Geochemistry of Thitsipin Limestone from Htinshu Taung and Chaungbwe Taung, Pinlaung Township, Shan State (South)

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Abstract

In the study area, the Thitsipin limestone is well exposed and being quarried. In this study, geochemical analysis of twenty limestone samples at five localities was carried out. The aim of this study is to examine the major oxides in the limestone in the study area, by using X-Ray Fluorescence Spectrophotometer (XRF), and to do an assessment of these limestones for a possible cement production. The chemical analysis show a wide range of variations in LOI (39.25% to 42.75%), SiO2 (0.21% to 8.89%), Al2O3 (0.26% to 1.61%), Fe2O3 (0.06% to 0.28%), CaO (50.13% to 55.49%) and MgO (0.04% to 1.84%). The highest CaO indicates that calcite is the principal carbonate mineral. Low Fe2O3 indicates low oxidizing conditions and that the pH of the water was not favorable for formation of Iron III oxides. Low Al2O3 probably reflects a low energy environment. The Low MgO contents suggest a lack of dolomitization process, while it's show a high concentration in dolomitic limestone. These results suggest that these limestones are suitable for the cement industry.

Keywords: Geochemistry, Limestone, Thitsipin, Cement

Introduction

Limestone is the most abundant commodity with a global industrial use. A wide range of products has been made from limestone and its by-products. Such products include fertilizers, refractory fillers, ceramics and paints. Cement production is the major industries, which use limestone. The chemical composition of a carbonate rock is an important determinant of its use in the cement industry, hence the reason for this work.

The study area is situated in the central part of Kalaw-Pinlaung basin, between Aungban and Pinlaung towns, Shan State (south). It is located about 24 km north of Pinlaung and about 25.6 km south of Aungban. The area lies in map no.93D/11 of one inch Topographic map and map no. 2096/11 of UTM map, bounded by latitudes 20º 14' N to 20º 31' N and longitudes 96º 34' E and 96º 45' E. Yangon-Loikaw car and rail road pass through the study area. So, one can reach by train or by car from Yangon to Aungban, then then Aungban to Thigyit throughout the whole year. As so far, the study area is easily accessible throughout the year (Fig.1).

The main stream of the study area is Balu Chaung which is perennial stream and flows from south to north. Thande Chaung, Loi-maw Chaung, Lonpo Chaung, Nantaing Chaung, Tidau Chaung and other tributaries are jointed to the Balu Chaung and then flowing into the Inlay Lake. According to their appearance of curvature and density, the drainage patterns can generally be divided into four units (Fig. 2).

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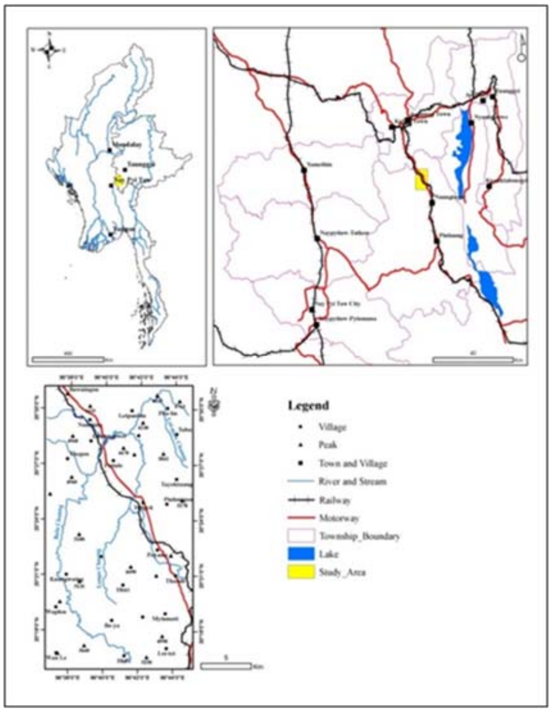

