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Characterization of Rock Composing Minerals Using the X-Ray Diffraction Method at the Samaenre-Mallawa Hot Spring, Maros Regency

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ABSTRACT

One of the areas in Maros Regency that has geothermal potential is located in Samaenre, Mallawa District, where the hot springs are located a few kilometers from residential areas. This hot water is a source located around the river. Hot springs are springs that are produced as a result of the discharge of groundwater from the earth's crust after being heated geothermal. Research has been carried out that aims to determine the mineral content around hot springs and determine crystal structure around the hot springs by using the X-Ray Diffraction method. Samples were obtained from a depth of 1 meter at points A, B, C, D and E. XRD test results showed that the mineral content was silicon oxide, kaolinite, magnetite, calcium peroxide, Dobassite-2M1a, alpha-SiO2, Calcium Peroxide, Maghemite-Q , Aragonite, Paragonite 2M1, Gehlenite, UTD-1, Silicon Oxide, Pyrophyllite 1A dehydroxylated, Paragonite 3T, and UTD-1. Most of the five samples are silicon oxide minerals. The crystal structures seen are tetragonal CaO2, Fe2O3, (Ca2 (Al0.92 Mg0.08) ((AlO.92), orthorhombic Ca (CO3), Si112 O224, Si O2, hexagonal SiO2, Na Al2 (Al Si3 O10) (OH)2, monoclinic Al4.5 (Al8.5Si3.2) O10(OH)8, NaAl2 ((AlSi3) O10 (OH)2, triclinic Al4(OH)8(Si4O10), Al4Si2 O22 and cubic Fe3O4.

Keywords: crystal structure, geothermal, mineral content, X-ray diffraction

ABSTRAK

Salah satu daerah pada Kabupaten Maros yang memiliki potensi panas bumi (Geothermal) terletak di Samaenre, Kecamatan Mallawa, dimana permandian air panas ini berada beberapa kilometer dari pemukiman penduduk. Air panas ini merupakan sumber yang terletak di sekitar sungai. Sumber air panas adalah mata air yang dihasilkan akibat keluarnya air tanah dari kerak bumi setelah dipanaskan secara geothermal. Adapun tujuan dilakukannya penelitian ini yaitu untuk mengetahui kandungan mineral di sekitar sumber air panas dan mengetahui struktur kristal di sekitar sumber air panas dengan menggunakan metode *X-Ray Diffraction*. Sampel diperoleh dari kedalaman 1 meter pada titik A, B, C, D dan E. Hasil uji XRD menunjukkan bahwa kandungan mineral yaitu *silikon oksida, kaolinite, magnetite, kalsium peroksida, Dobassite-2M1a, alpha-*SiO_2, *Calcium Peroxide,Maghemite-Q, Aragonite, Paragonite 2M1, Gehlenite, UTD-1, Silikon Oksida, Pyrophyllitte 1A dehydroxylated,* dan *Paragonite 3T*. Dari kelima sampel umumnya didominasi mineral silikon oksida. Struktur kristal yang terlihat yaitu *tetragonal* CaO_2, Fe_2O_3, $(Ca_2(Al_{0.92}\ Mg_{0.08})((AlO_{.92})$, *orthorhombic* $Ca(CO_3)$, $Si_{112}O_{224}$, SiO_2, *hexagonal* SiO_2, Na $Al_2(Al\ Si_3O_{10})$

$(OH)_2$, *monoclinic* $Al_{4.5}(Al_{8.5}Si_{3.2})O_{10}(OH)_8$, $NaAl_2((AlSi_3)O_{10}(OH)_2)$ *triclinic* $Al_4(OH)_8(Si_4O_{10})$, Al4 Si_8O_{22}dan *cubic* Fe_3O_4.

