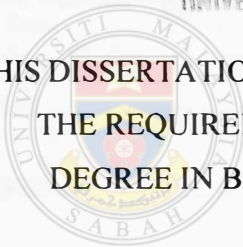


**GENERAL GEOLOGY AND COASTAL GEOMORPHOLOGY  
WITH POSSIBILITIES OF  
TSUNAMI OCCURRENCE IN LAHAD DATU TOWN AREA**

**JASSIMRAN SINGH**

**PERPUSTAKAAN  
UNIVERSITI MALAYSIA SABAH**

**THIS DISSERTATION IS HANDED IN TO FULFILL  
THE REQUIREMENTS OF OBTAINING A  
DEGREE IN BACHELORS OF SCIENCE**



**UNIVERSITI MALAYSIA SABAH**

**GEOLOGY PROGRAM  
SCHOOL OF SCIENCE AND TECHNOLOGY  
UNIVERSITI MALAYSIA SABAH**

**APRIL 2008**

## UNIVERSITI MALAYSIA SABAH

## BORANG PENGESAHAN STATUS TESIS@

JUDUL: General Geology and Coastal Geomorphology with the Possibilities of Tsunami Occurrence in Lahad Datu

IJAZAH: IP Sarjana Muda GEOLOGI

SAYA Jassimran Singh  
(HURUF BESAR)

SESI PENGAJIAN: 2005-2008

mengaku membenarkan tesis (LPSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:-

1. Tesis adalah hakmilik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan ( / )

SULIT

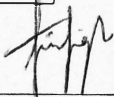
(Mengandungi maklumat yang berdarjah keselamatan atau Kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan Oleh



(TANDATANGAN PENULIS)

Disahkan Oleh NURULAIN BINTI ISMAIL  
(TANDATANGAN PUSTAKAWAN)  
UNIVERSITI MALAYSIA SABAH

Alamat Tetap: NO. 2, JALAN SUKSES,  
TAMAN SRI GEMBOK,  
69100 BAWANG LIPAT, SELANGOR

Nama Penyelia

Tarikh: 12/5/07

Tarikh: \_\_\_\_\_

CATATAN:- \*Potong yang tidak berkenaan.

\*\*Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa /organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.

@Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan atau disertai bagi pengajian secara kerja kursus dan Laporan Projek Sarjana Muda (LPSM).

## CONFESSION

I confess that this dissertation was done fully by myself and those that I have referred has been quoted its source.

19 April 2008



A handwritten signature in black ink, appearing to read 'Jassimran Singh'.

(JASSIMRAN SINGH A/L BHAG SINGH)

HS 2005-2798

UNIVERSITI MALAYSIA SABAH

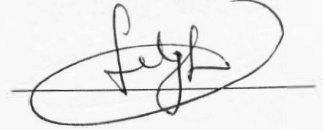
# EXAMINER CONFIRMATION

## CONFIRM BY

1. SUPERVISOR

Signature

(PROF. DR FELIX TONGKUL)



2. FIRST EXAMINER

Signature

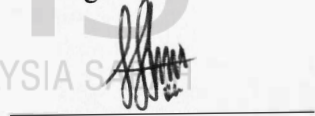
(EN. SAHAT SADIKUN)



3. SECOND EXAMINER

Signature

(EN. RODEANO ROSLEE)



4. DEAN

Signature

(SUPT. K/S PROF. MADYA DR. SHARIFF A.K. OMANG)



UMS  
UNIVERSITI MALAYSIA SARAWAK

## ACKNOWLEDGEMENT

First and for most, I would like to thank God for giving me the strength and courage to complete this dissertation on time. I would take this opportunity to thank all those that have been involved and given me a good help in completing this final year project.

Professor Dr. Felix Tongkul has been always a superior help. The teaching, motivation and courage that he has been giving will always be remembered till end.

