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Comparison of Petrographic Characteristics and Chemical Composition of Poz-E- Wazirabad and Qachandara Limestone Mine of Samangan Province

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Abstract


As limestone is one of the sedimentary rocks and one of the most extended materials of this group which is widely used for production of cement, glasswork industries, tile making, heat resistance. Therefore, a research experiment was conducted in 2020 at of Poz-E- Wazirabad and Qachandara of Samangan province in Afghanistan to compare the similarity and the differences of petrographic characteristics and chemical composition of limestone in both mines. The samples were taken from both the mines for spectrometric analyses at directorate of laboratories of ministry of mining. Besides the slides were prepared from these samples and the mineral composition, structure and texture characteristics. were studied under petrographic microscope in laboratory of Geology and Mines of Kabul Polytechnic University. The main objectives of this study were to know the similarities and differences in petrographic characteristics and chemical composition of both mines, which in case of more similarities and favorability of Qachandara limestone mine; it would be suggested as a good source for establishment of a cement factory and other dependent industries on limestone in this province. The results indicated a lot of similarities with minor differences in both the mines. The minor differences were the amount of calcium oxides which was 52.54 percent in Poz-E-Wazirabad which was reduced in Qachandara mine to 47.81 percent. The magnesium content of Qachandara limestone was about 4% richer than Poz-E-Wazirabad limestone mine. The Poz-E-Wazirabad limestone was white in color while the Qachandara limestone color was gray to black, which shows the existence of organic matter in composition of this mine. The structure of limestone in Wazirabad mine was biomorphic but the limestone structure in Qachandara mine was oolitic.

Keywords: Limestone, Petrographic, Chemical Composition, Spectrometer.

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Ethical: This study follows all ethical practices during writing.

1. Introduction

Carbonates are one of the sedimentary and the most abundant chemical rocks in bulk which is basically made from calcite (CaCO_3) and Dolomite $\text{CaMg}(\text{CO}_3)_2$. The amount of CaCO_3 and $\text{CaMg}(\text{CO}_3)_2$ in sea water is very high which is consumed by sea plant for their vegetative growth [1, 2]. As per US geologists records the sedimentary rocks consists 14-

29 percent limestone and Dolomite, which the extent of limestone is more than Dolomite in sedimentary rocks [3]. The limestone is usually formed in areas of warm water with shallow depths. The main factors of formation of carbonate rocks are the chemical and biochemical processes [3]. In the most arid and warmest southwestern parts of Afghanistan the covered area with gravels and huge amount of lime and other salts in superstratum of the soil is spreading [4].

Limestones are usually formed by accumulation of oysters, corals and Algae and in addition it can be formed by sedimentation of carbonate of calcium in lakes and oceans, but there is not any general idea regarding dolomite formation, however some theories confirm the dolomite formation from limestone under certain condition for longer period [5]. Due to existence of pores in limestone the emersion possibility of oil reserves can be imagined in it. Porosity in carbonate rocks is from 10 to 60% [1]. Calcium carbonate (CaCO₃) is the most important component of limestone formation which is found in two forms of Calcite (Hexagonal) and Aragonite (Orthorhombic). Sometime calcite with magnesium forms isomorphous chain which the calcite exists in two forms in this situation

1. While the magnesite is less than 4% in composition of calcite, they are called calcite of low magnesium.
2. While the amount magnesite is more than 4% in composition of calcite, they are called calcite of high magnesium [3].

As the limestone and dolomites are the most important and famous carbonate rocks, therefore different classifications have been done in this regard. Accordingly, the rocks which have more than 50% calcites are called limestone [6]. In addition of calcite and dolomite in composition of limestone, other elements and minerals, mud and other particles can be seen in very low percentages [7]. Depending on external materials in limestone composition. They can be found in different colors such as gray, white yellowish, brown, white, dark gray to black [8]. The gray to almost black color in limestone shows the existence of organic matter and the green color indicates the chlorite and glauconite presence in limestone [1]. As Afghanistan is a mountainous country with rich natural resources especially in useful solid material mines [9]. Majority of Afghanistan mines are still intact with no research and discoveries which has plentiful limestone, gypsum, silt, clay particles and stones having iron oxides, aluminum, magnesium, potassium. which these reserves originate from Badakhshan territories and continuous to north of Kabul and is extended to Herat province [10, 11].

