Geology at Beruang Kanan, Central Kalimantan, Indonesia

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Abstract. The samples are collected during our field investigations both from outcrops and from core drillings. They will be selected from rock units within the Beruang area, particularly from the pre and all syn mineralization rocks. The Beruang area is situated within a mid tertiary age magmatic arc that host a number of epithermal gold deposits (e.g., Kelian, Indon, Muro) and significant prospects such as Muyup, Masupa ria, Gunung Mas dan Mirah. Mineralization in the Beruang is associated with a number of intrusions that have been emplaced at shallow crustal levels at the junction between Mesozoic metamorphic rocks to the south and accreted Lower Tertiary sediments to the north. These intrusions are interpreted to be part of the Oligocene central Kalimantan Arc. The Cretaceous rock that found in Beruang Kanan are older intrusions which associated with volcanic and volcaniclastic rocks. The Beruang Kanan mineralization is hosted in a sequence of dacite tuff of probable Oligocene age, that overly lower Tertiary volcaniclastic siltstone and sandstones in the eastern prospect area. Premineral andesite, dacite to basalt-gabbro dykes are intruded into the tuffs and sediments zinc-arsenic-antimony in soils is hosted in intensely chlorite-pyrite altered tuff. In the West Zone, scattered zones of phyllic alteration. Subsequent shearing of quartz veins was accompanied by wallrock alteration and vein deposition of the quartz veins was accompanied by wallrock alteration and vein deposition of mineral assemblages that are zone temporally from early advanced argillic, through intermediate phyllic to late stage argillic and sub-propylitic. The alteration assemblages and associated mineralization are also spatially zoned.

Keywords: mineralization, alteration, vein, alteration

1. Introduction

In Indonesia, the Cu-Au metal arc deposits was founded in various types of gold formation deposits: porphyry copper gold, epithermal high sulfuration, epithermal low sulfuration, gold-silver-barite-base metal, skarn, and sediment hosted mineralization[9]. The regional tectonic conditions of the KSK Contract of Work are located in the mid-Tertiary magmatic arc [9] which host a number of epithermal gold deposits (eg, Kelian, Indon, Muro) and significant prospects such as Muyup, Masupa Ria, Gunung Mas and Mirah (Figure 1). Copper-gold mineralization in the KSK Contract of Work is associated with a number of intrusions that have occupied the shallow-level crust at the intersection between Mesozoic metamorphic rocks to the south and
continuously into the Tertiary sediment down to the north. This intrusion is interpreted to be part of the Oligocene arc of Central Kalimantan [9]. Volcanic rocks and associated volcanoes are older than intrusions, possibly aged Cretaceous and exposed together with all three contacts [9]. This region is dominated by a northerly trending fault (van Leeuwen et al., 1990) and is either a parallel arc, or an accretion. The normal cesarean fault, or a sliding fault crosses a structure that trails the Northeast Tertiary mid intrusions have generally been occupied in settings dilational at the intersection of key structural features. The prospect of Cu mineral deposits in Kalimantan lies in the same geologic structure setting [12]. The obvious shallow intrusion as a major anomaly in aero magnetic survey data.

The appearance of large circular morphology, clearly visible on satellites, landscapes, radar, and aerial photographs, generally coincides with Tertiary mid intrusions and is associated with high magnetic anomalies. The circular structure is interpreted to be a form of volcanic collapse and hosts numerous copper-gold porphyry prospects in the KSK Contract of Work. To date, more than 38 porphyry and porphyry-related copper and / or gold prospects have been specified in the KSK Contract of Work, and only a few are stated to be potential, those of Baroi, Mansur and Beruang Kanan.