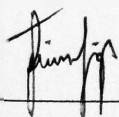
All those lecturers especially Prof. Dr. Hj. Sanudin Hj. Tahir, Prof. Madya Dr. Shariff A.K Omang, Prof. Dr. Felix Tongkul, Prof. Madya Dr. Baba Musta, Mr. Rodeano Roslee and Mr. Sahat Sadikun that have been teaching me from day one till now is appreciated.

I would also like to show my appreciation to my parents who has always been there to support me mentally and financially throughout the journey of completing this dissertation. Not forgetting those in Lahad Datu, Mr. Ram Tan and Madam Nikki who have always been there to make my stay easier during field observations.

To all the lab assistance of Geology program in Universiti Malaysia Sabah, Encik Mohammad, Encik Jalaludin Majalip and Encik Abdurrahman, I would like to wish thank you very much.

To all those workers of 'Jabatan Kaji Cuaca', 'Jabatan Tanah dan Ukur' and 'Jabatan Mineral dan Geosains' that has provided me with useful and vital information, i would like to say thank you.

Last but not least, I would like to thank my love Pavitar Kaur in giving me the courage and support throughout the whole journey in completing this dissertation.



(Jassimran Singh)

## ABSTRACT

The study area consists of 189.36 km<sup>2</sup> which is located at the main town of Lahad Datu. It starts approximately from Kg. Sepagaya Ulu to Taman Warisan. The study area is situated 260 km from Sabah's capital, Kota Kinabalu and lies on latitude between N 04° 56.5' - N 05° 03.5' and longitude of E 118° 15' - E 118° 24'. The area lies on 4 major formations which are the Quaternary Sediments, the Tabanak Formation, the Ayer Formation and the Crystalline Basement Rocks. There are two different types of Quaternary Alluvium that were seen in the study area which were the Coastal alluvium and the Fluvial deposit (pebbly alluvium). The Tabanak Formation which comprising conglomerate, boulder conglomerate, conglomeric mudstone, interbedded tuffaceous sandstone and shales, shales, tuffaceous sandstone and tuff were noticed. The Ayer Formation consists of slump breccia deposits to those of the Kuamut Formation. Tuffaceous sedimentary rocks are most abundant in the Ayer Formation. Crystalline Basement in Lahad Datu area has an age of Pre-Tertiary and probably metamorphosed mainly of basic igneous and plutonic intrusive rocks. The study of the area was emphasized the most on the geomorphology of the coastal line. Factors such as topography, drainage, erosion, coastal types and population density were all considered and associated with each and other to evaluate the risk of the study area in preventing a setback from a tsunami. It is believed that the main town area which includes Kg Ipil, Kg. Burung, Kg. Unta and Kg Puyut lays at the most risky region. Places such as Kg. Muhibah, Taman Aman, Taman Aman Jaya, Kg Tabanak, Kg. Sepagaya and Taman Warisan are considered at the moderate risk area while Kg. Dusun, Kg. wawasan, Kg. Damai, Kg. Durian and Kg. Jawa would be considered the most least prone to the effect of tsunami.

