

Biostratigraphy of the Kinta Valley, Perak

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Abstract: Besides tin, the Kinta Valley is known for its lithology and biostratigraphy. Study on some Permian microfossils from the Kampar area indicates the presence of *Maklaya* (fusuline) at H.S. Lee Mine. This finding is interesting because Genus *Maklaya* and other taxa found at this locality are yet unknown in other localities in the northwestern part of Peninsular Malaysia and Peninsular Thailand. *Maklaya* indicates the highest horizon of Bolorian or to some authors, to the base of Kubergandian. Moreover, the Bolorian limestone at the H.S. Lee Mine possibly extends into the Yahtashian and it may corresponds to a period without limestone deposition in the northwest Peninsular Malaysia and Peninsular Thailand. Furthermore, the characteristics shown by the lithology and stratigraphy of the Kinta Valley indicate that the palaeogeography of this area is different from the northwestern part of Peninsular Malaysia.

Abstrak: Disamping kaya dengan bijih timah, Lembah Kinta adalah juga menarik dari segi litologi dan biostratigrafi. Kajian yang telah dijalankan terhadap sebahagian fosil mikro berusia Perm di kawasan Kampar menunjukkan kewujudan *Maklaya* (fusuline) di H.S. Lee Mine. Penemuan ini adalah sangat menarik kerana Genus *Maklaya* dan lain-lain taksa yang ditemui di lombong ini, sehingga kini belum lagi ditemui mana-mana lokaliti di bahagian barat-laut Semenanjung Malaysia dan juga Semenanjung Thailand. Selanjutnya, batu kapur di H.S. Lee Mine berusia Bolorian berkemungkinan tersebar dengan meluas hingga keusia Yahtashian dan ianya mungkin berkait rapat dengan kala pemendapan tanpa batu kapur di barat-laut Semenanjung Malaysia dan Semenanjung Thailand. *Maklaya* menunjukkan ufuk bahagian teratas usia Bolorian atau bagi sesetengah penulis ia menunjukkan bahagian paling bawah usia Kubergandian. Disamping itu, ciri-ciri litologi dan biostratigrafi yang terdapat di Lembah Kinta menunjukkan kelainan dari segi paleografi dengan kawasan barat-laut Semenanjung Malaysia.

INTRODUCTION

Kinta Valley (Fig. 1) is a narrow, elongated alluvial plain, situated a few meters above sea level. The hard rock is mainly made up of limestone or dolomite with subordinate shale. The limestone is widespread and varies in thickness. It is massive or bedded with dips varying from 15° to 70°, forming a few steep sided hills from 100 m to 500 m in height. The eastern and western flanks of the Kinta Valley are demarcated by granitic bodies of more than 1,000 m in elevation. It is less than 10 km wide at the Chemor side and gradually widening up towards the south. An alluvium of Quaternary age may cover the bedrocks over the plains. The bedrock is not very deep and is mainly of limestone with subordinate shale and rare sandstone. In many areas, these rocks have undergone a strong contact metamorphism. For example, the limestone hills in the vicinity of Ipoh consist of crystalline limestone and their fossils have been altered beyond

recognition. Accordingly, Rastall (1927) considered that the Kinta Valley was "very unfavourable for the discovery of fossils". Ingham and Bradford (1960) wrote: "*The rocks of the Calcareous Series (of the Kinta Valley) are believed to be of Carboniferous age. No index fossils have been found in this area*". The limestone is commonly covered by a coating of secondary calcite obscuring its surface features. In other areas, it is weathered and altered to powdery substances on the surface but traces of some fossils which are difficult to be studied are still visible. De Morgan (1886) reported the occurrence of Late Silurian-Devonian limestone with *Platystrophia*. Since 1956, several fossil localities have been discovered, initially near Batu Gajah then followed by the discoveries in Chemor, Kampar and Kampung Sungai Keruh (Fig. 1). The age of the fossil ranges from Middle Ordovician to the Middle Permian.

