General Geology of Lawin Area along Grik – Lawin Transect with Emphasis on Sedimentology of Tertiary Sedimentary Basin

by

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13533

Dissertation submitted in partial fulfillment of

the requirements for the

Bachelor of Technology (Hons)

(Petroleum Geosciences)

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
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Approved by,

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UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
May 2014

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the reference and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MOHAMAD HISHAM BIN MAZLAN

ABSTRACT

This project is about geological study in Lawin, Gerik, Perak. The study would be divided into two part in which on the first part it is a general geology study where the final result would be rose diagrams, stereonet and geological map with its cross section along the transect line. Then the study will emphasize more on sedimentology of the Lawin Tertiary Sedimentary Basin and the end product would be from petrography, sedimentary log, and XRF. All the results then further discussed and concluded. Future study should be done to evaluate more on the presence of valuable minerals in the tertiary basin.

ACKNOWLEDGEMENT

Alhamdulillah, thanks to God for giving me strength and will to complete this Final Year Project. I would like to express my highest gratitude to my project's supervisor, Mr. Jasmi Ab Talib for guiding me besides giving me constructive comments, suggestions, wisdom and provides me with useful references. I really appreciate as he has let me to participate in his research project.

I would also like to give my special thanks to the Petroleum Geoscience Department, specifically to the lecturers and technicians that have provide me their assistance and guidance throughout the completion of this project. This project would not have been successful without them.

I would also like to express my gratitude to my family and friends who have given me support in many aspects. All their contribution to my accomplishment of this project would not be forgotten for the rest of my life.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1 Background

Lawin is an area located in Northern Perak, in between Lenggong and Gerik. It is under District and Municipality of Gerik. Its geographical coordinate is 5° 19’ 0” N, 101° 4’ 0” E. Connected to Gerik and Lenggong by Route 76, Jalan Baling – Kuala Kangsar.

From the map view, it is clearly seen that the area of Lawin is a valley where it is bounded by Bintang Granite to the West and Main Range to the East. River system in this area is very vast and most significant river in this area is Sg. Kenering and Sg. Lawin.

Agriculture has been their main economic activities. In agriculture, plantations of palm oil and rubber tree can be seen in most part of Lawin. Felda Lawin Selatan and Felda Papulut is example of plantations area. These industries is very well in Lawin for it has lots of river within it such as Sungai Kenering, Sungai Lawin, Sungai Bagah, Sungai Pari, Sungai Anak Kering and many more including the Sungai Perak which flows through Lawin.

Lawin has variations of rock type and structure including granite, pyroclastic rocks, and sedimentary rocks. Its location to the west of Titiwangsa range gives its variations in geological structure. Several studies have been conducted in this area but not much on the Tertiary Sedimentary Basin. Thus, continuation of the study can be made for future use. With presence of quarry and road cuttings around the area give several exposure of certain type of rocks would give great opportunity to conduct study and sampling procedure.

1.2 Problem Statement

The existence of Tertiary Sedimentary basin in Lawin has been long known. But, there still not much of studies have been made on it. Further study may give information for the Tertiary Sedimentary Basin potential especially in mining industry. The different in age of rock formation within the surrounding give geologist interests in the area which it varies from Silurian, Cretaceous to Late Tertiary or Quaternary.

1.3 Objectives

The objective of this study is:

1. To study the general geology of Lawin area.
2. To produce a geological map of the Lawin area and lithological cross-sections along transect line.
3. To study the sedimentology of the deposits in the Lawin Tertiary Sedimentary Basin.
4. To determine the source of sediments deposited in Lawin Tertiary Sedimentary Basin.

1.4 Scope of Study

The study will be divided into two parts which is FYP 1 and FYP 2. For FYP 1, the study will cover collection of available data from previous studies and published papers relating with geology of Lawin. Several fieldworks will be conducted to collect data and samples which significant with the study. Every data and samples collected will be used to proceed with respective analysis and mapping. For FYP 2, the study will be emphasis on the Grik – Lawin transect area and Lawin Tertiary Sedimentary Basin. The study includes the making of sedimentary logs of any good exposure of sedimentary rocks and XRF analysis to determine the elements composition of the deposits in Lawin Tertiary Basin.

CHAPTER 2

LITERATURE REVIEW

2. LITERATURE REVIEW

The geological study in Lawin, Perak has start since known recorded paper from Mr. Scrivenor's field notes in 1920. His works was used by C. R. Jones in his study published in 1970. Mr. Scrivenor's description of his findings in Lawin was on phyllite, granite, and quartz porphyry on road cuttings exposure. In Nak Sah and Ulu Pari, he recorded the findings of limestone. Furthermore, he also describe that the Sungei Perak stream-down flow from Kuala Kenderong to Janing. His observation also stated that the quartz porphyry is older than the granite. Yet, Jones in his published book confirms that the so-called quartz porphyry is actually an acid pyroclastic rock. Summarizations Mr. Scrivenor findings can be find in Geological Department Annual Report for 1914 (Scrivenor, J. B., 1915).

Generally, the geology of Lawin area history is as old as Early Cambrian, the age of which Papulut quartzite deposits and it was deposited in shallow marine environment (Jones, 1970). Jones also concluded that the Baling Group which extensively distributed from Northern Perak to Kedah was from as early as Late Cambrian and the upper part was from Lower Silurian age. The Baling group comprises of several facies which is argillaceous, calcareous and arenaceous facies (Jones, 1970).

Volcanic activities were identified to happen during Mid Ordovician in which the pyroclastic deposited in shallow marine forming Grik – Lawin tuff. The deposition was alternately deposited with argillaceous and calc-silicate rock (Mokhtar, 2007). The pyroclastic rock which represents volcanic activities composed of completely pyroclastic materials and it is hard, pale green, well jointed and crystalline. Also in Mid Ordovician, deposition of argillaceous and calcareous rocks forms Kroh Formation. The deposition ends in Lower Devonian (~ 410mya).

Activation of plate movement during the Late Carboniferous and Early Permian (~ 250mya) forming the Bok Bak fault which causing certain rocks were shifted and re-crystallize. This age also noted as which altered basic to ultrabasic intrusions to occur which the rock unit of Serpentine to forms (Jones, 1970). Then, the Bintang Granite and Titiwangsa Granite intrusion occurs which causes older rocks to be folded (Mokhtar, 2007). The Bintang Granite is basically grey in color, with medium to coarse grain size, porphyritic with essential mafic constituents of mafic (MT-JGSC, 2009). This breakthrough happens in Late Triassic which believes to be the main cause of the north-south trending folds (Jones, 1970). The granite continuous erosion leaves the granite to stand out as parallel mountain chains running along the length of the peninsular. Bintang range is the eastern edge while westerly lobe called Main Range granite (Jones, 1970).

In the Late Tertiary, re-activation of the Bok Bak fault about 2mya causing the formation of Lawin Basin (Mokhtar, 2007). The depositions of sands, grit and gravel state by Mokhtar to starts from Quartenary age. It was relatively same as C. R. Jones has stated in his book that in the west of Lawin, there is a structural sedimentary basin which comprises of semi-consolidated gravel, grit and sand deposits which is from Tertiary or Quartenary age. Jones also stated that the sedimentation takes place in a fluvial-lacustrine, possibly deltaic environment. The Lawin basin deposits was possibly up to 1,000 feet of loosely consolidated, poorly beded gravel, grit, and arkosic sand of fluviatile-lacustrine (possibly deltaic) or torrential origin (Jones, 1970).

The alluvium sedimentation then takes place in Quartenary causing Papulut quartzite and younger rock forms. This recent lithology comprises of variably thin mantle of mud, clay, silt, sand and gravel of alluvial and fluviotile origin occurring along the valley floors (Jones, 1970). This rock unit best represents by Mount Kenderong and Mount Kerunai which primarily composed of quartzite. The Tertiary Sedimentary Basin has grabbed the attention of many geologists to identify its potential in hydrocarbon or valuable minerals exploration.

CHAPTER 3

METHODOLOGY

3. METHODOLOGY

3.1 Data Collection

The first step to be take once the title of the project known is collecting data which gathered from various sources, mostly academic publications. Data collection comprises basic information, geological background, and previous studies of the area. All the data collected will be used as guidelines and parameters to proceed with the project.

3.2 Fieldwork

Fieldwork was conducted with supervision by a lecturer. Necessary steps to be taken before proceeding with the fieldwork is: (1) assembling all the field equipment needed; (2) identification of safety issues and measurements; (3) documentation of data collected.

Mandatory equipment needed for a geological fieldwork is hand lens, compass-clinometer, geological hammer and chisel, map, Global Positioning Systems (GPS), sample bag, and hardcopy field notebook. All these equipment were inspected before use to make sure it is safe to use.

The hand lens function is for in-situ examination of rock minerals to identify type of rock seen on an outcrop. The compass-clinometer is used to measure orientation of geological planes and lineation with respect to north besides its function to measure dip of geological features with respect to the horizontal. Map and GPS is important for identifying location and marking the coordinate of outcrops for future used. It is also crucial especially for road traversing or river traversing as safety precautions equipment.

For sampling, geological hammer and chisel is used to crush a rock so that smaller size of sample can be taken. Once the samples have been taken, it is then put into sample bags which labeled with description of rock type, outcrop name, and analysis going to be applied on it if necessary.

Hardcopy field notebook is necessary to record data in each outcrop comprises: (1) outcrop name; (2) coordinate and location of outcrop; (3) observation on outcrop including lithology and structural; (4) sample numbering; and (5) sketches of what seen on the outcrop.

3.3 Mapping

Initial aids needed to start making a geological map is base map which can be a topographic map, aerial photographs or satellite images including additional data such as geophysical and geochemical data.

Data collected during geological fieldwork also use. The findings in all outcrop found during the fieldwork were used to map the lithology of every location in the study area. Measurements taken also used especially to map boundary of lithology and structural properties exist in the area.

