Alteration and Minerals of Meri Block as an Indication of Gold Finding in Bolaang Mongondow District

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ABSTRACT: *The target of this research is the Meri Block in the Kotamobagu area, North Sulawesi. This study aims to determine the relationship of alteration and mineralization of the Meri Block to indications of South BolaangMongondow gold availability. The research was carried out by observing outcrops, taking samples, measuring geological structure data, and analyzing them. The analyzed were studio analysis, thin section, XRF, AAS, and XRD. The analysis results show that the Meri Block belongs to two original landform units: structural and denudational. The stratigraphy of the research location is composed of four units: andesite, travertine-silicified, sandstone, and diorite intrusive. The structure at this location is generally dominated by right-wing faults trending NNW-SSE and WNW-ESE. The Meri Block has a structure with a steep slope leading to the Northeast-Southwest and Northwest-Southeast. The Northwest-Southeast structural zone has quartz veins of Low Sulfidation Epithermal. The geological structure in the Meri Block is controlled by a right-hand fault with an NW-SE or N036E/52 direction. This fault is a boundary between the Andesite and Sandstone Unit and controls alteration traps. The deposit in this block is a Low Sulfidation Epithermal in the transition horizon from precious metal to base metal. The grade in the Meri Block is around 0.02 - 0.26 ppm, probably because the rock is still undergoing alteration outside the mineralized system, and no characteristic quartz veins have been found, even though the alteration has been intense. In the comparative chart analysis, the elements Au and Ag generally correlate positively, a characteristic of Low Sulfidation Epithermal. However, the elements Au and the base metals Pb, Zn, and Cu negatively correlate.*

KEYWORDS –*Alteration, Epithermal, Low Sulfidation, Meri Block, Mineralization*

I. INTRODUCTION

[1] in [2], high sulfidation deposits have varied forms from dissemination, replacement, veins, stockwork, and hydrothermal breccia bodies. The deposit form is controlled by lithology and structural factors. Control over the deposit geometry is then divided into lithology, structural, and hydrothermal [1]; [2];[3]; [4]; [5]; [6].

In lithology control, metal precipitates are generally dispersed in porous lithologies, such as ignimbrite, and in permeability control, such as unconformity and diatreme breccias. The control of the Meri Block structure lies in the veins, bundles of veins, and stockwork. These deposits can also be controlled by hydrothermal systems, which are generally hydrothermal breccias and vuggy silica alteration.

Quartz is the main gangue mineral forming urates which are formed from the freezing process of hydrothermal solutions. The characteristics of quartz, namely its crystal structure, chemical composition, and physical-chemical properties, can reflect the hydrothermal conditions at the time of vein formation. Quartz veins can be classified fundamentally based on observations of the texture of the quartz found in the veins. This texture can replace existing minerals by filling fractures or pores (open space filling textures). Textures due to filling include massive, cruciform, cockade, coliform, moss, comb, zonal, etc., which can be seen as megascopic allies or by thin incisions.

Research on epithermal deposits, characteristics, and associations of constituent minerals related to gold in Java has been extensively studied [7]; [8]; [9]; [10]. However, there are still few published studies regarding the alteration and mineralization of Sulawesi gold, especially in Bolaang Mongondow[11]. This research will add references regarding the alteration and mineralization of gold deposits, especially those in BolaanMongondow, especially the Mery Block.

II. Materials and Methods

This research is based on observing rock outcrops in the field, taking samples, measuring geological structure data, and analyzing them. The analysis was carried out in two stages: studio and laboratory in thin sections, XRF, AAS, and XRD. A thin section is carried out to determine the rock's mineral composition. AAS and XRF analyses were carried out to determine the elemental content and presence of ore minerals in the study area. Altered minerals are known from the results of XRD analysis on rock samples taken from the field.

III. Results and Discussion

The geology of North Sulawesi consists of volcanic rocks that are Cenozoic in age and are associated with intrusions that developed into island arcs in the Eocene through the amalgamation of oceanic crust formed during the opening of the Celebes Sea [12]; [13] with the accretion of thin fragments. of continental crust originating from the West [14]. Mineralization is associated with two volcanic-magma arc events in the Miocene and Pliocene – Pleistocene, with known gold deposits forming in younger arc events.