Shale is widespread in the southwestern part of the Kinta Valley but it is devoid of fossils. During

the recent fieldtrip in Kampar area (Fig. 2), *Amphipora* (stromatoporoid) which indicates Devonian age has been found in the limestone at "Morib Mineral Industries" mine (Mine No. 807) located 4 km north-west of the "old H.S. Lee Mine No. 8". Prior to this discovery, the extreme western boundary of the Devonian limestone of the Kinta Valley was known only to the east of this H.S. Lee Mine. Considering that there is a lateral facies change from Ordovician to the Carboniferous and the age of the shales in the Kanthan area (in the northwestern part of the Kinta Valley) is possibly Ordovician-Silurian, it may be concluded that the western side of the Kinta Valley is possibly demarcated by a pre-Devonian shale which is largely intruded by granite.

BIOSTRATIGRAPHY

In the Chemor area (Fig. 1), the following fossils have been reported by various authors:

- Middle Ordovician to Early Silurian graptolites in shale with abundant *Orthograptus cf. truncatus* (Jones, 1959). A better preserved Middle Caradoc to Early Ashgill graptolites were recorded at Ban Chong Tin Mine, southwest of Gunung Kanthan (Ingham and Bradford, 1960) and (Thomas and Scrutton, 1969).
- a Late Ordovician coral was found in limestone (Thomas and Scrutton, 1969),
- late Early to early Late Devonian conodonts in limestone (Alexander and Muller, 1963; Lane *et al.*, 1979),