Mapping techniques used can be divided into Traverse Mapping, Contact Mapping, and Exposure mapping. Each technique has its very own advantage and disadvantages. But, combination of several techniques can give better results.

Another crucial step while mapping an area is creating cross-sections. It is important to understand the geology, and may provide critical insight into developing a map. It is usually drawn along a line perpendicular to dominant strike of strata and structures so that it shows the subsurface structures more clearly. It is important to show real elevation scale and the topography along the line. If any subsurface structure is also needed to be shown, scale for depth also has to be shown.

3.4 Sedimentary Log

The recording of the sedimentary rocks description needed four main aspects which is: (1) the composition; (2) the texture of the rocks; (3) the sedimentary structures; (4) the fossils or its traces within it.

The process starts by recording the sedimentary lithology. It consists of identifying type of rocks in each unit which initially divided within the outcrop; identification of the depositional process, sediment source and environmental conditions; and recording of all seen features of the rock. Features of rock commonly recorded are color, fracture, and fissility. These features would give important information especially in identifying the rocks compositions.

Sedimentary structures were also recorded which it's important to give direct clues about the processes responsible for deposition of a sedimentary rock and processes occur after its deposition. Several steps are really crucial for recording sedimentary structures which are: (1) examine from three orthagonal faces if possible; (2) record size; (3) Look for associations of sedimentary structures both literally and vertically.

Lastly, all data collected were put into graphic logs. The conventions of graphic logs can be summarized as: (1) vertical scale; (2) horizontal scale; (3) lithology; (4) sedimentary structures; (5) other information; and (6) stratigraphic order.

3.5 Petrography

To further studies the mineral composition of all rocks samples collected, petrography analysis is needed. But, before the analysis to be carried, a thin section of each sample is made so that it can be used under microscope.

A thin section can be made by first cutting the samples by using slab saw. Samples were cut into smaller size which slightly smaller than the glass slides. The marks from the blade are removing by polishing. The sample is glued onto the glass slide by using epoxy resin and epoxy hardener.

All thin sections made is examine under Transmitted Light Microscope. Using several options of focus besides the use of polarizing glass slide so that further identification of minerals can be done as certain minerals appears differently when seen polarized.

3.6 X-Ray Fluorescence Spectrometry (XRF)

A non-destructive analytical technique used to identify and determine the concentrations of elements present in solid, powdered and liquid samples. The XRF spectrometer measures the individual component wavelengths of the fluorescent emission produced by the sample when irradiated with X-ray. The experiment conducted used powdered samples taken from different rock types at different area.

The XRF method depends on fundamental principles that are common to several other instrumental methods involving interactions between electron beams and x-rays with samples, including: X-ray spectroscopy (e.g., SEM - EDS), X-ray diffraction (XRD), and wavelength dispersive spectroscopy (microprobe WDS).

The analysis of major and trace elements in geological materials by x-ray fluorescence is made possible by the behavior of atoms when they interact with radiation. When materials are excited with high-energy, short wavelength radiation, they can become ionized. If the energy of the radiation is sufficient to dislodge a tightly-held inner electron, the atom becomes unstable and an outer electron replaces the missing inner electron. When this happens, energy is released due to the decreased binding energy of the inner electron orbital compared with an outer one. The emitted radiation is of lower energy than the primary incident X-rays and is termed fluorescent radiation. Because the energy of the emitted photon is characteristic of a transition between specific electron orbitals in a particular element, the resulting fluorescent X-rays can be used to detect the abundances of elements that are present in the sample.

The preferred method for analyzing powders or samples that are usually ground to a powder to make them more homogeneous is the hydraulic pressed pellet. The press uses a die set to contain and form the sample during pressing.

1. The sample is first dried and ground to a fine consistency, 400 mesh or better is recommended. Remember that the x-ray wavelengths are still substantially smaller than the particles.

2. Next the sample is usually blended with a binder that helps hold the pellet together, although some materials don't require it

3. To prepare the press, the die set must first be cleaned with methanol or other solvent. The backing, usually an aluminum cap, is inserted into the die.

4. A specific weight of sample is then poured into the cap, usually 5-10 grams. It is important to keep the mass constant because the sample may not be infinitely thick at high x-ray energies.

5. Next a polished pellet is placed over the sample to produce a smooth finish. The plunger goes in after that, and then the die set is positioned in the press.

6. Follow the press instructions for pressing the sample to 10-20 tons, and holding it for a period of time usually from 10-100 seconds**.**

7. The pellet is then removed from the die set, taking care not to crack it in the process.

3.7 Gannt Chart & Key Milestone

In order to ensure that the author will not stray from his duty and work, a Gantt chart had been proposed as a guideline for the author. The Gantt chart is as follows:

TABLE 1. Gannt Chart & Key Milestone For This Project.

Detail / Work	**FYP 1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Select Project Topic	■														
Background Research	■														
1st Fieldwork	■														
Submission of Extended Proposal	●														
Proposal Defense	■														
2nd Fieldwork	■														
Petrography Analysis	■														
Submission of Interim Draft Report	■														
Submission of Interim Report	■														
Project Work Continues	■	■	■	■	■	■									
3rd Fieldwork						■									
XRF Analysis							■								
Submission of Progress Report								●							
4th Fieldwork										■					
Pre-SEDEX											●				
Submission of Draft Final Report												●			
Submission of Dissertation (Soft Bound)													●		
Submission of Technical Paper													●		
Viva														●	
Submission of Project Dissertation (Hard Bound)															●

● Key Milestone
■ Gannt Chart

CHAPTER 4

RESULTS AND DISCUSSIONS

4. RESULTS AND DISCUSSIONS

4.1 Data Collected

Four fieldworks were done within the period since 7th March 2014 until 2nd August 2014. The main objective of the fieldworks is to identify more outcrop or exposure of rock bodies in the study area besides collecting all the data relevant to this project. As a result, 10 outcrop was identified which four was exposure of Tertiary Sedimentary Basin, one of Bintang Granite and five outcrop was identified to be exposure of the Lawin Tuff.

Below is the list of outcrop visited during this fieldwork:

TABLE 2. Outcrop Location and Data Collected.

SAMPLE NO.	LOCALITY	GPS COORDINATE	LITHOLOGY
1 (a)	ROAD TO SG. LAWIN	N 05° 17.404' E 101° 02.815'	Conglomerate (TSB)
1 (b)	ROAD TO SG. LAWIN	N 05° 17.520' E 101° 02.413'	Conglomerate (TSB)
2	SG. LAWIN	N 05° 17.870' E 101° 02.237'	Conglomerate (TSB)
3	PLANTATION HULU SG. LAWIN	N 05° 17.914' E 101° 02.054'	Conglomerate (TSB)
4	KG. ORG. ASLI HULU SG. LAWIN	N 05° 18.047' E 101° 01.422'	Light Grey Granite (Bintang)
5	QUARRY FELDA PAPULUT	N 05° 18.399' E 101° 03.360'	Greenish Tuff
6	FELDA LAWIN SELATAN JUNCTION	N 05° 20.139' E 101° 03.142'	Whittish Tuff
7	KG. TERSUSUN AYER PULAU	N 05° 19.037' E 101° 03.178'	Weathered Tuff

8	SG. KENERING BRIDGE	N 05° 17.918' E 101° 03.505'	Dark Green Tuff
9	KG. PADANG JERI	N 05° 20.599' E 101° 02.783'	Weathered Tuff
10	FELDA PAPULUT NO. 23	N 05° 20.928' E 101° 03.132'	Whittish Tuff

4.2 Outcrops Descriptions

4.2.1 Tertiary Sedimentary Basin

FIGURE 1. Outcrop 2, Sungai Lawin. (N 05° 17.870' E 101° 02.237')

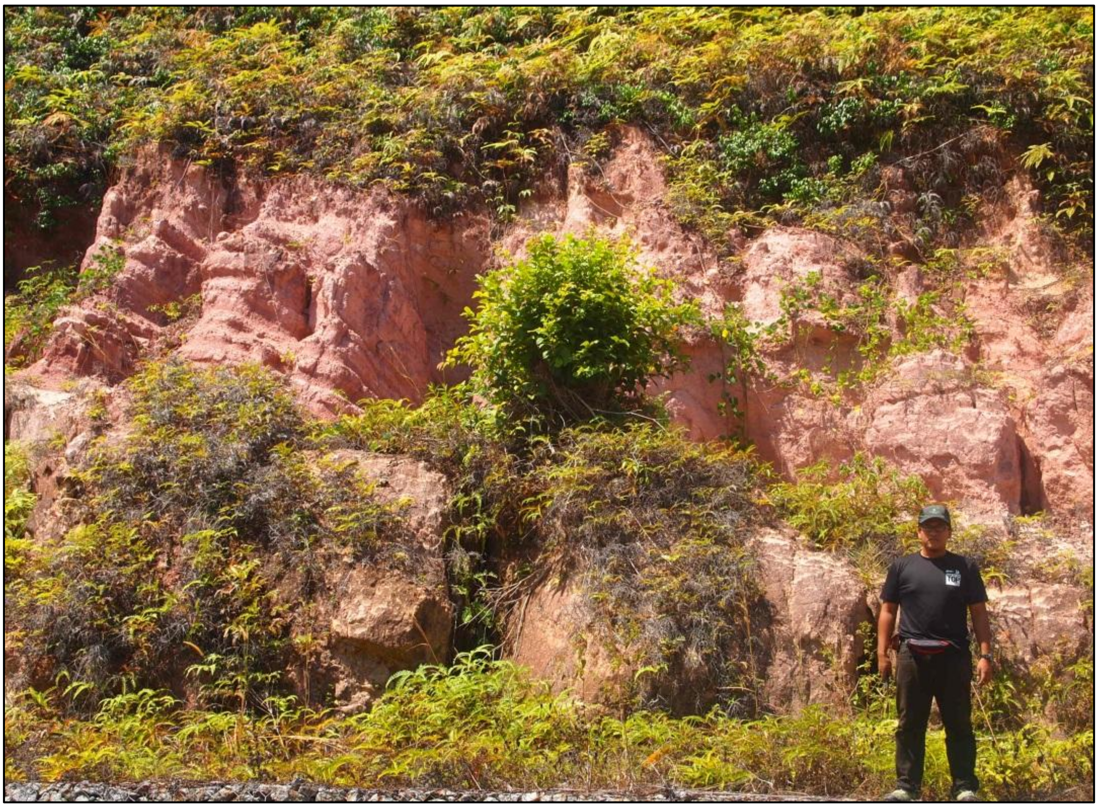


FIGURE 2. Outcrop 1 (a), Road to Lawin. (N 05° 17.404' E 101° 02.815')

Four outcrops of the Lawin Tertiary Sedimentary Basin were identified and studied. Outcrop 1 (a) and 1 (b) is on the roadside of the route to the Felda Lawin Selatan. Clear bedding can be seen and it appears reddish with some whitish facies present. It was exposed because of the road cuttings and seems to be unstable which responsible parties have stacks boulders of rocks on its slope to avoid further erosion. A sample from each outcrop was taken for petrography analysis only from well cemented facies and a lithology logs was made on Outcrops 1 (b).

