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Keywords: *marble, calcite marble, tectonic, XRF, khewa, nangrhar.*

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Abstract- This methodical investigation's primary goal is to ascertain the geological, geochemical, mineralogical, and mechanical characteristics of the calcite marble found in Khewa. The article includes all important information about Khewa calcite marble, including its quality, constituent minerals, related elements, and other data. The procedures employed for the precise investigation and evaluation of the mine's characteristics include manipulative field observation, laboratory examination of Khewa calcite marble, and preliminary library studies concerning the research location. The calcite marble library research provided exact and accurate information about the location of the examined area's geology, as well as information about its tectonics and magmatism. In order for the laboratory analysis to determine the true geology of the area under study, including adjacent rocks, and the chemical makeup of the calcite marble, laboratory examination is required. Mica schist is the neighboring rock to calcite marble (a metamorphic rocks). The researcher gathered five random, exact samples of the calcite marble from various locations in the field to acquire this. For the desired outcomes, various techniques were used on the assembled simples. The purpose of XRF, also known as X-Ray fluorescence, is to determine the precise proportion of certain elements and oxides. In addition to the calcite, which is discovered in small amounts in the Mica schist rocks that surround the calcite marble in the XRF results, the percentage of calcite is over 55%. The Mica schist neighboring rocks of the calcite marble also contain a small quantity of uranium. The unique characteristics of calcite marble, such as their hues, structures, and linked minerals, were elaborated by the microscopic analysis. We obtained a range of results from physical and mechanical tests such compressive strength, and unit weigh. Wherever iron, aluminum, and nickel are found, calcite marble is very hard. Overall, Khewa calcite marble is very hard but suitable for construction.

Keywords: marble, calcite marble, tectonic, XRF, khewa, nangrhar.

I. Introduction

Marble is the product of the recrystallization of limestone or dolomite by contact metamorphism or regional metamorphism The mineral composition is mainly calcite, which foams when it encounters hydrochloric acid Marble is also a large category of natural architectural decorative stones. Generally, marble cutting machines refer to metamorphic or unclassified carbonate rocks with decorative functions, which can be made into architectural stones or crafts.

Marble is commonly used as Building Stone, Countertops and sinks, Floor tiles, Terrazzo - marble chips mixed with concrete to form floors, Tomb Stones construction and dimensional stone in Afghanistan especially in eastern part of Afghanistan Nangrhar province such as Khewa Calcite Marble. There are different varieties of marble in different provinces such as Kunarr, Bamyan, Kabul, Balkh, Kandahar, Herat, Paktia, Parwan, Helmand, Nangrhar, Faryab, Wardak, and Samangan. which are extracting and supplying to different countries and are prized for

II. Geology of Study Area

It is necessary to consider the geological structure of this Tectonic Zone. The Tectonic zone of Jalalabad is located in eastern part of Afghanistan and the southeastern part of Nuristan zone. For the first time this was separated by Prof. Slavin and Syed Hasham Mirzad in year (1969) and Kalchanof and Sayed and added this zone in to Tectonic map and relate this zone with Alf Core.

a) Jalalabad Tectonic Zone (Spinghar Block)

The Jalalabad zone is a part of the depth of the past Cambrian which trace minerals lies above the ridges of the past Cambrian that form base of Geosyncline. These ridges appear in the mountain to the surface of the earth. In the eastern part of the Zone and in the southeastern part of Jalalabad city, on the left bank of the Kabul river and on the banks of Kunarr river the upper Paleozoic and lower Mesozoic sediment are visible on the ground and the central part of the Jalalabad zone is covered by Neogene Deposit.

In addition, In Jalalabad zone there are sediments ranging from Archean Proterozoic to Quaternary system. The Archean Proterozoic structure are composed of various Gneisses, Quartzite, Amphibolite and crystalline slabs including the white

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Marble layers of Marble. The thickness of the Marble layers inside the Gneisses is from 300 to 600 meters.

Furthermore, The Paleozoic group formation are relatively extensive in the Jalalabad zone including the Ordovician, Silurian, Devonian and Carboniferous formation. These formations are composed of Quartzite. Sediments, Sandstone and Limestone the relationship between which is not clear in some places. The sediments of the Neogene system are present on the top of the sediment disconcordantly which include Conglomerate Sandstone and Clays. The sediment of Quaternary has filled the shore of the river and their thickness is also high.

