ISSN: 2581-1274

XRD Analysis of Mineral Composition in Marble from Gunung Kerambil, South Aceh

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ARTICLE INFO

Article history:
Received
Revised
Accepted

Keywords:
marble
South Aceh
Gunung Kerambil
XRD

ABSTRACT

Gunung Kerambil is an area in South Aceh that well known for its marble deposits. The characteristic of marble from Gunung Kerambil is normally white. This study aims to determine the mineral characteristics of Marble Stone from Gunung Kerambil, South Aceh. Marbles was characterized by using X-Ray Diffraction (XRD). The sample used for was in powder form. The results of X-ray diffraction (XRD) analysis indicated that the sample of marble taken from Gunung Kerambil has a dominant phase of Calsite (CaCO3). Another minor phase identified in the sample was Quartz (SiO_2).

I. Introduction

Marble is a natural rock resulted from limestone metamorphous due to pressure and temperature change. Regarding to its natural properties and magnificent appearance, marble has been used for many decorative and construction applications [1]. In South Aceh, marble was not well utilized. According to its geographically location between mountain and sea, the marble stone has been only applied for sea-wave blocking/barrier. Nevertheless, the awareness of marble value for industrial need has increased lately. The local marble has been utilized and fabricated into many valuable products in marble production unit located in Tapaktuan [2]. Most of fabricated marbles are generally come from Gunung Kerambil. The Gunung Kerambil is one of areas in South Aceh that well known for its huge marble deposits. The availability of marble deposits offers the potential economic growth in the mining sector. In general, rocks are formed from several types of minerals with certain chemical and crystalline systems. Marble is composed of recrystallized carbonate minerals such as calcite and dolomite. The differences in mineral composition of a rocks in an area is significantly influenced by the differences in geological formations. The presence of some impurity in marble composition affects the colour appeared [3]. Physically, the appearance of marble from Gunung kerambil are white colour. However, the information related to mineral content of marble from has not published yet. The research was conducted to determined mineral deposits in Marble from Gunung Kerambil, South Acheh. The analysis was conducted by using X-Ray Diffraction method. X-ray diffraction (XRD) is a method allowed to analyse certain types and properties of minerals composed in marble. The mineral is determined based on the mineral diffraction patterns produced. The results of this research will be used as reference in subsequent studies.

II. Related Studies

The study related to mineral identification of marble from an area have been published. A Manan and Y Iqbal (2007) identified the mineral content of Pakistani marble stones using X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and Universal Testing Machine (UTM). O G Duliu et al., (2009), investigated some Greek Marbles and Limestones by EPR and XRD. J D

Lynn (2011) developed a new method to determine marble provenance with XRD accessory mineralogy. The result shows the method can easily differentiate between metamorphic marble and sedimentary limestone/dolomite. Leontakianakos et al., (2013) investigated the degree of calcination of a dolomitic and a calcite marble from Thassos Island. The assessment was done by combining both Raman spectroscopy (RS) and X-Ray diffraction (XRD) technique. M Fahad et al., (2016) conducted a review on Geo-mechanical Properties of Marble Deposits from the Nikani Ghar and Nowshera Formations of the Lesser Himalaya, Northern Pakistan. Khrissi et al., (2017) characterized various marbles collected from Moroccan careers by using Raman spectroscopy and XRD analysis. The result show X-Ray diffraction and Raman allowed the identification of both major (calcite and dolomite) and minor (quartz) mineralogical components.

III. Materials and methods

A. Material

Samples of marbles from Gunung Kerambil were collected from Marble Production Unit in Tapaktuan, South Aceh, Indonesia. The location of Gunung Kerambil is shown in Figure 1.

