Geochemistry of Geothermal Hotspring in Perak (CWS)

by

Tengku Hasnul Hadi Bin Tuan Salim

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Engineering (Hons)
(Chemical Engineering)

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Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Approved by,

____
(AP Dr Chow Weng Sum)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2010

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 references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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TENGKU HASNUL HADI BIN TUAN SALIM

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Abstract

This document basically contains the general overview of the project titled "Geochemistry of Geothermal hot spring in Perak (CWS)". Before the study started, the research should be done first in order to get the general idea on what is the research is all about in general. This report consists of background of study, problem statement, objectives and scope of study and also some literature review. Chemical analysis will be done on the hot spring water to determine the chemical content in the water before it can be use as drinking water. The goal of this analysis is to determine either the water is safe as drinking water. Basically in order to do the analysis, two common equipment can be use which are Atomic Absorption Spectrophotometry (AAS) and Inductively Coupled Plasma (ICP). In Malaysia, hot spring water is very high in Hidrogen Sulphide and cause faint smell. Hydrogen sulfide is considered a broad-spectrum poison, meaning that it can poison several different systems in the body, although the nervous system is most affected. Hydrogen Sulphide is a potent chemical asphyxiant, combining with haemoglobin in red blood cells and with intracellular cytochromes and thus rapidly stopping oxygen from access to cellular metabolism (just like gases such as carbon monoxide and hydrogen cyanide). Indeed H_2S is arguably as toxic as Hydrogen Cyanide HCN. Biological monitoring or tests for intoxication could be undertaken through spectrophotometry of the haemoglobin in blood.

CHAPTER 1

INTRODUCTION

1.1 Background

Deep down under the surface, water sometimes makes its way close to the hot rock and turns into boiling hot water or into steam. The hot water can reach temperatures of more than 148 degrees Celsius. This is hotter than boiling water (100 degrees C). It doesn't turn into steam because it is not in contact with the air. When this hot water comes up through a crack in the earth, we call it a hot spring, like Sungkai Hot Spring in Perak. Or, it sometimes explodes into the air as a geyser, like Old Faithful Geyser. Today, people use the geothermally heated hot water in swimming pools and in health spas. Or, the hot water from below the ground can warm buildings for growing plants, like in the green house on the right.

In San Bernardino, in Southern California, hot water from below ground is used to heat buildings during the winter. The hot water runs through miles of insulated pipes to dozens of public buildings. The City Hall, animal shelters, retirement homes, state agencies, a hotel and convention center are some of the buildings which are heated this way.

In California, there are 14 areas where we use geothermal energy to make electricity. Some are not used yet because the resource is too small, too isolated or the water temperatures are not hot enough to make electricity.

Some of the areas have so much steam and hot water that it can be used to generate electricity. Holes are drilled into the ground and pipes lowered into the hot water, like a drinking straw in a soda. The hot steam or water comes up through these pipes from below ground.

A geothermal power plant is like in a regular power plant except that no fuel is burned to heat water into steam. The steam or hot water in a geothermal power plant is heated by the earth. It goes into a special turbine. The turbine blades spin and the shaft from the turbine is connected to a generator to make electricity. The steam then gets cooled off in a cooling tower.

1.2 Problem Statement

Hot spring can be use in many ways. The largest use of the hot spring is as a recreational place. Basically, in recreational place, the water is used for bathing purpose. In some other places, people supply water by ladling with a dipper, turning on a faucet or drawing from a well to wash clothes & dishes, clean up and/or for Yutanpo (a hot-water bottle). The most popular use of the geothermal hot spring is its function to generate geothermal energy. Geothermal energy is the heat from the Earth. It's clean and sustainable. Resources of geothermal energy range from the shallow ground to hot water and hot rock found a few miles beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma.

Almost everywhere, the shallow ground or upper 10 feet of the Earth's surface maintains a nearly constant temperature between 50° and 60°F (10° and 16°C). Geothermal heat pumps can tap into this resource to heat and cool buildings. A geothermal heat pump system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger-a system of pipes buried in the shallow ground near the building. In the winter, the heat pump removes heat from the heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed, and the heat pump moves heat from the indoor air into the heat exchanger. The heat removed from the indoor air during the summer can also be used to provide a free source of hot water.

1.3 Objective and Scope of Study

- To determine the potential hot springs that can be utilized as a source of geothermal energy
- To analyze the hot springs water before it can be use as a drinking water
- To allocate the possible hot springs area as a recreational area in the future base on economic feasibility criteria and technical feasibility criteria

The scope of work for this project is to collect the sample of hot spring water and to investigate the temperature and the flow rate. Once the samples of hot springs water have collected, they will be analyzed to determine the chemical composition in the hot springs water. The temperature of the hot springs water can be measure with chemical geothermic measurement.

When all of the data from the sample had been calculated, then they will proceed to the next level which is the decision either to proceed with the generation of geothermal energy and to make an improvement with the water quality of the hotspring.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Thermal springs which are known at many localities in Peninsular Malaysia and especially in Perak are relatively rich in dissolved mineral salts are discharge. Most of these springs were then and still being used for bathing and recreational purpose. In order to complete the objectives, quality and quantity of flow, and the potential uses of the hot springs was determined by doing a preliminary study on hydrochemistry and flow characteristics of the thermal springs.

From the previous research, there are 15 hot springs been discovered so far in the Perak area and all of the hot springs are genetically related to tectonic activities. There are many uses of hot springs for example it can be used as a source to generate geothermal energy.

It also can be used as a drinking water if it fully the criteria of standard chemical composition for drinking water set by WHO and PAHO. Finally it also can be develop as a recreational area base on the technical and economic feasibility.

2.2 CWS

Some compounds have good warning properties. This means that they can be detected in air through odor or perhaps mild irritation at levels below which they are toxic. Learn whether the materials you handle have good warning properties. If they do, these properties can serve as an early exposure warning system — material being released into the air may warrant additional controls. However, be aware that individual odor thresholds vary widely for some compounds and that the olfactory system can become fatigued (lose its sense of smell) after short-term exposure to some compounds.

2.3 Balneology

Balneology is the scientific study of naturally occurring mineral waters. In the United States, this science is not very well known, and is even less seldom practiced. However, throughout Europe and Japan, balneology and hot springs therapy is very much a part of routine medical care. Medical prescriptions are given by licensed doctors for the treatment of a wide range of conditions, and utilizing mineral waters as a part of preventative medicine is widely recognized and encouraged. Balneotherapy is the practical study and application of the health benefits of water.

Hot springs therapy became popular in the United States in the nineteenth century and reached a pinnacle in the United States in the 1940's. During this brief hot springs era, doctors and resort owners, as well as an ever-enthusiastic general public, attributed many cures and health benefits to the use of therapeutic geothermally heated mineral waters. However, the hot springs movement did not last long enough to mature into a socio-cultural tradition which would have eventually resulted in formal research and medical acceptance. Furthermore, the FDA eventually stepped in and prohibited organizations from making unsubstantiated health claims concerning the medicinal value of natural mineral waters.

These facts notwithstanding, hot spring soaking has a deep and far reaching tradition in North America, starting with the indigenous North American Native Tribes who considered choice hot springs to be "power spots" in nature. Native cultures universally utilized the natural waters for healing, purification ceremonies, sacred gatherings, and tribal meetings.

