Geology of Simpang Pulai Area with Emphasis on Granite Industry

by

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Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Technology (Hons)
Petroleum Geosciences

May 2014

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the

Petroleum Geoscience Department

Universiti Teknologi PETRONAS

in partial fulfilment of the requirement of the

BACHELOR OF TECHNOLOGY (Hons)

(PETROLEUM GEOSCIENCE)

Approved by,

(AP Dr. Chow Weng Sum)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

MAY 2014

Abstract

This study is to understand the general geology of the Simpang Pulai area with the emphasis on the granite industry. Thus a geological map is produced describing the area studied. Furthermore, the quality of the granites were also tested to determine its possibility of usage in the industry because different sample areas consist of granites with slightly differing compositions and thus different quality.

Sufficient details on the geology of the Simpang Pulai area were not found especially with the emphasis on the granite outcrops. Furthermore, the quarries nearby the study area have been operating for many years and this will cause the outcrop as well as the general geology of the study area to have changed. Although this is the case there are no study on possible new prospects for the granite. Thus it is important to have a general outcrop map which is up to date and giving enough emphasis on the granite formations.

There are a few types of tests in the rock aggregate testing procedure. Only selected procedures were done due to the time constraint. Among them are listed below

a) Deleterious material test under microscope. (Thin Section)
b) Specific gravity determination. (British Standard 812:1990)
c) Water absorption test. (British Standard 812:1990)
d) Impact Value test. (British Standard 812:1990)
e) Crushing Value test. (British Standard 812:1990)

Results obtained has shown the suitability of the granites for the industrial usage. Although samples from different areas have different qualities and not all samples were suitable, most of the samples obtained were of good quality thus explaining the number of quarries operating in the Simpang Pulai area.

Acknowledgements

On the whole the success of this project is due to the guidance and help provided by my supervisor AP Dr. Chow Weng Sum. All his efforts and support given has been an essential part in this project. Furthermore, many thanks to all the Universiti Teknologi PETRONAS staffs who have helped me throughout this project in many ways.

On the other hand many thanks for the never-ending support given by both my parents throughout this project and as well as along this whole degree program. Also, thanks to my fellow classmates who have been very helpful to me in terms of support and guidance. Special thanks is also given here to all the staffs of Jabatan Mineralogi & Geosains Perak for all their help especially in the tests in this project. Last but not the least, this opportunity would liked to be taken to thank the companies that helped and gave their support for this project namely Lafarge company.

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1.0 Introduction

1.1 Background

As a petroleum geoscientist, one of the most basic yet important aspect in this field is the ability to describe the general geology of the investigated area. In cases of the onshore area, the usual method used is by the geologic mapping techniques. Thus, in this project, the main part is given on the description of the general geology of the Simpang Pulai area. In the Simpang Pulai area, especially in the project's outcrop location, there are three main types of rocks namely the limestone, granite and also some kaolin formations. However, in this project the emphasis is given on the granite formation.

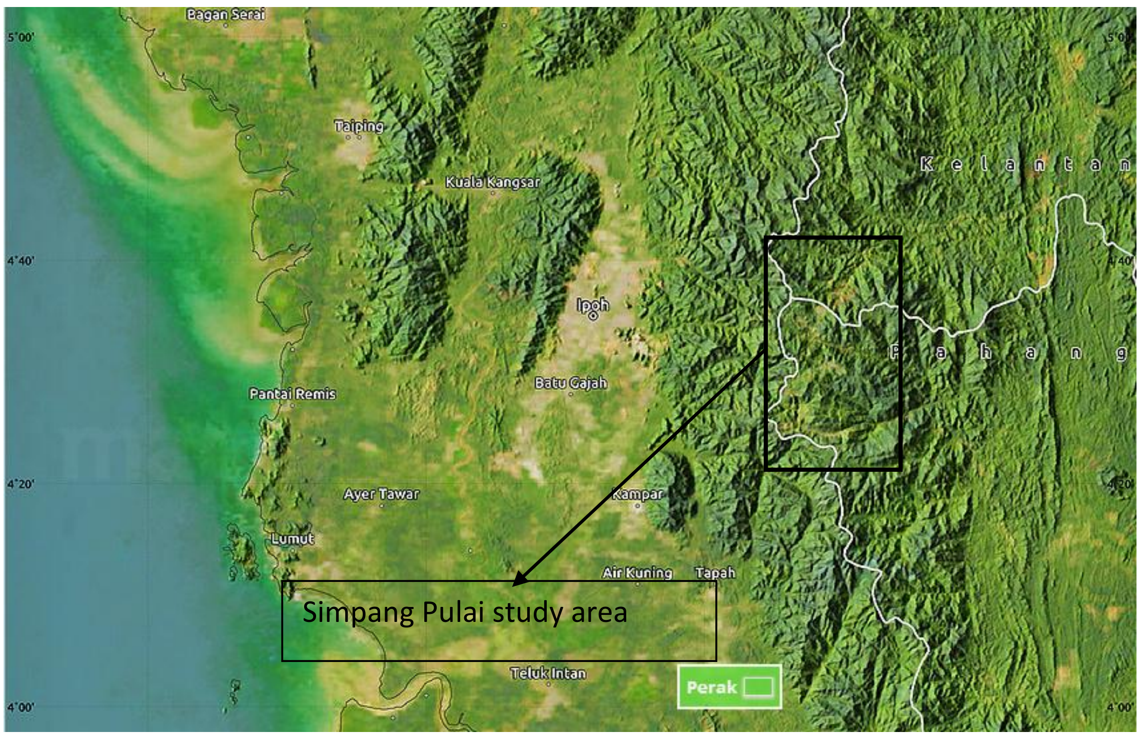


Figure 1 : Map of the study area from satellite view.

1.2 Problem Statement

There is not enough details on the geology of the Simpang Pulai area and insufficient emphasis on the granite outcrops. There is no detailed map for the geology in the scale 1: 50000. Furthermore, the quarries nearby the study area have been operating for many years and this will cause the outcrop as well as the general geology of the study area to have changed. Although the quarries are still operating, there is no real indication of study on other possible potential sites. Thus it is important to have a general outcrop map which is up to date and giving enough emphasis on the granite formations.

1.3 Objectives

Among the main objectives of this project are listed below :

a) To produce a geological map of scale 1:50000 of area studied in Simpang Pulai, Perak and further identifying the boundaries of granite area.
b) To analyze the quality of the granite samples from the study area by using rock aggregate tests.
c) To seek other potential granite quarry locations.

