 ISSN 2676-1386 (Print); ISSN 2676-1394 (Online)

Industrial rocks and minerals in Chandragiri-Chitland Range, southwest of Kathmandu Valley

***Manajari Acharya and Kabi Raj Paudyal**

Central Department of Geology, Tribhuvan University, Kathmandu, Nepal
**Corresponding author: acharya11.manjari@gmail.com*

ABSTRACT

Geological mapping along Chandragiri-Chitlang Range, southwest of Kathmandu valley shows that the area is a potential on non-metallic minerals especially industrial rocks like metasandstone, limestone, quartzite, dolomite and slate belonging to lower four geological units of the Phulchauki Group of the Kathmandu Complex. These units are the Tistung Formation, the Sopyang Formation, the Chandragiri Limestone and the Chitlang Formation from older to younger stratigraphy. These non-metallic mineral resources are considered potential in terms of quantity and quality and suggested for further prospecting and exploitation systematically and scientifically. Limestone distributed within the units of the Chandragiri Limestone and the Chitlang Formation may be the good raw material for cement industries. Similarly, Quartzite, metasandstone, dolomite and slate in the area may be the good source rock for the construction purposes. Existing mining of these resources in many areas are very traditional, haphazard and unscientific. These resources are located very near from the capital city of Nepal and there is great demand of these materials forever. However, systematic prospecting, exploration and exploitation techniques with zero waste mining concepts are not being applied for such fruitful resources. Non- metallic mineral resources present in the Chandragiri-Chitlang range helps industrial and economic development of a country and ultimately plays vital role to increase the national GDP if explored, exploited and utilized properly.

Key words: Chandragiri-Chitland Range, Kathmandu Complex, Phulchauki Group, Industrial rocks and minerals

INTRODUCTION

There are various metallic as well as non-metallic mineral deposits in different parts of the country. Nepal Himalaya is rich in non-metallic mineral resources like limestone, dolomite, marble, magnesite, and talc minerals, decorative, construction and dimension stones which have significant commercial value. The present study area lies in between 27°35'00"N to 27°43'30" N latitudes and 85°09'30"E to 85°19'00"E longitudes in Chandragiri-Chitlang section in the southwestern hills of the Kathmandu valley. Hagen (1969) brought forward the nappe concept in the Nepal Himalaya. He has reported the Nawakot Nappe made up of low-grade metamorphic rocks underlain by a medium-to high-grade metamorphic rocks of the Kathmandu Nappe. The study area mainly represents a part of the Kathmandu Complex, which is further divided into the Bhimphedi Group and the succeeding Phulchauki Group (Stöcklin and Bhattarai, 1977). A preliminary report published by ESCAP (1993) and mineral resources of Nepal (2004) published by Department of Mines and Geology are the main sources of information for the mineral resources of the study area. Sedimentary and low-grade metamorphic rock succession of the study area (4.8 km thick) is occupied by the four geological units as the Tistung Formation, Sopyang Formation, Chandragiri Limestone and Chitlang Formation from older to younger respectively (Acharya 2018). Low-grade metamorphic rocks like metasandstone, phyllite, argillaceous limestone, ortho-quartzite and slate dominate the study area (Acharya and Paudyal, 2019). The study area consists of many industrial minerals, decorative stones and dimension stones. Investigation on the stratigraphic control and the nature of mineralization are helpful to find out the possible new locations for exploration and to find the mineral resources for exploitation. The present study has aimed to overcome the mineralization zone in the study area and to prepare detail geological map in 1:25000 scale. Limestone, dolomite, metasandstone, quartzite and slate are the potential non-metallic minerals in the study area. Sustainable development of such resources is considered as the good source of the economy of a country.

LOCATION AND ACCESSIBILITY

The study area lies in Chandragiri-Chitlang section in the southwestern hills of the Kathmandu valley covering some parts of Kathmandu, Makwanpur and Dhading Districts (Fig. 1). The study area is of about 16 km from Kathmandu to Chandragiri and 13 km from Chandragiri to Chitlang. It is mainly connected by the Prithivi Highway from Kathmandu, which is linked further with many local earthen roads and foot trails.