Outcrop 2 is a large exposure on the riverbank of Lata Sg. Lawin which large beds of conglomerate and coarse grain successions can be observed. Vegetation was quite heavy and erosion from the river flow can be clearly seen. Another exposure was located further west from the other outcrops. It was also quite affected by the vegetation. It appears reddish like the roadside outcrops. Thin section was done from a sample from each of these outcrops and lithology log was only done on Outcrop 2.

4.2.2 Bintang Granite

FIGURE 3. Outcrop 4, Kg. Org. Asli Hulu Sg. Lawin. (N 05° 18.047' E 101° 01.422')

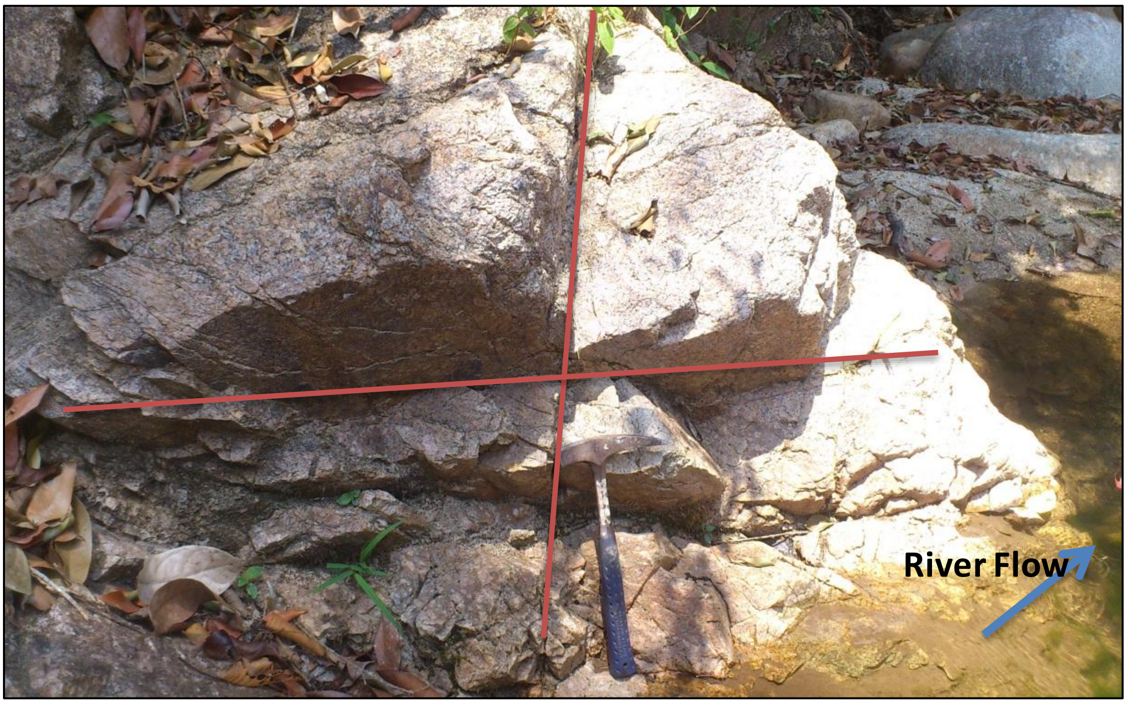


FIGURE 4. Outcrop 4, Kg. Org. Asli Hulu Sg. Lawin. (N 05° 18.047' E 101° 01.422')

The granite outcrop was found on the way to the Kg. Orang Asli Hulu Sg. Lawin. It is only accessible by using all wheel drive transportation. It is on the riverbank of the Hulu Sg. Lawin which is further west to the direction of Bintang Range. It is extensional further up along the river but no contact of this facies with the Tertiary Sedimentary Basin was found.

The outcrop appears light grey and heavily fractured. Erosion effects also can be observed. Vegetation only heavy on the upper side of the exposure so it does not affect the observation made. The river flow in this part of Sg. Lawin is oriented NW – SE.

When crashed with hammer, it is easy to observe the phaneritic texture of the felsic granite with significant amount of biotite can also be observed. The feldspar appeared grey to pinkish.

4.2.3 Lawin Tuff

FIGURE 5. Outcrop 10, Felda Papulut No. 23. (N 05° 20.928' E 101° 03.132')

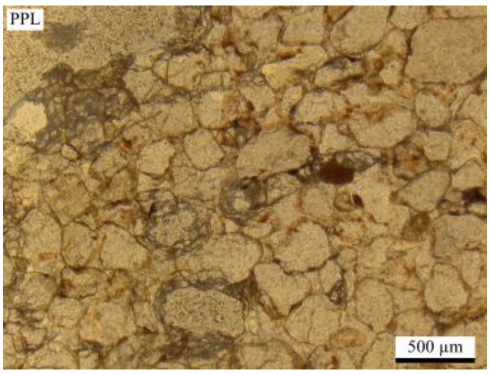
FIGURE 6. Outcrop 10, Felda Papulut No. 23. (N 05° 20.928' E 101° 03.132')

Tuff outcrops can easily be found in Lawin Area and several of it was located using the data from previous studies. Newest outcrops that haven't been shared in previous study are Outcrop 10 which located on the roadside of the plantation dirt road in Felda Papulut No. 23. The tuff appears grey and very fine grains. It also heavily fractured and can be easily broken probably affected by water flows.

4.3 Petrography

4.3.1 Rock Sample under Microscope

TABLE 3. Results of petrography analysis.

Outcrop	Thin Section Under Microscope	Description
L/TSB/1A (Sandstone)		**Minerals identified:** -Quartz (52.83%) -K-Feldspar (31.74%) -Orthoclase (11.39%) -Dark Iron Oxide (4.04%) **Analysis:** -Large and sub-angular clasts -Iron oxide cements -Submature -Arkosic -Feldspathic arenite

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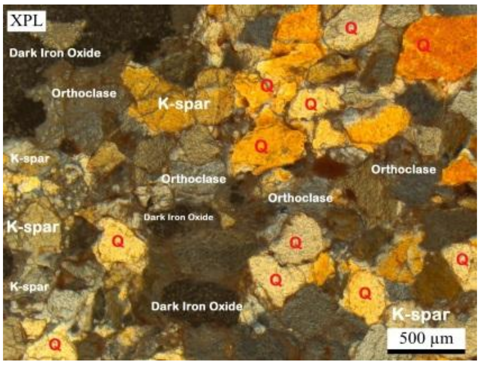
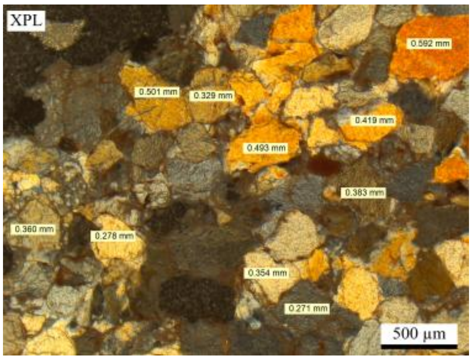
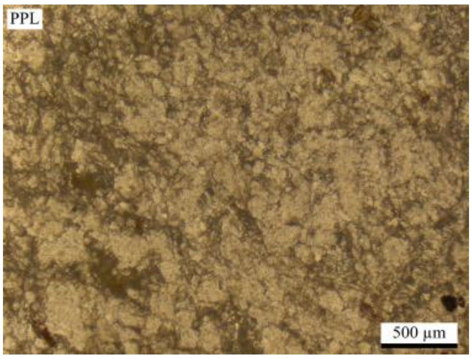
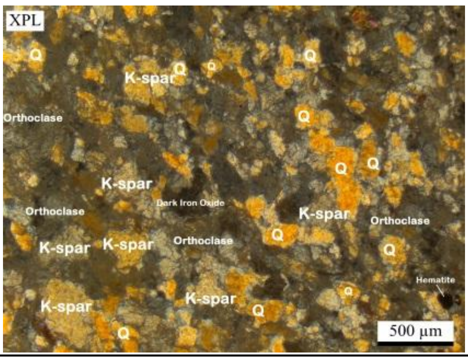




</td>
<td></td>
</tr>
<tr>
<td>L/TSB/2
(Sandstone)</td>
<td>




</td>
<td>Minerals identified:
-Quartz (51%)
-K-Feldspar (29%)
-Orthoclase (17%)
-Dark Iron Oxide (2.4%)
-Hematite (0.6%)