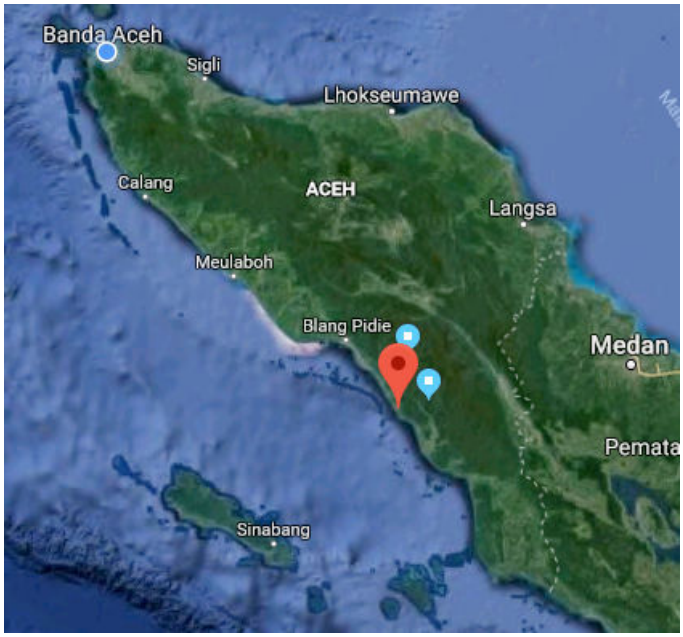

Fig. 1. Location of Gunung Kerambil

Substantially, a sample of marble stone from Mount Kerambil has a white colour with black fibres pattern. To determine the mineral content, the marble should be characterized by using X-Ray Diffraction (XRD). The sample used for XRD analysis is in marble powder form. The marble is cut into small pieces by using a marble stone cutting tool AND then crushed and mashed into fine powder that suits for XRD sample holder (Figure 2).

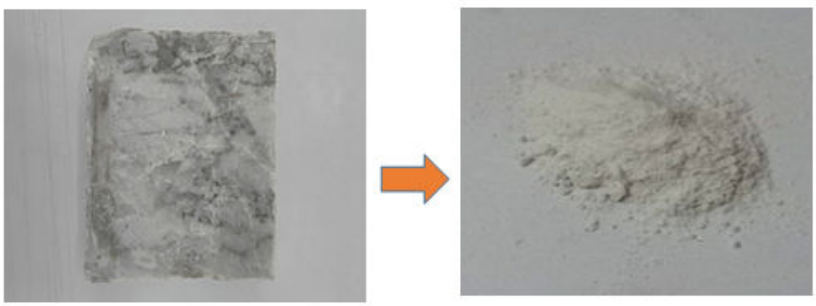

Fig. 2. Marble Sample

Mineral characterization with X-Ray diffraction (XRD) was carried out at the Materials Laboratory, Physics Department, Syiah Kuala University, Banda Aceh, Indonesia. X-ray Diffraction analyses was carried out powdered sample the Shimadzu XDR7000. The sample was radiated with Cu radiation at the wavelength of 1.54060 Å. Besides mineral composition, XRD allowed to determine the crystal structure. The particle size can be calculated by using the following Scherrer equation [9].

$$\tau = \frac{K\lambda}{\beta cos\theta}$$

Where D is average crystal size (nm), K is Scherrer constant (0.9), λ is X-ray (Å) wavelength, θ is diffraction angle (°), and β (FWHM) is maximum half width (radians).

IV. Results and Discussion

A. XRD Data

Table 1 shows the data obtain from X-Ray Diffraction analyses on marble sample from Gunung Kerambil, South Aceh. The parameters are in the form of diffraction angle (*2θ*), distance between two fields (*d*), maximum half width (FWHM) and intensity (*I*). The minerals composed in marble were determined based on the mineral diffraction peaks resulted of the relationship between diffraction angle (*2θ*) and intensity (*I*).

