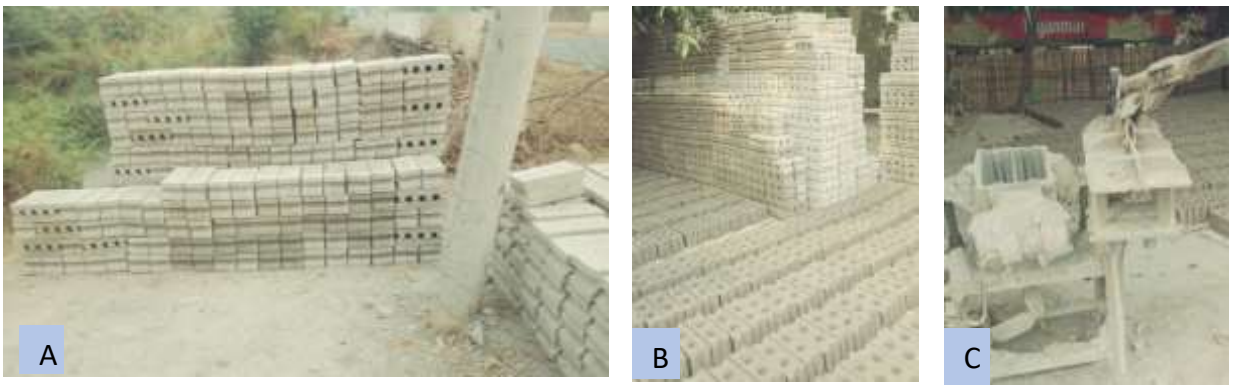


Figure 2.6 (A, B & C) Hand-made bricks /Sun-dried bricks (Byone-brick) are used as construction of buildings.

Various sizes of chippings of brecciated limestone, dolomitic limestones and limestones are used as foundation stones as well as road stone. Current price for One-pile is depending on the rock chippings size: (Big-sized 6″×9″), (Medium-sized 2″×4″), (Small-sized 1″×2″) and (Ngar-Moo Size 1/2″) (Figure 2.7).

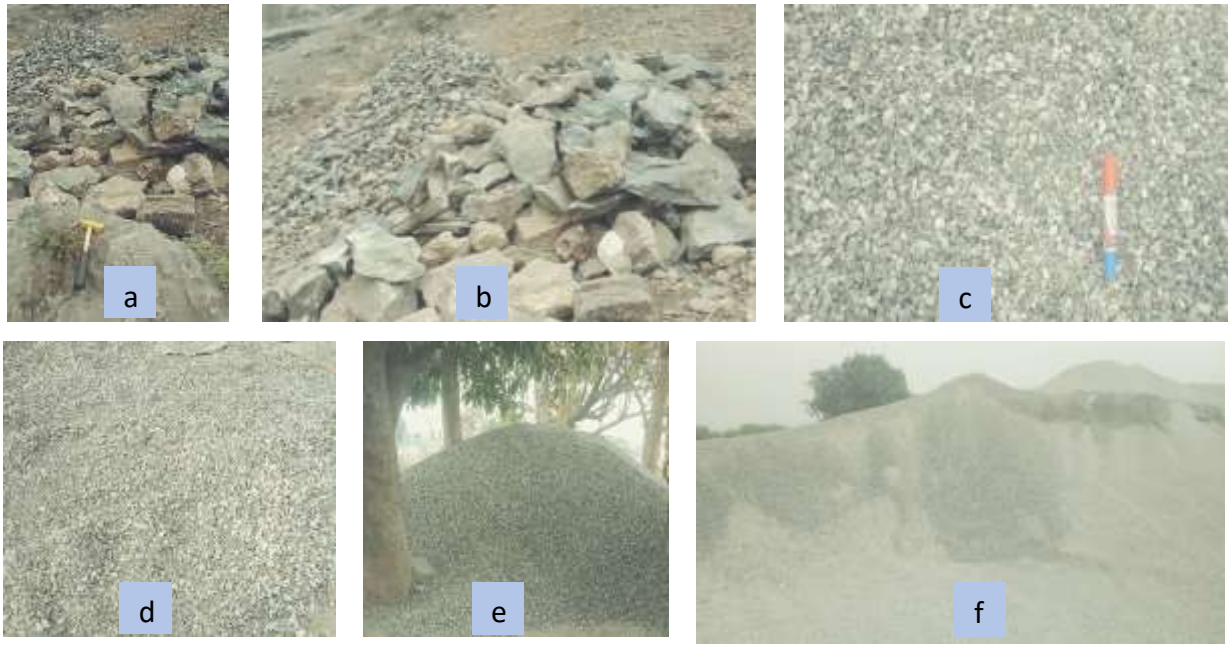


Figure 2.7. (a, b, c, d & e) Various sizes of chippings of brecciated limestone, dolomitic limestones and limestones of the study area are used in construction purposes.

In making concrete materials such as various diameter sizes of concrete barrels, concrete cover slabs, concrete tunnel pipes, and concrete fence poles (Figure 2.8). For making concrete materials using three kinds of materials ratio is 1 package of cement: 2 packages of sands: 4 packages of rock powders (3/4″ & 1/2″ Size). The best powder of rock is limestone unit. They all are registered in the list of Micro and Small Enterprises and some local people depend for their life by doing such jobs in the study area.

Sand and Rock Powders.