Analysis:
-Medium size and sub-angular clasts
-Iron oxide cements
-Submature
-Arkosic
-Feldspathic arenite</td>
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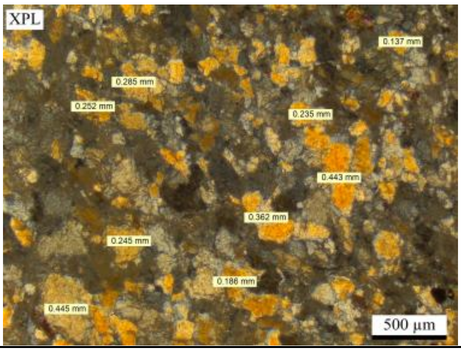
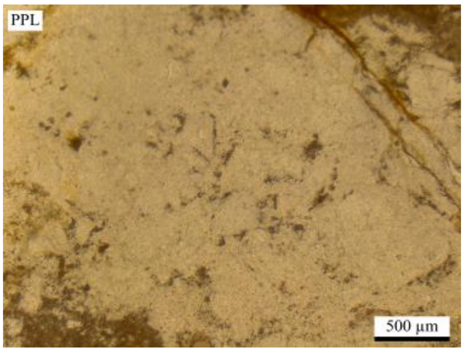
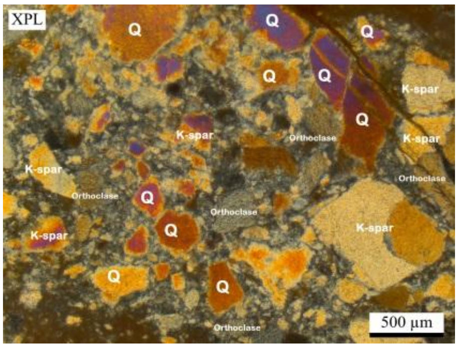
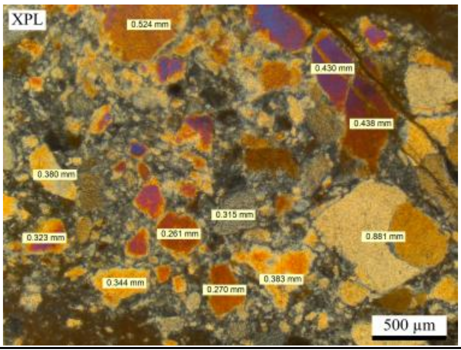
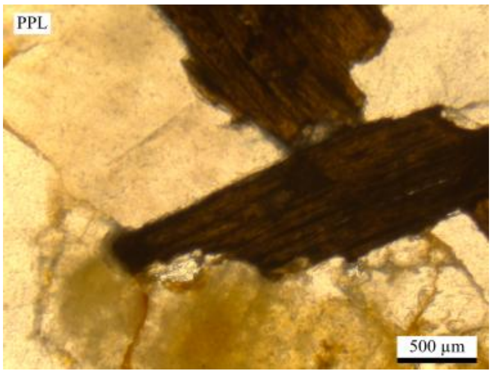
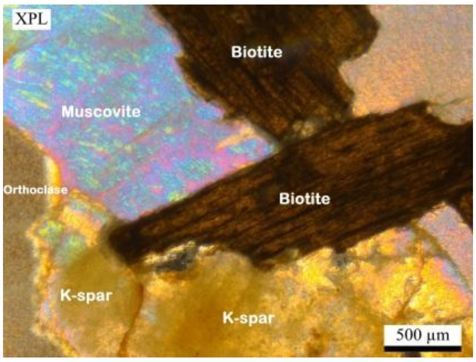
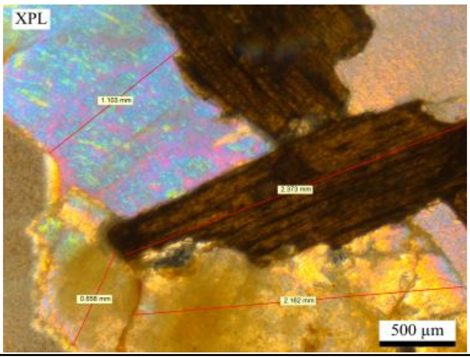
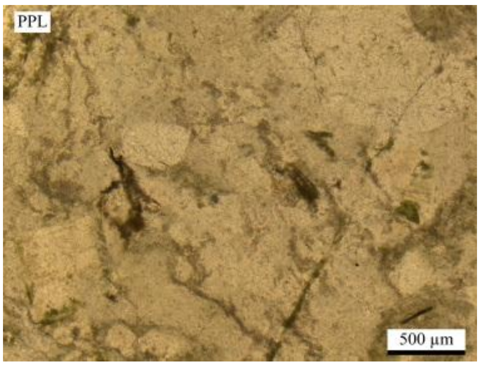
<tr><td></td><td>
</td><td></td></tr>
<tr><td>L/TSB/3 (Sandstone)</td><td>




</td><td>Minerals identified:
-Quartz (47.62%)
-Feldspar (28.57%)
-Orthoclase (23.81%)

Analysis:
-Large – medium (varied) size and angular clasts
-Iron oxide cements
-Immature
-Arkosic
-Feldspathic arenite</td></tr>
</table>

L/BG/4 (Granite)	  	**Minerals identified:** -Quartz (47.30%) -K-Feldspar (24.11%) -Orthoclase (14.19%) -Biotite (12.23%) -Muscovite (1.17%) **Analysis:** -Phaneritic -Large phenocryst of minerals -Biotite rich -Alkali feldspar granite (felsic)
L/LT/8 (Tuff)		**Minerals identified:** -Quartz -K-Feldspar -Orthoclase -Garnet -Rock Fragments **Analysis:** -Mostly made up by siliceous minerals (Rhyolitic) -Matrix is cryptocrystalline which appeared grey to dark green. -Porphyritic texture

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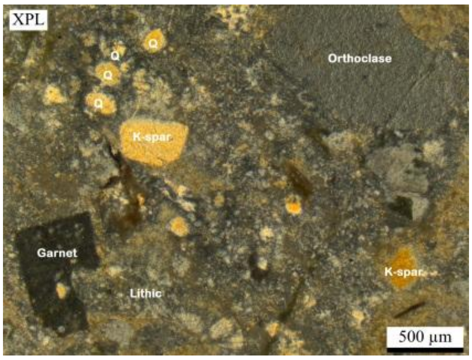
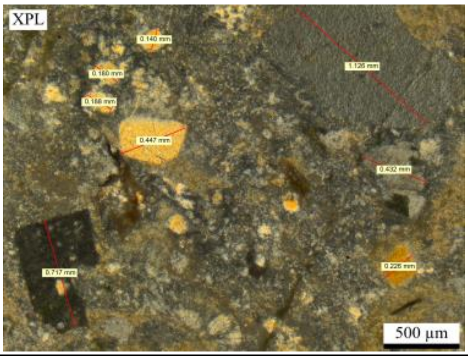
<td>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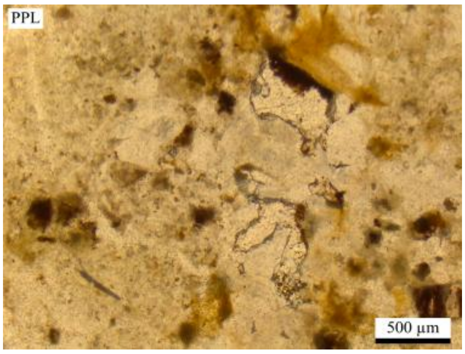
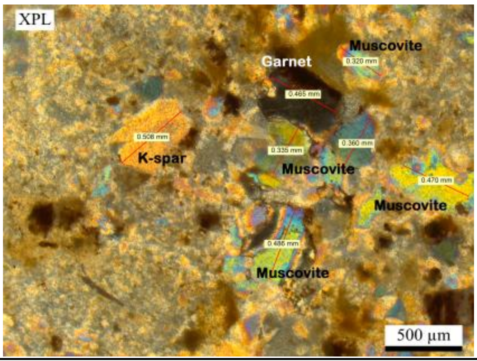
<tr>
<td>L/LT/9
(Tuff)</td>
<td>


</td>
<td>Minerals identified:
-Muscovite
-Garnet
-K-Feldspar

Analysis:
-Mostly made up by siliceous minerals (Rhyolitic)
-Matrix is cryptocrystalline which appeared micaceous and glassy.
-Porphyritic texture</td>
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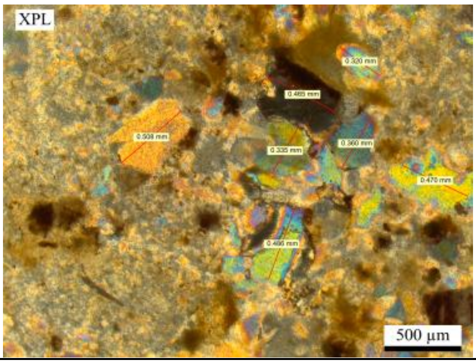
		

4.3.2 Discussion of Petrography Analysis

Tertiary Sedimentary Basin

All the samples from the Tertiary Sedimentary Basin were identified to be Arkosic Arenite. These samples are from the well cemented sandstones rather than the conglomerates because the conglomerates are too friable. All three samples grains were all glued by iron oxide cements. These cements are commonly related to granitic source because it has little amount of free oxygen which caused most common oxidation state is Fe^{+2}. When such minerals brought near to Earth surface, increase abundance of free oxygen caused the iron to oxidize to Fe^{+3} and can be carried away by hydrous fluids. Precipitation of Fe^{+3} from such fluids results in forming hematite (Fe_2O_3). Precipitation of hematite gives the red colored stain to the rock. Hematite present also indicates an oxidizing environment during diagenesis of the rock.

