STUDY OF HIGH SULFIDATION-EPITHERMAL DEPOSIT IN THE VOLCANIC ENVIRONMENT : A CASE STUDY IN BANJARHARJO AREA, AYAH DISTRICT, KEBUMEN REGENCY, CENTRAL JAVA

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Abstract. Indications of hydrothermal deposits have been found in Ayah District, Kebumen Regency, Central Java. In this area, there are products from the ancient volcanic activity of Menganti which has an age from Oligocene to Miocene. The existence of volcanic activity makes hydrothermal deposits can develop and have the potential to produce metal minerals. This study aims to identify the characteristics of alteration and mineralization that are developing in the research area. The methods used in the research are in the form of surface geological mapping and rock sampling for laboratory analysis in the form of Petrography, Mineragraphy, SEM (Scanning Electron Microscopy), Atomic Absorbtion Spectophotometry (AAS) and XRD (X-Ray Diffraction). The stratigraphic conditions of the research area from old to young consist of Dacitic Tuff Breccia, Andesite Lava, and Andesite Intrusion. The developing alterations are in the form of propylitic (Chl+Smc), argilic(Kao+Ill-Smc), advanced argillic(Kao+Alunite-Diaspor-Dickite-Barite), and silicification (Si-Qtz). The presence of ore minerals such as enargite, chalcocite and covellite is an indicator that high sulphidation alteration type mineralisation is developing in this area. The alteration and mineralization of the research area are controlled by the geological and lithological structure of the rock, where there are horizontal faults in the southeast-northwest direction and horizontal faults in the southwest-northeast direction. Andesite intrusion arises through the activation of the fault so that it can alter the rock it passes through. Based on AAS analysis there are also levels of economically valuable minerals, especially gold (Au) of 203.122 ppm and copper (Cu) of 2,500.05. Based on the alteration and mineralization characteristics from the results of laboratory analysis, the epithermal deposits in the study area have a high sulfidation type.

Keywords: alteration, mineralization, high sulfidation epithermal, Banjarharjo, Ayah District

A. Introduction

Indonesia is a country rich in natural resources, especially metal mineral resources. This is based on the fact that Indonesia is traversed by the Asia-Pacific volcanic mountain range that stretches from western to eastern Indonesia. Existing metallic mineral deposits are formed from various types of magma-related systems ranging from epithermal, porphyry, and skarn deposits.

In this research, the Banjarharjo area has interesting things where the research location is an ancient volcanic area in Menganti which was formed at the age of Oligocene to Miocene. This ancient volcanic activity can provide clues to the development of alteration and mineralization at the research area.

B. Methods

The methods used in this study include field data collection and laboratory data analysis. Field data collection was carried out by conducting surface mapping within a 2x2 km area. Mapping is carried out in the main body of the river and several points in the river branches so that the data obtained is more varied. After field data collection is complete, laboratory analysis is carried out using various types of analysis such as petrographic analysis, mineragraphy, XRD (X-ray Diffraction), SEM (Scanning Electron Microscopy), and AAS (Atomic Absorption Spectophotometry) to produce geological maps, stratigraphic columns, and alteration-mineralization zone maps.

Petrographic analysis is used to determine the minerals that make up the rock, which is used to name the rock. Alteration minerals can also be identified through this analysis. Observations were made by slicing the rock with a thickness of 0.3 mm and then observed through a polarizing microscope. Mineragraphic analysis is used to determine the mineralization formed in rock samples. The rock is cut into small pieces and then polished at the target observation point and then observed using a reflected light microscope. XRD (X-Ray Diffraction) analysis is used to determine the alteration minerals formed in the rock samples. This is the basis for determining the alteration zone of the study area. SEM (Scanning Electron Microscopy) analysis is used to observe the texture of minerals in rocks in more detail and sharply using an electron microscope. AAS (Atomic Absorption Spectophotometry) analysis is used to determine the content of Au, Cu, Ag, Pb, and Zn elements in rocks.