The Meri Block is included in the Kotamobagu area, composed of bedrock in the form of pillow basalt lava and basalt-andesitic rocks of the Eocene – Lower Oligocene age [15]. These deposits are covered unconformably by Basal-Andesitic Volcanic Rock Sequences, marine sedimentary rocks, and a few limestones of the Early Miocene - Late Miocene age. Middle Miocene repeatedly penetrated this rock sequence – Pliocene calc-alkaline polyphase batholiths, porphyry intrusions, and disks followed by Pliocene dacite-andesite porphyry intrusions and deposition of volcanic rocks. Most of the Kotamobagu area is covered by pyroclastic rocks, dacite rhyolite and epiclastic sediments, andesite lava, and pyroclastic rocks of the Pliocene-Plistocene age.

There are two major geological structures in Kotamobagu, namely the arc parallel graben structure (for example, the Dumoga-Kotamobagu valley) cut by a major NW trending arc transverse sub-parallel structure (for example, the Inobonto fault and the Eureka Trend). This arc transverse structure causes the initial rightward movement to be reactivated at present with a leftward movement which may be related to the orientation change of the stress regime as a result of the polarization reversal that occurred in the Late Miocene - Early Pliocene. The 15 km wide caldera was formed due to the meeting of these two large geological structures. The left Inobonto fault passes through the southwestern part of the caldera rim, and the caldera is surrounded by a young geomorphological panorama consisting of domes and funnels, including the Ambang Active Volcano.

The geomorphology of the Meri Block belongs to two original landform units: structural and denudational (Fig. 2). Structural control is highly developed to the east of the study site, influenced by right horizontal faults producing structural hilly landforms. This unit occupies 59.76% of the study area across the Northwest-Southeast direction with andesitic lithology, local alteration (argillic, silicification, and epidote-chlorination), and tuff. The orthography is in the form of hills with an elevation of 485-640 meters above sea level and a rather steep slope (21-34%). Meanwhile, the landform of denudational hills occupies 40.2% of the area of the study site, with a flat-slightly steep slope (7-22%). The orthography is in the form of hills with an elevation of 374-679 meters above sea level and stretching towards the Northwest-Southeast. The constituent lithology is in the form of sedimentary rocks, both massive and layered (sandstone, siltstone, and locally andesite and diorite).