Table 1. XRD Data

No	2θ (°)	d (Å)	FWHM (°)	Intensity
1.	26.60	3.35	0.11600	1283
2.	29.50	3.02	0.12750	5059
3.	30.09	2.97	0.10590	159
4.	39.51	2.28	0.14130	251
5.	42.77	2.11	0.11930	162
6.	43.26	2.09	0.12590	286
7.	47.60	1.91	0.13800	503
8.	48.60	1.87	0.13700	333

B. Mineral Phase

Based on data in Table 1, the relationship between diffraction angel and intensity is figured out in the following diffraction patterns (Figure 3). The figure shows the three highest peaks found at point 1,2, and 4 of diffraction angel *(2θ).* Point number 1 refers to 29,50, point number to refers to 26,59, and point number 3 refers to 47,60. The highest peak appeared at *2θ* = 29,50 with Intensity 5059.

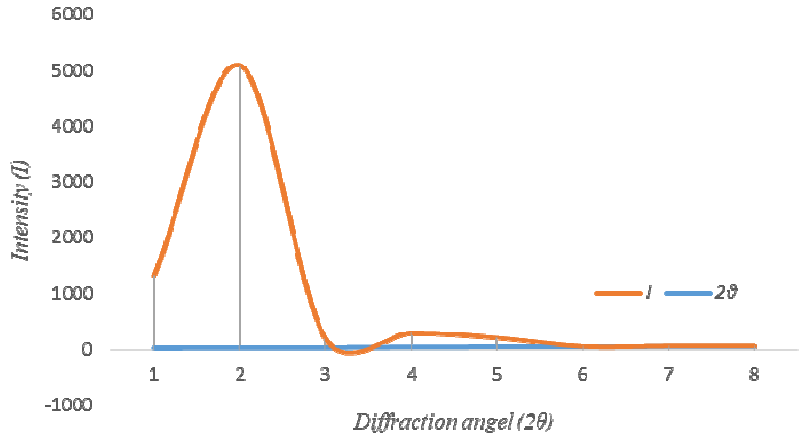

Fig. 3. Diffraction Pattern

Basically, X-ray diffraction (XRD) has been used to detect the mineral and structure crystal contained in the material. Every compound has a certain diffraction pattern. Table 2 shows the mineral composition identified at the three highest peaks. XRD analysis revealed the calcite as the major mineral phase composed in marble stone from Gunung Kerambil, South Aceh. Calcite ($CaCO_3$) is the main minerals that form limestone or marble. However, the presence of some impurities such as GaO4P affected the texture and colour of marble in such area.

Tabel 2. Mineral Phase Composed in Marble from Gunung Kerambil

No	2θ (°)	Intensity	Phase
1.	26.60	1283	SiO_2
2.	29.50	5059	$CaCO_3$
3.	47.60	503	$CaCO_3$

C. Crystalline Size

The size of the crystal of mineral is determined by widening of the X-ray diffraction peaks (FWHM). The crystalline size calculated by using the Scherrer equation is tabulated in Table 3. Crystal size counted from each mineral is 12,49, 13,65 and 12,20 nm. The peak width is inversely proportional to the size of the crystal. The larger the size of the crystal, the smaller the width of the diffraction peak appeared and vice versa.

Tabel 3. Crystalline size of Composed Mineral in Marble from Gunung Kerambil

No	FWHM (°)	2θ (°)	θ (°)	Crystalline Size (nm)
1.	0.11600	26.60	14.75	12.49
2.	0.12750	29.50	13.30	13.65
3.	0.13800	47.60	23.79	12.20

V. Conclusion

In this study, the mineral composition of marble from Gunung Kerambil, South Aceh is presented. The characteristic of marble from Gunung Kerambil is normally white in appearance. The result of XRD analysis indicated that the marble stone from Gunung Kerambil has a dominant phase of Calsite (CaCO3). Another minor phase identified in the sample was Quartz (SiO2). To determine the precise percentage of mineral composition, the XRF analysis is needed.

Acknowledgment

Authors thanks Indonesian Minister of Higher Education through General Director of Research and development for finding this research entitled “Identification of Mineral and Characteristics of South Aceh Marble” under contract number 117/SP2H/LT/DRPM/2018.

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