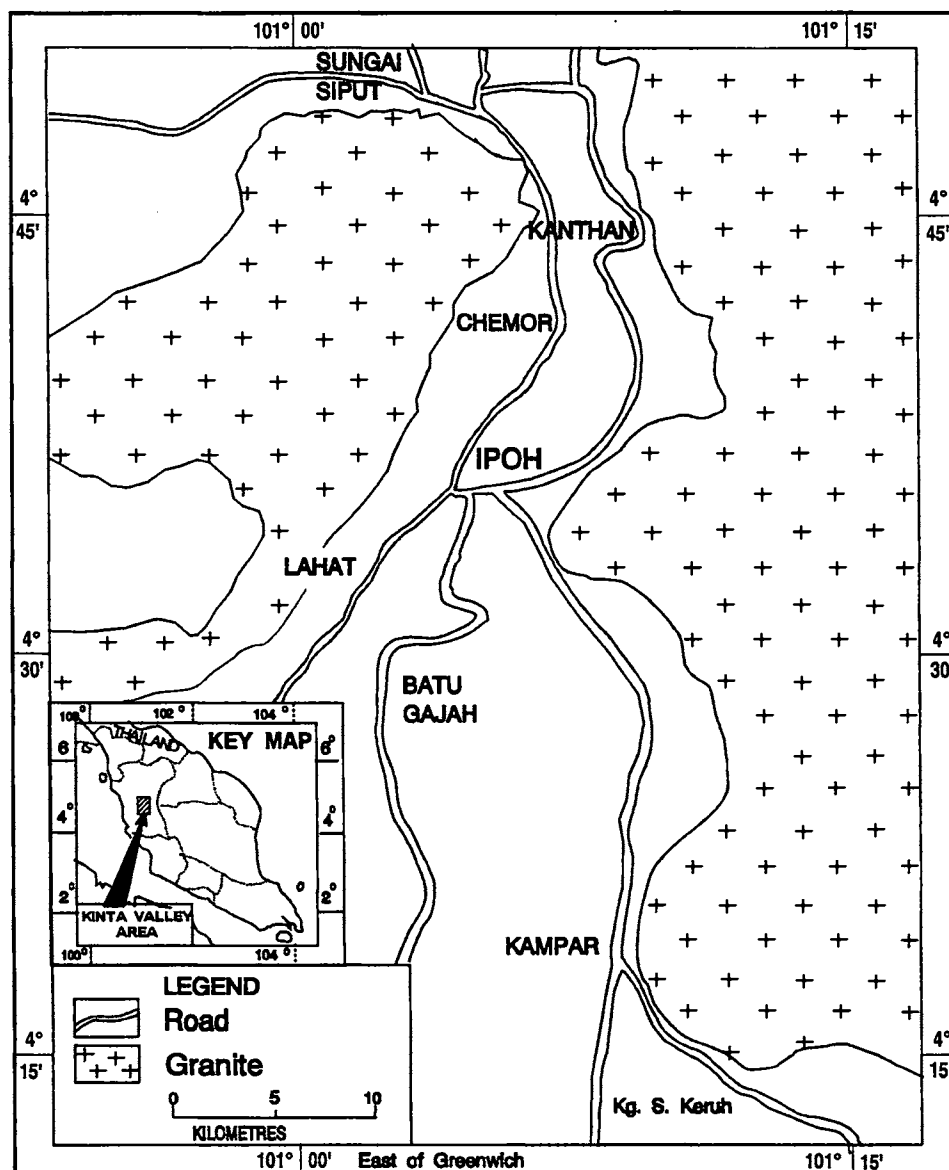


Figure 1. Location map of the Kinta Valley.

- d) Serpukhovian conodonts (Lane *et al.*, 1979; Metcalfe, 1979)
- e) Late Wolfcampian conodonts (Metcalf, 1981).
- f) C. Teichert identified *Glaphyrites* or *Eoasianites* from the Yee Fah Hin tin mine in the vicinity of Chemor (Geological Survey Malaysia Files, 1968). These genera indicated an age within Middle-Upper Carboniferous.
- g) A.J. Boucot (Geological Survey Malaysia Files, 1967) noted the occurrence of large post-Devonian productids, a Carboniferous type reticularid and a fragment of possibly *Neospirifer*. He suggested the age of the fossils are within Middle Carboniferous-Permian interval.

At Lee Fatt Mine No. 1, southwest of Batu Gajah town (Fig. 1), Givetian (Middle Devonian) conodonts was described by Metcalfe (1983). In an old mine pit (Wen Yoon Yuen Mine about 400 m northwest of Batu Gajah Golf Course), five solitary corals were found and identified by H.D. Thomas as *Siphonophyllia cf. gigantea* Michelin and *Zaphrentites* sp., indicating a Tournaisian-Visean age (Thomas and Scrutton, 1969). A fusuline (*Eoschubertella cf. obscura* Lee and Chen), indicating a Middle Carboniferous age was also found from the same pit. The difference in age given by the corals and fusulines had risen a controversy which resulted crisscrossing of letters between the Geological Survey of Malaysia, H.D. Thomas (the British Museum National History

and the Brunei Shell Petroleum which had determined the fusuline (Geological Survey Malaysia Files). Surprisingly, nobody discussed about the origin of the samples which probably had been collected from two different places or horizons of the same pit. Gobbett and Hutchison (1973, p. 74) indicated the presence of Sakmarian (Lower Permian) brachiopods in the eastern part of Batu Gajah (that is between Batu Gajah and Gopeng). However, they did not present any detail data on the Sakmarian brachiopods.

Near Batu Gajah, Givetian (Middle Devonian) conodonts have been described. In an old mine pit (Wen Yoon Yuen Mine, about 400 m northwest of Batu Gajah Golf Course), five solitary corals were found and identified by H.D. Thomas as *Siphonophyllia cf. gigantea* Michelin and *Zaphrentites* sp., indicating a Tournaisian-Visean age. From the same pit, a fusuline (*Eoschubertella cf. obscura* Lee and Chen) had also been found, indicating a Middle Carboniferous age. The presence of Permian with Sakmarian brachiopods has been noted east of Batu Gajah between Batu Gajah and Gopeng.