C. Results And Discussion

1. Geological Map & Stratigraphy Column

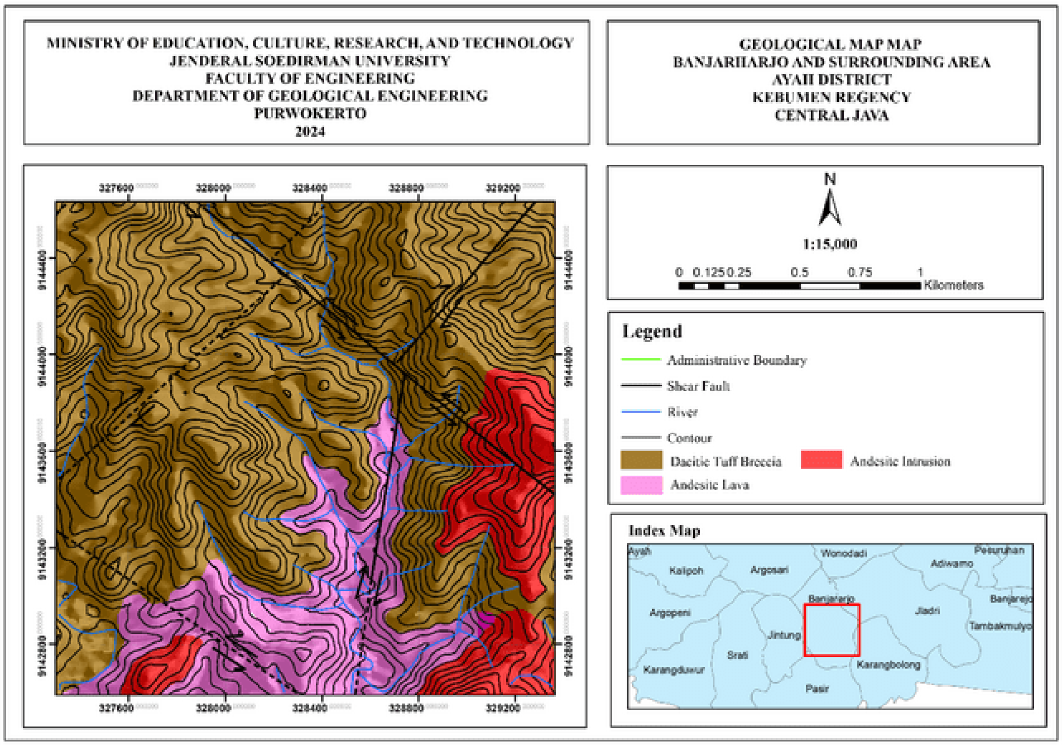

Figure 1. Geological Map Banjarharjo Area

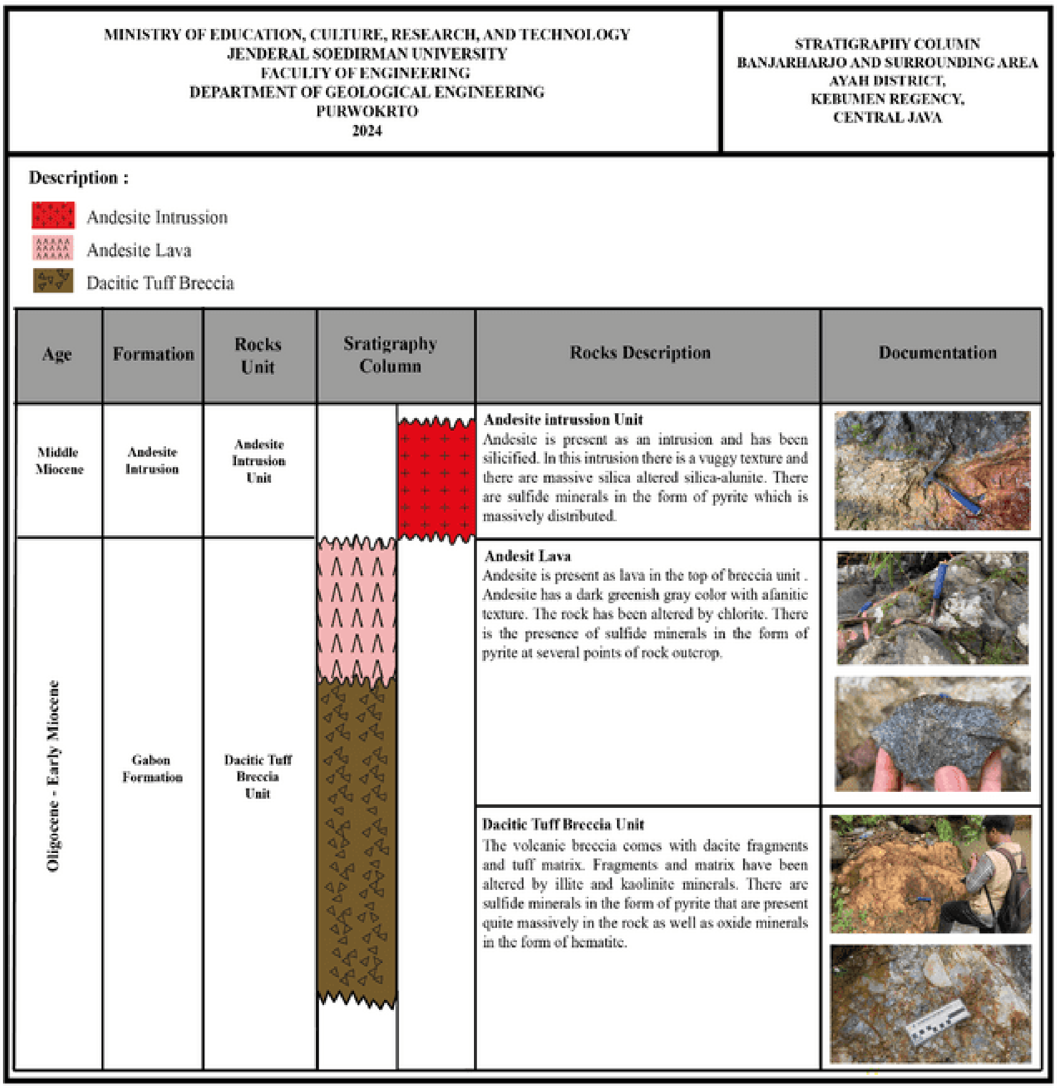

Figure 2. Stratigraphic Column

On the geological map, there are three rock units, namely Dacitic Tuff Breccia, Andesite Lava, and Andesite intrusion rock unit. The Dacitic Tuff Breccia ia is composed of dacite fragments and tuff matrix, both fragments and matrix have been altered. Then there is andesite lava on top of the Dacitic Tuff Breccia unit. This unit was deposited in the Oligocene to Early Miocene age and became the Gabon Formation. Then a tectonic event occurred in the form of a horizontal fault movement with a northwest-southeast direction and a horizontal fault with a northeast-southwest direction.

Then in the Middle Miocene age the andesite intrusion unit broke through the unit that had been deposited above it and the hydrothermal fluid that participated in the intrusion altered the wall rock unit through which it passed. In addition, there are secondary structures in the form of left shear faults and right shear faults. These structures and rock intrusions then control the occurrence of mineralization alteration in the study area.

2. Alteration Zone Map

The alteration zoning map shows that the alteration developed in the study area is in the form of silicified, advanced argillic, argillic and propylitic zones. The types of alteration zones that develop have unique characteristics.

The propylitic alteration zone is characterized by the presence of the main signature mineral, chlorite and epidote. In addition, there are other minerals that characterize the propylitic zone such as chamosite, illite, and montmorillonite. The formation temperature of the propylitic alteration zone minerals is interpreted to range from $120^0 – 220^0$ C.

