Petrography and Geochemistry of Bukit Yong and Sungai Nal, Kelantan: A Preliminary Study

Roniza I.[1]*, Nursyasya Izzati A.J.[1], Amal Najihah M.N.[1], Nursufiah S.[1]

[1] Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus, Locked Bag No. 100, 17600, Jeli Kelantan.
*corresponding author: roniza@umk.edu.my

Abstract

The purpose of this study is to understand rock alteration, mineralogy and geochemistry at Bukit Yong and Sungai Nal which are located in Ulu Sat Forest Reserve, Machang, Kelantan. It is quite close to Ulu Sokor Forest Reserve, Tanah Merah which is well-known with gold deposition. Thus, this study is essential to know the alteration as well as the potential of mineralisation in Ulu Sat. Five samples of rock and soil were collected randomly according to the alteration and rock types. Thin section samples were prepared for the petrography and soil samples for geochemical analyses such as Atomic Absorption Spectrometer (AAS) and X-ray Fluorescence (XRF) in order to determine the concentration of elements. Based on the petrography, some rocks in Bukit Yong display perthite texture which consist of large xenomorphic alkali feldspar crystals that possibly related to igneous intrusion. The compaction and strained grains of rock in certain area of Bukit Yong also could be identified and this texture reflects the area is resulted from metamorphism. Geochemical analyses of soil samples from Bukit Yong and Sungai Nal have shown some enrichment in iron (Fe) and manganese (Mn) elements which potentially have ore deposition.

Keywords: alteration, Bukit Yong, Sg. Nal, Ulu Sat, petrography, geochemistry

1. Introduction

Ulu Sat Forest Reserve is a tropical rainforest, located in Machang District, Kelantan, Malaysia (Fig. 1 and 2). It is quite adjacent to Ulu Sokor Forest Reserve which is well-known with gold deposition as it is located within the Central Gold Belt (Li et al., 2015, Ariffin, 2012) and was considered to be a volcanic-hosted massive sulphide deposit that originated from volcanic exhalatives in the Permian to Triassic (Heng et al., 2006). Thus, this study were conducted to observe the mineralogy in selected area within Ulu Sat based on petrography and also its potential of mineralisation through geochemical analysis. Bukit Yong and Sungai Nal are two selected areas that represent Ulu Sat Forest Reserve for this preliminary study. The rock alteration and mineralogy in this area should be identified in order to understand the geological occurrences of Ulu Sat, Kelantan.

In Kelantan, several formations have been identified which are Kemahang granite, Taku schist, Telong formation and Gua Musang formation (Department of Minerals and Geoscience, 2003). Kemahang granite formation is Triassic in age shows porphyritic granite intrusion that normally carry some gold mineralization in the shear zones. The quartz veins are well-developed along the shear zones and granitoid. The Taku schist is the metamorphic rock equivalent to the Mangga formation which predominantly pelitic schists and subordinate amphibolites (MacDonald, 1967). This rock is dissimilar to the adjacent Central Belt which consists rocks of limestone, clastics, and acid volcanics. It is believed that Taku schist to be in Permo-Triassic age as recorded by Bignell and Snelling (1977) and predominant rock type is quartz-mica schist with subordinate quartz-mica-garnet schist. Telong or Sokor Formation consists of interbedding siltstone, feldspathic litharenite sandstone and shale, dominantly located at the Central Belt elongated from

north to south of Peninsular Malaysia. Sediments and meta-sediments around the age of Ordovician to Cretaceous period are also distributed within this formation. These rocks are bordered with main and boundary range granites on both east and west side (Hashim, Pour and Misbari, 2017).