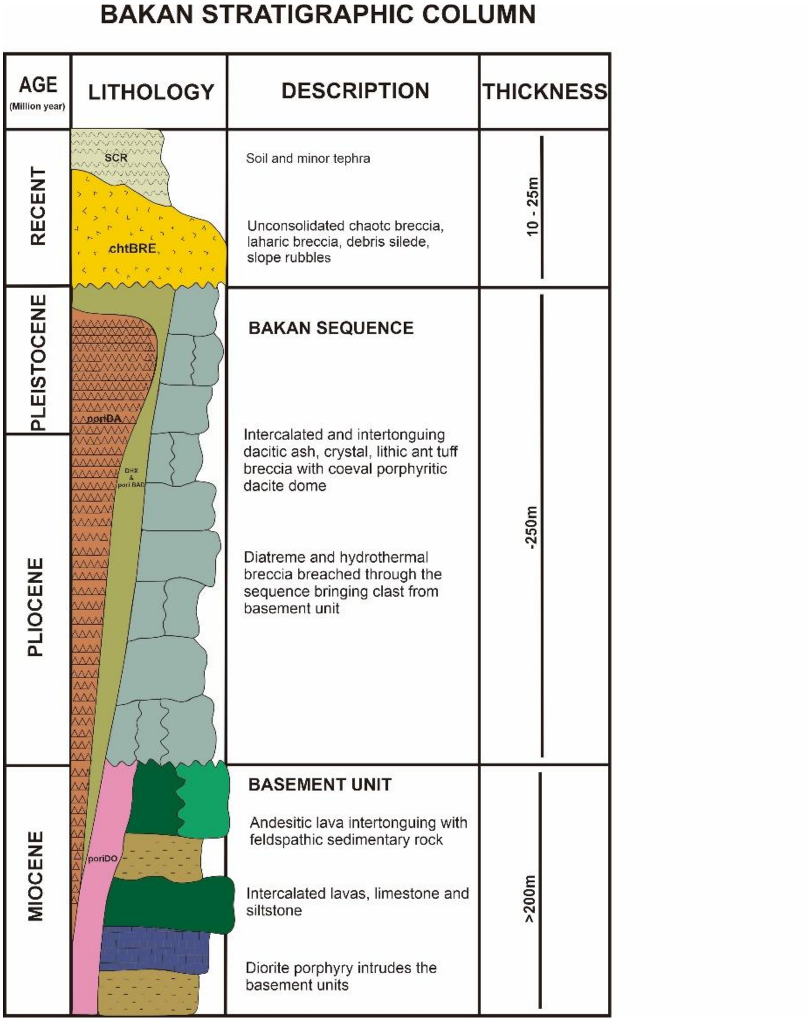

Fig. 1. stratigraphical relationship of the Bakan Block [16]

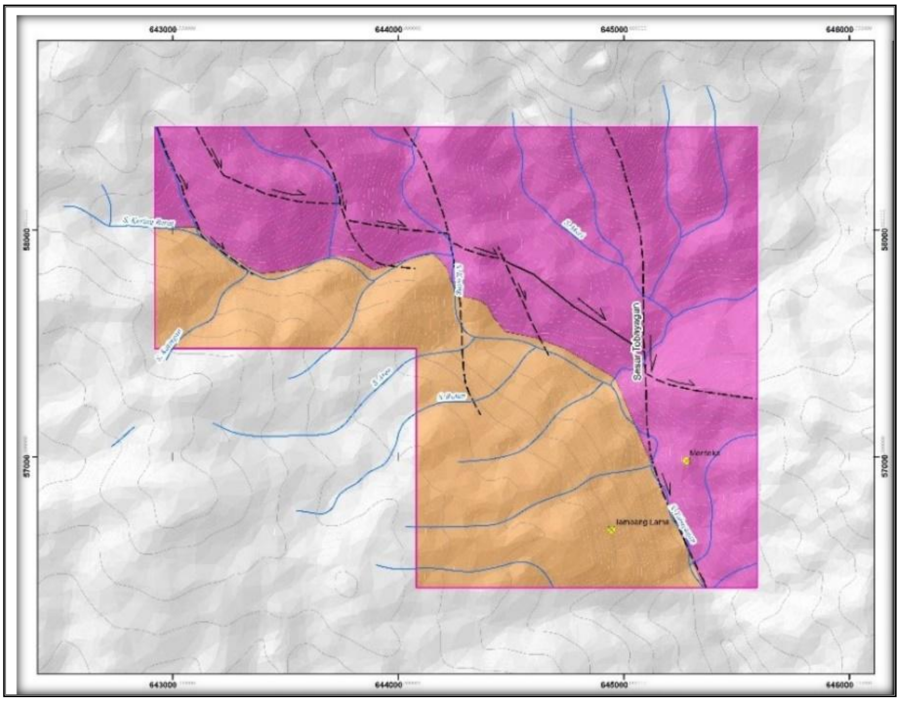

Fig. 2. geomorphological map of research locations

The stratigraphy of the study site is composed of four units, namely andesite, travertine-sillisified, sandstone, and diorite intrusive units (Fig. 3). In general, the research location's structure is dominated by right-wing faults trending NNW-SSE and WNW-ESE. This fault is exposed chiefly in the Andesite Unit and locally in the Sandstone Unit. This fault structure pattern is a pair or conjugate of a regional fault (sinistral strike-slip fault).