Kata kunci: geothermal, kandungan mineral, struktur kristal, X-ray diffraction

INTRODUCTION

Maros Regency is one of the regencies located in the western part of South Sulawesi. According to BPS, astronomically Maros Regency is located between 4 º45'-5 º07 'South Latitude (LS) and 109º 25'- 129º12' East Longitude (BT). It is bordered by Pangkep Regency in the north, Bone Regency in the east, Makassar Regency and Gowa Regency in the south, and the Makassar Strait in the west. Administratively, the area of Maros Regency is recorded at 1,619.12 km^2 consisting of 14 sub-districts with an altitude of Maros Regency ranging from 0-2000 masl. Maros Regency in the west has an altitude ranging from 0-25 meters and in the east has an altitude of 100-1000 meters more.

One of the areas in Maros Regency which has geothermal potential is located in Samaenre, Mallawa District, where the hot springs are located a few kilometers from residential areas. This hot water is a source located around the river. Where in the river there is a big rock. Hot springs are springs that are generated as a result of the discharge of groundwater from the earth's crust after being heated geothermally. The temperature below the earth's surface, the lower it will increase or get warmer. The geothermal energy found can be empowered, so it is hoped that it will increase economic development and the welfare of the people in this village. The government can take advantage of geothermal potential by building new power plants, namely Geothermal Power Plants (PLTP), whose potential in the Jailolo area is 75 MW (Pasha et al., 2019).

Geothermal energy is a renewable energy source that is more environmentally friendly (clean energy) compared to fossil energy sources. Geothermal energy cannot be exported so it is suitable to meet domestic energy needs (Rahmaniah & Wahyuni, 2020). Geothermal system is energy stored in the form of hot water or hot steam under certain geological conditions at a depth of several kilometers in the earth's crust. Geothermal systems include heat and fluids that transfer heat towards the surface. The existence of a concentration of heat energy in a geothermal system is generally characterized by a heat anomaly that can be recorded on the surface, which is characterized by a high temperature gradient (Broto, 2011).

In the analysis of the structure of this natural material-based material, a diffractometer is used, a powder sample with a flat surface and a thickness sufficient to absorb the X-ray path leading upwards (Munasir et al., 2012). Based on the results of experiments conducted by Roetgen, it is assumed that X-rays are electromagnetic waves with a wavelength of the order of 10-10 m (1A) (Fridawati, 2008).

The diffraction peaks produced by a diffractometer using a chopper. The monitor can be rotated around the sample and set at an angle of 2θ to the incident groove. The monitor is aligned so that its axis is always through and at an angle to the axis of rotation of the sample. The intensity of the X-ray diffracted as a function of angle is 2θ. This powder method can be used to analyze what materials are contained in a sample and can also be determined quantitatively. In this study, the powder method was used (Munasir et al., 2012).

Minerals can be found everywhere, can be in the form of rock, soil or sand deposited on riverbeds. Minerals can be defined as naturally occurring inorganic solid materials, which consist of chemical elements in certain proportions. In minerals, the atoms in them are arranged following a systematic pattern (Roman, 2018) Mineral is a solid substance (phase) of chemical elements or chemical compounds formed by inorganic processes, and has a certain chemical structure in it or is known as a structure. crystal. The structure in it shows that the position of the atoms in a mineral follows certain rules which are commonly called the space lattice (Fitriani, 2017).

The unique arrangement of the atoms in a crystal is called the crystal structure. The crystal structure is built by a unit cell, which is a collection of atoms arranged in a special way, periodically repeated in three dimensions in a crystal lattice. A crystal consisting of millions of atoms can be represented by the size, shape, and arrangement of the unit cell repeating in the repetitive pattern characteristic of a crystal (Widayati, 2018).

Based on the description above, the mineral characterization of rock composition has been carried out using the X-Ray Diffraction method at the Samaenre-Mallawa Hot Spring, Maros Regency. This study aims to determine the mineral content and crystal structure around the hot springs. Information on mineral content and crystal structure will be useful for exploration, agriculture, tourism and so on.

