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Indication Of Hydrothermal Alteration Based On Petrography Of Granit Garba (KGR), Tanjung Beringin Village, Muaradua District, South Sumatera

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SARI

Penelitian dilakukan di Desa Tanjung Beringin, Kecamatan Muaradua, Kabupaten OKU Selatan, Sumatera Selatan. Lokasi penelitian ini secara geologi terletak pada basement Cekungan Sumatera Selatan yang menyusun Pegunungan Garba, yaitu Granit Garba. Granit Garba merupakan intrusi batuan dengan umur paling muda di antara batuan basement pembentuk Cekungan Sumatera Selatan. Litologi penyusun formasi ini merupakan batuan granitoid dengan karakteristik mineral penyusun yang menarik serta terdapat indikasi proses alterasi hidrotermal yang memengaruhi keterbentukan batuan. Karakteristik dan alterasi hidrotermal batuan granitoid tersebut dapat diidentifikasi menggunakan analisis petrografi sayatan tipis batuan. Berdasarkan analisis petrografi tersebut diinterpretasikan terdapat dua kelompok granitoid yang menyusun Granit Garba. Kedua kelompok granitoid tersebut adalah batuan monzonite kuarsa dan granodiorit. Perbedaan kedua jenis batuan tersebut terletak pada komposisi penyusun mineral utama. Monzonit kuarsa merupakan batuan dengan komposisi kuarsa yang minim serta presentase plagioklas dan alkali feldspar relatif sama. Sedangkan granodiorit memiliki komposisi kuarsa yang lebih banyak dibandingan monzonit kuarsa dengan mineral plagioklas relatif lebih banyak daripada mineral alkali feldsparnya. Kenampakan sayatan tipis pada analisis petrografi batuan tersebut juga menunjukan adanya pengaruh alterasi hidrotermal yang dibuktikan dengan hadirnya mineral sekunder. Mineral sekunder tersebut membentuk asosiasi yang terjadi pada zona filik dan propilitik. Zona filik ditunjukan dengan hadirnya mineral serisit, klorit dan mineral opak berupa pirit sedangkan zona propilitik memiliki himpunan mineral epidot, klorit dan kalsit.

Kata kunci: Alterasi Hidrotermal; Granitoid; Granit Garba; Petrografi

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ABSTRACT

The research was conducted in Tanjung Beringin Village, Muaradua District, South OKU Regency, South Sumatra. The location of this research is geologically located in the basement of the South Sumatra Basin which composes the Garba Mountains, namely Garba Granite. Garba granite is an intrusion rock with the youngest age among the basement rocks forming the South Sumatra Basin. The lithology that composes this formation is a granitoid rock with interesting constituent mineral characteristics and there are indications of hydrothermal alteration processes that affect rock formation. The characteristics and hydrothermal alteration of these granitoid rocks can be identified using petrographic analysis of rock thin sections. Based on the petrographic analysis, it is interpreted that there are two groups of granitoids that make up Granit Garba. The two groups of granitoids are quartz monzonite and granodiorite. The difference between the two types of rock lies in the composition of the main mineral constituents. Quartz monzonite is a rock with minimal quartz composition and relatively the same percentage of plagioclase and alkali feldspar. Meanwhile, granodiorite has more quartz composition than quartz monzonite with relatively more plagioclase minerals than alkali feldspar minerals. The appearance of the thin incision in the petrographic analysis of the rock also shows the influence of hydrothermal alteration as evidenced by the presence of secondary minerals. These secondary minerals form associations that occur in the phylic and propylitic zones. The phyllic zone is indicated by the presence of sericite, chlorite, and opaque minerals in the form of pyrite, while the propylitic zone has an assemblage of epidote, chlorite, and calcite minerals.

Keywords: *Hydrothermal Alteration; Granitoid; Granit Garba; Petrography*

INTRODUCTION

The study was conducted in Tanjung Beringin Village, Muaradua District, South OKU Regency, South Sumatra Province **(Figure 1)**. Regionally geologically, the area is part of the South Sumatra Basin which was formed due to tectonic activity on the island of Sumatra and occurred in the Paleozoic to Mesozoic. Early Carbon – Early Permian is the initial period for the formation of metamorphic rocks as the basement of South Sumatra due to the subduction of the West Sumatra Block and Paleo-Tethys plates (Barber et al., 2005). Tectonic activity continues to cause double subduction between the Meso-Tethys with the West Sumatra Block and Woyla Arc which causes the formation of volcanic rocks and marine sediments (Barber et al., 2005). In the Early Cretaceous - Late Cretaceous period, there was thorough subduction of Meso Tethys towards the West Sumatra Block followed by a collision between the West Sumatra Block and the Woyla Arc. The collision and accretion of the two plates formed the Garba Hills (Barber et al., 2005).

