Chemical content analysis of coral limestone as prospecting of extractive development in Gorontalo City

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Abstract. The potential of limestone in Gorontalo City is very large and distributed over a wide area. This enormous potential has not yet been exploited. This study aims to determine the chemical content of limestone and the use solution of limestone to improve regional development. Field data collection was carried out in two places, namely Tanjung Keramat and Buli'ide. Sampling was conducted at the coordinates N 0°29’38.93” and E 123°2’49.62” for station 1, N 0°32’53.7” and E 123°1’56.19” for station 2. The method used in this research is chemical composition analysis using X-Ray Fluorescence (XRF). The results of the analysis of the chemical constituents of Coral Limestone are CaO 83.35%, Fe₂O₃ 6.92%, SrO 9.35% and ZrO₂ 3.25%. The prospect of Coral Limestone can be used in various industrial fields. Coral Limestone can be used in the mining industry, the cement industry, the sugar industry, ceramic raw materials, building materials, agricultural and road stabilizers. This indicates that the City of Gorontalo has the prospect of development and utilization of limestone resources available, in order to encourage self-reliance and open employment for community.

1. Introduction

Potential limestone (carbonate rock) in Indonesia is very large and spread almost evenly throughout the archipelago of Indonesia. The exact data on the amount of limestone resources does not yet exist. However, in general, the potential of limestone in Indonesia based on geological map is estimated to be about 28.678 billion tons [1], consisting of approximately 61.376 million tons (probable reserve) and 28.616 billion tons are (available reserve), reserves with speculative and hypothetical classifications [2]. The of the raw materials (limestones and clays) meet the requirements [3].

According to Cottam [4] and Septian [5], Gorontalo is a shallow sea area until the late Miocene undergoes rapid appointment from the early Pliocene, so that Gorontalo Province has the potential of limestone with wide spread (limestone and coral limestone) about 14 billion tons, also spread in Gorontalo City 10,193 ha with potential resources 3,324,550,000 m³ [6]. Total sufficient to meet industry requirements and resources.

The abundance of processed products requiring limestone indicates that the role of limestone in industrial processes is very important, supposing as the main ingredient [7]. The availability of abundant limestone is a great potential for industrial development, both as a raw material and as an additive. Limestone content is needed as information on the development of limestone to the wider direction. The utilization of limestones, in industrial processes must meet several requirements that one of the...
parameters or requirements is from the chemical parameters of the rock [8]. Based on these chemical parameters there are eight utilization of limestone, that is for building materials, agricultural lime, glass industry, silica brick industry, cement industry, carbide making, bleach, soda ash, and sugar industry besides non-utilization water purification, used in the process of precipitation of non-ferrous metal ores, building blocks, road stabilizers and ceramic materials [9]. Where for every function, percentage (%) of the presence of elements and chemical compounds is said to be quite good if it has CaO ≥ 50%; MgO between 0.03 - 1.35% and Fe₂O₃ between 0.05 - 0.17%, Indonesian National Standard (SNI) [9].

The research aims to determine the chemical content of limestone as a prospect of utilization and development of limestone resources in various industrial fields in Gorontalo City.

On the classification table there are fifteen prospects of utilization of limestone in accordance with the composition of its content.