OBJECTIVES

The main objective of the study is to prepare a prognostic map for mineral resources of the study area. The specific objectives are as follows:

i. Geological mapping around the Chandragiri-Chitlang range in 1:25,000 scales.

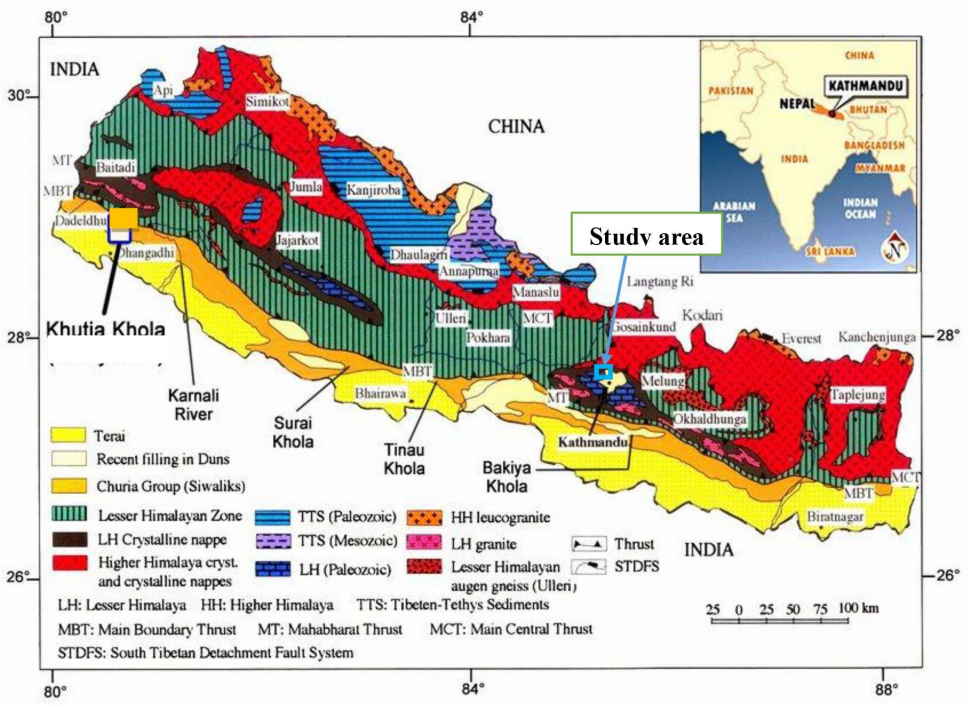

Fig. 1: Geological map of Nepal showing location of the study area (after Upreti and Le Fort, 1999)

ii. To prospect the mineral resources available in the area.

iii. To study the geological control of mineralization in the area.

iv. To assess the potentiality of the mineral resources for the further prospecting and exploitation.

METHODOLOGY

Various materials and equipments with systematic methodology (Fig. 2) were adopted. Different geological maps, research articles, journals, and reports were collected and reviewed for the desk study. The field work was carried out and the primary data were collected through direct observation on field. Different geological traverses along ridges, streams, motor roads and trails were carried out. Mainly mineral sample were also collected and marked the mineralized zone on the topographic map. Similarly, the geological reserve of the limestone deposit is determined by cross-sectional-method.

Geological and Mineralogical Mapping

The geological and prognostic map (Fig. 3) of the Chandragiri-Chitlang area was prepared in 1:25000 scales. The study area has covered by the rocks of the Lesser Himalaya succession of the Kathmandu Nappe of the Phulchauki Group in the central Nepal. Sedimentary and low-grade metamorphic rocks succession of the study area can be mapped under the four geological units as the Tistung Formation, Sopyang Formation, Chandragiri Limestone and the Chitlang Formation from older to younger respectively. The average thickness of the Tistung Formation is 1000 m, Sopyang Formation is 750 m, Chandragiri Limestone is 875 m and Chitlang Formation is 1750 m on the study area as determined from the geological cross-sections.

