HOT SPRINGS AT TAWAU HILLS PARK, *SABAH*, MALAYSIA

H.L.H CHONG[1], D. MOHD. NOH[1] & F. LIEW[2]

[1]School of Science and Technology, Universiti Malaysia Sabah, Sabah, Malaysia
[2]Sabah Parks, Sabah, Malaysia

SUMMARY - This paper reviews the geothermal manifestation in Tawau Hills Park, Sabah, Malaysia. Results obtained from the springs indicate that the geothermal resource is of the low enthalpy type. The warm sulphurous springs in the park with combination of other features have great potential for nature tourism industry.

1. INTRODUCTION

The state of Sabah, Malaysia, which is situated at the northern tip of Borneo island, is rich in biodiversity and indigenous resources. Sabah is geologically complex and since it is at the fringe of the volcanic belt, geothermal manifestations such as fumaroles, seepages, mud pools and hot springs are common especially in the Tawau region. In general, the geothermal resources here are unexploited and it is our vision to exploit these resources in a sustainable manner in the near future.

Historically, geothermal research in Sabah dates back to 1962 when Kirk (1962) reported geothermal manifestations in the Semporna Peninsula. In March 1979, two researchers fiom New Zealand studied the potential of power generation with positive results (Maduarin and Cheng, 1987). *An* expert fkom the Department of Technical Cooperation for the United Nation Development Programme undertook research here in October 1986 and suggested further geochemical and resistivity study in order to locate suitable sites for exploration drilling (Sanudin *et. al.*, 1990). As a follow up, the Malaysian Geothermal Work Committee was established in 1987 in which some momentum was gained. Several research papers were subsequently published by Radja (1986), Simandjuntak *et. al.* (1989), Sahat *et. al.* (1990), Sanudin (1995) and others. However, the momentum for research and exploration faded and the topic seem to have evaporated. We believe, however, that there is potential here to define an exploitable and renewable resource. Our first task is to re-establish the database.

This paper only covers the geothermal manifestations of Tawau Hills Park, one of the geothermal areas in the Tawau region. The geothermal manifestation of other areas will be the subject of other papers to come.

2. PHYSICAL SETTING

Tawau Hills Park headquarters (N04°14'42.7", E117°53'03.3") is located 20 km north of Tawau town. It is underlain mainly by Miocene to Pleistocene andesitic, dacitic and basaltic volcanic rocks with subordinate Early Neogene sedimentary rocks of the Kalumpang Formation (Sanudin, 1995). There are two geothermal manifestation areas (upper Tawau and Balung) within this 280 km^2 virgin lowland dipterocarp forest state park. Both are similar in that they are located along a river; however, one is located along the upper Tawau river while the other is located along the Balung river.

The first one is situated 3.2 km from the park headquarters. *An* hour walking along a jungle track will lead you to the first (labeled 2A) of a series of eleven springs along the river. The ecology here is unique due to the sulphurous environment.

The Balung geothermal manifestation sites can be reached by four-hour journey fiom the park headquarters; one and a half hours by off-road vehicle *to* the Balung sub-station and another two and a half hours by foot along the jungle trail.

3. NATURE OF DISCHARGES

Hot springs are the main thermal feature in Tawau Hills Park. These springs either emerge among boulders along the riverbank or from the riverbed. This section is mostly reproduced after Lim *et. al.* (1991).

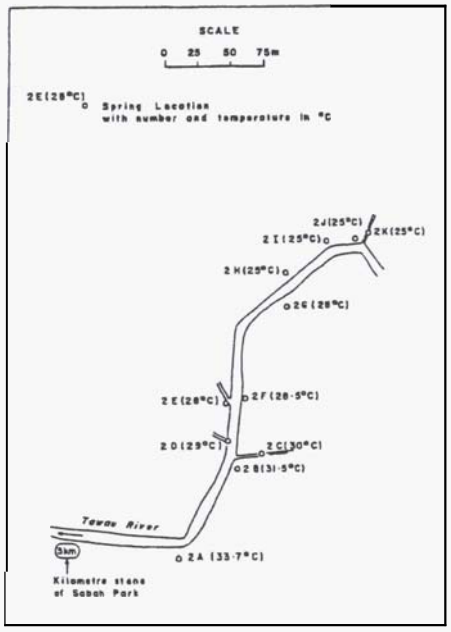

Figure 1: Distribution of warm sulphurous springs in the Upper Tawau Area (after Lim et. *al.*, 1991).