Although the brief hot springs movement in the United States faded, enough interest remained by way of naturalists, enthusiasts, and especially those more spiritually inclined, to keep many small resorts in operation throughout the country during the later part of the 20th century.

What remains universally true is the ignorance associated with potential healing powers of natural mineral waters. When questioning Native American healers, therapists, resort owners, and enthusiasts, vague opinions and unsubstantiated "facts" are often prevalent, some of which are contrary to established scientific fact.

2.4 Geothermal Energy

Geothermal energy is the heat from the Earth. It's clean and sustainable. Resources of geothermal energy range from the ground to hot water and hot rock found a few miles beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma.

One of the methods to generate electricity from geothermal energy is by pumping hot water into sedimentary hotspots. The steam generated by this method is used to produce electricity. The condensed steam is again circulated into the permeable sedimentary stream of a hotspot.

Another method is by using volcanic magma. The temperature of partially molten magma is approximately 650 degree Celsius. This heat is used to boil water to generate electricity.

Some geothermal plants also use the hardened magma that is extremely hot. This system uses hot dry rock. Pipes are looped through these hot dry rocks through which water is circulated. The heat of the rocks converts the water into steam prior to transferring the heat to a steam generator.

2.5 Drinking Water

The World Health Organization (WHO), set up some guidelines for drinking-water quality which are the international reference point for standards setting and drinking-water safety. The latest guidelines drew up by the WHO are those agreed to in Geneva, 1993. There is no guideline for some of the elements and substances which are taken into account. This is because there have not been sufficient studies about the effects of the substance on the organism, and therefore it is not possible to define a guideline limit. In other cases, the reason for a non-existing guideline is the impossibility of that substance to reach a dangerous concentration in water, due to its insolubility or its scarcity.

2.6 Recreational Place

Most of the hotsprings which are located in accessible areas are developed for recreational purposes. Some of the more popular hot springs such as the ones in Kampung Air Panas in Hulu Slim and in Tambun have up to 1000 visitors each on weekends. The hot waters are tapped and channeled into swimming pools and spas. Of the 45 hot springs studied, twelve are well developed, three are fairly well developed, thirteen are underdeveloped and the remaining seventeen are undeveloped.

It is anticipated that in the near future, more of these hot springs will be utilized for recreational purpose.

2.7 Medicated Use

Ancient Chinese and Japanese people bathed in hot springs and used the water for cooking. Ancient Romans used the water from hot springs as a medicine for skin diseases, and the buildings in ancient Pompeii were heated with hot water that ran under them. Native Americans settled near hot springs more than 10,000 years ago. During the

Middle Ages in Europe people traveled to towns in Germany and France that had built spas, or health resorts, around natural hot springs.
The ancient Greeks and Romans knew of a number of natural hot springs, many of them located near volcanoes. The oldest known hot springs bath still in existence is located in Merano, Italy. People are believed to have used it five thousand years ago. Bath, England, has long been famous for its natural hot springs. The waters at Bath are about 120°F (48°C) and contain numerous minerals, including calcium and magnesium. Ancient Celts are believed to have bathed in the springs as early as 800 BCE (before the common era). The Romans built bath houses around the springs nearly two thousand years ago; the town became a major tourist resort starting around the time of Queen Elizabeth I (1533–1603), who went there often to bathe.

Germany is full of natural hot springs, many of which long ago became the sites of baths. Ancient Romans built baths on these springs. Like Bath in England, Germany's bath towns became extremely popular with the rich in the nineteenth century. Towns such as Bad Cannstatt and Baden-Baden grew rich from their well-to-do visitors who came to bathe, be massaged, drink the waters, and indulge themselves in other entertainments. These baths are still popular today and have been supplemented with modern healing treatments such as shiatsu massage and with trendy shopping facilities. Japanese baths are likewise famous around the world. Hot springs resorts, called onsen, attract millions of visitors who come to soak in the waters. The waters often contain particular minerals that are said to have specific effects on physical and mental health. Some baths have facilities for drinking the water or inhaling the steam.

Americans began experimenting with large-scale geothermal heating in 1864, with the construction of the Hot Lake Hotel in La Grande, Oregon. In 1892 the city of Boise, Idaho, built a geothermal district heating system that piped hot water from a geothermal reservoir to the buildings in town.

2.8 Hot Springs Therapy

European balneologists have extensively studied the therapeutic value of mineral waters. Mineral springs with different mineral content are often recommended above others for various therapeutic uses.

In addition to the value of the trace minerals found in most hot springs, and the stimulating benefits of highly mineralized waters, balneotherapists generally agree on the following observations:

Bicarbonate

In Spain, a bicarbonate water is classified as such if the water contains more than 250 PPM of free carbon gas. However, springs that contain bicarbonate gasses (sodium bicarbonate, calcium bicarbonate, carbon dioxide, etc.) may also be utilized for the observed benefits commonly associated with bicarbonate hot springs.

Bathing in bicarbonate water, the balneologists believe, assists opening peripheral blood vessels and helps to improve circulation to the body's extremities.

European balneotherapists also utilize bicarbonate waters for bathing to address hypertension and mild atherosclerosis. For these conditions, tepid to warm baths are utilized (86 - 100°F). Some researchers believe that bicarbonate baths also assist cardiovascular disease and nervous system imbalances.

Sulfur and Sulfates

Hot Springs rich in Sulfur, in France, Spain, and Japan, are used to address a wide variety of conditions, including skin infections, respiratory problems, and skin inflammations.

Hot springs rich in sulfates (i.e. sulfur compounds) have a far reduced "sulfur" effect as compared to Sulfur-rich springs. Such waters are often prescribed internally for liver and gastrointestinal conditions, as well as for some respiratory conditions with inhalation therapy, in European spas.

Chlorides

Saline hot springs are rich in sodium chloride. Mineral springs naturally rich in chlorides, in amounts between .5 - 3%, are considered by some researchers to be beneficial for rheumatic conditions, arthritis, central nervous system conditions, posttraumatic and postoperative disorders, as well as orthopedic and gynecological disease.

Other Mineral Research:

Benefits of Arsenic

While arsenic in larger doses is toxic in the human body, minute amounts may assist the body with plasma and tissue growth. Foot bathing in mineral waters with a high content of arsenic is used to address fungal conditions of the feet.

Benefits Boron

Boron builds muscle mass, increases brain activity and strengthens bones.

Benefits of Magnesium

Magnesium converts blood sugar to energy and promotes healthy skin.

Benefits of Potassium

Potassium assists in the normalization of heart rhythms, assists in reducing high blood pressure, helps to eliminate body toxins and promotes healthy skin.

Benefits of Sodium

Sodium and natural salts assist with the alleviation of arthritic symptoms, and may stimulate the body's lymphatic system when used in baths.

Alkaline water that is high in calcium, magnesium, and potassium may assist the body in cleansing through the skin. It is believed among some circles that warm spring soaking is more beneficial (99 - 101° F) than thermal therapy. This is not necessarily supported by independent research and medical scientific analysis.

European medical doctors have conducted research into thermal therapy, and have found that:

Hydrostatic pressure in the body is increased

This will result in increased blood circulation and cell oxygenation and the elimination systems of the body are thus stimulated, improving the body's capacity to detoxify.
Then the body's metabolism is stimulated and will results in improvement of digestion system. Other than that, by 3 to 4 weeks of regular thermal bathing can assist in the normalization of endocrine glands and assist the automatic nervous system

Many of the stimulating benefits of hot springs water are temperature dependent. Balneologists have found that hot springs soaking temporarily relieves chronic pain directly associated with inflammation, even in cases where inflammation has not been reduced. This effect is heavily reliant upon the temperature of the waters.

