SCHOOL OF MATERIALS AND MINERAL RESOURCES ENGINEERING

UNIVERSITI SAINS MALAYSIA

HYDROGEOCHEMISTRY CHARACTERISTICS OF WATER AND STREAM SEDIMENT ORIGINATED FROM ACTIVITIES SURROUNDING GUNUNG PAKU, PENGKALAN HULU, PERAK

By:

WAN AHMAD NAZMI BIN WAN SABERI

Supervisor: ASSOC. Prof. Dr. Kamar Shah Ariffin

Dissertation submitted in fulfillment of requirement for the degree of

Bachelor of Engineering with Honours

(Mineral Resources Engineering)

Universiti Sains Malaysia

JUNE 2018

DECLARATION

I hereby declare that I have conducted, completed the research work and written the dissertations entitle ‘Hydrogeochemistry Characteristics of Water and Stream Sediment Originated from Activity Surrounding Gunung Paku, Pengkalan Hulu, Perak’. I also declare that is has not been previously submitted for the award of any degree or diploma or other similar title for any other examining body or University.

Name of Student: Wan Ahmad Nazmi Bin Wan Saberi Signature:

Date: 25 June 2018

Witness by:

Name of Supervisor: ASSOC. Prof. Dr. Kamar Shah Ariffin Signature:

Date: 25 June 2018

ACKNOWLEDGEMENTS

Alhamdulillah, thank to Allah Almighty for giving me a chance and strength for completing my project and this thesis on my last semester.

First of all, I would like to thank for my Assoc. Prof. Dr. Kamar Shah Ariffin for his support and guidance throughout this research. I have learned and gained first hand experience to be on site and work on something real.

All the thanks to tremendous effort shown by the staff and technician in helping me throughout my lab work especially En Junaidi, En Kemuridan, En Syafiq, Pn Mahani and En Mokhtar. Also, greatest thank to family and friends whose never get tires for giving me mentally and physically support. Thanks to everyone for the greatest support and hope for a greatest success for everyone.

TABLE OF CONTENTS

Contents **Page**

LIST OF TABLES

LIST OF FIGURES

CIRI HIDROGEOKIMIA AIR DAN SEDIMEN SUNGAI BERASAL DARI AKTIVITI SEKITAR GUNUNG PAKU, PENGKALAN HULU, PERAK

ABSTRAK

Gunung Paku yang terletak berdekatan Klian Intan, Perak, dalam jalur timah barat Semenanjung Malaysia, adalah merupakan mendapan bijih timah utama di Malaysia yang dilombong sejak 200 tahun yang lalu, menyumbang 3-5% bijih timah konsentrat sebelum ini, dan semenjak itu lebih daripada 70% bijih timah Malaysia. Gunung Paku beresosasi dengan granit biotite (184-230 Ma) banjaran granit besar yang menganjur hingga ke bahagian selatan Semenanjung dan bahagian tengah Thailand. Corak pemineralan timah utama di Gunung Paku sebahagian besarnya beresosasi dengan terdapatnya sistem pembentukan telerang quartza berbentuk kepingan yang berlaku secara meluas yang selari dengan jurus batuan induk dan terkepung dalam zon sesar sempit berjurus U-S. Pemineralan adalah terbentuk dalam satu jujukan batuan sedimen yang dipunyai formasi Baling berusia Paleozoik. Mengikut kajian geologi, Sungai Belimbing, Sungai Air Jernih, Sungai Kepayang, Sungai Rui, Sungai Kuak, Sungai Hitam dan Sungai Duri dipilih untuk ciri-ciri hidrogeokimia sedimen sungai dan air. Tujuan kajian ini adalah untuk mengetahui kesan aktiviti persekitaran terhadap sedimen sungai dan kualiti air. Sampel perwakilan tertakluk kepada beberapa ujian seperti pendarfluor X-ray, difraksi sinar-X dan Plasma yang Digabungkan secara Induktif. Dari analisis XRF, sedimen tanah aliran dari sungai sekitar Gunung Paku menunjukkan bahawa komposisi logam rendah kecuali unsur Al dan Fe. Analisis ICP menunjukkan bahawa kepekatan logam pada sampel B1, B2 dan B3 adalah tinggi disebabkan oleh aktiviti persekitaran berbanding dengan sampel air yang lain dan juga nilai pH yang paling rendah dan kekonduksian elektrik tertinggi.

HYDROGEOCHEMISTRY CHARACTERISTICS OF WATER AND STREAM SEDIMENT ORIGINATED FROM ACTIVITIES SURROUNDING GUNUNG PAKU, PENGKALAN HULU, PERAK

ABSTRACT

Gunung Paku near Klian Intan, Perak, located within the western Tin Belt of Peninsular Malaysia, is a primary tin deposit in Malaysia mined since 200 years ago, contributing 3–5% of tin ore concentrates previously, and recently over 70% of the Malaysian tin. Gunung Paku is associated with biotite granite (184–230 Ma) of the Main Range Granitoid which extends up to the southern part of Peninsular and Central Thailand. The primary tin mineralization style at the Gunung Paku is mainly associated with widespread occurrence of sheet-like quartz veining systems parallel to the strike of the host rocks and confined within a narrow N–S trending fault zone. The mineralization formed within a thick sequence of metasedimentry rock that belongs to the Baling Formation of Palaeozoic age. From the geological survey, Sungai Belimbing, Sungai Air Jernih, Sungai Kepayang, Sungai Rui, Sungai Kuak, Sungai Hitam and Sungai Duri are chosen for hydrogeochemistry characteristics of sediment and water. The purpose is to know the effect of activities surrounding to the stream sediment and water quality. Representative samples are subjected to several test such as X-ray fluorescence, X-ray diffraction and Inductively Coupled Plasma. From the XRF analysis, the stream soil sediment from the stream surrounding Gunung Paku shown that the composition of metal is low except element of Al and Fe. The analysis of ICP show that the concentrations of metals for B1, B2 and B3 are high cause of activities surrounding compared with other water samples and also the lowest of pH values and the highest of electrical conductivity.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Gunung Paku near Klian Intan, Perak, is a primary tin deposit in Malaysia mined since 200 years ago, contributing 3–5% of tin ore concentrates previously, and recently over 70% of the Malaysian tin. The primary tin mineralization style at the Gunung Paku is mainly associated with widespread occurrence of sheet-like quartz veining systems parallel to the strike of the host rocks and confined within a narrow N–S trending fault zone. Wall rock alterations at Gunung Paku are mainly characterized by the hypogene type alteration consisting of silicification, tourmalinization, chloritization, sericitization and kaolinization normally adjacent to mineralized quartz veins and brecciated-fault gouge zones. Pyrite, ilmenite, cassiterite, rutile, chalcopyrite and other secondary iron-oxyhydroxide are the common metallic minerals that accompanied the tin mineralization. Futhermore, the activity such as mining, agriculture will affected the geology of surrounding Gunung Paku. Thus, the study of the area are needed to know characteristics of water and stream sediment originated from activities surrounding Gunung Paku. The hydrogeochemistry of these depend on the geological around there. Thus, the water and stream sediment samples from the stream surrounding Gunung Paku are need to be taken and the analysis will be made. For analysis, it needs to use the proper equipment at site and chemical analysis method. In the same time, through these methods, researcher can know and learned what is the better way or method to know how much the concentration of elements in water.

