Regional tectonic and geochemical approach to distinguish bauxite characteristics in Pahang, Malaysia and West Kalimantan, Indonesia

R D Nugraheni1*, D Sunjaya2, and S Agustini2

1 Geological Engineering Study Program, Faculty of Earth Technology and Energy, Universitas Trisakti, Jl. Kyai Tapa no.1, Grogol, Jakarta Barat, Indonesia
2 PT Aneka Tambang Tbk, Unit Geomin, Jl. Letjen T.B. Simatupang no.1, Lingkar Selatan, Tanjung Barat, Jakarta Selatan

*corresponding author: rosmalia.dn@trisakti.ac.id

Abstract. Indonesia and Malaysia are neighboring countries that situated in a tropical area and suitable for weathering, particularly favorable for lateritic deposit. One of laterite deposit is bauxite, where bauxite was formed as a chemical weathering product of metaluminous to peraluminous igneous rocks. The study area is located in the Kuantan area, Pahang State, Malaysia and West Kalimantan Province, Indonesia, which has contrasting tectonic origin and serve a different parent rock of bauxite. This study aims to distinguish the geochemical characteristics of bauxite in West Kalimantan against bauxite in Pahang Province. Method used in this study consists of pitting examination, where samples were collected from surface to maximum 10 m intervals and vertically logged. Samples were analyzed petrographically, XRD and XRF in order to observe the mineralogical composition and chemical compound. Result shows that magmatism in Pahang is dominated by basalt with oxide concentration of Al2O3, Fe2O3, SiO2 and TiO2 respectively ranges from 43.96 - 51.01%, 16.59 - 18.97%, 2.17 – 9.01% and 2.83 - 2.91%. In Indonesia, the parent rock of andesite and diorite (Al2O3 = 48.11 – 53.49%; Fe2O3 = 6.15 – 17.25%) shows higher amount of Al2O3 than that in granodiorit (Al2O3 = 30.10 – 48.68%). It can be inferred that andesite and diorite as bauxite’s parent rock found in Kalimantan Barat generates abundant gibbsite and higher proportion of Al2O3 with lesser goethite and hematite (Fe2O3) relative to basalt as bauxite’s parent rock in Pahang.

1. Introduction
The term of bauxite is used for a weathering product of any type of rock that contains alumina. Bauxite ore is defined as an economically mineable bauxites that contain ≥ 40 – 50% Al2O3, ≤ 20% Fe2O3 and 3-5% TSiO2 [1]. The neighboring country of Indonesia and Malaysia was also known as one of bauxite producer in the world, particularly for lateritic bauxites. Both are situated in tropical climatic belts with intense alternating of dry and wet to play contibutes to the bauxitisation process. However, between East Malaysia Peninsular and West Kalimantan in Indonesia are tectonically different. Eastern Malaysia Peninsular belongs to terranes derived from Gondwanaland that separated in the late Devonian while West Kalimantan, Indonesia, belongs to terranes derived from South China / Indochina in the Cretaceous - Tertiary [2]. The different tectonic setting will automatically produce different magmatism, affinity and alumina saturation as well. In Kuantan area, Pahang Province, Malaysia, the parent rock of bauxite is dominated by mafic igneous rocks, in contrast with the parent rock of bauxite in Mempawah and Landak areas, West Kalimantan, Indonesia, where felsic to intermediate plutonic and volcanic rocks existed.
Looking at the history of bauxite exploration, in 2014, Indonesian government imposed a regulation to ban on export of unprocessed bauxite ore and force the industry to build smelter. The regulation was then renewed in January 2017 where the Ministry of Energy and Mineral Resources allow the export of bauxite. This condition boosts the exploration and mining activities that already started in 1924. Initially, the first discovery of bauxite is located in Kijang, Bintan Island, Riau Province [3] and was exported to China and Japan since 1935. Bauxite mine of Kijang was then closed in 2009 and moved to West Kalimantan, Indonesia. In Malaysia, bauxite exploration and mining activities also confront a complicated situation. In 2015, the Mineral Ore Licenses (MOL) of 34 bauxite contractors were revoked by Malaysian government due to over rising of air and water pollution from mining activity. Only about 11 operators with legal MOL remained.