In Japan, at the famous Kusatsu hot spring, a 3-minute 125° F bath is utilized for an extraordinary therapeutic experience. Each visitor is pre-screened by the "bath master" to determine if such a bath would be safe and beneficial for each individual.

The founder of Delight's Hot Springs Resort kept a private and personal use therapy tub set at a consistent 116° F.

Not everyone should utilize high-temperature hot springs for therapeutic use. The state of one's metabolism and the presence of medical conditions is the determining factor when considering the safest and healthy water temperature to bath in.

Contraindications to Hot Water Natural Mineral Springs Therapy:

- Conditions involving high fevers
- Extreme Hypertension
- Malignant tumors and cancerous conditions (internal)
- Liver, kidney, or circulation disorders
- Conditions presenting the risk of hemorrhaging
- Anemic Conditions
- Pregnancy
- Congestive heart failure, recent stroke, or recent heart attack
- Bathing under the influence of drugs or alcohol

The existence of these or other metabolic conditions does not necessarily mean that there would be no benefit derived from utilizing mineral waters. It does mean, however, that there is a risk associated that may out way any benefit to utilizing hot waters. In such situations, individuals should consult with a medical doctor before bathing, or consult with a European medical balneologist.

In any case, soaking in mineral waters should not be done at excessively high temperatures without medical clearance when any contraindicated condition exists. A tepid to warm bath (~ 95° F - ~ 99°) is as safe as taking a bath at home.

2.9 Spring Water Hydrochemistry

Water samples were collected as near as possible to the source of each spring. In some localities, where the springs issue from stream bed, some mixing with the stream water may have occurred. Basically the presence of hydrogen sulphide is apparent from the sulphurous smell in the vicinity of the springs and the water itself may on occasions be imparted with a similar odor.

Most of the thermal spring water is normally not so highly mineralized. These generally have low conductivity and dissolved solid values. Conductivity values are usually less than 450 umhos/cm and dissolved solids content ranges from 36 to 462 mg/l. The concentration of other anions and cations and heavy metal also relatively low and below the limit as set by WHO.

2.10 Atomic Absorption Spectrophotometer (AAS)

Atomic absorption spectrophotometer provides accurate quantitative analyses for metals in water, sediments, soils or rocks. (Samples are analyzed in solution form, so solid samples must be leached or dissolved prior to analysis.).

Atomic absorption units have four basic parts: interchangeable lamps that emit light with element-specific wavelengths, a sample aspirator, a flame or furnace apparatus for volatilizing the sample, and a photon detector. In order to analyze for any given element, a lamp is chosen that produces a wavelength of light that is absorbed by that element. Sample solutions are aspirated into the flame. If any ions of the given element are present in the flame, they will absorb light produced by the lamp before it reaches the detector. The amount of light absorbed depends on the amount of the element present in the sample. Absorbance values for unknown samples are compared to calibration curves prepared by running known samples.

The concept of operation is mainly about absorption of radiation by the sample ([18] Levinson). The light source will emit electromagnetic radiation (depend on the trace metal to be studied) to the excited atoms. Excited atoms will absorb the emitted ray and the collector will detect level of intensity of the electromagnetic after the absorption. The more radiation absorb by the sample, the more element of element of the cathode are present in the sample. Excited atoms are vaporized sample form after the atomization took place. Normally, atoms in the sample are in the ground state and emission from the light source will not provoke the absorption of electromagnetic ray. By supplying heat to the sample, atoms will start to excite and transit to the higher energy level (free atomic state). At this state, absorption process will occur. There are two approaches of atomization as explained by [9] Hardy (2000) which is flame atomization and cold vapor atomization. For this research, flame atomization will be used due to the reliable and suitability of liquid sample (after wet digestion) and gas sample (after atomization). Cold vapor required higher temperature range from 2000°C-3000°C which are not suitable for this method where sample will be destroyed.

After the absorption process, the remaining radiation will be modulate by a high resolution, holographic grating before entering the detection chamber. This is the monochromator. Light wave from the atomization are in random dispersial and monochromator will resolve the lines. In the detection chamber, the photomultiplier tube will amplify the intensity and corrected the ambient wavelength.

The analysis of AAS relies on the Beer-Lambert law. Beer-Lambert is a linear relationship between absorbance and concentration of the absorbing material.

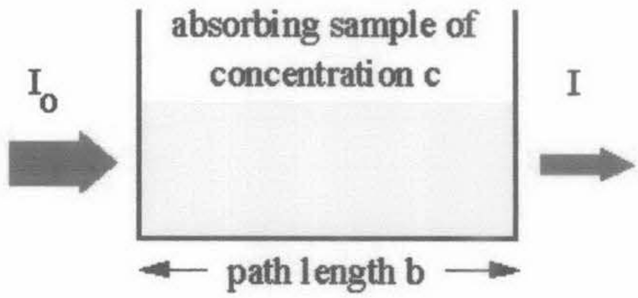


Figure 2.1: Representation of Beer-Lambert Law

The general Beer-Lambert law is usually written as:

$$A = a(\lambda) * b * c$$

where A = the measured absorbance,

$a(\lambda)$ = wavelength-dependent absorptivity coefficient,

b = the path length,

c = the analyte concentration.

When working in concentration units of molarity, the Beer-Lambert law is written as:

$A = \varepsilon * b * c$

where ε is the wavelength-dependent molar absorptivity coefficient with units of $M^{-1}cm^{-1}$

Result from the above procedure will be in term of absorbance correlated with concentration.

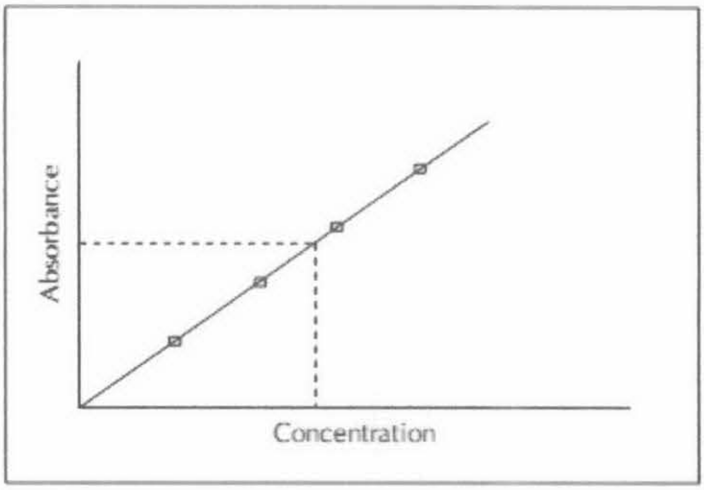


Figure 2.2:Plot of Absorbance against Concentration

Linear line calibration produced from the AAS analysis provides agreeable and reliable data of the sample contain element similar as the light source metal. For example, if the element to be tested is lead, lead cathode will be used as the light source and high absorbance of light during analysis confirm the analysis that the sample contains high concentration of lead.