1.4 Scope of Study

The scope of study of this project is listed as below :

a) To conduct appropriate few traverse along the rivers and roads.
b) To collect samples of granite for aggregate tests.

2.0 Literature Review and Theory

2.1 Geologic Background

This project concentrates in Malaysia located in the South East Asia region. In Malaysia, there are two parts, East Malaysia and West Malaysia where Simpang Pulai is located in the West Malaysia. West Malaysia is also known as Peninsular Malaysia which according to J.K. Raj (2009) measures around 130,268 km^2 and forms part of the Sundaland including Borneo, Java and Sumatra. The part of the Asian continent which is extended to the southeast is known as the Sundaland which is also partly submerged.

The Peninsular Malaysia has so far been studied and is said to have been emergent throughout the Cenozoic and was quite tectonically stable. Other sources like Stauffer (1973a) and Gobbett & Tija (1973) mentioned about some epeirogenic uplift and tilting, some fault movement and also local gentle downwarps.

According to de Smet & Barber (2005) during the Cenozoic time, there could be some deposition of continental margin sediments on the eroded surface of pre-Tertiary Sundaland basement. During the Late Eocene to the Late Oligocene time there were also some development of horst and graben features. (Barber et al, 2005a).

2.2 Granite History

In the Peninsular Malaysia, the granite composition can mainly be seen composed in figure 2.

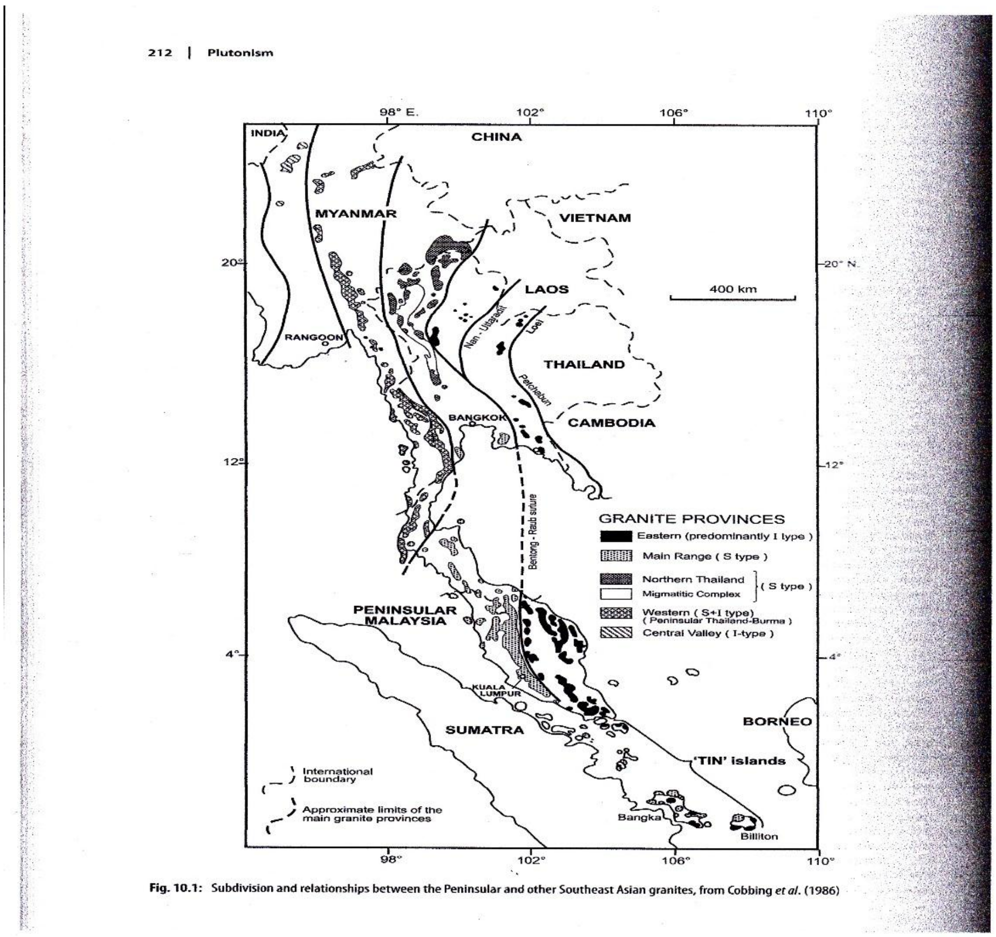


Fig. 10.1: Subdivision and relationships between the Peninsular and other Southeast Asian granites, from Cobbing *et al.* (1986)

Figure 2: The granite composition in the Peninsular Malaysia

The granites in the Simpang Pulai area are from the Main Range granites which according to Hutchinson (1975) is part of the Peninsular Malaysia where the other part is the Eastern Range. These two ranges are separated by the Bentong-Raub suture. The Main Range is also said to be continuing even until the latitude of Bangkok. The approximate ages of the formations of granite structure is around 207 to 230 Ma. (Bignell &Snelling, 1977). Among the characteristics of the Main Range granites is having silicon dioxide SiO_2 percentage of more than 65%. Other than that, the granites responsible for the tin mineralization are also of the S-type formed by the continental lithospheric collision.

2.3 Testing the Granite quality

According to the British Geologic Survey website, rock aggregates are actually any granular material that is formed from a natural rock substance. As this part of the project is focusing on the quality of the granite for usage in the industry, further tests are to be conducted on the samples taken. These tests are all done according to the British Standard requirements. As a guide, the British Standard requirement is used by following the Specification for Aggregates from Natural Sources for Concrete BS 882: 1992. Another edition was also viewed for more information which is the British Standards Publication titled Aggregates for Concrete BS EN 12620: 2013. Furthermore, the International Standards Worldwide (ASTM), 1981 is also taken into account for the specific gravity test.

3.0 <u>Methodology</u>

This project involves many procedures where it can be divided into two parts namely from the geologic procedure and the rock aggregate testing procedure.

3.1 <u>Geology Procedures</u>

This project involves many procedures where it can be divided into two parts namely from the geologic procedure and the rock aggregate testing procedure.

Geology Procedures

1) Obtaining the base map of the study area, Simpang Pulai, Perak.