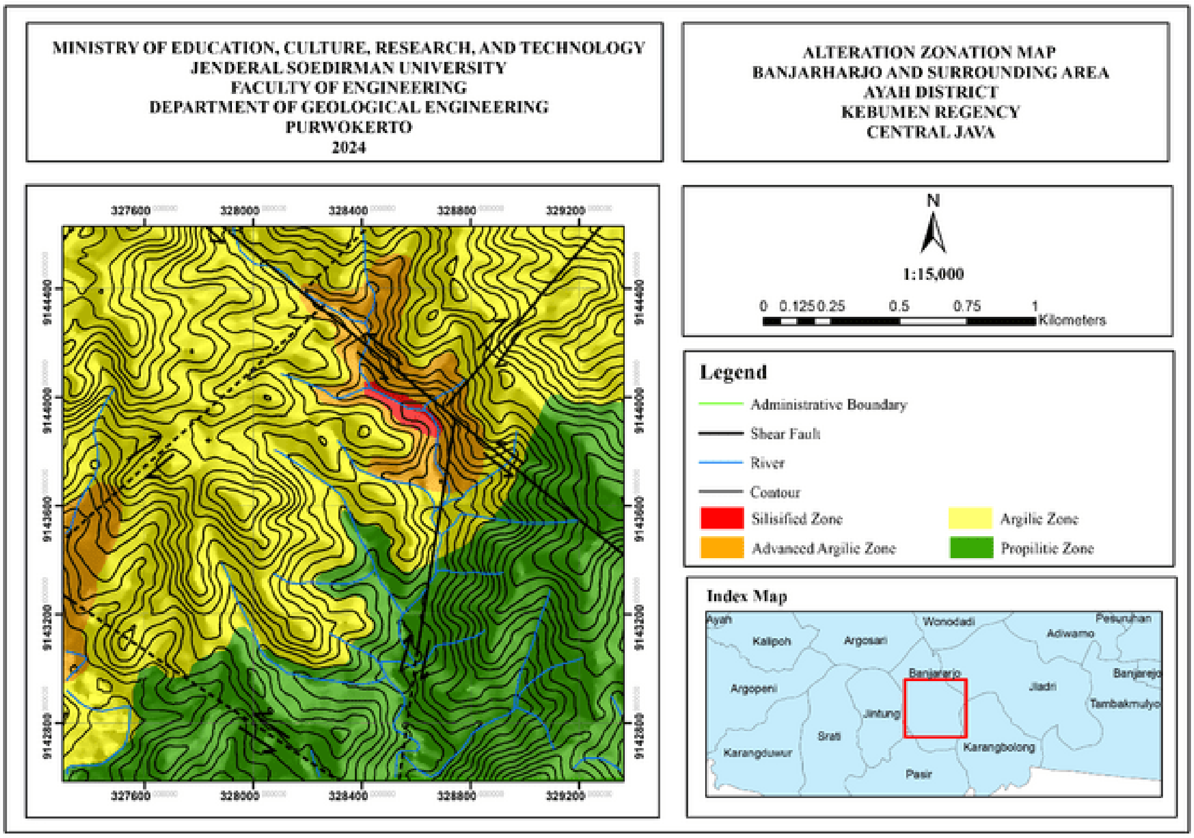

Figure 3. Alteration Zone Map Banjarharjo Area

Figure 4. Chlorite on rock sample

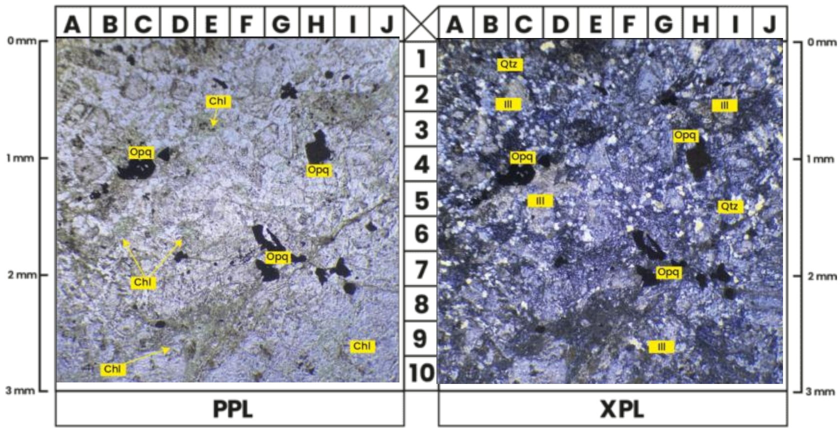

Figure 5. Petrography analysis on prophylitic zone

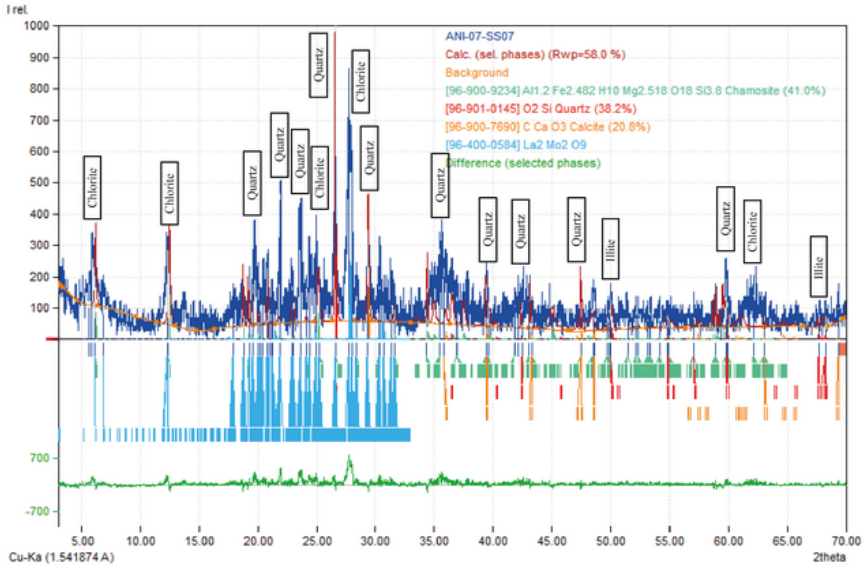

Figure 6. XRD analysis on prophylitic zone

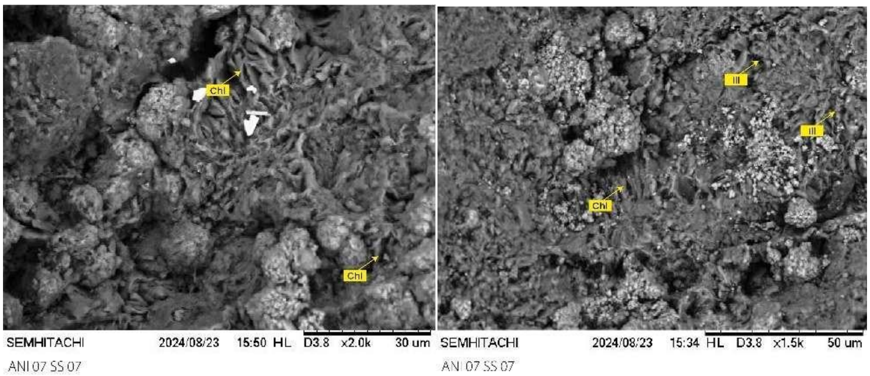

Figure 7. SEM analysis on prophylitic zone

The argillic alteration zone is characterized by the presence of illite, montmorillonite, and kaolinite minerals. Based on observations in SEM analysis, minerals such as illite, smectite, kaolinite, and montmorillonite. The formation temperature of the argilic alteration zone minerals is interpreted to range from $120^0 – 250^0$ C.