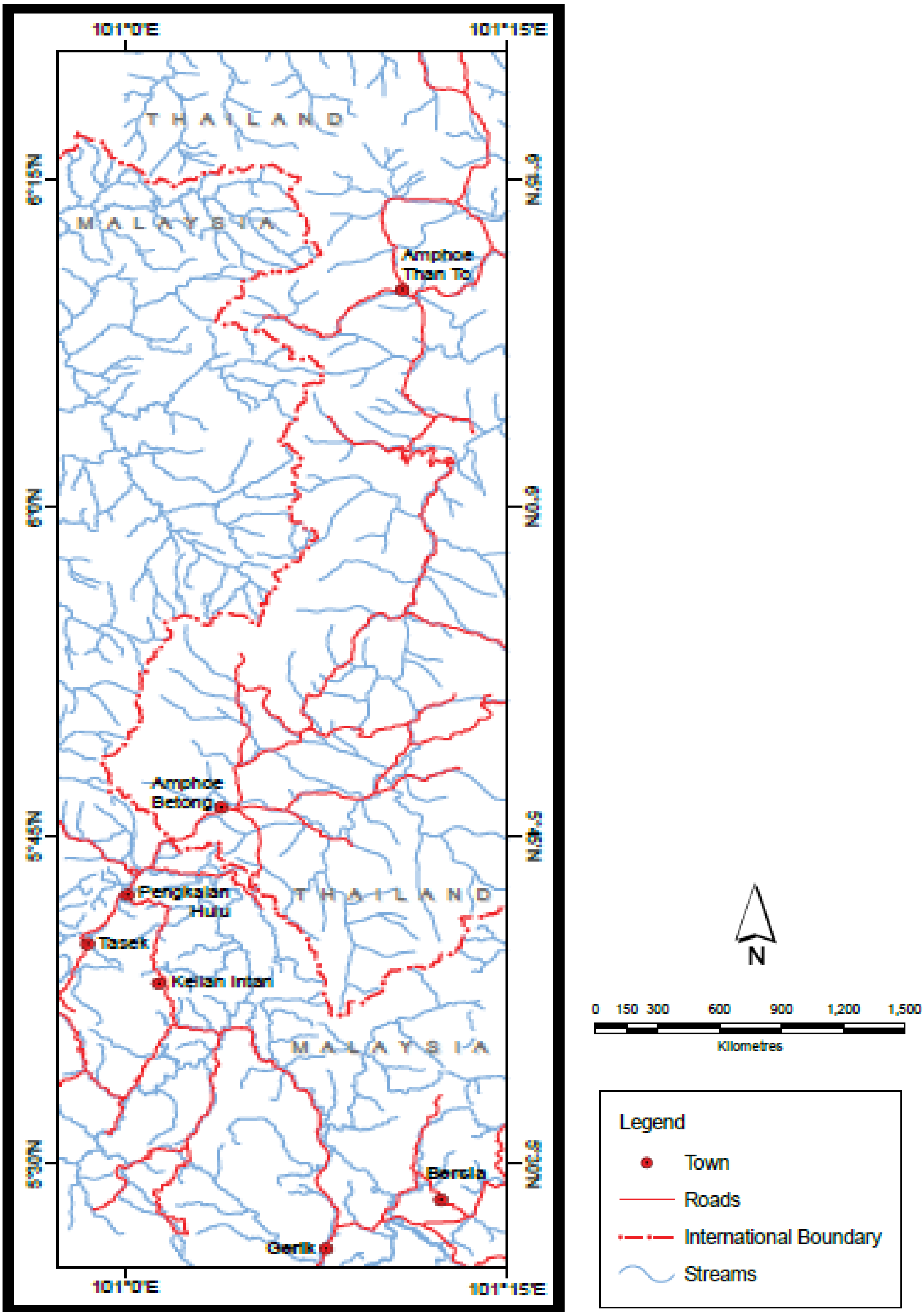

Figure 1.1 : Location of study area in Pengkalan Hulu, Perak

1.2 PROBLEM STATEMENT

Study of the hydrogeochemistry characteristics of stream sediment and water shows that problems came from geology of area or the activities surrounding area. Taking into account the severe effects that the water quality can bring to human health, properties and environment. Thus making it a necessary for a further study in this arena for making the surrounding a safer place. A small studies carried out nowadays on hydrogeochemistry characteristics of stream sediment and water. Plus, the studies are mostly conducted decades ago. Those studies has found out that the hydrogeochemistry of sediment and water affected by the activities surrounding (anthropogenic) or geology of area. The water quality is an important for the human living. Thus, this study showed the information of the water quality of this area which is the quality is either good or not.

1.3 OBJECTIVES

The main objectives of this research project :

1. To investigate environmental impacts of mining and human activities against the water and soil sediment.
2. To identify the mineral element concentration in stream sediments and water quality.
3. To analyse the element distribution pattern within Gunung Paku vicinity concentration and level of contamination.

1.4 SCOPE OF STUDY

The aim of this project is to investigate the hydrogeochemistry characteristics of water and stream sediment originated from activities surrounding Gunung Paku, Pengkalan Hulu, Perak. The samples are collected at the surrounding Gunung Paku. For the samples of water, the analysis of in-situ which consists of temperature, pH and electrical conductivity are did. These are the top parameters to know the quality of the water on site almost immediately, especially pH of the water. Example, the water taken in a river has a pH value of 2, it immediately tagged as a polluted river. Thus, it showed that that river classified as acid and showed the quality of water is bad. Further analysis for water samples are did by using the ICP to trace the element concentration of water.

Samples of sediment also are taken at surrounding of Gunung Paku. The samples of sediment are sent to the laboratory process and then will sent to the analysis of the composition of element. All the area that the each samples were taken, the coordinate took by using the Garmin GPS.

