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Six-year Record of Rate of Limestone Dissolution at Three Sites in Gunung Rapat, Kinta Valley, Perak, Malaysia

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Abstract: Dissolution rate of limestone in the Kinta Valley is continuosly measured. The last measurement before this study is done was taken in 2001. The whole six years has shown that limestone is further being degraded under natural environment. The estimated dissolution on the limestone bedrock is from 0.086 to 0.158 mm/yr. However it is too early for the author to conclude that extrapolation of short term micro erosion meter data is acceptable in this environment.

Abstrak: Kadar pelarutan batu kapur di Lembah Kinta diukur secara berterusan. Ukuran yang terakhir sebelum kajian ini dibuat pada 2001. Masa 6 tahun ini menunjukkan yang batu kapur terus mengalami pelarutan di dalam keadaan semulajadi. Pelarutan dianggarkan dari 0.086 ke 0.158 mm/tahun. Walaubagaimanapun, masih terlalu awal bagi penulis untuk membuat kesimpulan yang data jangka masa pendek yang diperolehi dari meter erosi mikro boleh diramalkan untuk masa akan datang.

INTRODUCTION

The study of the limestone dissolution rate in the Sungai Perak Basin was started in 1999 by Ros Fatihah Muhammad (2003) by using a micro-erosion meter (MEM). The rate was measured either directly on the bedrock surfaces or by using limestone tablets that were left in ponds and running streams of water. Dissolution rates were regularly measured for any indication of surface lowering. Detail of the methodology will be described later in this paper.

The last group of measurements were taken up to 2001 and all data was used in the author's unpublished PhD thesis (Ros Fatihah Muhammad, 2003). Fresh measurements were made in February, 2006 ans some of them representThe author returned to the field to get some data, some of which presents 6-year record of limestone dissolution rate in the Kinta valley.

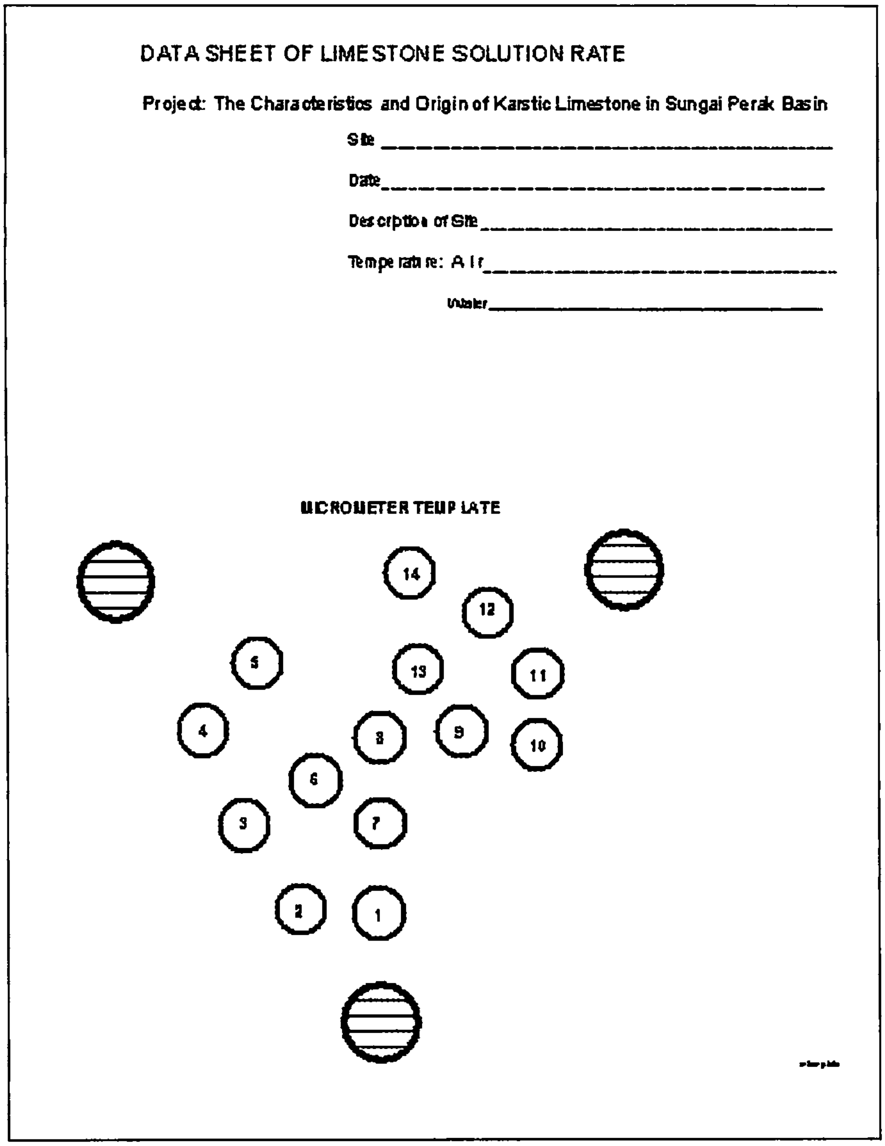
Figure 1: Micro erosion meter consists of micrometer gauge, a template and a standard plate.