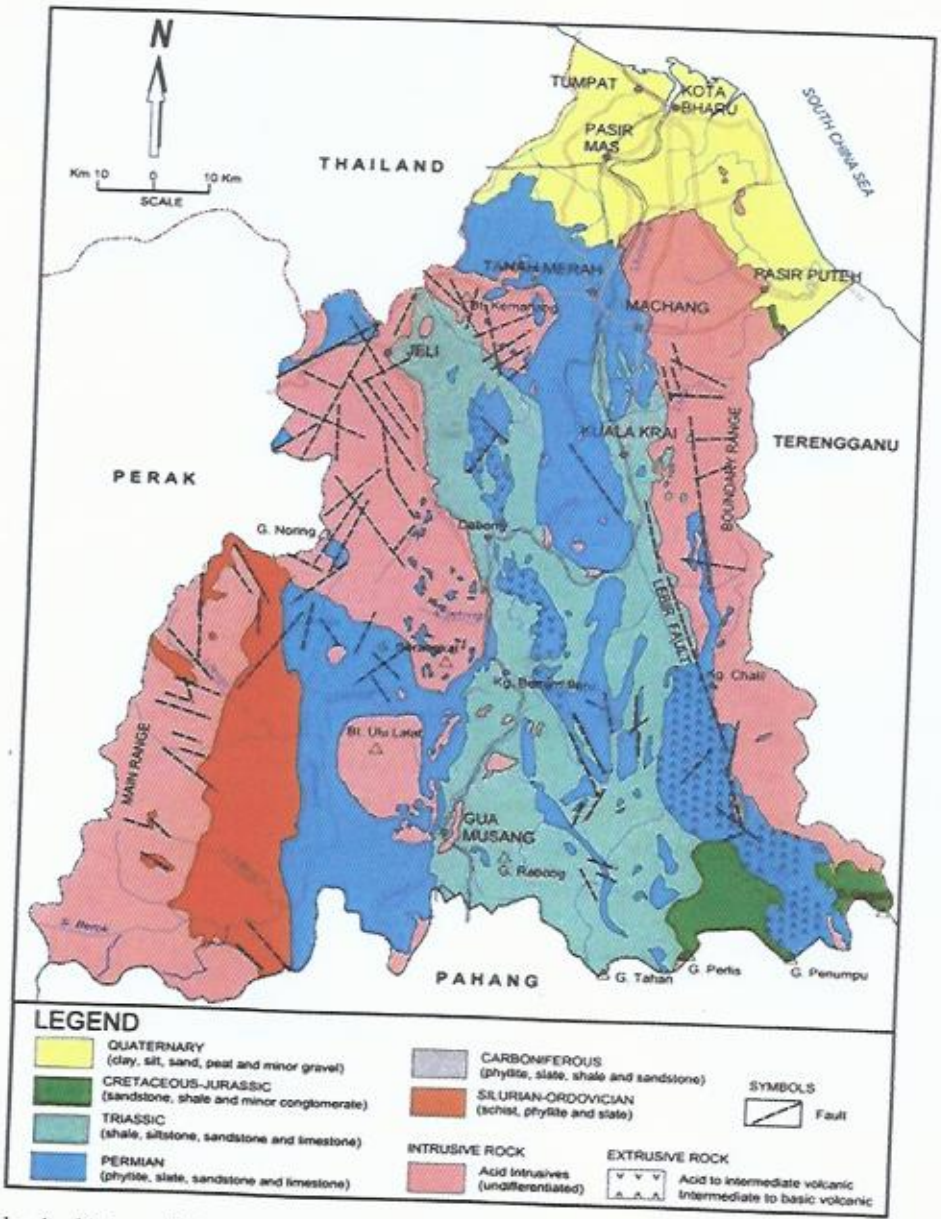

Fig. 1: Geological Map of Kelantan (Source: Department of Mineral and Geoscience, 2003)

