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Reseach Paper

Mineralogy and Geochemistry of Copper Deposits in Samaenre Village, Tonra Sub-District, Bone District, South Sulawesi Province

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Abstract: Samaenre Village has supergene copper mineralisation in rocks of the Kalamiseng Formation and geographically adjacent to diorite intrusions. The mineralisation outcrops are associated with alteration that changes the volcanic rocks of the Kalamiseng Formation. Previously, research was conducted on the characteristics of hydrothermal alteration and its alteration type in the Tonra area of Bone Regency, South Sulawesi Province. However, the research did not specifically examine the types of copper ore minerals and their associations and did not determine the copper content at the research location. The purpose of this study was to determine the types of copper ore minerals, associated minerals and copper content in samples in the study area. The analytical method used in this research is first carried out megaskopis analysis to determine the physical properties of the sample. After that, laboratory analyses of mineragraphy, X-Ray Diffraction (XRD) and Atomic Absorption Spectrophotometer (AAS) were carried out. The results of megascopic analysis of the two research samples have a fresh blue colour and a fresh green colour with a brown weathered colour, there are calcite minerals and also tend to oxidise. Copper ore minerals found based on Mineragraphy and XRD analysis are Cuprorhodsite ($CuFeRh_2S_4$), Auricuprite (Cu_3Au), Tenorite (CuO), Cuprite (Cu_2O). The associated minerals found based on the results of Mineragraphy and XRD analysis are Cupalite (Al_5Cu_5), Diopside ($CaMgSi_2O_6$), Siderite ($FeCO_3$), and Diopside ($CaMgSi_20_6$). The copper (Cu) content in samples from the study area based on AAS analysis results ranged from 0.11 % to 0.17 % Cu.

Keywords: Copper; Ore Minerals; Mineragraphy; XRD; AAS.

1. Introduction

Copper is known as one of the most widely used metals in the world. Copper is widely used in the electrical and electronic industries due to its high electrical conductivity. In addition, copper and its alloys are used in electrical engineering, mechanical engineering, communications and aviation, power generation and distribution, chemical industry and for other purposes [1]. The most common types of copper ore, copper sulphide ore and copper oxide ore, are processed by two different methods of pyrometallurgy and hydrometallurgy respectively, due to the different chemical properties of the ore. Oxide copper ores are secondary copper ores that are less attractive exploration targets than sulphide ores, as they are considered low-grade ores with lower copper percentages [2].

Samaenre village, Tonra sub-district, Bone district, South Sulawesi province, has supergene copper mineralisation in rocks of the Kalamiseng Formation and geographically adjacent to diorite intrusions based on the regional geology of Sukamto, 1982 [3]. The mineralised outcrops are associated with alteration that altered the volcanic rocks of the Kalamiseng Formation. Previously, research was conducted on the characteristics of hydrothermal alteration and its alteration type in the Tonra area of Bone Regency, South Sulawesi Province [4]. However, the research did not specifically examine the type of copper (Cu) ore minerals and their associations and did not determine the copper (Cu) content at the research location. Based on this, further research is needed to determine the

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copper ore minerals and their associated minerals and to determine the copper (Cu) content in the research area so that the potential of copper can be known for the development of copper prospects in Bone Regency in general, especially in Samanre village.

2. Methodology

This research began with direct sampling of rock outcrops in the study area. The type of sample taken was a chip sample of 2 samples weighing about 2 kilograms. Sampling in the field is in the form of hand specimens [5,6,7]. In addition to collection samples at several points were also observed on the geological conditions around the study area, and descriptions of rock samples to obtain information in the form of rock position, direction of rock distribution, outcrop coordinates, and mineral content of rocks megascopically [8]. The sampling pattern is taken randomly stratified. Samples that have been obtained in the field are then prepared to be sent to the laboratory [9,10]. The samples taken were subjected to sample preparation in the form of thin incisions into a powder of 200 mesh. This preparation process was carried out at the Laboratory of Mineral Processing, Mining Engineering, Faculty of Industrial Technology, Universitas Muslim Indonesia.

The analysis method used in this research is megascopic analysis to determine the physical characteristics of outcrops in the research area such as colour, texture, rock type, and so on. Furthermore, mineragraphic analysis is carried out to determine the mineral content contained in the samples in the research area. Then the samples will be tested with X-Ray Diffraction (XRD) to determine the copper ore minerals and their associated minerals. The XRD device used is Shimadzu, type Maxima X-7000. According to Bragg's law, diffraction data is used to calculate the distance of the atomic plane that produces a certain angular magnitude [9]. Most explanations of XRD address techniques for analyzing and identifying the crystalline phase of the material. The form of crystalline varies greatly in each material or mineral, so it is these are used as anomalous characteristics ofcertain minerals [10]. And finally, Atomic Absorption Spectrophotometry (AAS) analysis is carried out to determine the copper (Cu) content in the study area. The type of AAS instrument used is GFA-AA 7000. The entire analysis of both Mineragraphy, XRD, and AAS was carried out at the Rock Preparation Laboratory, Department of Geological Engineering, Faculty of Engineering, Hasanuddin University.