METHODOLOGY

For this study, to obtain estimation of rate of limestone dissolution, direct measurements of surface lowering by a micrometer gauge were done. The micro erosion meter (MEM) was developed by High & Hanna (1970 in Ford and Williams, 1989) and improved by Coward (1971) and Trudgill (1983).

This instrument consists of a probe connected to a micrometer gauge (Figure 1) and locks precisely into stainless steel studs set into the rock surface. The raw datasheet used for recording each set of measurements is shown in Figure 2. Selected points on this surface can be repeatedly measured which were guided by the holes drilled through a stainless steel template through which the micro-meter gauge could be pushed through. Any lowering of the surface would be taken to be due to erosional lowering. Results are accurate to the nearest 0.001 mm. For each MEM, there are 14 points that can be measured on the limestone surface. However, due to the uneven surface of the tablet or the bedrock, the meter gauge could not take measurements on all 14 points all the time. Normally it is because they are either too low and do not touch the reading point or too high. Any reduction in the readings on the micro-meter gauge indicates the surface lowering or erosion, whereas any increament shows that there is deposition on the surface.

Since 1999, 31 sites for dissolution rate measurement were created. 10 limestone tablets were placed in standing water in ponds, 11 in running streams around limestone hills in Kinta Valley and Lenggong. Ten sites were created on the bedrock, where 3 holes were drilled and studs were installed. The last measurements were taken in 2001 and results obtained showed that dissolution rates were averaged at 221 mm/ka for standing water, 369


DATA SHEET OF LIMESTONE SOLUTION RATE

Project: The Characteristics and Origin of Karstic Limestone in Sungai Perak Basin

Site ______________________

Date ______________________

Description of Site ______________________

Temperature: Air ______________________

Water ______________________

MICROMETER TEMPLATE

Figure 2: Raw datasheet used to record measurements of limestone dissolution

mm/ka for running water environment and on the bedrock surface, rate was averaged out at 134 mm/ka. Details can be found in Ros Fatihah Muhammad (2003).

The author returned to the field in February, 2006 but unfortunately most of the tablets that were left in the water could not be recovered. In the intervening five years, drastic changes have taken place to the rivers around the caves and notch areas under study. Sedimentation by mud from nearby active quarries has buried the limestone slabs. This was expected by the author even during frequent visits (every two to three months) made previously between 1999 and 2001. A number of tablets had also been lost due to heavy rain or flooding near the cave area. Only the sites from the bedrock that are still preserved were measured in this study.

Measurements on sub-aerial surfaces are often affected by mosses and lichen growth. These microbes could also play some roles in calcite deposition on the surface. Such growth would yield positive increments relative to the studs. Increment could also be found where airborne dusts were deposited on the surfaces. For the measurement of these surfaces affected, the writer had to carefully brush the surface to remove the growth or sedimentation using soft bristle. However, increment results were still obtained at certain points. This is due to some growth that was too hard to remove, or accumulated dusts that have became too thick. For these samples, Derek Ford (pers. comm.) advised the writer to leave them under the moss cover for a longer period so as to allow further erosion under such conditions to continue. Those points that showed increment measure-ments were set aside for the time being. Only points with the decreased (due to erosion /solution) measurements were used to calculate the rate of dissolution.