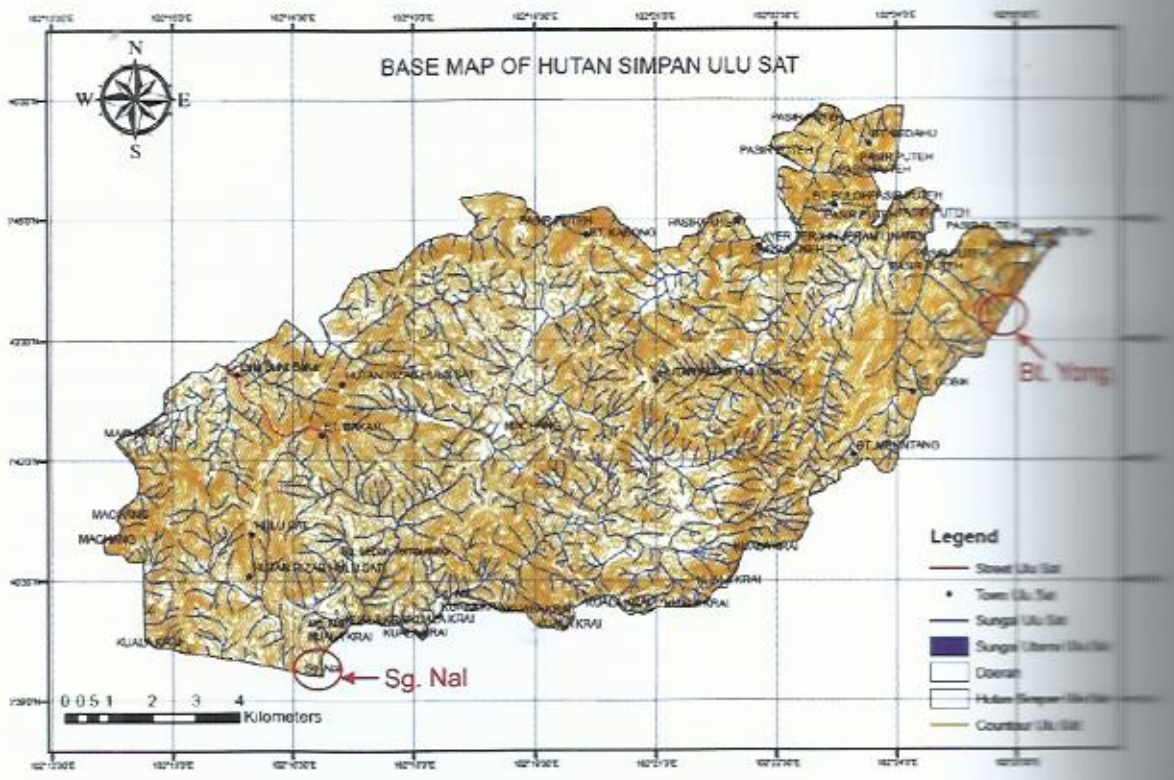

Fig. 2: Base Map of Ulu Sat Forest Reserve showing the location of study area

2. Materials and Methods

Five samples of rock and soil from different lithologies at Ulu Sat Forest Reserve have been collected for further analysis. Three samples represent Bukit Yong and two samples from Sungai Nal were prepared for geochemical analysis. The geochemical instruments such as Atomic Absorption Spectrometer (AAS) and X-ray Fluorescence (XRF) have been employed for elemental composition analyses. AAS analysis has been conducted in laboratory at Faculty of Earth Science while XRF analysis at University Malaya.

The sampling procedures and sample preparation during the study are described as follow:

i. Rock samples and thin section preparation:

Rock samples were collected to represent the geology of the area. The rock samples were cut into the piece of rock around 3 cm x 2.5 cm using diamond blade machine cutter. After heating the sample for one hour to remove the bubble, the sample is then sticks into the glass slide using Canada Balsam glue and polished into 30 microns thickness. Thin section samples were used for microscopic study to identify the minerals.

ii. Soil samples and geochemical analysis:

Soil samples were taken from 20 cm depth at selected location within the study area. The samples were collected randomly based on obvious appearance in the study site. The samples were dried

using oven for 100°C for about 12 hours or until its dried properly. For AAS analysis, 5 grams of pulverized, homogenized and sieved soil sample is digested by a mixture of hydrochloric acid, HCl and sulphuric acid, H_2SO_4 under shaking of 150 rpm for 15 minutes at 27°C. After filtered twice by filter paper and syringe filter, the sample was then tri-diluted by using 1: 10 ratio for sample to distilled water portion by taking 1.5 ml of stock solution to mix with distilled water to 15ml. For XRF analysis, samples were grinded, pulverized, binded and pressed into a pellet before analysis.

3. Results and Discussion

3.1 Petrography and rock description of Bukit Yong

Bukit Yong is situated close to the border between Kelantan and Terengganu. Some part of the hill is already developed as a quarry and has been managed by Dwi Daya Utama Sdn. Bhd. (Fig. 3a). The Boundary Range Granite exposed at Bukit Yong (Fig. 3b, c) is composed of fine- to medium-grained megacrystic biotite granite with pink K-feldspar phenocrysts. The granite consists of quartz, K-feldspar, plagioclase, biotite, muscovite, hornblende and others accessory minerals such as sphene and garnet. This granite is used for the production of aggregate especially for the new highway construction in Kelantan. The rock alteration and unconformity structure could been seen from the cutting hill (Fig. 3d).