Relatively in this zone Magmatic rocks are present in large amount that are visible on the ground of the left of Kunarr river and in the Spinghar mountain range which differ from one another in age and in composition and are divided in to two different complex.

1. Granite, Gabbro, Amphibolite Complex
2. Granite, Granodiorites Complex

And also Albite that are spread in different part of the Zone. And these Magmatic rocks are interesting according to Mines presence.

Tectonically Jalalabad zone is associated with the Cambrian structure with three structural formation layers separated by

O-T, AR-PR and N-Q

In a tectonic map in 1973 the department of Geology and Mines has divided Jalalabad zone to three further sub zone in this region.

1. The Kunarr Tectonic Zone
2. The Spinghar Tectonic Zone
3. The Jalalabad Basin (Waizy, July 2020)

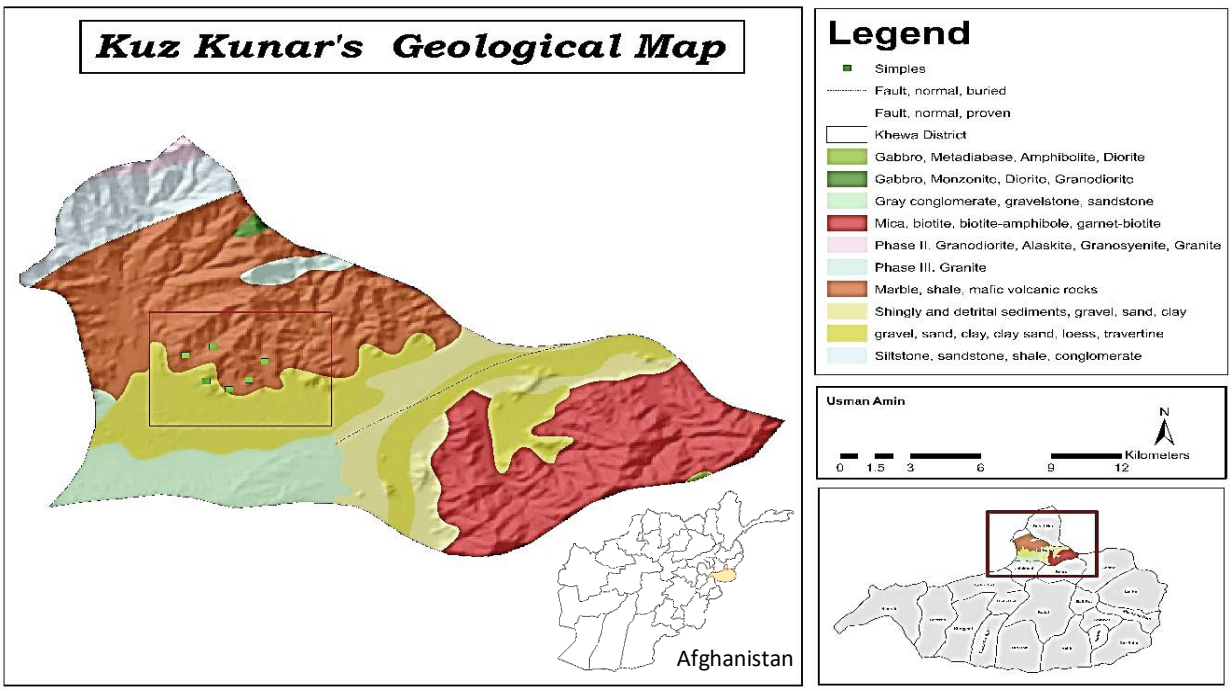

Figure 1: Shows the geological map of the marble area

b) Methodologies

To gather the prehistoric studies of the marble for this research, a desk study was undertaken prior to a field trip and laboratory analysis. Books, other articles, and Wikipedia information were all reviewed. For laboratory analyses, samples from the Marble mine were obtained. After that, the area was thoroughly researched by collecting GPS coordinate, readings of the location and taking samples from the precise mine. The conclusions were drawn by interpreting the fieldwork data and analytical data. A sufficient amount of rock sample was crushed and ground up for geochemical tests, and thin slices were made for microscopic examination in the Ministry of Mine and Petroleum. GIS mapping of the mining area makes up the third section of the stud.