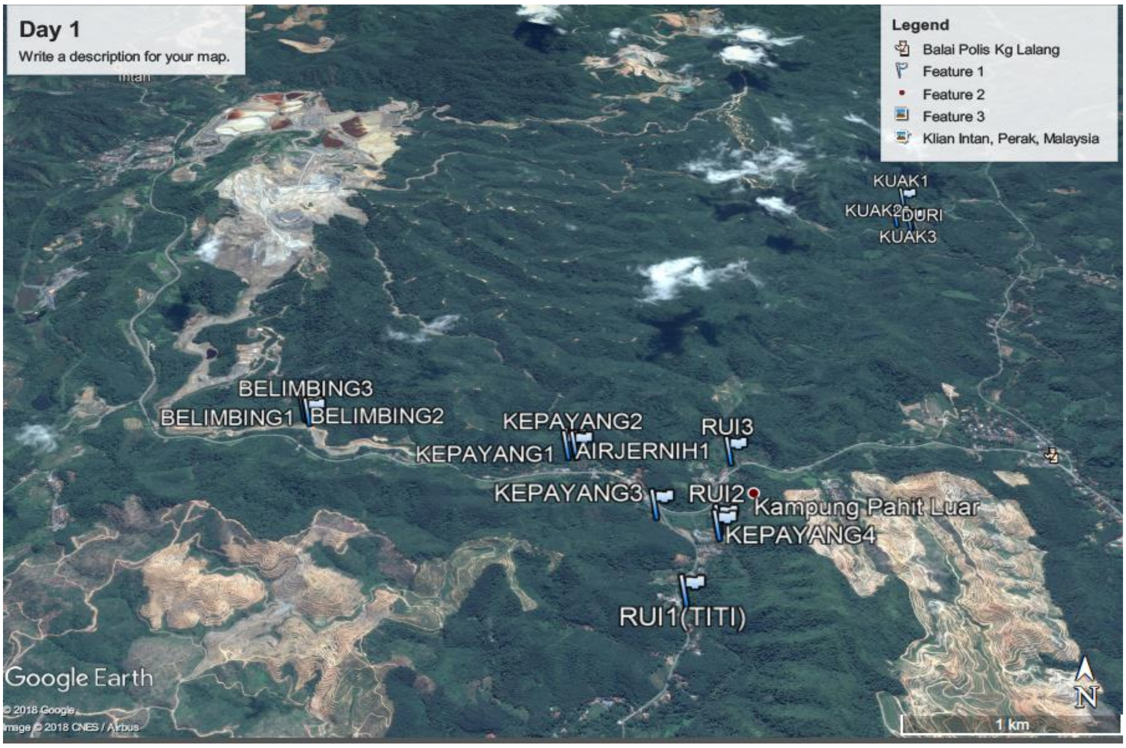

Figure 1.2 : Location of sampling points recorded by GPS

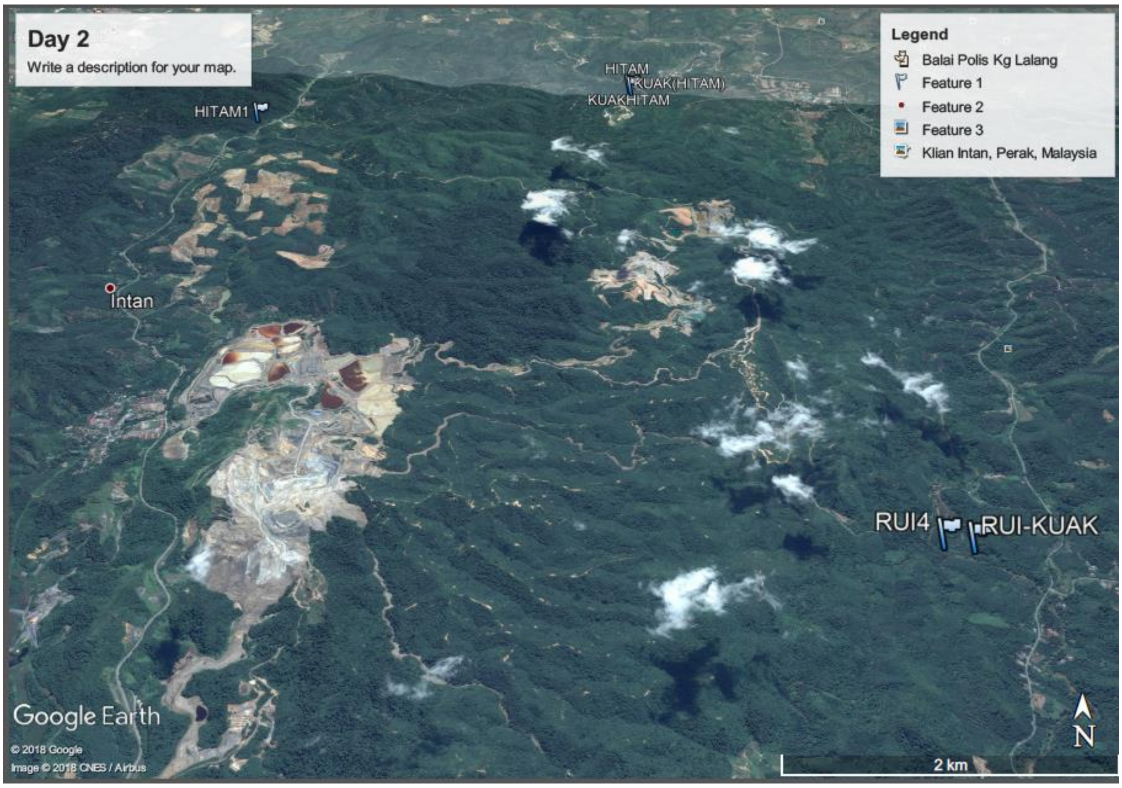

Figure 1.3 : Location of sampling points recorded by GPS

1.5 THESIS OUTLINE

This thesis is organized into five main chapters:

Chapter 1 introduces briefly the coverage of the thesis, including the overview of the research background, problem statement, objectives and scope of this research work.

Chapter 2 covers in detail the existing literature on the background of area, classification of stream sediment, properties of water, effects and regulations. Information on the equipment and measurement techniques and measurement techniques, as well as treatment methods that are available and applicable in the industry arena.

Chapter 3 presents the overall flow of this study and experiments conducted, information about the location, equipment, and methodology of the experimental work.

Chapter 4 presents and discusses results from the data and result tabulated. Explain the importance of findings and acknowledge any mistake or limitation in experiment.

Chapter 5 summarizes and draw conclusions for this study and its' objective.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Hydrogeochemistry is the chemistry of ground and surface waters, particularly the relationship between the chemical characteristics and quality of waters and the areal and regional geology. Other meanings are determining the time and source of groundwater recharge, identifying mineral make-up from activities surrounding, examining how stream sediment and water from various sources mix and interact and evaluating what types of (bio)geochemical processes have occurred during the water's journey through the system. This information of hydrogeochemistry provides a broad, more regionally extensive understanding of geology systems of the area. Furthermore, this improved knowledge can be used to create more comprehensive management and conservation plans, and more equitable surface water regulations.

Activities surrounding can relate with an anthropogenic. Anthropogenic refers to what is caused or influenced by humans. When discussing climate change, it is often used to refer to emissions produced as a result of human activities. *Anthropo* originates from Greek word *ánthrōpos* which means human being or man. For example, *anthropometry* (developed by Alphonse Bertillon) means "measurement of man". Genic means "cause" and also comes from Greek.