Afghanistan limestone mines had extensively growth and there are lots of probabilities that limestone mines of Poz-E-Wazirabad have fallen in Kotal-E-Rubatak and continues to the beginning of Aibak city of Samangan province. It also continues at deep layers of Balkh to Faryab provinces which requires more researches and investigations in this aspect. Therefore, it is suggested that Afghanistan geologists should put efforts to do regional, library and laboratory researches and other effective activities regarding Afghanistan mines. Due to above facts, I have done regional, library and laboratory research under the title of comparison of petrographic characteristics and chemical composition of Poz-E- Wazirabad and Qachandara limestone mine of Samangan province, with the following objectives.

1. Analysis for understanding the condition for formation of limestone mine in Poz-E-Wazirabad and Qachandara limestone.
2. Better understanding of petrographic and chemical composition of limestone in both mines.
3. Comparison and finding of similarities and differences of these mines from formation condition, chemical composition and petrographic characteristics points of view.

2. Material and Methods

This research experiment was conducted in 2020 at of Poz-E- Wazirabad and Qachandara of Samangan province, Afghanistan to compare the similarity and the differences of petrographic characteristics and chemical composition of limestone in both mines. Three samples for spectrometric research and three samples for microscopic research were taken from each mine of both the locations. The samples were numbered and transferred to the directorate of laboratories of ministry of mining for analysis. Besides the slides from these samples were prepared at Geology and Mine laboratory of Kabul Polytechnic University and the microscopic studies were done.

Table-1.
Comparison of limestone composition of Poz-E- Wazirabad and Qachandara mines.

| The spectrometric analyses result of Poz-E- Wazirabad limestone samples | | | The spectrometric analyses result of Qachandara limestone samples | | |
|---|--------------------------------|--------------------------|---|--------------------------------|--------------------------|
| No | Chemical formula | Chemical composition (%) | No | Chemical formula | Chemical composition (%) |
| 1 | CaO | 52,54% | 1 | CaO | 47.816% |
| 2 | MgO | 0,383 | 2 | MgO | 4.134% |
| 3 | SiO ₂ | 2,534% | 3 | SiO ₂ | 3.814% |
| 4 | Na ₂ O | 0,449% | 4 | Na ₂ O | 0.899% |
| 5 | Al ₂ O ₃ | 0,578% | 5 | Al ₂ O ₃ | 0,813% |
| 6 | P ₂ O ₅ | 0,106% | 6 | P ₂ O ₅ | 0,192% |
| 7 | SO ₃ | 0,152% | 7 | SO ₃ | 0,097% |
| 8 | Cl | 0 | 8 | Cl | 0,090% |
| 9 | Fe ₂ O ₃ | 0,225% | 9 | Fe ₂ O ₃ | 0 |
| | Total | 58.008 | | Total | 56.817 |

3. Results and Discussion

Each three samples which were taken from Poz-E- Wazirabad and Qachandara mines separately, were sent for spectrometric studies to the ministry of mining laboratories, which the results of spectrometric analyses are given in [Table 1](#).

The comparison of analyzed results from the taken samples of Poz-E- Wazirabad and Qachandara mines which are presented in ([Table 1](#)) are discussed below.

1. The amount of calcium oxide (CaO) was 52.54 percent in the sample taken from Poz-E- Wazirabad mine while it was 47.81 percent in limestone samples of Qachandara of Samangan province. Therefore according to classification of carbonatic clay rocks in cement industries, the mine of Qachandara limestone is called Marly limestone.
2. The amount of Magnesium oxide (MgO) in mine of Marly limestone of Qachandara was 4.13 percent which was richer than limestone mine of Poz-E- Wazirabad which contained 0.38%. Therefore according to classification such kinds of rocks are classified as Dolomic limestone.
3. The amount of silicon (SiO₂) was 2.54 percent in Poz-E- Wazirabad mine while it was 3.81 percent in limestone mine of Qachandara of Samangan which shows more than one percent increase.
4. Other elements such as oxides of Na₂O, Al₂O₃, P₂O₅, SO₃ were less than one percent and almost existed in equal proportion in both the mines except Fe₂O₃ which was 0.23 percent in Poz-E- Wazirabad mine while it was not observed in Qachandara mine. Similarly, about 0.1 percent Chlorine (CL) was present in Qachandara mine but it was not seen in Poz-E- Wazirabad mine.