2) Constructing the geology map of the study area is done by the following steps

   i. Visiting the study area.

   ii. Observing and taking readings of the lithology present.

   iii. Observing and taking readings of the fault trends and joints.

   iv. Relating the readings obtained with the coordinates and comparing with the base map to identify the location of observations made in the map itself.

   v. The map is constructed by using the ARCGIS software where important locations were marked in the Google Earth software and the transferred here.

   vi. To then label the geologic properties of the map created, the Adobe Illustrator software is used.

   vii. The cross sections were obtained by using the Google Earth software by drawing the transect line wanted. However this result is compared with the observations made at the road traversing or fieldtrip activity carried out.

3.2 Rock Aggregate Testing

There are a few types of tests in the rock aggregate testing procedure. Only selected procedures were done due to the time constraint. Among them are listed below

i. Deleterious material test under microscope.

ii. Specific gravity (British Standard 882:1992)

iii. Water absorption test. (British Standard 882:1992)

iv. Impact Value test. (British Standard 812:1990)

v. Crushing Value test. (British Standard 812:1990)

1) <u>Deleterious material test under microscope</u>

i. First, the rock sample is washed thoroughly, and then crushed.

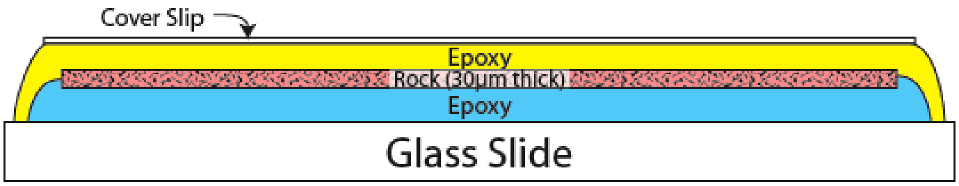


Figure 3 : Example of thin section diagram.

ii. As shown in the diagram above, the thin section is prepared with the sectioned crushed rock on the glass slide with about 3mm thickness.

iii. The epoxy is used to hold the sample together.

iv. Sample is then grinded slowly to produce the most smooth surface possible

v. The prepared thin section is analyzed under the polarized light microscope to observe any clay matter presence that can make the rock to be weak.

2) Specific Gravity and Water Absorption Test

This test is to measure the strength of the materials in the rock sample where lower values of specific gravity generally indicate a lower strength. Water absorbent rocks tend to have more porosity or in other words spaces in between grains causing the rock to have a more loose arrangement of grains hence, lower strength too.

i. Sample is washed and dried using normal air drying method.

ii. The mass of the sample is about 2 to 3kg and its particle size of sample is made sure to be about 10mm.

iii. Immersion of rock sample is done with at least 50mm of water level above the sample.

iv. The sample is then taken out to be wiped by a dry cloth and is then placed in the oven for 24 hours at 105 degree Celsius.

v. After step 4, the sample is taken out and left to be cooled and is then weighed.

3) Aggregate Impact Value Test

i. The granite samples are crushed and reduced in size of range (0.5-3/8) inches sieve.

ii. They are then collected and weighed accordingly.

iii. Then the samples are dried in the oven for 4 hours at 100 degrees Celcius.

iv. Then the instrument is filled with the samples in three layers.

v. Each layer is tamped 25 times by the round end of the tamping rod. Surplus aggregate is removed.

vi. Sample is now placed at the base of the machine where the hammer is adjusted to 380mm above the upper surface. It is then allowed to fall freely on the aggregates.

vii. The aggregates are subjected to 15 blows at intervals of at least 1 second.

4) Aggregate Crushing Value Test

i. The sample is prepared to be at the size range of (10-14)mm in size.

ii. Samples were filled in three layers and subjected with 25 strokes by the tamping rod. Force exerted is of 400 kN.

iii. The crushed sample was emptied onto a tray of known mass and the weight of aggregates were determined.

iv. Sieving is done and the weight of the retaining and passing samples through the 2.36mm sieve were recorded.

4.0 Results & Discussion

4.1 Main Lithologies of Study Area

Based on the road traverse done, it can be said that there were three main lithology or rock types present. They are limestones, granites and kaolin. These three types of lithology however are of various types namely in terms of mineral composition and possibly due to the high weathering effect. Thus the lithology found were present in a great variety.

These three main lithology all have quarries of their own and there are many factories producing materials from these rock sources. From visits to companies nearby, it has been established that the granites at the Simpang Pulai area are from the Main Range grainite of Malaysian Peninsular. This granite is called the Slim granite and underlays the area. Some of the areas composed of granite can be seen in the figures below.

Figure 4: Granite outcrop observed at Simpang Pulai area

From the figure on the left, it can be seen that the granite outcrops have been weathered to a certain extend. There are also some vegetations at this area. There are also sets of joints and fractures observed along this outcrop.

This figure below is another location composed of granite outcrops. It can be seen that this area is also weathered but has many factures and joint.

Figure 5: heavily fractured granite outcrop observed at Simpang Pulai area

The limestone outcrops observed were also what could be said as high quality limestones thus may factories work on these rocks mostly for the production of marble tiles. A factory producing these material was visited, Kintally Marble where some of the works were observed for better understanding. Other than that because some areas were weathered, it was hard to identify the limestone thus a small amount of acid (1.0 mol) was poured to confirm the presence of the calcium carbonate contents.

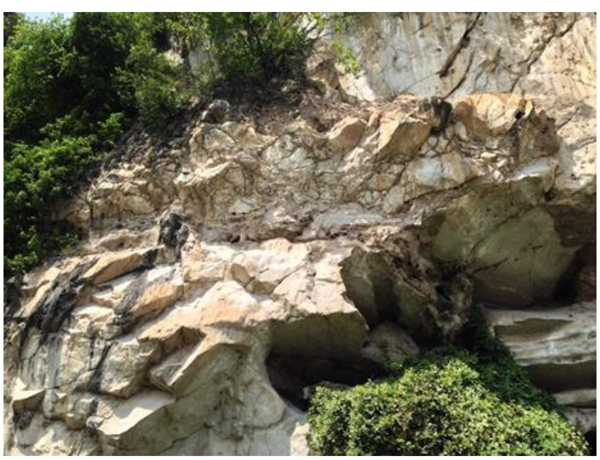


Figure 6: Limestone cave structure at the foot of the hill.