3. Results and Discussion

3.1 Megascopic Analysis

Megascopic analysis is aimed at analysing the physical characteristics of rocks such as: colour, texture, mineral composition that can be seen with the eye and so on. This analysis used two rock samples found at the study site. Megascopically, the 2 samples are characterised as follows.

3.1.1. Sample 1

The Universal Transverse Mercator (UTM) coordinates of zone 51S of sample 1 are at points X: 198963 and Y: 9462319. Megascopically sample 1 is characterised by having a fresh blue colour and a brown weathered colour. In the sample there is a calcite mineral which is characterised by a white colour and has a reaction when tested with hydrochloric acid (HCl) and also undergoes oxidation because it is characterised by a yellowish colour or like rust, can be seen in Figure 1.

Figure 1. The appearance of sample 1

3.1.2. Sample 2

Sample 2 is at coordinates X: 199014 and Y: 9462332. Megascopically sample 2 is characterised by having a fresh green colour and a brown weathered colour. In this sample there is a calcite mineral which is characterised by a white colour and undergoes a reaction when tested with hydrochloric acid (HCl) and the sample also undergoes oxidation because it is characterised by a yellowish colour or like rust, the sample can be seen directly in the picture.

Figure 2. The appearance of sample 2

3.2 Mineragraphy Analysis

3.2.1. Sample 1

Mineragraphic analysis was conducted to identify ore minerals based on their optical properties under a microscope. Under the microscope, the polished incision of sample 1 shows the presence of azurite minerals and oxide minerals as shown below.

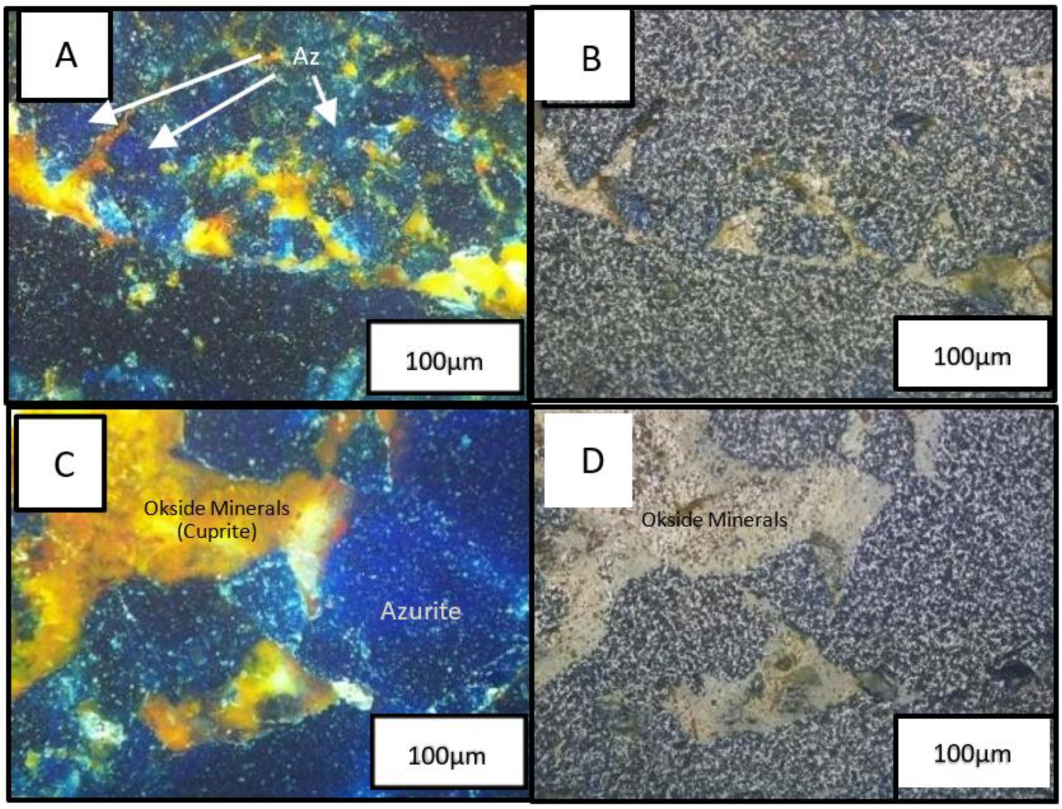

Figure 3. Microscope view of sample 1, crossed nicol (A, C) and aligned nicol (B, D).

