The Petrology Characteristic of Granitoid Rock Based on Geochemical Analysis of Bajau Cape Coast and its Surrounding, West Kalimantan

Karakteristik Petrologi Batuan Granitoid Berdasarkan Analisa Geokimia, Pantai Tanjung Bajau dan Sekitarnya, Kalimantan Barat

Noor C.D Aryanto [1*] , E. Suparka [2] C.I Abdullah[2] and H. Permana[3]

[1] Marine Geological Institute, Jl. Dr. Junjunan No. 236, Bandung-40174, Email: noor_aryanto@yahoo.com

[2] Faculty of Earth Sciences and Technology, ITB, Jl. Ganesha 10, Bandung-40132

[3] Research Center for Geotechnology, Jl. Sangkuriang, Bandung-40135

Email : *noor_aryanto@yahoo.com

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ABSTRACT : The aim of this study is to identify of petrology characteristic based on geochemical analysis in order to know the granitoid rock type. Administratively, the study area is in the City and District of Singkawang, West Kalimantan Province, at coordinate 108°48'30" - 109°1'30" E and 0°40'30" - 0°54'30" N and, situated ± 145 km to the north of Pontianak City. The outcrop of granitoid along Bajau Cape coast and its surrounding, had been analyzed petrographically and geochemically using AAS method. Based on analysis of five samples show that the ratio mole of $Al_2O_3/(CaO+Na_2O+K_2O) > 1$ ranged between 1.12 and 1.7, while the rest of three samples are moderately aluminous, with a ratio value between 0.5 and 1.0. The ratio between K_2O and (K_2O+Na_2O+CaO) ranges 0.07 to 0.55 (moderate) that forms alkali feldspar normative ranges from 3.8 to 15.89 wt%. This ratio shows that granite alkali feldspar is classified to be calc-alkaline series. Petrographically, this rock is porfiritic texture, hollocrystalline, granular hypodiomorphic and biotite present as phenocryst, yellowish brown, euhedral, thin and platy. The content of oxides element (Na_2O and MgO) tend to decrease, whereas of other oxides elements, namely Al_2O_3, TiO_2, K_2O, FeO and CaO increased, parallel with the raising of SiO_2. Therefore, the Singkawang Granitoid can be grouped as alkali feldspar granite, syeno-granite and quartz monzonite.

Keywords: petrography, geochemstry, major elements, calc-alcaline affinity, granitoid type and Bajau Coast, West Kalimantan.

ABSTRAK : *Penelitian ini bertujuan untuk mengidentifikasi karakteristik petrologi, berdasarkan analisa geokimia sehingga jenis batuan granitoidnya dikenali. Secara administratif, daerah penelitian termasuk ke dalam Kota dan Kabupaten Singkawang, Provinsi Kalimantan Barat, pada koordinat 108°48'30" - 109°1'30" BT and 0°40'30" - 0°54'30" LU dan terletak ± 145 km, arah utara dari Kota Pontianak.*

Singkapan batuan granitoid sepanjang pantai Tanjung Bajau dan sekitarnya telah dianalisis secara petrografi dan geokimia dengan menggunakan AAS. Berdasarkan 5 contoh yang dianalisa menunjukan perbandingan mol $Al_2O_3/(CaO+Na_2O+K_2O) > 1$, yakni berkisar antara 1,12-1,7, sedangkan 3 contoh sisanya bersifat peraluminus sedang, dengan nilai ratio antara 0.5-1.0. Perbandingan antara K2O dan (K2O+Na2O+CaO) berkisar antara 0,07-0,55 (sedang) yang membentuk alkali normatif feldspar berkisar 3,84 – 15,89% (berat). Perbandingan tersebut menunjukan batuan Granit alkali feldspar yang tergolong dalam seri batuan kalk-alkali. Secara petrografi, batuan tersebut menunjukkan tekstur porfiritik, holokristalin, hipidiomorfik granular dengan biotit hadir sebagai fenokris, coklat kekuningan, euhedral, pipih dan sedikit berlembar.

Kandungan unsur oksida (Na_2O dan MgO) cenderung mengalami penurunan, sedangkan unsur oksida lainnya, yaitu Al_2O_3, TiO_2, K_2O, FeO dan CaO mengalami kenaikan sejalan dengan makin bertambahnya SiO_2. Maka dengan demikian Granitoid Singkawang dapat dikelompokan menjadi granit alkali feldspar, syenit-granit dan kuarsa-monsonit.