Three sites namely NFTP, NF2 and NF3 were measured for this study. All of them are located in a wang in Gunung Rapat, Ipoh. The location of these sites is shown in Figure 3. GPS readings for location of NF2 and NF3 is 101° 11' 00" E and 4° 33' 00" N and for NFTP, 101° 10' 00" E and 4° 33' 00" N. NFTP is located on a collapsed limestone block in a wang. It is completely shaded by some trees and is heavily covered by mosses and lichens (Figure 4). Attempts were made to clean them by brushing with soft bristle.

NF2 is located on a wall of the limestone hill. The surface is almost flat, under an overhang. Dripping water from the wall have formed 'cockling' on the surface (Figure 5).

NF3 is located just besides NF3 but the surface is flatter and a bit reclined. It is exposed to the air and iron-quarrying in this area has deposited some airborne dusts on the surface (Figure 6).

Results from this study gave of dissolution rates for 2148 days (except for NFTP for 2147 days) from 16 April 2000 to 13 February, 2006 from 3 sites. Only15 points out of 42 points from these 3 sites were measured for surface lowering. The rest of the points show increment, and some are located on surfaces that are either too low or too high and no measurement was taken.

RESULTS/DISCUSSION

As mentioned earlier, NFTP is located in a shaded area and rainwater that trickled down from the leaves of the trees provides a suitable environment for the growth of