Figure 1 Locations of mineralized zones in the Magmatik arc region of Central Kalimantan (KSK, 2004)

According to previous research work, some researchers contributed details about the geological and mineralogical background, and some papers for it were published for the Beruang Kanan area and its surroundings but no one has been able to ascertain the genesis type of the Beruang Kanan region. In addition, it also undertakes some data collection of drill holes and geochemical studies. However, there is no study that mentions a detailed investigation of the origin and genetic aspects of deposits including geochemistry and mineral chemistry of rocks, petrology, characteristic of rock fluids and incorporates the region of a porphyry type. Therefore, detailed studies for geochemical analysis and origin. For mineralization, petrology, geochemical studies as well as mineral chemistry of rocks and fluid inclusions are still required and will be undertaken in this research area to be able to know the type and characterization of hydrothermal fluids found in the area of the Beruang Kanan.

Location and Accessibility
The Beruang Kanan is located within PT Kalimantan Surya Kencana Contract of Work area (KK KSK) in Central Kalimantan, south of the equator (Figure 2). It is about 190 kilometers north and slightly west of Palangkaraya, the capital of Central Kalimantan. The BKM project (centered at Long
113 25 00 E, Lat. 00 37 00 S) is in the mountains of a plains forest in the upper reaches of southern Kahayan and Samba streams in a remote area where no permanent villages exist. The isolated location and access to and around prospects are difficult and apply certain restrictions on field operations.

Daily air flights connect Jakarta with Palangkaraya, the capital of Central Kalimantan with a travel time of 2 hours 45 minutes, then headed to the prospect of the Beruang Kanan is takes about eight hours by vehicle (approx 350 km), or 50 minutes by helicopter from Palangkaraya. Road logging gives access to this previously remote area. Access to this project via footpath (foot) from the field camp, located on the east side at the base of the main ridge.

![Figure 2. Access to the Beruang Kanan from Palangkaraya, capital of Central Kalimantan Province (KSK, 2004)](image)

2. Methodology

The methodology mainly includes four sections: pre-field study, field investigation, laboratory analysis, and data analysis and interpretation. Pre-field studies include literature review and secondary data. Field work field will be mapping, data collection and sampling. Laboratory analysis to be conducted is petrography analysis, geochemistry and fluid inclusion studies will meet the research objectives. Research methods are related to petrography, geochemical analysis, and fluid inclusion studies and it will be evaluated genetic model and the origin of copper deposition mineralization.

*Literature review*

The literature study starts from a desk study in the form of literature review and from secondary data. The study desk studied a collection of all relevant research information and exploratory studies on all previous area and research data. The literature review includes learning about regional geology and tectonic order, stratigraphy, geological structure and fault distribution patterns, copper porphyry mineralization and mineralization related mineralization including also studying regional geology maps.
and reserve potential.

Studies of general characteristics and characteristics of copper deposits, genesis and alteration alteration, mineralization, geological characteristics, and the formation stage of some epithermal deposits were also studied to support this study. Secondary data primarily for area studies are also used in this study such as geological maps (1: 50,000) and several research papers from published and unpublished books, papers, theses, journals, reports etc. Field preparation is also important and involves the collection of necessary instruments, tools, materials and others, before leaving for the field.

Field work
Observation of Geological Condition. The first field visit will be conducted in the prospect area of the Beruang Kanan. Priority field investigations collect geological data exploring the genetic relationship of host rock, ore mineralization, alteration and sample samples from identifying rock types and lithology units in the study area.

Observation of Alteration / Mineralization. Other important field work in the research area is to map surface data to obtain solid data, veins, mineralized zones as well as mapping and sampling of rocks that are terubstated in alteration zones.

Surface Sampling
Sampling includes systematic collection of representative samples of units of each rock type including hostrock and bedrock of alteration and in mineralized zones, both from surface and subsurface; it aims to be used in various laboratory analyzes for various studies such as petrographic studies, geochemical analysis, mineral chemistry, mineralogy and fluid inclusions.

Selection and Sampling of Core Drilling
A hundred (100) core drilling samples were taken from nine drill holes for preparation and analysis for petrographic studies, rock chemistry, mineral chemistry and fluid inclusions. Intake of representative samples of this drilling core of each type of rock units, alteration rocks and with different depths.