Kata kunci: *Petrografi, geokimia, senyawa utama, afinitas kalk-alkalin, batuan granitoid dan Pantai Bajau, Kalimantan Barat.*

INTRODUCTION

The study area is located at the western part of West Kalimantan; bordered with Bengkayang at eastern side, to the west and north part is facing with Natuna Sea, while to the south is bordered by Mempawah District. Administratively, whithin City and District of Singkawang, West Kalimantan Province, which coordinates 108 48'30" - 109 1'30" E and 0 40'30" - 0 54'30" N, and is situated ± 145 km towards north of Pontianak (Figure 1).

This study was conducted to determine the characteristics of petrology based on geochemical analysis, including affinities composition.

Singkawang granitoid consists of alkali feldspar granite and granodiorite with silica content showed moderate range and were strong peraluminous (Harahap, 1993). This is a typical granitoid VAG (Volcanic Arc Granite) with affinity granodiorite magma, that is dominated by medium-K and high-K (Carlile, et al., 1994). Hutchinson (1996), described the regional geology in the northern part of Borneo (Malaysia and Brunei) and he divided three major tectonic zones, from NW to SE, respectively are: Miri, Siburajang and Kuching Zone. In the Central Kalimantan Magmatic Arc, dated Eocene igneous rocks as thin arc (width approximately 50 km) found in all sections (Singkawang to Dent Peninsula) and are dominated by acid volcanics. They consist of the Piyabung, Nyaan, Serantak and Muller Volcanics, and there affinities are low-K (tholeeitic) to medium-K (calc-alkaline). Soeria-Atmadja et al. (1999) and Priadi (2010) concluded that they were as products of (new) southward subduction in the NW of Kalimantan.

According to Suwarna and Langford (1993) the regional stratigraphy of the study area is composed by several rock units are (Figure 2):

- ***Raya Volcanic Rock*** (Klr) many steep hills form and islands with steep cliffs off the coast (Cretaceous).
- ***Mensibau Granodiorite*** (Klm) is widely established Singkawang batholiths, which tends to be the northwestern part of the peninsula, separated from widely Schwaner batholiths and generally underlies southwestern Borneo.
- ***Sintang Intrusion Rocks*** (Toms), which emerged as stocks and sub-volcanic plugs. All igneous rocks are overlain Alluvium deposits.
- Quaternary Sediments consists of alluvium Terbiku (Qat), floodplain alluvium and swamp (Qa), and littoral Recent sediment (Qc).

