Structural Control on Alteration Distribution of High Sulfidation Epithermal Deposit at Cijulang Prospect, Garut, West Java, Indonesia

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Introduction

The Cijulang prospect is part of PT. ANTAM Tbk Mining concession area in Garut Regency, West Java Province. It's about 3.75 km width of total area.

The mineralization within the Cijulang classified as Hish Sulfidation epithermal system and is characterized by massive and quartz vuggy textures which associated with alunite and phyrophyllite alteration, and ore mineral of enargite, tenantite-tetrahedrite, pyrite, that hosted by dacitic tuff of Miocene age.

This research is focus on the structural geology control on the distribution of alteration and mineralization based on field observation and statistical analysis.

Regional Geology

The physiography of Cijulang area is included in the Southern Mountain Zone (Van Bemmelen, 1949).

Based on geological map of Sindangbarang and Bandarwaru Quadranles, Jawa, lithology of Cijulang area is coverd by Koleberes Formation and Undivided Pyroclastic Deposits (Koesmono, et al 1996).

The structural geological features are forming fault, lineament and joint within the Oligo-Miocene up to Quarternary rock. Faults comprising strike-slip and normal types vary form NNW-SSE to NS trending directions. Fold pattern found is SW-NE anticline and NW-SE directions; and E-W flexure. Lineament is presumed to be fault with NW-SE and SW-NE trending directions and usually involved the Quaternary rocks. Joints are commonly found and well developed in andesitic rock of Quaternary and also Oligo-Miocene age.

Method

Lithology, altered mineral, vein or veinlet trending direction, and another geological structures are analyzed and interpreted. Joints are measured and analyzed by geostatistic method called Trend Surface Analysis. This method used to estimate the existing faults trending and direction in the field.

Local Stratigraphy

The research area is composed of three rock units. Stratigraphic units from the old unit to the young unit are :

1. Crystal Tuff (Tmtk), Late Miocene Age.

This unit composed of crystal tuff (figure 1) and andesite lava (figure 2). Crystal tuff is gray-yellowish gray and brownish if weathered, fine-coarse grained, angular-sub angular shapes, well sorted, consist of quartz, plagioclase, and altered mineral. Andesitic lava is gray-greenish gray, weathered color is brownish-dark gray, aphanitic and inequigranular textures, composed mainly plagioclase and altered mineral such as secondary quartz, carbonate mineral, clay mineral and chlorite. Sulphide, silica, and carbonate minerals are found in veinlet.

Figure 1. Crystal tuff outcrop in Cikahuripan River

Figure 2. Andesitic lava outcrop in Cikahuripan River

2. Microdiorite (Tmmd), Late Miocene Age

Microdiorite (figure 3) fresh color is gray-dark gray; weathered color is yellowish-dark gray; porphyritic texture; inequigranular; hard; composed of quartz, plagioclase, feldspar and altered mineral such as secondary quartz, carbonate mineral, chlorite, clay mineral. Microdiorite has massif structures. This microdiorite identified as dike which is younger than crystal tuff rock units.

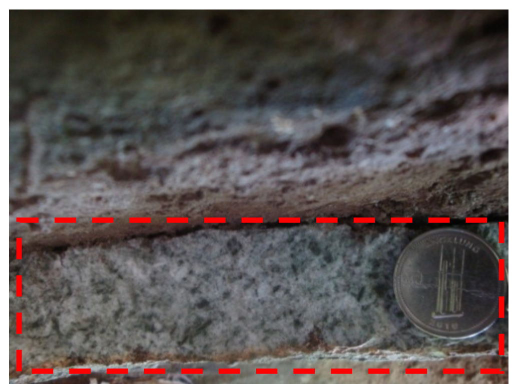

Figure 3. Microdiorite outcrop in Cilangong River

3. Vitric Tuff (Qtv), Pleistocene Age

The lithology is consist of vitric tuff (figure 4) and polymic breccia (figure 5). Vitric tuff fresh color is gray, weathered color is dark gray, fine grained, well sorted, massif texture, hard, contain plagioclase and altered mineral. Polimic breccias characteristic features, such as fresh color is dark gray-reddish gray, weathered color is brownish-dark gray, granules-boulders grained. Polymic breccia's components consist of andesite and crystal tuff. Polymic breccia's groundmass consist of vitric tuff and crystal tuff.