Figure 2.8. (A, B, C, D & E) Various forms of concrete materials can be made by using Cement, Sand and Rock Powders.

Heavy Enterprise (HE)

In the Kyaukse area, Heavy Enterprise (HE) are situated especially in SE of Kyaukse city such as cement factories of Alpha, Double Rhino and Sin Minn and one glass Factory. All factories need non-renewable resources like limestones, dolomitic limestones, dolomite, marbles and quartzites of the study area. Permian to Triassic age Plateau Limestones are well exposed at Thandawmywet, Nwalagauk and Taungni Taungs. It is a high-quality limestone mining area in Myanmar.

Geological information of industrial raw materials

Industrial Raw Materials in the study area are limestones, dolomitic limestones, marbles and quartzites. Age of the limestone and dolomitic limestones is (299 ma -199 ma), marble and quartzites is (199 ma-65 ma).

Depending on the application, the quartz must have varying grain sizes. Due to its weather-resistant and robust properties, quartzite is very well adapted as natural stone for floor coatings, gravel and other uses in the construction industry. The stone is also used as a raw material in the glass industry. Quartzite from Yinswe Taung is extracted for glass factory in the research area.

Low grade marbles of Thandawmyet and east of Shwethalyaung Hills are being used in cement factories. These rocks are metamorphosed Plateau Limestone. The marbles exposed near Sunye have been quarried for lime burning. The Plateau Limestones exposed at Dattaw Ridge and Thandawmyet Hill is also suitable for used in the cement industry. The limestones of the Pan Laung Formation and some limestones of the Plateau Limestone can be used in cement factory and in baking limestones for lime. Limestone has numerous uses: as a chemical feedstock for the production of lime used for cement, as aggregate for the base of roads, as fluxing materials in iron and steel industry, as white pigment or filler in products such as toothpaste or paints, as a soil conditioner, and as a popular decorative addition to rock gardens. Limestone is also used in sugar industry in the preparation of mill of lime which is added to cane juice to remove impurities. Lime is also an essential raw material in chemical industries and fertilizer manufacture. Analyzed results of limestones are shown in (Table 2.2) and analyzed samples locations is in (Figure 2.22).

Cement is a fine powder made up of calcium silicates, aluminates, and alumino ferrites, which are all hydraulic, cement components. There are 30 unripe components in all, divided into four categories (calcium, silica, alumina, iron).

Alpha Cement Plant

Alpha Cement Plant is situated in the Latitude 21° 36' 39″ N and Longitude 96°10'13″ and it also lies in Kyaukse area, NW of Thandawmywet Taung. Myanmar Conch Cement Co., Ltd. was incorporated by Anhui Conch Cement Co., Ltd. (China). The company is located at the industrial zone, Kyaukse. It is about 2 km to Kyaukse city and about 45 km to Mandalay city (Figure 2.9). Lime Quarry near the plant is shown in (Fig.2.10). Limestone and Dolomitic limestone exposed there (Figure 2.11 A & B).

Alpha Cement Limited is also famous for its low Alkali Content, Low Heat of Hydration, Excellent Consistency, Good Resistance to Sulphate and Chloride, High Early Strength, Low Expansion, No Cracks and Good Workability. Alpha Cement can be used in all general constructions especially in Major Projects where cement is to meet stringent requirements; it can

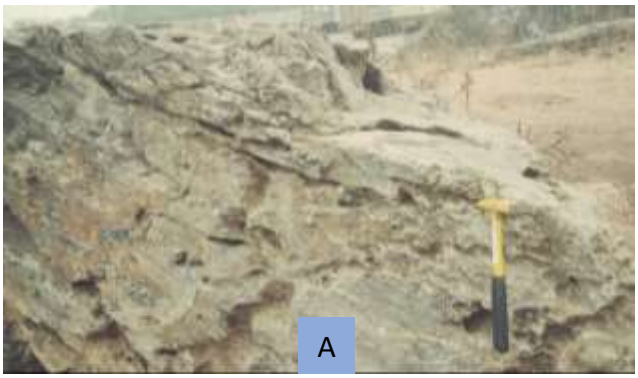
be used in concrete motors and grouts, concrete blocks and bricks, High rise buildings, dams, bridges etc.

Demand for cement in the construction of development of the Kyaukse District, Mandalay Region and Country Myanmar. Conch Cement Company was produced Alpha cement 5000 ton per day. Distribute two types of cement such as 50 kg bag and 30 Tons silo truck to users (Figure 2.12 A & B).

Figure 2.9. Cement plant of Alpha, Kyaukse

Figure 3.10 Lime Quarry for Alpha cement plant.

(GPS. 21° 36' 39″ N and 96°10'13″E)



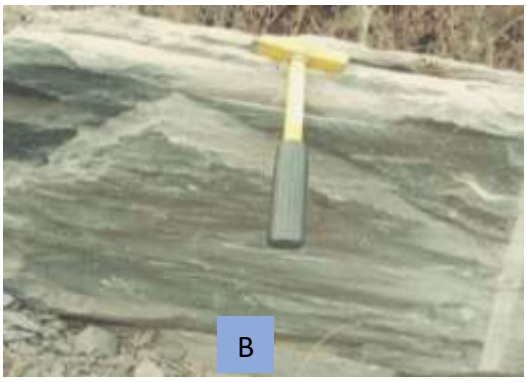


Figure 2.11. (A & B) Dolomitic Limestone and Limestone for Alpha cement at NW of Thandawmywet Taung (GPS. 21° 36' 39″ N and 96°10'13″E).