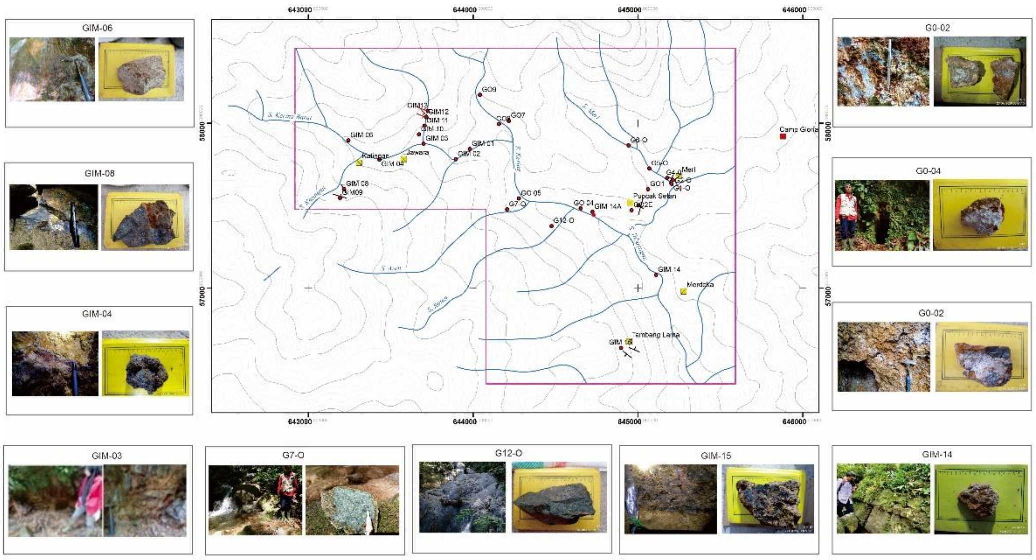

Fig. 3. rock samples at the Meri Block observation site

The Meri Block develops a structure with a steep slope trending Northeast-Southwest and Northwest-Southeast. Quartz veins from Low Sulfidation Epithermal are identified in the Northwest – Southeast structural zone.

The location of this block is at the contact of andesitic rocks in the West and volcanic sediments in the east, which is N293°E/45°. The composition of andesite in the form of plagioclase, pyroxene, and hornblende in small quantities follows the thin-section analysis on five rock samples. The andesite is believed to break through volcanic sedimentary rocks, as evidenced by thermal changes. The volcanic sediments alternate between volcanic sandstones, pumice breccias, and siltstones.

Fig. 4. rock samples at the observation site

The geological structure of the Meri Block is controlled by a right horizontal fault with an NW-SE or N036E/52 direction. This fault is the boundary between the Andesite and Sandstone Unit and controls alteration traps. This outcrop structure is found at GIM 06 on the slopes of the Blok Meri Block in the form of a West-East oriented normal fault which is a development of this fault (Fig. 5).

The rich Chlorite-Epidote alteration in the north and east of the site is shown from the results of the XRD analysis, and this change is weakened in the andesite rocks in the West of the site. In this zone, many clay veins are covered by locally enriched epidotes, such as at GIM 13.

Fig. 5. west-east trending normal fault

Silica and silica-clay alterations are found to replace rocks intensely and pervasively. The vertical vein sheath alteration geometry is seen in several locations below 4m – 6m depth. Meanwhile, above this depth, rock alteration occurs massively and appears irregular. Alteration geometry that resembles a lens is also found on the opening slope.

The deposit in this block is Low Sulfidation Epithermal in the transition horizon of precious metal to base metal. They are characterized by the texture of quartz veins found in coarsely crystalline, saccharoidal (sugar), and drusy. The galena found adds to the evidence that the system has begun to enter the horizon base metal. The presence of native gold in the GIA 01 hole indicates that the system is still transitioning between the precious metal and base metal horizon. The deposit geometry is controlled by an NW-SE trending structure, indicated by the quartz veins in the artisanal pits and Bukit Seberang. Another controller is permeable lithology in the form of volcanic sediments, which alters spread evenly and tends to be random. Besides being found embedded in quartz veins, the gold in this block is also scattered in porous sedimentary rocks along with widespread clay alteration.

Weathering by water and air on the soil's surface is intense, characterized by rich iron oxide minerals down to the depths. This process allows the gold bonds to separate from rocks and minerals, making it easier to separate chemically. However, this does not apply to gold in solid and massive quartz veins. The gold content of this block ranges from 0.99 – 5.44 g/t.

