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Characterisation, geochemistry and possible usage of the limestone hills in the Kinta Valley area, Perak

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Abstract: The primary purpose of the characterisation of the limestone hills in the Kinta Valley is to determine their physical and geochemical characteristics with the aim of ascertaining their most appropriate economic or industrial usage. The limestone (or more appropriately termed *marble*) has very varied usage depending on their chemical and physical characteristics.

The limestone hills in the Kinta Valley extend from Gunung Temelang near Tg. Rambutan in the north to Gunung Gajah, near Kuala Dipang to the south, a distance of about 30 km. The marble outcrops in the Kinta Valley, in fact, form 3 groups of limestone hills trending more-or-less north-south.

The main physical characteristics that were considered for each hill included colour, presence of fractures, joints or veins, texture or pattern, grain size, resistance to weathering, contamination and foreign material (such as chert nodules, quartz, etc.).

For their geochemical characteristics, the limestones were analysed for their $CaCO_3$, $MgCO_3$, SiO_2, Fe_2O_3 and Al_2O_3 contents. A thorough petrographic study was also carried out to determine whether they are calcitic or dolomitic and to detect the presence of other minerals which could jeopardise their quality and usage. Other than their $CaCO_3$ and $MgCO_3$ contents, the contents of Al_2O_3, SiO_2 and Fe_2O_3 are generally very low in the limestone samples; Al_2O_3 usually less than 0.25%, SiO_2 less than 0.55% and Fe_2O_3 less than 0.3%.

Geochemical analyses show that each limestone hill in the Kinta Valley has, generally, a distinctive, more-or-less homogeneous chemical composition throughout, except for Gunung Tempurung and Gunung Lanno. Hills with unusually high $CaCO_3$ content include Gunung Sepah (average 99.0%), Gunung Terendum (average 96.46%), Gunung Panjang (average 95.6%), Gunung Sentang (average 98.75%), Gunung Tasek (average 98.20%), Gunung Lang (average 97.35%), Gunung Mabella (average 98.3%), Gunung Rapat (average 96.8%), Gunung Karang Besar (average 97.8%), Gunung Merawan (average 97.1%), Gunung Toh Sembilan (average 95.5%), Gunung Pua (average 97.8%), Gunung Sin (average 97.9%) and Gunung Pipit (average 96.8%). Those with unusually high $MgCO_3$ content include Gunung Ayer Hangat (average 43.32%), Gunung Layang-layang (average 53.90%), Gunung Ginting (average 41.47%). Gunung Tambun (average 40.30%), Gunung Bercham (average 39.50%) and Gunung Temelang (average 38.80%), Gunung Keroh (average 40.7%), Gunung Kandu (average 40.8%) and Gunung Mesah (average 40.3%).

Based on their physical and chemical characteristics, the limestone resources in the Kinta Valley area that can be utilised as raw material for decoration like dimension stones, terrazzo or marble chips include Gunung Rapat, Gunung Lanno, Gunung Mabella, Gunung Sin, Gunung Tempurung and Gunung Terendum. In industries that require high calcium contents like cement, agricultural fertilisers, ammonia powder, animal feed, calcium carbide, the ideal hills are Gunung Datuk, Gunung Panjang, Gunung Rapat, Gunung Lanno, Gunung Karang Besar, Gunung Merawan, Gunung Toh Sembilan, Gunung Pua, Gunung Sin, Gunung Pipit, Gunung Sepah and Gunung Tempurung (south). In industries that require high $MgCO_3$ contents like magnesium fertilisers, glass, Gunung Air Hangat, Gunung Layang-layang, Gunung Keroh, Gunung Kandu, Gunung Mesah, Gunung Tempurung (north) should be considered. For use as aggregate and concrete most of the hills can be exploited except Gunung Karang Besar, Gunung Keroh, Gunung Kandu, Gunung Mesah. Finally for conservation in terms of religion, tourism and preserving the environment, Gunung Cheroh, Gunung Lang, Gunung Panjang, Gunung Datok, Gunung Rapat, Gunung Tempurung and Gunung Terendum are potential candidates.

INTRODUCTION

The Kinta Valley is well-known for the picturesque limestone hills on both sides of the North-South Highway. Besides being a thing of beauty, the limestone rock has varied usage depending on their chemical and physical characteristics. The purpose of this paper is to characterise these hills with the aim of ascertaining their most appropriate usage — economic, industrial or touristic — depending on their chemical and physical characteristics.