Laboratory Analysis
Samples will be analyzed to study mineralogy studies, geochemistry studies and mineral chemistry studies using microscope, X-ray Diffraction (XRD) in Geology Engineering Center Laboratory of Geology Engineering Department Gadjah Mada University's Faculty of Engineering, X-Ray Fluorecence (XRF) and Scanning Electron Microscopy coupled with Energy Dispersive X-ray (SEM-EDX) at the Nanotechnology Research Laboratory, Bandung Institute of Technology (ITB), Inductively Coupled Plasma Mass Spectrometry (ICP-MS) at ALS Canada, and fluid inclusion studies at PT. Aneka Tambang Geomin unit, Pulogadung, Jakarta. Petrography preparation and analysis for thin incisions and polishing incisions was done at the Economic Geology Lab at the Department of Geological Engineering, Faculty of Engineering, Gadjah Mada University, Indonesia.
3. Physiography
The existence of a continental bow is a temporary prediction from the Northeast of South Kalimantan through Central Kalimantan to West Kalimantan and towards Sarawak. Pre-Cretaceous rocks include Mesozoic sedimentary units located above the Paleozoic Final Skill fillet (Paleocene) which is consolidated or incorporated in the early Mesozoic orogenesis process (Hutchison, 1989). Then granite intrusion on the Triassic End may be included in the ongoing events in the Mesozoic Beginning of the Southeast Asian belt. This granite was intruded early Plutonic Limestone from the Schwanner Mountain arc. Rhyolite tuffs in Middle Eocene were 49.7 and 48.6 million years ago [9] dating before the end or upper Eocene through the Oligocene sediment sequence. The absence of rhyolite tuffs that have the same properties as mineralization may be due to the division or opening of the Celebes (Moss, et.al., 1988). (Figure 3).

![Figure 3. Geological Map of Kalimantan (Moss, 1998)](image-url)
4. Result and Discussion

4.1 Geology of Research Area

The research location is located in Beruang Kanan area, Tumbang Miri sub-district, Gunung Mas district, Central Kalimantan province. Based on this it is known that the location of this study is part of the Geomorphological Unit of Corrugated Hills in the middle of the island of Borneo. Schwahner Mountains stretched in the middle (KSK, 2004). The study area has an altitude ranging from ± 50 meters to ± 400 meters.

Geomorphology of the research area based on field observations and aerial photographic analysis, including volcanic origin (sub geomorphology of ejected volcanic hill). The flow patterns that develop in the telitian region are based on observations including a subdendritic pattern whose pattern resembles the shape of a tree in which control by erosion and denaturation. The Middle Bear River has a valley shape like the U-letter that characterizes the river in a young berstadia. The river empties into the Kahayan River which is the largest river in Central Kalimantan KSK, 2004) In general, the morphology of the research area can be divided into two morphological units, namely the corrugated morphological units and the prominent hill morphology units. The corrugated rolling morphology units are represented.

Figure 4. Regional Geological Maps of Research Areas (Margono, et.al., 1995)
by sedimentary rocks with altitudes between 300 meters to 500 meters above sea level. While the prominent hill units are represented by the intrusion of igneous rocks with altitudes between 700 meters to 1500 meters above sea level.

4.2. Litology

4.2.1. Units of sandstone rocks

The rocks found that occupy the East of the research area in the Beruang Kanan. Color of rock: Color of brownish ash brown, Boxed open mask texture medium-poor, size of fragment 0.2-5mm, matrix size 0.5-1mm, Massive Structure

Mineral Composition of origin:
- Quartz: Colorless color, size <0.1 mm, gloss of glass, no cleavage, translucent light transparent, abundance 1%
- Clay mineral: Reddish yellow, size <0.1 mm, gloss, unobserved shape, unobserved cleavage, opaque light browning, 7% abundance
- Plagioclase: Color gray, size <1 mm, glass luster, 2-way hemisphere, translucent transparent glow, 80% abundance
- Feldspar: Black, 0.5-3 mm, glass gloss, 2-way halves, translucent transparent, abundance of 10%.