2.11 Inductively Coupled Plasma (ICP)

The ICP is an inductively coupled plasma etching system, which can be used to etch a variety of materials. It is currently equipped with boron trichloride (BCl_3), chlorine (Cl_2), argon (Ar) and hydrogen (H_2).
Advantages of using an ICP include its ability to identify and quantify all elements with the exception of Argon; since many wavelengths of varied sensitivity are available for determination of any one element, the ICP is suitable for all concentrations from ultratrace levels to major components; detection limits are generally low for most elements with a typical range of 1 - 100 g / L. Probably the largest advantage of employing an ICP when performing quantitative analysis is the fact that multielemental analysis can be accomplished, and quite rapidly. A complete multielement analysis can be undertaken in a period as short as 30 seconds, consuming only 0.5 ml of sample solution. Although in theory, all elements except Argon can be determined using and ICP, certain unstable elements require special facilities for handling the radioactive fume of the plasma. Also, an ICP has difficulty handling halogens--special optics for the transmission of the very short wavelengths become necessary.

CHAPTER 3

METHODOLOGY/PLANNED PROJECT WORK

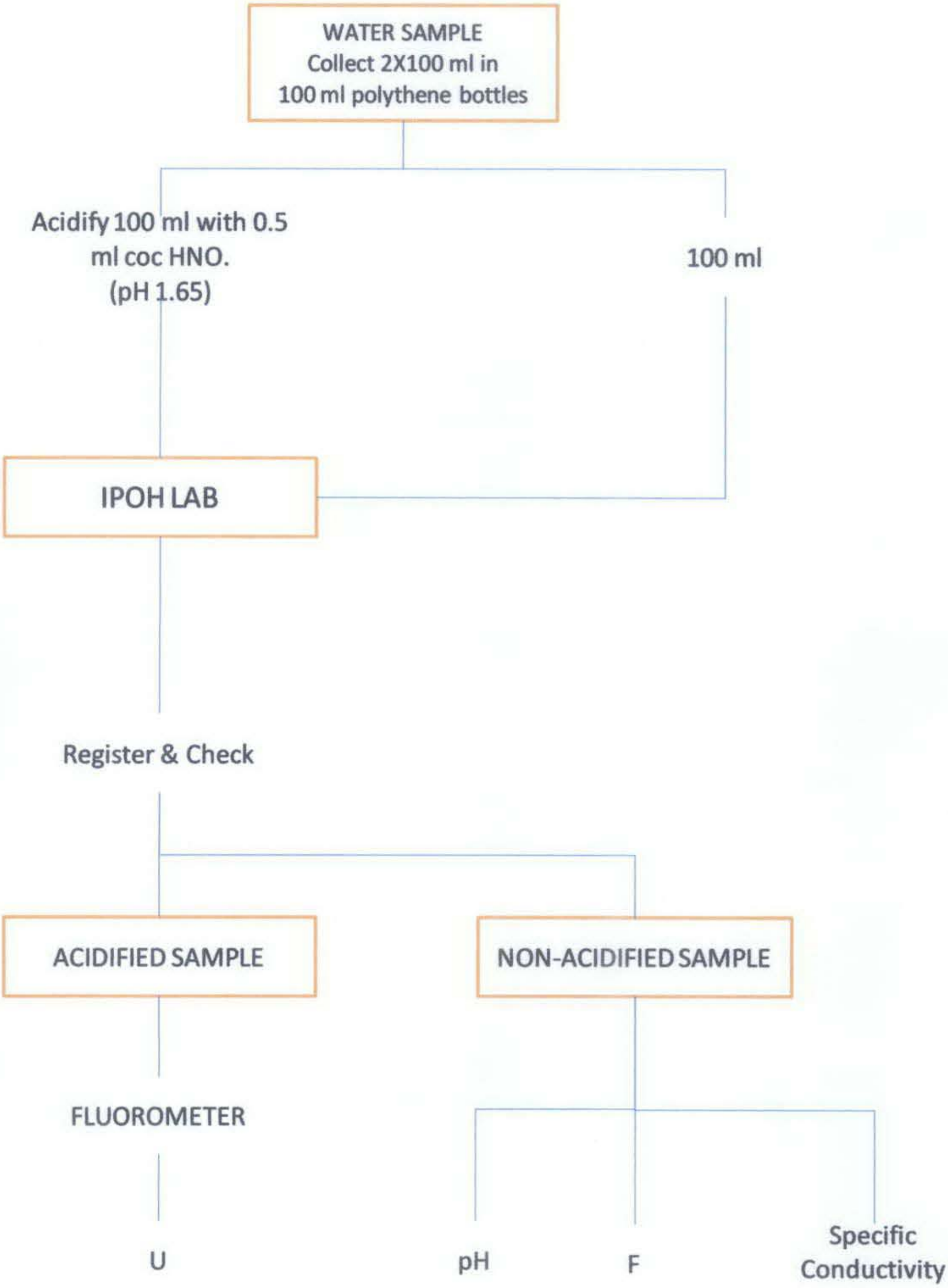
3.1 Geothermal Energy

After some testing and experiment had been done, the geothermal energy is currently not viable in Malaysia because the hot spring in Malaysia have a lower temperature and flow rate base on previous research from the required to generate the geothermal energy. Even if the geothermal energy can be generated, it is not profitable at all. The hot springs water temperature and flow rate can be measured by using chemical geothermometric measurement.

3.2 Water Chemical Analysis

In water chemical analysis, there are two methods available either by using ICP or Atomic Absorption Spectrophotometer. The flow chart given below shows a general overview of process that should be taken in order to do the water analysis.

Basically, we have to take two type of sample which is acidified and non-acidified. This is because in order to examine composition in the water, certain element can be detected in acidic condition and in non-acidic condition.


WATER SAMPLE
Collect 2X100 ml in
100 ml polythene bottles
Acidify 100 ml with 0.5
ml coc HNO.
(pH 1.65)
100 ml
IPOH LAB
Register & Check
ACIDIFIED SAMPLE
NON-ACIDIFIED SAMPLE
FLUOROMETER
U
pH
F
Specific
Conductivity

3.2.1 Sampling Procedure

The procedure for collecting water samples is as follows:-

1. Use a clean water sample bottle.
2. If sample bottle is not available, use another suitable container, ensuring it is strong and durable, so that it will not break in transit and that the cap does not leak once the cap is secured. The laboratory requires a minimum of 500 mL, so a plastic soft drink bottle, of 1 - 2 L capacity, would be suitable;
3. Rinse the bottle at least 4 times with the water to be sampled;
4. Do not dispose of the rinse water where it may contaminate or mix with that which is to be sampled;
5. Take 5 sub-samples (100 - 200 mL each), to make up the full sample;
6. Fill the bottle to the top, leaving little or no air space and seal tightly with the cap;
7. Ensure the bottle is adequately labeled so it can be identified at all stages of the transport and analytical process;

3.2.2 AAS Procedure

See Appendix I

3.2.3 Open Water Sampling

3.2.3.1 Thermometer Preparation

1. Remove the cover from the field thermometer and place the thermometer in the shade, out of the wind, preferably about 1 metre above the ground to minimize the heat influence from anything other than ambient air temperature.
2. Leave the thermometer for 5 - 10 minutes or for the time it takes to collect the water samples.
3. Record the air temperature to the nearest 0.5 degrees Celsius. (See Appendix 2 for a sample Data Card).