The rock sample from outcrop 1 (a) and 2 are sub-mature texturally and in its degree of weathering. It is because it is identified that both samples contains less than 5% clays or silt and moderately sorted besides that it still contain abundance of feldspars. On the other hand, sample from outcrop 3 is classified as immature because of its high content of clays or silt and poorly sorted. It also still contains high amount of feldspars.

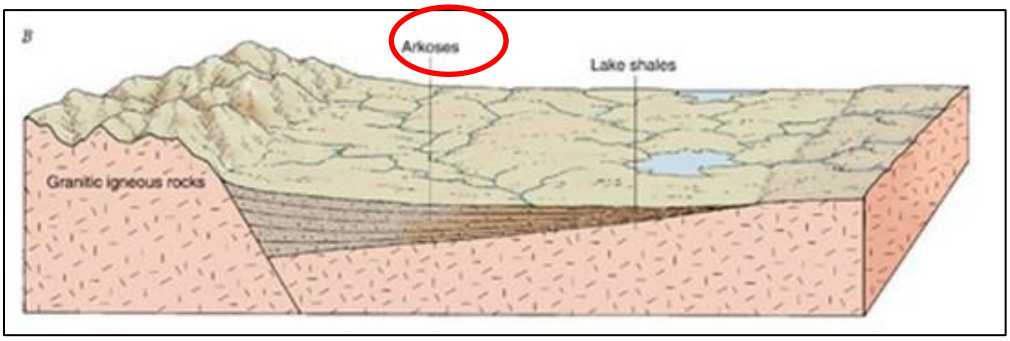


FIGURE 7. Illustration of Arkosic Sandstone Deposition.

The amount of feldspars which is abundance in all three samples can be used as an indication that the sandstone is the deposits of a short time depositional basin (Figure 7). It also implies rapid erosion, tectonic activity and steep slopes. It is common in low areas along granitic mountains. It is associated to weathering of granite because granite has high compositions of feldspars and supposedly feldspars is easier to be destroyed than quartz because they are less stable thus abundant of feldspar and other ferromagnesian minerals indicate relatively little weathering and transport.

Granite

The Bintang Granite sample was identified to be rich in F-feldspar and pinkish orthoclase besides quartz as the major minerals composition. It also contain significant amount of biotite which is can be clearly seen even in naked eye on the hand specimen. Present of muscovite in the granite gave some micaceous appearances on it.

It is determined that the granite is an Alkali Feldspar Granite or also called felsic igneous rock. But, the abundance of biotite also gives the granite appearance near to granodiorite yet it can be easily distinguished under microscope as the granite has few to absent of plagioclase feldspar.

The granite has phaneritic texture in which it consists of large phenocryst of minerals in which most of the minerals can be seen by naked eye on hand specimen. This texture shows that the granite was forms by slow cooling of magma deep underground in the plutonic environment.

Tuff

Both samples of tuff have been identified to be rhyolitic which a felsic pyroclastic deposits. It was both made up mostly by siliceous minerals and has porphyritic texture. Observed quartz, feldspars, garnet and other lithic component are seen to be set in cryptocrystalline matrices.

Tuff of sample L/LT/8 appeared dark green in hand specimen and appeared dark grey under microscope. The cryptocrystalline matrix is mostly made up of quartz and feldspars. It is lack of mica but have several large garnet minerals as an accessory mineral. The grains of minerals are further separated and the grain size varies from 0.14mm to 1.13mm.

On the other hand, the tuff sample L/LT/9 appeared light brown in hand specimen and under microscope. But, under microscope, the cryptocrystalline can be observed to have micaceous appearance and glassy. Medium size grains of muscovite also give its micaceous feature. However, grains of garnet are present in this sample as an accessory mineral. The grains are not far separated and the size ranges from 0.32mm to 0.51mm.

4.4 X-Ray Fluorescence Analysis (XRF)

4.4.1 Result of XRF Analysis

A) Sample: L/TSB/1A (Sandstone)

TABLE 4. XRF result of sandstone sample from outcrop 1 (a).

ELEMENT	CONCENTRATION
Si	59.0%
K	19.5%
Al	10.3%
Fe	6.61%
P	1.68%
Ca	0.834%
Ti	0.683%
Ce	0.462%
Rb	0.307%
Mg	0.230%
Zr	0.156%
Sr	0.0270%

B) Sample: L/TSB/2 (Sandstone)

TABLE 5. XRF result of sandstone sample from outcrop 2.

ELEMENT	CONCENTRATION
Si	52.4%
K	21.7%
Al	12.3%
Fe	6.89%
Ca	1.77%
P	1.49%
Ti	1.36%
Cl	0.504%
Rb	0.499%
Zr	0.192%
Sr	0.0353%

4.4.2 Discussion of XRF Analysis

The most common element in the sandstone sample from the Tertiary Sedimentary Basin is Si, K and Al. These elements are abundant in these samples because of the high contents of Quartz and Feldspar in the rocks as previously stated in Petrography results. Quartz is primarily SiO_2 while Feldspar can be varied based on their "end-members". As found out in the petrography analysis, these rocks have abundant of K-Feldspar and Orthoclase.

The iron (Fe) element is abundant because of the cements of these rocks which is iron Oxide cements. It is a result from weathering process. This element is responsible to give the reddish color to the rocks. There are also possibilities of these iron elements to be existed as a chemical component of Ilmenite which is one of the heavy minerals commonly found in the depositions or eroded sediments from granitic source. Ilmenite can also form a solid solution with geikeilite which are magnesian end-members.

Besides Ilmenite, other common minerals that might be present in the sandstone are rutile (TiO_2), zircon (Zr), and monazite ($CePO_4$). Rubidium (Rb) is a possible element which might be redistributed during deuteric and hydrothermal alteration of granite plutons. Strontium is known as its radiogenic daughter which produced during the decay process of Rb with its half-life of 48.8 billion years.

From the result of this XRF analysis, it indicates that the Tertiary Sedimentary Basin was form by depositions with granitic source. With the integration with the petrographical analysis data, there is much possibilities that the source of provenance of the Tertiary Sedimentary Basin is Bintang Granite. Both minerals and chemical compositions identified agree that the Tertiary Sedimentary Basin was from granitic source and the source is supposed to be near as it is determined that the transportation was short in both distance and time.

4.5 Sedimentary Log

4.5.1 Result of Sedimentary Logs of Outcrop 1 (b)

Outcrop 1 (b) – Roadside to Lata Lawin Selatan

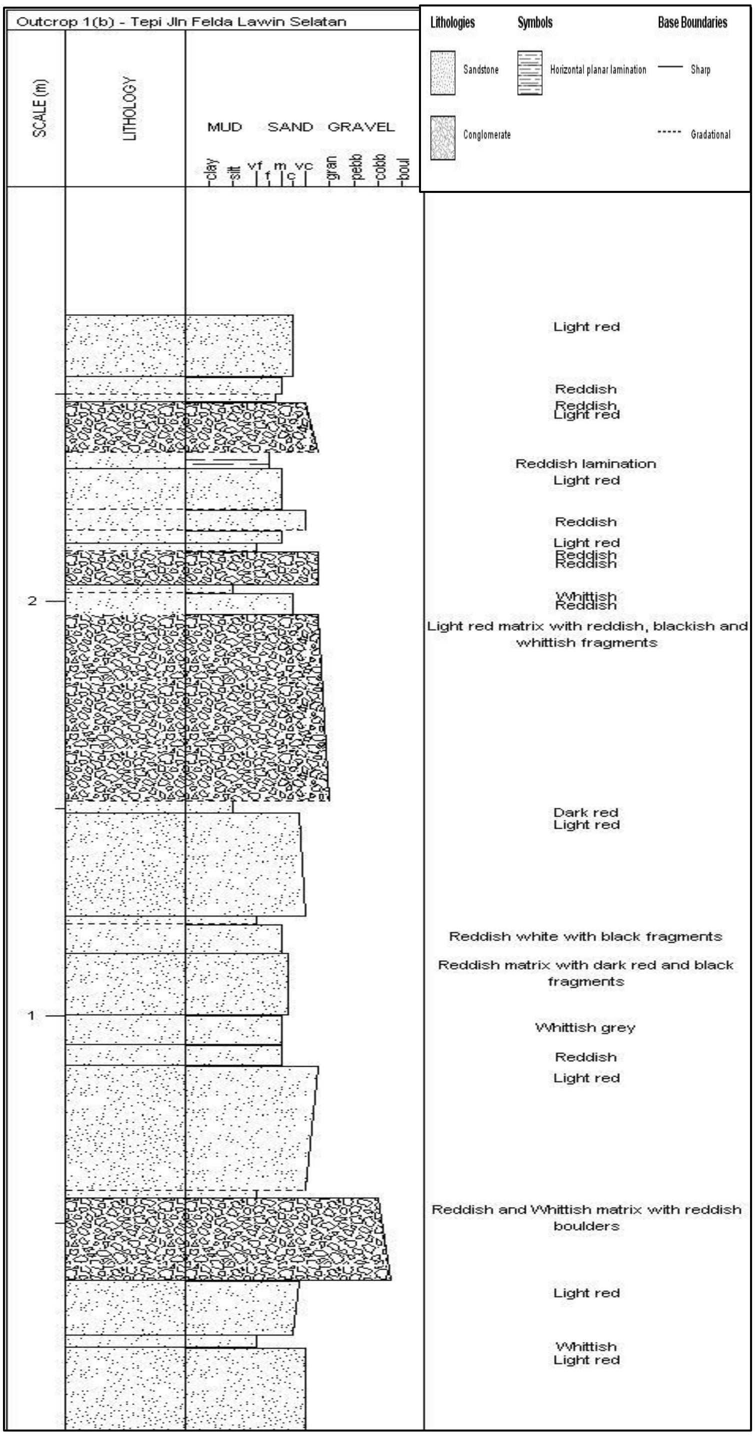


FIGURE 8. Sedimentary log and its interpretation for Outcrop 1 (b).