Figure 4. Vitric tuff outcrop in Cibuni River

Figure 5. Polymic breccia outcrop in Cisuren River

Structural Geology

The Cijulang prospect occurs on the margin of Cikahuripan River complex which is inferred to have been localized by NE-SW trending Cikahuripan fault and N-S trending strike-slip fault. Strike-slip fault as dilational fault consist of Cibuni Fault, Citando Fault, and Cilangong Fault.

1. Cibuni Fault

Cibuni fault is found in the northern part. The NE-SW lineament of Cibuni River is interpreted as left slip fault. The fault shows NE-SW orientation (figure 6) with strike/dip N 75^o E/64^o; pitch 10^o E; normal-sinistral movement; $\sigma1=N350^oE/27^o$; $\sigma2=$ N184^{o}E/64^o; $\sigma3=N88^oE/4^o$.

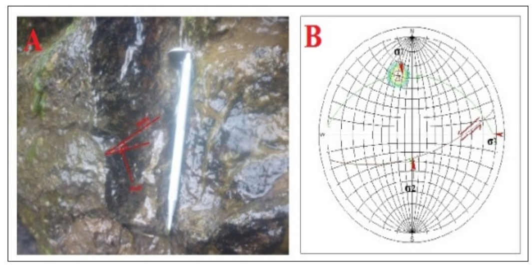

Figure 6. A. Slicken side in Cibuni River

B. Stereogram analysis of slicken side

2. Citando Fault

Citando fault is found on the middle part. The NE-SW lineament of Citando River is interpreted as reverse left slip fault. The fault shows NE-SW orientation (figure 7) with strike/dip N 214^o E/62^o; pitch 15^o NE; reverse-sinistral movement; $\sigma1=N14^oE/9^o$; $\sigma2=N273^oE/58^o$; $\sigma3=$ N107^{o}E/30^o.

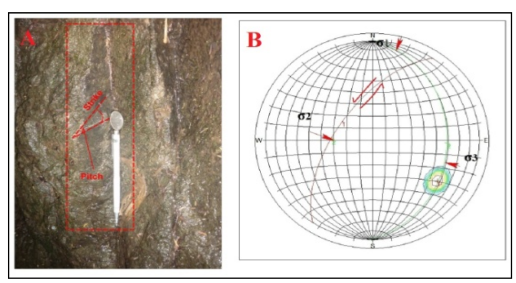

Figure 7. A. Slicken side in Citando River

B. Stereogram analysis of slicken side

3. Cilangong Fault

Cilangong fault is found on the southern part. The NE-SW lineament of Cilangong River is interpreted as thrust left slip fault. The fault shows NE-SW orientation (figure 8) with strike/dip N 238° E/27°; pitch 13° NE; thrust-sinistral movement; σ1=N41°E/5°; σ2=N312°E/28°; σ3 = N126°E/63°.

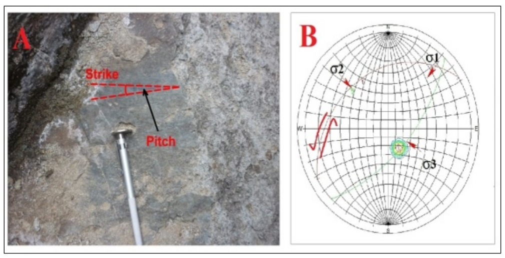

Figure 8. A. Slicken side in Cilangong River
B. Streogram analysis of slicken side

4. Cikahuripan Fault

Cikahuripan fault is found on the middle part. The N-S and NW-SE lineament of Cikahuripan River is interpreted as normal fault. The fault shows N-S orientation (figure 9) with strike/dip N 304° E/70°; pitch 75°NW; normal-dextral movement; σ1 = N 20° E/66°; σ2 = N 122°E/5°; σ3 = N 214°E/30°.