3.3 Recreational Place

Finally to develop hot spring as a recreational area, first make sure the hot spring is save for people to bath. Next targeting the visitor by distributes survey form or questionnaire to the public in order to gather and analyze the data. This step is to determine number of people who willing to come to the hot spring if it develops as a recreational area.

CHAPTER 4

RESULTS AND DISCUSSION

After the experiment had been done, the result is then almost close to the expectation value. Based on the result, the explanations is then been discussed in order to decide whether the hot spring which include in the study can fulfill the objectives or not.

No	Location	Surface Temperature, (^{o}C)	Discharge, (l/sec)
HS1	Kg Air Panas, Hulu Slim	87	5.8
HS2	Batu 15, Tapah	40	4.4
HS3	Hulu Kampar Estate, Gopeng	40	2.5
HS4	Lian Seng Tong Chinese Temple, Ipoh	29	1.26
HS5	Sg Klah Felda Land Scheme, Tanjung Malim	98	2.52
HS6	Tambun Hot Spring, Ipoh	65	20

Table 1 : Table of Temperature and Flow Rate

From Table 1, it shows the two important criteria that are very important in order to generate what we call geothermal energy which is some kind of a renewable energy. Although the geothermal energy can help to mitigate the global warming, but only some of the place is profitable in generate this energy. Besides, it is costly expensive for the drilling and exploration process.

From the result below, we can see that water is highly in sulfur, SO_4. We already expect that the water contain the sulfur from the smell like rotten egg. Below is the experiment data showing the presence of sulfur and some other data that is relevant to my study.

Sample No. (mg/l)	SO_4	Ca	Mg	Na	K	Fe	Mn	CO_3	HCO_3	Cl	NO_3	F	As	Pb	Cd
HS1	12	2.4	1.0	45.0	2.0	0.3	0.2	18.00	85	1	3	7.3	0.02	0.2	0.2
HS2	8	3.1	1.2	38.5	1.3	0.3	0.1	11.00	75	1	5	5.8	0.02	0.3	0.1
HS3	10	8.4	1.0	45.0	1.3	0.3	0.1	9.00	88	1	5	9.0	0.04	0.2	0.1
HS4	5	80.3	10.0	1.5	0.6	0.2	0.2	1.00	275	1	3	0.6	0.006	0.2	0.2
HS5	7	0.5	0.8	41.0	2.5	0.1	0.1	16.00	84	1	4	4.0	0.006	0.1	0.2
HS6	6	14.0	0.5	42.6	3.5	0.2	0.1	6.00	143	1	4	9.3	0.004	0.1	0.2

Table 2 : Experiment Data for water analysis

From these values, we can compare it with the standard requirement. The comparison of the requirement data can be seen in Table 2.