3.1 Upper Tawau River

As seen in Figure 1, eleven warm (25-33.7°C) sulphurous springs occur along the 250 m stretch of the upper Tawau river. the distribution of the spring temperatures is noteworthy; spring waters get hotter to the south. The elevation of this site is approximately 370 m above sea level. Several– of the outlets are on the riverbed or by the bank just below water level. According to Lim *et. al.* (1990), the northeasterly alignment of the springs indicates structural control. The close proximity of these springs to major northeasterly trending lineaments observed on LANDSAT imagery had been noted by Lim (1 988).

The spring waters are acidic (pH 3.68-4.10). A strong hydrogen sulphide smell could be detected at 150 m range before reaching the first spring (2A). The discharge of Spring 2A emerge fiom among boulders of rhyolitic rocks. The boulders surrounding the springs are characteristically sulphur coated.

It is not possible to obtain a total flow discharge of this area; however, Spring 2B has a flow discharge of 0.15 l/s, a pH of 4.04 and a temperature of 31.5°C. The chemistry of Spring 2B is summarized in Table 1. Its temperature was 23.6°C and the pH 6.50 at 10 m downstream from this spring; at 10 m upstream, the temperature was 23.1°C and the pH 7.51. The upper Tawau river flow rate here is approximately 1600 *Vs*. The temperature downstream of all the springs was 24.3°C and the pH 6.35. Upstream of all the springs, the stream temperature was 23.1°C and the pH 7.51.

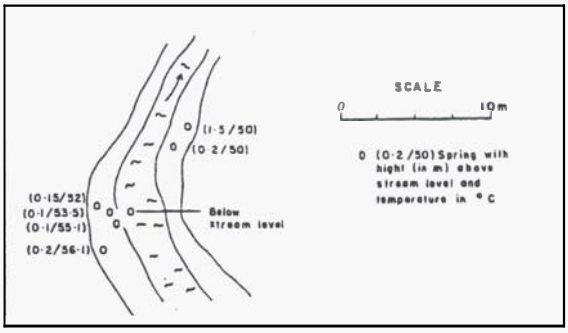

Figure 2: Distribution of hot springs in the Balung 1 Area (after Lim, *et. al.*, 1991).

3.2 Balung 1

As shown in Figure 2, *six* outlets occur on both banks and of the riverbed of a tributary of the Balung river (200 m asl). This site is characterised by its strong hydrogen sulphide smell. The springs on the left bank are 0.1-0.2 m above water level and emerge fkom boulders of silicified rocks. The two outlets on the right bank are situated higher, 0.2-1.5 m above water level, and emerge from weathered dacitic rocks.

The temperatures of the springs range from 50-56.1°C and the pH fiom 6-6.2. Flow discharge rates of four of the most active springs total 0.5 Vs Thin films of silica were being deposited on the boulders. The springs are aligned northeasterly.

3.3 Balung 2

This site is located about 0.5 km northeast of Balung 1 at an elevation of about 200 m above sea level. Hot water at 55.6°C emerges fiom among boulders of silicified rocks. The outlet is a few centimeters above water level. The discharge rate is 0.5 l/s and the pH is 5.97. Similar to Balung 1, there is a strong hydrogen sulphide smell.

A warm pool of 39°C, 1.5 m in diameter occurs 30 m northeast of Balung 2 away fiom the river. The pH of the pool water is 6.05.

4. CHEMISTRY OF THE SPRINGS

The result of the springs chemical analysis is summarized in Table 1. In general, the waters are all dilute (total solids < 7000ppm) and contain low silica.

The spring waters fiom upper Tawau (2B) and the Balung areas (B1 & B2) are chemically similar although water from upper Tawau is more acidic and contains lower Ca, K, Na, HCO_3 and As, but is higher in Fe. Their similarities are reflected in their similar Na/K, Na/Ca and Cl/SO_4 ratios. An interesting question regarding the spring water from the

upper Tawau is how it has obtained its acidity. Is it because the fluid is a steam condensate or is it ground water mixed with gas (H_2S most likely)? The low concentration of CO_2 indicates there is low gas flow (Lim *et. al.,* 1991). On the other hand, if the fluid is steam-heated ground water, then the implication is that there is steam somewhere at depth. The waters of both areas are of the acid sulphate type although the waters of the Balung areas are near neutral, perhaps due to their contact with and neutralized by cold underground water. The Balung springs are located at a lower elevation of 200 m compared with those in the upper Tawau area (370 m).

The low Na/Ca ratios of the Balung and upper Tawau springs may indicate that the waters are not supplied directly from the aquifer. Acid sulphate waters are normally at some distance fkom a major up flow zone or at the perimeter of a field. The waters may reach the surface rapidly along faults or permeable formations.

The low Cl and high SO_4 may indicate steam heating. The high SO_4 may be produced by oxidation of sulphur compounds in the magmatic steam by atmospheric oxygen in solution in groundwater or the waters could have passed through sulphur-rich rocks.