That situation has driven a challenge to still explore and mine bauxite with a proper method. Better understanding in bauxite exploration and production is needed to minimize the bad effects. To produce a high proportion of alumina from a vertical profile of bauxite laterite need an understanding of the genesis of bauxite. Bauxite genesis is closely related to their parent rocks, bauxite formation and geological to environmental variables relevant to its genesis. Only few studies concerns on the geochemistry of bauxite as well as its relationship with parent rocks. This paper will discuss about the influence of tectonic setting against igneous rock types that will present as a parent rock of bauxite as well as the aluminous proportion against other major components (i.e. Fe₂O₃ and TiO₂).

2. Methodology

2.1. Material and method
The research applies a combination method of field investigation and laboratory analysis (consisting of petrography, X-ray Diffraction and X-ray Fluorescence). Field investigation consists of regional mapping, pitting (Figure 1a), test pit description and bauxite sampling (Figure 1c). This method was conducted to observe the distribution of bauxite laterite and also the vertical weathering profiles pertains to describe of its texture and colour changes. Based on the depth of bauxite profile and test pit points (50 m spacing), pitting is carried out with dimension of width from 10 to 12 cm (N-S direction), length from 60 – 80 cm (W-E direction) and depth of 10 m. Sample was taken from the channel wall of pit, starting from the bottom to top (respectively from fresh rock–clay–ore zone–top soil) in order to avoid any contamination. Channel sampling was carried out according to the length and width size of 10 cm and height of 20 cm (Figure 1b).

![Figure 1](image1.png)

**Figure 1.** Continuous procedure of pitting (a), channel sampling (b) and description (c)

![Figure 2](image2.png)

**Figure 2.** The vertical profile of weathered rock shows the overburden, bauxite (ore) and saprolith zones. Pit of bauxite in Mempawah area, West Kalimantan.
About 66 samples were taken from Jabor and Bukit Goh areas, Kuantan – Pahang, Malaysia and 65 samples from Landak and Mempawah areas, West Kalimantan, Indonesia. Samples taken from pit are weighed, washed with distilled water while sieved on 1 to 12 mesh till clean, dried in open air a day, splitting until ready to be sent to laboratory for analysis. Petrography analysis is carried out to observe and identify the fresh or weathered rock texture, composition and their rock name. XRF analysis is used to identify oxide (i.e. Al₂O₃, Fe₂O₃, TiO₂, R-SiO₂, T-SiO₂). XRD analysis is applied to gain information about specific clay types and other minerals.

2.2. Location and Access
The study area lies in Bukit Goh, Jabor Valley and part of Mukim Sungai Karang, Kuantan area, in the border states of Pahang and Terengganu, Peninsular Malaysia as well as in Landak and Mempawah areas, West Kalimantan, Indonesia. Location to Bukit Goh and Jabor Valley is accessible via highway to Kuala Terengganu, new Kuantan bypass and relatively not far from Kuantan bypass. Location to Landak and Mempawah areas are accessible via highway from Pontianak to Landak and Mempawah (about 3 – 4 hours drive).

3. Geological Setting

3.1. Morphology
Morphology condition in the study area of West Kalimantan, Indonesia is divided to 3 main parts: 1) Steep-sloping hills, 2) Undulating hills and 3) Lowland area. Steep hill morphology occupies the altitude of >140m above sea level with slope of >40%. Undulating hill morphology has altitude between 25m – 140 m above sea level, with slope of 15% – 40%. This morphology becomes the largest part of the study area and has major concentration of bauxite deposit. Most of lowland morphology occupies the area around river, swamps and valley, with altitude of 10m – 25m and slope of <15%. Morphology in Kuantan area is nearly similar to West Kalimantan, where the study area is flat to undulating. Kuantan area is also associated with swamps and commonly lowland (15 m).