The Garba Hills are composed of various formations, including the Tarap Formation, Garba Formation, Insu Members for Garba Formation, Situlanglang Members for Garba Formation, Melange Complex, and Garba Granite (Idarwari et al., 2018). One of the formations that make up the research area and the dominant formation is Granit Garba. Granit Garba is a granitic intrusion as a result of intensive deformation that occurred in the study area due to

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the thickening of the earth's crust. Granit Garba is a granitoid rock lithology that can be distinguished based on the characteristics of the constituent minerals. In addition to showing mineral characteristics, granitoid rocks in the study area show a hydrothermal alteration process that affects these rocks. So further research is needed on the characteristics and hydrothermal alteration process of Garba Granite. This research was conducted using a thin-slice petrographic analysis method.

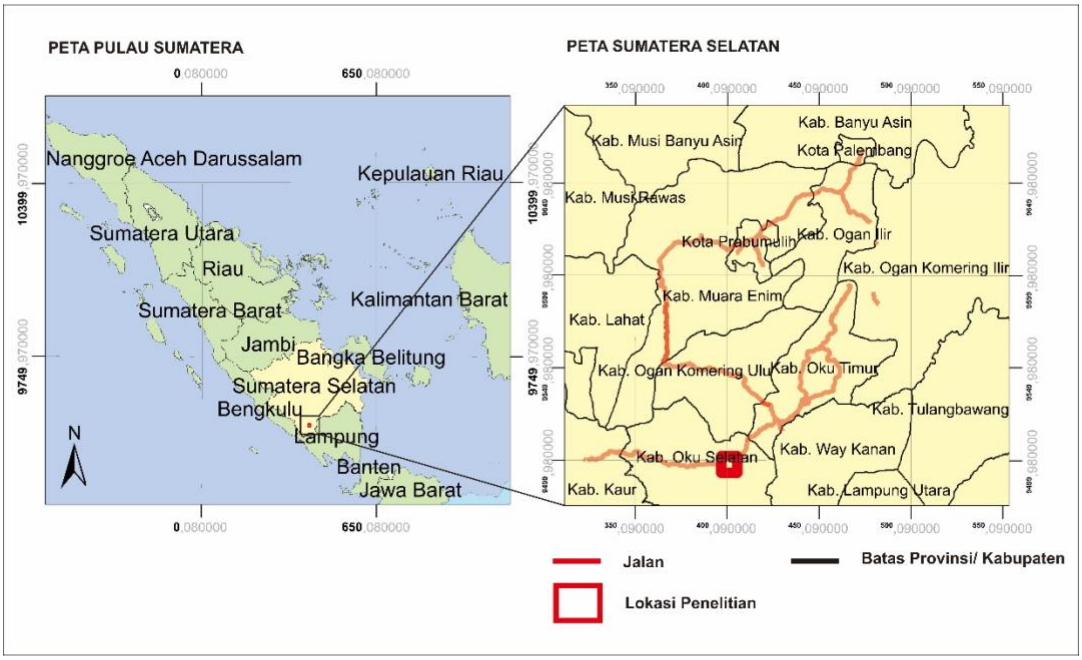

Figure 1. Map showing the location of the study area

SETTING TECTONIC

The research area is included six formations, some of the constituent formations from old to young are the Insu Members of the Garba Formation, Granite Garba, Cawang Members of the Kikim Formation, Talangakar Formation, Baturaja Formation, and Ranau Formation. Members of the Insu Garba Formation are the oldest formations with Early Cretaceous – Jurassic age and the constituent lithology is andesite igneous rock. Granit Garba is a granitic intrusion with Late Cretaceous age and has a granite constituent lithology. The Cawang member of the Kikim Formation is the first sedimentary sediment composed of a conglomerate of quartz fragments with an Early Oligocene – Late Paleocene age. Next is the Talangakar Formation with a siltstone lithology containing mollusca and claystone formed in the transgression phase with a fluvial depositional environment (Kamal et al., 2005). In the Middle Miocene, the Baturaja Formation was deposited with the constituent lithology of limestone. The youngest formation that composes the research area is the Ranau Formation which is composed of tuff. The geological structure that developed in the study area is a local structure

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that occurred in the second phase due to extensional forces in the Late Cretaceous – Early Tertiary. The tectonic activity causes the formation of a right horizontal fault and a left horizontal fault in the study area.

DATA AND METHODOLOGY

The data used in this study are primary data taken directly during field observations and secondary data obtained from previous literature studies. Field observations were carried out to identify the characteristics of granitoid rocks megascopically and to take samples or samples for further petrographic analysis. A total of seven rock samples were made into thin incisions with a thickness of 0.03 mm as the main data in this study. The research methodology used is petrographic analysis. The analysis was carried out using a microscope polarization "Olympus Model NP-107A" to determine the constituent minerals.