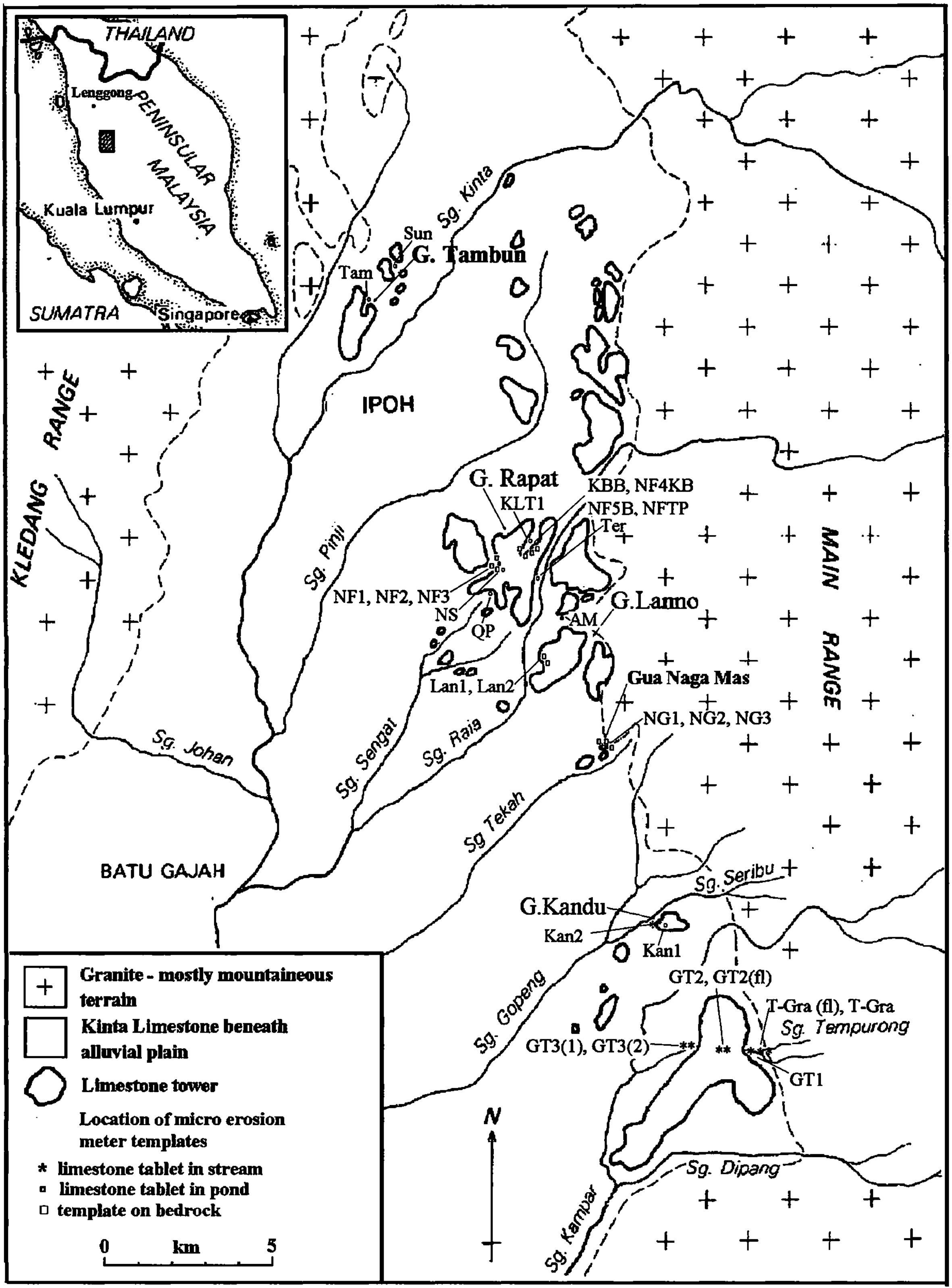


Figure 3: Location of limestone tablets and bedrock used in the dissolution rate studies (taken from Ros Fatihah Muhammad,2003). The location of NF2, NF3 and NFTP is shown in bold letters.

Figure 4: Growth of moss and lichen is common on NFTP

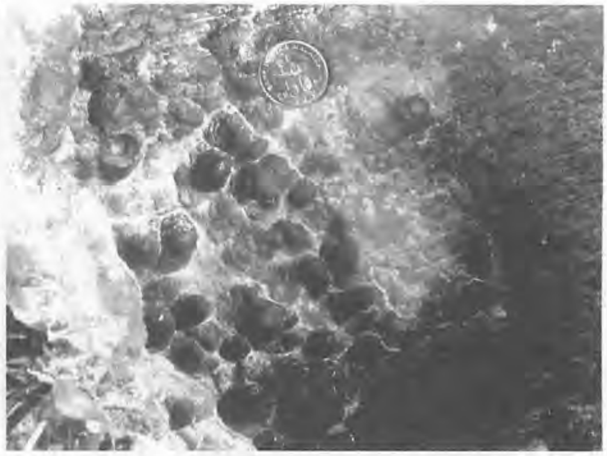


Figure 5: Cockling shown on NF2 surface

lichen and moss. That is the reason why increment was expected from this surface. However, it is set aside for the time being as, in a longer duration, it could provide dissolution rates under such environment.As for NF2 and NF3, both are not shaded and they are located at the wall of the hill, but close to an iron quarry. Deposition of airborne dusts is more intense on NF3 as the surface is more exposed to the quarrying activities. This is unavoidable, and at certain points, they ere hard to be removed completely by just brushing with soft bristle.

Falling small leaves, however accumulated on NF2 but they could easily be removed.

Rates are calculated based on the average of reductions in the reading using the Microsoft Excell Programme. They are then extrapolated to a value for a one year period. The rates here are presented in mm/yr and comparison to results from 2001 is also shown in Table 1.

From the previous results, highly variable rates of dissolution were obtained from measurement on bedrocks compared to from tablets in running and standing water. Therefore, it was expected to produce similar results during the 5 years. Readings from each point are highly variable as the lowest lowering was estimated at 0.002 mm/yr to the highest at about 0.294 mm/yr.

Though measurements were taken from points that show surface lowering, increment on the surface continued to occur due to the reasons mentioned earlier. It is shown in both NFTP and NF3. However, measurements will be continuously made in the future in order to see the dissolutional effect under mosses and lichen growrh cover.

NF2, however shows some dissolution had taken place on the surface. The readings are still highly-variable but some points shows steady lowering from 2001.

Stephenson and Kirk (1996) have measured erosion rates of shore platforms in South Island, New Zealand using the MEM on two data sets: one was taken after 2 years and the other 20 years and concluded that extrapolation of short term MEM data is acceptable in certain environment.

As for the case in the Kinta Valley limestone, it is probably too early for the author to make such conclusion.

Figure 6: Airborne dust from quarrying on NF3

CONCLUSIONS

Some conclusions deduced from the study are as follows:

Dissolution rate of the limestone bedrock in the Kinta Valley are highly variable

Airborne dust from quarries and the growth of lichen and mosses contributes to the increments on the limestone surface. While this is unavoidable, it can be guidelines while choosing other sites for future studies.

Everage measured limestone degradation rate of the bedrock from 3 subaerial sites for 6 year record from April, 2000 to February, 2006 is between 0.086 to 0.158 mm/yr.

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