3.2. Structural Geology of Study Area

Figure 3. A schematic model illustrates the tectonic history of western, central and eastern belt of Peninsula Malaysia [4].

Figure 4. The origin of continental blocks, terranes and sutures of Southeast Asia [2]
The study area in Kuantan area, Pahang Province, Malaysia is situated in the eastern belt as bordered to the west by Bentong- Raub Suture Zone (Figure 4). The Western belt terranes is derived from the separation of Gondwanaland in the late early permian, while the Eastern belt derived from the separation of Gondwanaland in the Devonian (Figure 4). The continental fragments as produced by separation of Gondwanaland have opened the Palaeo-Tethys but then was eliminated by subduction. During the Permo-Triassic stages of suturing, the subduction is preceding collision and followed by post-collisional thickening of the continental crust and accretion events [4] (Figure 3).

The microplate origin of Kalimantan is still controversial. Metcalfe (2006) as cited in Figure 4 interpreted that SW Kalimantan (Borneo) was derived from South China/ Indochina in the Cretaceous - Tertiary, meanwhile, Hall (2012) has another interpretation that Kalimantan was derived from Australia origin in the Late Jurassic.

3.3. Geology of Study Area
In West Kalimantan, Indonesia, the oldest rock formation is Jura to Triassic Serian Volcanics that belong to Gunungapi Raya Formation (Figure 6). They consist of altered andesite, dasite, basalt, which are rich of chlorite and epidote added with thin conglomerate intercalation, sandstone and mudstone. Those rocks were intruded by Mensibau Granodiorite Formation (Early Cretaceous). The Mensibau Granodiorite was known as Singkawang batholith and demonstrates I-type affinity. This formation is unconformably overlaid by Hamisan Formation in Oligocene and comprised of Quartz arenite and Conglomerate. The youngest alluvial and swamp deposits (mud, loose pebble and organic remnant) occupy the top surface and was deposited in Pliocene.

Granitoids of Eastern belt Peninsula Malaysia are dominated by I-type and extends over a wide ranges from Permian – Triassic and Upper Cretaceous [6]. These granitoids occupy the north and
northwest of the study area in Kuantan and comprising grey porphyritic and non-porphyritic granite (Figure 5). The younger volcanic series comprises of the basalt flows and the dolerite dykes (Figure 5). They occupy the southern area of Jabor and Bukit Goh. According to K-Ar radiometric dating, basalt samples gave an age of Quaternary (Pleistocene), while the dolerite shows an Early Cretaceous age [7].

4. Results
There are many external factors controlled the genesis of bauxite, such as parent rocks, tectonic position, geomorphology, climate, vegetation cover and hydrogeologic condition. The following paragraphs will discuss the relation of external factors toward bauxite genesis and its mineralogical content.

4.1. Topography
Topography of the study area is characterized by lowland marsh bounded by undulating hills. In Landak and Mempawah areas, West Kalimantan, slope varies from 30° to 40°. Most of exposed of source rocks are located in a gentle-sloping hill, with slope of less than 25°. Those exposed source rocks consist of diorite, granodiorite, quartz diorite and andesite. Meanwhile, the altitude in Kuantan reaches 30 – 60 m with highest point of basalt outcrop at Bukit Tinggi is about 136 m. The altitude was decreased towards south (below 15 m in height). The coverage area of low land and swamp areas in Kuantan is about 40%. The low relief and swamps occupy about 40% of the northeast study area. The relatively low relief can assure low erosion rates, good drainage condition and protect the bauxite from mass movement.

4.2. Climate
East Malaysia Peninsular and West Kalimantan, Indonesia are having a tropical climate (annual temperature is 24-33°C) and sufficient amount of rainfall (amount of rainfall is up to 200mm) that distributed over 4 - 8 rain and 4 – 6 dry months, thus, the chemical weathering will increase and support for the occurrence of bauxitisation.