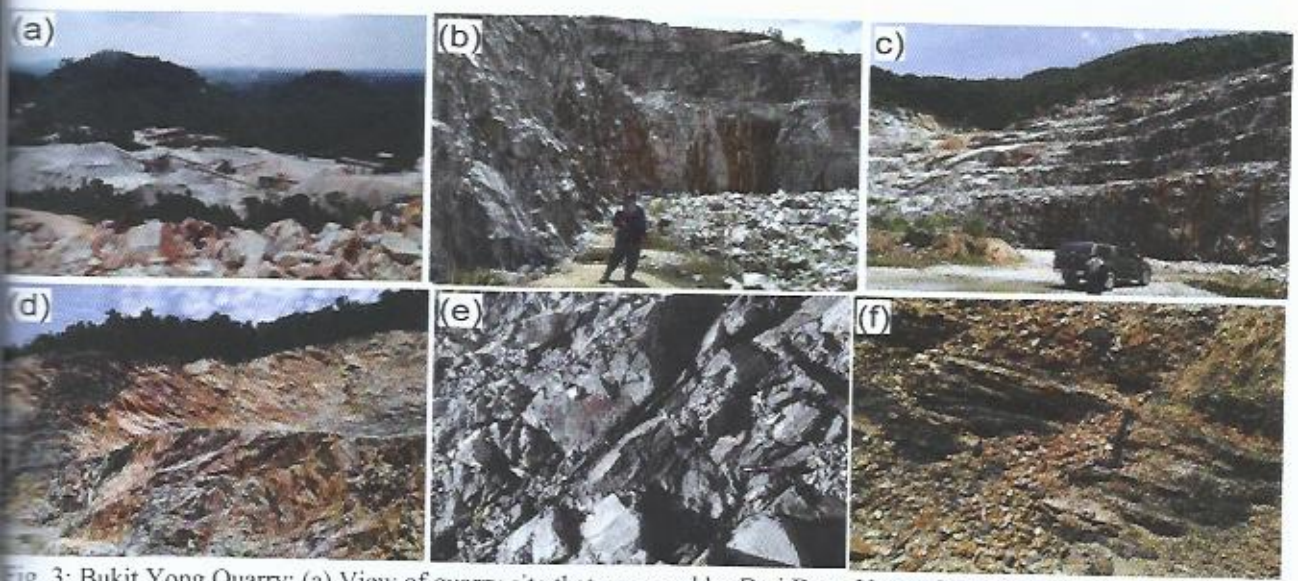

Fig. 3: Bukit Yong Quarry; (a) View of quarry site that managed by Dwi Daya Utama Sdn. Bhd. (b) & (c) Blocks of granite at Bukit Yong, (d) Alteration and unconformity can be seen from the cutting hill (e) Metamorphosed slate and shale in the surrounding area (f) Bedding of iron enrichment and organic matter found in the sedimentary rock of Bukit Yong