Figure (1). Location map of the study area

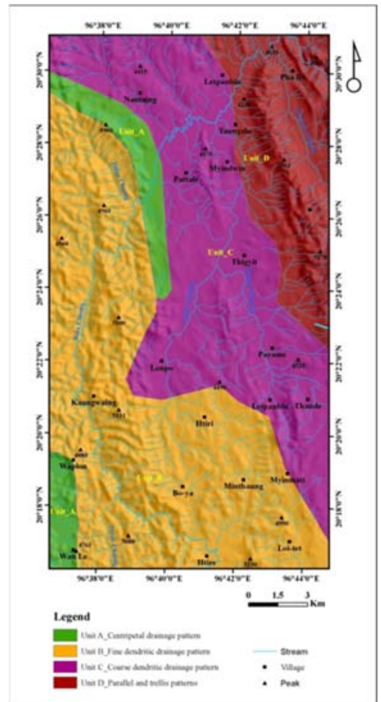

Figure (2). Drainage map of the study area

Geological Setting

The Thigyit basin is situated on the western margin of the tectonic province of Shan-Tanintharyi Block or in the Eastern Highland of Myanmar (Western part of Shan-Thai Block). This basin lies in the central part of Kalaw-Pinlaung basin which a NNW-SSE trending elongated trough of 30 miles long and 7 miles wide, extends southwards from the Pan Laung valley through Kalaw and up to the southern parts of the Loikaw area.

The rock units of the entire basin are mainly composed of Paleozoic to Mesozoic sedimentary rocks, as well as Tertiary rock unit is cropped out as a minor. Generally, the trends of the rock units run nearly NNW-SSE in direction. The carbonate rock units are Thitsipin Limestone Formation (Permian) and Nwabangyi Dolomite Formation (Late Permian to Early Triassic), and clastic rock units are Loi-an Group (Jurassic) and Kalaw Red Beds (Cretaceous). Tertiary rock unit, Hsi-hkip Formation is the youngest rock unit in the study area. The stratigraphic succession of the present area is shown in Table 1. Geologic map of the study area is shown in Fig (3).

Table (1). Stratigraphic Succession of the study area

Lithologic Units	**Age**
Hsi-hkip Formation	Pliocene
Kalaw Red Beds	Cretaceous
Loi-an Group	Middle-Jurassic
Nwabangyi Dolomite Formation	Late Permian to Middle Triassic
Thitsipin Limestone Formation	Permian

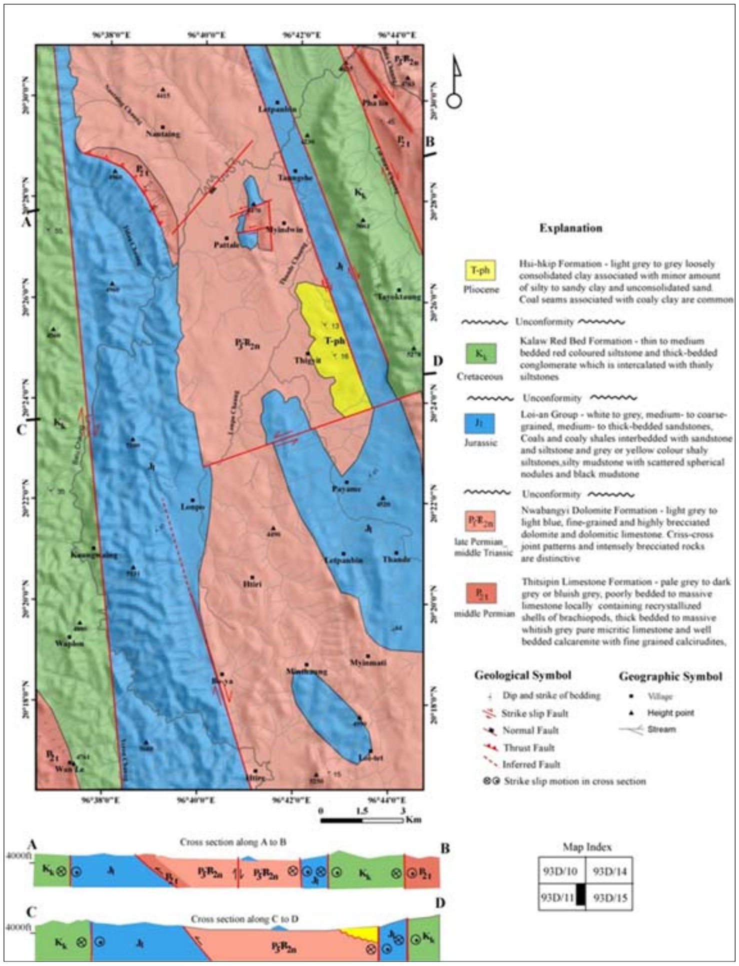

Figure (3). Geologic map of the study area

Methods of Study

20 samples of Thitsipin limestones at the five representative drill holes localities were collected in the study area Table (2). These limestones were subjected to geochemical analysis via X-Ray Fluorescence method at Dragon Cement Laboratory.