4.3. Vegetation
Some vegetation covers the undulating hills of Landak and Mempawah areas, such as eaglewood tree, timber tree, rattan, etc. Surrounding lowland swamp is occupied by paddy field, rubber, cocoa and fruit plants. Abundant oil palms and rubber were cultivated in a large part of Jabor, Kemaman district, Terengganu and Bukit Goh, Kuantan, Pahang (Figure 7). All of those vegetation are essentially protect the weathered materials against erosion, settle the limit of water evaporation, provide soluble organic compounds and increase the rain-water percolation [8].

4.4. Weathering Profile
Bauxite zone found in the study area is characterized by its concretion which is embedded within soft sandy clay matrix. The average size of concretion varies from 1 cm to 10 cm, however, greater size found in Landak and Mempawah area, which is up to 70 cm. Other characteristics of concretions are
spherical and elongate in shape, relatively hard and reddish to brown in color (Figure 8). In most location, the thickness of bauxite is approximately 3 m, with total depth of profile is up to 10 m. The distribution of concretion increased to the middle of weathering profile and decreased to the top and bottom part.

Figure 8. The weathering profile of basaltic rock shows the greater size of concretion accumulated in the middle zone of profile. The middle and right bottom photos are showing washed bauxite ore samples of Kuantan, Pahang State, Malaysia

4.5. Mineralogy and Geochemistry
Petrography analysis of the concretion and parent rocks shows that some resistant minerals are present, such as quartz (varies from 2-30%), magnetite with lesser to trace of ilmenite (tr to 1% from Hornblende Diorite, Mempawah) and sphene (found from tonalite and basalt parent rocks, respectively found in West Kalimantan and Kuantan, Pahang). Some oxide and hydroxide minerals are also observed according to petrography and XRD analyses, such as gibbsite, goethite, hematite and kaolinite. Most of the concretion is porous with pore size ranges from 1 to 3 mm. Goethite and hematite are typical of Fe-oxide which is shown by yellowish to reddish-brown color.

The major components of bauxite in Jabor and Bukit Goh areas have alumina content ranging from 24 – 51.01% with higher iron content (Fe₂O₃ value ranges from 16.59 – 27%) (Table 1). Total silica value is generally low (TSiO₂ varies from 2.17 – 24%). Another type of silica, named as reactive silica content (RSiO₂ varies from 10 – 20%) is present in the Kemaman – Terengganu. RSiO₂ is a typical of silicate in kaolinite mineral which tends to reactive during the refinery process [1]. TiO₂ content varies from 2.83 – 5%.

| Sample Code | SiO₂ (%) | Al₂O₃ (%) | Fe₂O₃ (%) | TiO₂ (%) | CaO (%) | K₂O (%) | Na₂O (%) | RSiO₂ (%) |
|-------------|----------|-----------|-----------|----------|---------|---------|---------|----------|
| RA II       | 2.50     | 49.82     | 16.59     | 2.91     | 0.01    | 0.02    | 0.08    | 1.88     |
| SKR TP      | 9.01     | 43.96     | 18.97     | 2.83     | -       | 0.01    | 0.09    | 8.41     |
| JABOR       | 2.17     | 51.01     | 17.96     | 2.89     | -       | <0.01   | 0.07    | 1.7      |
| TP 30       | 0.75     | 42.68     | 24.24     | 4.65     | -       | -       | -       |         |
| TP 29       | 2.18     | 44.91     | 23.68     | 3.58     | -       | -       | -       |         |
| RA I        | 3.42     | 41.50     | 16.14     | 3.42     | 0.01    | 0.01    | -       | -        |