### Table 1. Limestone function and quality specifications required [2]

| No. | Function                                      | Quality specifications (requirements)                                      |
|-----|-----------------------------------------------|--------------------------------------------------------------------------|
| 1   | Building stone                                | solid or hard, fine crystalline, compressive strength 800 – 2500 kg/m²    |
| 2   | Building material                             | (CaO+MgO) ≥ 95%, (SiO₂+Al₂O₃+Fe₂O₃) ≤ 5%, CO₂ ≤ 3% and 70% escaped the sieve 0,85 mm. |
| 3   | Road stabilizer                               | low sulphur content                                                      |
| 4   | Calcium farming                               | MgCO₃ ≤ 10%, grain size < 5 mm (95% <3 mm)                                |
| 5   | Ceramic material                              | don't have a specific specification                                       |
| 6   | Glass industry                                | (SiO₂ 0.96%), (Fe₂O₃ 0.04%), (Al₂O₃ 0.14%), (MgO 0.15%), and (CaO 55.8%)       |
| 7   | Silica brick industry                         | CaO ≥ 90%, MgO < 4.5%, (Fe₂O₃ + Al₂O₃) ≤ 1.5% and CO₂ ≤ 5%                |
| 8   | Cement industry                               | CaO: 50-55%, MgO ≤ 4.5%, (melt viscosity 3.200 cp, 40% H₂O), Fe₂O₃: 2.47% and Al₂O₃: 0.95% |
| 9   | Making carbide (calcium oxide)                | CaO ≤ 92%, MgO ≤1.75%, SiO₂ ≤ 2%, Fe₂O₃ + Al₂O₃ ≤ 1%, Fe₂O₃ ≤ 5%, S ≤ 0.2%, P ≤ 0.02%, and incandescent (LOI) in the example taken in the furnace 4% |
| 10  | smelting and refining of steel                | Den and hard, CaO ≥ 52%, SiO₂ ≤ 4% (1.5-4%), Al₂O₃ + Fe₂O₃ ≤ 3%, MgO ≤ 3,5%, Fe₂O₃ ≤ 0.65%, P ≤ 0.1 |
| 11  | bleaching agents in the paper, pulp, and rubber industries | pure crystal (close to CaCO₃), limestone cone shells and microorganisms (98% CaCO₃ content) |
| 12  | Making sodium carbonate                       | CaCO₃: 90-99%, MgCO₃ 0.6%, Fe₂O₃ + Al₂O₃ + SiO₂ 0.3%                       |
| 13  | Water purification                            | don't have a specific specification                                       |
| 14  | Process of precipitation of non-ferrous metal ores | don't have a specific specification                                     |
| 15  | Sugar industry                                | H₂O 0.2%, HCl 0.2%, SiO₂ 0.1%, Al₂O₃ 0.1%, CaO 55.0%, MgO 0.4%, CO₂ 43.6%, not real SO₄ (Na₂O·K₂O) 0.3% |
2. Data and Method
The research was conducted at two different locations representing, in the area of Tanjung Kramat and Buli’ide which is included in the administrative area of Gorontalo City. Sampling was conducted at the coordinates N $0^\circ29'38.93''$ and E $123^\circ2'49.62''$ for station 1, N $0^\circ32'53.7''$ and E $123^\circ1'56.19''$. Station was selected based on initial observation of the field in direct observation of rock.

The field equipment used in this research are Garmin Global Positioning Satellites (GPS) devices; Geological Hammers (Pointed Tip and Crack Hummer); Bruton Geological Compass; Mineral comparators and bulk grains; Loupe enlargement 30x and 60x; 50m roll meter; Digital camera; Sample bags; HCL 0.1 N; Tape measure; Stationeries (ballpoint or pens, pencils, coloured pencils, colour markers, marker markers, ruler, protractor, term, protective Douglas, note pad, description sheet, clipboard); and other supportive tools, such as field clothes, boots, and so on.

Laboratory equipment used in this research is: Samples; Instrument X-Ray Fluorescence (XRF) S2 Ranger Bruker; Analytical balance; Vibrating Sieve-Shaker Analyst 3; Herzog HSM 100; Alcohol 75%; Mylar Foil; Sample Cup; Spoon; and other supporting equipment, such as lab clothes, masks, tissue and others.

The method used in this study chemical analysis of limestone using X-Ray Fluorescence (XRF). Each sample performed a megascopic analysis of fragments, cement, colour, degree of sorting, grain shape, packing, porosity, compactness, grain size, roundabout, and settling type. The sample was prepared with HSM 100 Herzog 100 to reduce the water content, the dried sample in swipe using Sieve-Shaker Analysette 3 Vibrator to the size of 80 Mess, the subsequent mechanism weighed the 1.5 g sample to be tested using X-Ray Fluorescence Instruments. X-Ray Fluorescence S2 Ranger Bruker instrument's automatically provides infrared wave shooting results that react the content of the compounds in the sample samples. The results are recorded in the X-Ray Fluorescence Software that is ready to be printed and analysed easily and simply.