The figure on the left show the limestone outcrop found where it is very massive consisting of a higher mountain. At the foot of this mountain, it can be observed to be a cave-like structure formed possibly due to the weathering effect during times of higher sea levels. There are also huge fractures along this outcrop and also change of colour at different areas also due to the weathering effects.

Figure 7: Limestone cave structure with stalactite and stalagmite features

This figure on the left shows another area of limestone also partly weathered and composed partly of vegetation. There can be observed is the presence of stalactite and stalagmite features.

By far, kaolinite was the least amount found compared to granite and limestone. This is probably because kaolin is just a weathered product of granite and it should be in mind that it is also mined at the same time. Some areas were weathered and some were not but all were located at the end of the traverse pathway.

Figure 8: Kaolin deposit observed at Simpang Pulai area.

The kaolin outcrop observed as shown contained many areas of silicate rock and there is also a pond in the middle. The kaolin observed here are very clear mostly from grey to clear white colour.

4.2 Latest Map

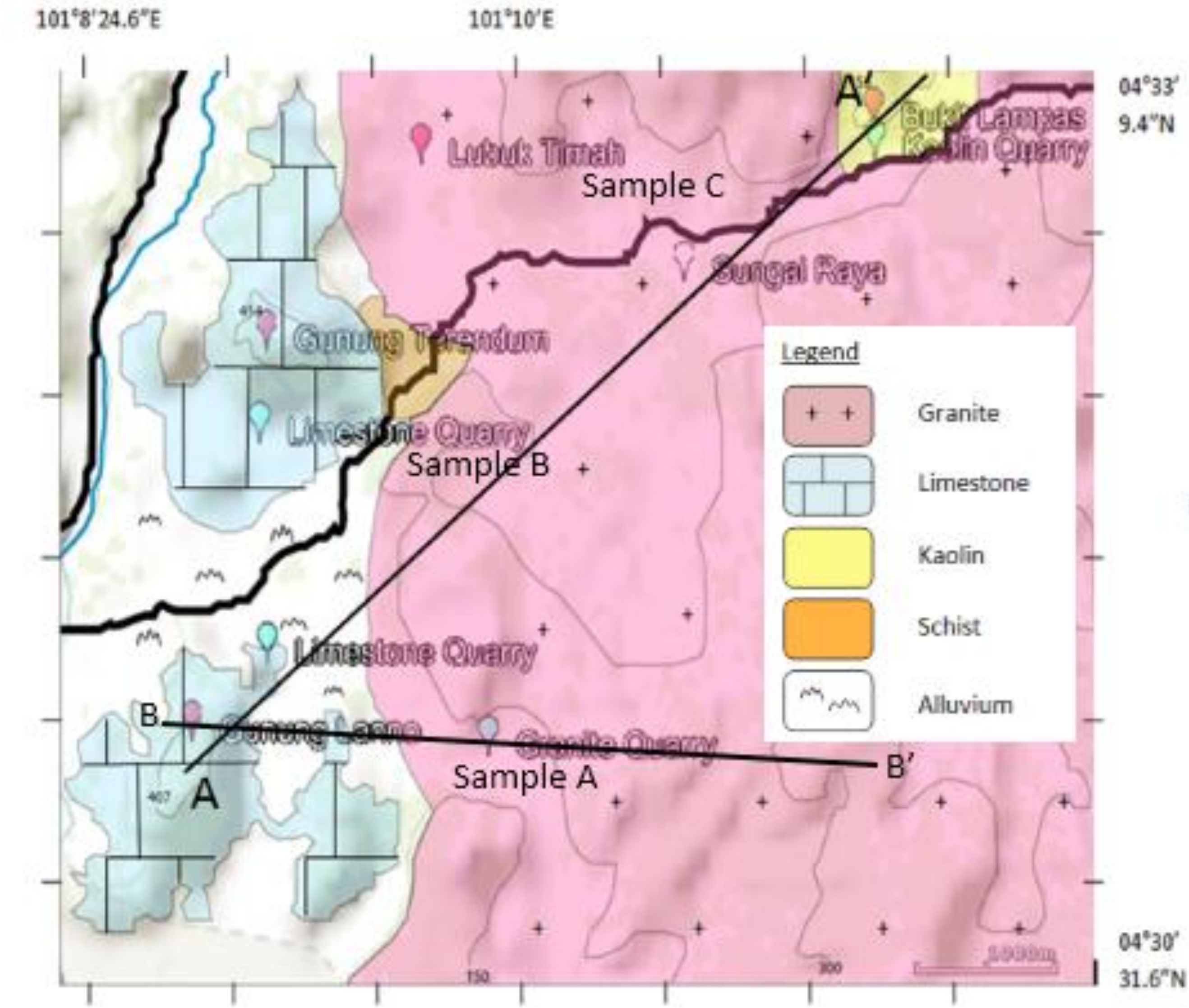


Figure 9: Geology map of Simpang Pulai area

In the topography base map obtained, it can be seen that the area that is focused in the projectaded area with different colors showing different main outcrops. This information has been obtained by the reconnaissance survey done with the project supervisor's guidances. A reconnaissance survey actually involves a rapid and rough survey where a thorough examination of the area through which the proposed survey line is run. There are a few steps followed throughout this reconnaissance survey done on the Simpang Pulai area.

1) Available aerial photographs or available maps were initially collected.
2) The distance of the area studied along the path selected was determined. In this case the distance along the road of approximately six kilometers. Also the coordinates of the location were also marked which is from 101° 8′ 24.6″ to 101° 10′ East and 04° 30′ 31.6″ to 04° 33′ 9.4″ North.
3) A rough estimation was also done on the geologic information especially on the rock types along the road.

The next part is done by using the ARCGIS software which enables the marking of importamt locations around the study area for example the highest peaks, the locations of obtained samples and so on. Then the Adobe Illustrator software is used to shade the map according to the lithology observed in the study done. Thus this enables the efficient knowledge of the lithology boundaries and also estimation of the boundary of important outcrops.

Based on the map created, there are two lines drawn A to A’ and B to B’ which indicate the path of the cross sections made. This will be explained in the cross section part separately. Also labelled is the locations of the samples of granite obtained for the aggregate tests sample A, B and C.