Figure 2.12. (A) Distribute type of Alpha cement 30 tons silo truck, and (B) 50 kg bag.

Double Rhinos Cement Plant

Double Rhinos Cement Plant is situated in the Latitude 21° 34' 38″N and Longitude 96°14' 57.83″ and it also lies in Kyaukse District, SE of Thandawmywet Taung (Figure 2.12 A). Lime Quarry near the plant is shown in (Figure 2.12 B). Limestone and dolomitic Limestone exposed there (Figure 2.13 A & B).

In Myanmar, this site is the best quality limestone mine-lot area, covers an area of 400 acres, it is currently the only one largest capacity 10,000 Ton per day of cement clinker production project in Myanmar country. Distribute two types (A) Casting-bricked and (B) 50 kg Bag (Figure 2.14 A & B&C).

The classes of this cement are 32.5 and 42.5. 32.5 class cement is suitable for ordinary concrete works, i.e., general housing construction, concrete pavement, concrete tiles, drain pipes, water tanks, masonry and plastering works, etc. 42.5 class cement is suitable for high permeability and high temperature resistant engineering, highways roads, high-rise buildings, all kind of concrete piles and poles, it is also recommended for construction projects, general industrial and civil construction.

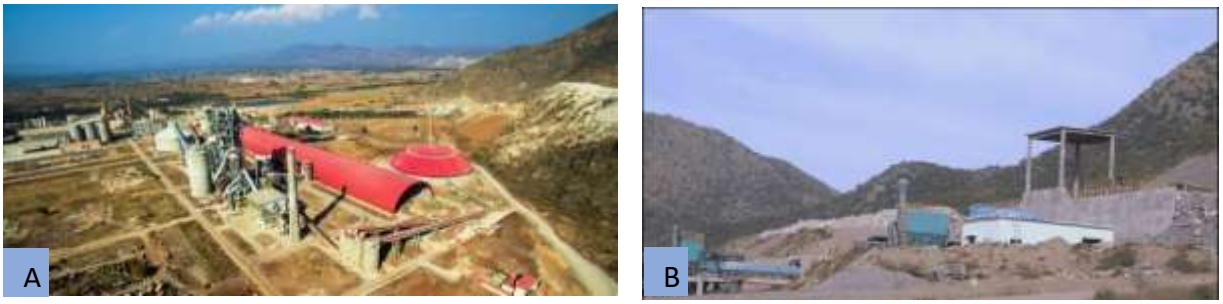


Figure 2.12. (A) Cement plant of Double Rhino in the Kyaukse Industrial Zone.

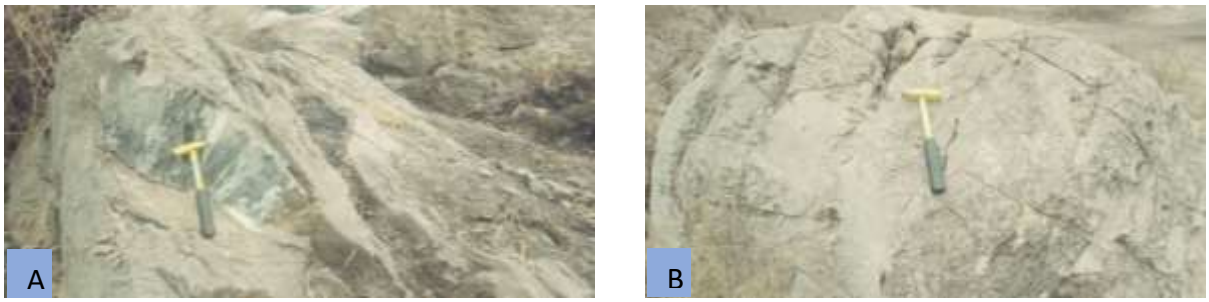


Figure 2.13. Exposures of Limestone and Dolomitic limestone for Double Rhino cement Plant at SE of Thandawmywet Taung (GPS. 21° 34' 38″ N and 96°14' 57.83″E).

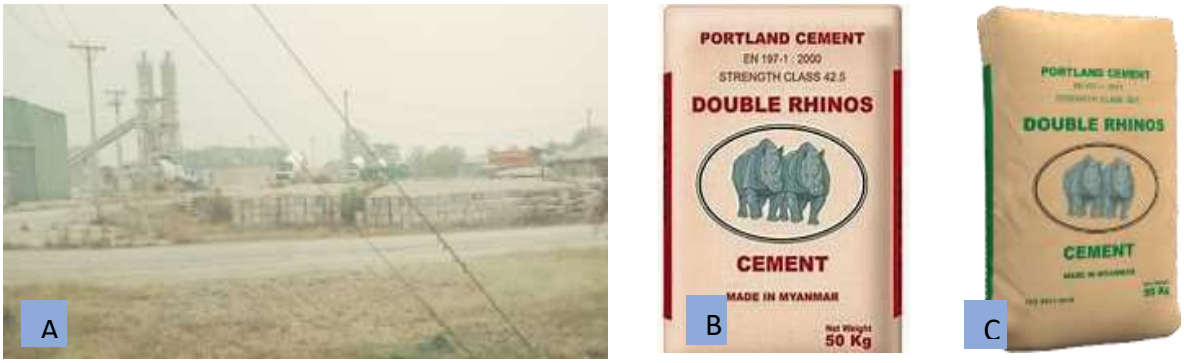


Figure 2.14. Distribute type (A) Casting-brick and (B & C) 50 kg Bag of Double Rhino cement.