Data analysis results of Instrument and Software analysis from X-Ray Fluorescence is then classified based on the type of development potential with reference to the table of the function of limestone and the required quality specification [1]. In the table 1, the purpose of the classification is intended to determine the potential feasibility of the utilization of the already analyzed samples.

3. Result and Discussion
The existence of coral limestone formations of quarter in the area of Gorontalo City and its surrounding areas has a major component of coral and in some shows the coating shows the development potential that needs to be developed in various industrial fields. Common features of coral limestone formations are poor sorting, open packing, good porosity, brittle cohesiveness, angular roundabout, biochemical-biogenic precipitation types; with differences such as white to grey, fine crystalline grain shape to coarse crystalline, large medium sand grains of very fine sand.

![Figure 1](image1.png) **Figure 1.** The appearance of limestone outcrop in the area of Tanjung Keramat.

![Figure 2](image2.png) **Figure 2.** The appearance of limestone outcrop in Buliide area.
From the sample analysis with Fluoroscence X-Ray analysis, it can be seen the compound content of each sample in the two study areas. In the Tanjung Keramat areas, there are 3 compounds known as CaO, Fe$_2$O$_3$, and SrO with percentage according to table 2. In the Buliide area, the content of the compound in the limestone is 4, that is Fe$_2$O$_3$, SrO, and ZrO$_2$ with percentage according to table 3.

**Table 2.** Results of X-Ray Fluorescence analysis of the composition of compounds and elements in the Tanjung Keramat area

| Formula | Concentration | Formula | Concentration |
|---------|---------------|---------|---------------|
| CaO     | 83.86%        | Ca      | 59.94%        |
| Fe$_2$O$_3$ | 10.74% | O       | 28.00%        |
| SrO     | 5.40%         | Fe      | 7.51%         |
|         |               | Sr      | 4.56%         |

**Table 3.** Results of X-Ray Fluorescence analysis of the composition of compounds and elements in the Buliide area

| Formula | Concentration | Formula | Concentration |
|---------|---------------|---------|---------------|
| CaO     | 82.85%        | Ca      | 59.29%        |
| Fe$_2$O$_3$ | 3.10% | O       | 26.80%        |
| SrO     | 13.29%        | Fe      | 2.13%         |
| ZrO$_2$ | 3.25%         | Sr      | 11.47%        |
|         |               | Zr      | 0.24          |
Based on the results of the graph above, the chemical content of limestones in the two study areas has the same ratio of content values. For example, in the Tanjung Kramat area CaO levels were around 83.86% and in the Buliide area around 82.96%. This proves that the chemical content of the two regions is the same. The data also show that the chemical content of the limestone is average CaO 83.35%, Fe$_2$O$_3$ 6.92%, SrO 9.35% and ZrO$_2$ 3.25%, performance limestone discovery can be used in various fields of industry at this time. main according to chemical content [6].

Limestone in Gorontalo province has levels of 51.10 - 54.36% CaO, 2% MgO as a raw materials cement industry. The results of this study are not much different from the analysis of limestone chemical content performed by Kusdarto [6]. In addition, the prospect of limestone in the city of Gorontalo can also be utilized in the mining industry.
that is bleach water and in the process of precipitation of non-ferrous metal ores; in other industries with the addition of additional materials such as sugar industry, can also be used as a raw material for the manufacture of ceramics, building stone, agricultural lime, and road stabilizers [7]. From various prospects of exploiting and developing limestone in Gorontalo City can be developed for various micro-medium to multinational business capital.

4. Conclusion
Coral limestone in the study area has average CaO content of 83.35%, Fe2O3 6.92%, SrO 9.35% and ZrO2 3.25%. Based on the usefulness of limestone and the required quality specifications, the limestone can be developed in various industrial fields such as the mining industry and cement industry as raw materials, sugar industry as additional material, ceramic raw materials, building stone, agricultural lime and road stabilizers which do not require specifications special. This indicates that the Gorontalo city has the prospect of developing and utilizing the available limestone resources, in order to encourage independence and regional development and the opening of employment opportunities.

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Acknowledgment
The authors would like to thank all those who have assisted with the completion of this research. The staff of the Geological Engineering Laboratory and Physics Laboratory who gave knowledge in completing our research. We also thank our friends for sharing their knowledge and have supported us so much that we can present the results of this research.