RESULTS

Geology of Research Area

The research focuses on Granit Garba exposed in Tanjung Beringin Village and its surroundings as the dominant formation in the research area (**Figure 2**). Based on morphographic analysis, the area is classified as low hills to high hills (100 – 275 meters) with steep – very steep slopes. Active and passive morphostructural processes also affect the study area as evidenced by the discovery of joints and landslides. The existence of degradation in the form of avalanches with type slides at several observation locations is characterized by the presence of slide material at the bottom of the outcrop (Varnes and Cruden, 1996).

Stratigraphically, Granit Garba is an igneous rock intrusion with the youngest age among the Pre-Tertiary rock complexes. Based on Djohor (2005), it is an intrusive stock originating from the magmatic type of continental crust. The granite rocks intrude into contact with the andesite rocks of the Garba Formation **(Figure 3)**. The granite rock outcrop has a weathered brown color with fresh pink white color, fine to medium phaneritic grain size, uniformity between equigranular grains, and holocrystalline degree of crystallization. The constituent compositions are alkali feldspar, plagioclase, quartz, biotite, and hornblende.

The geological structure that developed in the research area is in the form of joints and faults. The joints were found in the Kejantur River, Tekna Village which was then analyzed to obtain the name Vertical Strike-Slip Fault (Fossen, 2010). Fault areas were also found in the research area, precisely on the Biabia River, Tanjung Beringin Village. Based on the analysis results, the fault is a left horizontal fault with the name Vertical Strike-Slip Fault (Fossen, 2010) **(Figure 3)**.

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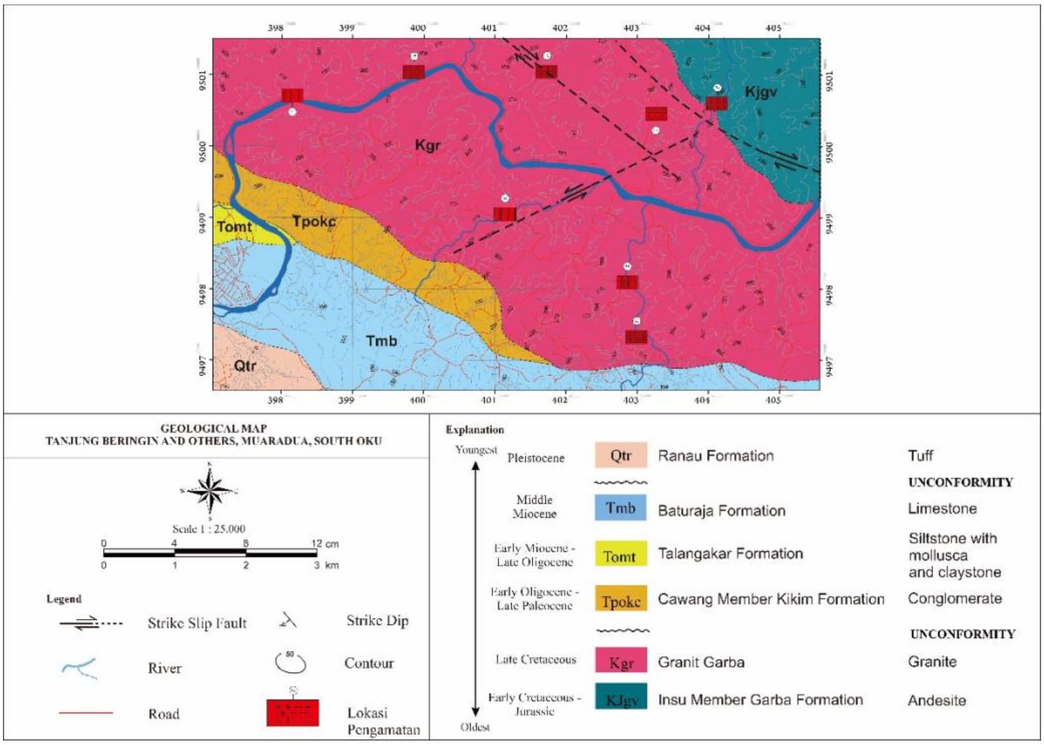