Table 1: Springs chemical analysis results.

Sample	2B	B1	B2
Site temp. °C	31.5	55.1	55.6
pH at 25 °C	3.7	6.1	6.0
Total SiO_2	32	37	32
Ca	138.66	445.2	447.06
Mg	14.91	16.4	17.5
K	3.55	8.3	9.6
Na	14	39.25	30.0
Li	ND	0.2	0.2
HCO_3	7.32	89.06	78.08
SO_4	500	1254	1302
Cl	6	10	8
F	0.23	0.66	0.72
B	ND	ND	ND
AS	5	23.3	17.5
Fe	1.4	0.1	0.3
Mn	0.4	1 _ ▮	1.1
Total Solids	644	1846	1834
Conductivity	835	1853	1822
Na/K	6.7	6.5	5.2
Na/Ca	0.18	0.12	0.12
Na/Li		46.9	45.2
Cl/SO_4	0.03	0.02	0.02
Cl/F	14.17	8.06	5.95

(After Lim et. al., 199)

Note:
All cations and anions are expressed in ppm
Total solids are expressed as mg/l & conductivity as umho
. ND – Not detected

5. NATURETOURISM

There are 280 km^2 of virgin lowland dipterocarp forest which has been gazetted as state park since 1979. It houses interesting species such as *Phalaenopsis gigantea, Presbytis rubicunda, Tarsius bancanus, Otus lempiji* and the hornbill rhinoceros. Within a few kilometers of the park headquarters, two waterfalls and eleven warm sulphurous springs exist.

The nature tourism attraction of this park has regularly lured tourists, especially the local people of Tawau. In 1999, 17,624 tourists were recorded. This figure is expected to rise once the road-upgrading project is completed.

6. CONCLUSION

From the data available on these springs, we noticed that the geothermal fluids are of low enthalpy type. The upper Tawau geothermal fluid is not hot enough for any direct use in this region; however, the Balung geothermal fluids have the potential to be developed as a hot bath recreational spot such as the one we have in Poring. According to the local people, the spring water has its own medicinal properties for skin treatment. Bathing in these springs is popular here. As a final conclusion to this paper, we strongly believe that these springs have an important role to play in the nature tourism industry of Tawau Hills Park.

7. ACKNOWLEDGEMENT

We wish to express our special thanks to the Director of Sabah Parks for granting us the permission to undertake this study in the park and to the staff in assisting us while in the field.

8. REFERENCES

Kirk, H.J.C. (1962). The geology and mineral resources of the Semporna Peninsula, North Borneo. *Brit. Borneo Geol. Surv.* Mem 14: 178.

Lim, P.S. (1988). *Geology and geothermal potential of the Tawau area, Sabah.* Geological Survey Malaysia 1987 Annual Report, pp. 402-413.

Lim, P.S., Intang, F. and Chan, F.O. (1990). Geothermal prospecting in the Semporna Peninsula with emphasis on the Tawau area. *Presented at GSM Annual Geological Conference 1990.*

Lim, P.S., Intang, F. and Chan, F.O. (1991). Geothermal prospecting in the Semporna Peninsula with emphasis on the Tawau area. *Geological Society Malaysia, Bulletin 29,* pp. 135-155.

Maduarin, R and Cheng, S.Y. (1987). Status of geothermal development in Sabah, Malaysia. *6th ASEAN Geothermal Cooperation Project Meeting, 23-25th Nov. ,1987, Tawau.*

Radja, V.T. (1986). The role of ASEAN geothermal genaration in the world geothermal scenerio. *6th Conference* on *Electrical Power Supply Industry (CEPSI), 3-7th Nov., 1986, Jakarta.*

Sahat, *S.*, Sanudin, T. and Jumat, S. (1989). *Preliminary survey of the Sungai Jepun Hot Spring.* Report for the Malaysia Geothermal Work Committee.

Sanudin, T. (1995). Geology and geothermal potential of Tawau Hills Park, Sabah. In: *A Scientific Journey Through Borneo: Tawau Hills Park, Sabah,* Ghazally, I., Siraj, O. and Laily, D (eds). Pelanduk Publication, Kuala Lumpur, pp. 31-44.

Sanudin, T., Sahat, S. and Brunotte, D. (1990). Potensi penjelajahan geoterma di Sabah. *Abstrak dan Prosiding Persidangan Sains Bumi dan Masyarakat, 9-10 Julai 1990, UKM Bangi:* 129-138.

Simanjuntak, J., Chan, F.O. ,Lim, P.S. and Brunotte, D. (1989). *Geochemical studies for geothermal activity on Andrassy and Sungai Jepun areas.* Report for the Malaysian Geothermal Work Committee.