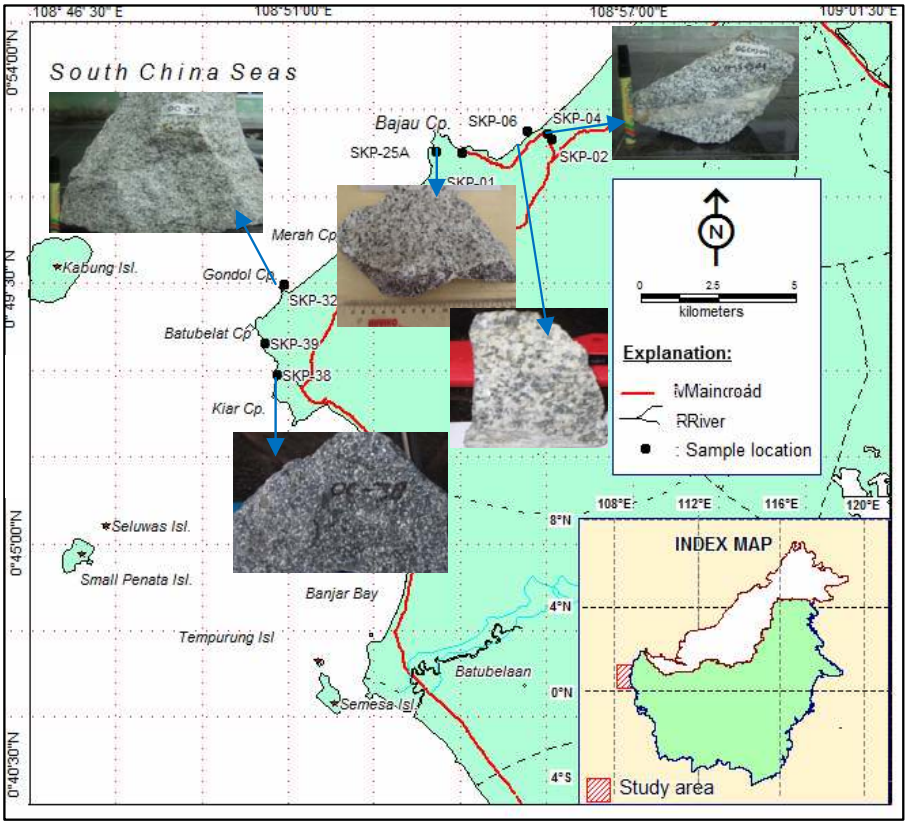


Figure 1. Study area and sample location map

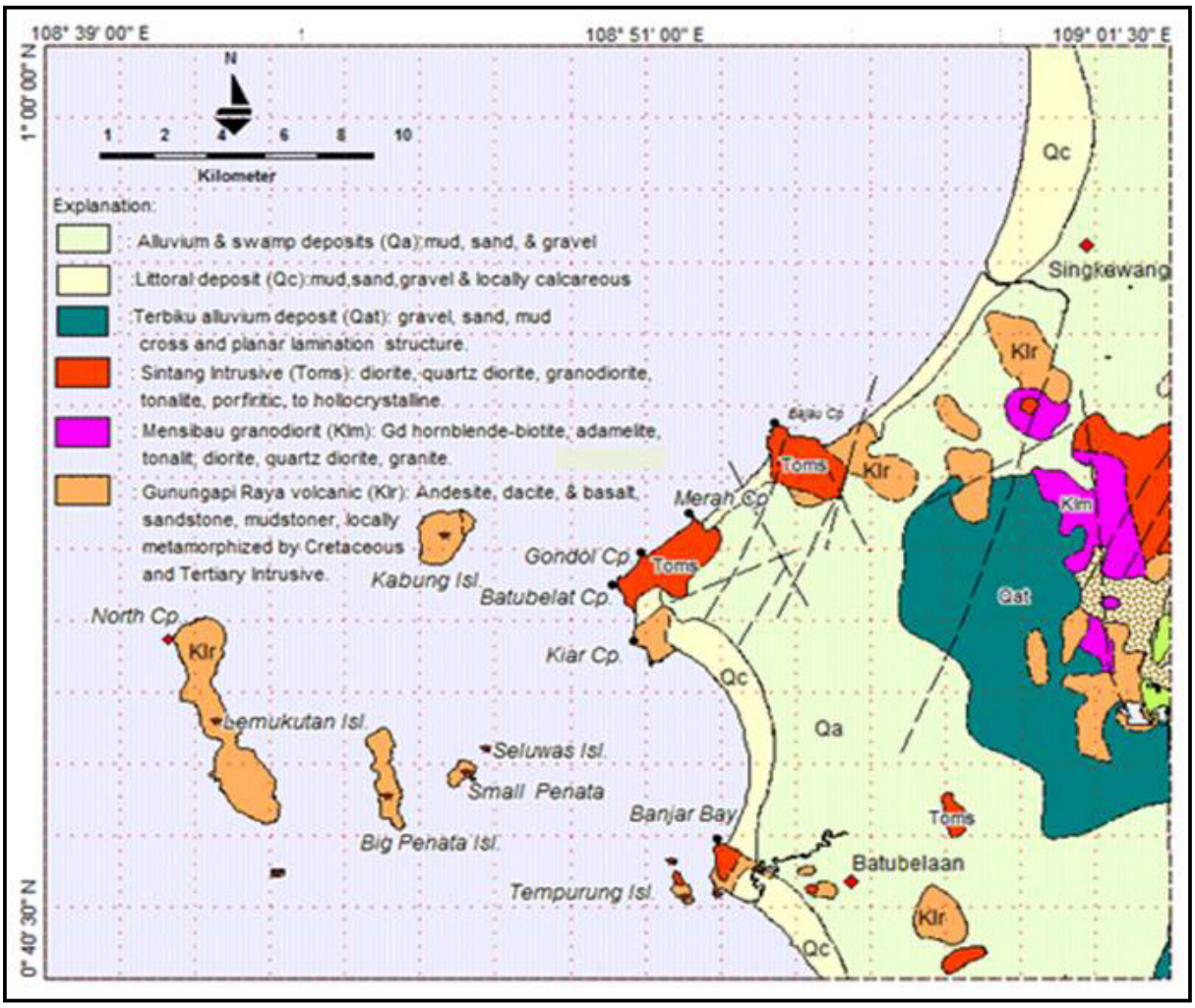


Figure 2. Study area geology map

METHODS

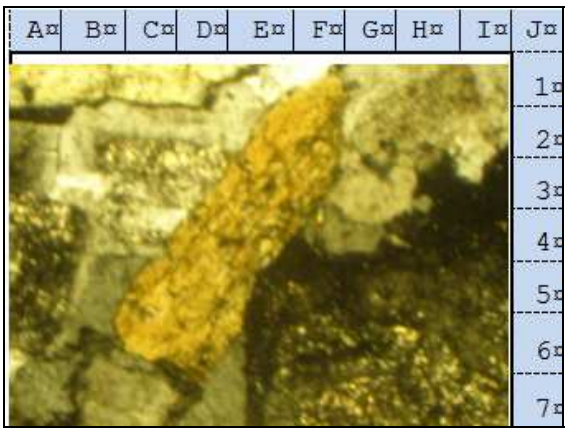
Eight rock samples were selected for major element analysis using Atomic Absorption Spectroscopy (AAS) taken to the dry ingredients with a temperature between 105 C - 110 C at Quaternary Geological Laboratory, Center of Geological Survey. Petrographic analysis was done from thin section five rock samples that were considered to represent the study area. This analysis used polarizing microscope Nikon Eclipse LV 100 at the petrography laboratory Marine Geology Institute.

Classification of the plutonic rocks using Alkali Feldspar Quartz and Plagioclase (AQP) classification (Streckeisen, 1979).

RESULTS

Based on the observation of thin section petrographic analysis, plutonic rocks in the study site is generally characterized as porphyritic, granular hollocrystaline and hypodiomorphic. Sample of SKP-06 is taken in the east Bajau Cape, dominated by plagioclase and K-Feldspar. Quartz is present as anhedral grains with a size of 0.5 to 1.25 mm, was partly inclusion by opaque minerals. Biotite is present as