![Image of sandstone units](image)

Figure 5. Petrography photos of sandstone units in RA 156 samples (right Nikol Sejajar, Left Nikol Silang)

The dasit tuff unit

This porphyry dashboard unit occupies most of the research area in the Beruang Kanan. This unit is encountered in the sampling loop RA 152, and RA 3. This unit has a brown color; clastic texture; granules supported by fragments; grain size from 0.5 to 1.5 mm; grain shape slightly rounded - angled; bad disguised; open containers; relationship grain float contact, long contact. Mineral composition in this unit:

- **Glass**: Glasses, on PPL observations have colorless color and brown XPL, with low relief, lack of pleochroism, subhedral mineral relations, mineral size 0.2-0.7 mm, granular-tabular shape, 20% abundance.
- **Opak minerals**: On black PPL and XPL observations, with high relief, lack pleochroism, subhedral mineral relations, mineral size 0.4-0.6 mm, granular-tabular shape, 10% abundance.
- **Quartz**: Quartz on PPL observation has colorless color, low relief, no plekoirismo, with inter-subhedral mineral-anhedral relationship, size of mineral 0.1 mm-1 mm. The XPL observation has a clear gray le clear color interference, with wave type, granular-tabular shape, 45% abundance.
- **Piroksen**: Piroksen on PPL observation has colorless color, strong relief, no pleokroismo, with inter-subhedral mineral-anhedral linkage, mineral size 0.3 mm - 0.5 mm. In observation XPL has the color of the first order green interference, with unobserved dark type, granular-tabular shape, 10% abundance.
- **Mud**: Mud at brown PP and XPL observations, with low relief, no pleocromism,
subherald mineral relation anyway, abundance of 15%

Diorite Intrusion.
Diorite intrusion is scattered locally in the research area. The most widely disclosed location is in the southwest of the study area. This lithodem is found in samples RA26, RA 57, RA 63, and RA 121B. These units are petrographically colored: grayish white; holocrystalline Christianity; granularity of fine-medium fan; euhedral – subhedral mineral form; mineral size 0.1 - 2 mm; inequigranular-porphyritic relations. Mineral composition contained in this rock:

- **Plagioclase.** Plagioclase in PPL observation has colorless color, medium relief, has no pleokroisme, with inter-subhedral mineral-anhedral relationship, mineral size 0.1-0.5 mm. In XPL observations it has clear I Will gray interference color, with twin albrite type, granular-tabular shape, on 1mm phenocrist with An-42 type of andesin, and on microsite 0.5 mm with An 40 type of andesin, 55% abundance.
- **Horblende.** Horblende on PPL observations has a brown color, medium relief, has pleokroisme, with inter-subhedral subhedral-anhedral linkages, size of minerals 0.2 mm-0.6 mm. In XPL observations it has a brown color II-order interference, with unobserved dark type, granular-tabular shape, 20% abundance.
- **Opaque minerals.** in PPL and XPL surveillance berwarnahitam, with high relief, no pleokroisme, inter-subhedral mineral relations, the size of minerals 0.1-0.3 mm, granular-tabular form, abundance of 10%.
- **Piroksen.** on PPL observation has colorless color, strong relief, no pleokroisme, with inter-subhedral mineral-anhedral linkage, mineral size 0.3 mm - 0.5 mm. In observation XPL has the color of the first order green interference, with unobserved dark type, granular-tabular shape, 10% abundance.
- **Quartz** on PPL observations have colorless color, low relief, no pleokroisme, with subhedral-anhedral mineral relationships, mineral size 0.1 mm-0.4 mm. The XPL observation has a clear gray i.e. reference color, with wave type, granular-tabular shape, abundance.

Silica sand sediment units
Silica sand sedimentary unit is ducking ridge in the middle of the hill with the easterly eastward on the hill of the Beruang Kanan. This unit is the youngest unit and is deposited incorrectly over other units. This unit has not experienced diagenesis process.