4.3 <u>Cross- Section</u>

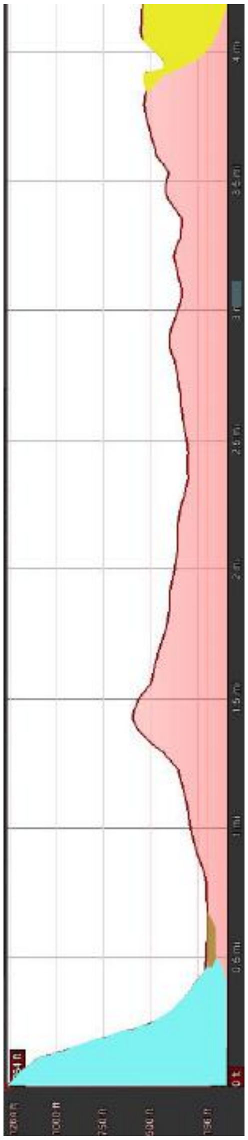
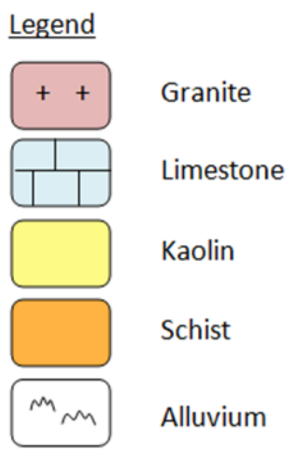


Figure 10: Cross-section of A to A’

Based on this cross section, it can be seen that towards A’, there is some kaolin deposits. The highest peak is at the A area near the starting point. Its is elevated 1264 ft and is a limestone hill. It slowly moves on to some deposited alluvium and to the granite quarry labelled in purple.



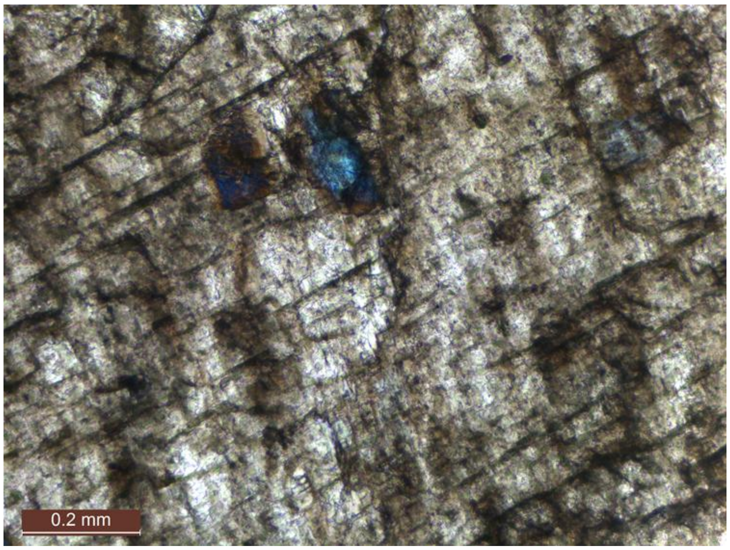
4.4 Sample Description

4.4.1 Granite Samples

There are three main samples of granite taken from different areas around the study area. These areas are all already marked in the map created shown in the previous pages.

Sample A

Sample A rock is obtained from the Lafarge Aggregates Quarry located in the Simpang Pulai area. This rock sample can be categorized as medium to coarse grained granite rock. The rock consists of mostly crystalline structures and there are very clear forms of twinning. This is interpreted to be the feldspar and from examining the rock's physical colour of grey to white, it can be said that is plagioclase feldspar. This is because the presence of potassium feldspar would cause a slight pink colour to be observed.



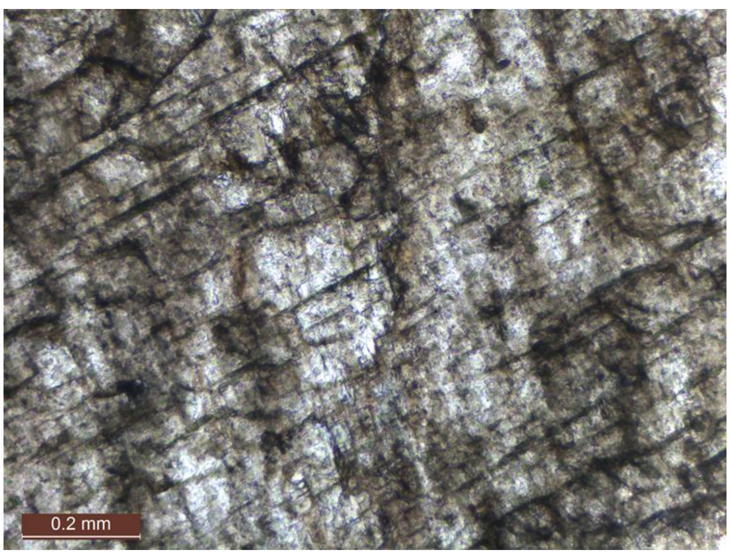
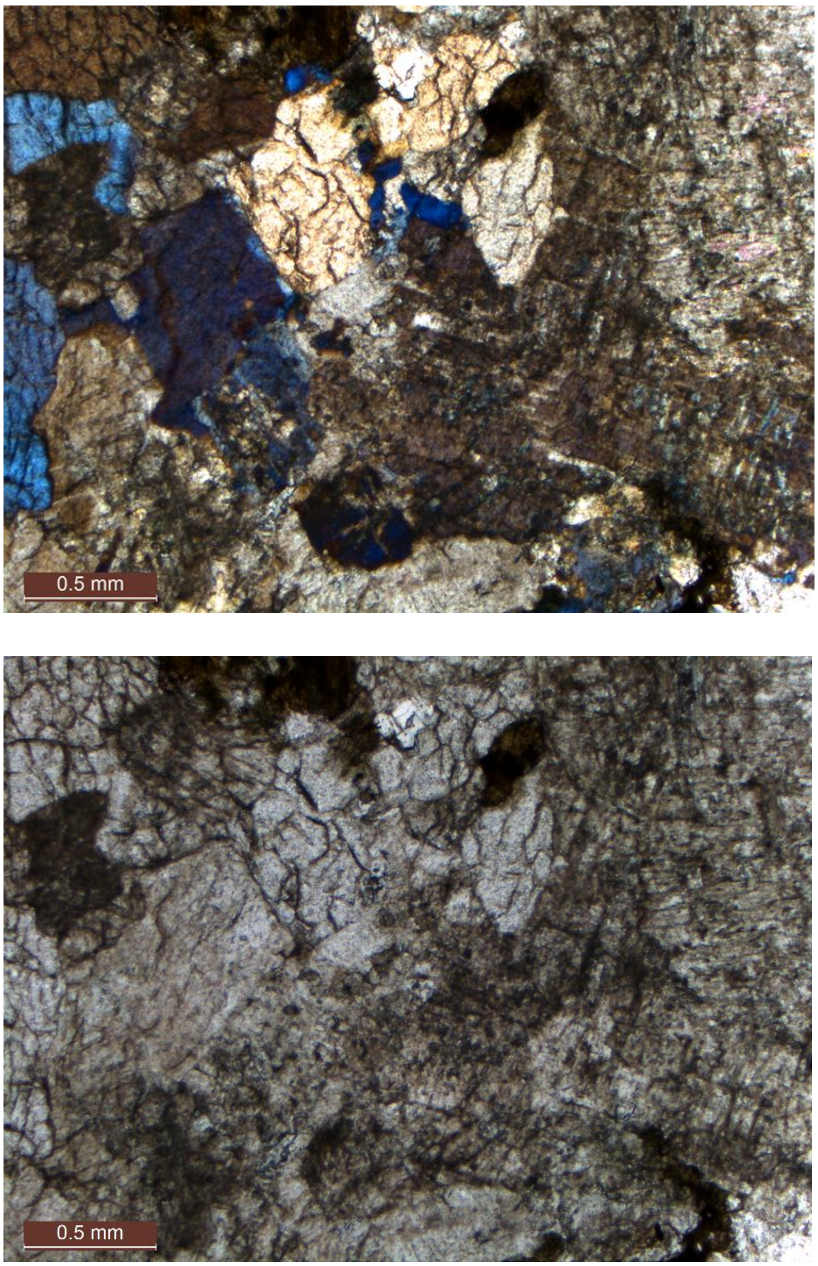