Sin Minn Cement Plant

Sin Minn Cement Plant is situated in the Latitude 21° 36' 08″ N and Longitude 96°15' 13.83″E and it also lies in Kyaukse District, west of Nwalagauk Taung (Figure 2.15) Outcrops of

Limestones and Dolomitic limestones are shown in (Figure 2.16 A&B). Sin Minn cement is symbolized by the strength of an Elephant. It offers more than just a solution to the general construction industry but also a brand of imperceptible standard, resonates quality, power, maturity, resilience, durability and reliability. Distribute type of Sin Minn cement is shown in (Figure 2.16 C).

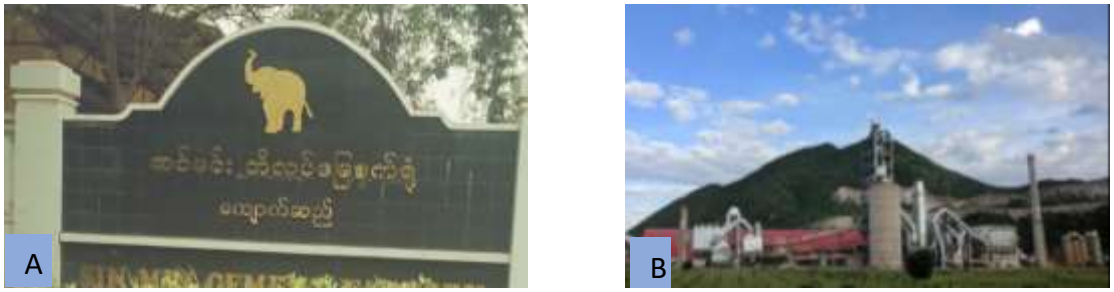


Figure 2.15. (A&B) Cement plant of Sin Minn in the Kyaukse Industrial Zone (21° 36' 08″ N and 96°15' 13.83″E).

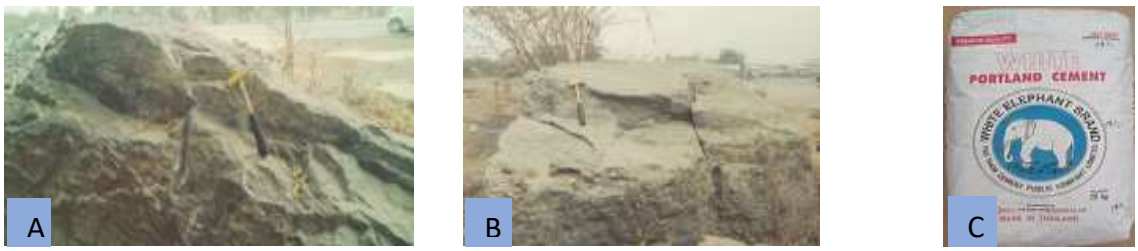


Figure 2.16. (A & B) Outcrops of Limestone and Dolomitic limestone for Sin Minn cement Plant at west of of Nwalagauk Taung (21° 36' 08″ N and 96°15' 13.83″E). (C) Distribute type of Sin Minn cement.

Glass Factory

Glass factory is situated in the Latitude 21° 35' 31.28″ N and Longitude 96°12' 47.56″E and it also lies in Kyaukse District, south of Yinswe Taung (Figure 2.17). Phyllite, schist and quartzite units are well exposed at the Yinswe Taung. Quartzite from Yinswe Taung is extracted for glass factory (Figure 2.18). The important Industrial Raw Materials for manufacture of glass are quartzites, dolomites, limestones, feldspars, Ssodium sulphates (salt cake), carbons and soda ashes. Mirror stands in the Glass Factory is shown in (Figure 3.20).

Cullet occurs as a byproduct from the Glass Factory and it can be reused in the manufacture of glass (Fig.2.19).

Figure 2.17. (A, B) Glass Factory, near Yinswe Taung, Kyaukse Industrial Zone. (C) Quartzite unit from Yinswe Taung (21° 35' 31.28″ N & 96°12' 47.56″E).

Figure 2.18. (A) Bullet-protect mirror, (B & C) Mirror Stands in the Glass Factory.

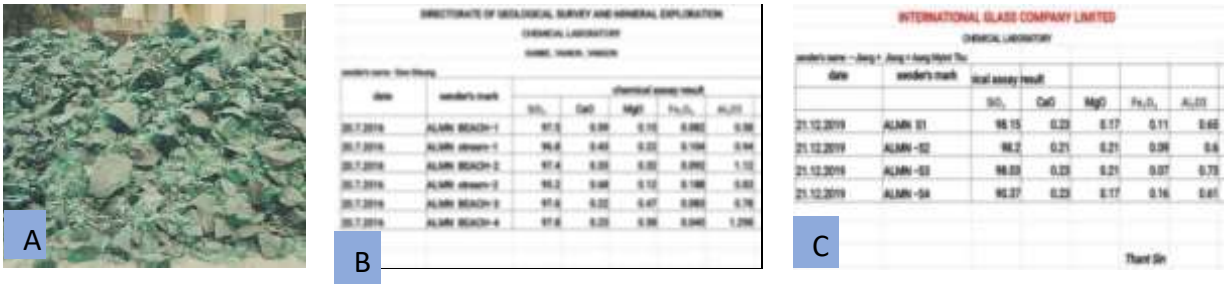


Figure 2.19. (A) Cullet is the byproduct of manufacture of glass in the Glass Factory. (B&C) Geochemical analysis of raw materials for Glass Factory.

