

## PETROLOGICAL ANALYSIS AND ENVIRONMENTAL IMPACT OF CARBONATE ROCKS: A CASE STUDY OF THANDAWMYWET TAUNG, MANDALAY REGION

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### Abstract

Thandawmywet Taung (TDM\_T) is located in Kyaukse Township, Kyaukse District, Mandalay Region. The study location is located approximately 8 kilometers SE of Kyauks. Field works were carried out during in 2024. This study serves as an initial investigation of economic aspect and evaluation of environmental impacts. The GPS and Brunton compasses were used to locate the lithologic contact and collect rock samples. The Haz-Scanner Wireless Environmental Perimeter Air Station (EPAS) was used to collect Ambient Air Monitoring data. Air quality survey was conducted for 24 hours in 2024. The lithology in the TDM\_T have mainly composed of carbonates rocks. It was composed of bioclastic constituents which composed of calcareous algae (5%) and bryozoan-foraminiferal bioherm (7%). The calcite cements filled the (80-90%) pore space prior to burial, preventing compaction. Carbonate rocks have been used for cement-making materials in cement factories. Cement-making has been considered as the most significant source of air pollution in the Kyaukse area. The research areas had NO<sub>2</sub> concentration values higher than 20 µg/m<sup>3</sup>, AQ<sub>4</sub> had PM<sub>10</sub> values higher than 50 µg/m<sup>3</sup> the Myanmar and WHO guideline. Based on this research, the economic aspect of the area was fairly good. The findings suggested that industrial sources be controlled to reduce to reduce air pollution-related health risks in population in these areas. This information has been used for the government to support in setting up an appropriate mitigation control strategy for reducing their emissions and impacts on human health.

**Keywords:** Central Cenozoic Belt, Carbonates Rocks, Cement-making, AQ

### Introduction

Myanmar is recognized to consist of four primary tectonic provinces. They are specifically the Shan Tanintharyi Block, Central Cesozioc Belt, Westem Fold Belt, and Rakhine Coastal Belt. Kyaukse Region, encompassing the designated area entirely, can be considered the boundary zone between the Shan Tennasserin Block in the eastern marginal zone and the Central Cenozoic Belt at the western edge. The lithology in the east Thandawmywet Taung (TDM\_T) is mainly composed of carbonates, where the rock sequence remains virtually unmetamorphosed and consists of these rock types.

Many geologists have been studying this area because it is a part of the Mogok Metamorphic Belt. Among them La Touche. (1913) and Chhibber (1934) described that the Kyaukse area and they stated that the metamorphic rocks of Kyaukse area are Precambrian in age. The TDM\_T, Myint Thein (1997) and Lay Lay Khaing and Than Than Nu. (2020) proposed that most granodiorite and diorite rocks of the Belin area and Kyaukse area have originated metasomatically from epidote-biotite schists and epidote calc-silicate rocks on the basis of the field and petrographic evidences. The research papers submitted by DGSE and UN described the geology and exploration on geochemistry of the area east of Kyaukse, Thazi, Tatkon, Shan Scarps Regions and Central Burma.