Figure 11: Granite Sample A cross polarized light (top), plane polarized light (bottom)

The feldspar found are all oriented in one direction and are mostly of white colour to grey. On the whole, this rock can be said to be consist of 60-80% feldspatic and 15-30% quartz with the rest being some inclusions of biotite.

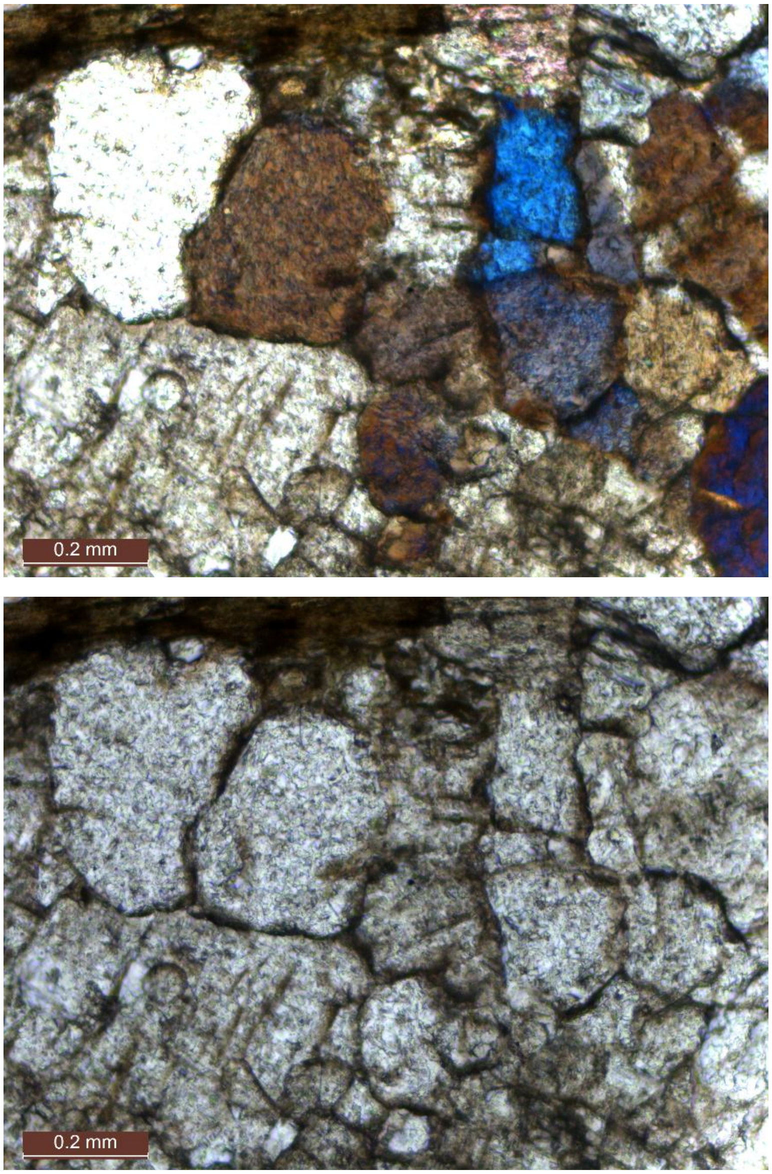
Sample B



Sample B granite is also of medium to coarse grained minerals. It is composed mostly of feldspar with very visible cleavages. The grain sizes relatively are equigranular and the grain shapes are mostly anhedral. There are small inclusions of biotite minerals as well. The quartz observed are of a characteristic low birefringence of the first order. The feldspar observed here are of a very high birefringence but of low relief.

Figure 12: Granite Sample B cross polarized light (top), plane polarized light (bottom)

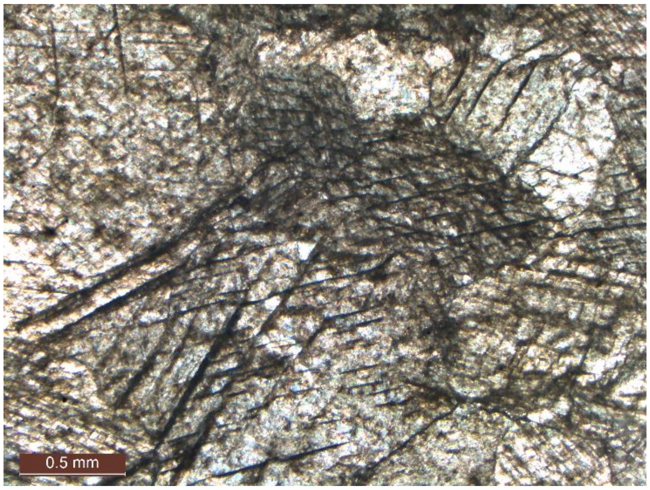
Sample C



This rock sample was obtained along the road towards the kaolin outcrop. This location is not a quarry location but the granite was also found here. However, based on the physical properties of the rock it can be seen that the samples obtained here have been highly weathered. The granites appear to be of dark brown in colour with some areas of red marks possibly due to the minor iron deposits. The rock here is composed by about 60-70% feldspar and about 20-30% quartz. The relief of the feldspars minerals are quite visible with also some cleavages.