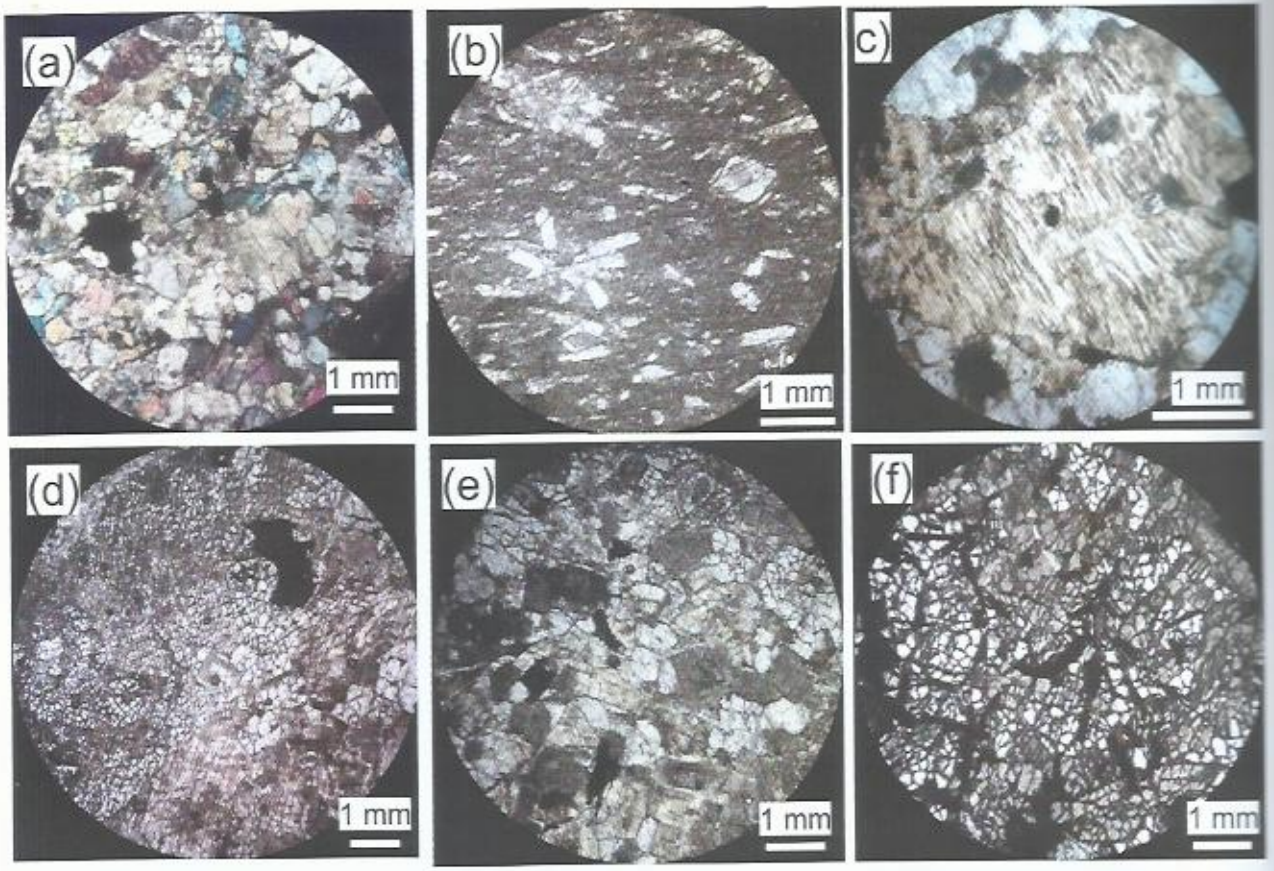

Fig. 4: Petrography of rock samples in Bukit Yong Quarry; (a) Granite taken under crossed polars, showing minerals of quartz, feldspar, biotite and muscovite (b) Tabular orthorhombic of andalusite or chiastolite in contact metamorphosed slate, (c) Exsolution textures of feldspar domains in granite (d) Rock under metamorphism show compaction and layering textures (e) Feldspar, calcite and quartz in granite (f) Biotite is scattered in mosaic calcite and pyroxene.

Low-grade metamorphism took place resulting the change of original rocks to slate, phyllite, phyllitic shale and slate (Fig. 3e). Metamorphosed shale and slate show the existence of andalusite mineral. The crystals of andalusite or chiastolite are found scattered within it with prismatic habit and square cross-section (Fig. 4b). The existence of andalusite give indication the formation of this rock occurred in the temperatures between 200-700°C and pressure between 2-3 Kbar according to the stability chart of Al_2SiO_5 (Pattison, 1992). Bedding of iron enrichment and organic matter can also be found in the sedimentary rock (Fig. 3f) such as mudstone along the cutting hill at the entrance road to the quarry. The rock around the quarry have shown varieties of textures and minerals that represent the occurrence. The igneous rock also displays hypersolvus alkali granite with large xenomorphic alkali feldspar crystals of perthite (Fig. 4c). This may include many vermicles and exsolution albite bands. Some rock also exhibit the compaction and strained grain as it may resulted from the metamorphism (Fig. 4d) whilst some may show typical mineral grain distribution of granite (Fig. 4e). Several blades of biotite can also be found scattered in

hornblende and feldspar association (Fig. 4f). All of the described textures above are related to the igneous intrusion and some may involve the metamorphism.

