Quantitative mapping of limestone reserves using cross-section method in Mangkung Village, Western Praya, West Nusa Tenggara

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Abstract. West Nusa Tenggara Province has the potential of natural resources such as marble, calcite, limestone, manganese and gold. The research area consists of limestone, which is included in the Ekas Formation which is based on the Geological Map of Lombok. One of the mineral resources available in the study area is material limestone in Mangkung Village, West Praya District, Central Lombok Regency. With the potential for minerals, it is necessary to do a reserve calculation to find out the range of the amount of material limestone quarry in Mangkung Village. The purpose of this research is to find out the amount of limestone resources in Mangkung Village. This study focus on quantitative mapping of limestone, widely used for natural building stone, sources of water for urban and agricultural development in Mangkung village, Western Praya. This research applied the cross-section method to calculate limestone deposits in study area. This cross-section method divides the study area into several cross-sections with a distance of 25 meters each. The calculating result shows the volumetric of limestone reserves in Mangkung Village is about 73,874.42 m\(^3\). For the weight calculation, this research uses average density of limestone of about 2.38 ton/m\(^3\), and we found a total weight of limestone in Mangkung village is about 176,338.25 tons.

1. Introduction

West Nusa Tenggara Province has a high geological potential. This geological potential is generated by the activity of three plates beside the Flores fault that passed in North Lombok. The high Geological activity is causes the Nusa Tenggara region to be an area that has high potential of mineral. Based on the research, the need of limestone as a cement base material has increased along with population growth which is estimated to reach 273.2 million in 2025.

Limestone is a major raw material for cement manufacturing. It can also be used to produce asphalt filler, ceramics, flux in glass making, fertilizer filler, explosive to mention just a few [3][4]. Limestone are composed mostly of the mineral calcite (CaCO\(_3\)), and they may also contain some other carbonates minerals and several non carbonate impurities [7]. Limestone is one of the...
considerable minerals found in West Nusa Tenggara Province. This rock formed in Ekas Formation, which extends to the south of Lombok island. One area that has limestone potential is located in Mangkung Village, Central Lombok. This village has high limestone reserve, therefore, it is important to calculate the limestone resources, and this study using cross-section method. Classification of excavated materials taken from Putra 2016 stated that there is a division of resources and reserves classification which becomes a reference in determining the classification of calculation results later. In estimating resources, determining the method used is based on the type of quarry material being studied. There are several methods used, such as the calculation of marble resources can use geophysical methods, the krigging method, and the block model method [5][9]. In this study using a cross section method, where this method makes an incision is calculated and finally the volume can be determined by using the distance between the incisions [6].

2. Method
This study applied the cross-section method for quantitative mapping of limestone reserve in Mangkung village. In general, the cross-section method commonly uses resource estimation conventionally by dividing several sections at certain intervals with interval distance, depending on the geological conditions. To calculate the volumetric stock of limestone, width of the area and length of the block are multiplied (Figure 1). The total volume is obtained by summing each of the blocks [10]. In calculating the amount of limestone resources using computer assistance with ArcGIS 10.4 Software [8].

The equation for estimating the limestone volume are shown in equation (1) and (2) [10]:

\[ V = V_1 + V_2 + V_3 + \ldots + V_n \]  
\[ V = (L_1 \times S) + (L_2 + S) + \ldots + (L_n + S) \]

Where:

- \( V \) = Total Volume of limestone stock (m\(^3\))
- \( V_1, V_2, V_3, V_n \) = Volume of each cross section (m\(^3\))
- \( L_1, L_2, L_3, L_n \) = Wide area of each cross section (m\(^2\))
- \( S \) = Distance

![Figure 1](image)

**Figure 1.** Quantitative mapping technique by using cross-section method for calculating limestone stock. S: distance.

To calculate the total weight of the limestone deposit the equation [10] was used equation (3) as follows:

\[ Q = Q_1 + Q_2 + Q_3 + Q_n \]

Where:

- \( Q \) = Total limestone weight (ton)
- \( Q_1, Q_2, Q_3, Q_n \) = Limestone Tonnage for each cross-section

\[ \]
3. Result and Discussion

3.1. Topography
To get topographic data that is adjusted to the location of the study, in this case, it is necessary to change the coordinates to UTM. The topographic conditions in the study area have the highest altitude at an elevation of around 180 meters above the mean sea level and the lowest elevation is at 107 meters above the mean sea level. The topographic map of the study area can be seen in Figure 2.

3.2. Geomorphology of the research area
According to Zuidam 1985, Geomorphology is an inseparable part of geology, this science is the study of landscape; how it spans nature is formed constructively (caused by endogenous forces: tectonic activity / geological structure), and how the landscape is influenced by external factors in the form of exogenous forces such as climate, rivers, and others. Geomorphological formation in the study area is based on Zuidam 1985 by dividing the slope based on a certain slope [2]. The geographic morphology of the research area is the hill. Geomorphology seen from the state of the study area and its surrounding consists of undulating hills of approximately 50 meters to 400 meters high as provided on Figure 3.