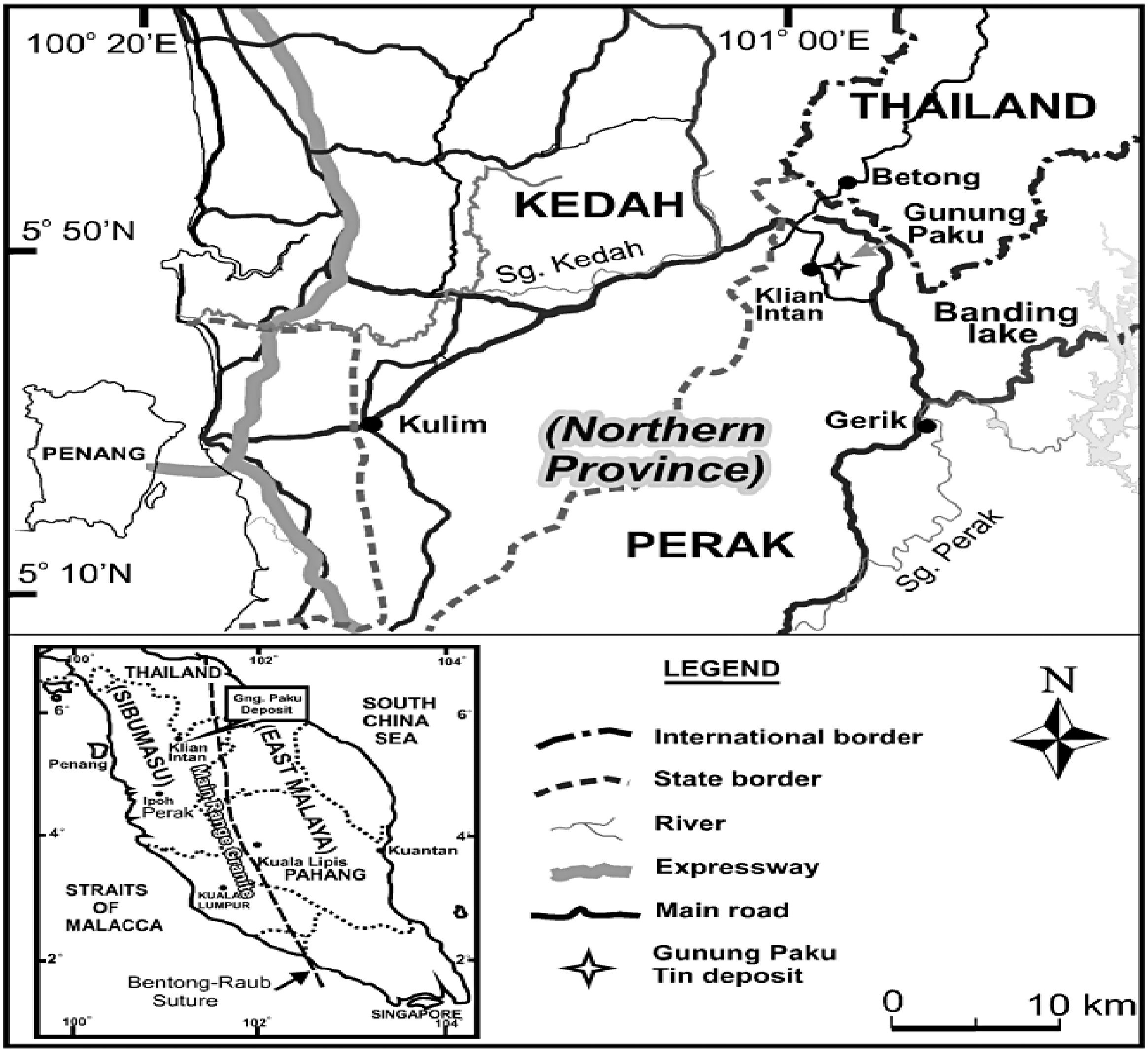

Figure 2.1 : Location map of Gunung Paku area (Ariffin 2012)

The general geology of the Gunung Paku and its vicinity is given in Figure 2.2. The main area is mainly overlain with thick sequences of metasedimentary rock that belong to the Baling Formation of Palaezoic age. The Baling Formation comprises a variety of argillaceous metasediments with minor arenaceous metasediment strata including chert and hornfels which cannot be arrange into stick stratigrafical succession and mapable calcareous and argillaceous-calcerous facies, in which the argillaceous beds are predominant (Burton, 1970; Ismail Iman, 1989; Khoo, 1989)

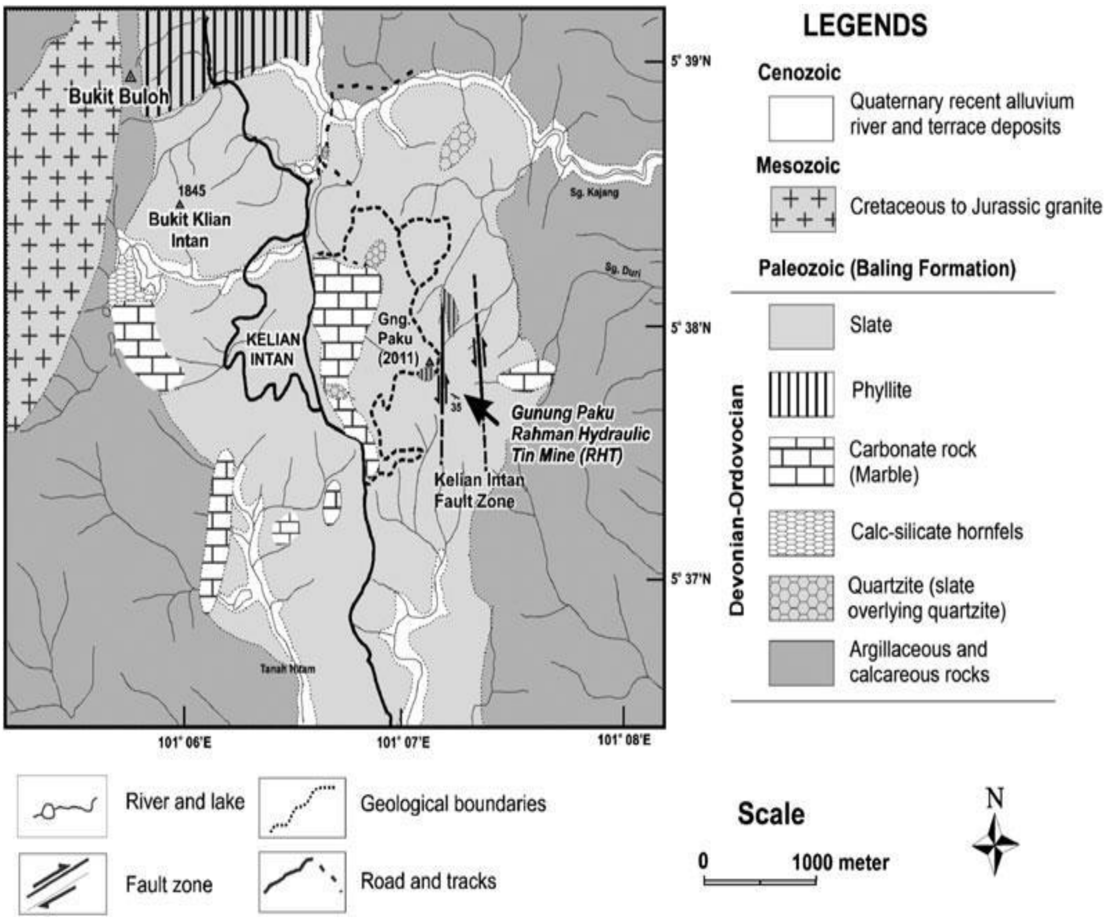

Figure 2.2: Geological map of Gunung Paku tin deposit (Ariffin, 2012)

Structurally, Gunung Paku is obviously confined in a fault zone of about 200-300 m wide which is known as the Intan fault zone (Khoo, 1989). Theoretically, this fault zone that accommodated Gunung Paku tin deposit formed due to the development of fractures and sheared zones within two adjacent sinistral faults that were caused subsequently and allegedly by the granite emplacement underneath. This intrusion had resulted in deformation, left-lateral movement and tilted within this fault system. Furthermore, this stratigraphically an impermeable seal produced by the overlaying metasedimentary rock units was thought to have prevented further ascent of hydrothermal fluids (Halter et al, 1998) within zones.