In the Chemor area, Middle Ordovician to Early Silurian graptolites with abundant *Orthograptus cf. truncatus* have been reported in shale and a Late Ordovician coral was also found in limestone. Late Early to early Late Devonian, Serpukhovian and Late Wolfcampian conodonts have also been found in the limestone.

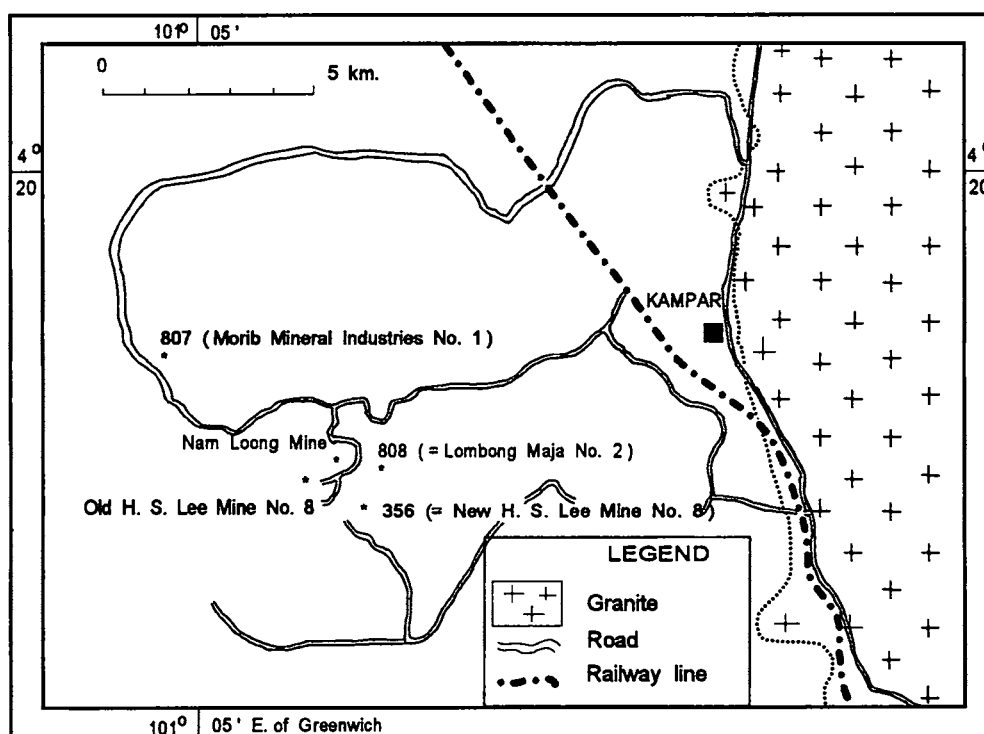


Figure 2. Location map of the Kampar area.

In the Kampar area (Figs. 1 and 2), limestone, dolomitic limestone and dolomite which underlie the Givetian (Middle Devonian) limestone are the oldest rocks. Suntharalingam (1968) recorded the presence of corals (*Thamnopora*) and gastropods (*Murchisonia*, *Straparollus*) in these rocks which suggest a Lower Devonian and maybe to the Silurian age. The Givetian limestone exposed at more than twelve mines provided a good stratigraphical markers (Suntharalingam, 1968, Geological Survey files and new observation). The most important fossils observed in the limestone are a species of *Stringocephalus* (brachiopod) (Gobbett, 1966) and diverse stromatoporoids with common *Amphipora* (a genus usually found in the Givetian of Vietnam and northeast Thailand). Upper Devonian fossils/sections was not found. The Carboniferous was poorly dated by the presence of a coral (*Siphonophyllia*), a pelecypod (*Schizodus?*) and a cephalopod (*Cyrtoceras?*). On the contrary, the Permian limestone yielded a large number of well-preserved fossils, consisting of algae (Elliott, 1968, with the description of *Epimastopora malaysiana* n. sp. from H.S. Lee Mine No. 8), fusulines (Ishii, 1966), corals (Suntharalingam, 1968), large and thick shells of pelecypods (Runnegar and Gobbett, 1975; Yancey and Boyd, 1983), cephalopods (Lee, 1980) and gastropods (Batten, 1972, 1979 and 1985). These fossils were collected mainly from the old "H.S. Lee Mine No. 8".