3.2.2. Sample 2

The mineralogical analysis of sample 2 revealed the presence of cuprite minerals and oxide minerals. Below is the microscope view of sample 2.

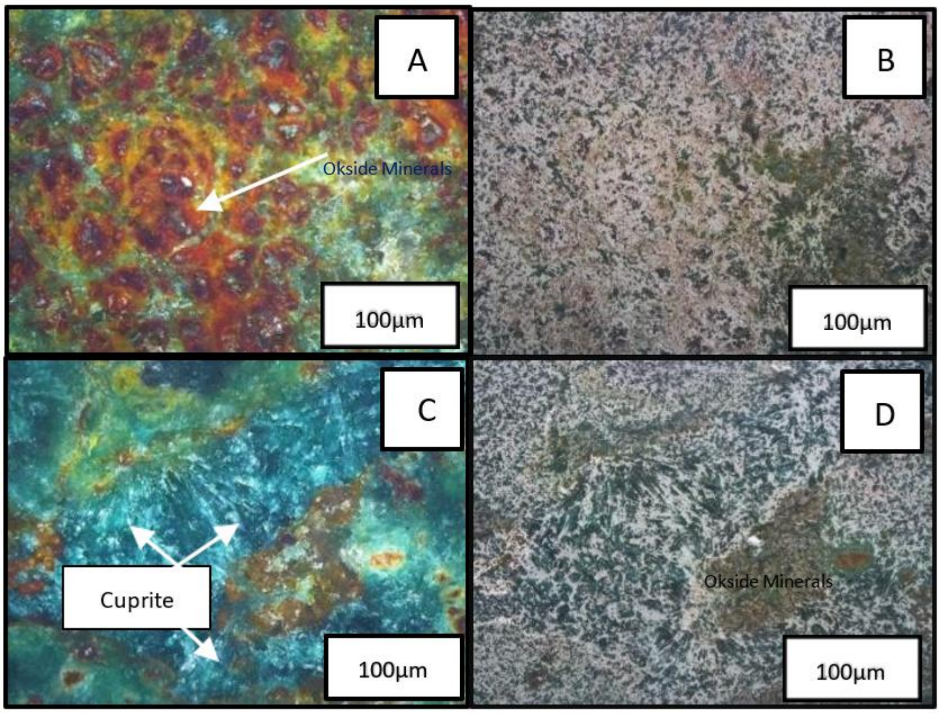

Figure 4. Microscope view of sample 2, crossed nicol (A, C) and aligned nicol (B, D).

3.3 X-Ray Diffraction Analysis

X-Ray Diffraction can show the mineralogical composition and mineral percentage of a sample [11]. Minerals that cannot be seen in later microscopy analyzed using XRD (X-Ray Diffraction) method [12]. The measurement result obtained is the amount of intensity per step (time step) by carrying out time series statistical analysis.The measurement results per step are converted into a graph of intensity peaks which is also called a diffractogram [13].

3.3.1. Sample 1

Based on the results of X-Ray Diffraction (XRD) analysis in sample 1, the presence of cupalite minerals with a content of (61.6 %), diopsid (20.0 %), cuprorhodosite (13.9 %), siderite (4.4 %) and auricuprite (0.1) was found. Below is the appearance of the diffractogram of sample 1.

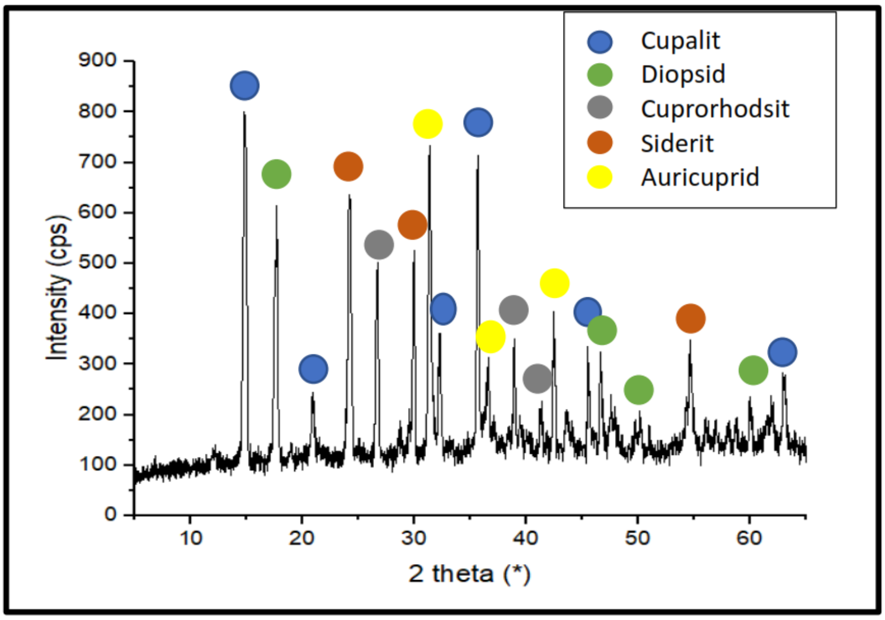

Figure 5. X-Ray Diffraction (XRD) graph of sample 1

A summary of the minerals identified from the diffractogram results of sample 1 along with the percentage of each mineral can be seen in table 1 below.