METHODOLOGY

The method used uses X-Ray Diffraction by firing X-rays at the sample. Samples obtained from rocks around the hot springs of Samaenre-Mallawa, Maros Regency with five different points with the same depth of 1 m can be seen in Table 1. The results of the X-Ray Diffraction test are in the form of a diffractogram between 2θ and the intensity which is a diffraction pattern. processed using a match software application to determine the mineral content and crystal structure in the sample. The location of the sampling coordinates in the field with a hot water temperature of 35 ^{o}C, a cold water temperature of 26 ^{o}C and a natural temperature of 29 ^{o}C can be seen in the table 1.

Table 1. Data coordinates, excavation temperature and distance from the reference point in sampling around hot springs

Sample	Coordinate		Digging Temperature (°C)	Distance from ground zero (m)
	LS	BT		
A	04° 49′ 003′′	119° 51 50,7′′	30,3	4
B	04° 49′ 00,2′′	119° 51 50,8′′	30,2	3
C	04° 49′ 0,00′′	119° 51 50,6′′	30,7	5
D	04° 49′ 0,07′′	119° 51 49,5′′	30,1	3
E	04° 49′ 02,7′′	119° 51 44,5′′	29,4	9

RESULTS AND DISCUSSION

This research was conducted in the vicinity of the Samaenre hot spring, Samaenre village, Mallawa sub-district, Maros district. Sampling was carried out at five sample points, for each point sampling was carried out with a manual excavation process, each consisting of one depth. Furthermore, plotting the coordinates at each sampling point using GPS, the results can be seen in Figure 1.

Based on the results of sample analysis of the five samples in the sameenre village, mallawasub-district, Maros district using the X-Ray Diffraction (XRD) method, the following diffractogram image results are obtained on figure 2 to 6.