In the Kampung Sungai Keruh area (Fig. 1), the Geological Survey files indicate the presence of some fossils at the Foong Ngean Mine (small

gastropods and some stromatoporoids), Hoong Cheong Mine (large gastropods, streptelasmid and amplexoid corals, *Actinostroma* and *Clathrodictyum*) and Kwong Fook Loong Mine No. 3 (*Murchisonia*-type gastropods). The presence of stromatoporoids indicates that the age of the rocks exposed at these mines cannot be younger than Devonian. Gastropods and bivalves were noted at the Toong Poh Mines north of Kampung Banir and at the Zain and Nun Mine northwest of Kampung Banir.

Study of the limestone thin sections from the old "H.S. Lee Mine No. 8"

The old "H.S. Lee Mine No. 8" (Fig. 2) described by Suntharalingam (1968) and Runnegar and Gobbett (1975) in the Kampar area is no longer accessible. It has been abandoned and entirely filled with sand and clay. However, the thin sections of the limestone samples collected from this mine which are deposited at the Geological Survey Laboratory in Ipoh enabled the authors to restudy at least part of the microfossils mentioned by the earlier workers.

Ishii (1966) mentioned two species of fusulines found at H.S. Lee Mine No. 8, i.e. *Misellina claudiae* (Deprat) which is restricted to the upper horizon and *Pseudofusulina krafftii* (Schellwien) in the lower horizon. However, his interesting report was not accompanied by a detailed description nor the figures of these species. In fact, these two species was found to occur together (within the same horizon) in Japan and their stratigraphical ranges

Plate 1. Old H.S. Lee Mine No. 8, Kampar, Perak. Sheet 65 Tapah. Scale bar = 1 mm

Figures 1 to 6. *Cancellina (Maklaya) ex gr pamirica* Leven.

Fig. 1. Specimen 5, thin section 4.

Fig. 2. Specimen 5, thin section 5.

Specimen 5, known by 22 thin sections, is a reworked wackestone. Fusulines are abundant, but not diverse; they may be strongly micritized and altered beyond recognition. *Maklaya pamirica*, *Parafusulina undulata* and *Pseudofusulina* aff. *japonica* have also been identified in this specimen. Small foraminifera are very rare. Organisms other than fusulines are scanty and consist of fragments of algae, *Tubiphytes*, calcispheres, *Climacamina*, *Hemigordius?*, branching Bryozoa, crinoids and gastropods.