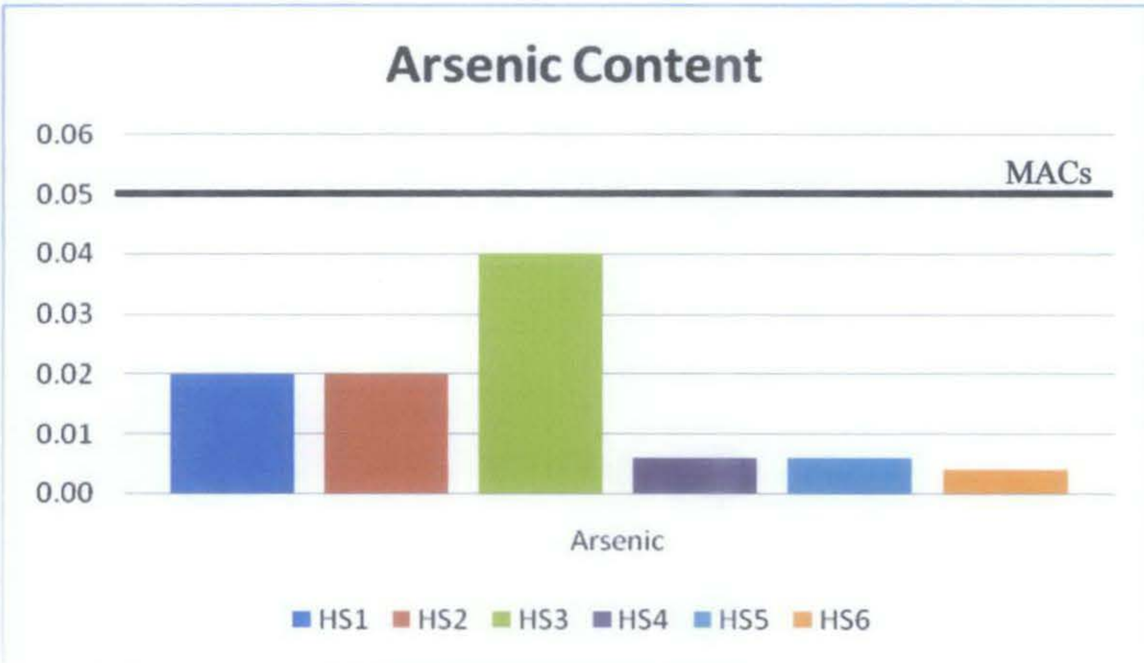


Table 3 :Arsenic Content in Water

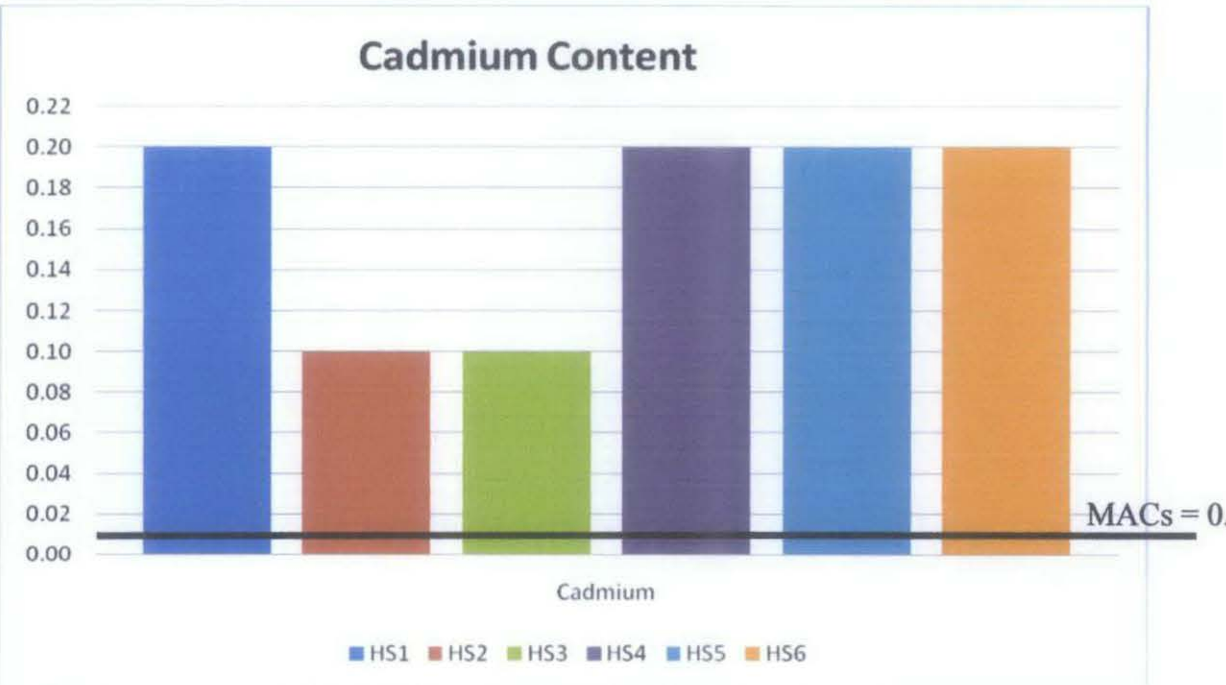


Table 4 : Cadmium Content in Water

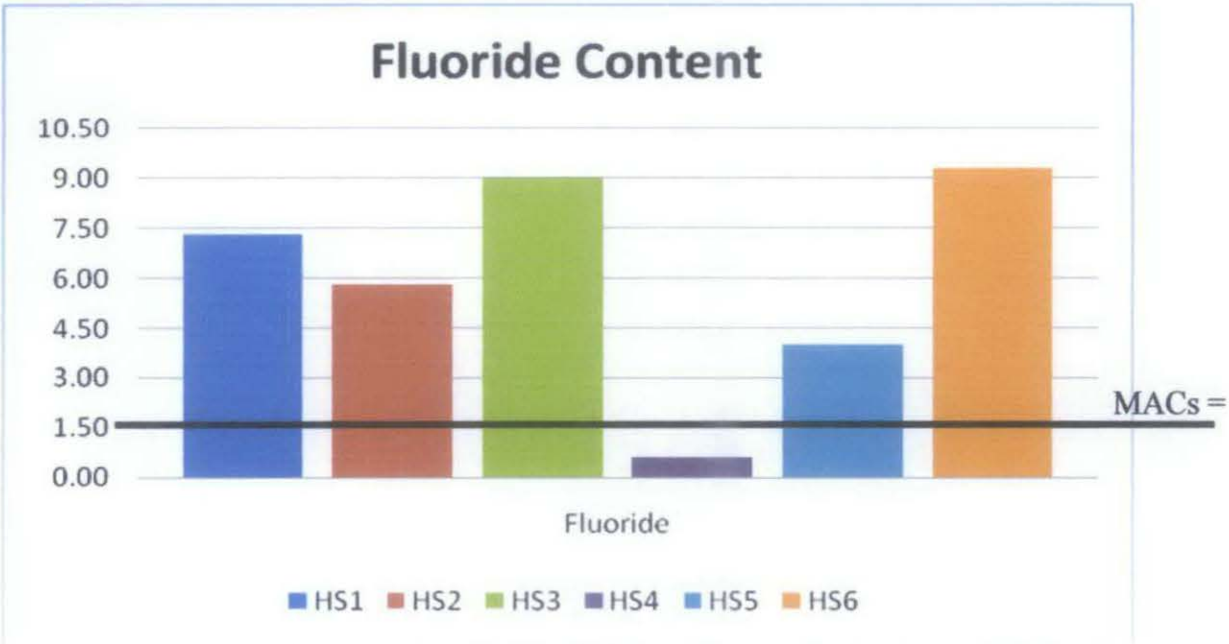


Table 5 : Fluoride Content in Water

Table 6 : Lead Content in Water

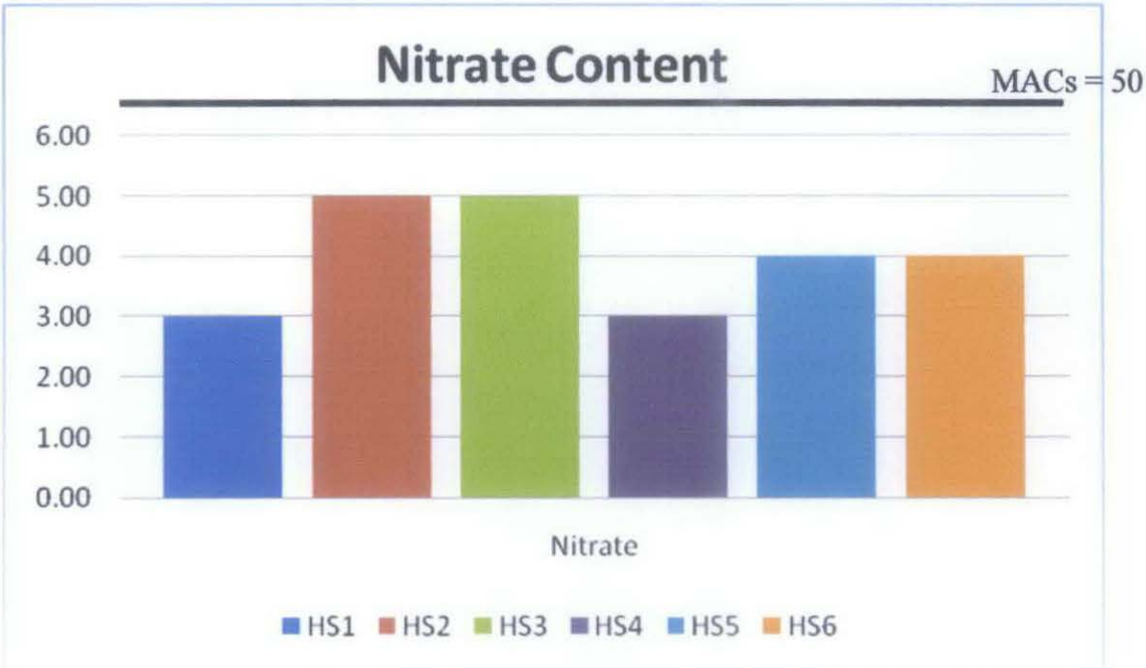


Table 7 : Nitrate Content in Water

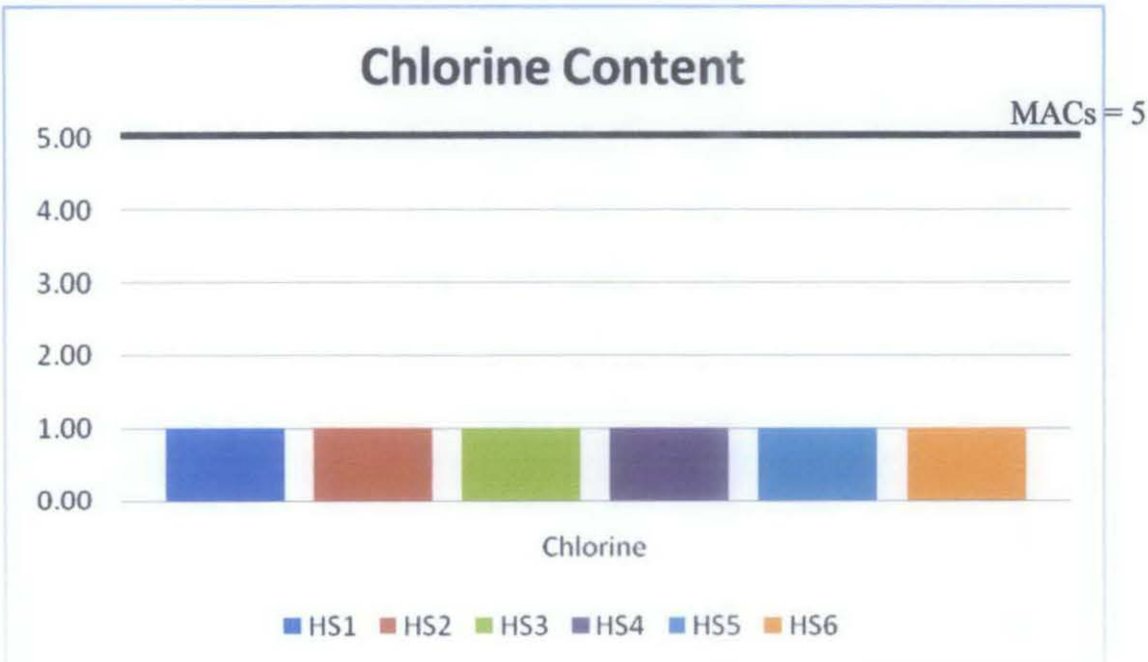


Table 8 : Chlorine Content in Water

Chemical	Location Number : **HS1**	
	MAC (mg/L)	Experiment (mg/L)
Arsenic, As	0.01~0.05	0.02
Cadmium, Cd	0.01	0.2
Flouride, F	1.5	7.3
Lead, Pb	0.01	0.2
Nitrate, NO_3	50	3
Chlorine, Cl	5	1
Location Number : **HS2**		
Arsenic, As	0.01~0.05	0.02
Cadmium, Cd	0.01	0.1
Flouride, F	1.5	5.8
Lead, Pb	0.01	0.3
Nitrate, NO_3	50	5
Chlorine, Cl	5	1
Location Number : **HS3**		
Arsenic, As	0.01~0.05	0.04
Cadmium, Cd	0.01	0.1
Flouride, F	1.5	9.0
Lead, Pb	0.01	0.2
Nitrate, NO_3	50	5
Chlorine, Cl	5	1
Location Number : **HS4**		
Arsenic, As	0.01~0.05	0.006
Cadmium, Cd	0.01	0.2
Flouride, F	1.5	0.6
Lead, Pb	0.01	0.2
Nitrate, NO_3	50	3
Chlorine, Cl	5	1
Location Number : **HS5**		
Arsenic, As	0.01~0.05	0.006
Cadmium, Cd	0.01	0.2
Flouride, F	1.5	4.0
Lead, Pb	0.01	0.1
Nitrate, NO_3	50	4
Chlorine, Cl	5	1
Location Number : **HS6**		
Arsenic, As	0.01~0.05	0.004
Cadmium, Cd	0.01	0.2
Flouride, F	1.5	9.3
Lead, Pb	0.01	0.1
Nitrate, NO_3	50	4
Chlorine, Cl	5	1

Table 9 : Comparison Experimental Value with Maximum Acceptable Concentration (MAC) Value

From Table 2, we can see that all of the sample taken show that it is not suitable to make it as a drinking water but from the data, we can see that high intention should be taken to the Flouride. Based on the environ mental profile and the baseline information, MACs were established for cadmium, fluoride, lead, nitrate and chlorine. There MACs are the same as the WHO guideline values (GVs).