i. *Petrographic description of the Samples*

This specimen contains Calcite, Dolomite and Plagioclase with mosaic structure and metamorphic origin. the dye of the specimen is whitish yellow. (figure a,b)

a. This specimen contains Muscovite, Biotite Garnet and Quartz with schistose structure and metamorphic origin. the dye of the specimen is yellowish. (Figure c,d)
b. This specimen contains Muscovite, Biotite and Quartz and other opaque minerals with

schistose structure and metamorphic origin. the dye of the specimen is white. (Figure e,f)

c. This specimen contains Dolomite and Calcite with mosaic structure and metamorphic origin. the dye of the specimen is pale yellow. (Figure g,h)

d. This specimen contains Muscovite, Biotite and Quartz with mosaic structure and metamorphic origin. the dye of the specimen is yellowish. (Figure g,h)

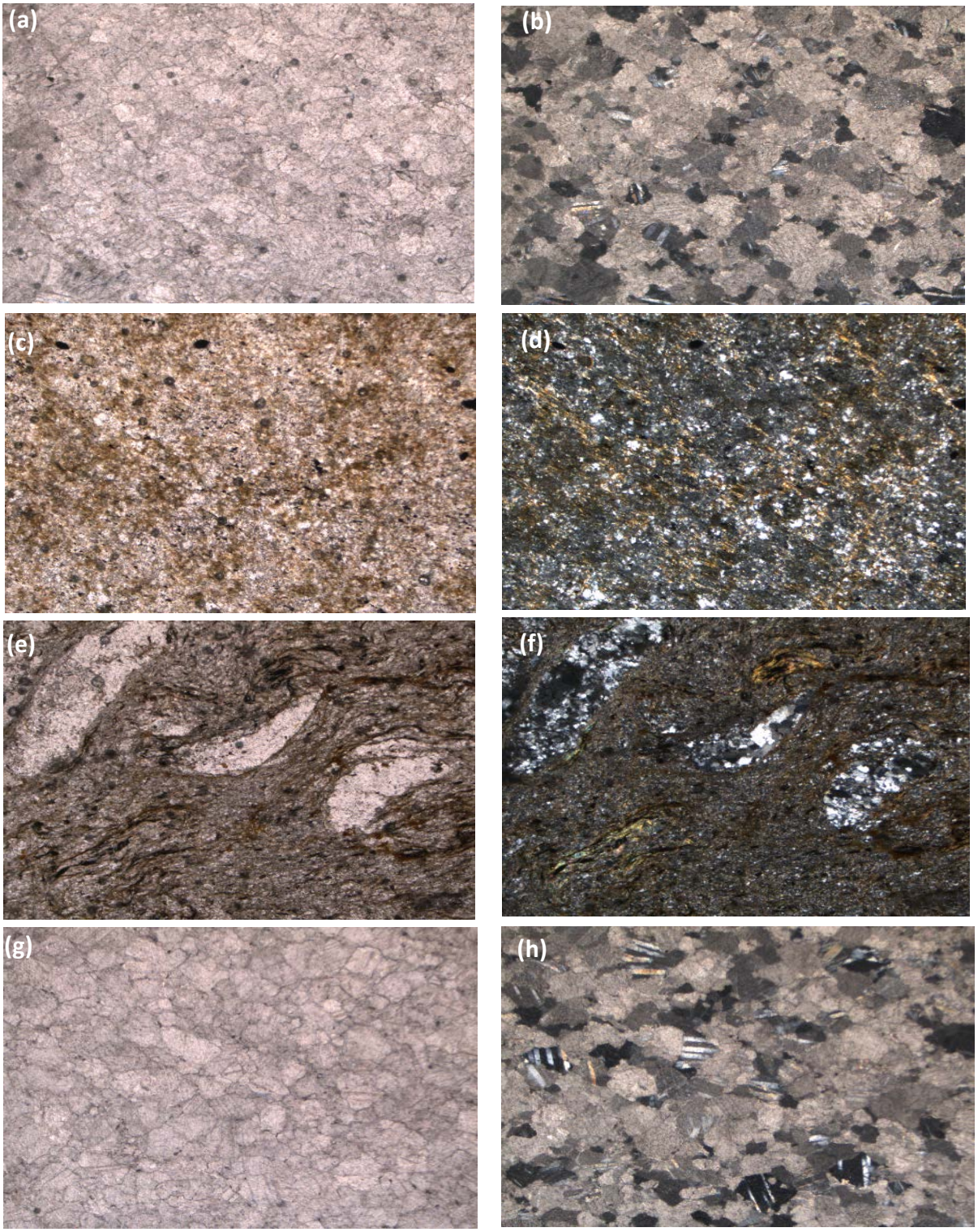

Figure 2: Microscopic Images; (a) Marble PPL and (b)Marble XPL from C1.1 ; (c) Mica schist PPL and (d) Mica Schist XPL, from C2.2 sample; (e) Mica schist PPL and (f) Mica Schist XPL from sampleC3.1; (g) Calcite Marble PPL and (h)Calcite Marble XPL, from sample C4.1