LOCATION AND DISTRIBUTION

The limestone hills studied stretch from Gunung Temelang near Tg. Rambutan in the north to Gunung Gajah, near Kuala Dipang to the south, a distance of about 30 km (Fig. 1). The marble outcrops in the Kinta Valley, in fact, form 3 groups of limestone hills trending more-or-less north-south (Fig. 1 and Table 1). One group to the east in close contact with the Main Range granites comprises Gunung Layang-layang in the north to Gunung Ayer Hangat,

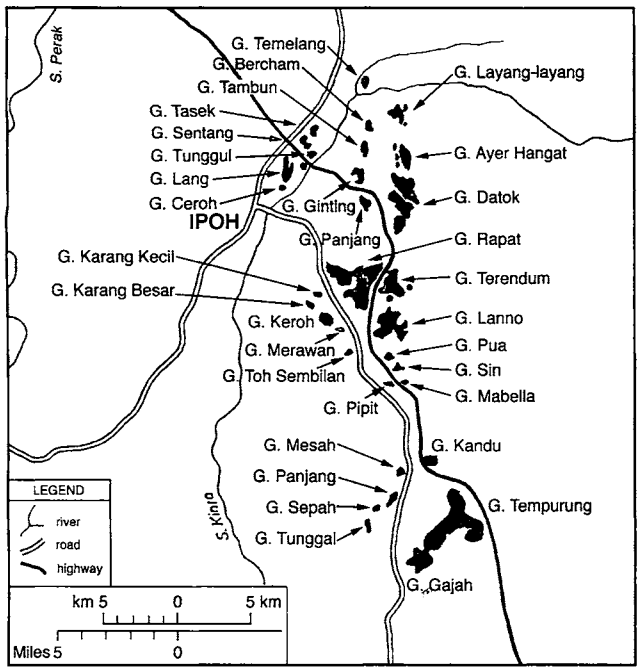

Figure 1. Location map of limestone hills in the Kinta Valley.

Table 1. Distribution of limestone hills in the Kinta Valley area.

Western Group	Middle Group	Eastern Group
Gunung Tasek	Gunung Temelang	Gunung Layang-layang
Gunung Sentang	Gunung Bercham	Gunung Ayer Hangat
Gunung Tunggul	Gunung Tambun	Gunung Datok
Gunung Lang	Gunung Ginting	Gunung Terendum
Gunung Cheroh	Gunung Panjang	Gunung Lanno
	Gunung Rapat	Gunung Pua
	Gunung Karang Kechil	Gunung Sin
	Gunung Karang Besar	Gunung Pipit
	Gunung Keroh	Gunung Mabella
	Gunung Merawan	Gunung Kandu
	Gunung Toh Sembilan	Gunung Mesah
		Gunung Panjang
		Gunung Sepah
		Gunung Tunggal
		Gunung Tempurung
		Gunung Gajah

Gunung Datok, Gunung Terendum, Gunung Lanno, Gunung Pua, Gunung Sin, Gunung Pipit, Gunung Mabella, Gunung Kandu, Gunung Mesah, Gunung Panjang, Gunung Sepah, Gunung Tunggal, Gunung Tempurung and Gunung Gajah to the south. A group to the west in contact with the Kledang Range granite comprises Gunung Tasek to the north to Gunung Sentang, Gunung Tunggul, Gunung Lang, Gunung Cheroh to the south. A third group in between the two earlier groups comprises Gunung Temelang in the north to Gunung Bercham, Gunung Tambun, Gunung Ginting, Gunung Panjang, Gunung Rapat, Gunung Karang Kechil, Gunung Karang Besar, Gunung Keroh, Gunung Merawan and Gunung Toh Sembilan, to the south (Abdullah Sani, 1990, 1991; Aw and Ooi, 1978; Mahat Sibon, 1988; Mohd Sazani Saarani, 1998; Ong, 1976; Ooi, 1978, 1981; Teh *et al.*, 2000).

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE LIMESTONE

The physical characteristics that were considered for each hill included colour, presence of fractures, joints or veins, texture or pattern, grain size, resistance to weathering, contamination and foreign material (such as chert nodules, quartz, clays etc.) (Table 2).

For their geochemical characteristics, the limestones were analysed for their $CaCO_3$, $MgCO_3$, SiO_2, Fe_2O_3 and Al_2O_3 contents (Tables 3, 4 and 5). A thorough petrographic study was also carried out to determine whether they are calcitic or dolomitic and to detect the presence of other minerals which could jeopardise their quality and usage. Other than their $CaCO_3$ and $MgCO_3$ contents, the contents of Al_2O_3, SiO_2 and Fe_2O_3 are generally very low in the limestone samples, Al_2O_3 usually less than 0.25%, SiO_2 less than 0.55% and Fe_2O_3 less than 0.3%.