WHO recognized that the stringent GV of 0.01 mg/L for Pb(lead) might not be achieved immediately because of the difficulty in controlling the dissolution of lead from the lead pipes. However, it had been decided that such a value could be realistically achieved due to pipes are not used in the country and lead is present in water from natural sources.

For the arsenic (As), analytical capability is not available. But then the value recommended by WHO of 0.01 mg/L is based on hypothetical cancer risk estimates which are a bit far from the actual value for prevention. For this reason, it had been agreed that, the range of 0.01 to 0.05 mg/L to be attained.

In order to study what people expect from a recreational place, a survey had been conducted among the nearby villagers and also among the students of Universiti Teknologi PETRONAS. The result of the survey is then being interpreted to a graph form to make it easier to understand.

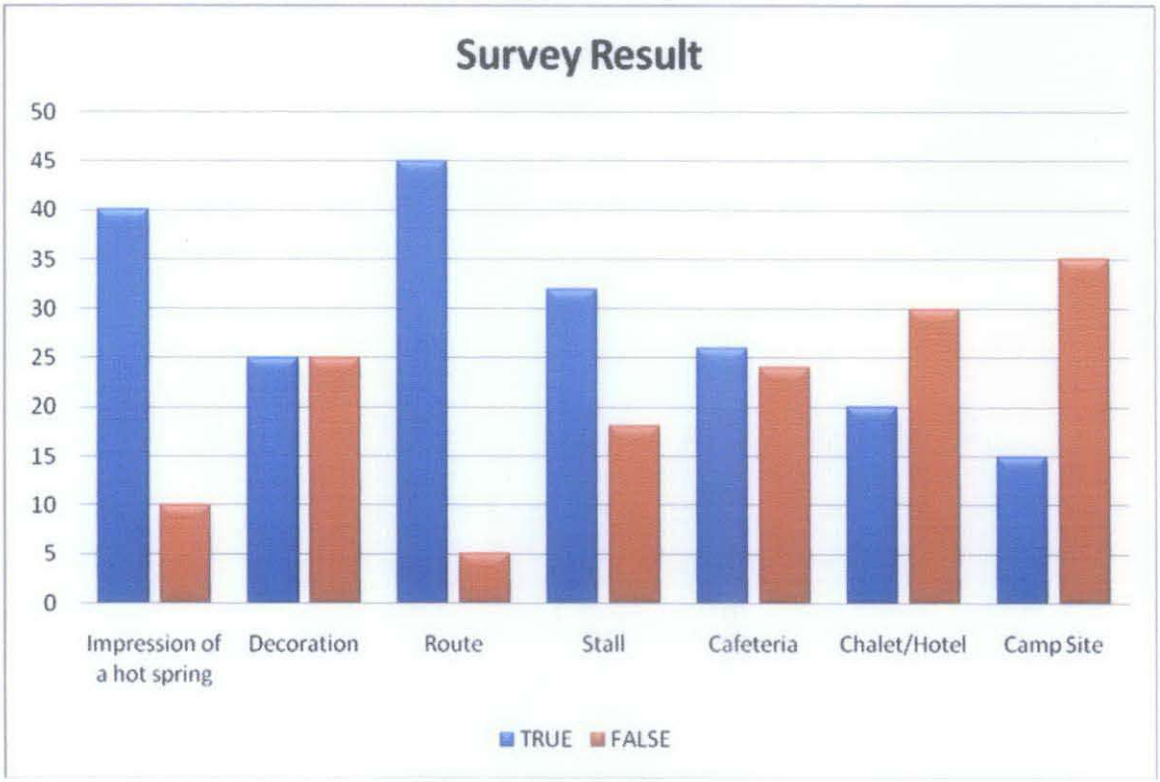


Figure 1 : Result of Survey

The survey questions can be seen in the appendix I.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

By looking at the result shown, some of the hot spring is capable to generate the geothermal energy by looking from the temperature side but fail in the flow rate side and also some of them capable of generate the geothermal energy by looking at the flow rate side but fail in the temperature side. Both of these qualities are needed in order to generate the power plant that is based on the geothermal power. As a conclusion, the geothermal energy cannot be generated in these places or else the profit is lost. As a recommendation, deep investigation and study should be taken in order to make it as a reliable energy resource especially how to increase the flow rate. Forecasting the future of geothermal power should be depending on technology growth, the price of energy, subsidies, and interest rates.