Ore minerals in the study area

Copper ore

In the study area, copper ore is found as veins and in the Ye-Yaman tract, south-east of Kyaukse city, copper are is associated with barites. These veins are small and impersistent. Copper mineralization is also found in the Lower Paleozoic rocks as fissure-filled deposits, (Maung Thein, 1984). Copper mineralization occurs in this district is confined to the Late Precambrin and Lower Paleozoic rocks. Common copper ores occur as chalcopyrite, azurite and malachite (Fig.2.20). The concentration of copper (Cu) content ranges from 0.01 % to 8.01 % in (Table 2.3). Copper is ductile and a great conductor, its main use is in electric generators, household/car electrical wiring, and the wires in appliances, computers, lights, motors, telephone cables, radios and TVs. The old adit is found in the vicinity of Kyauk-Aii village.

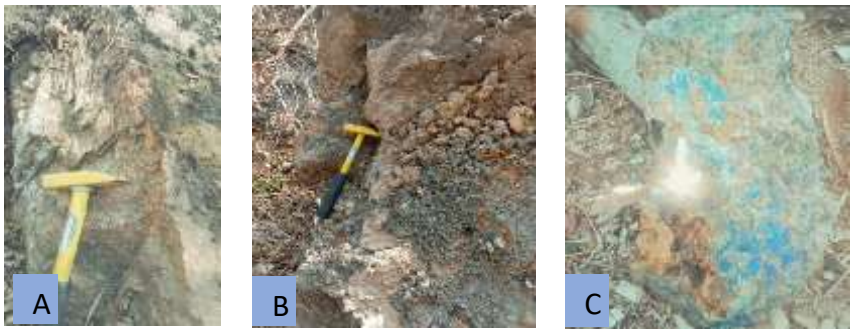


Figure 2.20. Fissure-filled types copper mineralization in Old adit, vicinity of Kyauk-Aii village (N 21° 37'19.82" and E 96° 16' 30.13")

Iron ore

Iron commonly found at the south of Kyauk-Aii village and the ore minerals are magnetite, hematite and limonite. These metallic ore found in phacoidal limestone unit of Nyaungbaw Formation of Silurian age. The ore is a coarse-granular mixture of magnetite and manganese ore.

It occurs as small, lens-shaped massed (Figure 2.21 A & B). The mode of occurrence suggests that the ore lenses had been originally sedimentary iron nodules or lenses in limestone. The concentration of iron (Fe) content ranges from 2.52 % to 24 % (Table 2.3). It is the most useful industrial raw mineral and the primary use of iron ore (98%) is to make steel**,** for home and other construction process.

Figure 2.21. (A&B) Massive type Iron ores occurred in phacoidal limestone unit of Nyaungbaw Formation (N 21° 37'19.82" and E 96°16' 30.13")

Lead-Barite ore

Barites mineralization found in the west of Kyauk-Aii village and at Tha-mone-ye-htwet, barite associated with lead in the host rocks of thinly bedded limestones and siltstones (Fig.2.22 A, B & C). of Ordovician age, it is about 12 km from north-east Kyaukse city.

The barite deposits also observed as fissure-filled epigenetic veins, although the source probably was endogenous (Maung Thein, 1984). The concentration of barite (Ba) content ranges from 0.03 % to 10.66 %. Lead (Pb) is ranges from 0.01 % to 5.01 % (Table 2.3). It is an important industrial raw mineral and it is used as manufacture of white paint, in the production of wall paper and in the drilling mud.

Figure 2.22. (A, B & C) Barite associated with lead in the thinly bedded limestones and siltstones at west of Kyauk-Aii village and at Tha-mone-ye-htwet, (N 21° 37'19.82" and E 96°16' 30.13").

Manganese ore

At the southern part of Shantaung-U Taung, the manganese ore bands occurred in the dark blue marbles layers and the ore bands found as widely distributed (Fig.2.23 A&B). These manganese ore bands are interlayered with thin-bedded blue marble and calc-silicate rocks. The bands are generally two inches to six inches in thickness. There are at least six ore bands having a cumulated thickness of about four feet. The thickest is traceable along the strike of the enclosing marble which is approximately east-west direction at that locality. According to Maung Thein and Soe Win, 1969, these ores can be said that they have been originally manganese of sedimentary origin later metamorphosed together with the host rock. The grade of ore is pyrolusite (MnO_2). The concentration of manganese (Mn) content ranges from 0.13 % to 6.11 % (Table 2.3). Manganese is a grey-white, pinkish-gray, chemically active element**,** hard and very brittle metal. Manganese ore is primarily used in steel and iron production.

Figure 2.23. (A, B & C) manganese ore bands occurred in the dark blue marbles layers at the southern part of Shantaung-U Taung (N 21° 37'19.82" and E 96°16' 30.13").