Table (2). Locality of limestone samples

No.	Name	Locality (UTM)		Remark
1	DH-A-0	N-2263665.184	E-258351.766	
2	D-H-C-1	N-2263993.554	E-258491.346	
3	D-H-C-2	N-2263946.476	E-258669.203	
4	D-H-E-1	N-2264397.802	E-258569.731	
5	D-H-F-1	N-2264376.563	E-259062.012	

Results and Discussion

Major Oxides

The result of major elemental oxides (Table 3) for the analysed samples show that the concentration of CaO ranges from 50.13 – 55.49% with an average of 52.81%. The SiO_2 content varies from 0.21 – 8.89% with a mean of 4.55% and Fe_2O_3 ranges between 0.06 – 0.28% with a mean of 0.17% while MgO and Al_2O_3 contents vary from 0.31 – 1.84% and 0.26 – 1.61% with average values of 1.07 and 0.93% respectively. The Loss of Ignition also varies from 39.25 – 42.75% with a mean of 41%.

CaO and SiO_2

From the result of the major oxides, CaO is prevailing. CaO shows inverse relation with silica SiO_2. Relatively, high value of CaO shows a low value of MgO. Comparatively, high level of CaO and low values of Silica and MgO show a high degree of purity of the limestone. This makes suitability for cement production. The CaO percentage shows decrease with increase of SiO_2 /MgO/Fe_2O_3.

Table (3). Major Oxides (%) Concentration of Thitsipin limestone

Sr.No.	Sample No.	L.O.I	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	∑
1	DHA0-1	40.96	1	0.72	0.06	54.46	0.35		97.55
2	DHA0-2	40.72	0.93	0.86		54.34	0.32		97.17
3	DHA0-3	41.24	0.46	0.64	0.06	54.74	0.87		98.01
4	DHA0-4	40.1	2.47	0.86	0.23	53.74	0.55		97.95
5	DHA0-5	41.78	0.77	0.5	0.11	54.95	0.52		98.63
7	DHA0-7	41.54	1.54	0.5	0.23	55.11	0.58		99.5
8	DHC1-1	41.35	0.88	0.91	0.12	55.18	0.96	0.85	100.25
9	DHC1-2	41.69	1.62	0.96	0.24	54.9	0.73	0.16	100.3
10	DHC1-3	40.13	0.91	0.46	0.12	54.7	1.84	0.74	98.9
11	DHC1-4	39.25	8.89	0.49	0.24	50.13	1.04	0.4	100.44
12	DHC1-5	40.91	4.85	0.59	0.14	52.55	0.42	0.53	99.99
13	DHC1-6	40.83	2.56	0.45	0.28	54.43	0.61	0.44	99.6
14	DHC1-7	41.85	1.12	0.44	0.16	54.5	0.55	0.87	99.49
15	DHC1-8	41.65	1.44	0.83	0.12	54.18	0.32	0.87	99.41
16	DHC2-1	39.87	1.81	0.41	0.12	54.73	1.28	0.54	98.76
17	DHC2-2	42.75	1.08	0.44	0.11	53.85	0.73	0.31	99.27
18	DHC2-3	42.16	0.28	0.31	0.07	55.4	0.31	0.1	98.63
19	DHC2-4	42.26	0.21	0.26	0.19	55.49	0.38	0.43	99.22
20	DHC2-5	42.44	0.35	1.61	0.09	53.9	0.55	0.41	99.35

Al_2O_3 and MgO

Alumina and Magnesium oxide concentrations are low with mean values of 0.64% and 0.81% respectively. The low concentration of alumina suggests a low energy environment. The skeletal debris of marine invertebrate has low magnesium with increasing level in the phyla. The Thitsipin limestone in study area is rich in brachiopods, gastropods and shell fragments which are typical of an open shelf environment. The presence of these invertebrates is suspected to be responsible for the low level of magnesium in the samples. Magnesium concentration is also a function of temperature of formation, and often low in shells living in shallow waters. Consequently, shallow marine environment is therefore proposed for Thitsipin limestone.