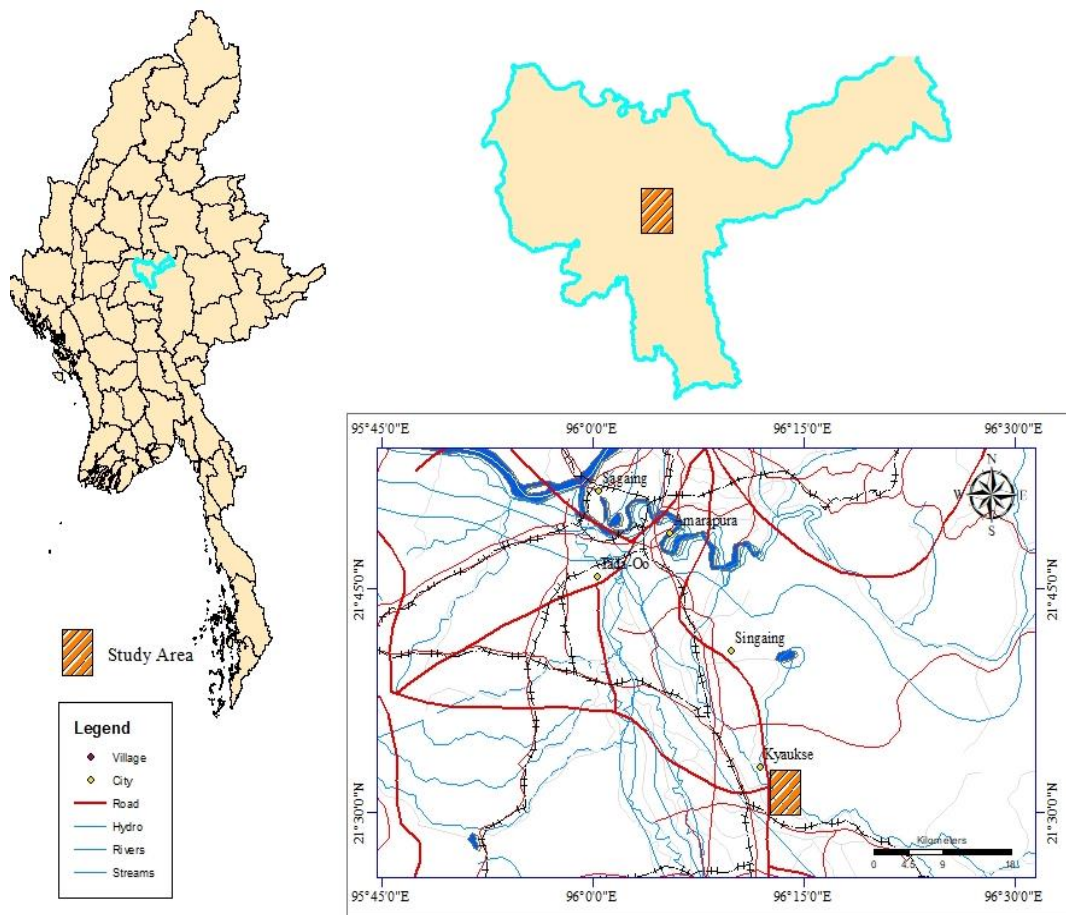
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This research recognizes the benefits of carbonate rocks for economic and air quality modeling for predict concentrations of air pollutants. The predicted concentrations of air pollutants from cement-making obtained from the simulation will help the public understand the extent of toxic air pollutants that may arise from cement-making industry. This information can be used to support in setting up an appropriate mitigation and the implementation plans to reduce their emissions and impacts on air quality. Results from this research can be utilized further to assess the impact on human health, as well as economic impacts.

### Location and size

TDM\_T is situated in Kyaukse Township, Mandalay Region. The research location is positioned approximately 8 kilometers southeast (SE) of Kyaukse. The present investigated area is bounded by latitudes  $21^{\circ}34'30''$  to  $21^{\circ}36'00''$  north and longitudes  $96^{\circ}13'30''$  to  $96^{\circ}15'00''$  east. The project area is also positioned in a one-inch topographic Map 93C/2 of Myanmar Survey Department. This region is roughly 5 square miles in size and has rugged terrain. All year round, a car can be driven from Kyaukse University to this location. Figure 1 exhibitions the location map of the research region.

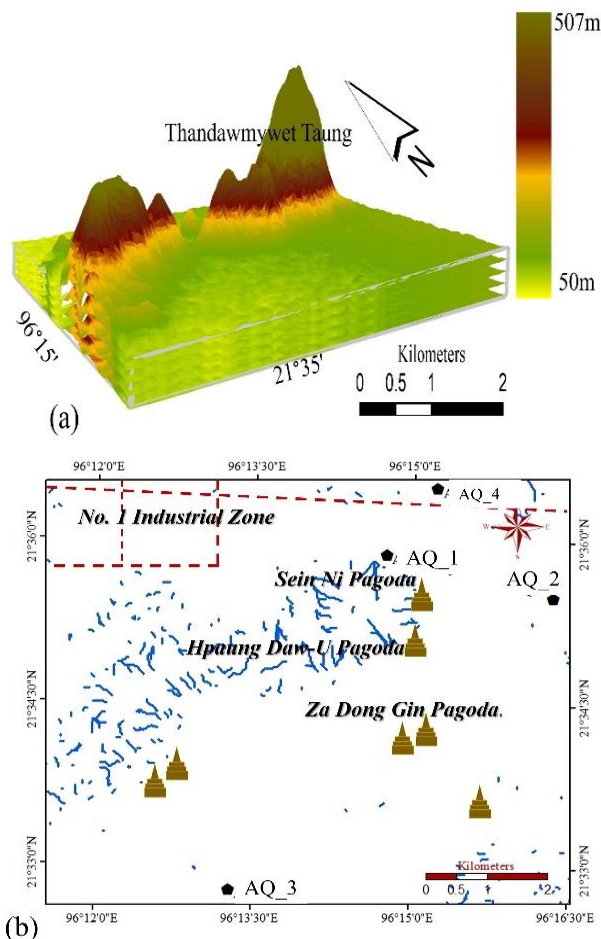


**Figure 1** Location Map of the TDM\_T, Kyaukse Township, Mandalay Region. (MIMU)

### Physiography

The research area is fairly rugged terrain. TDM\_T was generally low-lying in the west (W) but is high and rugged in the east (E) where it forms as cliffs composed of carbonate rocks. The range is trending approximately ENE-WSW direction, and this trend is found to be more or less parallel to the general structure trend of the area shown in Figure 2 (a). Topography is dependent upon the major structure and

underlying bedrock. Respectable acquaintances are found in road sections and some mountain ridges. This area demonstrates a dendritic and rectangular drainage pattern with highly jointed units given in Figure 2 (b).