RESULTS AND DISCUSSIONS

Geochemical analyses show that each limestone hill in the Kinta Valley has, generally, a distinctive, more-or-less homogeneous chemical composition throughout, except for Gunung Tempurung and Gunung Lanno. Hills with unusually high $CaCO_3$ content include Gunung Sepah (average 99.0%), Gunung Terendum (average 96.46%), Gunung Panjang (average 95.6%), Gunung Sentang (average 98.75%), Gunung Tasek (average 98.20%), Gunung Lang (average 97.35%), Gunung Mabella (average 98.3%), Gunung Rapat (average 96.8%), Gunung Karang Besar (average 97.8%), Gunung Merawan (average 97.1%), Gunung Toh Sembilan (average 95.5%), Gunung Pua (average 97.8%), Gunung Sin (average 97.9%) and Gunung Pipit (average 96.8%). Those with unusually high $MgCO_3$ content include Gunung Ayer Hangat (average 43.32%), Gunung Layang-layang (average 53.90%), Gunung Ginting (average 41.47%). Gunung Tambun (average 40.30%), Gunung Bercham (average 39.50%) and Gunung Temelang (average 38.80%), Gunung Keroh (average 40.7%), Gunung Kandu (average 40.8%) and Gunung Mesah (average 40.3%).

CONCLUSIONS

Based on their physical and chemical characteristics, the limestone resources in the Kinta Valley area that can be utilised as raw material for decoration like dimension stones, terrazzo or marble chips include Gunung Rapat, Gunung

Table 2. Physical properties of the eastern group of limestone hills , north of Ipoh.

Physical Properties	Gunung Terendum	Gunung Datok	Gunung Ayer Hangat	Gunung Layang-layang
Colour	Various Whitish Yellowish	Various Light grey Banded	Grey and white alternating	Light grey
Presence of fractures	Minor	Minor	Medium	Minor
Texture/Pattern	Interesting pattern	Uninteresting pattern	Uninteresting pattern	Not interesting
Grain Size	Intermediate to coarse	Fine to intermediate	Fine to coarse	Fine to intermediate
Resistance to weathering	High	High	High	High
Contamination	Presence of some pyrite	Presence of stylolite and mud	Minor contamination	Presence of calcite and carbonaceous veins

Table 3. Analytical data (wt%) of the eastern group of limestone hills, north of Ipoh.

Gunung Terendum					
Sample	**$CaCO_3$**	**MgCO**	**Fe_2O_3**	**SiO_2**	**Al_2O_3**
G Te1	98.40	1.40	0.02	0.15	0.01
G Te2	97.60	2.30	0.03	0.01	0.05
G Te3	92.00	7.10	0.10	0.57	0.22
G Te4	98.00	1.70	0.01	0.23	0.03
G Te5	96.28	2.17	0.08	0.03	0.51
Average	96.46	2.93	0.05	0.20	0.16
Gunung Datok					
Sample	**$CaCO_3$**	**MgCO**	**Fe_2O_3**	**SiO_2**	**Al_2O_3**
G P1	81.50	17.40	0.61	0.42	0.10
G P2	93.40	5.20	0.07	0.03	1.30
G P3	96.70	1.90	0.02	0.25	1.13
G N1	91.30	7.70	0.12	0.60	0.24
G N2	83.80	14.50	0.16	1.15	0.37
G N3	95.30	13.00	0.15	1.15	0.37
Average	90.33	9.95	0.19	0.60	0.59
Gunung Ayer Hangat					
Sample	**$CaCO_3$**	**MgCO**	**Fe_2O_3**	**SiO_2**	**Al_2O_3**
G D1	61.80	47.90	0.07	0.08	0.07
G S1	53.10	46.40	0.27	0.22	0.04
G S2	56.30	41.10	2.27	0.27	0.04
G X	57.30	41.60	0.15	0.66	0.32
G Y	57.90	41.70	0.09	0.21	0.03
GX	58.10	41.20	0.02	0.39	0.15
Average	57.42	43.32	0.48	0.31	0.11
Gunung Layang-layang					
Sample	**$CaCO_3$**	**MgCO**	**Fe_2O_3**	**SiO_2**	**Al_2O_3**
G La1	54.90	42.50	2.46	0.11	0.08
G La2	52.90	45.70	0.76	0.42	0.13
Average	53.90	44.10	3.22	0.53	0.21

Lanno, Gunung Mabella, Gunung Sin, Gunung Tempurung and Gunung Terendum (Tables 6 and 7). In industries that require high calcium contents like cement, agricultural fertilisers, ammonia powder, animal feed, calcium carbide, the ideal hills are Gunung Datuk, Gunung Panjang, Gunung Rapat, Gunung Lanno, Gunung Karang Besar, Gunung Merawan, Gunung Toh Sembilan, Gunung Pua, Gunung Sin, Gunung Pipit, Gunung Sepah and Gunung Tempurung (south). In industries that require high $MgCO_3$ contents like magnesium fertilisers, glass, Gunung Air Hangat, Gunung Layang-layang, Gunung Keroh, Gunung Kandu, Gunung Mesah, Gunung Tempurung (north) should be considered. For use as aggregate and concrete most of the hills can be exploited except Gunung Karang Besar, Gunung

Table 4. Histogram showing the $CaCO_3$ content in the limestone hills north of Ipoh.

