The geological economic of sand quarry resources in Jantho, Aceh Besar

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Abstract. Jantho, the Great Aceh district, is rich in its natural resources, which can benefit people. With the increasing need for humankind to increase minerals in both quantity and type, the knowledge about exploiting minerals into the material of high economic value also increases. Therefore, the research on sand quarry resources' economic potential needs to be carried out to estimate sand resources and their geological economy. This research was conducted in the area of Jantho with the scope of study covering characteristic lithology analysis, calculation of sand resources, and study of geological condition based on field data analysis and data derived from the literature. In estimating the resources, the contour method was used, and for the economic value, the sieve analysis method was employed. The result informed that sand resources are very economical when the sand is classified based on its type and size. The results also show that economically sand resources are four times more profitable when it is categorized based on type and size than when it is sold in the form of no sorting.

1. Introduction
Jantho City is a sub-district in Aceh Besar District, Aceh Province, Indonesia. Jantho City is also the capital and administrative center of Aceh Besar District. Geographically, Aceh Besar District is located at coordinates 5.2°-5.8° North and 95°-95.8° East. Aceh Besar District has an area of 2,969.00 Km² covering 23 Districts and 604 Villages [1]. The condition of the Aceh Besar Regency consists of mountainous areas, lowlands, and water areas.

Aceh Besar District is rich in natural resources and many potentials that have not yet been explored to be used for the benefit of the people. Along with the development of human needs for minerals, the knowledge on how to explore the mineral will also increase. This is due to technological advances and new discoveries in various industries that require mineral raw materials. One of the potential mineral rock quarries in the city of Jantho is C-quarry material in the form of sandstone [1].

Sandstone resources found in the city of Jantho are the object of research. Therefore, to find out the quantity and quality of these sandstone resources, it is necessary to assess and research resources. In estimating resources, the method used was the contour method [2]. This method is suitable for use in mineral deposits whose thickness changes [3], and for the economic value [4],[5],[6], a sieve analysis
The method was applied [7]. The calculation is focused on the quality and amount of deposits of the mineral deposits. The feasible mining activity was determined by the quality and volume of the extracted material [8],[5]. The results of the calculation and analysis of appropriate natural resources can determine production targets so that the management of natural resources is more beneficial and does not damage the environment. The problem is that there is no economic analysis on the source of a quarry of C-mine minerals in Jantho, which has traditionally been taken. Therefore, in this study, an estimate of the volume of sandstone resources in the study area will be carried out so that it can be estimated how much the economic value of the sandstone resources will be.

The expected benefit of this research is knowledge of sandstone resource reserves and geological economics. This research is expected to optimize mining, facilitate further activities, and maximize sandstone production in the study area. The results of this study can also be used as advice and evaluation in the context of sandstone management efforts so that it can be utilized by the government, the management, and the community.

2. Method
The research location was in Jantho, Aceh Besar district, with a research area of 140 m² and a mapping area of 25 km. Geographically the location of the study is at coordinates (5°19'40.82"N – 5°19'14.87"N and 95°35'14.00"E – 95°35'39.82"E) while the mapping location is at coordinates (5°18'34.35"N – 5°21'14.82"N and 95°33'54.01"E – 95°36'35.84"E) as shown in Figure 1. This research was done for about six months, starting from March 2018 to August 2018.

Before measurement measurements, methods of field mapping, tracking, sampling, and contour measurement using Theodolite were used [10],[11]. The field mapping phase is carried out by directly observing the geological conditions of the study area [12]. At each outcrop that is found, the outcrops are described, taking photos, sketching outcrops, taking stance and tilt, and taking the coordinates of the outcrop, then the coordinates are entered into the topographic map.

Furthermore, to calculate resources, the contour method uses Theodolite. The processing data was based on the multilevel sieved analysis results, and the processing of contour data was generated from the Theodolite device. Theodolite data processing used AutoCad 2007 software, and then used mapcreatesurface tools to unify all the data that has been obtained in the field. The area calculation used
tools area that is applied in the same contour elevation. The results of the filter analysis and contour analysis were then processed into the mining material economy analysis.