Figure 2. Geological Map of Research Area

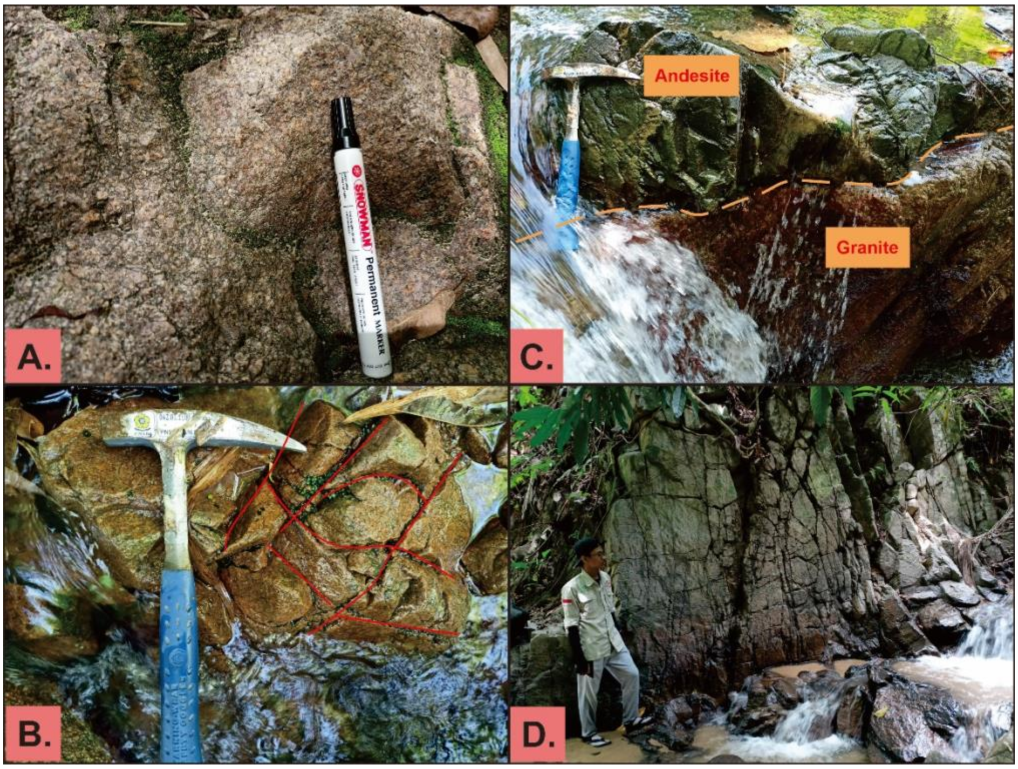

Figure 3. (A) Photomacrograph Granite Outcrop in Tanjung Beringin Village (B) Fractures on Granite (C) Contact Granite and Andesite in Granit Garba and Garba Formation (D) Stepping Fault on Granite lithology in Biabia River, Tanjung Beringin Village

Jurnal Geomine
E-ISSN 2541-2116
ISSN 2443-2083

Petrographic Analysis of Granit Garba

Petrographic observations were made on seven thin section samples. The results of the analysis show that there are two types of granitoid rocks that make up Granit Garba, namely six samples of quartz monzonite and one sample of granodiorite (Streckeisen, 1978) **(Figure 4).**

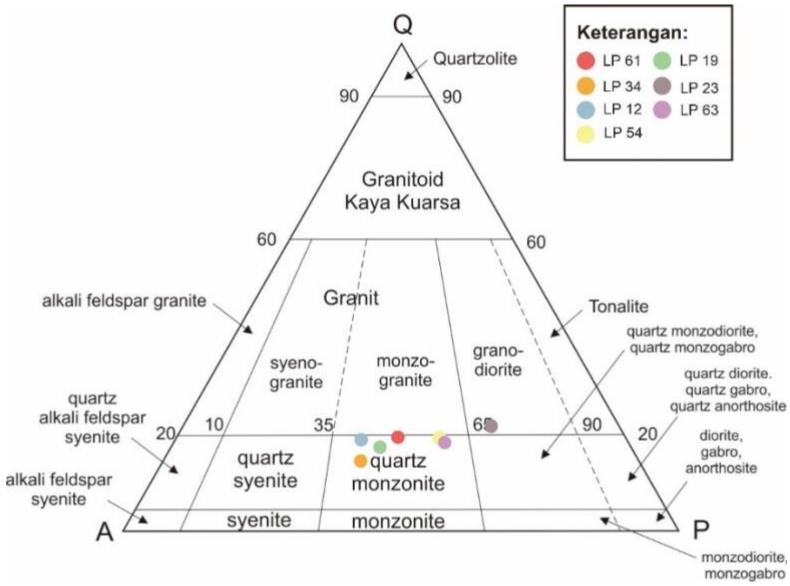

Figure 4. Granitoid Rocks Classification Based on the Streckeisen Classification (1978)