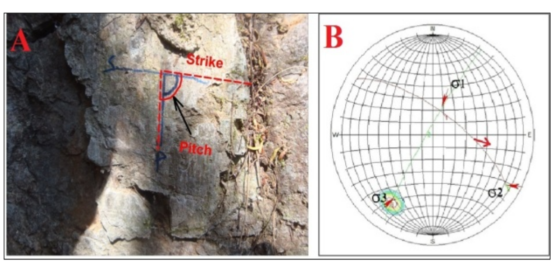

Figure 9. A. Slicken side in Cikahuripan River
B. Streogram analysis of slicken side

Mineralization Related Fracture Systems

Trending of shear fractures shows relationship between local fractures and fault zone. Tension fracture/veins represent extensional fractures or cracks which is filled with minerals and develop in orthogonal an oblique convergent setting. Trending NNE-SSW of veinlets formed in dilational strike slip fault setting. Veinlets which develop during the dynamic process, under the influence of the local stress environment, hosted stockwork and sheeted quartz veinlets and localized subsequent sulfide mineralization.

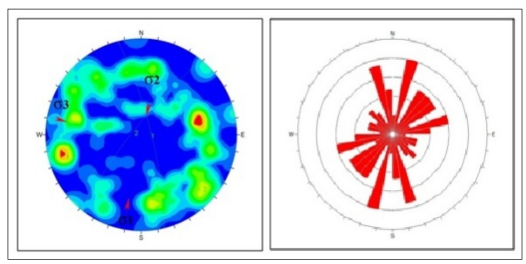

Figure 10. Tension fractures analysis shows NNE-SSW trending.

Trend Surface Analysis

Trend Surface Analysis is the geology term for a mathematical method of separating map data into two component that of a regional nature and local fluctuation. The major fault is referring to "regional trend" and joints as opposed to "local structures". Measuring joints as local anomalies used to estimate fault zone (figure 11). The local anomaly has the same pattern with Cikahuripan Fault, Cilango Fault, Citando Fault and Cibuni Fault.

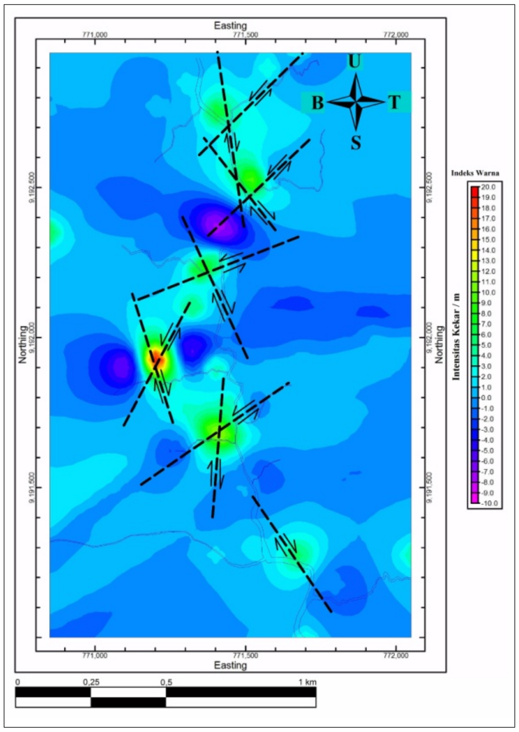

Figure 11. Estimate fault map.

Fault Model

Mechanism of fault development in Cijulang Prospect area is compared with Riedel Shear Model (figure 12). Sinistral strike-slip fault (Cibuni fault, Citando fault, Cilangong fault) is synthetic faults and Cikahuripan fault is the antithetic fault which has oblique (normal-dextral) movement. The stress regimes orientation NS, NE-SW trending that are described as pure shear which equates to setting of Java orthogonal convergence (and also localized extension). Localized changes from orthogonal to oblique subduction may promote mineralization, as fluids which were constrained within intrusion during orthogonal compression resolved along fractures dilated under the influence of strike-slip structures. Fracture orientations within the NS trending indicative of formation during extension phase.