The NNW-SSE trending faults developed along before joints and fracture systems allowed the deposition of mineral from the hydrothermal fluids that carried tin and other minerals and metals. This resulted in the formation of a vein system, parallel to strike of the phyllite beds as sheet-like veins.

The sheeted-veins could be classified into mineralization and unmineralized quartz veins. The mineralized veins range from simple quartz-cassiterite, quartz-tourmaline-cassiterite to complex quartz-cassiterite-polymetallic sulphide veins. They are hosted within light grey, grey to light brown regolith and slightly to moderately weathered rock of weakly metamorphosed argillite. Mineralization is characterized by the presence of tourmaline, cassiterite or polymetallic sulphide in quartz veins (Ariffin, 2012).

The mineral chemistry of the Gunung Paku are indicated that apart from major elements such as As, Fe, Cu and Ti, other elements including Pb, Bi, Sb, Ba, Cr, and Co were also significant. They normally occurs as complexs Fe-Cu-As-Bi-Sb-Pb bearing minerals phases in trace amount.

2.2 Stream Sediment

Stream sediment is partially of soil which is part of the assortment of natural bodies of earth. The soils contain organic matter, mineral particles, air and water. The combinations of these conclude the soil's properties – its structure, texture, porosity, chemistry and colour. Soil sediment includes the horizon close the surface that vary from the underlying rock material as a result of living organisms, interactions, parent materials, through time, climate and relief.

Texture is how the shape surface of soil sediment. The proportions of sand clay and silt determine the soils texture. The texture defines how the well moistures and roots can penetrate the soil and how well excess moisture can drain away. The ideal arrangement for oil texture is roughly 40% silt, 40% sand and 20% clay forming what is known as a loam soil. Brown earths fall into this category. They have a well-developed crumb structure which lets water air and organisms pass through it easily and roots can spread out in it easily. Water retention is good as it is soaked up by the crumbs of the soil and nutrient retention is good also. They also have good aeration and drainage properties. Loam soils such as brown earth are ideal for cultivation.

Soil colour gives a hint of the many processes going on in the soil as well as the type of minerals in a soil. For example, the colour of red in the soil is due to the abundance of an iron oxide under oxidised conditions in the soil, dark colour is usually due to the accumulation of highly decayed an organic matter, yellow colour due to the hydrated iron oxides and hydroxide, black nodules are due to the manganese oxides, mottling and gleying are related with high water table and/or poor drainage. Abundant pale yellow mottles tied with very low pH are indicative of the possible acid sulphate soils. Colours of soil matrix is indicative of the water and drainage conditions in the soil and hence the suitability of the soil for the aquaculture. Lighter colour of soils deflect sunlight while dark soils absorb more light. This allows the soil to heat up much more quickly and encourages seed germination and crop growth. Heat also important in humification process. Brown earths have high humus content which makes it a darker soil and thus supports good crop growth.

2.2.1 Parent material

Parent materials were mostly deposited by the rivers and streams. Others these sediments were altered by wind. Muds high in silt and clay deposited by slow-moving or still water and air. While the fluids that deposited sandy sediments were moving fast to retain suspended clays and silts. Finer textured of soils were possibly once marshes and other backwater areas that protected from river currents that may reflect the composition of parent rock.

2.2.2 Mineral Particles

Mineral particles are the largest element and make up approximately 45% of soils. The original rock that got broken down by the weathering and erosion to form the basis of soil. The type of rock that broken down to form it called the parent rock. The broken down rock produced minerals such as phosphorus, potassium and calcium in the soil on which the plants feed. The parent material influences the soil texture, depth, colour, and pH value.

2.2.3 Organisms

Organisms affected the type of organic matter that added to the soil, the rate at which the organic matter decomposed, the part of the soil to which the organic matter added and translocated, and the types of chemical reactions occurred in soil.

2.2.4 Climate

Climate is an important factor in the soil formation. Climate affected soils by leading the rate at which chemical reactions can take place and the amount of percolating water that translocated materials from one part of the soil to another. Temperature and precipitation influences the speed of weathering of the parent materials and thus, soil properties such as organic matter content and mineral composition. Actually temperature directly influences the speed of chemical reactions. Thus, the warmer the temperature, the faster of reactions occur. Fluctuations in temperature increase physical weathering of rocks. Evapotranspiration is combination of water evaporated from soil surface and water transpired by the growing plants. As air temperatures increase, the evapotranspiration increases. The high evapotranspiration relative to the precipitation means less water is an available to move through a soil.

2.2.5 Relief

Local relief is the factor that has the big effect on the soils. Major changes on soil properties caused by the changes in elevation of only a few feet, all attributable to the topography 's effect on soil water. Simply stated, water runs downhill. So the water drains into the low areas caused of from the soil on topographic high.

2.2.6 Time

Time is also the factor of formation soil sediment . Vegetation and climate acted on the parent material and topography over time. The age of a soil is determined by development and not the chronological age. Degree of aging depends on the intensity of the other soil forming factors. Factors that slow soil formation include high lime content in the parent material, high quartz content in the parent material, high clay content in the parent material, hard rock parent material (resistant to weathering), low rainfall, severe erosion, cold temperature, low humidity, steep slopes, high water table constant deposition, accumulations and the mixing by animals or man.

2.2.7 Vegetation

The soil formation process has been greatly affected by biotic agents. Biotic agents include organisms such as gophers and bacteria that live in the soil and vegetation growing on a surface. The organisms in the soil can slow down or speed up the soil formation. The microorganisms can assist chemical reactions or excrete organic substances to increase the infiltration of water in the soil. Other organisms, such as gophers, the slow soil formation by mixing and digging the soil materials, destroying the soil horizons that have formed.

2.3 Stream sediment composition

Soil sediment structure is the arrangement of soil particles into small clumps, called peds or aggregates. Soil particles which are sand, silt, clay and even organic matter bind together to form the peds. It is depending on the composition and on the conditions in which the peds formed (getting wet and drying out, freezing and thawing, farming, foot traffic.), the ped has a exact shape. They could be as the granular (like gardening soil), columnar, platy, blocky, massive (like modeling clay) or single-grained (like the beach sand). Structure relates to the pore-space in the soil which influences the root growth, air and the water movement.