Six samples of quartz monzonite in thin sections showed a colorless – brown appearance in Parallel Polarized Light (PPL), phaneritic grain size 0.1 – 1mm, uniformity between grains is equigranular, with anhedral – subhedral crystal shape, and degree of crystallization holocrystalline **(Figure 5)**. The main mineral compositions that make up the rock are alkali feldspar, plagioclase (oligoclase) with an $An_{21-30,}$ and quartz, while the accessory minerals present are biotite, sphene/titanite, muscovite, and zircon **(Table 1)**. The petrographic analysis of the six samples showed the influence of the hydrothermal alteration process as indicated by the presence of secondary minerals such as chlorite, epidote, sericite, and carbonate minerals. In some rock thin sections, it is seen that there are special textures commonly found in intrusive igneous rocks in the form of intergrowth and exsolution textures. The intergrowth textures contained are graphic and myrmekitic. The graphic texture is the presence of intergrowth where the quartz mineral is covered by alkali feldspar. Myrmekitic texture is an intergrowth that occurs between quartz minerals and plagioclase-type oligoclase. These textures occur due to the crystallization of magma in both minerals simultaneously at a certain temperature and a change in magma freezing that takes place slowly and then turns into a fast one. The next texture is the exsolution texture in the form of perthite. Perthite texture is an exsolution that occurs between alkali feldspar and plagioclase. The host mineral in this texture is alkali feldspar. This texture occurs due to the unmixing process and chemical breakdown that occurs in both minerals in solid conditions. The three textures show that the

Jurnal Geomine
E-ISSN 2541-2116
ISSN 2443-2083

main minerals, namely plagioclase, alkali feldspar, and quartz in the quartz monzonite rocks that make up Granite Garba were formed simultaneously. After the formation of the main minerals, accessory minerals with higher relief such as biotite and sphene are formed. The last phase is the phase of hydrothermal alteration which triggers the changing of primary minerals into secondary minerals.

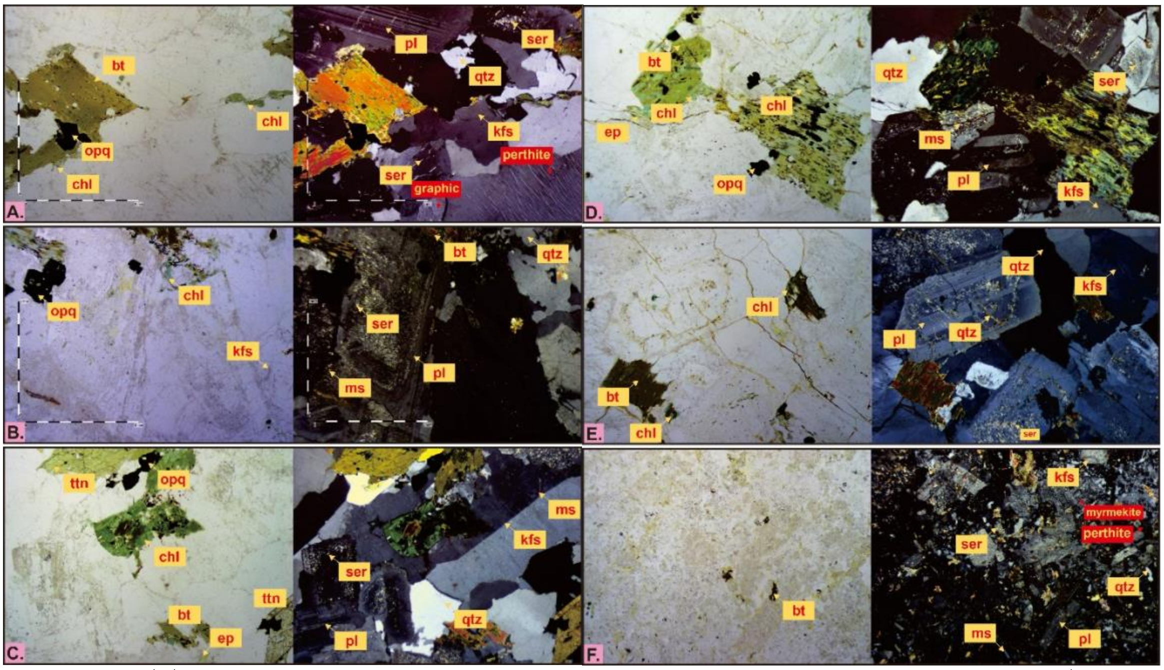

Figure 5. (A) Photomicrogprah Quartz Monzonite with perthite and graphic texture (Kgr LP19). (B) Quartz Monzonite (Kgr LP34). (C) Titanite and secondary minerals on Quartz Monzonite (Kgr LP12). (D) Quartz Monzonite (Kgr LP54). (E) Quartz Monzonite (Kgr LP63). (F) Myrmekitic and perthite texture on Quartz Monzonite (Kgr LP61). Abbreviations based on Whitney and Evans (2010): Qtz: Quartz, Pl: Plagioclase, Kfs: Alkali Feldspar, Bt: Biotite, Chl: Chlorite, Ep: Epidote, Ser: Sercite, Ms: Muscovite, Opq: Opaque.