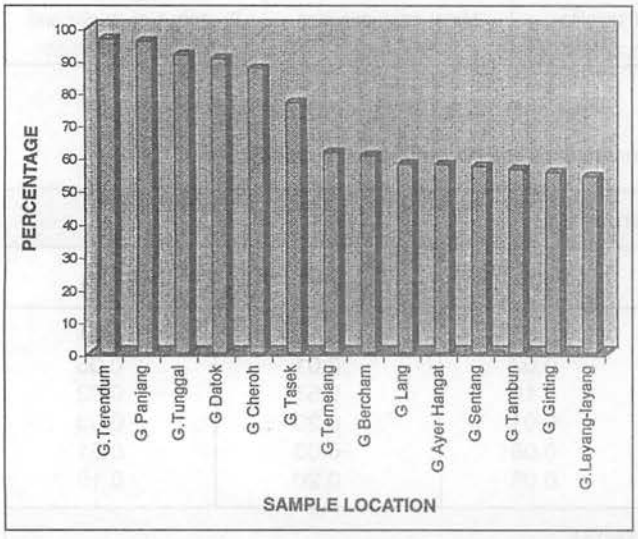

Table 5. Histogram showing the SiO_2 content in the limestone hills north of Ipoh.

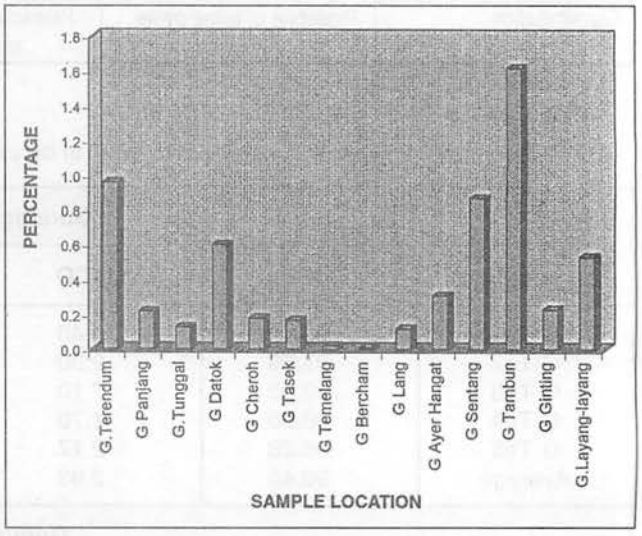

Table 6. Tabulated data on the physical and chemical characteristics and potential of selected limestone hills from the Ipoh area.

No.	Name	Chemistry and Potential
1.	Gunung Rapat	• carbonate rock with chemical composition almost homogeneous • most samples show cement grade composition • generally limestone with high calcium • suggested potential — raw material for cement manufacture — flux material — powder source of carbonate with high calcium — dimension stone — aggregate material
2.	Gunung Lanno	• carbonate rock of not homogeneous chemical composition • majority show cement grade composition • 3 samples show high calcium • majority carbonate rock with high magnesium • attractive colour and texture • suggested potentials: — dimension stone — raw material for cement — flux material — magnesium carbonate rock for agriculture — rock aggregate
3.	Gunung Karang Besar	• chemical composition homogeneous • show cement grade composition • carbonate rock with high calcium • fine grained but not so attractive • suggested potentials: — raw material for cement — flux material — source of lime powder with high calcium — principally rock aggregate

Table 7. Potential of limestone hills south of Ipoh.

Name	Potential		
	Dimension Stone	Industrial raw material	
		high $CaCO_3$	high $MgCO_3$
Gunung Rapat	X	X	
Gunung Lanno	X	X	X
Gunung Karang Besar		X	
Gunung Keroh			X
Gunung Merawan		X	
Gunung Toh Sembilan		X	
Gunung Pua		X	
Gunung Sin	X	X	
Gunung Pipit		X	
Gunung Mabella	X	X	
Gunung Kandu			X
Gunung Mesah			X
Gunung Panjang		X	
Gunung Sepah		X	
Gunung Tempurung		X	X

Keroh, Gunung Kandu, Gunung Mesah. Finally for conservation in terms of religion, tourism and preserving the environment, Gunung Cheroh, Gunung Lang, Gunung Panjang, Gunung Datok, Gunung Rapat, Gunung Tempurung and Gunung Terendum are potential candidates.

It is hoped that this prior knowledge of the physical and chemical characteristics and their potential usage of the various limestone hills in the Kinta Valley will help the authorities and those in the industry plan on their proper exploitation, development and best usage.

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