Stream sediment is made up of different particle size range. Some metallic and non-metallic minerals might always found as major component of stream sediment. The mineral portion of stream sediment is separated into three particle size ranges which are sand, silt and clay. They are <2 mm in diameter. Above the 2 mm in diameter, it called and referred as rock fragments and have their size classes which are pebbles, cobbles and boulders. **Figure 2.3** shows the picture of particle size range. The three particle size classes defined as follows:

Table 2.1 : Particle size range of stream sediment

Particle name	Size range
Sand	2 mm – 0.05 mm
Silt	0.05 mm – 0.002 mm
Clay	< 0.002 mm

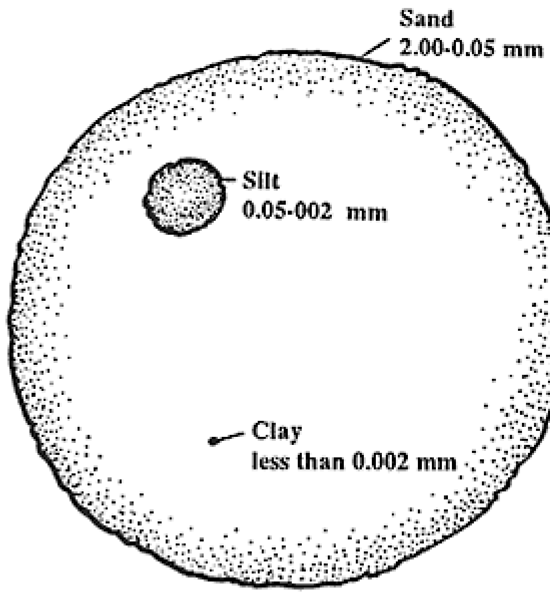

Figure 2.3 : Particle size of soil

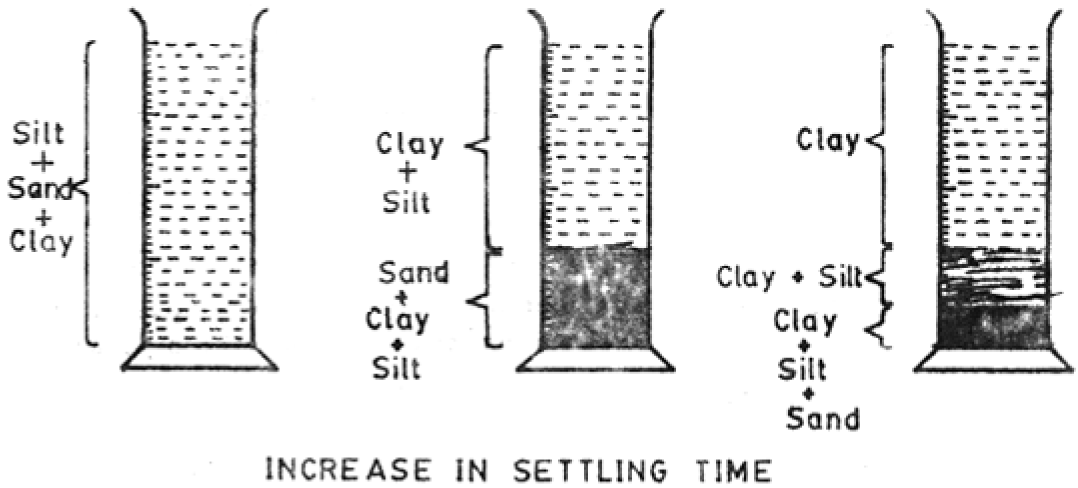

Figure 2.4 : The settling of particles in a soil suspension

There are 12 soil textural classes characterized on the soil texture triangle. This triangle used so that terms like "loam" or "clay" always have the same of meaning. Each texture corresponds to specific percentages of sand, clay or silt. Knowing the texture helps us manage the soil.