Well exposed granitoids are widely distributed in Landak and Mempawah areas, West Kalimantan, Indonesia. Petrography analysis supported by field observation shows that the parent rocks consisted of Monzo-granite, Syeno-granite, Quartz syenite, Granodiorite, Diorite and Quartz monzonite that belong to Mensibau Granodiorite Formation and andesite that belongs to Gunungapi Raya Formation. According to petrography and XRD analyses, common mineral composition comprises of kaolinite, hematite, limonite, sfin, magnetite, gibbsite, anatase, ilmenite etc as summarized in Table 2 and shown in Figure 9-13). Gibbsite is known as one of alumina minerals comes from plagioclase and/or kaolinite that undergo dissolution or precipitates from circulating Al-rich solutions [8].
Table 2. The result of XRD analysis of bauxite ore from The Mempawah and Landak Granitoids origin, West Kalimantan, Indonesia

| Sample Code | Mineral Composition | %  | Parent Rock types | Notes                |
|-------------|---------------------|----|-------------------|----------------------|
| **Mempawah** |                     |    |                    |                      |
| MPW 01      | Gibbsite            | 21.78 | Diorite          | Slightly weathered |
|             | Goethite            | 75.22 |                |                      |
| MPW 02      | Gibbsite            | 45.02 | Monzo granite    | Fully weathered     |
|             | Quartz              | 29.44 |                |                      |
|             | Goethite            | 11.02 |                |                      |
|             | Kaolinite           | 3.42  |                |                      |
|             | Hematite            | 11.1  |                |                      |
| **Landak**  |                     |    |                    |                      |
| LDK 01-3    | Quartz              | 24.8  | Syeno granite    | Fully weathered     |
|             | Gibbsite            | 65.46 |                |                      |
|             | Geothite            | 0.52  |                |                      |
|             | Kaolinite           | 8.5   |                |                      |
|             | Anatase             | 0.73  |                |                      |
| LDK 01-4    | Quartz              | 34.1  | Monzo granite   |                      |
|             | Gibbsite            | 48.78 |                |                      |
|             | Clinohlore          | 17.12 |                |                      |
| LDK 02      | Quartz              | 16.89 | Quartz syenite  | Fully weathered     |
|             | Gibbsite            | 72.96 |                |                      |
|             | Goethite            | 4.73  |                |                      |
|             | Kaolinite           | 5.42  |                |                      |
| **BEI 01**  | Quartz              | 46.11 | Granodiorite    | Fully weathered     |
|             | Gibbsite            | 21.94 |                |                      |
|             | Kaolinite           | 15.66 |                |                      |
|             | Muscovite           | 1.01  |                |                      |
|             | Anatase             | 1.44  |                |                      |
|             | Illite              | 13.84 |                |                      |

**Figure 9.** Hand specimen sample of bauxite concretion shows yellowish to reddish brown in color

**Figure 10.** Secondary mineral of zeolite (Zeo) as produced by volcanic glass alteration

**Figure 11.** Cross nicol microphotograph of bauxite view shows the present of clay mineral
As compared with bauxite derived from granite in Kuantan area, most of felsic igneous rocks (Monzo-granite, Syeno-granite, Quartz syenite, Granodiorite, Diorite and Quartz monzonite) contain Al$_2$O$_3$ (30.10 – 48.68%) and vary in Fe$_2$O$_3$ (5.24 – 16.05%) while intermediate rocks (andesite and diorite) contain Al$_2$O$_3$ (48.11 – 53.49%) with moderate proportion of Fe$_2$O$_3$ (6.15 – 17.25%) and SiO$_2$ (2 - 19.42%).

5. Discussion

5.1. Bauxite Occurrence in Relation with Its Parent Rock

The vertical bauxite profile in Kuantan areas, Malaysia is easily observed through pitting, road cuts and quarries, where granite and basalt present as the most common decomposed parent rocks. However, an intensive lateritic which produced bauxite and topsoil is subjected to basalt rather than granite. The chemical data is also support this interpretation, where most of concretion samples taken from granite of Kemaman – Terengganu show lower Al$_2$O$_3$ which varies from 10 to 20% and higher silica percentage (in the form of FSiO$_2$ and/ or RSiO$_2$). However, most of concretion derived from basalt parent rock contains higher percentage of Al$_2$O$_3$ (43.96 – 51.01%), lower SiO$_2$ (2.17 – 9.01%) and moderate proportion of Fe$_2$O$_3$ (16.59 – 18.97%). Therefore, bauxite derived from basalt was named as ferruginous bauxite. Granitoids in West Kalimantan, Indonesia mostly have higher percentage of alumina (Al$_2$O$_3$) as compared with granite in Kemaman- Terengganu, Malaysia. Both of granitoids are largely of I-type but probably have different saturation of alumina as controlled by tectonic origin. The low proportion of Al$_2$O$_3$ of some granite in the north Kuantan is suspected caused by poorly exposed or slightly buried condition, hence protected from erosion, compacted and chemically changed from load pressure.