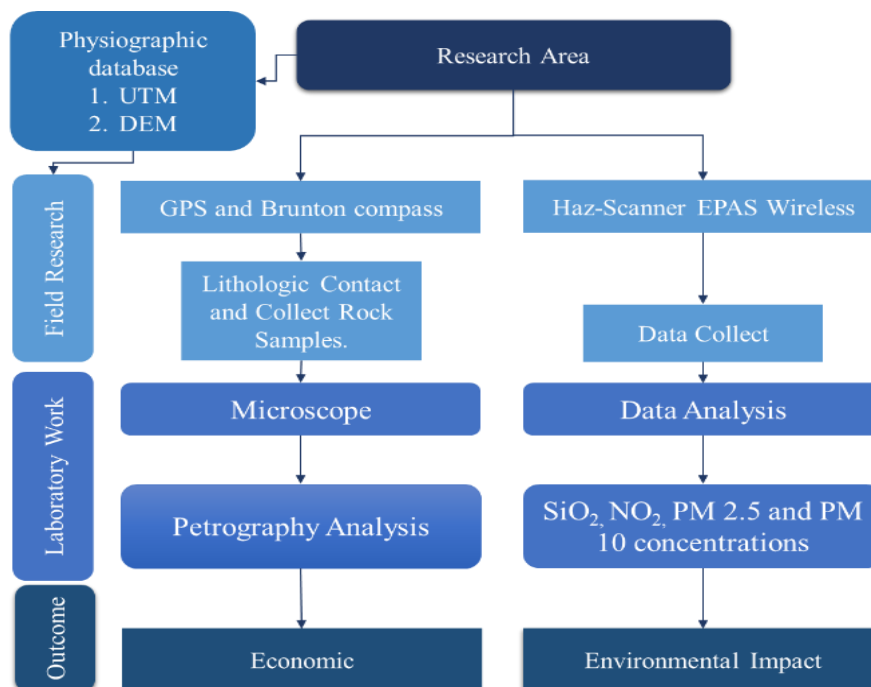
**Figure 2** (a) The three-dimensional topographic view of the research area (b) The drainage map of the research area. (USGS)

### Purposes of the Research

- 1) To identify the petrological characteristics of the carbonate rocks unit and their distributions in the research area.
- 2) To recognize economic aspect and evaluate environmental impacts of the research area.

### Materials and Methods

- 1) Extensive field research and laboratory work are the two key components of the research methodologies.
- 2) The GPS and Brunton compasses were used to locate the lithologic contact and collect rock samples. The field works were carried out during mainly in 2024.
- 3) Sampling and analysis of ambient air pollutants was conducted by referring to the recommendation of United States Environmental Protection Agency (U.S. EPA). The Haz-Scanner Wireless Environmental Perimeter Air Station (EPAS) was used to collect Ambient Air Monitoring data. Air quality survey was conducted for 24 hours in 2024. In Figure 3 shown flowchart of the materials and methods used in this research.

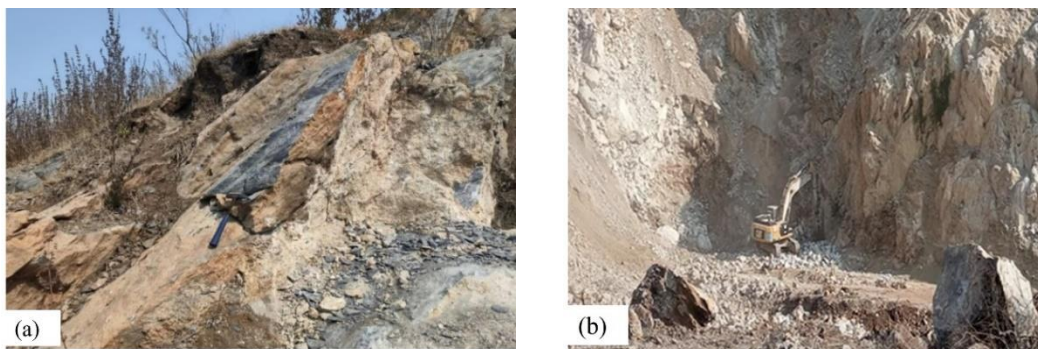


**Figure 3** Flowchart showing the materials and methods used in this research.

## Results and Discussion

### Petrology of Carbonate rocks

Carbonate rocks widespread in the research area. Good exposures of these rocks located Eastern part of the research area (N21°35'16", E 96°14'46"). It consists of light to dark grey, brecciated limestone and dolomite in Figure 4.