Classification of Limestone

The classification of limestone in the study area is made after Todd, 1966. The standard ratio; Ca/Mg ratio and its reciprocal ratio: Mg/Ca was employed by Todd as a parameter for Chemical Classification of limestone. Todd grouped Limestone samples with Ca/Mg ratios with a range of 1.41%-12.30% as Dolomitic Limestone, samples with Ca/Mg ratio of 12.30%-39.00% as “Magnesian Limestone” and Limestone samples having 39.00% to 100% are grouped as “Pure Limestone” (Table 4).

Table (4). Chemical Classification of Limestone (after Todd, 1966)

Descriptive term	Standard ratio Ca/Mg	Reciprocal Ratio Mg/Ca
Dolomitic Limestone	12.30 – 1.41	0.08 – 0.18
Magnesian Limestone	39.00 – 12.30	0.03 – 0.08
Pure Limestone	100.00 – 39.00	0.00 – 0.03

However, the standard Ca/Mg ratio varies from 25.87 to 37.63 while the reciprocal ratio Mg/Ca ranges from 0.03 – 0.04. This result reveals that the limestone of the Thitsipin Limestone Formation is pure limestone type Table (5).

The Ca/Mg ratio also corresponds to stability condition during the formation of carbonate rock. He pointed out that the degree of salinity increases with decrease in Ca/Mg ratio. Higher values of Ca/Mg ratio of the studied carbonate indicates comparatively less evaporation of sea water and low salinity which prevailed during the formation of limestone in general.

Table (5). Chemical classification of Thitsipin Limestone

Sr.No.	Sample No.	CaO	MgO	CaO/MgO	MgO/CaO	Remarks
1	DHA0-1	54.46	0.35	155.600	0.006	-
2	DHA0-2	54.34	0.32	169.813	0.006	-
3	DHA0-3	54.74	0.87	62.920	0.016	Pure Limestone
4	DHA0-4	53.74	0.55	97.709	0.010	Pure Limestone
5	DHA0-5	54.95	0.52	105.673	0.009	Pure Limestone
7	DHA0-7	55.11	0.58	95.017	0.011	Pure Limestone
8	DHC1-1	55.18	0.96	57.479	0.017	Pure Limestone
9	DHC1-2	54.9	0.73	75.205	0.013	Pure Limestone
10	DHC1-3	54.7	1.84	29.728	0.034	Magnesian Limestone
11	DHC1-4	50.13	1.04	48.202	0.021	Pure Limestone
12	DHC1-5	52.55	0.42	125.119	0.008	-
13	DHC1-6	54.43	0.61	89.230	0.011	Pure Limestone
14	DHC1-7	54.5	0.55	99.091	0.010	Pure Limestone
15	DHC1-8	54.18	0.32	169.313	0.006	-
16	DHC2-1	54.73	1.28	42.758	0.023	Pure Limestone
17	DHC2-2	53.85	0.73	73.767	0.014	Pure Limestone
18	DHC2-3	55.4	0.31	178.710	0.006	Pure Limestone
19	DHC2-4	55.49	0.38	146.026	0.007	Pure Limestone
20	DHC2-5	53.9	0.55	98.000	0.010	Pure Limestone

Loss on Ignition (L.O.I)

L.O.I reveals the content of volatiles present in the limestones. The L.O.I value in the study area averages 40.96%. High L.O.I value is indicative of high volatile content and this suggests a high carbonate content since it is synonymous with the evolvement of carbon dioxide after heating at 1000 ºC.

According to the geochemical investigation of Thitsipin limestone, the high of CaO indicates that calcite is the principle carbonate mineral. Fe2O3 with average of 0.18% indicates low oxidizing conditions and that the pH of the water was not favourable for formation of Iron III oxides. Presence of Fe2O3 and high CaO indicates reducing environment and deposition in closed basin (Wolf et.al, 1967). Low alumina probably reflects a low energy factors. The low MgO contents suggest a lack of dolomitization process.

Conclusion

In general, these results suggest that the Thitsipin limestone in the study area is the pure limestone type deposited in a shallow marine environment and suitable for cement industry.

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