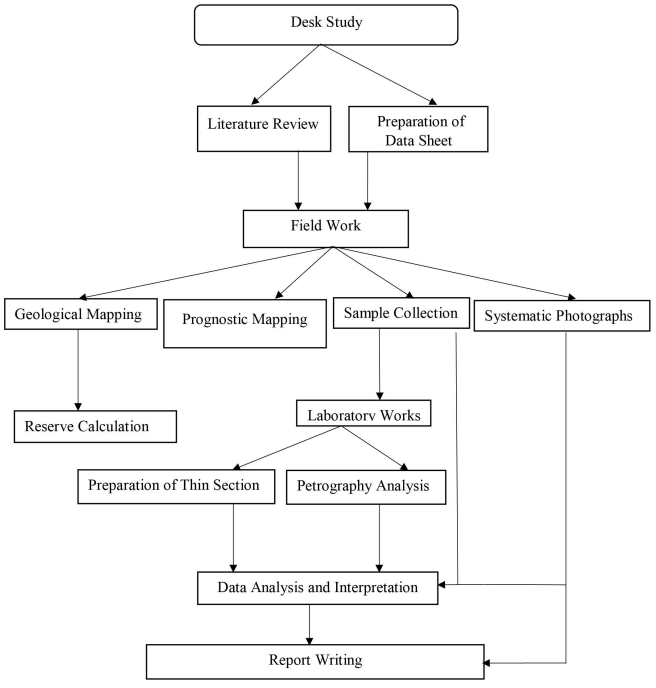

Fig. 2: Flow chart showing detailed methodology

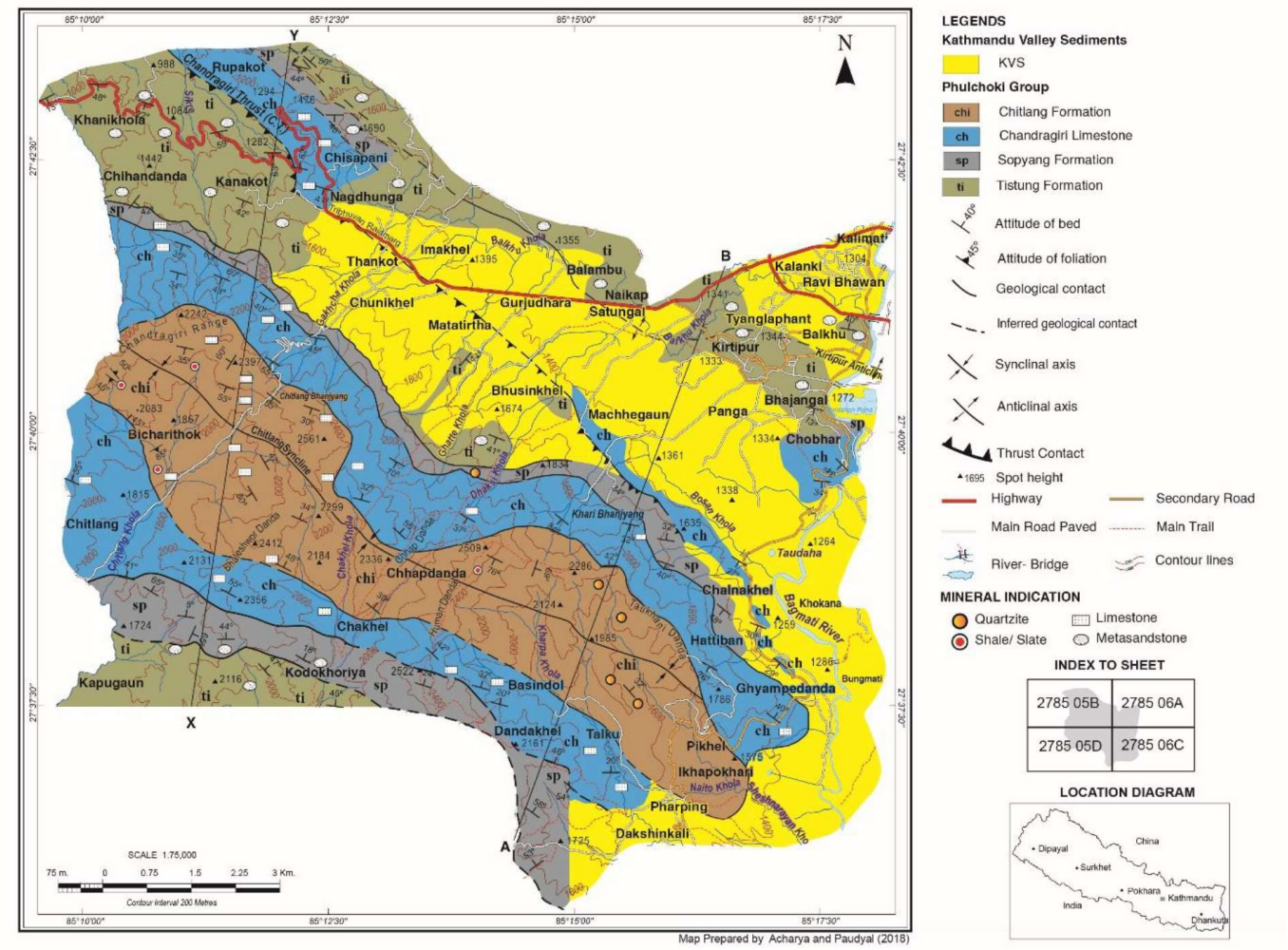

Fig. 3: Geological and prognostic map of the Chandragiri-Chitlang Range, SW of Kathmandu Valley

Non-metallic mineral resources and geological control

Limestone

Limestone is a sedimentary rock composed mainly of calcite and dolomite, and is dominantly distributed within the units of the Chandragiri Limestone and the Chitlang Formation (Fig. 4) and it may be the good raw material for cement industries. It is the cliff forming unit in the region with dense forest. The topography is of limestone deposit is relatively steep and covered by dense forest. Massive, huge outcrops of limestone (Fig. 5) on the Chandragiri Limestone may be cement grade. Similarly, thick-bedded argillaceous limestone with minor amount of white, fine-grained ortho-quartzite, pelitic phyllite and micaceous metasandstone are also observed as sub-ordinate amount within the unit. The lower part of the succession of the Chandragiri Limestone consists of argillaceous-arenaceous partings, yellowish brown weathered, and thin-to medium bedded limestone. In some area, the proportion of limestone with other rocks like phyllite, quartzite, and dolomite is found in 4:1. The caves and vugs are fairly common in various parts. In addition to the production of cement, limestone may also be used as building material and manufacturing of Iron depending on the chemical composition. In the study area, local community has crushed the limestone block into gravel size and are using as construction material (Fig. 6). The total gross geological reserve calculation of the limestone deposit is given below:

Total area of limestone deposit = 13,500 m^2 (from graphical method); estimated depth of mining = 75 m, total volume of limestone deposit = total area × depth= 13,500 m^2× 75 m= 1,012,500 m^3.

Quartzite

Quartzite is common rock in the Nepal Himalaya which is excellent source rock for the dimension stones, flooring stones, slabbing stones, paving stones, wall making and for building construction. White, laminated quartzite is distributed at the upper part of the Chandragiri Limestone (Fig. 7). The