**Figure 4** (a) Light to dark grey, brecciated, limestone, and (b) dolomite well exposed at eastern part of the area (N21°35'16", E 96°14'46").

Chert nodules occur characteristically in plateau limestone. It is composed of quartz (10%) and chert (10%). The calcite cements filled the (70%) pore space prior to burial, preventing compaction. Chert nodules show fine grained texture with microcrystalline crystal under microscope. It has conchoidal fracture in Figure 5 (a and b). Undulose extinction is seen in brown due to impurities in terms of transparency, it forms opaque. It can be a diagenesis process, silica precipitates from the nodules, it caused surrounding materials to compress and deform. This could be due to the geological process like pressure solution, chemical weathering, thermal contraction and expansion. It should be pointed out in this connection that chert nodules occur characteristically in Dattaw Hill.

The carbonates of the studied material are pack-/grainstones, floatstones, and bindstones with small number of calcareous algae and foraminiferal bioherm as well

as oncoids and intraclasts. It is composed of bioclastic constituents which are mainly calcareous algae (5%) and bryozoan-foraminiferal bioherm (7%). The calcite cements filled the (80-90%) pore space prior to burial, preventing compaction. Clearly, given the absent of matrix, this must have been a grain supported deposits, but if carbonate mud has infiltrated into the porous sediments, this once was a grain-supported fabric (bryozoan grainstone) in Figure 5 (c). The irregular chamber of a possible encrusting tabular foraminifer are seen here forming part of the bryozoan-foraminiferal bioherm. Moreover, foraminiferal bioherm are found Permian strata. The photographs are not see rounded calcite grain because of the inter-articular cloudy, bladed, calcite cement filled matrix the (90%) pore space prior to burial, preventing compaction (floatstones, and bindstones) in Figure 5 (f).

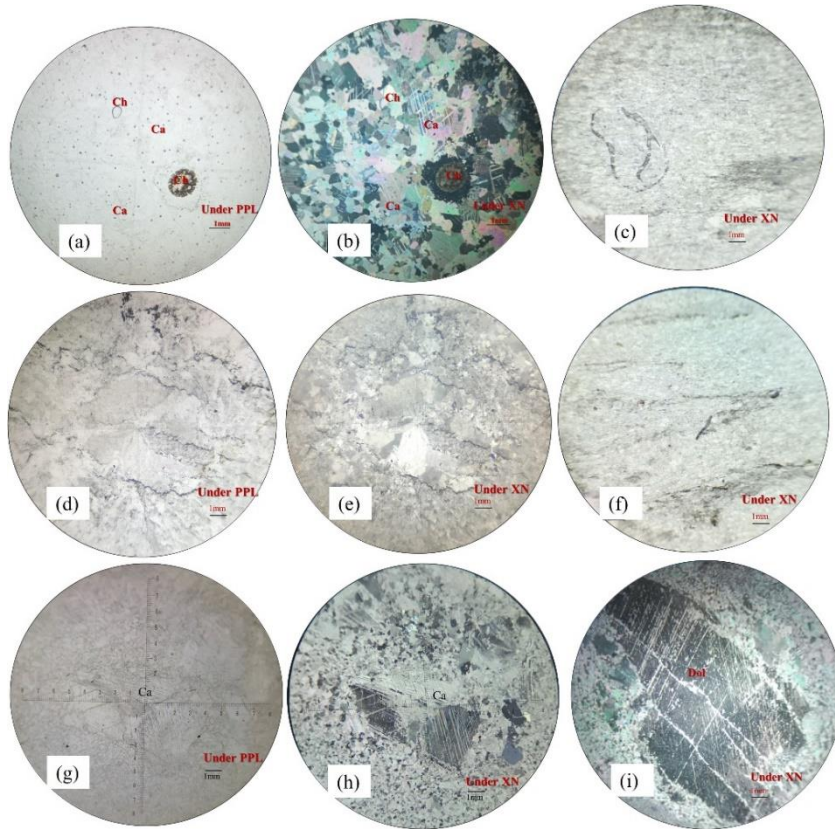
The most common magnesites are rich in magnesium, with only minor substitution of  $\text{Fe}^{2+}$  for  $\text{Mg}^{2+}$ . However, a complete solid solution exists between magnesite and siderite,  $\text{FeCO}_3$ . The iron-rich compositions are common in Permian iron-formations. Magnesite is isostructural with calcite. Perfect rhombohedral cleavage is seen. Color ranges from white to gray, yellow, and brown (the latter two colors result from variable substitution of  $\text{Fe}^{2+}$  for  $\text{Mg}^{2+}$ ). Cleavable varieties may resemble dolomite but have higher specific gravity. The massive white variety resembles chert but has a lower hardness **Baroque dolomite** in Figure 5 (d and e) Alsharhan and Williams (1987); (Mehmood et al., 2018). Crystal form: Hexagonal; Crystals are commonly curved rhombohedra. Generally, in coarse, cleavable masses. Color ranges from colorless to flesh colored white, gray, and black in Figure 5 (g, h, and i).