4.5.2 Discussion of Outcrop 1 (b) log

The succession of sediments in this outcrop was identified to be having grain sizes ranging from silt to boulder. The variations indicate that the controlling transportation mechanisms also vary such as the difference in transportation energy in the channel system.

The grains and the clasts of the deposits are angular to sub-angular which indicates short transportation distance. Most probably from the Bintang Mountain Range which is the source of the present river system. The color was varied might be because of the difference minerals composition. Most significant probability is the composition of iron oxide cements. Oxidized iron suggests a continental deposition.

The sandstone was observed as arkosic sandstone in which it implies a short time depositional basin. It also implies rapid erosion, tectonic activity and steep slopes. It is a common occurrence in low areas along granitic mountain. Sharp base of the sandstones might result from overbank flows on floodplains. While the gradational base boundaries indicates the continuous gradational increase or decrease of energy.

The planar laminations observed is an indicator of the product of upper stage plane bed transport which also the upper flow regime. Meanwhile the conglomerates here were matrix supported which can be specifically classified as paraconglomerate. It is observed that the larger clasts sets below the smaller clasts which can be interpreted as a record for several events of sediment gravity flow deposits (mass flow).

Model example from Gerhard Einsele book shows a possible formation of the Tertiary Sedimentary Basin which support the interpretation made on the log. In the book, it has divided two types of sediments to be deposited in an alluvial fans depositional environment. It is stream deposits and sediment gravity flows. It will deposit arenaceous sandstones and conglomerate from the debris flows. Finer sediments deposited in possible lake forms at the bottomsets.

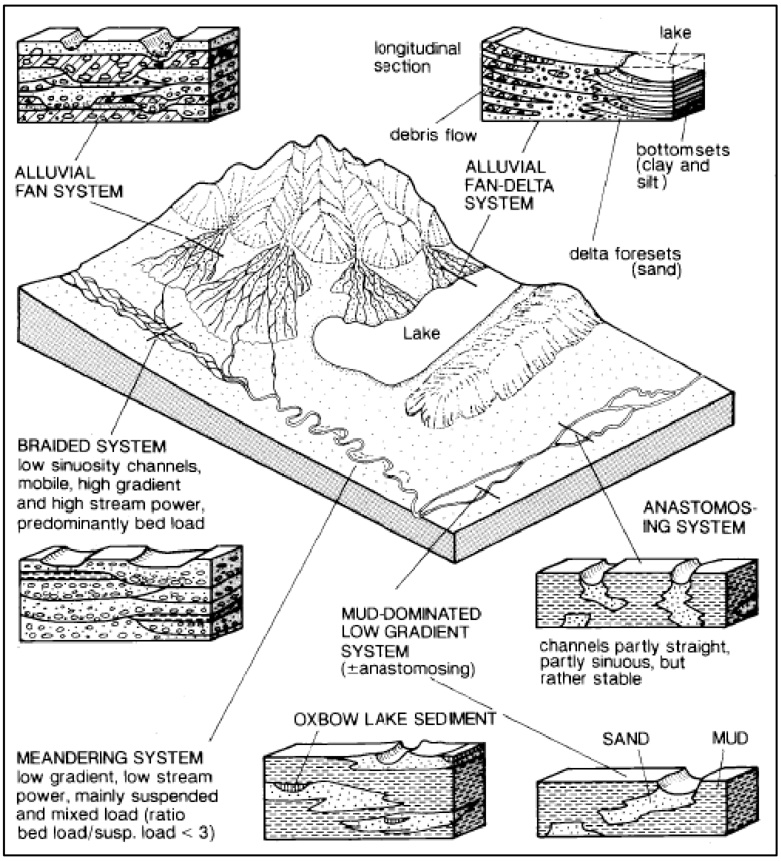


FIGURE 9. Terrestrial Alluvial Fans And Channel Deposits.

In idealized vertical sequence in an alluvial fan deposits and their possible cause. It is from the observed of large-scale coarsening upward sequence due to continuous faulting and fan progradation followed by large-scale fining upward sequence caused by the retreat of scarp front and lowering of relief in source area or less possible is the shifting and abandonment of fan. Then small-scale coarsening-upward cycles due to the prograding of individual fans lobes occur followed by channel base depositions.

From the reddish colors of the deposits in this outcrop, it shows that it is deposited in a humid climate. Alluvial fans in humid regions would have lower gradients and are dominated by stream processes with marked seasonal variations in run-off. Yet, there’s no sheet-flood facies observed in this deposits. Sheet-flood occurs when extreme rain storms occur.

4.5.3 Result of Sedimentary Logs of Outcrop 2

Outcrop 2 – Riverbank of Lata Lawin Selatan

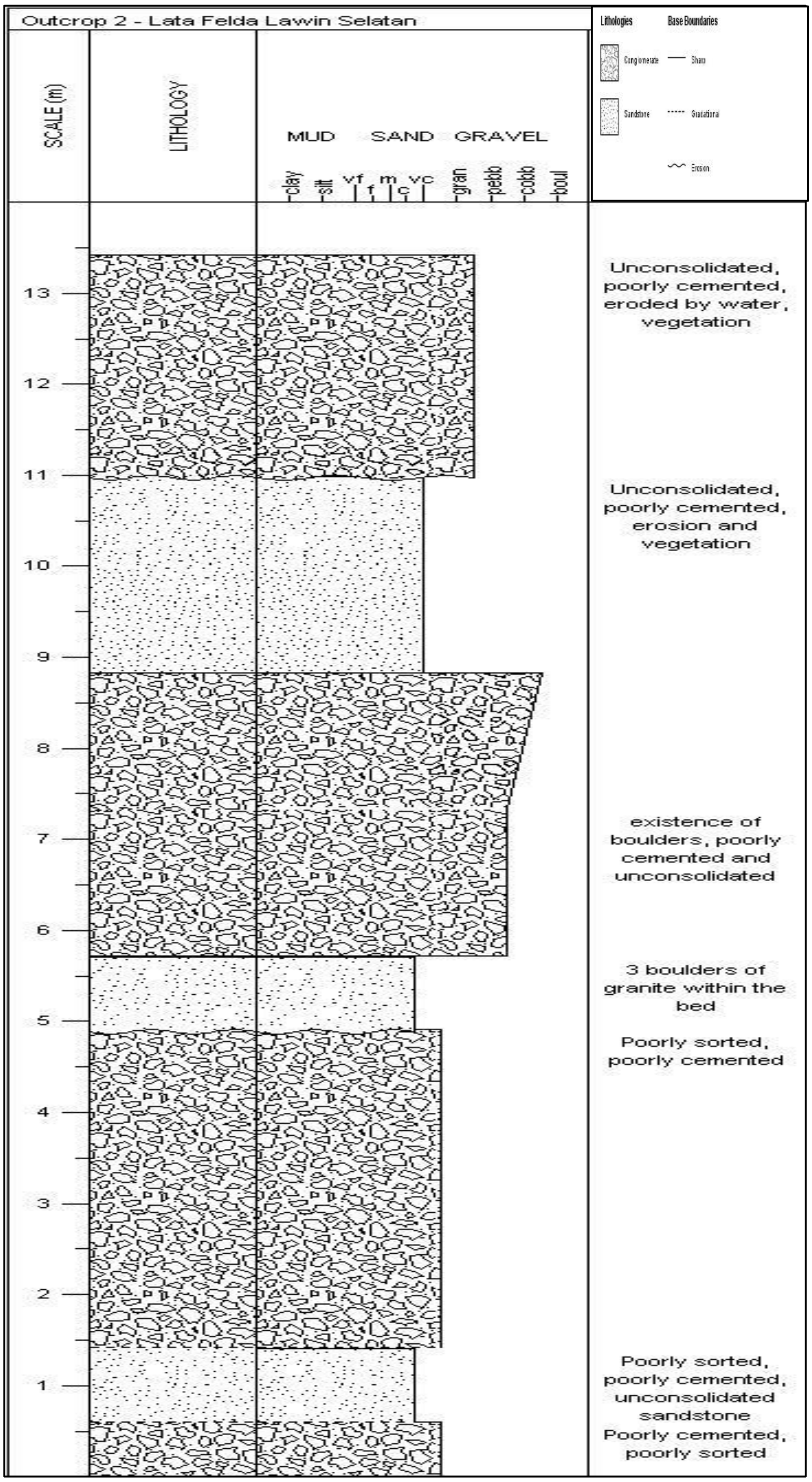


FIGURE 10. Sedimentary Log and Its Interpretation for Outcrop 2.

4.5.4 Discussion of Outcrop 2 log

The initial interpretation of the succession in this outcrop was it is a Conglomeratic Alluvial Facies because it contains significant proportions of pebble-size and larger clasts with some boulders.

The conglomerates were identified to be Matrix-supported Conglomerates (Para-conglomerates). With the observation on the larger clasts was on top of the conglomerates beds lead to an interpretation that this succession was generally the product of cohesive debris flows. It might also indicate a growth of faulting and uplift of the source area.

The clasts in the conglomerates were mostly sub-angular and the boulders were mostly angular. It shows short distance transportation but increase of rounding of the clasts can also indicates that they have resided in a high energy environment for some time. Conglomerates with erosional base probably reflecting stage of fluctuations over the crest of the bar occurred.

The sandstone was observed as arkosic sandstone in which it implies a short time depositional basin. It also implies rapid erosion, tectonic activity and steep slopes. It is a common occurrence in low areas along granitic mountain.

The sandstones deposition with individuals boulders might shows an event of preserved cut-bank. It also sometimes occurs as large boulders slid or fallen from the cut-bank and accumulated with little erosion or reworking.