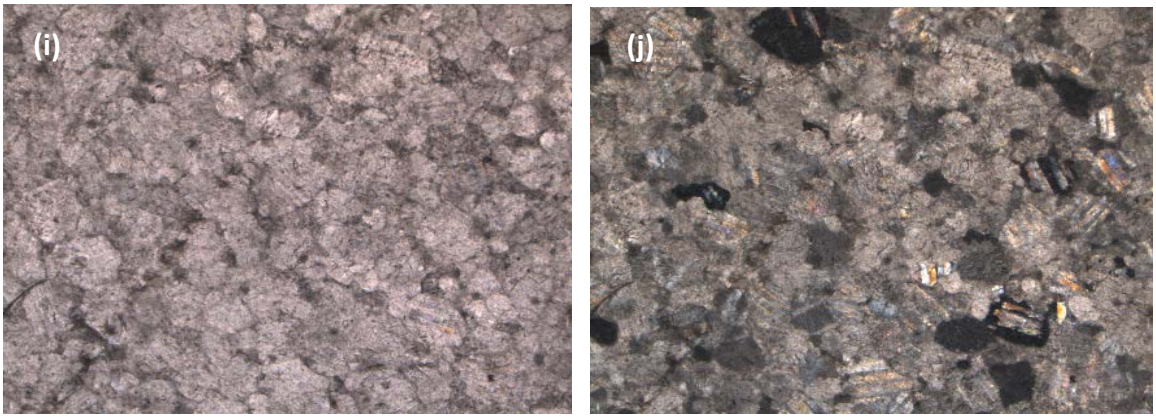

Figure 3: The marble specimen under petrographic microscope,(i) Marble PPL and (j)Marble XPLfrom C5.1 sample

ii. *Geochemical result*

The purpose of geochemical analysis is to identify the constituents of Khewa Calcite Marble's chemical makeup. The XRF analysis results in the determination of 28 elements. The elements with the highest percentages are silicon, calcium, magnesium, aluminum, iron, potassium, and sulfur, as well as heavy metals like Fe, Cr, and Ti.

Table 1: Shows the oxide percentage in Marble in its adjacent rocks with PPM

Oxides	C1-1	C2-2	C3-3	C4-4	C5-5	Over all PPM
MgO	124169.281	129315.227	118810.945	40573.023	41836.957	454705.433
Al_20_3	9800.377	6439.447	40826.293	164967.313	163134.250	385167.680
$Si0_2$	15316.664	11887.871	13935.673	758900.938	90381.525	890422.671
Fe_20_3	385.620	409.443	2564.272	60375.730	52280.992	116016.057
Cr_20_3	101.027	45.940	166.520	254.507	172.603	740.597
CaO	43167.294	41281.397	35411.609	27817.947	24670.201	172348.448
TiO_2	0.000	0.000	762.605	6597.444	6378.446	13738.495
K_20	521.857	382.843	3485.495	32264.771	27118.930	63773.896
$S0_3$	2145.588	2357.083	7541.333	8220.825	4054.696	24319.525
P_20_5	0.000	0.000	0.000	2745.132	3472.462	6217.594