Figure 1. Sampling point location map

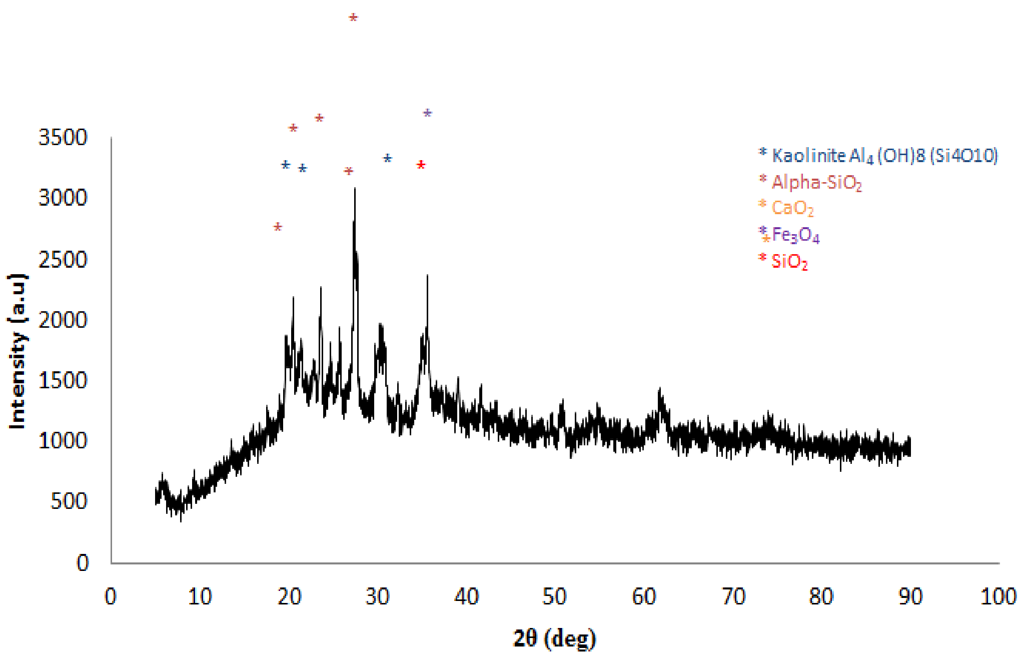

Figure 2. The relationship between intensity and angle 2θ in sample A

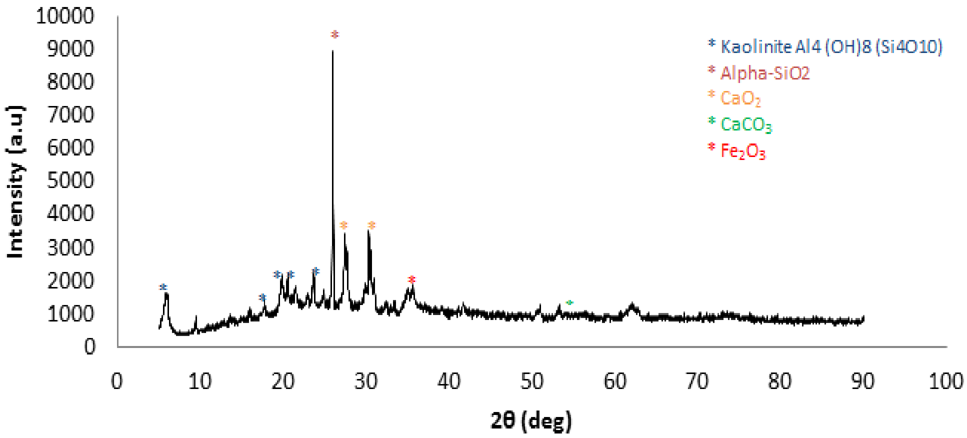

Figure 3. The relationship between intensity and angle 2θ in sample B

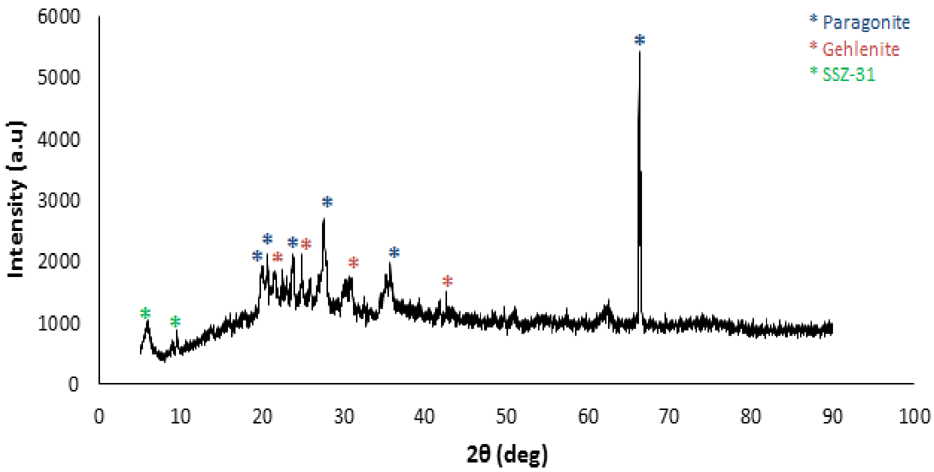

Figure 4. The relationship between intensity and angle 2θ in sample C

After obtaining the results of the diffractogram graph, then analyzing the diffractogram graph with search match software to determine the crystal structure. Based on the results of research conducted in Samaenre village, Mallawa sub-district, Maros Regency, from the five sampling points, it was obtained that the mineral content varied at each sampling point. Mineral SiO2 is a mineral that dominates from all samples. Based on Fatmawati's research (2019), the theory explains that quartz (SiO2) is the most important silica oxide mineral in soil formation. Dominant quartz comes from soil or rock that is acidic, hard so that in the slow decomposition process, quartz minerals are mostly found in the coarse soil or sand fraction, causing the soil to have low water-holding capacity and making the soil less sticky.