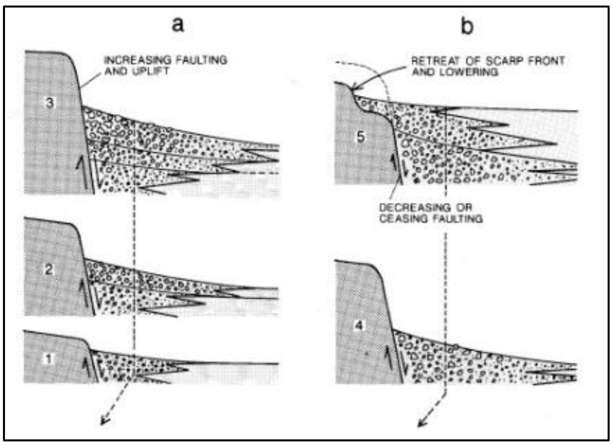


FIGURE 11. Visualization of Uplift and Retreat of Source Area and Its Deposits.

Interbedded arkosic arenites with para-conglomerates can be conclude it is a deposits from uplifting and retreat of the source area, as shown in the figure above, which in this case most probably the granitic mountainous of Bintang Range.

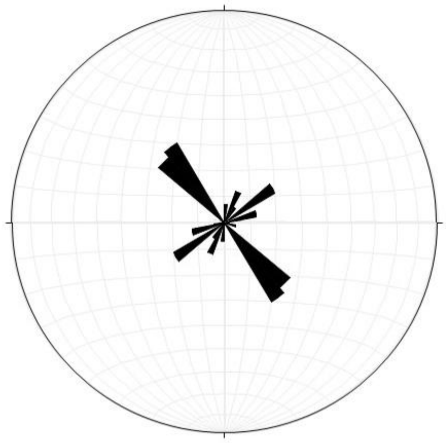
The uplifting and retreat of the granitic source can be related to the tectonic history of the area. Most significant tectonic activities that might trigger the uplifting are the formation of Bok Bak Fault which has NW-SE orientation.

4.6 Structural Analysis

4.6.1 Result of Structural Analysis

Data collected from the fractured granite and tuff exposure was used to plot Rose Diagram. The objective of this study is to identify characteristics of the fractured system in Lawin area along the transect line. All three sets are determined to have Mode 2 Cracking (In-plane shear).

Outcrop 4 – Exposure of Granite

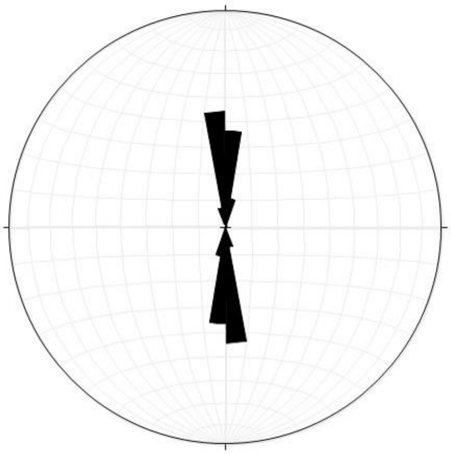


Major fracture occurred at 145° and 325°

Compressional force from 115° and 295° direction (NW & SE)

Extensional force from 25° and 205° direction (NE & SW)

Outcrop 5 – Exposure of Tuff

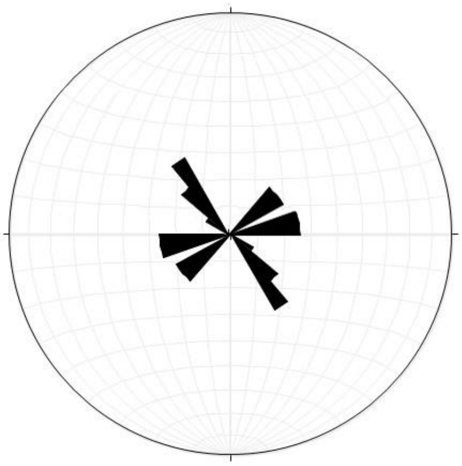


Major fracture occurred at 175°and 355°

Compressional force from 25° and 205° direction (NE & SW)

Extensional force from 115° and 295° direction (NW & SE)

Outcrop 7 – Exposure of Tuff



Major fracture occurred at 145° and 325°

Compressional force from 115° and 295° direction (NE & SW)

Extensional force from 25° and 205° direction (NW & SE)

4.6.2 Discussion of Structural Analysis

Major compressional force applied on the granite was from NW – SE direction and the direction of the extensional force was identified to be from NE – SW. Mode 2 cracking was occurred in the orientation of NW – SE which it is an In-plane shearing. This also occur to the tuff in the surrounding the Outcrop 7 area.

In comparison, the orientation of the fracture system on the tuff in Outcrop 5 is the same as both the granite and Outcrop 7 tuff. But, the orientation of the major compressional force is different where it is from NE – SW direction while the extensional force was coming from NW – SE direction.

4.7 Maps

4.7.1 Results of Maps Construct

FIGURE 12. Location of study area which is within the grid.

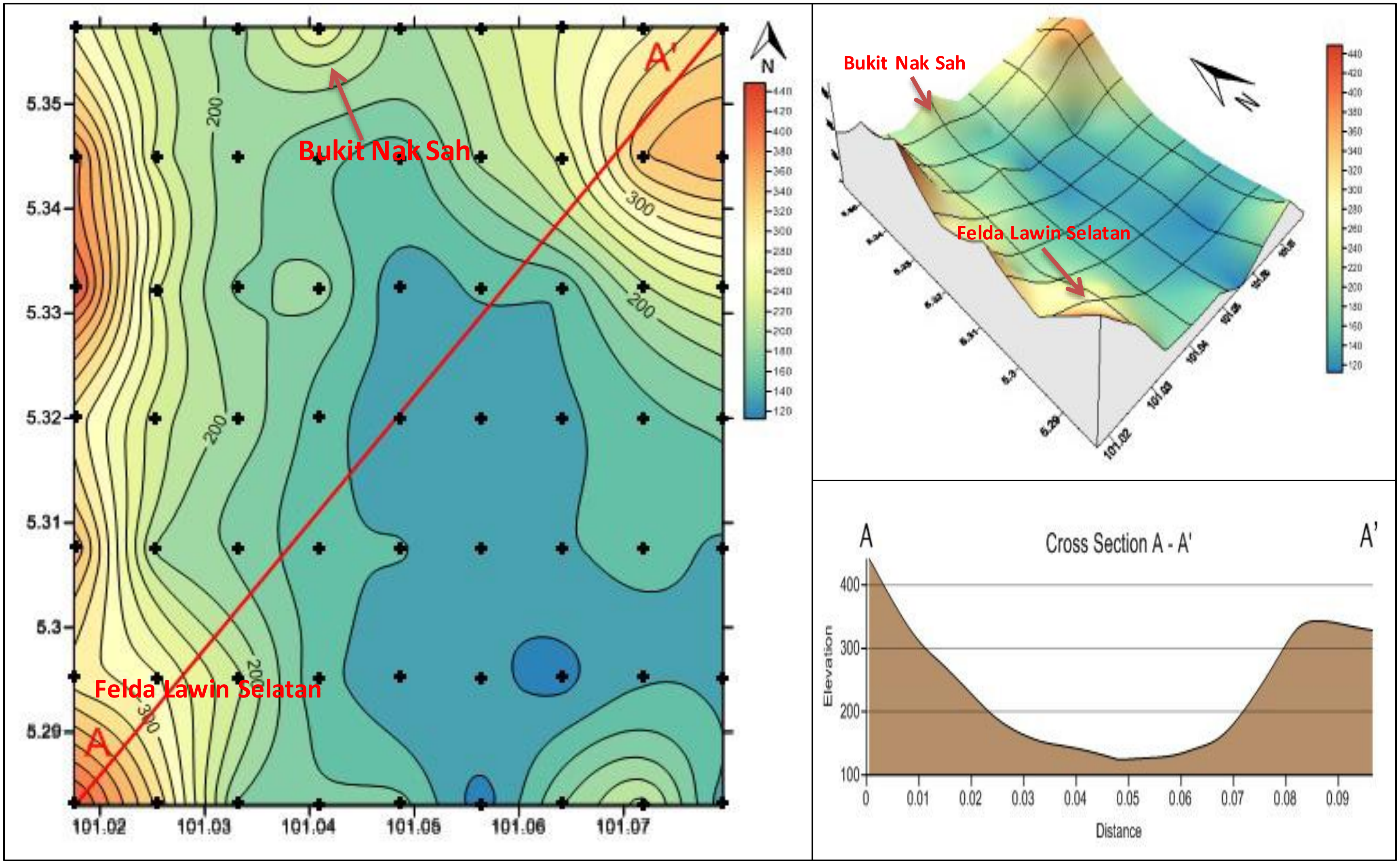


FIGURE 13. (A) Topographic Map Of The Study Area Extracted From Gridded Area; (B) 3D Topographic Projection; (C) Cross Section From Point A To A'.