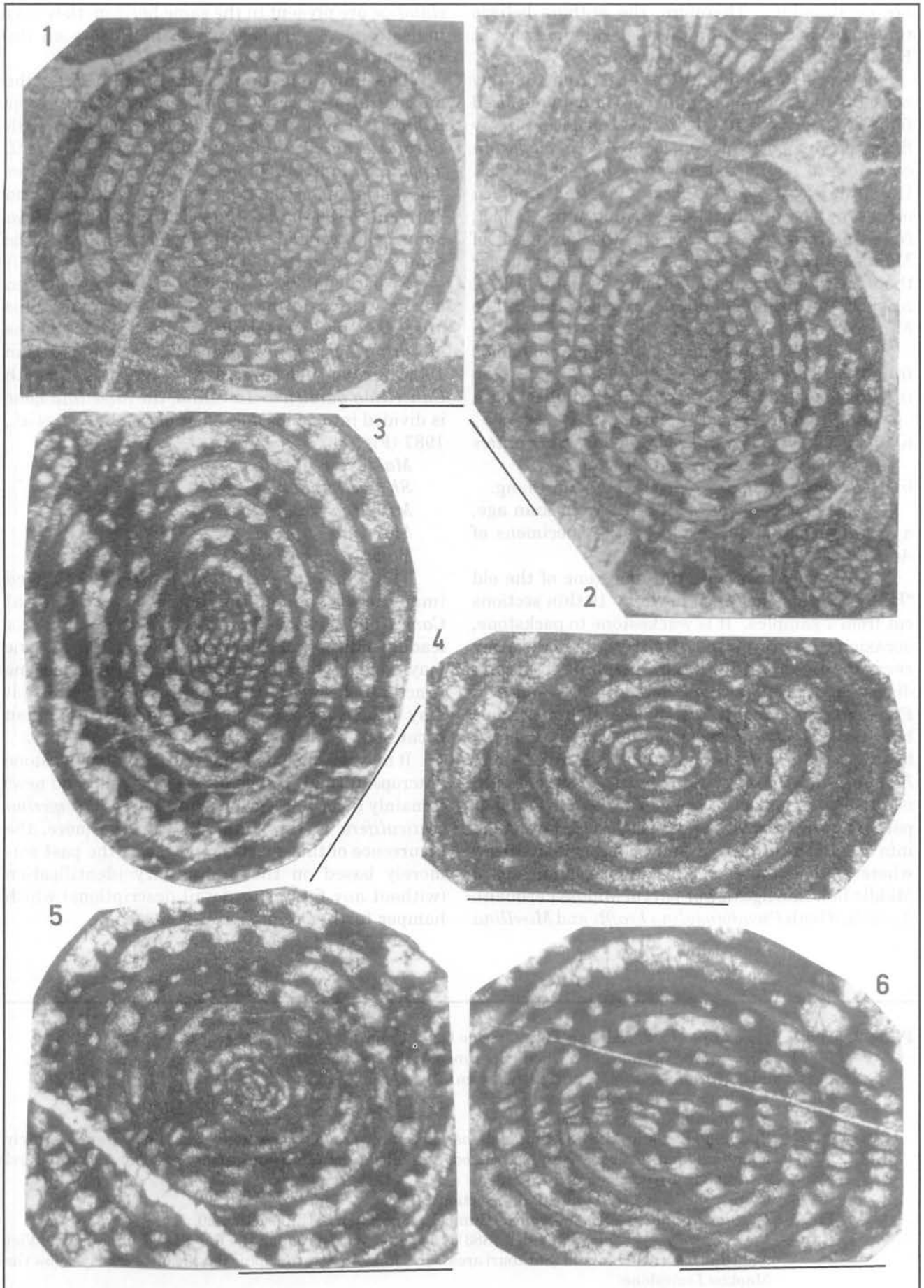
Fig. 3. Specimen 16, thin section 18.

Fig. 4. Specimen 16, thin section 16.

Fig. 5. Specimen 16, thin section 29.

Fig. 6. Specimen 16, thin section 14. Specimen 16, known by 31 thin sections is lightly recrystallized; it is a reworked wackestone to a grainstone with cortoids. Fusulines are common but neither abundant nor diverse and they consist mainly of *Maklaya pamirica*. Small foraminifera are rare except *Climacamina* which is common and they include a few nodosariidae, *Geinitzina* and *Agathammina*. Crinoids and fragments of shells (brachiopods and pelecypods) are scanty. Fenestellidae are very rare and gastropods are somewhat relatively common.

Maklaya pamirica (Leven) is known at Khao Phrong Phrab, Saraburi Province, central Thailand. It belongs to a horizon slightly higher than the *Misellina* Zone.



are overlapping. Therefore, the authors believe that their distribution in two separate horizons at H.S. Lee Mine No. 8 is questionable.