## ABSTRAK

Kawasan kajian meliputi keluasan sebanyak 189.36 km<sup>2</sup> dan terletak di kawasan Pekan Lahad Datu. Kawasan kajian bermula dari Kg. Sepagaya Ulu yang terletak di sebelah timur hingga ke Taman Warisan yang terletak disebelah barat kawasan kajian. Kawasan kajian terletak 260 km dari ibu negeri Sabah, Kota Kinabalu dan terletak di latitud U 04° 56.5' - U 05° 03.5' dan longitud of T 118° 15' - T 118° 24'. Terdapat 4 formasi iaitu Sedimen Kuarteneri, Formasi Tabanak, Formasi Ayer dan Batuan Dasar Berhablur. Dua jenis Sedimen Kuarteneri yang telah diperhatikan iaitu aluvium pantai dan aluvium sungai. Konglomerat, boulder konglomerat, batu lumpur konglomerat, batu pasir bertuf dan lodak membentuk Formasi Tabanak. Formasi Ayer mengandungi *breccia* yang juga dijumpai di Formasi Kuamut. Batuan sedimen yang bertuf adalah paling dominan bagi formasi ini. Batuan dasar berhablur di Lahad Datu adalah batuan yang paling tertua iaitu pada usia *Pre-Tertiary* dan dipercayai merangkumi batuan igneus dan plutonik yang termetamorf. Kajian yang lebih mendalam telah dijalankan pada kawasan persisiran pantai dari aspek geomorfologi. Faktor-faktor seperti topografi, sistem sungai, hakisan, jenis pantai dan populasi penduduk telah dikaji untuk menentukan kadar risiko beberapa kawasan tertentu di kawasan kajian bagi mengatasi kemungkinan tsunami. Kawasan utama seperti Kg Ipil, Kg. Burung, Kg. Unta dan Kg Puyut terletak pada kawasan yang mempunyai risiko yang tertinggi. Manakala Kg. Muhibah, Taman Aman, Taman Aman Jaya, Kg Tabanak, Kg. Sepagaya dan Taman Warisan dipercayai terlindung dalam kawasan risiko sederhana. Kg. Dusun, Kg. wawasan, Kg. Damai, Kg. Durian and Kg. Jawa adalah kawasan yang paling rendah risikonya mengatasi kesan yang boleh ditimpa oleh ombak tsunami..

## CONTENTS

	Page
TITLE	i
CONFESSION	ii
CONFIRMATION	iii
ACKNOWLEDGEMENT	iv
ABSTRACT	v
ABSTRAK	vi
LIST OF CONTENTS	vii
LIST OF TABLES	x
LIST OF FIGURES	xi
LIST OF PHOTOSS	xiii
LIST OF MICROPHOTOS	xv
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Foreword	1
1.2 Study Area	1
1.3 Objective	4
1.4 Methodology	5
1.4.1 Early Preparation	5
1.4.2 Field Work	7
1.4.3 Lab Analysis	8
1.4.4 Writing	9
1.5 Literature Review	9
1.6 Research Limitation	10
 <b>CHAPTER 2 GEOGRAPHY</b>	 <b>12</b>
2.1 Introduction	12
2.2 Geography	13
2.2.1 Weather	13



2.2.2	Connectivity	14
2.2.3	Population	16
2.2.4	Socioeconomic	17
2.2.5	Flora and Founa	19
<b>CHAPTER 3</b>	<b>GENERAL GEOLOGY AND STRATIGRAPHY</b>	<b>22</b>
3.1	Introduction	22
3.2	Regional Geology	22
3.2.1	Tectonic Positioning	22
3.3.2	Regional Stratigraphy	29
3.3	Stratigraphy of Study Area	31
3.3.1	Crystalline Basement	31
3.3.2	Ayer Formation	33
3.3.3	Tabanak Conglomerate Formation	35
3.3.4	Quaternary Alluvium	37
3.4	Structral Geology	40
3.4.1	Lineament	40
3.4.2	Bedding	42
3.4.3	Joint	45
3.5	Petrography	47
3.6	Summary	48
<b>CHAPTER 4</b>	<b>COASTAL GEOMORPHOLOGY</b>	<b>47</b>
4.1	Introduction	47
4.2	Regional Geomorphology	47
4.3	Geomorphology	51
4.3.1	Topography	51
4.3.2	Drainage	53
4.3.3	Weathering	58
4.3.4	Costal Topography	60
4.3.5	Coastal Types	66