phenocrysts with a bird's eye texture, yellowish brown, euhedral, slightly lamellar with a high pleochroism. Secondary minerals (sericite), blackish brown, presence among plagioclase (Figure 3). Meanwhile, microscopic observation of plutonic rocks of SKP-32 which was taken from Gondol Cape, is characterized by porphyritic texture, hollocrystalline, hypidiomorphic granular. Mineral composition of this rock consists of quartz (granular and anhedral), K-feldspar, plagioclase, pyroxene (mostly in inclusion by opaque minerals), hornblende and opaque minerals (Figure 4). Referring to the diagram AQP (Figure 5), SKP-06 and SKP-04 are the alkali feldspar granite which is characterized by presenting of orthoclase, sanidine and microcline; SKP-

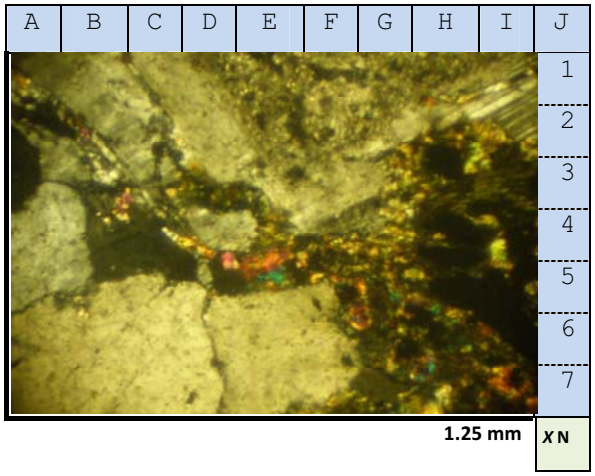
(A)



(B)

Figure 3. (A) Granite handspecimen SKP-06; (B) thin section SKP-06, plagioclase, prismatic, subhedral-euhedral (5B, 7C and 4G); serisite – blackish brown, presence among plagioclase (6B and 7D)

(A)



(B)

Figure 4. (A) Granit handspecimen SKP-32; (B) thin section (cross nikol), plagioclase, prismatic, subhedral-euhedral and zoning (1I, 1H and 2I); hornblende, prismatic, pale green, moderate pleochroism and rim opaque structure (4D).