There were also other minerals such as kaolinite, magnetite, calcium peroxide, Dobassite-2M1a, Calcium Peroxide, Maghemite-Q, Aragonite, Paragonite 2M1, Grehlenite, Pyrophyllite 1A, dehydroxylated and Paragonite 3T. other elements (Amin, 2014a; 2014b), The composition of oxide minerals is simpler than silicates, oxide minerals tend to be harder and heavier than other minerals except silicates. Previous research that explained about silica oxide, namely (Ramadhan & Munasir, 2014) which explained that nanoparticles (SiO_2) It can be used in various processes, in particular it can be used as an ideal support material for magnetic nanoparticles, because its function is very easy to optimize. Where the mineral content that often appears is quartz (*SiO_2*). In samples A and B with a depth of 1 meter found minerals ($CaCO_3$) according to the theory, this calcium content can be converted into calcium oxide by calcination so that it is easier to purify to get calcium. Calcium carbonate (CaCO3) is the main constituent mineral of limestone. The research is described by (Laraebi, 2017) regarding "Characterization of Mineral Content and Elements of Limestone At PT Semen Tonasa ", with the results of his research, the characteristics of limestone minerals were obtained. Limestone is a type of sedimentary rock.

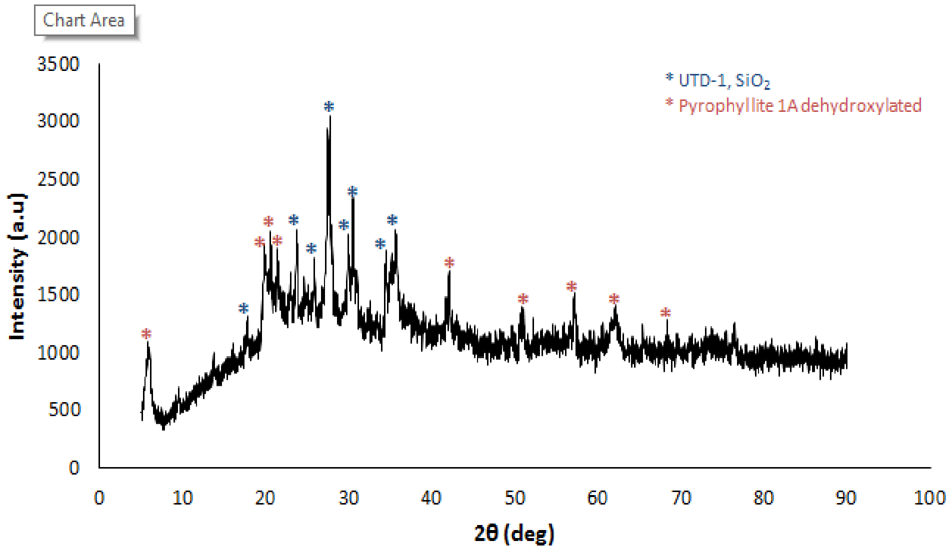

Figure 5. The relationship between intensity and angle 2θ in sample D

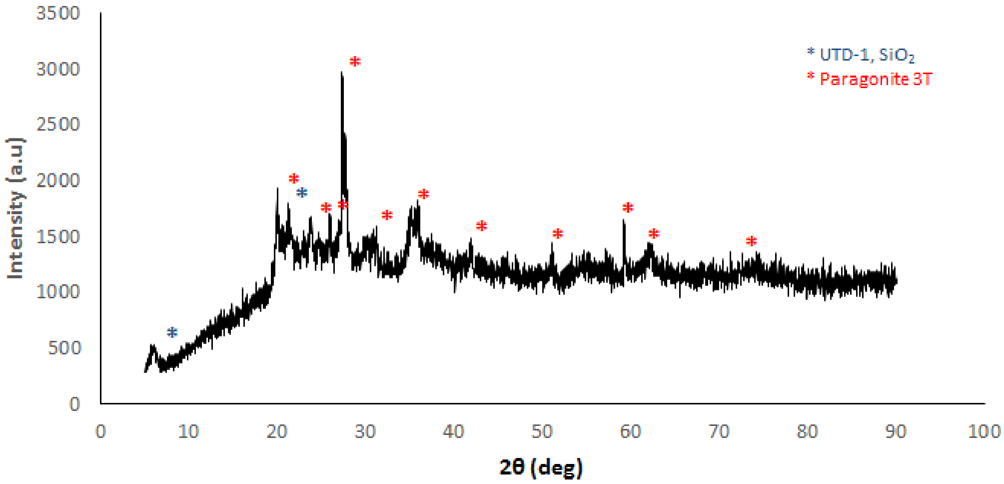

Figure 6. The relationship between intensity and the angle 2θ in sample E

Table 2. Crystal structure, formula and percentage of mineral content found in each sample in the vicinity of the hot springs.