4.3.6	Costal Morphology	70
4.3.7	Tides	76
4.4	Possibilities of Tsunami	79

## **CHAPTER 5 DISCUSSION AND SUGGESTIONS**

5.1	Foreword	84
5.2	Discussion	84
	5.2.1 Effect and Mitigation	85
5.3	Suggestions	89
5.4	Conclusion	90

<b>REFERENCE</b>	<b>94</b>
------------------	-----------

## **APPENDIX**



**UMS**  
UNIVERSITI MALAYSIA SABAH

### LIST OF TABLES

Table number		Page
1.1	Topographic map that was used to sketch the base map	6
1.2	Aerial Photograph's that was used	6
2.1	Population of lahad Datu district from Department of Statistics, Sabah	17



**UMS**  
UNIVERSITI MALAYSIA SABAH

## LIST OF FIGURES

Number	Page
1.1 Sabah's map that shows the exact location of the study area.	2
1.2 Study area in Lahad Datu town.	3
1.3 Study area in Lahad Datu town from Google Earth.	4
2.1 Total rainfall in Lahad Datu	13
2.2 Roads that are connected to other Sandakan and Tawau	15
3.1 Position of the tectonic plates that bounds Sabah. (Tan and Lamy, 1990)	24
3.2 The determining of Sabah evolution (Tongkul, 1991).	25
3.3 The positioning of tectonics in Sabah (Tongkul, 1993).	26
3.4 Structural trends of Sabah region (Tongkul, 1993).	27
3.5 Tectonics setting and regional framework of Sabah basin (Tongkul, 1993).	28
3.6 General stratigraphy of Sabah (Lim, 1985).	30
3.7 Formation boundaries in study area.	39
3.8 Negative and positive lineaments in study area.	41
3.9 The strain direction of the bedding in Tabanak Formation.	44
3.10 The strain direction for joint sets.	46
4.1 The costal lines and the seas that bounds Malaysia.	53
4.2 Topography of study area.	55
4.3 Flowage of the river of the study area in Lahad Datu town.	60
4.4 Areas that are critical towards flooding that may be caused by high rise of tides or tsunami.	64
4.5 Population density that may be affected the most with a tsunami.	65
4.6 The gulf shape coastal and the impact of the Sakar Island that will be discussed further in the next chapter.	66
4.7 The Coastal types that represent the costal line at the town bay.	72
4.8 Tombolo and beach ridges that were observed from the aerial	

photographs.	78
4.9 Monthly distribution of the height of tides.	81
4.10 Yearly distribution of the height of tides.	82
4.11 The possibilities of a tsunami source that could occur from an internal volcanic eruption or an earthquake.	84
4.12 The most likely entrance of massive high tidal or Tsunami.	85
5.1 Risk of the area that was identified from several factors.	90



**UMS**  
UNIVERSITI MALAYSIA SABAH

## LIST OF PHOTOS

Number		Page
1.1	Some of the swampy areas that were interfering in the study.	11
2.1	Lahad Datu airport.	14
2.2	Road that is made of pebbles or gravel.	16
2.3	Oil palm estate around Kg Ipil.	18
2.4	Fishing complex nearby the jetty in Lahad Datu town area.	19
2.5	Short trees and bushy jungle at south part of the study area.	20
2.6	Some of the swampy that were seen around the costal area.	21
2.7	Some of the swampy that were noticed behind the hospital area.	21
2.8	Part of the town was noticeable from this high point.	22
3.1	Ultrabasic intrusion rocks that were found at Kg. Silam.	32
3.2	An outcrop of Ayer Formation found on the way to Kg Damai.	34
3.3	An outcrop of Ayer Formation that consist of sandstone with tuff was observed on the way to Taman Aman.	34
3.4	Sandstone and shale of Tabanak Formation at Kg Sabah Baru.	36
3.5	Boulder conglomerate of Tabanak Formation at Kg Betik.	36
3.6	Costal alluvium at Kg. Singahmata.	38
3.7	Pebbly alluvium deposits at Edam River.	38
3.8	The sandstone and mudstone beds that were observed in Kg. Layung.	43
3.9	Interbedding between shale and sandstone at Kg. Layung.	43
3.10	Sets of joints that were used to determine the trench direction.	45
4.1	Part of the town was noticeable from this high point.	56
4.2	Sea area that is being reclaimed for development purposes.	57
4.3	The main Segama River that feeds to the other minor rivers.	58
4.4	River deposits that originated from fluvialtile rather than marine.	58
4.5	Tabanak River that flows along the hospital is being upgraded.	59
4.6	Sepagaya River that flows along Taman Aman and Kg. Sepagaya	