Figure 8. Rock sample argilic zone

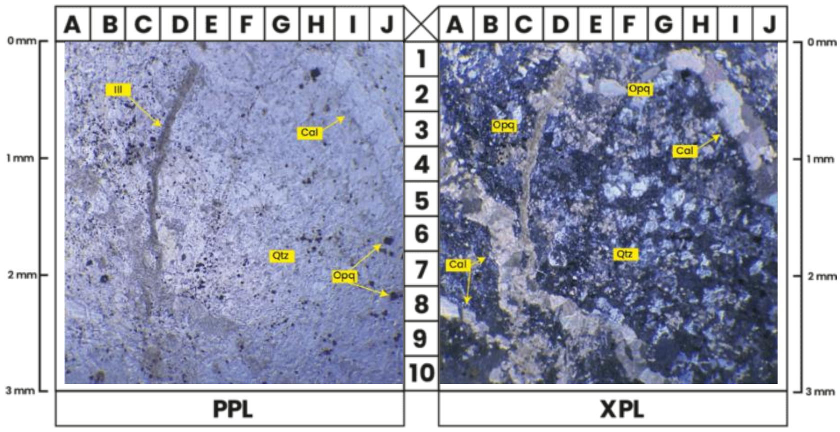

Figure 9. Petrography analysis argilic zone

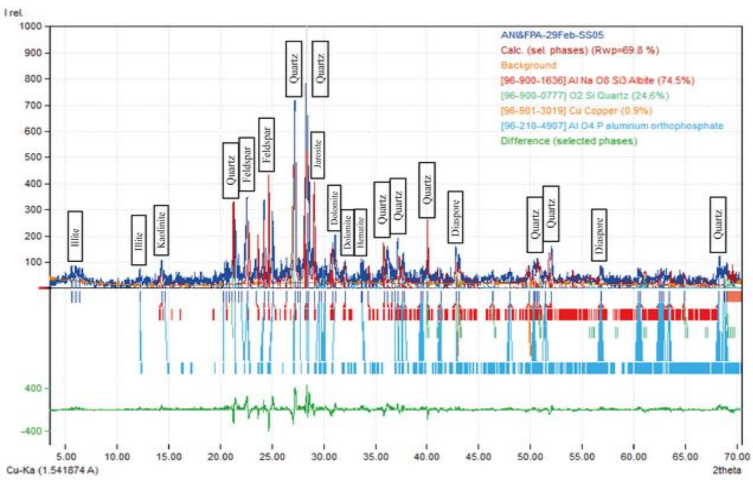

Figure 10. XRD analysis on argilic zone

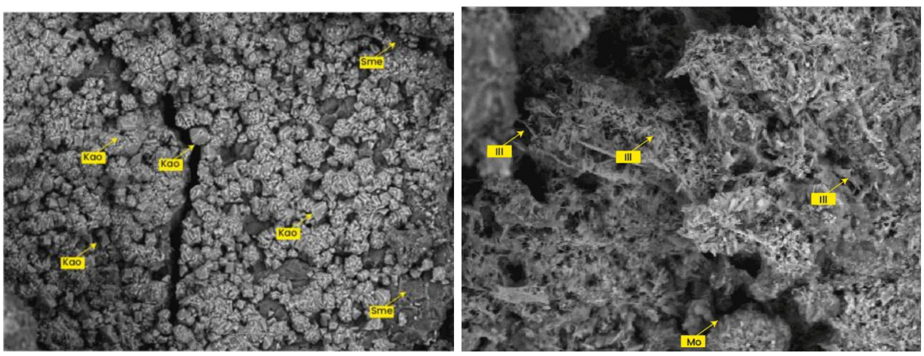

Figure 11. SEM analysis result of argillic zone

The advanced argillic alteration zone is characterized by the presence of kaolinite, quartz, alunite, diaspore, and dickite minerals and the presence of sulfide minerals in the form of pyrite in petrographic observations. The formation temperature of the advance argilic alteration zone minerals is interpreted to range from 170^0 – 275^0 C in an environment with a relatively acidic pH.