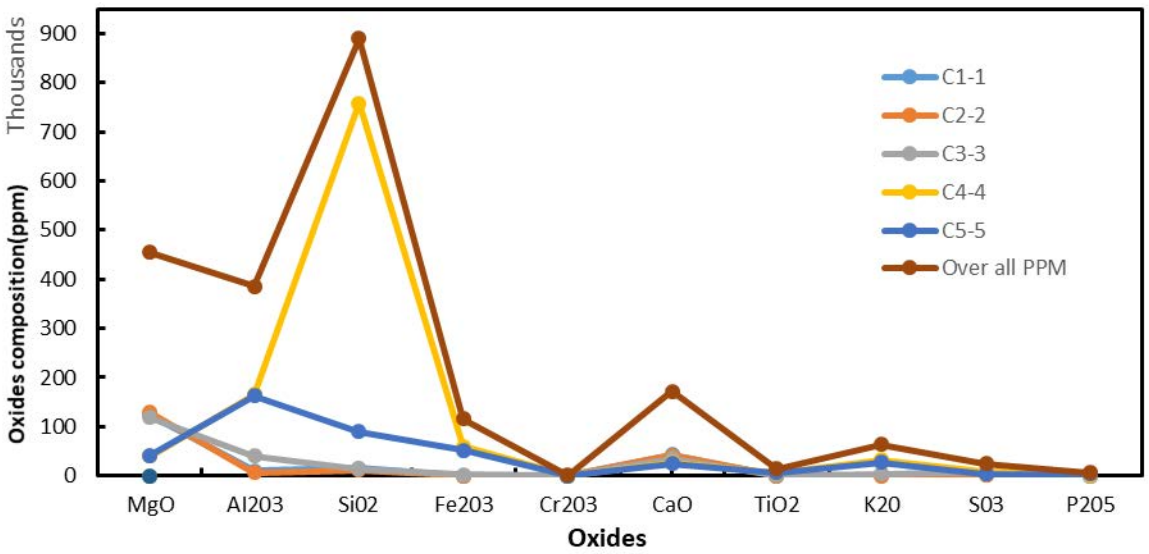

Figure 4: The graph shows the high point of SiO_2

Table 2: Shows the total 28 elements percentage in Marble in its adjacent rocks with PPM

Elements	C1-1	C2-2	C3-3	C4-4	C5-5	Total PPM	Percentage
Mg	74,800.77	77,900.74	71,572.86	24,441.58	25,202.99	273,918.94	27.3919
Al	5,185.39	3,407.12	21,601.21	87,284.29	86,314.42	203,792.42	20.3792
Si	7,157.32	5,555.08	65,119.97	354,626.59	422,343.56	854,802.53	85.4803
P	0	0	0	1,198.75	1,516.36	2,715.11	0.2715
S	858.235	942.833	3,016.53	3,288.33	1,621.88	9,727.81	0.9728
Cl	415.01	588.91	1,069.03	672.319	520.006	3,265.27	0.3265
K	431.287	316.399	2,880.57	26,665.10	22,412.34	52,705.70	5.2706
Ca	308,337.81	294,867.13	252,940.08	19,869.96	17,621.57	893,636.55	89.3637
Ti	0	0	456.65	3,950.57	3,819.43	8,226.64	0.8227
V	0	43.459	43.082	174.223	143.756	404.52	0.0405
Cr	69.196	0	114.055	174.32	118.221	475.79	0.0476
Mn	125.522	126.257	116.608	395.57	319.658	1,083.62	0.1084
Fe	269.664	286.324	1,793.20	42,220.79	36,560.14	81,130.12	8.1130
Co	0	22.028	0	118.604	0	140.63	0.0141
Ni	60.83	81.547	71.589	94.3	84.973	393.24	0.0393
Cu	0	0	0	49.76	32.263	82.02	0.0082
Zn	15.56	18.8	28.204	91.311	88.923	242.80	0.0243
As	0	0	0	14.258	0	14.26	0.0014
Rb	0	0	0	55.933	52.166	108.10	0.0108
Sr	68.047	50.702	30.84	88.796	100.362	338.75	0.0339
Zr	0	0	0	201.972	178.984	380.96	0.0381
Nb	0	0	0	11.829	11.198	23.03	0.0023
U	0	7.479	0	0	0	7.48	0.0007
Ba	261.008	285.623	218.639	859.116	707.169	2,331.56	0.2332
Au	0	0	0	0	0	0.00	0.0000
Pb	0	9.021	0	23.296	28.11	60.43	0.0060
Bi	0	0	0	15.338	7.112	22.45	0.0022
Th	0	0	0	17.563	7.482	25.05	0.0025

Silicon, Calcium, Manganese, Aluminum and Iron are the elements in the composition of Marble that gave the much hardness, and pale color. In addition, the existence of sulfur with 3.490 percent and prolong chemical weathering have played important role in the alteration of the marble color into pale white color.