Figure 13: Granite Sample C cross polarized light (top), plane polarized light (bottom)

4.4.2 Limestone Samples



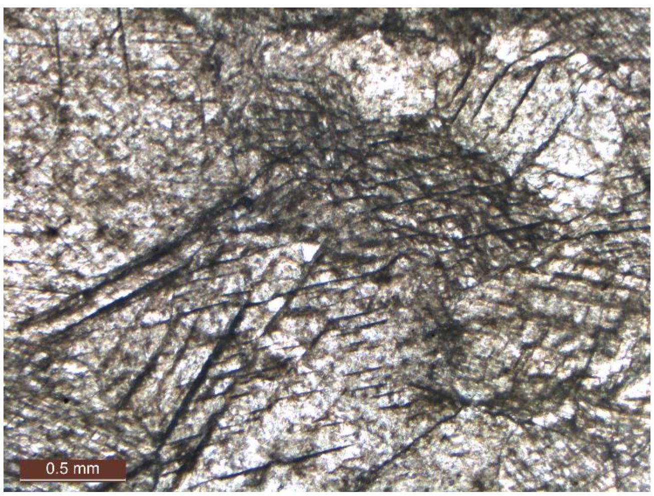


Figure 14: Limestone sample cross polarized light (top), plane polarized light (bottom)

The figures show the sample of limestone thin section obtained from the study area. This thin section is done just for a mere confirmation on the rock sample as a limestone. The thin section shows very high amount of cleavages present. Majority of the minerals are identified as calcite and appear to be white to slight grey colour.

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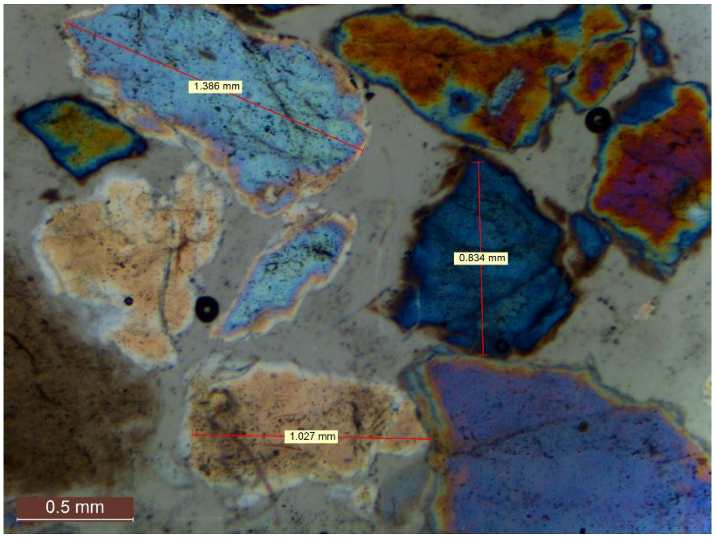
4.4.3 <u>Kaolin Sample</u>



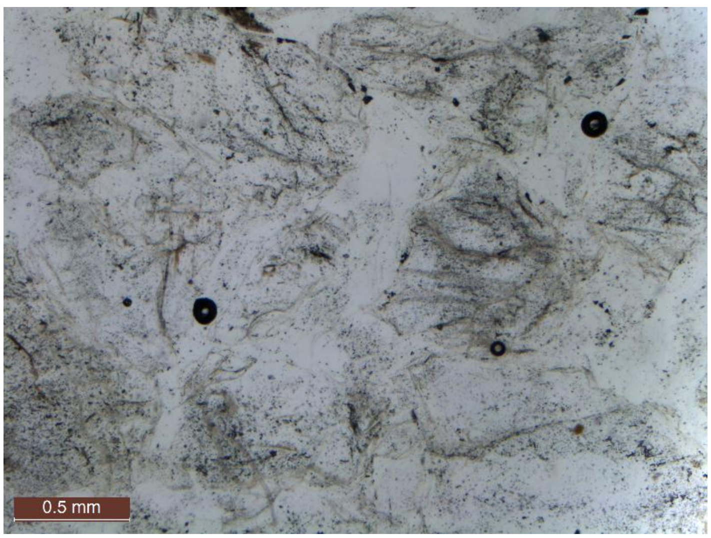


Figure 15: Kaolin sample cross polarized light (top), plane polarized light (bottom)

The figures show another sample of the main lithology which is the kaolin where the sample is made into thin section. This is also part of the confirmation process apart from the physical observation done on the rock sample. The thin section observed here shows very less cleavages which are not prominent in the grains. Also there is no twinning observed here and it can be seen that the feldspar grains have a birefringence of first order which is low.

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4.5 Deleterious Material

On the whole, the deleterious material is basically an analysis of the thin section to detect the presence of foreign materials. These materials may cause the particles or the mineral arrangements to be weaker and thus act as a reason for not selecting the sample for industrial uses.

In some cases, there may be some other trace minerals such as pyrite. The presence of this material has been known to cause problem because from an aesthetic point of view, it may stain the granite usually experienced in polished tiles. On the other hand, pyrite tends to oxidize causing major problems because it will expand. Once this happens there may be breakage in the construction material or in certain cases an underfloor infill may be produced. Thus by observing all the samples of granites obtained, it can be said from the physical and thin section observation, there is no pyrite found.

In another situation, the presence of microcrystalline quartz may also cause many problems in construction use. This type of quartz in granite may affect the performance of the cement when this granite is used. This is because this type of quartz reduces the alkali silica which causes swelling of the material leading to breakages. From the observation made, all three samples do not contain these deleterious materials thus it can be used widely as construction materials.