3.2 Petrography and rock description of Sungai Nal

Sungai Nal located in the south of Ulu Sat Forest Reserve (see Fig. 2). The rubber and palm oil plantations could be seen along the entrance road to Sungai Nal. Major part of this river is almost dried during dry season (Fig. 5a) and several of the granite outcrops can be observed along the river. Mafic enclaves or xenoliths sized between 3 to 6 cm could be seen within the host felsic granite (Fig. 5b) suggest that partial melting has occurred during the formation of this rock. In some cases xenoliths may show evidence of high temperature and even internal melting. The granite outcrops have several quartz veins crosscutting the rock. The larger quartz veins in some part of the outcrops showing pinkish colour (Fig. 5c, 6a). Some part of the outcrops also exhibit the contact between sandstone and granite with smaller veins of quartz crosscutting it (Fig. 5d). The sand along the river has shown some concentration of metallic minerals according to the shiny look with the flowing stream (Fig. 5e). From a closer look to the sand particles, this shiny look is revealed comes from the tiny, brassy flakes of chalcopyrite (Fig. 5e &f). This tiny flakes of chalcopyrite are easily break when slight pressure put on them which the real gold will only bend because gold is denser (s.g =19.3) compared to chalcopyrite (s.g = 4). Further petrography using thin section from Sungai Nal rock samples showed typical minerals of granite such as plagioclase, quartz and biotite (Fig. 6b). The size of minerals grain are ranging from 100-400 microns. Some grains of plagioclase have been replaced by chlorite according to the alteration as it possibly have contact with hydrothermal fluid (Fig. 6c).

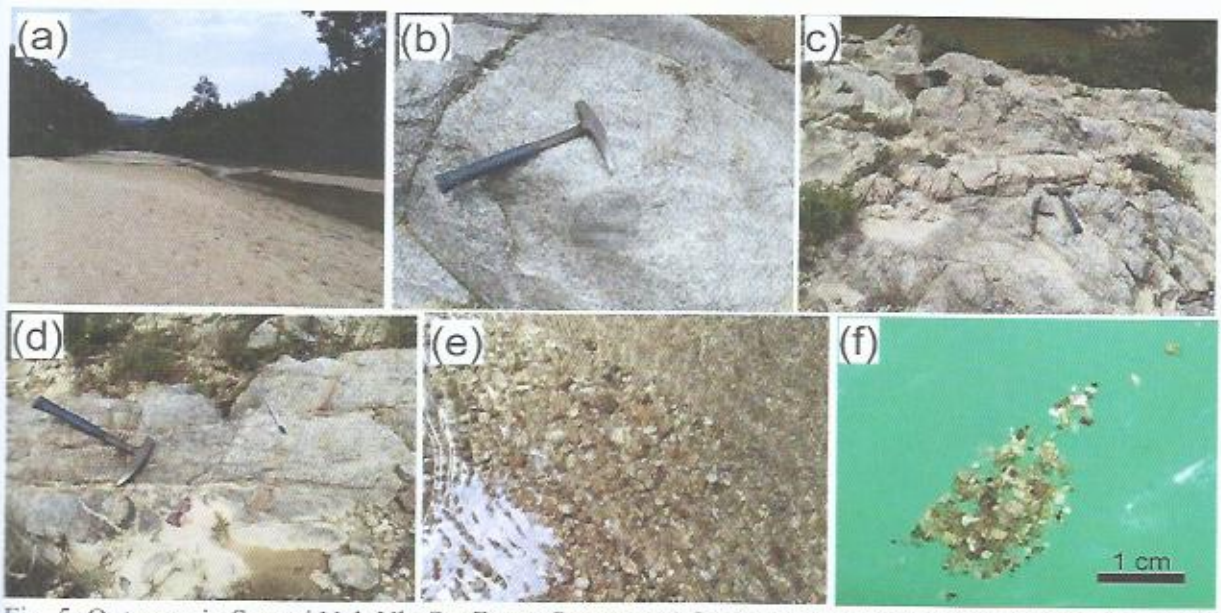

Fig. 5: Outcrops in Sungai Nal, Ulu Sat Forest Reserve; a) Sg. Nal has low water flow during dry season b) Mafic enclave in host granite outcrop (size around 6cm) c) Large veins of pinkish quartz crosscut the granite d) Boundary between sandstone and granite with small veins of quartz cutting the rock e) Sand in the Sg. Nal has shiny look as sulphide minerals may flow along the river f) Fake gold visible after separation from the sand.