In West Kalimantan, Indonesia, laterite belt elongates NW-SE from Ketapang, Sanggau, Landak, Kubu Raya, Pontianak, Bengkayang to Singkawang. According to some investigation in peninsular Malaysia, the region prone for bauxite is locally located in Jabor – Terengganu Province, Bukit Goh- Kuantan area, Pahang Province and Johor Province. Local existence of bauxite in Malaysia is probably caused by deeply burried igneous rocks beneath the subsurface or thicker overlying sediments above the plutons and or sub-volcanic rocks. The episodes of Permian- Triassic magmatism in Eastern Province (consist of Central and Eastern belt of Figure 3) were produced from different magma sources. On the contrary, the parent rocks of bauxite in West Kalimantan, Indonesia are well exposed in correspond with the direction of faults (Sinistral strike- slip fault). Those rocks (predominantly granitoid) present as a multi stages of intrusive rocks of Permian to Quaternary that also intruded the basement of Mesozoic sedimentary and metamorphic rocks.

The existence of lateritic bauxite in the study area is mainly controlled by lithology, morphology and structural geology [1]. Most of lateritic bauxite in the study area derived from the chemical weathering product of igneous rocks. Lithology play roles in producing different color of laterite, such as yellowish color for granodiorite and tonalite, reddish yellow for quartz diorite, reddish for diorite.
and reddish to brownish for basalt. Light to pale color indicates that bauxite rich of SiO₂ while darker color of red or brown indicates rich of Fe₂O₃. Quartz (SiO₂) is known as the most stable mineral, meanwhile mafic and or minerals formed under high pressure and temperature are less stable and easily weathered near surface condition. The chemical bond of unstable minerals is weak (have ionic to Van der Waals bonds). During chemical weathering, the chemical bond of unstable minerals will be destroyed and leave the elements later on. Some soluble elements (such as Na, Ca, K, Mn and Fe) will have higher mobility than the elements of hydrolysates (Al, Si, Fe, Ti, Zr, Th, etc). At the time of water percolation, Al elements will be remained and concentrated in the bauxite zone or relatively increase from saprolith to bauxite zone and decrease to the top soil. Ti element which composes TiO₂, their trend from bottom to top will continuously decrease, while Si and Fe are relatively decrease but can be varied near top soil.

The bauxite thickness is mainly influenced by morphology and structural geology, where gentle- sloping produces thicker bauxite zone rather than the steep one. Furthermore, the structures (i.e. fault and joints) are having a role as an infiltration path for groundwater during bauxitisation. As the most important factor for bauxite formation, permeability of parent rocks is found essential to allow water percolation, dissolve some mobile elements and enrich the bauxite ores (i.e. gibbsite). The enrichment process is known as a supergene enrichment and this process much depend on the proximity with ground- water level or situated up to several tens of meters above the groundwater [9]. Undulating morphology with constant high ground water table fits for bauxite deposits because it situated in the range of seasonal fluctuation of groundwater or mainly has upward migration.

Based on the study, we conclude that the alumina content (Al₂O₃) in lateritic bauxite is mainly depend on the type of igneous parent rocks. Higher grade of bauxite ore (gibbsite) and value of TAl₂O₃ is commonly found derived from intermediate to mafic igneous rock where their primary minerals are typically unstable or easily altered to secondary minerals (smectite, kaolinite, gibbsite, goethite and limonite). The parent rock type of basalt in Kuantan area is also prone for bauxite, but the value of TAl₂O₃ is smaller than intermediate igneous rocks since their Fe₂O₃ percentage is higher in the forms of hematite and goethite content.