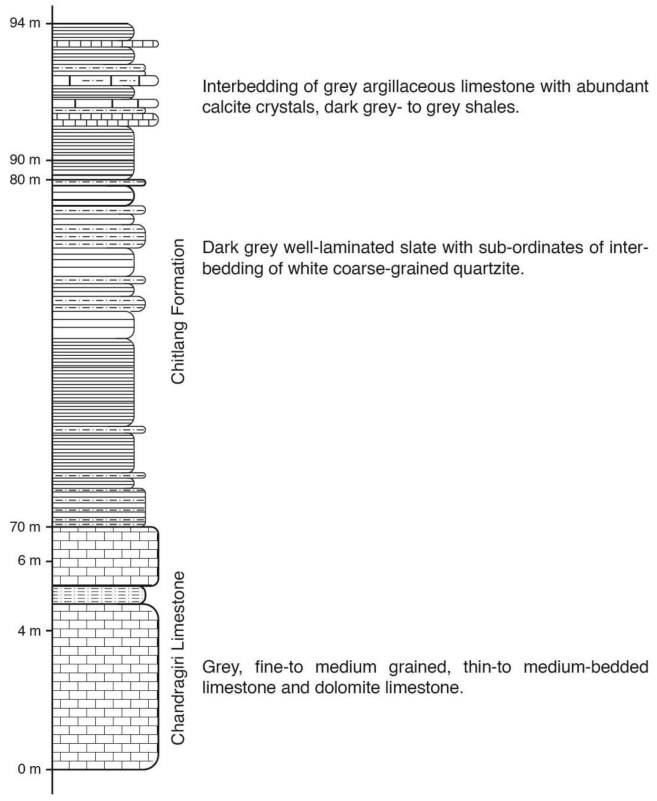

Fig. 4: Detailed columnar section of part of the Chandragiri Limestone and the Chitlang Formation about 2 km downhill from Chitlang Bhanjyang

Fig. 5: Outcrop showing massive limestone bed of the Chandragiri Limestone about 1.5 km uphill from Godam, Thankot

middle part of the Chitlang Formation is also comprised of whitish grey quartzite. The upper part of the Chandragiri Limestone comprised of partings of dark grey-to light grey phyllite subordinates with white, slabby quartzite (about 150 m) band and grayish leachate on limestone (Fig. 8). Quartzite

Fig. 6: Locally mined aggregates from the Chandragiri Limestone near Godam for concrete purpose

is found with intercalation of light grey with orange weathered color, psammatic, and well laminated, argillaceous phyllite. In the study area, the quartzite is not found monotonously distributed but found intercalated with limestone, phyllite, slate and shale in various proportion. White, thickly-bedded quartzite, variegated colored shale and grey slate were common on the Chitlang Formation. In the study area, mining of such quartzite is haphazard for roofing, slabbing and wall making purposes. The total geological reserve calculation of the quartzite deposit is given below:

Total area of quartzite deposit = 1,750 m^2; estimated depth of mining = 75 m, total volume of quartzite deposit = total area × depth which is about 131,250 m^3.

Metasandstone

The grey, thickly-bedded metasandstone is dominant in the Tistung and the Sopyang Formation (Fig. 3). Villagers in the study area have crushed the metasandstone into the gravel size for construction purpose. Strong lamination (about 2-3 mm thick) is observed in these rocks. These laminations are due to the contrasting composition between pelitic and psammatic interlayers. Compositionally the pelitic part is dominated by muscovite and chlorite while the psammatic part is dominated by quartz. The succession of the Sopyang Formation mainly consists of compositional layering between dark grey, fine-grained, pelitic phyllite and grey, coarse-grained metasandstone (Fig. 9). Massive-to thick bedded metasandstone (Fig. 10) is locally mined and used for slabbing, construction, wall making, flooring, etc. At Naubise to the Khani Khola section along the Tribhuvan Highway, brown- to yellowish brown, grey, highly weathered metasandstone was observed. Around Masinegaun, intercalation of grey, 7-2 cm thick, well laminated metasandstone and thinly-bedded phyllite was observed. In Naikap, at Aadhyakalika Mandir, pinkish grey, calcareous metasiltstone was observed. Along the Balkhu Khola, succession consists of intercalation of grey, ash-grey, well laminated metasandstone and grey, psammatic phyllite. This geological succession both

in vertical and lateral extension seems good for construction materials. However, analyses of geological and geo-technical properties have not carried out in this work. The total geological reserve calculation of the metasandstone deposit is given below:

Total area of metasandstone deposit = 18,250 m^2 (from graphical method); estimated depth of mining = 75 m, total volume of metasandstone deposit = total area × depth= 18,250 m^2× 75 m= 1,368,750 m^3.