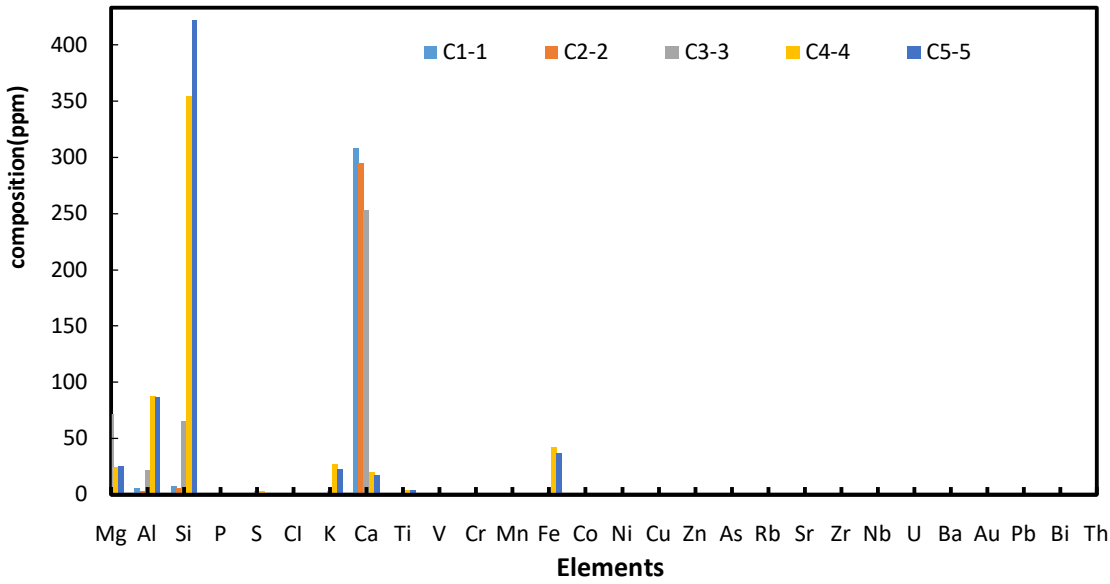

Figure 5: Shows the elements graphs where the Al and Si are in very high range

III. Mechanical Result

The Calcite Marble mechanical studies consist of the following tests which is completely described with their result done in Nangrhar Alfalah University Engineering Laboratory.

a) Compressive Strength

Uniaxial unconfined compressive strength is the amount of load a stone can tolerate before it breaks in to pieces, such measure of stone's ability to support load bearing structures (Prof., 2022)

The table below shows that the uniaxial compressive strength of Calcite Marble ranges from 53 to 81 Mpa under dry to wet circumstances. Based on strength recognition and description, this rating is assigned in the category of powerful rock break with hammer in hand.

Table 3: Shows Compressive strength result of Calcite Marble.

Crushed Aggregate of Khewa Calcite Marble				Material Source	Khewa Calcite Marble
Cube NO	Dimension (mm^2)		Area (mm^2)	Load (KN)	Compressive Strength Kg/Cm^2
	Length	Diameter			
1	71	72	5112	472.5	92.4
2	72	72	5184	278.2	53.7
3	72.1	72.8	5248.88	522.8	99.6
		Mpa		Kg/Cm^2	Psi
		81.9		835.1	11878.11

IV. Unit Weight Test of Calcite Marble

The unit weight test is used to measure the quality of aggregate through determining the placed materials volumes the hallows within the distant range. When the scale of the aggregate reaches to 25(5inch) mm so the mold is used to measure unit weigh. (Prof., 2022).

Table 4: Shows Compressive strength result of Calcite Marble

Unit Weight of course Aggregate				
Test No		1	2	3
Mass of material + Container	g	4742	4728	4740
Mass of Empty Measure	g	3052	3052	3052
Mass of Material	g	1690	1676	1688
Volume of Measure	Cm^2	928.9	928.9	928.9
Bulk Density	g/cm^2	1.819	1.804	1.817
Average Unit Weight g/cm^2			1.814	