From the presence of the Sulfur, SO_4, it is not too reliable to make it as drinking water unless we remove it first. Also from the overall result by comparing to the guideline that should be followed, we can see that the water is not same as standard values but it does not mean that it cannot make as a drinking water anymore. With suitable simple absorption process, the water should make as a drinking water.

Even though the water cannot be as a drinking water, it does not mean that the water is harmful if being drank not on purpose for example while bathing. It is because the guidelines from the WHO show the limit of acceptable value that is far from certain for early prevention. Although recreational places is not in our highest intention, but mostly all of the places that is included in this study is capable of being a recreational places. Even some of them situated a little bit far from the main road but all of them have the potential to be a famous recreational place with correct development. There is no recreational place without profit and no profit gain without visitors. Therefore, before any development done, a survey had been conducted to get the surveillance opinion for what they need in a recreational place. As a first question, 80% realize what is the hot spring is. From the graph that had been interpreted by the survey results, we can see that the important thing is the route which consists of transportation and road. Other thing that is in concern is the stay accommodation such as hotel, chalet and also camp site. From these three accommodations, most people choose that the host spring is very suitable for camping site rather than chalet or hotel rooms. Even though that according to tourist that all the hot spring is suitable to become a recreational place, but from the result of the experiment that had been done, the place is not very suitable to bath due to its temperature and the water contamination that contain element that is harmful to the human. Therefore, in order to turn it to a perfect recreational area, all of this should be fix by filtering the elements and cool the water to the acceptable temperature rather than its original temperature that is almost near to boiled water.

Another option for the use of hotspring water is as a medicated product. As all we know, hotspring water contain very high in sulfur concentration. Rather than remove the sulfur, it is more reliable to keep the hotspring in its original condition due to sulfur can be use to heal many of skin problems. Due to the time limitation, the experiment regarding the medication use of hotspring water cannot be continue for this time being but it can be keep for further discussion.

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APPENDIX

Appendix I : AAS Procedure

1. Make sure that computer is running the GBC software (double-click icon on Windows 95 desktop) and that the spectrometer is on (on/off button on side of AAS). Also, turn on the fuel and oxidant on the regulators on the tanks connected to the nebuliser (check both gauges on each tank).

2. Choose the Application Editor option to adjust settings for data collection:
   a. **Name**—Choose a file name for your settings
   b. **Element**—Type the abbreviation for the element in your solution
   c. **Matrix**—The solvent you are using (probably water)
   d. **Wavelength**—select an appropriate wavelength for your element and concentration range
   e. **Slit width**—given for each element
   f. **Slit height**—Normal setting
   g. **Measurement Mode**—Integration
   h. **Calibration Parameters**— Calibration Mode = Concentration
   i. **Flame Parameters**— *Flame type* = Air or N_2O/Acetylene *Acetylene and Oxidant Flow* = set ratios for reducing or oxidizing flame according to element (more air/N_2O = oxidizing, more fuel = reducing) *Burner Angle* = 0.0 degrees
   j. **Data Collection Parameters**—*Replicates* = machine will take average of this number of measurements (5 is a common number) *Read Time* = time in between replicate measurements (3 sec is common) These parameters can be saved by hitting Enter at the Save Parameters option and can be recalled later by selecting Load Parameters on the Main Menu.

3. Open the lamp door on the left side of the spectrometer and turn the lamp holder to where the lamp labeled with the desired element is closest to you (the machine should prompt you to do this).
4. To perform a measurement run, choose the Run Parameters option from the Main Menu. Set the analysis mode at Random and the sampling mode at Manual (since this spectrometer is not equipped with a peripheral sample changing device).

5. Before you light the flame, ensure that the correct burner for your oxidant (air or N_2O) is in the nebulizer. To change the burner, pull the burner plug out of the right side of the burner compartment, turn the burner counter-clockwise and pull it out. Put the desired burner in place, turn it clockwise to lock into place, and plug into flow lines. Ensure that the burner is in the correct position by placing a white card over the burner slot. Use the Horizontal Vertical adjustment knobs to adjust until the beam is parallel with and about 1 cm above the burner slot. The deuterium knob next to the cathode lamp can also be adjusted.

6. To ignite the flame, push the ignite button on the side of the AAS to light. Make sure that the flame sustains for about 20 seconds before continuing. The flame should be fairly small with little or no yellow color at the top and slightly pinkish at the bottom. The bright blue band at the bottom should be as thin as possible. To set the flame accordingly, adjust the gas flow of the air, acetylene, and nitrogen tanks using the knobs on the tanks themselves, as well as adjusting the air/acetylene ratios on the computer under Flame Parameters.

7. Select the Alignment option on the Main Menu. This will display two dials that gauge the amount of signal reaching the spectrometer. With one of your samples aspirating (a moderate concentration) (see #8- instructions for aspirating) adjust the Vertical alignment to where the dial on the left is approximately in the middle of the gauge while not decreasing the reading on the dial on the right.

This is to ensure that extremely high/low concentrations do not read absorbance's that are too close to the maximum/minimum sensitivity of the spectrometer. (See Minimum Measurable Absorbance section of discussion). Also ensure that this does not disrupt previous alignment performed in step 5.

8. When you are ready to begin the calibration procedure, hit F2 to go to the results screen. Hit F10 to take data on a sample. The machine will ask for the sample in a new dialog box. At the beginning of your runs, you should test a water sample as a blank. Select the Solution as Cal Blank. On the nebulizer, make sure that the apparatus is aspirating by watching for fluid coming out of the trap into the waste tube (or by aspirating a concentrated sodium solution. The flame will turn bright yellow). Place the capillary tube in DI water (idle machine should already be aspirating water). Select Read on the dialog box. The AAS will collect the specified number of measurements and average them. This will zero the machine.

9. Aspirate each calibration standard in the same manner, only choosing Sample as Solution. Wipe off the capillary tube with a Kim-wipe and place it back in DI water between each standard.

10. After you have taken data on all standards, plot the absorbance vs. concentration on Excel or other data program. If the machine is working properly, the data should be relatively linear. (For sample plots, see Appendix 3.) If the data is not linear, then certain parameters will have to be varied to make data more linear for the determination of unknown concentrations with Beer's Law (see discussion).

11. To turn the machine off, extinguish the flame by pressing the ignite button on the AAS. Turn off the pressure on regulators on the fuel and oxidant tanks. Then select the Bleed Lines option from the Flame Parameters option in the

Applications Editor. This will remove any excess gas from the system. Exit the GBC software by hitting Escape (ESC) until the system goes back to Windows.

Appendix II : Survey Form

1. Do you know what is Geothermal Hotspiring?
    a. Yes
    b. No
2. Do you think that the decoration of a recreational place is an important element?
    a. Yes
    b. No
3. Is it important that the route to the recreational places can be easily found? (Signboard, highway, etc)
    a. Yes
    b. No
4. Most of the modern style of recreational places do not allowed bringing outside food. Do you prefer there is stall in there?
    a. Yes
    b. No
5. Other than stall, is it cafeteria/restaurant is suitable?
    a. Yes
    b. No
6. Do you prefer there is built a guest room such as hotels or chalet?
    a. Yes
    b. No
7. Should be the camping site is reliable for the hot spring recreational area?
    a. Yes
    b. No