![Figure 14. The scatter plot of Fe₂O₃ vs TAl₂O₃ is used to distinguish the quality of parent rock in producing higher Al₂O₃.](image1)

![Figure 15. High quality bauxite is shown by low TSiO₂/Fe₂O₃. Samples for scatter plot were taken from Landak area, West Kalimantan, Indonesia](image2)

The increasing value of Al₂O₃ in felsic igneous parent rock (based on the geochemical data of West Kalimantan) is followed by the increasing value of Fe₂O₃ as shown in the Figure 14 and the decreasing grain size of their minerals as compared between granodiorite and Quartz syenite in Table 2. On the contrary, the XRF data of bauxite in Kuantan shows a strong negative correlation between Al₂O₃ and Fe₂O₃, which suggests that the increase proportion of Al₂O₃ is followed by the decrease of Fe₂O₃.
6. Conclusion

Overall, the behaviors of lateritic bauxite in weathered granitoids and or calc- alkaline igneous rock types are determined by mineralogical- chemical characteristics of primary minerals, permeability, porosity, grain size and other geological environment during weathering processes. The tectonic activity play contributed to produce specific degree of alumina saturation in magma that could be enriched through chemical weathering. Moreover, the quantity of major oxide components of bauxite depends on the original abundance of element in igneous parent rock beside the mobility character of element. Dissolution rate of a mineral is strongly depend on permeability, porosity, grain size and related specific surface area.

Other geological environments that affect the bauxitisation are controlled by climate, geomorphology, hydrogeology and vegetation cover. Bauxitisation strongly depends on geomorphology, bauxite deposits will absent in the steep- slope topography and swampy area due to transported and not suitable conditions. The root system of vegetation can facilitate drainage and leaching in correspond with climate condition.

This approach is found useful to determine the prospect of bauxite from different tectonic position and parent rocks. In the future, the author would like to compare each different control of external variables against alumina proportion.

Acknowledgment

The author would like to thank PT. Aneka Tambang, Tb.k., Unit Geomin for providing us laboratory data needed for comprehensive study and giving us permission to publish the data. The author also would like to extend gratitude to FTKE, Universitas Trisakti for valuable support during preparation to publish this paper.

References

[1] Valeton I. 1972 Bauxites. Amsterdam: Elsevier Publishing House
[2] Metcalfe I. 2006 Palaeozoic and Mesozoic tectonic evolution and palaeogeography of East Asian crustal fragments: The Korean Peninsula in context. *Gondwana Res*. Epub ahead of print. DOI: 10.1016/j.gr.2005.04.002.
[3] van Leeuwen TM. 1994 25 years of mineral exploration and discovery in Indonesia. *J Geochemical Explor*. Epub ahead of print. DOI: 10.1016/0375-6742(94)90021-3.
[4] Hall R. 2014 The Origin of Sundaland. In: *Proceedings of Sundaland Resources. MGEI Annual Convention*. Epub ahead of print 2014. DOI: 10.4236/cm.2014.52008.
[5] Senathi Rajah S. 1986 Bauxite in the Kuantan area, Peninsular Malaysia. *J, Geol Soc Malaysia Bull*.
[6] Gasparon M, Varne R. 1995 Sumatran granitoids and their relationship to Southeast Asian terranes. *Tectonophysics*. Epub ahead of print. DOI: 10.1016/0040-1951(95)00083-6.
[7] Bignell JD, Snelling NJ. 1977 K-Ar ages on some basic igneous rocks from Peninsular Malaysia and Thailand. *Geological society of Malaysia Bulletin*; 8: 89–93.
[8] Bardossy, G. & Aleva, G.J. J. 1990 Lateritic Bauxites. Amsterdam - Oxford - NewYork - Tokyo: Elsevier
[9] Tardy Y, Bardossy G, Nahon D. 1988 Activity of water fluctuations and hydrated or dehydrated mineral successions within bauxitic and ferruginous lateritic profiles. *Comptes Rendus - Acad des Sci Ser II*. 