3. Results and discussion
3.1 Geology analysis
From the geological data and other supporting data obtained in the field during the study, geological information is presented in the form of a geological map that includes the distribution of lithology and other information as in Figure 2.

![Geology map of the study area](image)

**Figure 2.** Geology map of the study area

The study area is in the Seulimum Formation, Indrapuri Member, Indrapuri Formation, and Alluvium. Based on geological maps [13][14]. The Seulimum Formation is composed of limestone sandstones, conglomerates, and a few mudstones. The Seulimum Formation has a Member Formation section in the form of a Lam Kabeue Limestone Member dominated by limestone coral rock [15]. Based on observations in the field, it is composed of several rock units, including Alluvium Unit, Carbonate Sandstone Unit, Batukonglomerate Unit, and Sandstone Unit.

The study area's geological order consists of carbonate sandstone units, carbonate claystone, and conglomerates, which are members of the Seulimum Formation. In addition, in the study area, the Alluvium Unit was the youngest unit consisting of gravel, sand, and mud found during the mapping. Carbonate sandstone is the rock that dominates in the Research area. The lithology of carbonated sandstone from every observation point is a type of bedding with medium sand to very fine sand size and brownish-gray with good porosity properties and a subrounded to rounded roundness. Shell Fragmented Carbonated Sandstone Unit also found in the study area. This type of rock unit has almost the same characteristics as carbonate sandstone, but its presence is only scattered at locations with the morphology of a 125-meter hill. The thickness of these rock formations ranges from ± 30 - 100 cm, with fine grain size and coarse sand, and has good grain uniformity and fine grain sorting. This rock also contains calcite components resulting from marine fossil ruins, and there are alternating clay layers with
a layer thickness of 15-20 cm. Conglomerate stones found generally have lithology with a brownish-gray color and have grain sizes from cobble to pebble. The level of backwardness of conglomerate stones is subrounded to rounded and has good porosity.

The geological structure in the form of slope occurred in the outcrop of the Seulimeum Formation unit, where the rock lithology was in the form of carbonate sandstone. The sedimentary layers are deposited close to horizontal and basically parallel to the surface plane where the sedimentary layer is deposited. The composition of the layer, which is not a horizontal position, means that it has undergone another geological process after its deposition, for example, influenced by tectonic forces.

3.2 Sandstone resources

The results of the calculation of Sandstone resource volume in this research area can be seen in Table 1. It shows that the smaller the elevation, the larger the volume produced. This is because at a small elevation, the cross-sectional area is larger, resulting in a volume greater than the elevation volume above it.

| No | Elevation (m) | Area (m²) | Volume (m³) |
|----|---------------|-----------|-------------|
| 1  | 15.5          | 3,761.19  | 5,641.79    |
| 2  | 14.0          | 4,584.56  | 2,292.28    |
| 3  | 13.5          | 5,070.32  | 2,535.16    |
| 4  | 13.0          | 5,514.11  | 2,757.06    |
| 5  | 12.5          | 5,930.85  | 2,965.43    |
| 6  | 12.0          | 6,321.95  | 75,863.40   |
|    | **Total Volume** |          | **92,055.11** |

The sieve analysis method is done by sifting the sample and then analyzing the distribution of fine and coarse aggregates. Figure 3 shows the cumulative aggregate filtering analyzed. The percentage of the largest cumulative pass is 98.84% found on a 2 mm sieve, and the smallest is 5.2% on a 0.075 mm sieve. This shows that the smaller the filter size, the smaller the cumulative percentage of passes.