Table 1. X-Ray Diffraction (XRD) analysis results of sample 1

Minerals	Chemical Formula	Percentage
Cupalite	Al_5Cu_5	61.6 %
Diopside	$CaMgSi_2O_6$	20.0 %
Cuprorhodsite	$CuFeRh_2S_4$	13.9 %
Siderite	$FeCo_3$	4.4 %
Auricuprite	Cu_3Au	0.1 %

3.3.2. Sample 2

Based on the X-Ray Diffraction analysis of sample 2, minerals such as diopsid (67.7 %), tenorite (23.1 %), rhodostanite (7.0 %) and cuprite (2.2 %) were found to be present. Below is the appearance of the diffractogram of sample 1.

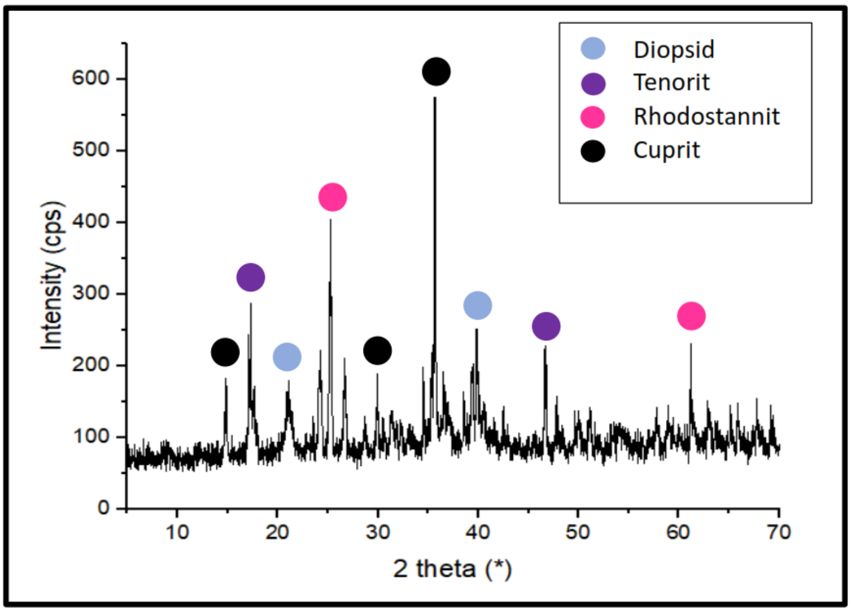

Figure 6. X-Ray Diffraction (XRD) graph of sample 2

A summary of the minerals identified from the diffractogram results of sample 1 along with the percentage of each mineral can be seen in table 1 below.

Table 2. X-Ray Diffraction (XRD) analysis results of sample 2

Minerals	Chemical Formula	Percentage
Diopside	$CaMgSi_20_6$	67.7 %
Tenorite	CuO	23.1 %
Rhodostannite	$CuFeS_4Sn_2$	7.0 %
Cuprite	Cu_2O	2.2 %

3.5 Atomic Absorption Spectrophotometry Analysis

Atomic Absorption Spectrometry (AAS) is a device based on the principle that atoms absorb light [14]. Atomic Absorption Spectrophotometry (AAS) analysis was used to determine the copper (Cu) content of both samples. The following are the results of the analysis using AAS (table 3).

Table 3. Atomic Absorption Spectrophotometry (AAS) analysis results

Sample	Element	Grade (mg/kg)	Grade (ppm)	Grade (%)
1	Cu	1054.21	1054.21	0.11
2	Cu	1731.69	1731.69	0.17

4. Conclusion

Copper ore minerals found based on Mineragraphy and XRD analysis are Cuprorhodsite ($CuFeRh_2S_4$), Auricuprite (Cu_3Au), Tenorite (CuO), Cuprite (Cu_2O). The associated minerals found based on the results of Mineragraphy and XRD analysis are Cupalite (Al_5Cu_5), Diopside ($CaMgSi_2O_6$), Siderite ($FeCO_3$), and Diopside ($CaMgSi_20_6$). The copper (Cu) content in samples from the study area based on AAS analysis results ranged from 0.11% to 0.17% Cu.

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