Figure 12. Advanced argillic zone outcrop

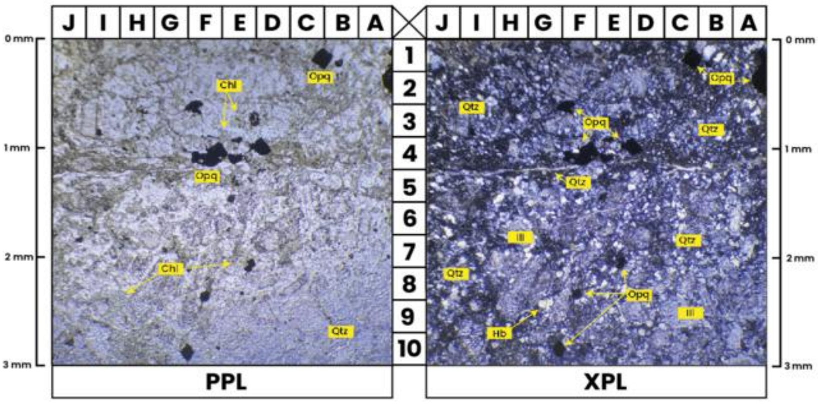

Figure 13. Advanced argillic zone petrography results

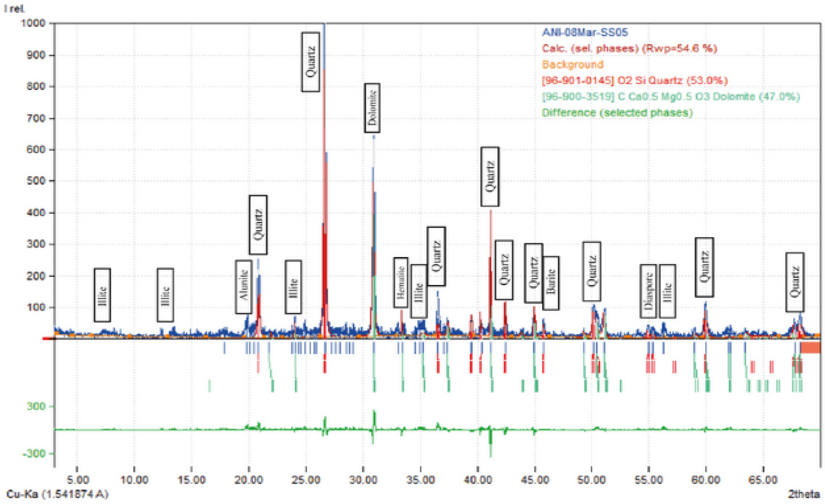

Figure 14. XRD analysis on advanced argilic zone

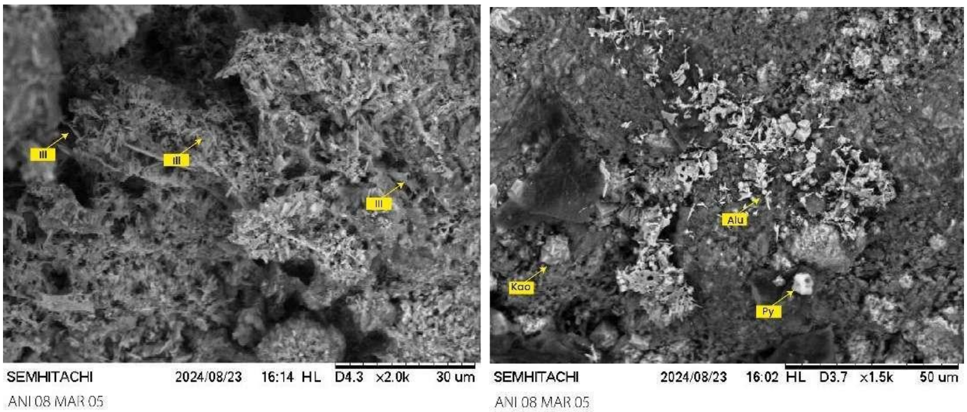

Figure 15. SEM analysis result of advanced argillic zone

The silicified alteration zone is characterized by the presence of silica, alunite, barite, and quartz based on petrographic observations and XRD analysis. Based on observations in SEM analysis, minerals such as illite, pyrite, and hematite are visible. There is the presence of sulfide minerals in the form of pyrite, covellite, sphalerite, and calcopyrite in ore microscopy observations. There is the appearance of vuggy silica quartz which is formed due to acidic epithermal fluids replacing minerals so that the texture of vuggy silica quartz is formed.

Massively formed alteration in this zone is controlled by southeast-northwest trending horizontal fault structures and southwest-northeast trending horizontal faults. Then the lithological control is in the form of andesite intrusions that carry hydrothermal fluids and penetrate the overlying rock units. Hydrothermal fluids passing through the side rocks change the composition and mineral content of the side rocks.