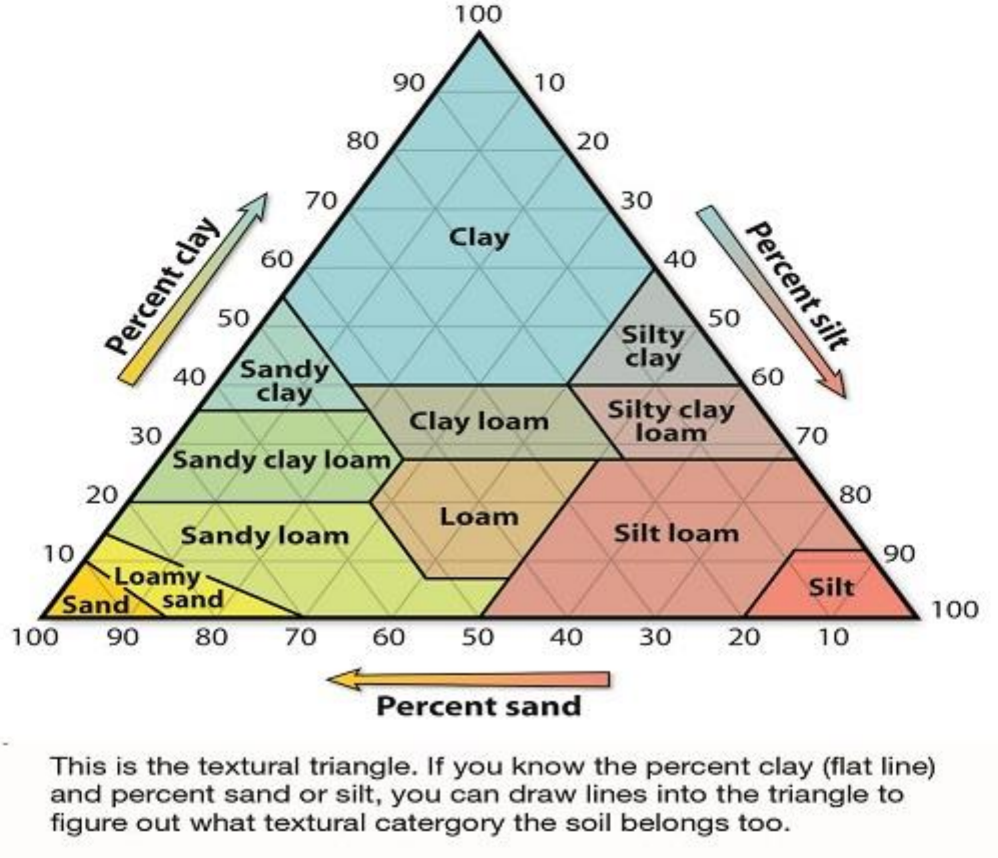

Figure 2.5 : The textural triangle of soil sediment

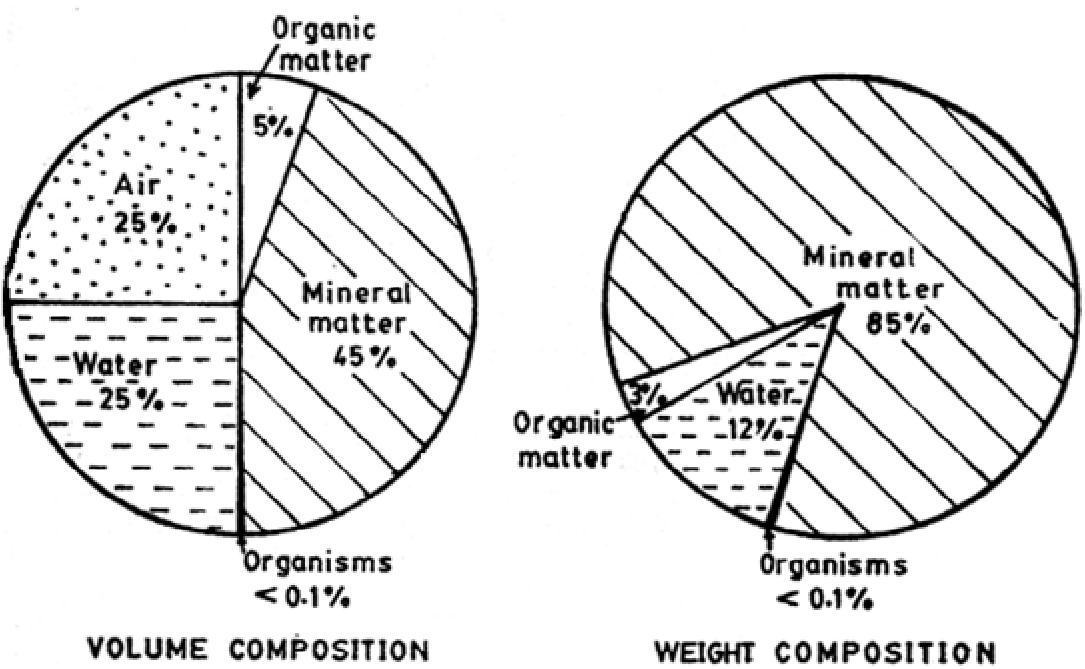

Figure 2.6 : The composition of soil sediment

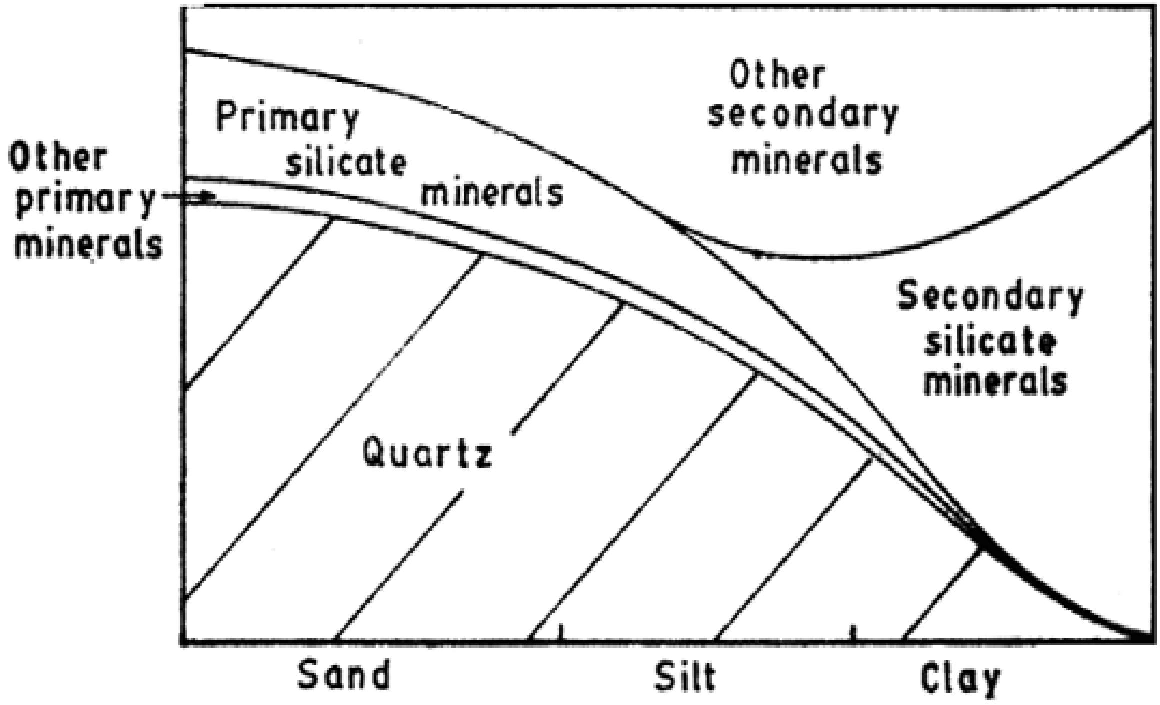

Figure 2.7 : Mineralogical composition of soil

2.3.1 Sandy Soil

Sand forms mostly by the physical or chemical breakdown of rocks which is composed of mineral grains and it is a natural unconsolidated coarse material. This process is known as weathering. Sand is not a mineral. It is a sediment like clay, gravel and silt. Sand is composed of the sand grains which are either rock fragments, mineral particles, or biogenic in origin. Finer granular material than sand is stated to as silt. Common of sand is dominantly composed of silicate rock fragments or silicate minerals. By far the most common mineral in sand is quartz. Hence, the term "sand" without qualification is imagined to be composed of quartz mostly. However, sand is a natural assortment which means that it is never pure. By no means can one say that sand and quartz are the same thing. Consolidated sand is a rock type known as sandstone.

Quartz is one of mineral that found in sand and it is so dominant in most sand samples because it is an abundant. 12% of the crust is composed of it. Only feldspars are more an abundant than quartz. Relatively rare minerals like zircon, tourmaline, rutile and etc. are also very resistant to weathering, but they rarely make up more than few percents of the composition of sand. These minerals are collectively referred to as heavy minerals. Minerals that relative with sand which are often extracted from placer deposits are cassiterite, ilmenite, rutile, monazite, magnetite, zircon, gold, etc. (Springer Siever, R. 1988)

2.3.2 Silty soil

Silt is composed of small grains of soil and minerals that easily carried and deposited by water. The size of silt of granular material which is between sand and clay whose mineral origin is quartz. Individual silt particles are small that they are difficult to see. Silt is formed by physically weathering. When the rains pound soil some of the fine granular particles are carried by the runoff water as silt. Silty soil is slippery when wet, not rocky or grainy. The soil itself can be named as silt if its silt content is more than 80 percent. If deposits of silt are compressed and the grains are pressed together, the rocks will form such as siltstone.