Table 1. Laboratory Analysis Results

IJENT	**Au1**	**Au2**	**Au3**	**Au4**	**Au1**	**Au2**
UNITS	PPM	PPM	PPM	PPM	PPM	PPM
DET.1..1 11	0,01	0,01	0,01	0,02	0,02	0,03
SCIEIE	FA51/ AA	FA51/ AA	FA51/ AA	FA51/ AA	AR50/A AS	AR50/ AAS
GIA 01 A-15M	2,86				NA	
GIA 01 C-07 M	0,99				NA	
G2 0 2-3M	0,02	0,02			NA	
G4 0	0,26				NA	
GIM 13 A	<0,01				NA	
GIM 08 A	1,14				NA	
GO 02 B	0,17				NA	
GS 02	0,38				NA	
GIM 14 C	5,79				NA	
GIM 9 C	5,44				NA	
GIM 9 D	0,67				NA	
GIM 9 G	3,97				NA	
G2-0	0,03				NA	

IJENT	Au3	Ag	Cu	Pb	Zn
UNITS	PPM	PPM	PPM	PPM	PPM
DET.1..11 1	0,04	1	0,01	0,02	0,02
SCIEIE	AR50/A AS	2A/AA2 01	2A/AA2 01	2A/AA2 01	2A/AA20 1
GIA 01 A-15M		40	184	1120	4370
GIA 01 C-07 M		8	98	111	232
G2 0 2-3M		<1	123	12	116
G4 0		3	320	38	19
GIM 13 A		<1	83	11	129

IJENT	Au1	Au2	Au3	Au4	Au1	Au2
UNITS	PPM	PPM	PPM	PPM	PPM	PPM
GIM 08 A			33	177	12270	1350
GO 02 B			2	29	248	16
GS 02			4	113	406	178
GIM 14 C			23	152	661	129
GIM 9 C			<1	24	161	407
GIM 9 D			2	32	42	101
GIM 9 G			5	14	348	21
G2-0			<1	122	9	133

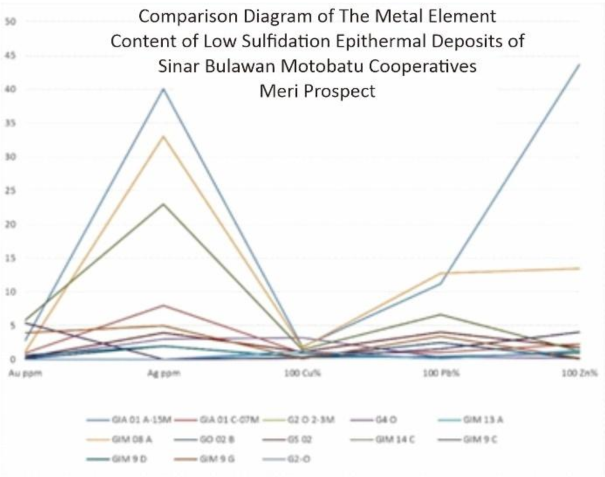

Fig. 6. comparison diagram of prospect meri metal elements

From the results of the analysis data (Figure 6), it can be concluded that the rock samples analyzed using the AAS method (GIA 01 A and GIA 01C) show levels of 0.99 – 5.44 ppm, this is because these samples are zones of quartz veins and intense clay and alteration. In the Meri Block, the levels obtained were around 0.02 – 0.26 ppm, this is possible because the rock alteration is still on the outside of the mineralized system, and no quartz veins have been found, which are the hallmarks, but the alteration is already intense.

The comparative chart analysis shows that the elements Au and Ag generally have a positive correlation, which is a characteristic of Low Sulfidation Epithermal. Meanwhile, Au and the base metals Pb, Zn, and Cu correlate negatively. It can be seen in the GIA 01A and GIM 08A samples with a high base metal content; the gold element is lower than in some samples with less base metal content.

IV. CONCLUSION

Based on the results of the semi-detailed mapping, observation, and sampling of altered (altered) rock at the Meri Prospect, it can be concluded that the gold deposit system in the area is a Low Sulfidation Epithermal and Sediment Hosted. The Low Sulfidation Epithermal System is found in quartz veins in a Southeast-Northwest (SE - NW) direction, spreading from the South to the West. Based on the ore minerals, quartz vein texture, and alteration characteristics, these low sulfidation epithermal deposits generally exist in the transition precious metal horizon and base metal horizon. Gold deposits occur in quartz veins and in disseminated ore that replaces porous sedimentary rocks.

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