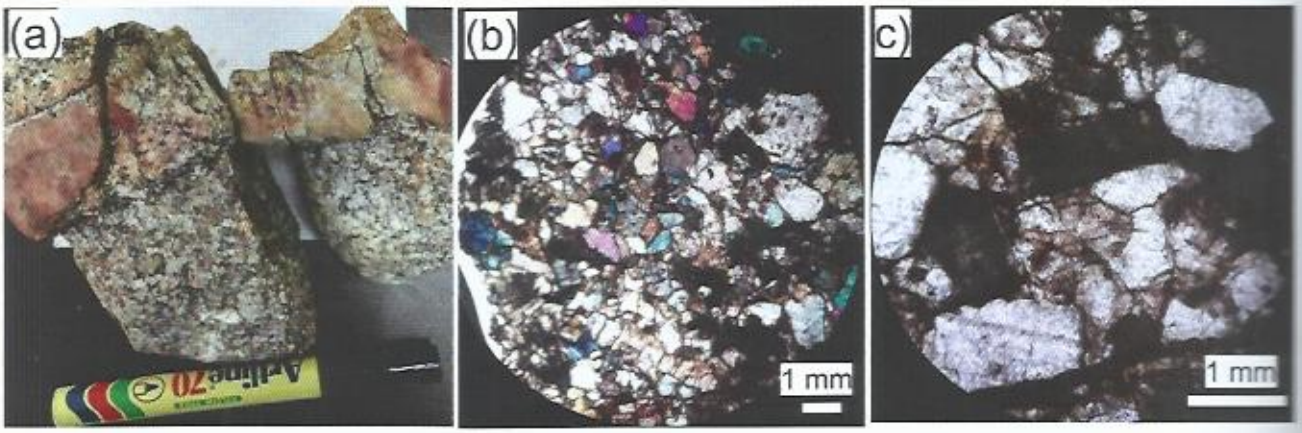

Fig. 6: Granite from Sungai Nal; (a) Typical granite grains with quartz, feldspar and biotite but the quartz vein that crosscut the rock also have pink colour (b) Cross-polarized view of Sungai Nal granite (c) Euhedral plagioclase with some chlorite and sericite alteration.

3.3 Geochemistry of Bukit Yong and Sungai Nal in Ulu Sat.

Geochemical analysis using Atomic Adsorption Spectrometer (AAS) and X-ray Fluorescence (XRF) have been done to determine the concentration of heavy metal elements and composition of oxides in the selected soil samples. Three soil samples of Bukit Yong (named as BY1, BY2 and BY3) and two soil samples of Sungai Nal (named as SN1 and SN2) were analysed. The result of AAS analysis is shown in Table 1. The iron (Fe) concentration of Sungai Nal soil samples have values ranging from 240 to 253 ppm according to AAS analysis. Meanwhile, the Fe concentration for Bukit Yong are varied from the lowest 30 ppm and as high as 283 ppm. Selected samples from Bukit Yong and Sungai Nal have shown promising value of iron (Fe) and manganese (Mn) elements which these areas might have potential of mineralization. Especially for sample SN1 which was taken at the area of fake gold deposition (Fig. 4e) in the stream show the highest concentration of Mn (160 ppm) compared to others that ranging around ten ppm only. According to XRF analysis, the silica (SiO_2) content for Bukit Yong varied from 60 to 70% wt. while for Sungai Nal, the silica content is around 80% wt. Iron oxide composition for both areas are quite similar and ranged between 14-16% wt. However, more exploration activities with extensive sampling should be conducted around this area for further confirmation.

Table 1: AAS results of soil samples from Bukit Yong and Sungai Nal

Sample Name	Ag (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Pb (ppm)
BY1	0.08	0.052	174.9	6.483	0.566
BY2	0.007	0.076	283.4	40.69	0.851
BY3	0.004	0.056	30.73	13.26	0.663
SN1	0.007	0.085	253.9	160.1	0.268
SN2	0.006	0.079	244.8	5.205	0.174

4. Conclusion

Petrographic study on Bukit Yong and Sungai Nal samples display various types of alteration differs from igneous intrusion to metamorphism. The existence of perthite texture on granite and andalusite mineral in metamorphosed slate can be used as proof to those alterations. Based on the limited sample of geochemical analyses, results of element concentration are quite promising and show high concentration of Fe and Mn elements which values ranging in hundred ppm. However, further exploration is needed for confirmation and economy evaluation of ore deposition.

5. Acknowledgements

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