In the research area, plateau limestone is also exposed in the Jurassic to Cretaceous unit in the eastern part. However, the present research mainly emphasizes on the plateau limestone of Permian -Triassic unit in central and western part of the area. Terminology and definitions introduced by Dunham (1962) are used throughout this work. The microfacies recognized are readily compared with the standard microfacies types (SMF) of Wilson (1975). The carbonates of the studied material are pack-/grainstones, floatstones, and bindstones with small amount calcareous algae and foraminiferal bioherm as well as oncoids and intraclasts. Facies types are differentiated based on their biotic composition obtained by point counting represented by bar graph Figure 6. The bar graph shows the main components for each microfacies which mainly consist of calcareous algae and foraminiferal bioherm fragments and micrite as well as calcite cement.

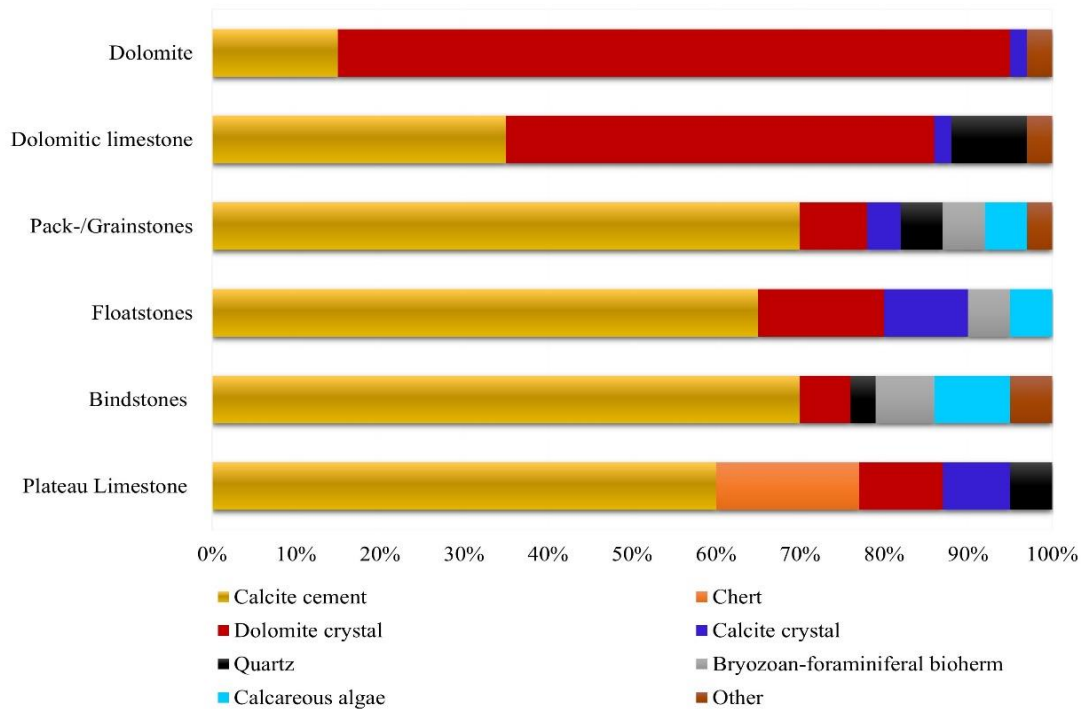
**Foraminifers:** The Foraminifers (indicative of Early Permian age to of Middle Permian age), have been reported from this locality Boscolo Galazzo et al. (2014). Moreover, the foraminifer's fauna of the studied limestone samples yields Early Permian.

**Calcareous algae:** Algae are a common floral element in the allochthonous coarse grain carbonates of the Khao Wong hill, which is in accordance with the general composition of the algal flora of the Permian that is strongly dominated by discards Parvizi et al. (2013).