Based on the Wentworth scale (1992) sandstone deposits in the study area can be grouped into 3 dominant sizes consisting of sand measuring 0.85 mm around 16.69%, sand measuring 0.425 mm around 34.73%, and sand measuring 0.25 mm around 25.96%. The predominant sandstone deposits are very dominant in the size of 0.425 mm (medium sand).
3.3 Geological economic analysis

Revenue obtained from the sale of sandstone as much as one truck is Rp. 650,000, therefore income is obtained per day if sold as many as 30 trucks per day will be obtained at Rp. 19,500,000. In a year, the income earned is Rp. 7,020,000,000. In the calculation, the total volume of available resources is 92,055.11 m³ with a truckload capacity of 4 m³ per truck, so 23,013 trucks will be produced. The yield of minerals will run out in two and a half years if 30 trucks per day continuously operate.

Production costs and operational costs incurred in this analysis are excavator operating costs, labor costs, and business costs. Operational excavators are charged Rp. 150,000 per truck, then for 30 trucks, there is an expenditure of 4,500,000. While the amount of labor costs is Rp. 100,000 per truck that costs Rp. 3,000,000 per day. Business costs are estimated at Rp. 2,500,000 per day. Consequently, the total cost per day is Rp. 10,000,000, which means there is an Rp. 3,650,000,000 cost per year.

The net profit of a business is the income received is reduced by the number of costs incurred. In this case, the net profit obtained is equal to Rp. 3,370,000,000.

4. Conclusion

The estimation result of sand quarry resources is 75,863.40 m³ where sandstone deposits in the study area can be grouped into 3 granular sizes, namely sand of 0.85 mm about 16.69%; sand of 0.25 mm estimated as 25.96%; and sand of 0.425 mm as much as 34.73%. Based on the basic economic analysis, it concludes the research area is very economical.

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References

[1] Government of Aceh Besar 2018 Retrieved from http://www.acehbesarkab.go.id. (in Bahasa Indonesia).
[2] Agnerian H, Roscoe W E 2002 CIM Bull. 95 100 – 107.
[3] Rauf A. 1999. Perhitungan cadangan endapan mineral. Yogyakarta: Jurusan Teknik Pertambangan, Fakultas Teknologi Mineral UPN “Veteran” Yogyakarta. (in Bahasa Indonesia).
[4] Jones O, Aspandiar M, Dugdale A, Leggo N, Glacken I, Smith B 2019 The Business of Mining. 121-179. doi:10.1201/9780429057540-5.
[5] Duczmali-Czernikiewicz A 2016 Geologos 22 261-262. doi:10.1515/logos-2016-0026.
[6] Kesler S E, Simon A C 2015 Geologos. 22 261 – 262.
[7] Irham M, Febriarista I, Sugianto S, Setiawan I 2017 Jurnal Rekayasa Kimia & Lingkungan. 12 59 – 76. (in Bahasa Indonesia).
[8] Global Mineral Reserves and Resources (GMR&R) 2017 Mineral Resources, Economics and the Environment. 342-354. doi:10.1017/ebo9781139871426.015.
[9] Bakosurtanal Topographic Maps (BTM) 1998 Aceh topographic maps. (in Bahasa Indonesia).
[10] Werkeheiser W 2017 Mapping the Future of America. United States Geological Survey.
[11] Griffiths J S 2019 Engineering Geology: Geological Maps for Engineering Geology, Reference Module in Earth Systems and Environmental Sciences.
[12] Donadio E, Spanò A 2015 Proceedings of the 1st International Conference on Geographical Information Systems Theory, Applications and Management.
[13] Bennett J D, Cameron N R, Bridge D McC, Djuuddin A, Ghazali S A 1981 Geologic map of the Banda Aceh quadrangle, North Sumatra, Indonesia. Geological Research and Development Centre.
[14] Wajzer M R, Barber A J, Hidayat S, Suhrasono 1991 J. Southeast Asian Earth Sci. 6 159 – 476.
[15] Polom U, Arsyad I, Kümpel H J 2008 Adv. Geosci. 14 135 – 140.