Dolomite

Dolomite is used as a construction material; boulders are crushed into the gravel size and used for various purposes like flooring, slabbing, etc. Such type of products is obtained from the carbonate beds of the Chandragiri Limestone and the Chitlang Formation. In the study area, ash grey, thick-bedded dolomitic limestone is observed and systematically mapped within the Chandragiri Limestone and the Chitlang Formation. Bluish grey, medium-bedded limestone is intercalated with thick-bedded dolomitic limestone and thin-bedded phyllite on the Chandragiri limestone. The Elephant- skin type weathering on dolomite and dolomitic limestone is observed near to the Chakhel from Deurali, and at the Chobhar. Intercalation of ash grey, blue, thinly-layered phyllite and pinkish white dolomitic limestone with frequent calcite vein are dominant in the study area. Similarly, upper part of the Chitlang Formation comprised of intercalation between yellowish grey shale and dark grey limestone in which wave marks is observed with sub-ordinates of dolomite. The proportion of the limestone and dolomite in the study area is 3:1. A dolomite can be used as an ornamental stone and construction material. Though there is occurrence of dolomite in the study area, people do not have concerned about dolomite extraction. The total geological reserve calculation of the dolomite deposit is given below:

Total area of dolomite deposit = 750 m^2 (from graphical method); estimated depth of mining = 75 m, total volume of dolomite deposit = total area × depth= 750 m^2× 75 m= 56,250 m^3.

Fig. 7: Field photograph of well-laminated quartzite on the Chandragiri Limestone on the way to Chitlang Bhanjyang from Godam