The sediments of the limestone and dolomitic limestone have been grouped for the units. All faunas and floras present in these facies including calcareous algae together with the structural characteristics point to an agitated, shallow water environment (Figure 6).



**Figure 5** (a and b) Photomicrographs of chert nodules show fine grain texture with microcrystalline crystal. Ch-chert, Ca-calcite. (c and f) Photomicrographs of Calcareous algae and foraminifera grainstones. (d and e) Photomicrographs of Baroque dolomite and Optical microscopic image showing stylolites in the light-grey limestones. (g and h) Photomicrographs of Hexagonal calcite. (i) Photomicrographs of Magnesite is isostructural with calcite.



**Figure 6** Bar graph showing relative abundance of components of research area.

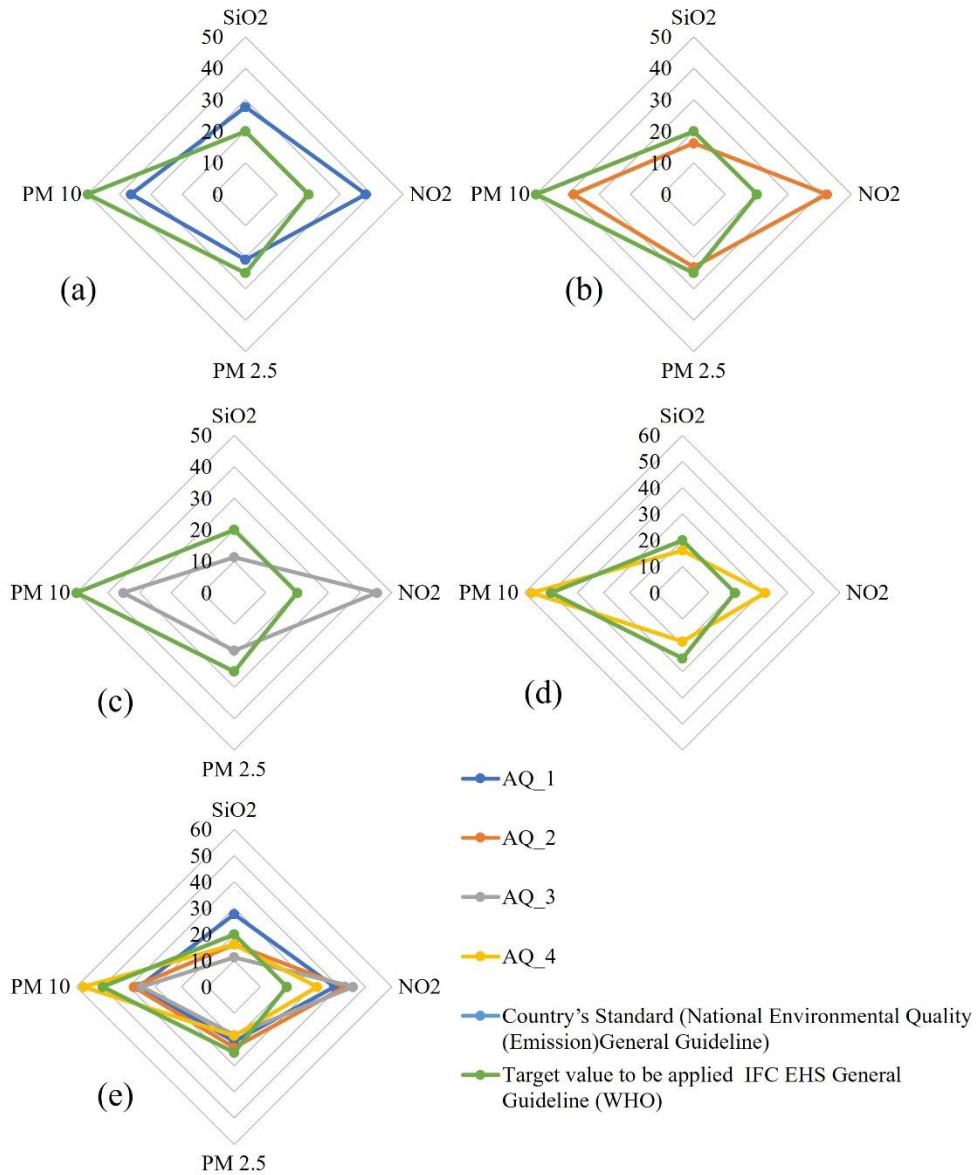
### **Economic Aspect of Carbonate rocks**

Industrial materials are also present in the research area. Therefore, the economic aspect of the area is fairly good. Carbonate rocks are also used for cement-making materials in cement factories. Myanmar Conch Cement commercially mines limestone from the research area, producing approximately 2.4 million tons (Alpha Cement) and 1.8 million tons (Double Rhino cement plant) annually. The cement contains 35 to 40 percent lime, 40 to 50 percent alumina, up to 15 percent iron oxides, and preferably not more than about 6 percent silica.