Estimate annual production of limestones from the Thandawmywet and Nwa-la-gauk Taungs in the study area

Major oxide composition of cement is SiO2 (20.87 %), CaO (60.63 %), MgO (1.51 %), Fe_2O_3 (3.53 %), Al_2O_3 (5.29 %), Free Lime (0.86 %), SO_3 (2.25 %), IR (2.01 %). Production rate of limestones from NW of the Thandawmywet Taung (**Work Site I**) is 2000 metric tons /per day and for annual production rate of limestones (One year /300-days) probable reserves is approximately 600,000 metric tons. Limestones quarry mine life is last about 50 years for NW of Thandawmywet Taung and that is about 30,000,000 metric tons limestones will be used in future (Fig. 2.22). Production rate of limestones from SE of the Thandawmywet Taung (**Work Site II**) is 1800 metric tons /per day and for annual production rate of limestones (One year /300-days) probable reserves is approximately 540,000 metric tons. Limestones quarry mine life is last about 30 years for SE of Thandawmywet Taung and that is about 16,200,000 metric tons will be mined in future (Figure 2.22). Production rate of limestones from the Nwalagauk Taung (**Work Site III**) is 800 metric tons /per day and for annual production rate of limestones (One year /300-days) potential reserves is approximately 240,000 metric tons. Limestones quarry mine life is last about 20 years for Nwalagauk Taung and that is about 12,000,000 metric tons will be consumed in future (Figure 2.22).

Table (2.2) Major oxides (%) composition of limestone units from the Thandawmywet and Nwa-la-gauk Taungs in the study are

Sample No/ Symbol	Th-1 ▮	Th-2 ▮	Th-3 ▮	Th-4 ▮	Th-5 ▮	Th-6 ▮	Th-7 ▮	NL-1 ▮	NL-2 ▮	NL-3 ▮
CaO	44.78	44.68	48.4	50.63	48.4	50.63	46.58	40.4	39.68	40.25
SiO_2	8.96	10.2	4.6	3.69	4.6	3.69	9.2	4.5	6.96	9.2
Al_2O_3	0.42	0.13	3.9	0.34	3.6	0.34	0.13	3.6	0.42	0.13
Fe_2O_3	0.53	0.15	0.12	0.2	0.1	0.2	0.17	0.1	0.33	0.16
MgO	1.94	1.91	1.98	2.00	1.45	1.41	1.58	0.67	1.46	0.51
K_2O	0.3	0.3	0.36	0.15	1.44	13.56	10.46	11.67	9.67	9.97
Na_2O	0.03	1.03	0.03	0.3	0.3	0.03	0.03	0.03	0.3	0.3
Cl	1.09	0.12	0.31	0.03	0.03	0.06	0.12	0.31	0.03	0.03
SO_3	0.03	0.02	0.02	0.05	0.23	0.03	0.02	0.02	0.05	0.043
LOI	41.48	41.37	40.00	42.35	40.30	31.38	32.39	39.00	41.3	39.54
Total	99.56	99.91	99.72	99.74	100.4	100.3	99.6	100.3	100.2	100.1

Figure 2.24. Map showing the analyzed sample locations of limestones and Limestone Quarry Work Sites of Thandawmywet and Nwa-la-gauk Taungs in the study area.

Table 2.3 XRF analyzed results of major and minor elements constituents in rock units of study area

Elements	L9	L14	L15	L16	L17	L20	L21	L28	L29	L30	L32	L38	L43	L48	L50	L53	L56	L57	L64	L66
Mg	1.01	0.16	2.93	0.69	0.82	0.72	0.21	0.29	1.70	0.40	0.87	0.46	0.77	0.30	0.14	0.10	9.64	1.81	-	3.94
Al	9.59	8.11	10.10	8.55	10.30	8.40	8.22	8.49	9.72	7.36	9.20	9.46	9.29	8.35	9.16	9.38	5.12	9.16	8.43	10.60
Si	55.60	66.80	44.30	59.20	57.30	58.90	64.50	64.70	56.80	66.20	59.60	59.40	60.40	63.10	62.00	56.30	38.60	53.90	63.60	38.70
P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	0.23	0.15	0.11	0.20	0.11	0.13	0.16	0.15	0.11	0.14	0.13	0.13	0.24	0.25	0.12	0.15	0.10	0.13	0.12	0.30
Cl	0.66	0.33	0.71	0.78	0.30	0.69	0.37	0.36	0.31	0.89	0.63	0.79	0.32	0.40	0.30	0.71	0.53	0.75	0.27	0.25
K	13.80	11.30	6.40	9.30	10.50	9.71	12.30	12.70	9.58	10.40	9.50	11.80	9.37	13.20	12.20	8.34	2.55	6.22	17.10	1.49
Ca	5.38	3.70	8.25	6.15	6.27	6.87	3.53	4.02	4.91	4.65	5.74	5.40	5.63	3.98	4.44	7.74	18.30	7.78	1.06	16.30
Ti	0.70	0.44	2.01	0.91	0.85	0.83	0.44	0.36	1.17	0.62	0.87	0.75	0.88	0.53	0.46	1.10	1.13	1.27	0.07	1.85
V	0.01	0.01	0.04	-	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.03	0.02	0.02	-	0.01	0.01	-	0.00	0.09
Cr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20	-	-	-
Mn	1.23	6.11	0.38	3.21	1.19	5.21	0.13	0.13	5.21	0.14	3.24	0.17	1.24	0.15	0.13	2.22	1.41	0.28	0.19	2.38
Fe	5.46	2.88	17.30	7.19	5.46	5.51	4.14	3.45	10.70	4.32	7.79	6.07	7.04	3.99	5.18	9.01	21.00	12.70	2.52	24.00
Co	0.02	0.01	0.06	0.03	0.01	0.03	0.01	0.00	0.01	0.02	0.03	0.02	0.01	0.00	0.01	0.03	0.09	0.04	0.00	0.02
Ni	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.14	0.03	0.01	0.01
Cu	5.01	1.01	8.01	0.01	3.01	4.01	2.01	0.01	8.01	0.01	6.01	3.01	0.01	6.01	2.01	0.01	1.05	0.01	5.01	1.01
Zn	0.02	0.01	0.05	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.04	0.03	0.01	0.04
Ga	1.01	0.01	2.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ge	0.00	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	-	-	0.00	-
As	-	0.00	0.00	-	-	-	-	-	-	-	-	-	0.00	0.00	-	-	0.00	-	0.00	-
Se	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Br	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rb	0.11	0.13	0.06	0.09	0.11	0.08	0.11	0.11	0.09	0.08	0.08	0.10	0.10	0.08	0.11	0.05	0.02	0.05	0.16	0.01
Sr	0.17	0.08	0.25	0.01	0.17	0.17	0.09	0.10	0.08	0.09	0.12	0.14	0.16	0.14	0.09	0.23	0.22	0.19	0.02	0.26
Y	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.01
Nb	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	-	0.01	0.00	0.00	0.00	0.05	-
Mo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ru	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rh	-	-	0.00	-	-	-	-	-	0.00	-	-	-	-	-	-	-	-	-	-	-
Pd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ag	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Environmental impact of cement factories in the south-east of Kyaukse City