32 and SKP-38 are syeno-granites while SKP-01 and SKP-25A are quartz monzonite. The geochemical analysis results of major elements and CIPW normative calculation of 8 selected samples at the study area, are presented in Table 1.

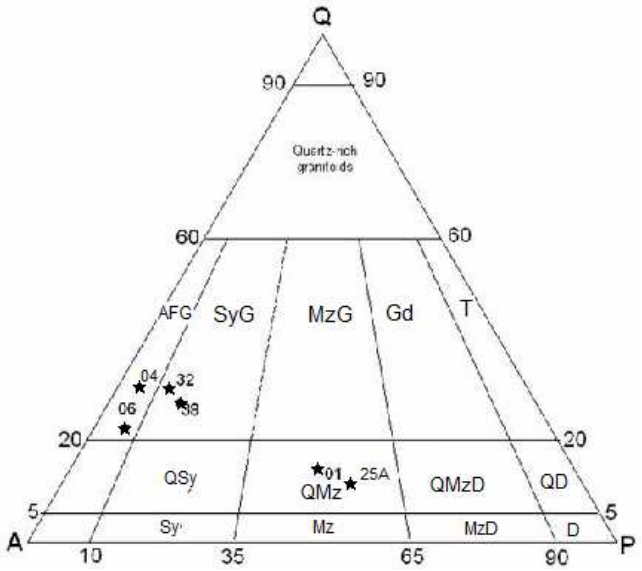
From Table 1, show that the 5 of 8 samples are relatively still fresh or not altered (refers to LOI content <1%). The content of SiO_2 has moderate range, between 60.95% and 69.55 wt% (strong peraluminous) represented by 5 samples, namely SKP-01, 04, 25A, 38 and 39. Those samples have mole ratio of Al_2O_3 / ($CaO+Na_2O+K_2O$) > 1, which ranged between 1.12 and 1.7 with average of 1.3 (calculated from samples above).

While the other samples (SKP-02, 06 and 32) are moderately aluminous, with a ratio value of 0.88; 0.87 and 0.61 (between 0.5 and 1.0). Ratio K_2O / (Na_2O + K_2O + CaO) is moderate, ranges from 0.07 to 0.55 with a 0.26 average, while the raises normative of feldspar alkaline between 3.84 and 15.89 wt% as a feldspar alkaline granite. Major element oxides Al_2O_3, TiO_2, K_2O, MnO and CaO increased (Figure 6), whereas the other element oxides (Na_2O, Fe_2O_3 and MgO) decreased in line with the increasing of SiO_2 as shown in the Diagram of Harker (Figure 7).

Based on AQP diagram (normative alkali feldspar-quartz-plagioclase), granitoid at the study area are classified as the regime syeno-granite, feldspar-alkaline granite and quartz monzonite. Furthermore, based on classification of Peccerillo and Taylor (1976) are grouped in Calc-alkaline rock series. Later, it was modified by Rickwood (1989) and Le Maitre (2002) as shown in the K_2O vs. SiO_2 diagram (Figure 8).

DISCUSSION

Based on normative orthoclase-plagioclase-quartz rocks, granitoids at the study area belong to the calc-alkaline series where the magnetite-rich gabbro fractionation can produce a calc-alkaline rocks series (Kuno, 1968). According to Cawthorn and O'Hara



AFG: Alkali Feldspar Granite
SyG : Syeno-granite
MzG : Monzo-granite
Gd : Granodiorite
T : Tonalie
QSy : Quartz-syenite
QMz : Quartz-monzonite
QMzD: Quartz-monzodiorite
QD : Quartz-diorite