Silt also can change landscape such as silt settles in still water. So, deposits of silt slowly fill in places such as lakes, wetlands and harbors. Floods deposit silt along river banks and on flood plains. Deltas grow where rivers deposit silt as they empty into another body of water. About 60 percent of Mississippi River Delta is made up of silt.(Simonson, 1959)

2.3.3 Clay

Clay particles are mineralogically dissimilar from sand and silt. It may contain significant amounts of alkali metals, alkaline earths or irons. Chemically, clays are hydrous aluminium silicates, containing minor amounts of impurities such as magnesium, sodium, calcium, potassium or iron. Clay minerals formed at or near earth's surface, in water or soil. Most clays fit to a class of minerals called phyllosilicates, which had formed from breakdown products of other minerals. Like all phyllosilicates, clay minerals also have sheet-like structure, which is exposed when the crystals are detected through a scanning electron microscope. Micas such as muscovite and biovite are the usually phyllosilicate minerals that can be seen with naked eye because its large enough.Properties of clay minerals are plasticity, shrinkage under air drying and firing, colour after firing, fineness of grain, cohesion, and capacity of the surface to take decoration. On the foundation of such qualities, clays are variously separated into groups or classes.

2.4 Water Quality

Water quality is determined by chemical, physical and microbiological properties of water. These water quality of characteristics throughout the world are characterized with wide variability. Physical characteristics of water such as temperature, taste, colour, odour and etc are determined by senses of touch, smell, taste and sight. For example, temperature by touch, colour, floating debris, turbidity and suspended solids by sight, and taste and odour by smell.

Parameter	Unit	Class					
		I	IIA	IIB	[*]III	IV	V
Temperature	°C	-	Normal± 2	-	Normal± 2	-	-
pH	-	6.5 – 8.5	6.0 – 9.0	6.0 – 9.0	5.0 – 9.0	5.0 – 9.0	-
Conductivity	[1]µmhos/cm	1000	1000	-	-	6000	-
Colour	TCU	15	150	150	-	-	-
DO	mg/L	7	5 – 7	5 – 7	3 – 5	<3	<1
BOD	mg/L	1	3	3	6	12	>12
COD	mg/L	10	25	25	50	100	>100
Oil & Grease (mineral)	µg/L	Natural Level	40; N	40; N	N	-	-
Oil & Grease (emulsified edible)	µg/L	Natural Level	7000; N	7000; N	N	-	-
Total Dissolved Solids	mg/L	500	1000	-	-	4000	-
Total Suspended Solids	mg/L	25	50	50	150	300	300
Turbidity	NTU	5	50	50	-	-	-
Ammoniacal Nitrogen	mg/L	0.1	0.3	0.3	0.9	2.7	>2.7
Floatables	-	N	N	N	-	-	-
Odour	-	N	N	N	-	-	-
Salinity	%	0.5	1	-	-	2	-
Taste	-	N	N	N	-	-	-
Feacal Coliform	[2]counts /100mL	10	100	400	5000 (20000)[a]	5000 (20000)[a]	-
Total Coliform	[2]counts /100mL	100	5000	5000	50000	50000	>50000
Hardness	mg/L	Natural Level	250	250	-	-	Levels Above IV
K	mg/L	Natural Level	-	-	-	-	Levels Above IV
F	mg/L	Natural Level	1.5	1.5	10	1	Levels Above IV
NO_3	mg/L	Natural Level	7	7	-	5	Levels Above IV
P	mg/L	Natural Level	0.2	0.2	0.1	-	Levels Above IV
S	mg/L	Natural Level	0.05	0.05	- (0.001)	-	Levels Above IV
Cd	mg/L	Natural Level	0.01	0.01	0.01[*] (0.001)	0.01	Levels Above IV
Cu	mg/L	Natural Level	0.02	0.02	-	0.2	Levels Above IV
Fe	mg/L	Natural Level	1	1	1	1 (leaf); 5 (others)	Levels Above IV
Pb	mg/L	Natural Level	0.05	0.05	0.02[*] (0.01)	5	Levels Above IV
Mn	mg/L	Natural Level	0.1	0.1	0.1	0.2	Levels Above IV
Ni	mg/L	Natural Level	0.05	0.05	0.9[*]	0.2	Levels Above IV

Figure 2.8 shows National Water Quality Standard (EQR 2006)

Water quality data are used to determine the water quality status weather in clean, slightly polluted or polluted category and to classify the rivers in Class I, II, III, IV or V based on Water Quality Index (WQI) and Interim National Water Quality Standards for Malaysia (INWQS) every year. The national water quality standard and the classifications are used when writing environmental reports, either government agencies or private companies. However, this table can only be used for classification of water in Malaysia.

Class I represents water bodies of excellent quality. Standards are set for the conservation of natural environment in its undisturbed state. Water bodies such as those in the national park areas, fountainheads, and in high land and undisturbed areas come under this category where strictly no discharge of any kind is permitted. Water bodies in this category meet the most stringent requirements for human health and aquatic life protection.

Class II represents water bodies of good quality. Most existing raw water supply sources come under this category. In practice, no body contact activity is allowed in this water for the prevention of probable human pathogens. There is a need to introduce another class for water bodies not used for water supply but of similar quality, which may be referred to as Class IIA. The determination of Class IIB standards is based on criteria for recreational use and protection of sensitive aquatic species.

Class III is defined with the primary objective of protecting common and moderately tolerant aquatic species of economic value. Water under classification may be used for water supply with extensive and advanced treatment. This class of water is also defined to suit livestock drinking needs.

Class IV defines water quality required for major agricultural irrigation activities, which may not cover minor applications to sensitive crops.

Class V represents other wastes, which do not meet any of those above uses. (EQR 2006)

2.4.1 Physical characteristics of water

2.4.1.1 Temperature Effect

The temperature of water affects some of important physical properties and characteristics of water: thermal capacity, specific weight, density, viscosity, specific conductivity, surface tension, salinity and solubility of dissolved gases and etc. Biological and chemical reaction rates increase with increasing temperature. Reaction of rates usually assumed to double for an increase in temperature about 10 °C. The temperature of water streams and rivers throughout the world varies from 0 to 35 °C.

2.4.1.2 Colour characteristic

Colour in water is mainly a concern of water quality for aesthetic reason. Coloured water show the presence of being unfit to drink, even though the water might be perfectly safe for public use. On the other hand, colour can show the presence of organic substances, such as humic compound or algae. More recently, colour has been used as a quantitative assessment of the existence of toxic organic materials or potentially hazardous in water.

2.4.1.3 Taste and Odour

Taste and odour are human perceptions of water quality. Human perception of taste consist of sour salty (sodium chloride), sour (hydrochloric acid), bitter (caffeine) and sweet (sucrose). Relatively simple compounds produce salty and sourtastes. However bitter and sweet tastes are produced by more complex organic compounds. Human detect many more tips of odour than tastes. Organic materials discharged directly to water, such as falling leaves, runoff, are sources of tastes and odour-producing compounds released during biodegradation.

2.4.1.4 Water Turbidity

Turbidity is a measured of the light-transmitting properties of water and is comprised of colloidal and suspended material. It is important for the health and aesthetic reasons.

2.4.1.5 Velocity

The velocity of water in a stream or river is the distance that water travels in a given amount of time. The velocity of the water in a river is related to the amount of energy that the water has. A fast-moving river can erode materials more quickly and can carry larger particles than a slow-moving river. Many factors affect a river's velocity, including the steepness of the slope, the amount of water traveling downstream, and the shape of the path through which the water travels.