In the study area, Heavy Industries Enterprise of Cement Plants and Glass Factory are located about the 2 km SE of Kyaukse City. Cement is the primary material for building and civil engineering constructions. Therefore, the cement manufacturing sector plays a vital role in the nation’s economic development.

The main environmental issues associated with cement productions are the consumption of raw materials and energy use as well as emissions to air. Negative impacts of cement production plants are primarily loss of vegetation in quarry areas, SE of Kyaukse.

The increasing harvesting of raw materials for mounting cement manufacturing causes reduction in quantity of the non-renewable resources of limestones and dolomitic limestones exposed at Thandawmywet, Taungni and Nwa-la-gauk Taungs, (Figure 2.24) and (Figure 2.25 A & B). The cement factory activities linked to harvesting of the non-renewable resources from limestones exposures natural surroundings, damages the green landscape in the SE of Kyaukse City which is the habitat of flora and fauna exposing to the risk of ecological imbalance. The continuous extraction of these precious resources of limestone outcrops it to the risk of depletion in future. Besides the processing phases of raw materials in the factory releases dusts, noises, greenhouse gases especially carbon dioxides that contaminates the environment and aggravates the climate change (Figure 2.26 A & B).

In the cement industry areas, SE of Kyaukse City there are some major environmental impacts such as solid waste, wastewater, flue gas, and noise. The cement industry requires a large amount of energy to use in the whole process and to generate this. Even though some renewable resources use in some industries still a large amount of fossil fuel use for this process. So due to this matter, major impacts on the environment are CO_2, CO, NO_2, SO_2, and Volatile Organic Compounds (VOCs).

The emissions of those gases into the atmosphere can pose environmental problems but also affect public health. Climatic changes, global warming, ozone depletion, acid rain and biodiversity loss can cause the reduction of crop productivity, etc. It integrates the effects of various variables, such as soil properties, topographic attributes, tillage, and plant population. Water is used at some stages in the cement production process. Wastewater discharge to the environment causes to contaminate water sources such as rivers of Pan Laung, Zawgyi, Myitnge and Ayeyarwady and groundwater sources in the research area.

Noise pollution occurs during the whole process of the cement production process. From preparing raw materials, from the clinker burning and production process, from material storage, the heavy machines large fans used in the process. There are some impacts on rock-quarries near populated areas in Kyaukse. It can be directly affected high-story buildings and especially concrete buildings. The repeated blasting of mine quarries can cause the vibrating and crushing of building walls and then all structures can collapse.

Dust emission pathways can be minimized by the frequent spraying of water, oil, or other materials on soil stabilization. Air pollution caused by particular matters (PM) is one of the major problems of environmental pollution.

In view of the points mentioned above, it is suggested that the continuous environmental impact assessment studies are to be carried out in the cement industry areas, SE of Kyaukse, to be able to obtain environmental clearance. In addition, the production plants should be established in accordance with the Federal Environmental Protection Agency's rules and guidelines for predicting the ground level concentration of pollutants.

Figure 2.25. (A&B) Depletion of non-renewable resources of limestone and dolomite exposures near cement plant, Kyaukse area.

Figure 2.26. (A) Dust emission can be seen in limestone quarry of cement plant in the Kyaukse area. (B) Flue gas and smoke emitted from the cement plant in the Kyaukse area.

Conclusion

The study area is situated in Sintgaing and Kyaukse Townships, Kyaukse District, Mandalay Region. It lies between Latitude 21° 31' N to 21°47' N and Longitude 96°07' E to 96°17' E in UTM Map Sheet No.2196-02 and 06. In the project area, Upper Paleozoic Permian-Triassic (299ma-199ma) age rock units and Jurassic-Cretaceous (199ma - 65ma) metasedimentary rocks and their metamorphic equivalents units are well exposed. These rocks are intruded by biotite granites, microgranite, leucogranite, hornblende diorites, and a few hornblendites units of Early Tertiary in age (65ma-55.8ma).