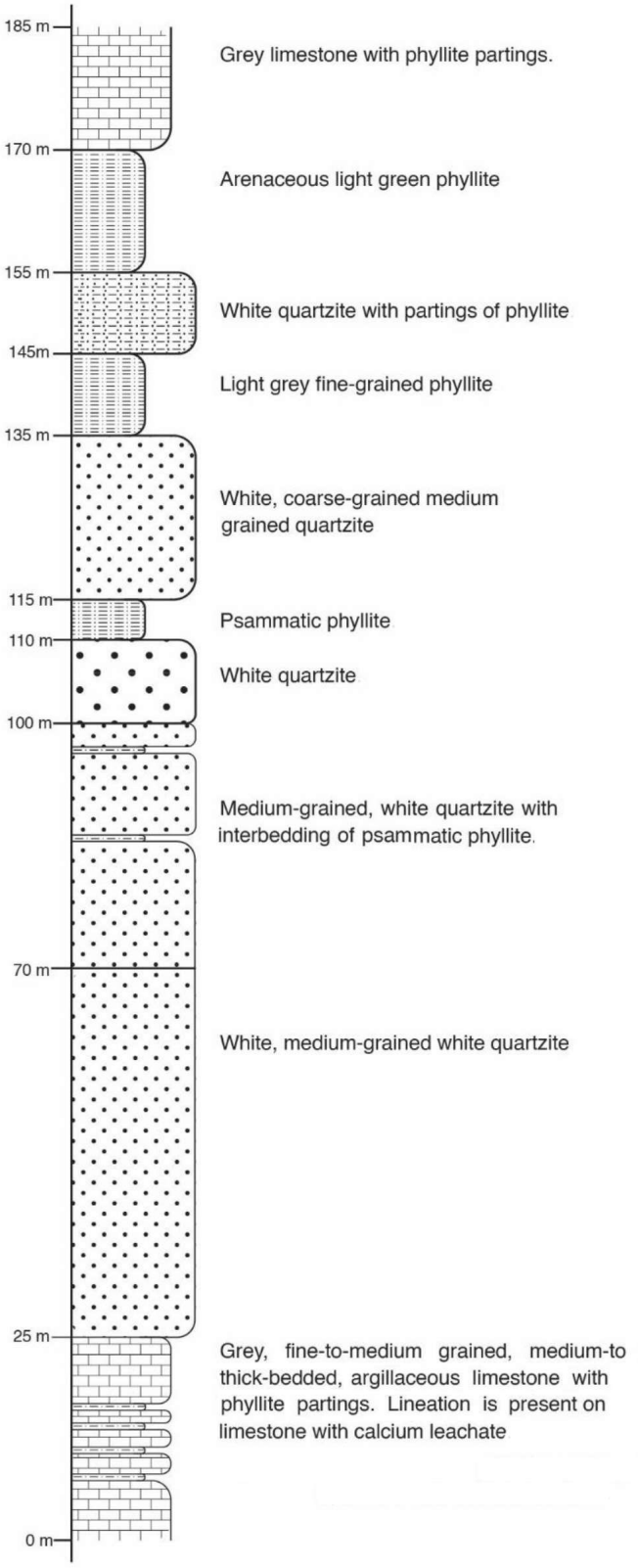

Fig. 8: Detailed columnar section showing quartzite band on the Chandragiri Limestone near deurali, Makwanpur (way to the Chandragiri Temple)

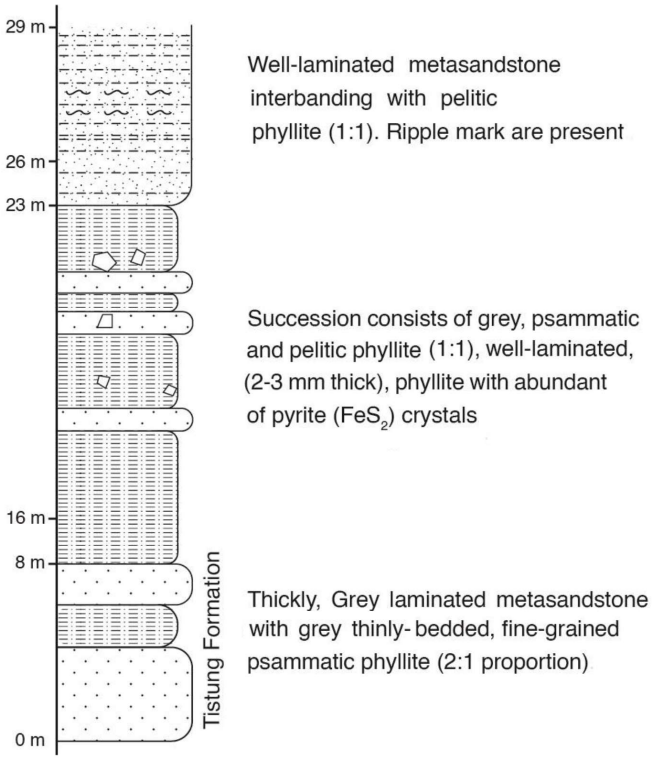

Fig 9: Detailed columnar section showing compositional layering between pelitic phyllite and grey, coarse-grained metasandstone

Slate

Grey weathered slate is observed near Chitlang Bhanjyang (Fig. 11). Slate of this unit is being used as roofing and flooring stone.

The lower part of the Chitlang Formation consists of violet-to- grey slate, white, muddy quartzite, grey, fine- to coarse-grained metasandstone, and thick- to massive, fine-to medium-grained limestone, dark grey, well-laminated shale and phyllite in some parts. The shale and weathered argillaceous slate are subordinates over quartzite (4:1) on the Chitlang Formation. The total geological reserve calculation of the slate deposit is given below:

Total area of slate deposit = 3,750 m^2 (from graphical method); estimated depth of mining = 75 m, total volume of slate deposit = total area × depth= 3,750 m^2× 75 m= 281,250 m^2.

Uses

Minerals are used almost in all industries. Some uses of mineral resources found in the study area are as follow:

1. Limestone is main source for cement industries for making cement and can be used as construction material.

Fig. 10: Thick-bedded metasandstone of the Tistung Formation near Kanakot

Fig. 11: Outcrop of slate of the Chitlang Formation near Chitlang village

2. Slate of the Chitlang Formation being used as roofing and flooring stone.

3. Dolomite is used as a construction material, boulders are crushed into the gravel, pebble size and used for various purposes.