The samples which were taken from Poz-E- Wazirabad and Qachandara of Samangan province area for spectrometric analyses and making slides were transferred in laboratory of Kabul Polytechnic University and studied under the microscope with the zoom in of 10*10 which the results are illustrated as below.

3.1. Description of limestone sample of Qachandara mine of Samangan province under 10*10 microscope zoom in

The result of chemical analyses of above samples indicated that the amount of calcium is far more than magnesium in composition of these samples. Therefore, the optimum limestone is from pure or calcite type and according to the microscopic observations small SiO₂ particles, small pieces of rocks and very little feldspars and plant organic organisms were observed in these samples. Similarly, in some of above samples small pieces of mud in black color were irregularly observed under microscope. As these samples contained 15-20% terrigenous material, therefore this rock is called marly terrigenous calcite limestone ([Figure 1](#)).

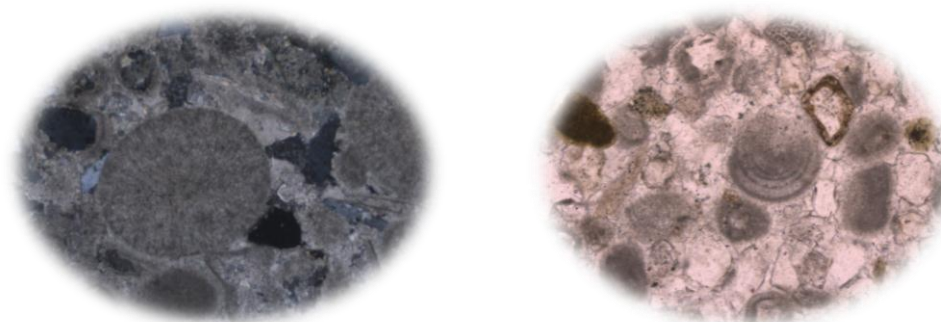


Figure-1.

Slide No. 1 of Qachandara limestone under microscope of 10*10 zoom in
Structure: according to microscopic analyses and mineral composition this rock is having oolitic structure.

Texture: according to microscopic observation it has mass texture.

Crack: no cracks have been observed in the samples. It doesn't have any lamination. Mud: The spectrometric analyses and microscopic observations indicated insignificant amount of mud in these samples.

3.2. Studies of limestone of Poz-E-Wazirabad mines under microscope of 10*10 zoom in

The fossil organs were observed in these samples which majorities of them were intact and only a small number were slightly damaged which had the organic origination ([Figure 2](#)).

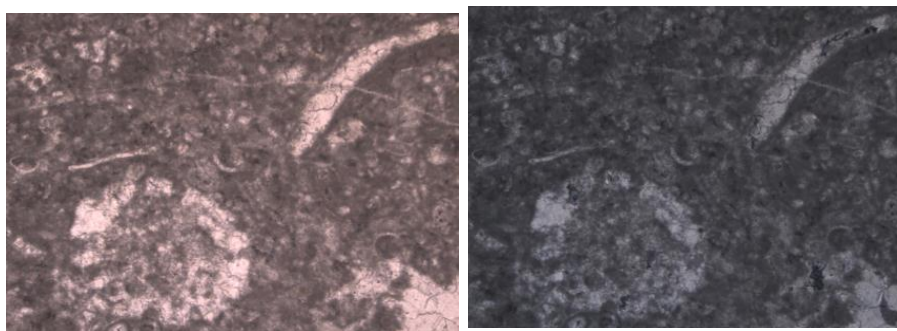


Figure-2.
Slide No. 2 of Poz-E-Wazirabad limestone under microscope of 10*10 zoom in.