![Figure 2. Topographic map of the study area in Mangkung Village, Central Lombok](image)

![Figure 3. Geomorphology map of study area in Mangkung Village, Central Lombok](image)

3.3. Geological setting
Mangkung Village and its surrounding, according to the Geological Map of the Lombok is referred to as Mangga [11], The emergence of a number of dasit and hacks basalt that broke through the scavenger Formation and Kawangan Formation instrusive is a post-magmatic activity which results in a process of change and sulfide ore and the presence of quartz veins in the rock that was broken through in the Late Miocene in the basin condition allows the Sedimentation of the Ekas Formation, in the open deep sea environment, at the Tertiary End or Early Quarter tectonic activities occurred, causing the emergence of sliding faults and normal faults. Generally limestone is yellowish white, grayish white, compact, hard, and locally there are cavities and are strained. Weathering land in the form of sandy clay, reddish yellow, rather loose, nest and slightly containing limestone fragments sized gravel 2-64 mm. Based on the previous research about the evaluation of limestone resources in East Lombok Regency, West Nusa Tenggara Province, the density of limestone is 2,387 tons / m3 [12]. While the geological conditions of the study area are dominated by the limestone units (Figure 4).
3.4. Sampling sites
Based on the limestone deposit in Mangkung Village, this study was taken 22 samples sites (Table 1). Sampling is done randomly by following the area of the study (2220 m²). The sampling location can be seen in Figure 4.

![Geological Map of the study area in Mangkung Village, Central Lombok, West Nusa Tenggara](image)

**Table 1. Sampling Sites Coordinate at Mangkung Village, Central Lombok, West Nusa Tenggara.**

| Site | Latitude  | Longitude  |
|------|-----------|------------|
| 1    | 413139.07 | 9024925.48 |
| 2    | 413129.72 | 9025013.92 |
| 3    | 413131.41 | 9025079.95 |
| 4    | 413200.81 | 9025052.46 |
| 5    | 413308.69 | 9025037.64 |
| 6    | 413361.39 | 9025108.39 |
| 7    | 413261.45 | 9025129.06 |
| 8    | 413293.01 | 9025229.87 |
| 9    | 413244.61 | 9025292.11 |
| 10   | 413206.24 | 9025233.68 |
| 11   | 413154.74 | 9025316.80 |
| 12   | 413038.35 | 9025315.02 |
| 13   | 413129.91 | 9025212.63 |
| 14   | 413020.54 | 9025213.01 |
| 15   | 413057.72 | 9025108.97 |
| 16   | 413165.83 | 9025126.40 |
| 17   | 413028.64 | 9024995.27 |
| 18   | 413033.48 | 9024871.82 |
| 19   | 412967.35 | 9024795.82 |
| 20   | 413082.89 | 9024766.88 |
| 21   | 413100.80 | 9024817.60 |
| 22   | 413192.49 | 9024797.21 |
The study area is divided into 9 cross section. The area in the table 2 is the result of using Arc Gis software. Next, the volume and tonnage of limestone are calculated. Limestone specific gravity uses limestone specific gravity at the study site [2].

If limestone specific gravity about 2.387 tons/m$^3$ [2]
Width = Area x Scale

\[ \text{Total Volume} = \text{Area} \times \text{Distance between Cross Section} \]

\[ = 73874.42 \text{ m}^3 \]

Total Tonnage = Total Volume x Limestone specific gravity

\[ = 176338.25 \text{ tons} \]

3.5. Assessment of limestone resources

Data processing results for the calculation of the limestone resources using cross-sectional methods can be seen in table 2.

Table 2 Quantitative Analysis using Cross-Section Method

| No | Sections | Area (m$^2$) | Volume (m$^3$) | Tonnage (Ton) |
|----|----------|-------------|---------------|---------------|
| 1  | A'-A'    | 244.80      | 7314.69       | 17460.18      |
| 2  | B'-B'    | 242.73      | 7881.20       | 18812.42      |
| 3  | C'-C'    | 245.49      | 12036.33      | 28735.51      |
| 4  | D'-D'    | 247.68      | 12122.32      | 28935.98      |
| 5  | E'-E'    | 248.44      | 11296.43      | 26964.58      |
| 6  | F'-F'    | 246.22      | 6904.39       | 16480.79      |
| 7  | G'-G'    | 246.96      | 6563.83       | 15667.87      |
| 8  | H'-H'    | 244.80      | 5839.88       | 13939.80      |
| 9  | I'-I'    | 246.10      | 3913.31       | 9341.08       |
|    | Total    | 2213.25     | 73874.42      | 176338.24     |

The result of this limestone tonnage is qualified as inferred resources. It is necessary to conduct a more intensive study related to the content of limestone which is suitable for cement raw material to estimate the possibility of limestone in Mangkung Village as cement material.

4. Conclusion

This study has successfully performed quantitative mapping of limestone using cross-section method and found that the total limestone cross-section in Mangkung Village, Central Lombok is about 176338.25 tons. The result of this limestone tonnage is qualified as inferred resources.

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