### **Environmental Impact of Carbonate Rocks**

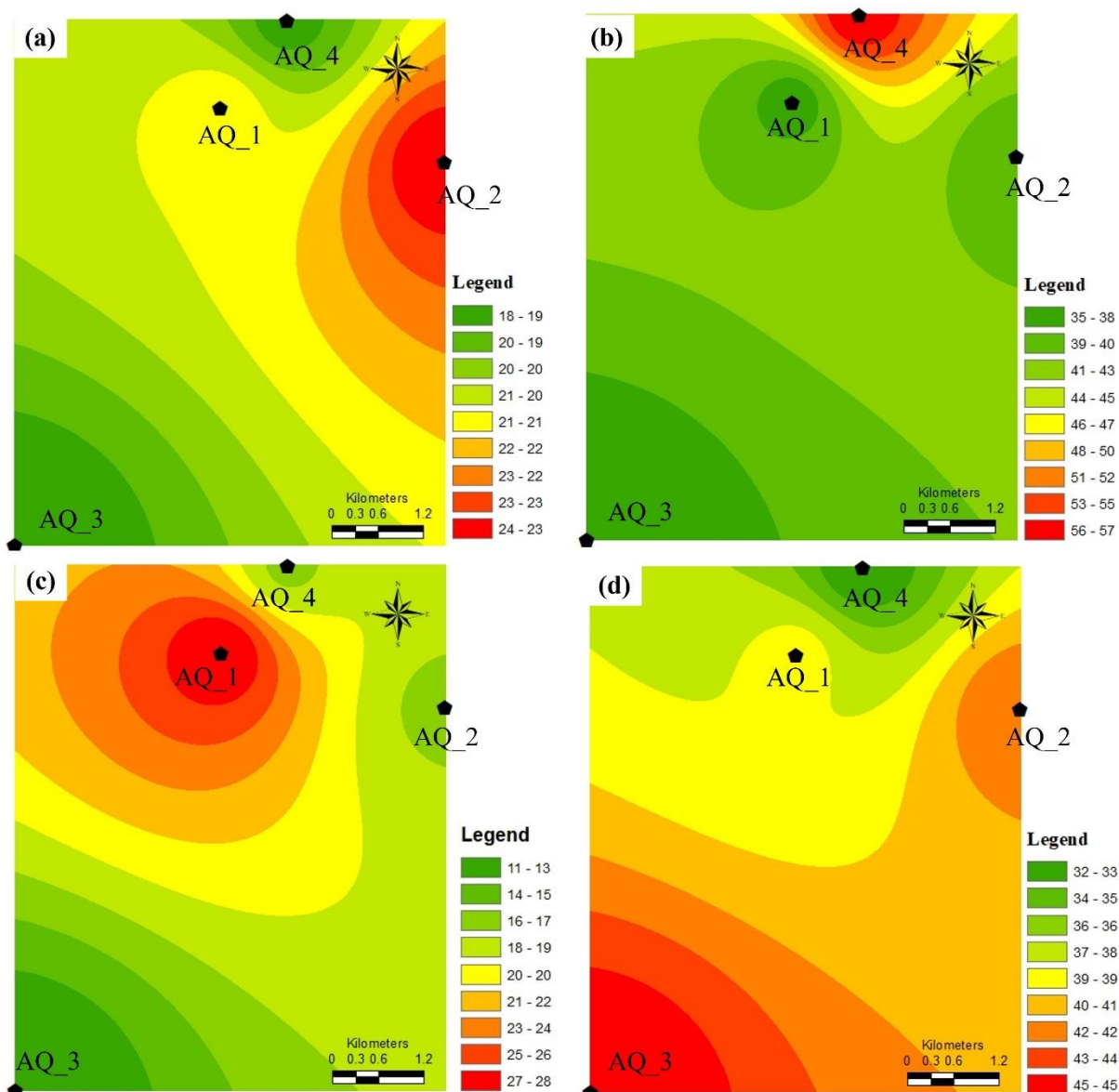
Sampling points for Air Quality AQ\_1 and AQ\_2 was surveyed at TDM\_T Cement Compound and Pyauk Seik Pin Village, Kyaukse, Kyaukse Township 21°34'53.17"N, 96°14'44.75"E and 21°35'30.03"N, 96°16'19.89"E. The location AQ\_3 and AQ\_4 was cited in the Hmine Pan Village, east of Yepyadaw Village, Kyaukse Townhsip 21°32'47.09"N, 96°13'17.41"E and 21°36'30.91"N, 96°15'13.21"E.

