JPPIPA 9(4) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Analysis of Mountain Sand Material Content in Rumah Tiga and Hative Besar Villages, Teluk Ambon District Using X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) Methods)

Sisca M. Sapulete[1,2,3,4*], Matheus Souisa[1,2,3,4], Amirah Hanifah[1], Ferdinanda C. Papilaja[1,3]

[1]Department of Physics, Faculty of Mathematics and Natural Sciences, University of Pattimura, Ambon, Indonesia.
[2] Landslides Laboratory, Faculty of Mathematics and Science, University of Pattimura, Ambon, Indonesia.
[3] Disaster Mitigation Laboratory, Faculty of Mathematics and Science, University of Pattimura, Ambon, Indonesia.
[4] Geosciences Center, Faculty of Mathematics and Science, University of Pattimura, Ambon, Indonesia

Received: February 13, 2023
Revised: April 23, 2023
Accepted: April 25, 2023
Published: April 30, 2023

Corresponding Author:
Sisca M. Sapulete
msapulete086@gmail.com

DOI: 10.29303/jppipa.v9i4.3168

Abstract: One area that has a mountain sand mine is Maluku, especially Ambon City, Teluk Ambon District, Hative Besar Village, and Rumah Tiga Village. This study aims to analyze mineral content, lattice parameters/crystal size, and the percentage of elemental and oxide content that forms a material on mountain sand in Wailete, Hative Besar Village and Kota Jawa, Rumah Tiga Village, using XRD and XRF methods. The mineral content analyzed by the XR-D method at both research locations showed the presence of diffraction peaks of the relationship between angle (2θ) and intensity (I) in the diffraction pattern with the main mineral content dominated by Quartz, Cristobalite, Sodalite, Calcite-synthetic, Anorthite, and followed by other minerals. Analysis of the percentage of elemental content using the XR-F method. Based on the results of XR-F analysis, the most dominant element in Wailete mount sand is Si (Silicon) with a percentage of 66.3% then followed by Al (Aluminum) at 10.8%, Fe (Iron) at 3.75% and in Kota Jawa hill, namely Si (Silicon) is 46.2%, Al (Aluminum) is 10.8%, Fe (Iron) is 9.11% and the rest is in the form of several elements with smaller percentages, namely Rb (Rubidium) and Sr (Strontium) 0.09%.

Keywords: Rumah Tiga; Hative Besar Village; Sand Mountain; Quartz (SiO_2); XRD Method; XRF Method.

Introduction

The Maluku Islands were a unique formation because Maluku is an archipelago arc flanked by four world plates (the Indo-Australian plate, the Pacific plate, the Philippine Sea plate, and the Eurasian plate) so it has an interesting geological setting (Souisa and Sapulete, 2021). Thousands of islands formed enchantingly in the province of Maluku. The existence of the distribution of mountains which are the result of plate collision processes and the formation of sedimentary rocks, volcanic rocks as a vast expanse of karst areas, abundant minerals, hot springs, fertile seas, and land overgrown with rich spices are strands of natural resources that have been formed since ancient times millions of years ago to the present (Lewerissa et al., 2018). Even geologically, there are fundamental differences between regions and cities in Maluku province, and of course, it will produce a variety of mountains that store economic materials below the surface, especially in Ambon City.

Mountain sand is obtained directly from the ground or by digging. The form of mountain sand is usually sharp, angular, porous and free of salt content although it usually has to be cleaned from dirt/soil by washing it first (Supriani et al., 2019). One of the supporting economic materials is sand. Sand is a granular material that is often used in building construction, furniture, and crafts (Tang et al., 2017; Sapulete et al., 2020). As we know, sand is very important and very influential as a building material mixed with cement adhesive. In Ambon City, there are several areas of sand material sources, two of which are

How to Cite:
Sapulete, S.M., Souisa, M., Hanifah, A., & Papilaja, F.C. (2023). Analysis of Mountain Sand Material Content in Rumah Tiga and Hative Besar Villages, Teluk Ambon District Using X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) Methods). *Jurnal Penelitian Pendidikan IPA*, *9*(4), 1982–1986. https://doi.org/10.29303/jppipa.v9i4.3168

Hative Besar Village and Rumah Tiga Subdistrict of Teluk Ambon. This sand material is exploited on a large scale every day to meet the needs of infrastructure development.