The next type of granitoid that makes up Granit Garba is granodiorite rock which has colorless characteristics in the appearance of Parallel Polarized Light (PPL), anhedral mineral shape, moderate phaneritic grain size (1mm), holocrystalline crystallization degree, and uniformity between grains equigranular **(Figure 6)**. The main mineral compositions are plagioclase with oligoclase type, alkali feldspar, and quartz, accessory minerals in the form of biotite. The thin section of this granodiorite rock sample also shows a hydrothermal alteration process which is characterized by the presence of altered minerals such as chlorite, epidote, and sericite. The special texture that is present is in the form of perthite texture which indicates the exsolution of alkaline feldspar minerals as host minerals and plagioclase.

Jurnal Geomine
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Table 1. Parentage Mineral on Petrographic Analysis Granitoid Rock Sample on Granit Garba (Before QAP Normalized)

MINERAL COMPOSITION OF ROCKS

Sample	A%	P%	Q%	Accessory Mineral %	Secondary Mineral %	Rocks Name
Kgr LP 12	32,25	24,75	14	10	19	Quartz Monzonite
Kgr LP 19	34,25	29,75	13,5	17	5,5	Quartz Monzonite
Kgr LP 23	15	38,75	17,25	18	11	Granodiorite
Kgr LP 34	39	27,5	11	9	13,5	Quartz Monzonite
Kgr LP 54	22,5	32	13,5	12	20	Quartz Monzonite
Kgr LP 61	28,75	27,25	14	5	25	Quartz Monzonite
Kgr LP 63	24	36	13,25	4	22,75	Quartz Monzonite

Abbreviations: A: Alkali Feldspar, P: Plagioclase Q: Quartz

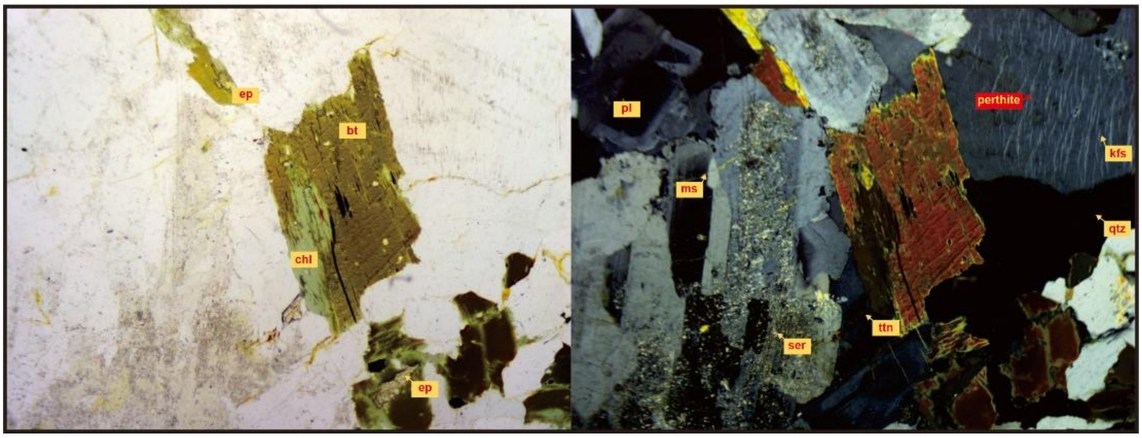

Figure 6. Micrograph Granodiorite with perhite texture Kgr LP 23. Abbreviations: Qtz: Quartz, Pl: Plagioclase, Kfs: Alkali Feldspar, Bt: Biotite, Chl: Chlorite, Ep: Epidote, Ser: Sercite, Ms: Muscovite.

Alteration Zone Distribution

The effect of hydrothermal alteration is evidenced by the presence of secondary minerals in the thin section through petrographic observations. Seven thin sections of granitoid rock samples indicated altered minerals such as chlorite, epidote, sericite, and vein

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calcite **(Figure 7)**. The intensity of alteration in the study area based on microscopic analysis is included in the weak – moderate alteration (5 – 30%). The assemblage of altered minerals in this Granit Garba rock sample shows that it occurs in the philic and propylitic zones **(Table 2)**.