Figure 16. Rock outcrops of silicified zone

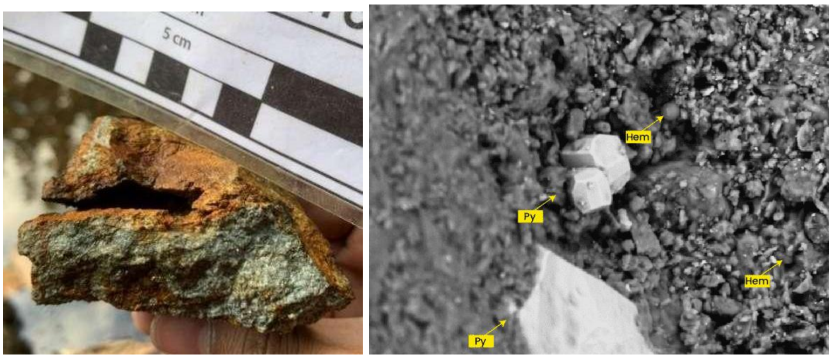

Figure 17. Vuggy Silica Quartz appearance and SEM results

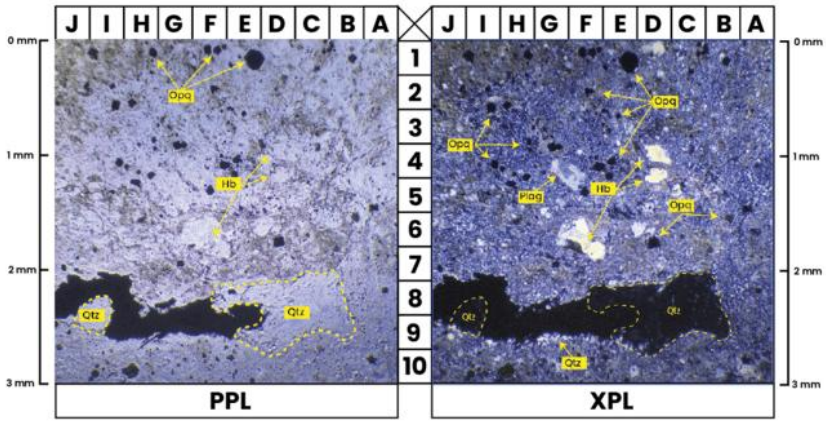

Figure 18. Petrographic results of silicified zone

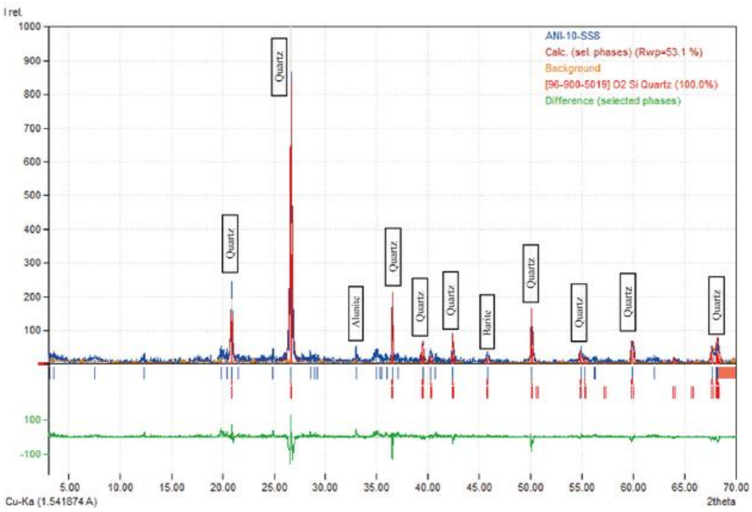

Figure 19. XRD results of silicified zone

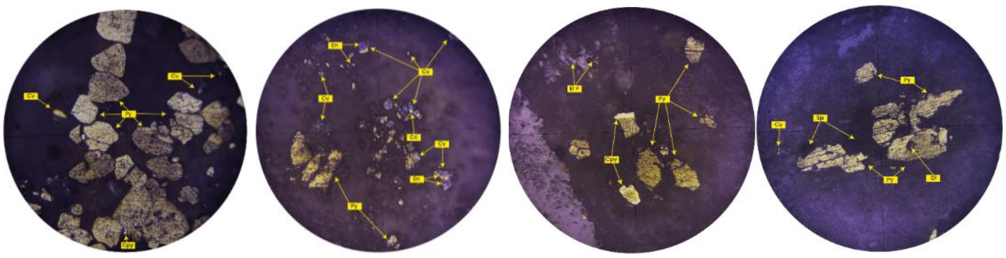

Figure 20. Mineragraphy analysis results

It can be seen in the mineragraphic results above, rock samples in the silicification zone have the presence of sulfide minerals in the form of pyrite, calcopyrite, and sphalerite which are massively distributed and mineral occurrences of enargite, covellite and calcosite are seen in this alteration zone which characterise the high sulphidation epithermal deposits..

Figure 21. Mineralisation in the study area (Hydrothermal Breccia with vuggy texture)

Metal ore mineralisation formed in this deposit was identified through megascopic and microscopic observations. From these observations, it was found that the dominance of sulphide minerals in the form of pyrite, chalcopyrite, sphalerite, galena. Chalcopyrite, covellite and enargite minerals are identified as being formed by the supergene process resulting from the replacement process of chalcopyrite.

Table 1. Elemental metal content in silicified zone rock samples based on AAS analysis

Sample	Result of Test (ppm)				
	Zink (Zn)	Copper (Cu)	Lead (Pb)	Silver (Ag)	Gold (Au)
ANI 10 SS 08	8.298,04	2.500,05	<0,003	48,130	203,122

In this alteration zone, there are also levels of economically valuable minerals, especially gold (Au) of 203.122 ppm and copper (Cu) of 2.500,05 ppm.

D. Conclusion

Rock lithology found in the study area from oldest to youngest, namely dacitic tuff breccia unit, andesite lava, and andesite intrusion unit. The alteration mineral set zones formed are Silica - Quartz (Silicification), kaolinite-quartz-alunite-diaspore-dickite zone (Advanced Argilic), Kaolinite ± illite - Monmorillonite - Smectite Zone (Argilic), and Chlorite - Smectite - Epidote Zone (Prophylitic). Hydrothermal alteration in the study area is controlled by SE - NW trending geological structures and SW - NE trending geological structures which become the entry point for hydrothermal fluids from the occurrence of andesite intrusions. Genetic deposits formed in the study area are high sulfidation epithermal deposits with alteration mineral set zones with high temperature mineral associations known based on XRD analysis, namely alunite, kaolinite, dickite and other features found in the form of replacement by sulfide minerals. Based on the lateral cross section of the high sulphidation alteration zone according to Arribas, 1995, the area around the study, a silicified, advanced argillic, argillic, to propylitic alteration zone was formed with a set of alteration minerals formed as many as 4 zones in the form of dominance of silica, alunite, kaolinite, illite, to chlorite with lateral distribution. Ore mineral formed in research area is enargite, calcosite, covellite, pyrite, calcopyrite, sphalerite, and galena. Based on the minerals formed in the study area, it indicates that the study area develops a type of high sulphidation epithermal deposits. From the research results, a more detailed study will be continued to determine further potential related to drilling and geophysical analysis in order to make further modeling related to the deposits formed.

E. References

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