This research is focused on mountain sand material found in Hative Besar Village (Wailete) and Rumahtiga Village (Kota Jawa), because every day the mountain sand material is only used by the government and the people of Ambon city as a building material used in the house construction process. Information obtained from mountain sand users is that the sand mining in Wailete Hative Besar Village has a slightly large size and less fine grain, so it is very suitable for foundation and building floor casting. Meanwhile, the mountain sand mined in Kota Jawa, Rumahtiga Village, has a small size and fine grain, so it is suitable for making stronger foundations and smoother plastering (Mabui et al., 2021).

A study or research is needed to obtain the benefits of mountain sand material in Wailete, Hative Besar Village, and Kota Jawa, Rumahtiga Village. Research on mountain sand material content analysis uses two methods: X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRD and XRF) methods.

Method

Research area

This research was conducted in the Wailete area, Hative Besar Village, Teluk Ambon District, Ambon City which is located at coordinates 3°39'47.97" LS dan 128° 9'25.61" BT, and Kota Jawa, Rumahtiga Village, Teluk Ambon District, Ambon City which is located at coordinates 3°39'32.56" LS dan 128°10'30.98" BT. Analysis of mountain sand material characteristics using XRD and XRF methods in the Hydrogeology and Hydrogeochemistry laboratory, Faculty of Mining and Petroleum Engineering, Bandung Institute of Technology (ITB). The map of the research location can be seen in Figure 1.

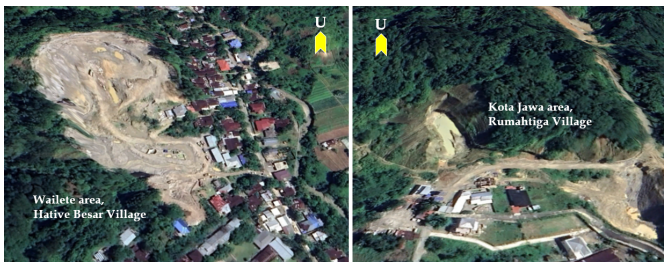

Figure 1. Research location map

Data acquisition and field data processing

In this stage, a surface survey and preparation of equipment are carried out to support the implementation of the research. Then track the coordinates around the research location in a zig-zag way using GPS. Then the mountain sand samples were taken at the two research locations. The first sample was taken above the surface and the second sample was taken by drilling at a depth of 1.0 – 1.5 m. In both research locations, 2 samples of sand material were taken, so the number of samples taken and analyzed was 4 samples.

After conducting data acquisition, the next step is data processing which consists of the following steps: (i) make a topographic map of the research area which has mountain sand material, and (ii) analysis of the content of mountain sand samples using X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) methods. Analysis of mineral content and lattice parameters/crystal size on mountain sand in Wailete, Hative Besar Village, and Kota Jawa, Rumahtiga Village, was carried out using the XRD method (Muliawan et al., 2019a; Muliawan et al., 2019b). Meanwhile, the analysis of the percentage of elemental and oxide content that forms a mountain sand material in Wailete, Hative Besar Village, and Kota Jawa, Rumahtiga Village, was carried out using the XRF method (Suastika et al., 2018; Langi et al., 2020; Kono et al., 2021).

Result and Discussion

Topography of the research area

Coordinate data collection of the research area was measured directly using GPS at each measurement point which was carried out in a zig-zag way. This coordinate data was used to design the topographic map of the research area on Wailete Hill, Hative Besar Village and Kota Jawa Hill, Rumah Tiga Village. The design results are shown in Figure 2 and Figure 3.

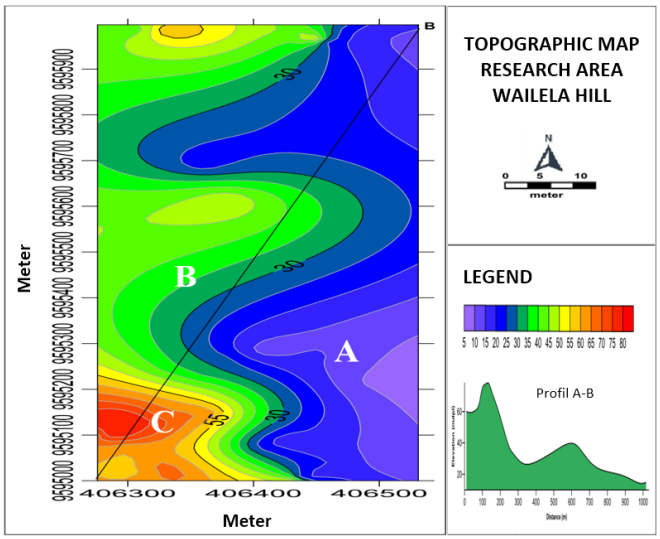

Figure 2. Topographic map of reset arch area, Wailete Hill

Figure 2 topographic map of Wailete Hill, purple contours show areas that have very low hill surface areas indicated by point A, green contours indicate areas with moderate plains or zones between the hill surface and

the top of the hills indicated by point B and this area is also a mountain sand excavation site, and the dark orange contour shows a very high hill plain and is covered with a variety of vegetation indicated by point C.