Figure 5. Granitoid types on AQP diagram

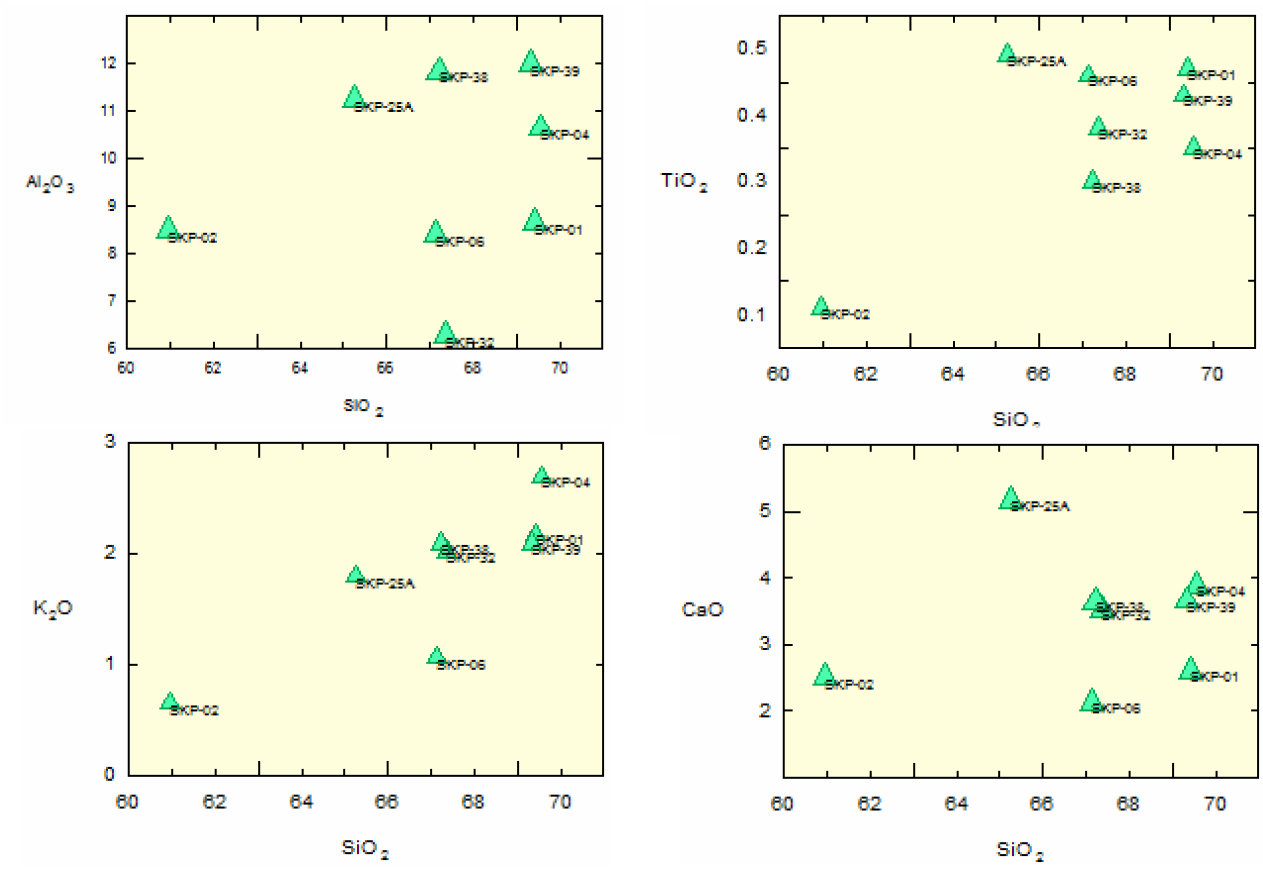


Figure 6: Major oxide increases in line with increasing SiO_2

Table 1. Major elements oxides and CIPW normative

	SKP-02	SKP-25A	SKP-06	SKP-38	SKP-32	SKP-39	SKP-01	SKP-04
SiO_2	60.95	65.26	67.12	67.21	67.37	69.34	69.42	69.55
Al_2O_3	8.48	11.22	8.39	11.83	6.27	11.97	8.64	10.63
Fe_2O_3	14.01	8.11	5.92	4.67	5.6	6.38	8.04	5.73
CaO	2.5	5.16	2.12	3.64	3.52	3.65	2.6	3.88
MgO	2.47	2.37	3.4	1.88	1.59	2.02	0.84	2.09
K_2O	0.65	1.79	1.06	2.09	2.02	2.09	2.17	2.69
Na_2O	6.5	3.1	6.47	4.28	4.76	1.26	1.55	2.85
MnO	0.006	0.1	0.01	0.1	0.002	0.05	0.002	0.1
FeO	1.04	1.46	0.82	1.72	2.51	2.86	1.85	1.64
P_2O_5	0.004	0.13	0.003	0.07	0.056	0.43	0.002	0.032
TiO_2	0.11	0.49	0.46	0.3	0.38	0.43	0.47	0.35
H_2O	2.11	0.82	2.3	2.63	2.12	0.15	2.19	0.45
LOI	0.01	1.32	0.77	0.62	0.23	1.86	0.13	1.14
Norm CIPW	Weight percentage (wt%)							
Q	18.35	29.26	22.91	26.79	30.62	44.22	47.98	33.84
Ab	41.38	37.98	38.88	44.1	22.29	25.78	24.4	32.53
Or	3.96	10.64	6.56	12.65	12.71	12.29	13.41	15.96
Cor	-	-	-	-	-	2.03	-	-
Di	9.96	10.47	8.57	8.53	15.03	-	2.18	8.42
Hy	1.73	1.1	5.16	0.83	1	5.01	1.18	1.33
Acm	13.64	-	16.14	-	17.21	-	-	-
Il	0.21	0.93	0.91	0.59	0.76	0.82	0.93	0.66
Mag	3.19	3.64	0.87	5.1	-	8.1	4,83	4.63
He	7.57	5.67	-	1.26	-	0.76	5.08	2.57
Ap	-	0.3	-	0.16	0.14	1	-	0.07