Figure 7 illustrate the spatial distributions of 24-h average PM 2.5, PM 10, NO<sub>2</sub>, and SiO<sub>2</sub> concentrations in TDM\_T. For AQ\_1 to AQ\_4 the highest value of PM 2.5 over the concentration range 18.16 to 23.15  $\mu\text{g}/\text{m}^3$ . All areas had concentration values lower than 25  $\mu\text{g}/\text{m}^3$ , the Myanmar and WHO guideline. The PM 10 concentration values in the range of 36.28, 38.19, 35.14  $\mu\text{g}/\text{m}^3$ , and 57.34  $\mu\text{g}/\text{m}^3$  covered of the area, respectively. AQ\_1 to AQ\_3 had concentration values lower than 50  $\mu\text{g}/\text{m}^3$ , the Myanmar and WHO guideline. However, AQ\_4 had concentration values higher than 50  $\mu\text{g}/\text{m}^3$ . For AQ\_3 the highest value of maximum average 24-h concentration of NO<sub>2</sub> over the modeling domain during the simulation period was 45  $\mu\text{g}/\text{m}^3$ . All areas had concentration values lower than 100  $\mu\text{g}/\text{m}^3$ , the Myanmar and WHO guideline. The SiO<sub>2</sub> concentration values in the ranges of 11  $\mu\text{g}/\text{m}^3$  and 23.15  $\mu\text{g}/\text{m}^3$  covered AQ\_1 to AQ\_4 of the area of the research domain, respectively. AQ\_2 had concentration values higher than 20  $\mu\text{g}/\text{m}^3$ , the Myanmar and WHO guideline.



**Figure 7** Radar plots for the via AQ wherein each of the four axes shows the SiO<sub>2</sub>, NO<sub>2</sub>, PM 2.5 and PM 10 of (a) AQ\_1, (b) AQ\_2, (c) AQ\_3, and (d) AQ\_4, (e) AQ\_1 to AQ\_4 compare with Country's standard and WHO.

Figure 8 shows about the value of the AQ map of the project area. PM 2.5 value of AQ\_2 (red color) is more than that of AQ\_1, AQ\_3, and AQ\_4, and is found to be close to the WHO level. Most studies suggest that PM 2.5 levels at or above 25 µg/m<sup>3</sup> are considered healthy, red where air pollution is considered unhealthy with more to risk from exposure. Exposure to high PM 2.5 levels can cause various health problems, including: Respiratory Issues, Cardiovascular Problems and Premature Death. PM 10 value of AQ\_4 is more than that of AQ\_1, AQ\_2, and AQ\_3 in Figure 8. Short-term exposure can cause respiratory irritation, while long-term exposure can lead to more serious health issues, as well as lung damage, asthma, and cardiovascular problems. NO<sub>2</sub> value of AQ\_1 is more than that of AQ\_2, AQ\_3, and AQ\_4. However, all areas had concentration values is lower than 100 µg/m<sup>3</sup>. SiO<sub>2</sub> value is decreasing range of AQ\_3 (red color), AQ\_2 (orange color), AQ\_1, and AQ\_4. This is the form of silica of chief concern for health, as AQ\_3 (red color), AQ\_2 and (orange color) can be inhaled into the lungs and cause silicosis, lung cancer, and other respiratory diseases.



**Figure 8** A map showing air quality levels across in 2024. Areas shaded green denote where air quality is deemed at healthy levels; yellow where it is moderately poor; orange where it may affect sensitive individuals; and red where air pollution is considered unhealthy. (a) PM 2.5 (b) PM 10 (c) SiO<sub>2</sub>, (d) NO<sub>2</sub>, in the AQ\_1, AQ\_2, AQ\_3, AQ\_4.

### Conclusion

The lithology in the TDM\_T is mainly composed of carbonates rocks, where the rock sequence remains virtually unmetamorphosed and consists of these rock types. All faunas and floras present in these facies including calcareous algae together with the structural characteristics point to an agitated, shallow water environment. Carbonate rocks are also used for cement-making materials in cement factories. Therefore, the economic aspect of the research area is fairly good. AQ\_4 PM 10 and AQ\_2 SiO<sub>2</sub> is higher than the Myanmar and WHO guideline. The important factors such as water pollution, background pollution, other emission sources, chemistry, and dry deposition should be applied in further research.

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