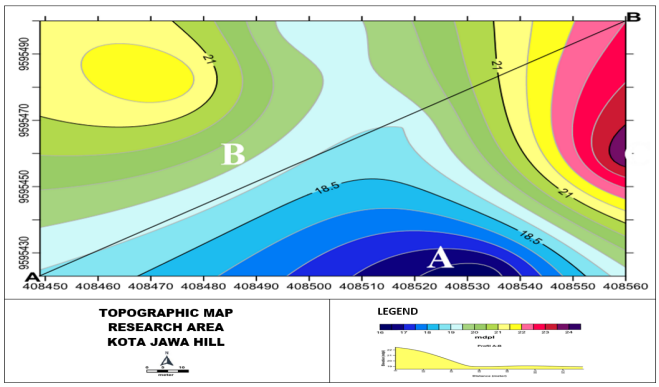

Figure 3. Topographic map of the research area, Kota Jawa Hill

In Figure 3 the Java City Hill topographic map, the blue contour shows an area that has a very low hill plain which is indicated by point A, the dark green contour shows an area that has a low hill plain and this area is a place for mountain sand sampling which is indicated by a point. B and purple contours indicate areas that have high hills and are covered with various vegetation indicated by point C.

XRD and XRF test results for the sands of Mount Wailete, Hative Besar Village, and Kota Jawa Hill, Rumah Tiga Village

Analysis of mineral content and crystal size in mountain sand in Wailete, Hative Besar Village, and Kota Jawa, Rumahtiga Village, used the XRD method (Souisa, 2018; Boccalon et al., 2019; Ali et al., 2022). The results of the XRD qualitative analysis of mountain sand samples from the two data collection locations Yanny et al. (2020), and Shariatmadari et al. (2021), showed that there were diffraction peaks in the relationship between the diffraction angle (2θ) and intensity (I) in the diffraction pattern presented in Figures 4 and 5.

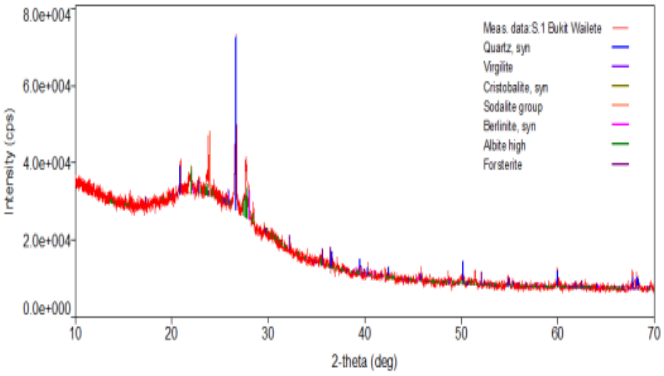

Figure 4. Analysis Result of Minerals Contain Mountain Sand on Wailete Hill Using XRD

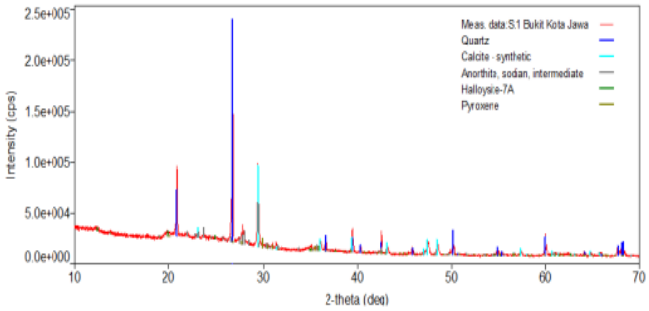

Figure 5. Analysis Result of Minerals Contain Mountain Sand on Kota Jawa Hill Using XRD