4. Metasandstone can be crushed into the gravel-pebble size for construction purpose. Massive metasandstone can be mined and used for slabbing, construction, wall making, and flooring purposes.

5. Quartzite is excellent source rock for the dimension stones, flooring stones, slabbing stones, paving stones, wall making and for house design.

DISCUSSIONS

Industrial rocks and minerals especially the dimension stones and raw for construction materials such as slate, limestone, quartzite, metasandstone are observed and systematically mapped

in the study area. Reserve calculation is very tentative in this study and has focused in the limited area. However, there are large possibilities of finding continuity of these geological units in the adjacent areas. All these mineral resources are being used locally and mined in a traditional way. Massive, more pure and monotonous limestone of the Chandragiri unit could be a good source of cement as we have evidence of Himal Cement Ltd. of Chobhar using limestone of this unit. The limestone beds which are highly mixed with phyllite partings and argillaceous limestone can be used for construction purposes. Quartzite of the area can be used as dimension stone for flooring, roofing and walling purposes. The study area is close to Kathmandu, capital city of the country. Therefore, there will be everlasting demand of these resources. However, there is no systematic prospecting of such valuable resources. The existing mines are haphazard and unscientific from the perspective of technically and environmentally. Concept of zero waste mining should be employed to use all the products and by-product of the resources.

CONCLUSIONS

The following conclusions are drawn from the present study:

1. Chandragiri-Chitlang area is potential for industrial rocks and minerals like limestone, dolomite, quartzite, metasandstone and slate.

2. Stratigraphic units like the Chandragiri Limestone, Chitlang Formation and Tistung Formation are the main geological units for the potential sources of limestone, slate and metasandstone. In addition, Chandragiri Limestone unit is also rich for laminated quartzite and dolomite. Similarly, the Chitlang Formation is rich for white quartzite and slab-quality phyllite.

3. High quality limestone of the Chandragiri unit can be used for cement production while the low quality for construction materials.

4. Present mining is haphazard and unscientific in nature.

RECOMMENDATION

Systematic prospecting and scientific mining are necessary for the sustainable development and use of industrial rocks and minerals of the Chandragiri-Chitlang region.

REFERENCES

Acharya, M., 2019. Geological mapping of Chandragiri-Chitlang Range, southwest of Kathmandu Valley, with special reference to geological structures. Unpublished M.Sc. thesis, submitted to the Central Department of Geology, Nepal, PP. 1–77.

Acharya, M., and Paudyal K.R., 2019. Geological setting of the Chandragiri-Chitlang Range, southwest of Kathmandu Valley, central Nepal. Journal of Nepal Geological Society, v. 58, pp. 199–207.

Department of Mines and Geology, 2004. Mineral Resources of Nepal. DMG publication, 154 p.

Department of Mines and Geology/ Escape, 1993. Geology and Mineral Resources of Nepal. ESCAP/ DMG publication, 107 p.

Hagen, T., 1969. Report on the Geological Survey of Nepal. Denkschr Schweizerischen Naturforschenden Gesellschaft, v. 81, 185 p.

Paudel, L.P., 2011, K-Ar dating of white mica from the Lesser Himalaya, Tansen-Pokhara section, Central Nepal: Implications for the timing of metamorphism. Nepal Journal of Science and Technology, v. 12, pp. 242–251.

Stöcklin, J., and Bhattarai, K. D., 1977, Geology of Kathmandu area and Central Mahabharat Range, Nepal Himalaya. Unpublished technical report, DMG/UNDP Mineral Exploration Project.

Upreti, B.N. and Le Fort, P., 1999, Lesser Himalayan crystalline nappes of Nepal: problem of their origin. In: Macfarlane, A., Quade, J., and Sorkhabi, R., (eds.), Geological Society of America Special paper, v. 17, pp. 11–28.