All these above units are cropped out in the northern part of Singaung, Pann Taung and Tawma Taung, western and south-western part of Nwa-le Taung. Hornblende diorite is exposed in the northern part of Pann Taung and hornblendite and pegmatite dykes occur in the western part of Pann Taung (Near Mogaung). Limestones are exposed at eastern part of the study area (Dattaw, Thandawmyat, Taungni and Nwa-la-gauk Taungs.

This research work is aimed to explore the needs of MSME and HE with the natural resources of industrial raw minerals such as quartzite, marble, limestone, and dolomitic limestones units and also for the decorative stones as well as road materials and construction materials such as biotite granites, microgranite, leucogranite, hornblende diorites, hornblendite, calc-phyllite, schist, gneiss, calc-silicate, quartzite, marble and limestone of the study area are attempted. Besides, the non-renewable ores such as lead-barite, copper, iron and manganese ores are observed and their content percentage and uses are described.

Production of limestones for cement plants will take the quarry mine life last about 50 years for the Thandawmywet Taung and 20 years for the Nwa-la-gauk Taung in the future. The important

things to be dealt with in this area is the prohibition of the over harvesting of non-renewable rocks such as limestones and dolomitic limestones for mounting cement manufacturing in the future and the control of the tasks for repeated blasting of quarries near populated areas. Moreover, the main environmental issues associated with cement productions need to be detected annually and to mitigate these impacts with the aid of advanced technological methods.

The results of this research works are to be applied for the proper production of natural resources. The research will fulfill the academic needs of Kyaukse University, and use the teaching programs for the Department of Geology. This research is the first to study the Micro, Small and Medium Enterprises (MSME) and Heavy Enterprise (HE) with the observation of the natural resources found in the Kyaukse area, especially from both views of geological and environmental perspectives.

Acknowledgements

Firstly, the author would like to express my deepest gratitude to Dr. Yee Yee Oo, Rector of Kyaukse University, for giving me an opportunity to write this research paper. Then, I also give my special thanks to Dr. Ni Ni Yin, Dr. Myint Yee, Dr. Winn Minn Thein, Pro-Rectors of Kyaukse University, for their kindness and valuable encouragement and suggestions to do this research.

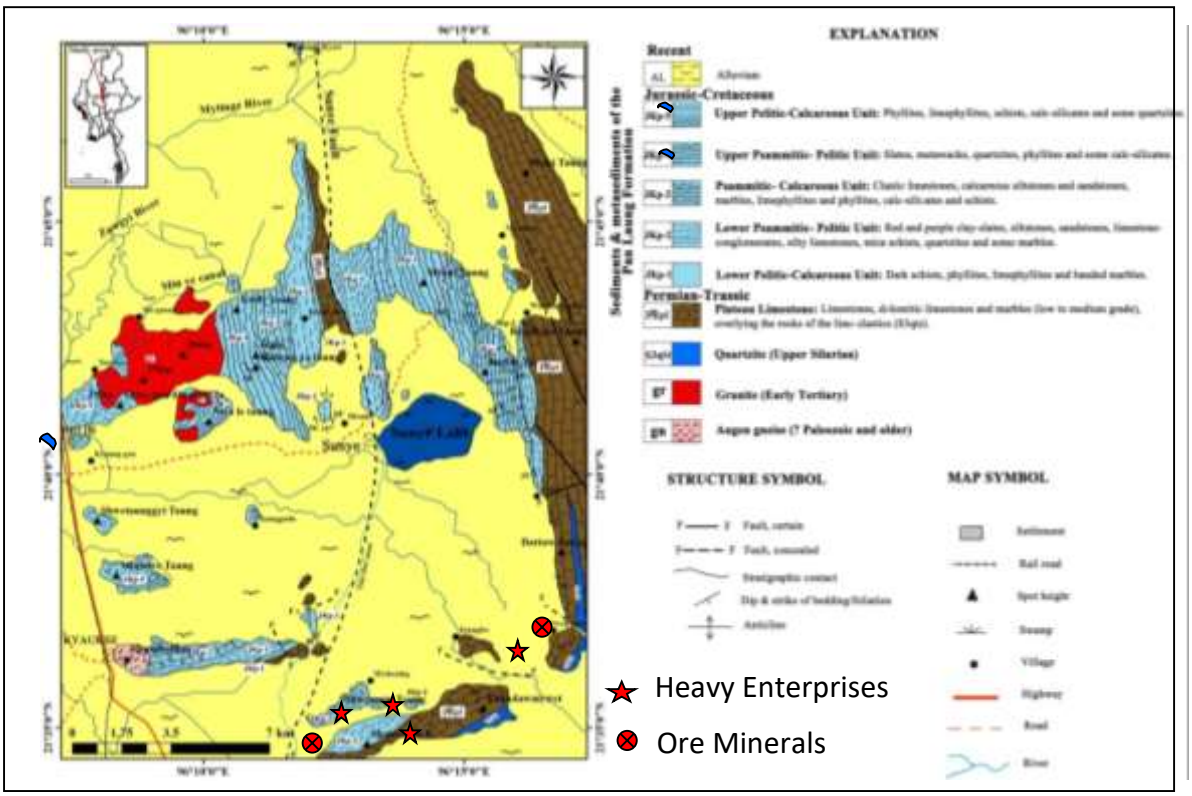


Figure 2.26. Geological map of the study area (Modified after Myint Thein,1984).

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