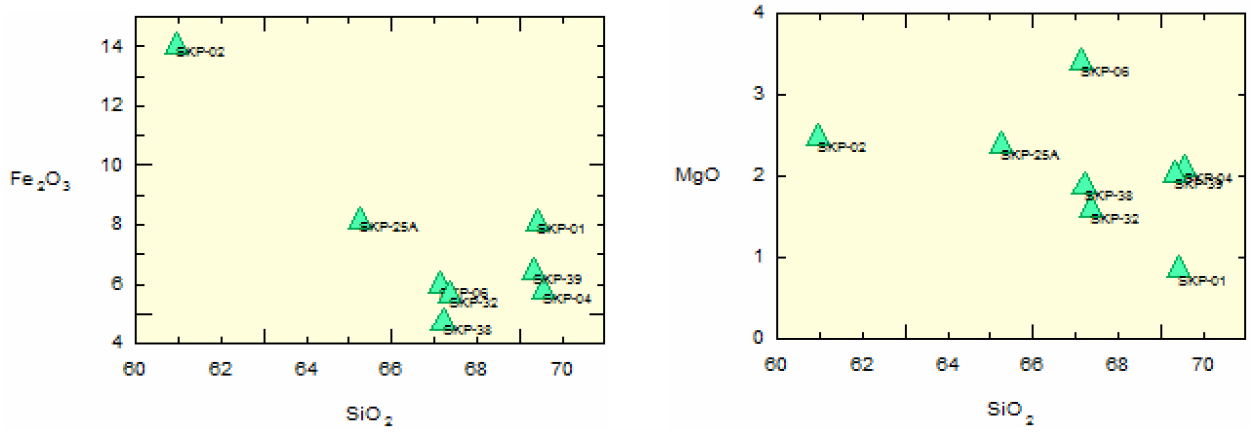


Figure 7: Major oxide element decreases in line with increasing SiO2

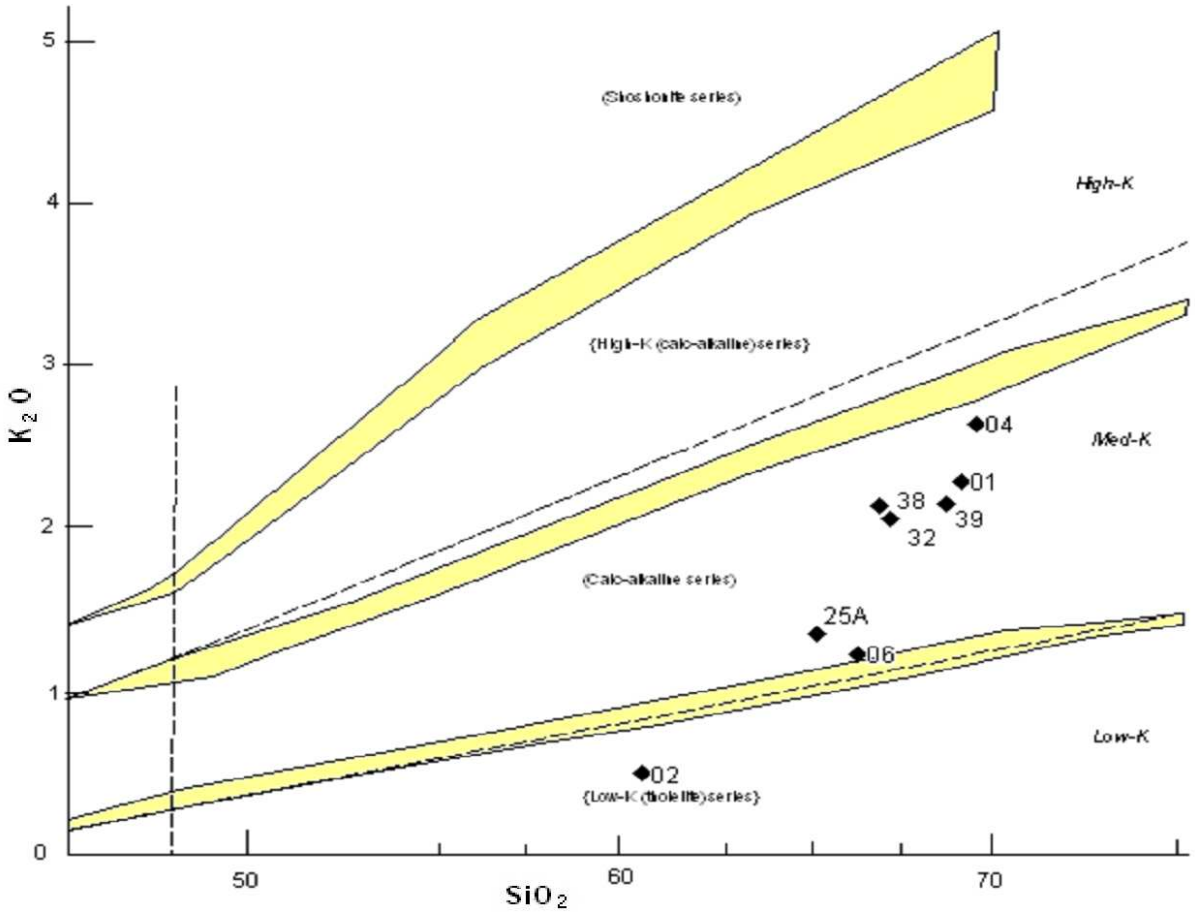


Figure 8: K2O vs. SiO2 Diagram (Peccerillo dan Taylor, 1976) Le Maitre modified, (2002) – italic; and Rickwood (1989) – in brackets ( ).

(1976), the varies composition of amphibole crystallization can explain about the formation models of calc-alkaline rocks with varying chemical composition. Most of the granitoid samples from the study area show the presence of normative diopside and hyperstene. This can be understood by the presence of pyroxene based on petrographic observations. The occurrences of normative quartz and hyperstene show that granitoid at the study area are very saturated silica (oversaturated). The emergence of normative corundum is around 2.03 wt% (and only appears in one location), marking the absence of aluminous silicate minerals such as garnet and cordierite.

Although it is common or most of the granitoid rocks in the study area calc-alkaline affinity areas however there is one (SKP-02) rock areas tholeiitik affinity, this would need to be geologic explanation, but it was previously necessary to re-check the different rocks, both with more careful petrographic observations or by using other discrimination models, suppose based on trace elements.

CONCLUSIONS

Granitoid rocks at the coast of Bajau Cape and surrounding area are the regime syneo-granite, feldspar-alkaline granite and quartz monzonite that classified in Calc-alkaline rock series or particularly in Medium-K. The content of SiO_2 show moderate range, between 60.95% - 69.55 wt% (strong peraluminous). Quartz is present as anhedral grains with a size of 0.5 to 1.25 mm that is partly inclusion by opaque minerals. Biotite is present as phenocrysts with a bird's eye texture, yellowish brown, euhedral, slightly lamellar with a high pleochroism.

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