which is being upgraded.	59
4.5 Chemical weathering at Kg Sabah Baru area.	62
4.8 Chemical weathering of a conglomerate rock in Kg. Jawa area.	62
4.9 Kg. Ipil that is at the region of below 5 metres from sea level.	67
4.10 Kg. Puyut that is at the region of below 5 metres from sea level.	67
4.11 Taman Warisan at the region of below 5 metres from sea level.	68
4.12 Houses that are particularly very close to the bank of Segama River in Taman Aman Jaya.	68
4.13 Mangroves that were observed at the back of Kg. Tengah Nipah.	70
4.14 Rock barriers that were build to prevent coastal erosion by tides.	70
4.15 Sand and gravel at Kg Ipil area.	71
4.16 Primary forest that was observed in Kg. Binuang.	71
4.17 A horizontal line indicating wave's activities that erodes and cuts the surface hence produce a mass waste at Kg Ipil.	74
4.18 A horizontal line indicating wave's activities that erodes and cuts the surface hence produce a mass waste at Kg Ipil.	75
4.19 Break down of big rocks into smaller sediments which is caused by the tidal activity. Seen in Kg Ipil.	75
4.20 Beach at Kg Ipil that consist of less sand and more pebbles and boulders.	77
4.21 Mud flats that were observed at Kg. Singamata.	77
4.22 Beach ridge that was observed from the plane which is believed to be from Sakar Island.	79
5.1 High point at the back of Lahad Datu Hospital.	91
5.2 Evacuation point at Taman Aman Jaya.	91

## LIST OF MICROPHOTOS

Number		Page
3.1	The thin section of tuffaceous sandstone that mainly consist of quartz and other volcanic particles that gives the tuffaceous conditions (magnified X 10) .	45



UMS  
UNIVERSITI MALAYSIA SABAH



## CHAPTER 1

### INTRODUCTION

#### 1.1 FOREWORD

This chapter will be discussing the few important aspects such as the area of study, objectives, methodology, literature reviews and the problems that were faced during the tenure of study.

#### 1.2 STUDY AREA

The study area consists of 189.36 km<sup>2</sup> which is located at the main town of Lahad Datu. It starts approximately from Kg. Sepagaya Ulu to Taman Warisan. The study area is situated 260 km from Sabah's capital, Kota Kinabalu and lies on latitude of N 04° 56.5' - N 05° 03.5' and longitude of E 118° 15' - E 118° 24' (Figure 1.1). The map of the study area is shown in Figure 1.2 which consists of the river, roads and contours. A satellite view of the area was also managed to be retrieved from 'Google Earth' (Figure 1.3).