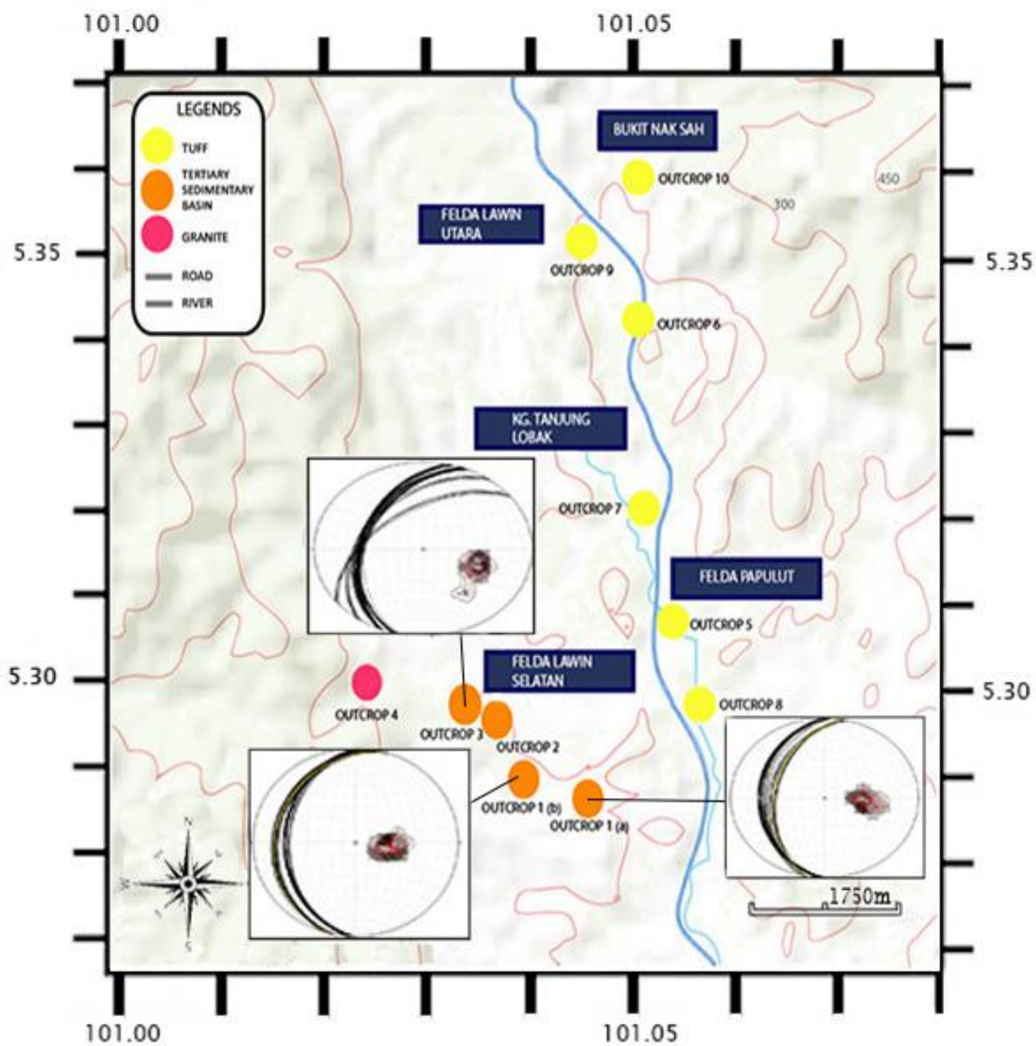


FIGURE 14. Outcrop map with stereonet of respective Tertiary Sedimentary Basin exposure (bedding).

4.7.2 Discussion for Map Constructed

From the geological map and its cross section attached at the end of this book, it is seen that the geology of the Lawin area is varies. The formation of different rock types throughout the geological history of the area is found to be also triggered by the changes in environment of depositions and the tectonic activities occur at places.

Besides that, the Lawin area is seen to be a valley where it is in-between two mountain ranges where the Main Range on its Eastside and on the Westside is the Bintang Range. The position of the basin which is at the mountain feet along Bintang Range supports the theory that the Bintang Granite is the provenance of the sediments forming the Tertiary Sedimentary Basin. Best interpreted that it is most probably deposited in alluvial fans environment.

The Lawin area is consists of three main lithology which is granite, sedimentary rocks and tuff. The granite is a large intrusion which forms the Bintang Range. Several river flows from the higher elevation of the granitic mountains towards the plain and feed into Sg. Kenering. Most significant river is Sg. Puchong Babi and Sg. Lawin.

The Tertiary Sedimentary Basin is mainly consists of conglomerate and arkosic sandstones. The true thickness of the basin is still not specifically mention in any references. The boundary is an assumption as there is no contact was identified and it is based on the interpretation of the data collected during the study on the area.

The tuff is largely made up the Lawin area. It varies in appearances from dark green to light brown in color. The composition also quite varies. A lot of exposure of tuff can be observed along the Grik – Lawin Transect line.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From all the analysis made, it is determined that the Lawin area is consists of three main lithology which is granite, sedimentary rocks and tuff. The granite exposed in Hulu Sg. Lawin has been identified as Biotite Alkali Feldspar Granite with phaneritic texture.

On the other hand, the Tertiary Sedimentary Basin can be concluded that it is consists of Para-conglomerate which is matrix supported and other facies main is Arkosic Arenite which appear reddish due to the iron oxide cements.

The tuff was identified to be a rhyolithic tuff and differs between several exposures probably caused of different weathering process. The color ranges from dark grey to light brown. It depends on the cryptocrystalline matrix components.

From the petrography, sedimentary logs and XRF analysis, it is concluded that the provenance of the Tertiary Sedimentary Basin deposits was from granitic source. It was determined through the mineral compositions and chemical composition in the sandstones of Tertiary Sedimentary Basin. The conglomerate was the deposits from debris flows most probably caused by tectonic activity. Besides that the angularity and K-Feldspar contents shows that the deposits has only transported a short distance which is an evidence that it is from the Bintang Range which is made up by Bintang Granite.

5.2 Recommendation

Even though this project had achieved its objectives, it is recommended for a more thorough sedimentology studies to be made in this area to gained better knowledge of the area.

Besides that, a geophysical approach of study is reliable here to understand the real morphology of the basin and to know the true depth of it. In combination of it with more detailed structural analysis can be used for further study on constructing a Tectonic History Model of the area to understand more on how does the basin was developed in that specific region and not in other part along the mountain feet of Bintang Range.

A detailed heavy mineral analysis is also heavily recommended to be done on the Tertiary Sedimentary Basin. By conducting the study, the real potential of this basin can be known whether it contains valuable ore which is a usual occurrence in conglomerate originated from granitic source.

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APPENDIX

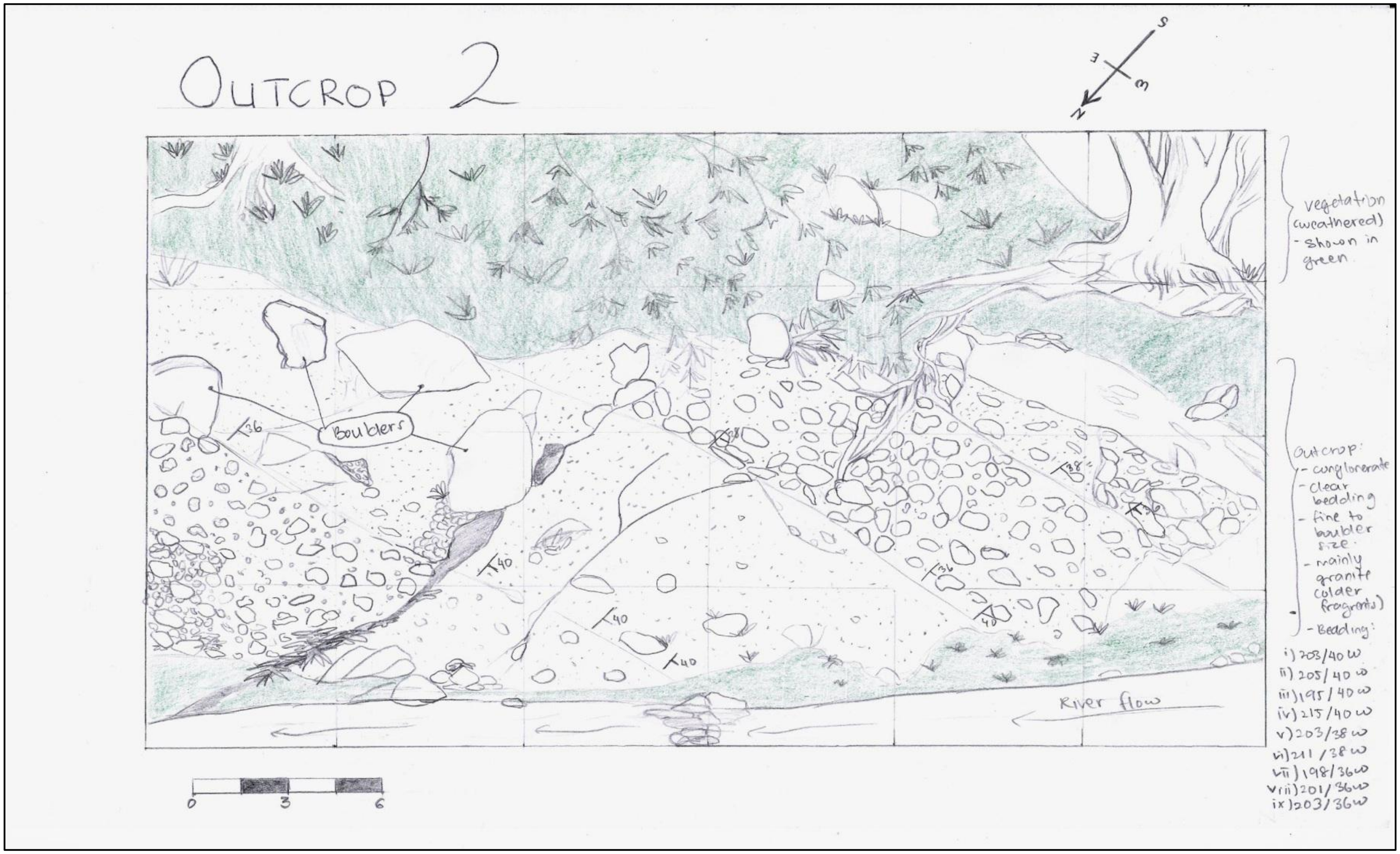

FIGURE 15. Sketch of the Outcrop 2.