V. Result and Discussion

The results of petrographic investigations performed on constructed simples under a microscope showed that the calcite mineral was present in excess in the majority of the sampled simples, with the Khewa marble having a calcite mineral proportion of exactly 55%. The marble is known as "calcite marble" because to its enormous calcite content. Calcite marble's light white tint is caused by the presence of iron and iron oxide. In addition, the proportions of iron and iron oxides are 8.174% and 11.689%, respectively. Additionally, the inclusion of silicon, titanium, nickel, aluminum, and nickel oxides added to the calcite marble's incredible hardness. Calcite, Dolomite, Plagioclase, Muscovite, Biotite, and Quartz are only a few of the minerals that make up calcite marble that were discovered in petrographic research. The XRF examination identified the elements and oxides that were present in the calcite marble's composition. Si, Ca, Mg, Al, Fe, K, S, Ti, Cl, Ba, P, Mn, Cr, Ni, Sr, V, Zr, Zn, Co, Rb, Cu, Pb, Th, Nb, Bi, As, U, and Au are the twenty-eight elements determined by the XRF with their precise percentages. The composition of calcite marble contains significant amounts of silicon, calcium, magnesium, and aluminum. Along with the calcite marble, eight oxides are also present in addition to the elements. CaO, SiO2, Al2O3, Fe2O3, SO3, K2O, TiO2, P2O5, and Cr2O3 are the mineral oxides. High percentages of MgO, CaO, SiO2, and Al2O3 are present. The presence of uranium with a 0.0007479% concentration in the sample is noteworthy in the XRF examination. Studies in mechanics and physics produced thorough findings. Calcite marble has a compressive strength of 81.9 MPa in dry form and 53.4 MPa in humid form. Physical and mechanical testing showed that Khewa calcite marble is suitable for use in drainage walls and basements but should not be used for interior decorating, kitchen countertops, or other locations where there is a lot of moisture or humidity.

VI. Conclusion

1. Although there was a small amount of uranium in the calcite marble, the XRF analysis elaborated its existence. Carbonate rocks are the primary cause of the existence of uranium.
2. Out of the other twenty-eight elements, silicon, calcium, magnesium, aluminum, and iron were the elements most often detected.
3. The calcite marble now has four gradations of hardness due to the outstanding interplay of silicon, iron, and aluminum.
4. Ten oxides have been collected, but among them, magnesium oxide, calcium oxide, silicon oxide, aluminum oxide, and iron oxide have the highest percentages.
5. Due to the presence of iron and extended physical and chemical weathering, the marble has developed a pale white tint. However, apart from this, the color has also lightened significantly within.
6. Calcite, dolomite, and plagioclase are the three important minerals, whereas quartz and mica (muscovite and biotite) are the accessory minerals, according to the microscopic study. Additionally, mica schist makes up the adjacent rocks.
7. Due to its low water absorption, marble may be used in basements, drainage walls, and particularly in damp areas.
8. According to Los Angeles studies and compressive strength, the marble can withstand a large amount of pressure and weight.

VII. Suggestions

1. Extensive research showed that the tested samples all had a trace level of uranium after the XFR assessment. Because it causes cancer and other harmful diseases, the province authorities must inform the permanent people who live close to the calcite marble mountainous area of the Khewa.
2. Given that we are aware of the superior quality of Khewa marble, we highly advise the present administration to launch a thorough prospecting study to learn more about the locations of calcite marble.
3. To accurately analyze the calcite marble and their internal fractures. Deep drilling is required to figure out whether or not a prospected region may produce blocks of calcite marble that are desirable.

4. The Khewa district to Kunarr Khaas districts are where calcite marble first began to thrive. We sincerely want the government to produce accurate and comprehensive satellite, regional, topographical, and geological imagery. This will help the government, businesses, and other researchers.
5. In the field of research, calcite marble from the locations that produce good blocks should be utilized for interior decorating of homes, sculptures, and tabletops, while calcite marble from the locations that produce poor blocks should be used for roads, basements, and other sites.
6. The marble extraction process started some years ago. Additionally, tons of marble have been rotting as a result of extractors using outdated equipment. The government must maintain a close eye on upgraded machinery and must force extractors to employ these tools for efficient extraction.
7. To encourage vendors who have been functioning with marble, travertine, and granite to increase their investments in the marble industry, the government should prolong contracts for up to 10 years.
8. The government need to refrain from extracting the calcite marble from areas where nickel, cobalt, and iron concentrations are high.
9. In order to come down with the loss of marble, the business owner needs pay professionals to do the extraction.
10. The government ought to waive or lower the tax in order to encourage marble dealers.
11. The value of marble domestically in the nation will be impacted by illegal marble exports to foreign nations. The Afghan government must stop illicit exports.
12. In order to generate high-quality cement, the government should persuade traders to participate in the cement business.

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