**Figure 1.1** Sabah’s map that shows the exact location of the study area.






05° 05'U

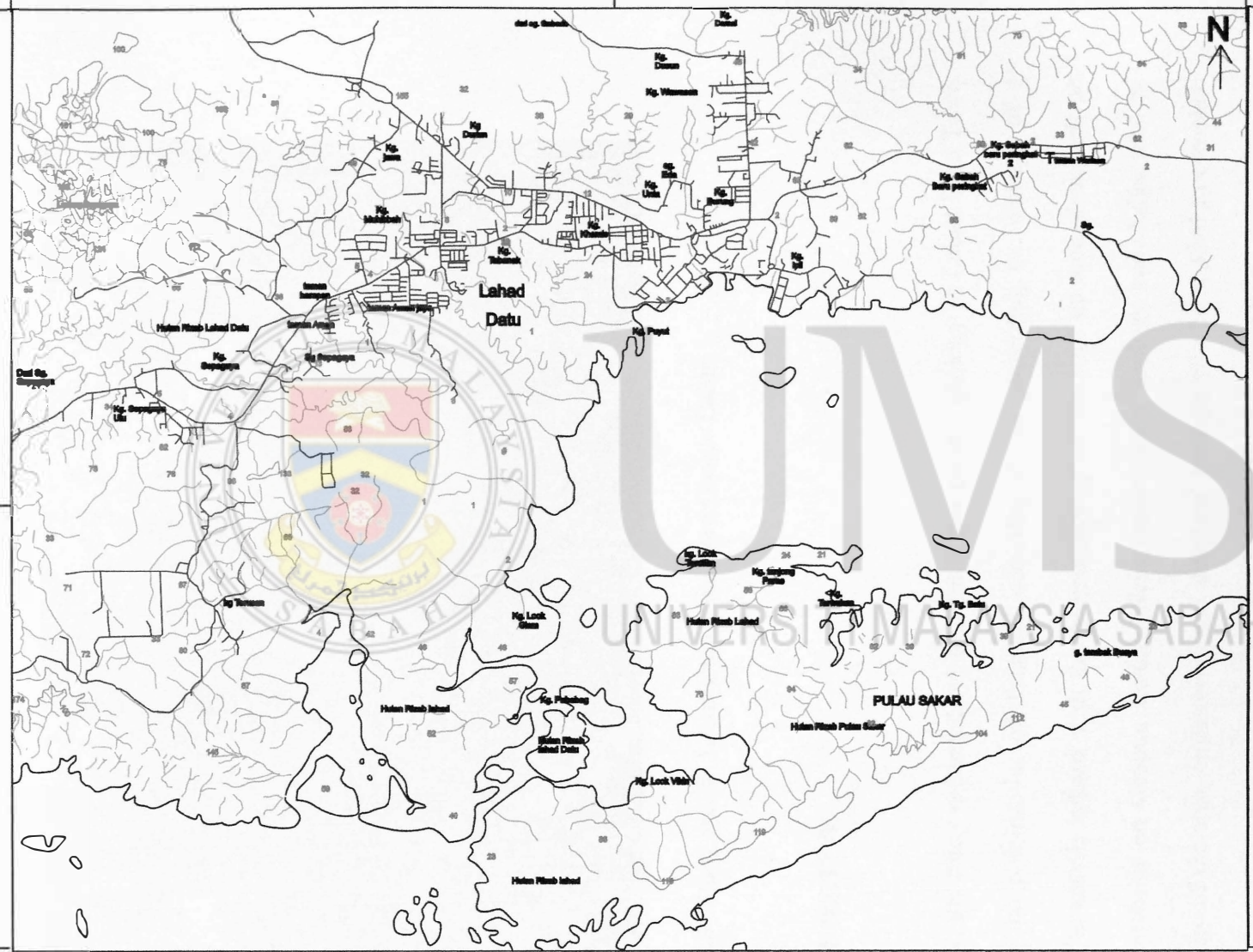
05° 00'U

04° 55'U



# KEY

-  River
-  Road
-  Land Outline
-  Contour
-  Spot Height



# SCALE

1 : 150 000 cm

**Figure 1.2** Study area in Lahad Datu town.



**Figure 1.3** Study area in Lahad Datu town from Google Earth.

### 1.3 OBJECTIVE

Generally, the study is carried out to identify the general geology of Lahad Datu Town area and the possibilities of Tsunami occurring. Since preventing the damage of a Tsunami is heavily related with the geomorphology of the built up area, there will be greater emphasis on Geomorphology. Nevertheless, basic geology knowledge such as stratigraphy of the area, engineering and structural geology will be applied to complete and give a better result in this research. Objectives in detail are as follow:

- To develop and produce an updated geological map of the study area.