4.2 Geological Structure
From the results of field geological reports of KSK and aerial photography interpretation found two types of geological structures that developed the fault structure and a sturdy structure. The burly structure that develops in the area of the telitian is generally stout, stout and stocky muscles associated with lava formation. The general direction of the quartz vein is N 312 ° E / 43 °. Field fault data are characterized by different morphology and straightness of the river from the interpretation of aerial photographs.

The geological structure of the study area also follows a similar pattern with the regional geological structures of the northeast (NE), and southwest (NW). Geological structure control is very influential on the presence of mineral ore in the research area. The two main trends of this geological structure have a great influence on the presence of mineralization. Based on the geological data around the research area it is shown that the general direction of the presence of the mineralized system has a pattern parallel to the pattern of the geological structure (Van Leeuven, et.al., 1990 in KSK, 2004).

Regionally controlled by horizontal fault that is north-east and locally controlled by northwest-trending tensional fractures associated with a northeast-trending horizontal fault that is ± 400 km extending from Central Kalimantan to East Kalimantan.
The structure in this region is dominated by the northerly trending faults (van Leeuwen et al., 1990) and is a parallel arc, or accretion. The normal cesarean fault trend, or a sliding fault, crosses a structure that trails the Northeast. Tertiary mid intrusion has generally been occupied in a dilational setting at the intersection of key structural features.

### 4.3 Prospect deposit Mineral Cu

The prospect of Cu mineral deposits in Kalimantan lies in the same geological structure setting (Corbett and Leach, 1998). Clear shallow intrusion as a major anomaly on aero magnetic survey data. Based on the results of analysis by previous researcher (KSK, 2004) with a scale of 1: 25,000 and geological structure data found in the field, the geological structure that developed in the research area in the form of a solid structure and cesarean. Here is an explanation of both.

The forces that make up the faults in this area are southeast-northwest. The right-sided fault that runs relatively east-northeast-western southwest is the main fault in this area. This fault zone produces a right-sided fault that runs east-south-west of the northwest, which is the R shear of the previous fault zone. While in the north, there is a right horizontal fault trending northeast - southwest which is the P shear of the main fault zone. 1 left horizontal fault on the northwest of the map which is antithetical from the main right-right fault that cuts the right flank. The working force may be derived from the subduction of the southern Chinese sea located in the northwestern part of the study area. (Riedel, 1929 in Goerge, 2000).

The geological structure of the study area also follows a similar pattern with the regional geological structures of the northeast (NE) and southwest (SW). Geological structure control is very influential on the presence of mineral ore in the research area. The growing geological structure trends are seen on the geologic map of the Tewah Sheet with the general direction of the north-east (NE) - north west (NNW) and northwest (NW) - southeast (SE). The two main trends of this geological structure have a great influence on the presence of mineralization. Based on the geological data around the research area shows that the general direction of the presence of the mineralized system has a pattern parallel to the pattern of geological structure (KSK, 2004).
5. Conclusion
1. Physiography and geomorphology then include rolling hills of volcanic origin (sub geomorphology of dependable volcanic hill). The flow patterns that develop in the telitian region are based on observations including a subdendritic pattern whose pattern resembles a tree shape controlled by erosion and is denuded.
2. The units of lithology contained in research areas in the form of sandstones, intruded diorite, dacite tuff and silica sand deposits.
3. The structure in this region is dominated by a northerly trending fault (van Leeuwen et al., 1990) and is a parallel arc, or accretion. The normal cesarean fault trend, or a sliding fault, crosses a structure that trails the Northeast. Tertiary mid intrusion has generally been occupied in a dilational setting at the intersection of key structural features.
4. Control of geological structure is very influential on the presence of ore minerals in the research area. The growing geological structure trends are seen on the geologic map of the Tewah Sheet with the general direction of the north-east (NE) - north west (NNW) and northwest (NW) - southeast (SE).

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