Comparison analysis of Kanaan Sand, Loktunggul Sand, and Sambera Sand using the methods of XRD and XRF

A Muliawan*1, R Jumardi2, R Fernando3, and M Lutfi4

1Department of Electrical Engineering, Sekolah Tinggi Teknologi Bontang, 75313 Indonesia
2Department of Informatic Engineering, Sekolah Tinggi Teknologi Bontang, 75313, Indonesia
3Department of Mechanical Engineering, Universitas Trunajaya Bontang, 75311, Indonesia
4Department of Petroleum Engineering, STT MIGAS, Balikpapan, 76127, Indonesia

*Conference Author: ariefstitek@gmail.com

Abstract. All this time, the utilization of sand of Kanaan, Loktunggul, and Sambera villages is only for building material. The abundant sand can be used as an advanced material if its metal and quartz contents are known. The analysis of metal and quartz contents on sand for the three villages has been conducted using the methods of x-ray diffraction (XRD) and x-ray fluorescence (XRF). The analysis with XRD method (X-Ray 0.15406 nm) revealed that the scatter angles at 2θ were 26.7470, 26.7360, and 26.7320 degrees with crystal widths of each sand are 1.2067 nm, 1.1876 nm, and 1.81085 nm. Meanwhile, the analysis with XRF method revealed that the concentrations of quartz were 95.5%, 96.6% and 79.1%. According to the analysis, the aluminium content was approximately 14.9 %, and it means that the purification process need to be conducted. The result revealed that the sand of Kanaan and Loktunggul villages was better than the sand of Sambera village regarding of its utilization as quartz material.

1. Introduction
Silicon is a semiconductor raw material that can be used as a solar panel to convert radiation energy into electric current [1]. It is rarely found in its free form and can be found in silica compounds (SiO2) and sand. It has a purity of 99.99% for making solar panels [2]. Quartz sand in Indonesia contains a lot of silica, which ranges from 60-98% in the form of SiO2 with Al2O3, Fe2O3, CaO, TiO2, NaO, or K2O impurities [3].

Research related to the use of natural resources in East Kalimantan to produce advance materials has been widely carried out [4, 7]. In this research, sand sampling was carried out at three locations, namely the sand of Kanaan village, Bontang city, Loktunggul village, Bontang city and Sambera Kutaikartanegara village. The white sand at those locations indicate that it contains quartz. The availability of abundant quartz sand can be further processed as nanomaterials with typical characteristics [8]. Purification of quartz sand into nanosilica can be conducted with acidic solution [9] and wet [10].
In this research, X-Ray Diffraction (XRD) was used to determine the crystallographic characteristics and composition of sand with X-Ray Fluorescence (XRF) [5], [11]. Further results are expected to determine the type of atom in the crystal and its size.

2. Material and Method
This research was conducted in several stages, namely:

- Specimens were collected from the Kanaan village of Bontang city, Loktunggul village, Bontang city and Sambera Kutaikartanegara village.
- Each sample is then washed thoroughly with distilled water to remove dirt and then dried.
- Each sample is then sieved with a 70 mesh filter then separating the element Fe in sand [12].
- Specimens were tested and analyzed using XRD method. XRD is set at a voltage of 40kV with 30 mA, where angle shooting ranging from 10-90 degrees, step size 0.02 degrees, time step is 0.7 seconds, and continuous scan speed. XRD data was analyzed using the Highscore Plus software, diffraction analysis software from PAN analysis [13].
- Specimens were tested and analyzed using XRF method. XRF is set at a voltage of 20 kV with 160 µA.

3. Results and Discussion
XRD and XRF tests have been carried out on specimens obtained from the Kanaan village of Bontang city, Loktunggul village, Bontang city and Sambera Kutaikartanegara village. XRD data analysis was carried out automatically by using software at the Laboratory of Advanced Materials at the Mathematics and Natural Sciences Department of Malang State University followed by manual calculations. The results are explained in detail in the following sections:

3.1. XRD analysis
The XRD results from Kanaan sand are shown in Figure 1. There are 21 peaks detected on the sand of Kanaan with the distance between atoms in units of cells (d) is between 0.12272 - 0.42387 nm. The total peak value of the FWHM is 2.9928, this shows the degree of crystallography. The size of the Kanaan sand crystals is between 0.36063 - 2.17211 nm. The identification pattern of 100% quartz absorbed absorption has the chemical formula SiO2 falling at an angle of 2θ = 26.7470 with a crystal size of 1.20676 nm.

XRD results from Loktunggul sand are shown in Figure 2. There were 20 peaks detected in Loktunggul sand samples. With the distance between atoms in units of cells (d) is 0.12266 -0.42420 nm. The total peak value of FWHM is 3.7094, this shows the degree of crystallography. The size of Loktunggul sand crystals in sample 2 is between 0.42628 - 2.12844 nm. The pattern of identification of absorbed 100% quartz has the chemical formula SiO2 falling at an angle of 2θ = 26,7362 with a crystal size of 1,18763 nm.
Figure 1. The peak of Kanaan sand absorption with XRD method

Figure 2. The peak of Lektunggul sand absorption with XRD method
XRD results from Sambera sand are shown in Figure 3. There are 27 peaks detected at Sambera sand, with the distance between atoms in units of cells (d) is 0.11136 -0.71403 nm. The total peak value of FWHM is 6.158, this shows the degree of crystallography. The size of sambera sand crystals is between 0.13708 nm and 2.51266 nm. The pattern of identification of absorbed 100% quartz has the chemical formula SiO2 falling at an angle of 2θ = 26.7321 with a crystal size of 1.81085 nm.

![Figure 3](image)

**Figure 3.** The peak of Sambera sand absorption with XRD method

### 3.2 XRF analysis

XRF test was conducted to determine the chemical composition of minerals of specimens of Kanaan sand, Loktunggul sand and Sambera sand.

**Table 1. Chemical analysis**

| Chemical composition | Weight (%) |          |          |
|----------------------|------------|----------|----------|
|                      | Kanaan     | Loktunggul| Sambera  |
| SiO2                 | 95.5       | 96.6     | 79.1     |
| Al2O3                | 0.0        | 0.0      | 14.9     |
| CaO                  | 1.4        | 1.4      | 1.2      |
| TiO2                 | 1.0        | 1.2      | 1.2      |
| Fe2O3                | 1.4        | 1.3      | 1.1      |

Table 1 shows the content of SiO2 as the largest sand constituent on the three specimens. Sambera sand shows the large content of Al2O3, which is indicating that Sambera sand is clay [14]
4. Conclusions
Quartz was detected at 20 angles of 26.7470, 26.7360, and 26.7320 with a crystal size of 1.20671 nm, 1.1876 nm, and 1.81085 nm. Quartz concentration was obtained with a concentration of 95.5%, 96.6% and 79.1%. At Sambera sand, there is an aluminum concentration of 14.9%, which shows Sambera sand is clay. The result revealed that Kanaan sand and Loktunggul sand was better than Sambera sand, where it can be used as a source of quartz material.

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