- To determine the geomorphologic evolution mainly on the coastal site of the study area.
- To understand and take safety measurements to overcome a flood that may be cause by a Tsunami in Lahad Datu Town area.

## 1.4 METHODOLOGY

In the main, there were four common methods that were used to sustain the objectives of this research. It starts with the early preparations follows with the field work and sampling, lab analysis and ends with the final report writing. These methods will be discussed more in detail as follow.



UMS  
UNIVERSITI MALAYSIA SABAH

### 1.4.1 Early Preparation

Early preparation is done at the most prime before other methods could be carried out as is always important to prepare basic needs and information regarding the area. Before the next step which is the field work is carried out, information on the research area is collected from all type of sources such as books, journals, magazines, bulletins, reports dissertations and internet. Important books and journals were borrowed or taken from the library of Universiti Malaysia Sabah, as well as library of Universiti Kebangsaan Malaysia. Information were also gain from the 'Jabatan Mineral and Geoscience Sabah',

### 1.4.2 Field Work

Field work is one of the important methods that have to be carry put by all. The basic features of the area are studied much more in detail. Before making a field trip to the study area, we are supposed to equip ourselves with important geological tools such as geological compass, geological hammer, camera, GPS reader, and hand lens that would ease our study.

There were two trips made to the study area for the time being. The first one was done mainly to get use to the location, identifying as well as to update the roads in the base map that have been upgraded at the study area. Since the study area is a developing area, roads and paths are often in a process of being upgraded. Basically, the evolution of the area which has change for the past years has been updated in the base map. The overall picture of the study area was also taken down as well as the geographic futures and the economic status of the study area. The major formations of the place were recognized as well. Outcrops were searched at the same time pictures of the rivers and costal region were taken to assist in the lab analysis later on. The first visit was made on 23<sup>rd</sup> of August 2007.

Second visit was made on 17<sup>th</sup> of October 2007. This time the emphasis was given on the structural geology and the geomorphologic features of the study area, mainly at the coastal region of it. Primary and secondary structures such as fault and joints were all taken into account. The flowage of rivers and the depth are estimated. Every data and

pictures that were taken were labeled on the base map. Some rock samples were also taken to be analyzed later on.

### **1.4.3 Lab analysis**

The basic geological and geomorphologic data that were taken during the field work are now being analyzed. These data were then used to explain the geological and geographical processes that had taken place in these years. The geomorphologic activity and changes that were recognized were then looked into it much more in detail. The changes on the coastal line of the study area throughout the years were observed from the aerial photographs. Aerial photographs were used as a main guidance in this particular analysis since it has a good three dimension view of the area and its high resolution helps in identifying particular changes more rapidly.

For the petrography section, thin sections were done on a sand stone samples that were collected in the study area. The rock samples were cut into thin layer using the cutting machine. Hence, it was smoothed until their thickness was approximately 0.03 mm and pasted on the slide. Finally the samples were observed using the light microscope in identifying the types of minerals that were consisted.

pictures that were taken were labeled on the base map. Some rock samples were also taken to be analyzed later on.

### **1.4.3 Lab analysis**

The basic geological and geomorphologic data that were taken during the field work are now being analyzed. These data were then used to explain the geological and geographical processes that had taken place in these years. The geomorphologic activity and changes that were recognized were then looked into it much more in detail. The changes on the coastal line of the study area throughout the years were observed from the aerial photographs. Aerial photographs were used as a main guidance in this particular analysis since it has a good three dimension view of the area and its high resolution helps in identifying particular changes more rapidly.

For the petrography section, thin sections were done on a sand stone samples that were collected in the study area. The rock samples were cut into thin layer using the cutting machine. Hence, it was smoothed until their thickness was approximately 0.03 mm and pasted on the slide. Finally the samples were observed using the light microscope in identifying the types of minerals that were consisted.