Qualitative analysis using XRD on the sand of Mount Wailete (Figure 4) shows that the main mineral content is dominated by Quartz (SiO_2), Cristobalite (SiO_2), Sodalite ($Na_8(ALSiO_4)_6(MnO_4)_2$), followed by other minerals such as Virgilite ($Li_xAl_xSi_{x-3}O_6$)), Berlinite ($AlPO_4$), Albite ($K_{0,2}Na_{0.8}AlSi_3O_8$), and Forsterite ($(Mg_{0.9}Fe_{0.1})_2SiO_4$) re-listed on the peaks from a 2θ angle. In the sands of Mount Bukit Kota Jawa (Figure 5), the main mineral content is dominated by Quartz (SiO2), Calcite-synthetic ($Ca(CO_3)$), Anorthite ($(Ca, Na)(Si, Al)_4$), followed by other minerals such as Halloysite-7A ($Al_2Si_2O_5(OH)_4$), and Pyroxene ($Ca(Mg_{0.70}Al_{0.30})$) are listed on the peaks from the 2θ angle. The results of the measurement of the lattice parameters/size of mineral crystals are only seen from the diffraction pattern of the mineral Quartz (Hariyanto et al., 2021) which is quite abundant for the two mountain sand samples (Sapulete et al., 2020). The size of the quartz mineral crystal can be seen in Table 1.

Table 1. Size of Quartz Mineral Crystals in the Hills of Wailete dan Kota Jawa

Sample Name	Diffraction angle		Maximum half-peak width, *l* (radian)	Average crystal size, τ (nm)
	2θ	θ		
S.1 Wailete Hill	27.71	13.86	0.22	2.26
S.1 Kota Jawa Hill	26.66	13.33	0.09	2.16
Average			0.15	2.21

The results of the XRF test at both research locations showed that the percentage of Si (Silicon) was higher than the other elements as shown in Table 2. The most dominant elemental content in the Mount Wailete sand was Si (Silicon) with a percentage of 66.3%. followed by Al (Aluminum) at 10.8%, Fe (Iron) at 3.75%, and the rest in the form of impurities with some elemental content whose percentage is smaller, namely Zr (Zirkinium) of 0.01% and the most dominant element content in the mountain sand of Bukit Kota Jawa contains Si (Silicon) which is high enough at 46.2% then followed by Al (Aluminum) at 10.8%, Fe (Iron) at 9.11 % and the residues are in the form of impurities with several

elements with smaller percentages, namely Rb (Rubidium) and Sr (Strontium) of 0.09%.

Table 2. Results of Elemental Analysis in Mountain Sand Using XRF

Element Name	Percentage (%)	
	Wailete Hill	Jawa City Hill
Na	1.21	0.48
Mg	0.05	0.36
Al	10.8	10.8
Si	66.3	46.2
P	-	0.12
S	0.02	0.21
Cl	0.32	0.11
K	1.46	5.50
Ca	2.44	2.60
Ti	-	0.67
Mn	0.16	0.19
Fe	3.75	9.11
Co	0.12	-
Rb	0.12	0.09
Sr	0.03	0.09
Zr	0.01	0.49

Based on the analysis of XRD and XRF on the sands of Mount Wailete Hill, Hative Besar Village, and Kota Jawa, Rumahtiga Village, it shows that the mineral found is dominated by Quartz (SiO_2). Quartz minerals show the presence of the semimetals Silicon and Oxygen (Si and O_2). These results are also supported by the analysis using the XRF method that has been carried out. This can be said because the percentage of elemental content in the sand of Mount Wailete, Hative Besar Village, and Kota Jawa, Rumah Tiga Village is dominated by Silicon (Si). Mount Wailete Sand Mountain, Hative Besar Village, and Kota Jawa, Rumahtiga Village can be said to have a high level of silicon purity because other chemical elements are less than 15%. Thus, the presence of silica compounds as well as Si elements was higher and dominant in both research locations.

Conclusion

Based on the results of the research and discussion that have been stated, it can be concluded as follows the results of the analysis of Mount Wailete sand have the characteristics of the main mineral content which is dominated by Quartz and followed by other minerals, namely Cristobalite, Sodalite, Virgilite, Berlinite, Albite, and Forsterite, while the sands of Bukit Kota Jawa show the main mineral content which is dominated by Quartz is followed by other minerals, namely Calcite-synthetic, Anorthite, Halloysite-7A, and Pyroxene. The mountain sand in Wailete, Hative Besar Village, and Kota Jawa, Rumahtiga Village, contains three elements with dominant concentrations, namely Si, Al, and Fe elements, while the other elements are minor phases.

Acknowledgments

Thanks to the Geoscience Center FMIPA, Pattimura University that have prepared facilities for data analysis, and all parties who have supported the completion of this research.

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