4.6 Aggregate Analysis

Type of Test	Approved Standard (Jabatan Kerja-Raya Malysia)
Impact Value	10-20%
Crushing Value	Below 30%
Water Absorption	Not more than 2%
Specific Gravity	More than 2.56 g/cc (ASTM C615)

Table 1: Table of approved standards for aggregate analysis for construction use

4.6.1 Impact Value Test

	Sample A	Sample B	Sample C
Weight of aggregate (g)	350	350	350
Weight of aggregates passing 2.36mm sieve (g)	292.6	287.35	290.15
Weight of aggregates that retained (g)	57.4	62.65	59.85
Percentage of retained sample (Impact value) %	16.4	17.9	17.1

Table 2: Table of Impact value test results

Sample A, B and C shows not the highest quality because value below 10% is good. The values are between the ranges of 10-20% so still could be used in construction. The Jabatan Kerja Raya or the Malaysian Road Works Authority has mentioned these standards. The value of the results obtained indicate the possibility of usage in construction involving concrete pavement. The best is Sample A which was taken from a granite quarry in Simpang Pulai followed by sample C and B.

4.6.2 Aggregate Crushing Value

	Sample A	Sample B	Sample C
Weight of sample (g)	2700	2700	2700
Retained sample on 2.36mm sieve (g)	2057.4	2033.1	2052
Weight of sample passed through 2.36mm sieve (g)	642.6	666.9	648.0
Percentage of passed sample (Crushing Value) %	23.8	24.7	24.0

Table 3: Table of Crushing value test results

Appropriate quality is below 30% for wearing surfaces like pavement roads. If the values do however exceed 30%, it could still be used for construction of concrete provided it does not exceed 45%. All samples fit the standard but sample B is the best and could possibly be used for more tough or wearing surfaces such as airfield pavement surfacing.

4.6.3 Specific Gravity

Sample A	Sample B	Sample C
2.63	2.61	2.64

Table 4: Table of Specific gravity test results

The specific gravity results here are obtained as a comparison with the density of a reference material in this case water. The standard procedure here is followed and the results here is compared to the American Society for Testing and Materials (ASTM). It is mentioned that the minimum value should be 2.56. All three samples have good specific gravity values. Thus this in other words shows strength in the rock samples through its density.

4.6.4 Water Absorption

Sample A	Sample B	Sample C
0.55	0.51	0.58

Table 5: Table of Water absorption test results

The standard for the pavement surfaces indicates water absorption of below 2%. This is because a rock that can absorb more water shows that there are more void spaces in it thus a more weaker structure. Absorption of water from samples are quite good and suitable for usage as pavement surfaces.

4.7 New Possible Site for Granite

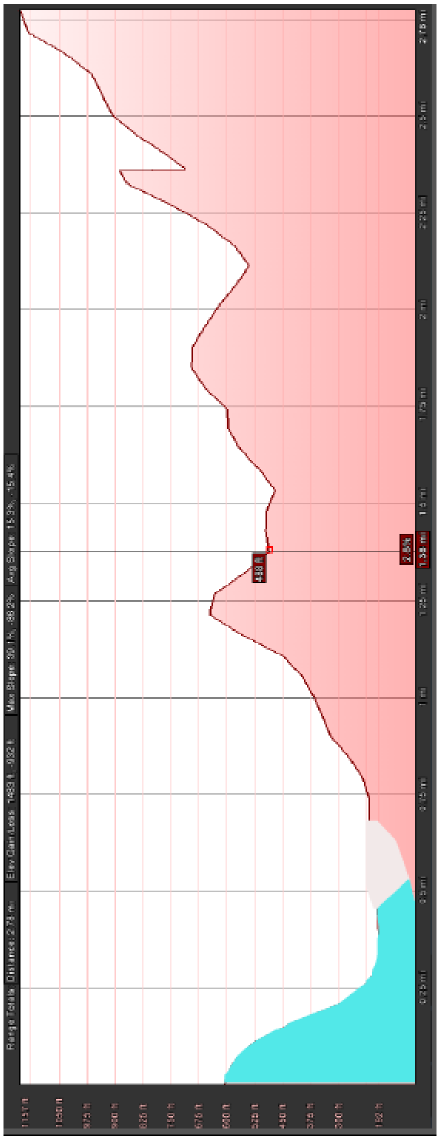
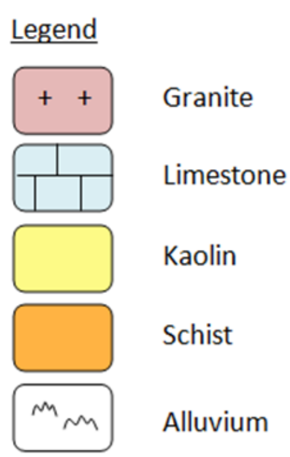


Figure 16: Cross section of B to B’

The figure on the left shows the cross section made in an attempt to find new possible site for granite source. Some observation was made and the region towards the B’ indicates a possible granite site. This conclusion is based on the visit made to that area. At the moment, this area labelled in the circle is regarded as a reserve forest area. This forest area is composed mainly of granite. Furthermore, the cross section shows elevation of more than 1157ft thus making it very suitable for a new granite quarry site. Now the only factor is whether the quality of the granite outcrops here are suitable for construction. Some test samples can be taken in order to solve this doubt.



5.0 Conclusion and Recommendations

On the whole, in this project all the main aims and objectives have been accomplished. All three samples have been observed to be very appropriate for industrial usage such as making road pavements, wearing surfaces and or airfield pavements. The map of scale 1: 50000 has also been constructed with sufficient indication of the geologic features present. On the other hand, another possible prospect for the granite exploration has also been successfully indicated. This has all come from not only the effort but also from being methodical and planning the steps in this project. All the processes were finished within the time frame given which is for about two semesters.

As a recommendation, the studies carried out at the Simpang Pulai area can be developed in ways such as adding the types of aggregate analysis. Furthermore, the general geology could also be improved in terms of adding more detail to the map created and as well as the cross-section map produced. The proposed quarry site needs to be studied better using these tests.

i. A detailed topographic study should be conducted.
ii. Drilling of cores should be conducted to estimate the thickness as well as the continuity of the outcrops.
iii. A shallow seismic exploration should also be conducted for further identification of the resources present.

Furthermore, the general geology could also be improved in terms of adding more detail to the map created and as well as the cross-section map produced

6.0 References

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