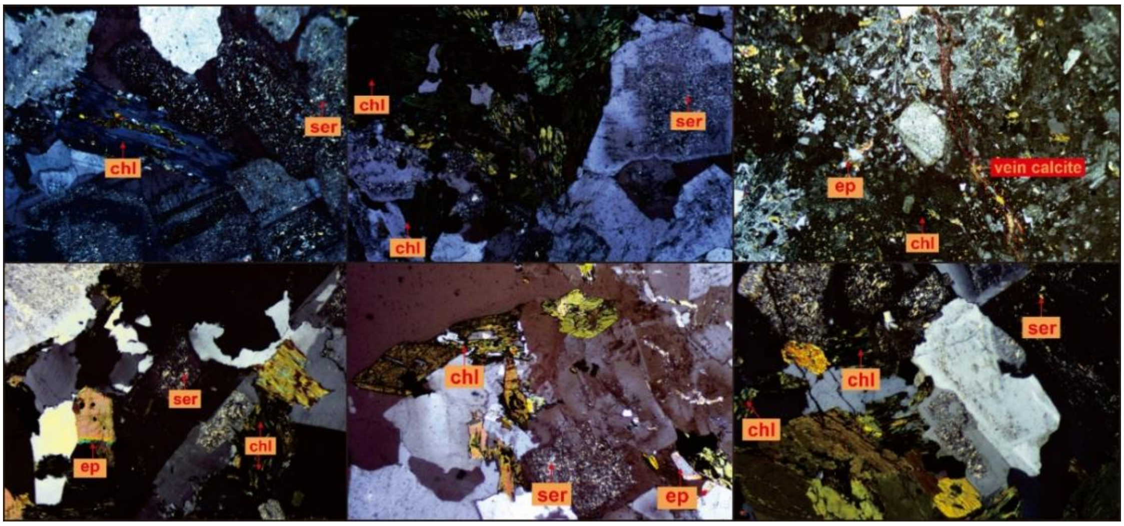
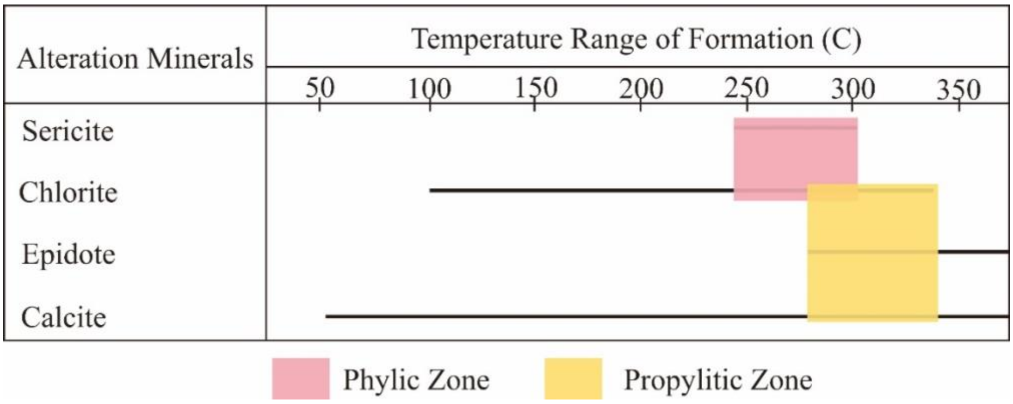


Figure 7. Alteration Minerals Assemblage on Granitoid Rock Granit Garba

Table 2. Paragenetic Alteration Mineral



Phylic Alteration Zone

The phylic zone in the study area is characterized by the presence of sericite minerals associated with pyrite and chlorite minerals (Corbett and Leach, 1998) **(Figure 8)**. This phylic zone has constituent rocks in the form of granitoid rocks with the types of quartz monzonite and granodiorite. The chlorite mineral is an alteration or replacement of the mafic silica mineral in the form of biotite, while the sericite mineral is changed from the feldspar mineral. The temperature of the formation of this phylic zone ranges from 240 – 300°C with an acid-neutral pH. This phylic zone belongs to the mesothermal alteration type and the chlorite group (Corbett and Leach, 1998). The depth where the phylic zone occurs is around 200-250 meters below the surface (Bunchanan, 1981 in Adi Maulana, 2017).

E-ISSN 2541-2116
ISSN 2443-2083

Propylitic Alteration Zone

The propylitic alteration zone has a granitoid type of quartz monzonite as a constituent rock. The secondary mineral that characterizes this zone is the mineral assemblage of epidote + chlorite + carbonate (calcite) (Corbett and Leach, 1998) **(Figure 8)**. In the appearance of a thin section of quartz monzonite, alteration in certain parts shows the presence of calcite veins. The temperature of the formation of this zone is in the range of 280 – 340°C with a pH close to neutral. This type of alteration is mesothermal and the calc–silicate group. The propylitic zone of the research area can occur at a depth of 0 – 250 meters below the surface (Bunchanan, 1981 in Adi Maulana, 2019).