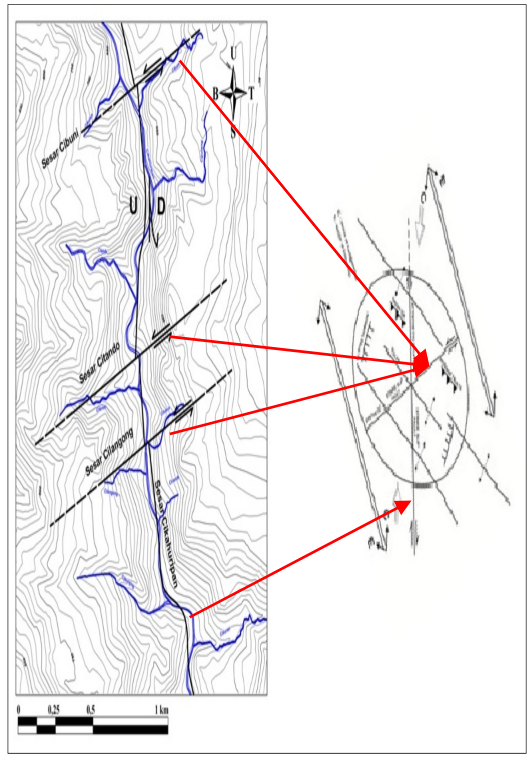

Figure 12. Cijulang prospect faults zone and Riedel Shear Model

Structural Control on Alteration Distribution

High sulfidation systems at Cijulang prospect which display both lithological and structural control. Crystal tuff which typically a permeable lithological could be classed as alteration distribution margin. An initial lithological control to the high sulfidation is evidenced by the localization of silicification on Cisuru, Dangur, and Limus Hill at intersection of NE trending structures and permeable host rock.

Dilatant structures which tap the magmatic source typically control the fluid flow at depth. On regional scale, the inferred magmatic source for the high sulfidation alteration and mineralization may have been localized by intersection of NS, NE-SW Plio-Pleistocene trending transfer structures which offset the magmatic arc. These structures also create post mineral offsets of alteration. In addition N-S structures localize fracture controlled mineralization which is best developed in portions of the N-S structures which deviate to NW-SE trends.

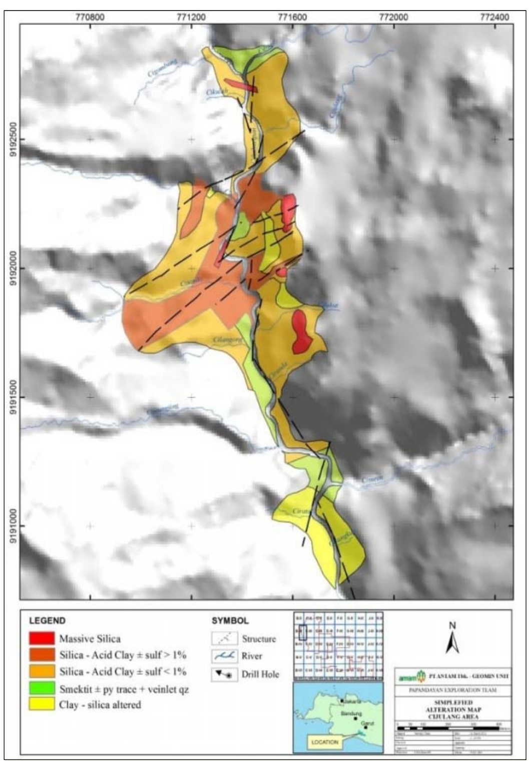

Figure 13. Cijulang Area Alteration Map (PT. Antam Tbk.,2012)

The Riedel Shear model suggests that NE-SW regional sinistral movement on the northern similar to the sinistral strike-slip fault (Cibuni Fault, Citando Fault, Cilangong Fault), has facilitated the formation of local dilational fault where the NS fractures transgress the silicification zone.

Conclusions

High sulfidation systems at Cijulang Prospect which display both lithological and structural control. Permeable host rock (crystal tuff and andesite volcanic) localized the silicification zone. The alteration is interpreted to be derived from acid leaching by magamatic fluid which migrated upwards and the laterally southeast along the Cikahuripan fault NS, NW trending dilational feeder structures. Silicification on Cisuru, Dangur, Limus Hill is localized by intersection of dilatant sinistral strike-slip fault.

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