Sample	Crystal Structure	Formula	Presentation of Mineral Content (%)
A	Hexagonal	SiO_2	34%
	Triclinic	$Al_4(OH)_8(Si_4O_{10})$	33%,
	Tetragonal	CaO_2	14%
	Cubic	Fe_3O_4	11%
B	Monoclinic	$Al_{4.5}(Al_{8.5}Si_{3.2})O_{10}(OH)_8$	41%
	Hexagonal	SiO_2	36%
	Tetragonal	CaO_2	22%
	Orthorhombic	$Ca(CO_3)$	1,0%
	Tetragonal	Fe_2O_3	0,1%
C	Monoclinic	$NaAl_2((AlSi_3)O_{10}\ (OH)_2$	61%
	Tetragonal	$(Ca_2(Al_{0.92}$ $Mg_{0.08})((AlO._{92})$	38,7%
	Orthorhombic	$Si_{112}\ O_{224}$	0,57%
D	Triclinic	Al4 $Si_8\ O_{22}$	59%
	Orthorhombic	$Si\ O_2$	41%
E	Hexagonal	$Na\ Al_2(Al\ Si_3\ O_{10})\ (OH)_2$	97%
	Orthorhombic	$Si\ O_2$	2,90%

CONCLUSION

Mineral content in the hot springs of Samaenre, Mallawa District, Maros Regency, is silicon oxide(SiO_2) 34%, *kaoline* (*Al_4 $(OH)_8(Si_4O_{10})$* 33%, *kalsium peroksida* (CaO_2) 14%, magnetite (Fe_3O_4) 11%, *Dobassite-2M1a* 41%, *Calcium Peroxide* 36%, *Maghemite-Q Aragonite* 22%, *Paragonite 2M1* 1,0%, *Grehlenite*61%, $(Ca_2(Al_{0.92}\ Mg_{0.08})((AlO._{92})$ 38,7%, $Si_{112}O_{2240,}$ 0,57%, *Pyrophyllite 1A dehydroxylated* ($Al_4Si_8O_{22}$) 59%, and *Paragonite 3T* $NaAl_2(AlSi_3O_{10})(OH)_2$ 97%. The crystal structure in rocks is crystal structure *tetragonal* untuk CaO_2, Fe_2O_3, $(Ca_2(Al_{0.92}\ Mg_{0.08})((AlO._{92})$, *orthorhombic* untuk mineral $Ca(CO_3)$, $Si_{112}O_{224}$, SiO_2, *hexagonal* SiO_2, $Na\ Al_2(Al\ Si_3O_{10})\ (OH)_2$, *monoclinic* $Al_{4.5}(Al_{8.5}Si_{3.2})O_{10}(OH)_8$, $NaAl_2((AlSi_3)O_{10}(OH)_2$, *triclinic* $Al_4(OH)_8(Si_4O_{10})$, Al4 $Si_8\ O_{22}$ dan *cubic* Fe_3O_4.

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