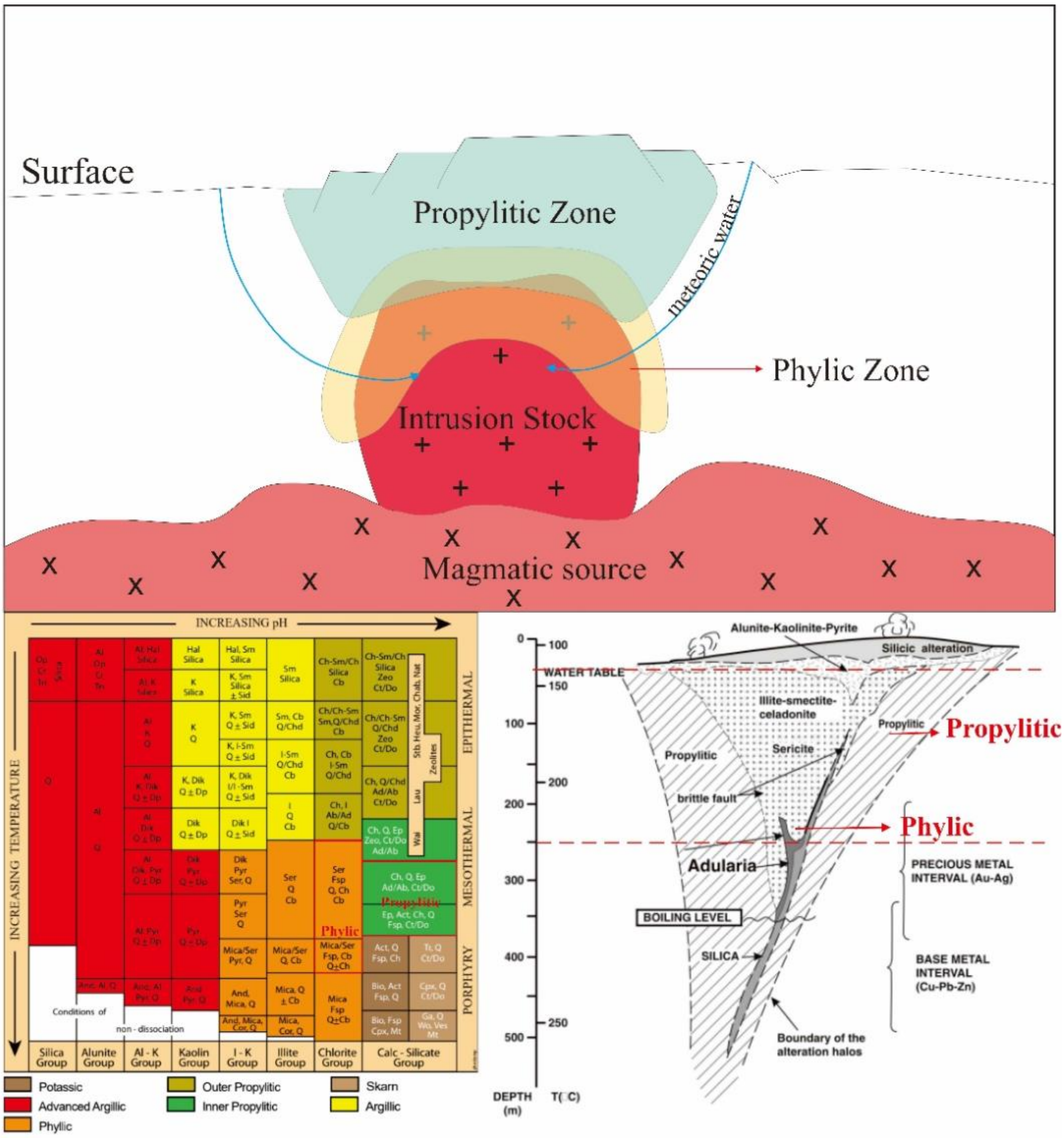


Figure 8. Alteration Zone Schematic, Alteration Zone Based on Corbett and Leach (1998) and Temperature & Depth Alteration Zone (Buchanan, 1981 on Adi Maulana, 2019)

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CONCLUSION

The results of petrographic analysis of a thin section granitoid rock Granit Garba obtained naming with two types of granitoid, namely quartz monzonite and granodiorite based on the classification of Streckeisen (1978). The difference between the two types of rock lies in the main minerals, granodiorite rock has a more quartz mineral percentage (> 20%) than quartz monzonite. Quartz monzonite is also a type of granitoid rock composed of 5 – 20% quartz with relatively the same percentage of alkali feldspar and plagioclase minerals. In addition, the analysis carried out also found indications of hydrothermal alteration processes. This is evidenced by the presence of secondary minerals in the form of sericite, chlorite, epidote, and carbonate minerals. The mineral associations show that the Granit Garba in the study area has been altered in the phylic zone with sericite + chlorite + pyrite minerals and the propylitic zone with chlorite + epidote + calcite minerals.

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