The microscopic animals were also seen in different shapes such as circular and oval shape with the fossil size of 0.5 mm and with basic mass particle size formation of 0.15-0.5 mm. The types of fossils were observed as shells, corals, ammonites.

3.3. Analyses of Spectrometric Samples

Analyses of spectrometric samples in Table 2 indicated that

1. Color is one of the basic indicators of rocks determination. The samples which were taken from limestone mines of Poz-E-Wazirabad had white color which indicates that these rocks contain insignificant organic matter in their composition, while the Qachandara’s limestone color was gray to black which shows the remarkable amount of organic matter in the samples.
2. The structure of Qachandara limestone was oolitic but Poz-E-Wazirabad had biomorphic structure, meanwhile both the mines had similar mass textures.
3. According to erosion degree, Poz-E-Wazirabad had no erosion but Qachandara limestone had slight erosion. Meanwhile the Qachandara limestone had no porosity while the little porosities were observed in Poz-E-Wazirabad limestone.
4. Calcite was the basic minerals of both the mines and sub-minerals of Qachandara mine were Quartz and very little feldspars but no sub-minerals were observed in Poz-E-Wazirabad mines.

Table-2.
Comparison of petrographic properties of Poz-E- Wazirabad and Qachandara limestone mines.

| Samples from Poz-E- Wazirabad | | | | Samples from Quchandara | |
|-------------------------------|-----------------------|------------|-----|-------------------------|----------------------|
| No | Name of sample | Limestone | No. | Name of sample | Marly calcite |
| 1 | Color | White | 1 | Color | Gray |
| 2 | Structure | Biomorphic | 2 | Structure | Oolitic |
| 3 | Texture | Mass | 3 | Texture | Mass |
| 4 | Degree of erosion | None | 4 | Degree of erosion | Low |
| 5 | Basic minerals | Calcite | 5 | Basic minerals | Calcite |
| 6 | Sub-minerals | Rare | 6 | None | Quartz and feldspars |
| 7 | Porosity | Little | 7 | Porosity | None |
| 8 | Reaction against acid | Boils | 8 | Reaction against acid | Boils |

4. Conclusions

Poz-E- Wazirabad limestone mine with having 52.54 percent calcium oxide (CaO) is called as pure limestone while Qachandara limestone mine with 47.81 percent oxide of calcium and 4 percent magnesium oxide is considered as dolomite marly terrigenous calcite limestone. The color of Poz-E- Wazirabad limestone was white while the limestone color of Qachandara mine was gray to black which shows the existence of organic matter in composition of this limestone. Insignificant amount of magnesium oxide was seen in composition of Poz-E- Wazirabad limestone mine but this oxide was not present in Qachandara mine. Similarly insignificant chlorine was observed in Qachundara mine while it was not seen in Poz-E- Wazirabad. The rocks in Poz-E- Wazirabad was not eroded while in Qachandara it was slightly eroded and unlikely the porosities were observed in Poz-E- Wazirabad rocks while no porosity was observed in Qachandara rocks. This research article is important for students and geologists who write their thesis or need information regarding limestone studies in Afghanistan. This article is also important for better understanding and usage of limestone in cement factories, glasswork industries, decreasing the melting degrees of metals, construction of buildings and resistant material

against temperature in metallurgy. Despite this study will clear all the doubts and theories about the extension of Poz-E-Wazirabad of Pulikhumri limestone which is extended towards Rubatak and even to the beginning of Aibak city. Whereby in case of chemical composition and petrographic similarities among these two mines, likewise Ghori Cement Factory which its raw material is supplied by Poz-E- Wazirabad limestone, the limestone of Qachandara of Samangan province will be a good source of raw material for establishment of a cement factory in western part of KotalRubatak of Samangan province.

5. Recommendation

The comparison of petrographic characteristics of Poz-E- Wazirabad and Qachandara mines declared the similarities and differences among these mines which is helpful for enterprises specially for establishment of a cement factory in Qachandara of Samangan province.

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