A list of fossil identifications (unfortunately without any detail notes or any accompanying fossil figures) which is available in the Geological Survey files, suggests the presence of *Neoschwagerina craticulifera* in the southwestern part of the H.S. Lee Mine No. 8 whereas *Pseudofusulina japonica* occurs in the central part of the same mine. In fact, *Neoschwagerina craticulifera* is the key fossil of Middle Murghabian, an age which is much younger than the age of fossils mentioned by Ishii (1966). As such, the authors doubt its presence at H.S. Lee Mine No. 8.

Lee (1980) identified the following ammonoids from the H.S. Lee Mine No. 8:

- i) *Prostacheoceras skinneri* (Miller) indicating a Late Artinskian age (Bolorian)
- ii) *Adrianites* cf. *insignis* Gemmellaro (*Adrianites insignis* indicates a Wordian age)
- iii) *Neocrinite* cf. *guangxiensis* Chao and Liang.

Although Lee favoured a Late Artinskian age, a Wordian age is suggested by the specimens of *Adrianites*.

In the current study, the limestone of the old "H.S. Lee Mine No. 8" is known by 19 thin sections cut from 7 samples. It is wackestone to packstone, occasionally brecciated, lightly to moderately recrystallized and has undergone a strong diagenesis. The authors noted the presence of *Pseudofusulina krafftii* in some of the thin sections but *Misellina claudiae* was not observed, probably because this species is not in abundance. *Pseudofusulina krafftii* (Schellwien et Dyrenfurth) is rather common in the Upper Yahtashian (= upper part of Lower Permian) and this species may extend into the Bolorian (Leven and Scherbovitch, 1978), whereas *Misellina claudiae* (Deprat) indicates a Middle Bolorian age (lower part of Middle Permian). As such, if both *Pseudofusulina krafftii* and *Misellina*

claudiae are present in the same horizon, they may indicate an assemblage which highlights on the Bolorian age.

The limestone thin sections studied by the authors also contain *Cancellina* (*Maklaya*) ex gr *pamirica* Leven 1968 which is associated with *Parafusulina* cf. *undulata* Chen 1934, and *P.* aff. *japonica* (Gumbel) (Plates 1, 2 and 3). *Maklaya* was established as a genus by Kanmera and Toriyama (1968), and the occurrence of *Maklaya pamirica* in central Thailand was described by the same authors in the same paper.

Even though the typical *Misellina* was not seen by the writers in the studied thin sections; some *Misellina* specimens described in the past such as *Misellina subelliptica* (Deprat, 1915) sensu Han 1985, are very close to, if not synonymous with *Cancellina pamirica*. In China, the *Misellina* Zone is divided into 5 biozones as proposed by Wei *et al.*, 1987 (Fig. 4):

- Maklaya elliptica*
- Shengella simplex*
- Misellina claudiae*
- Misellina termieri*
- Brevaxina dyrhenfurthi*

The *Maklaya elliptica* biozone is placed immediately below the horizon with typical *Cancellina* (= *Cancellina liuzhiensis* in China), a leading indicator of Kubergandian age (Fig. 3). One may wonder whether this *Maklaya elliptica* biozone is actually belong to the top of Bolorian because it may also be assigned to the base of Kubergandian because of its strong affinities with *Cancellina*.

It may be concluded that the age of the limestone outcrops at the H.S. Lee Mines No. 8 (old and new) is mainly Bolorian. The presence of *Neoschwagerina craticulifera* is very unlikely. Furthermore, the occurrence of this species reported in the past was merely based on the preliminary identification (without any figures or detail descriptions) which hamper further reinterpretation work.

Plate 2. Old H.S. Lee Mine No. 8, Kampar, Perak. Scale bar = 1 mm

Fig. 1. *Parafusulina* gr *undulata* Chen. Specimen 5, thin section 10.

Figs 2 and 3. *Pseudofusulina krafftii* (Schellwien).

Fig. 2. Specimen 6, thin section 25.

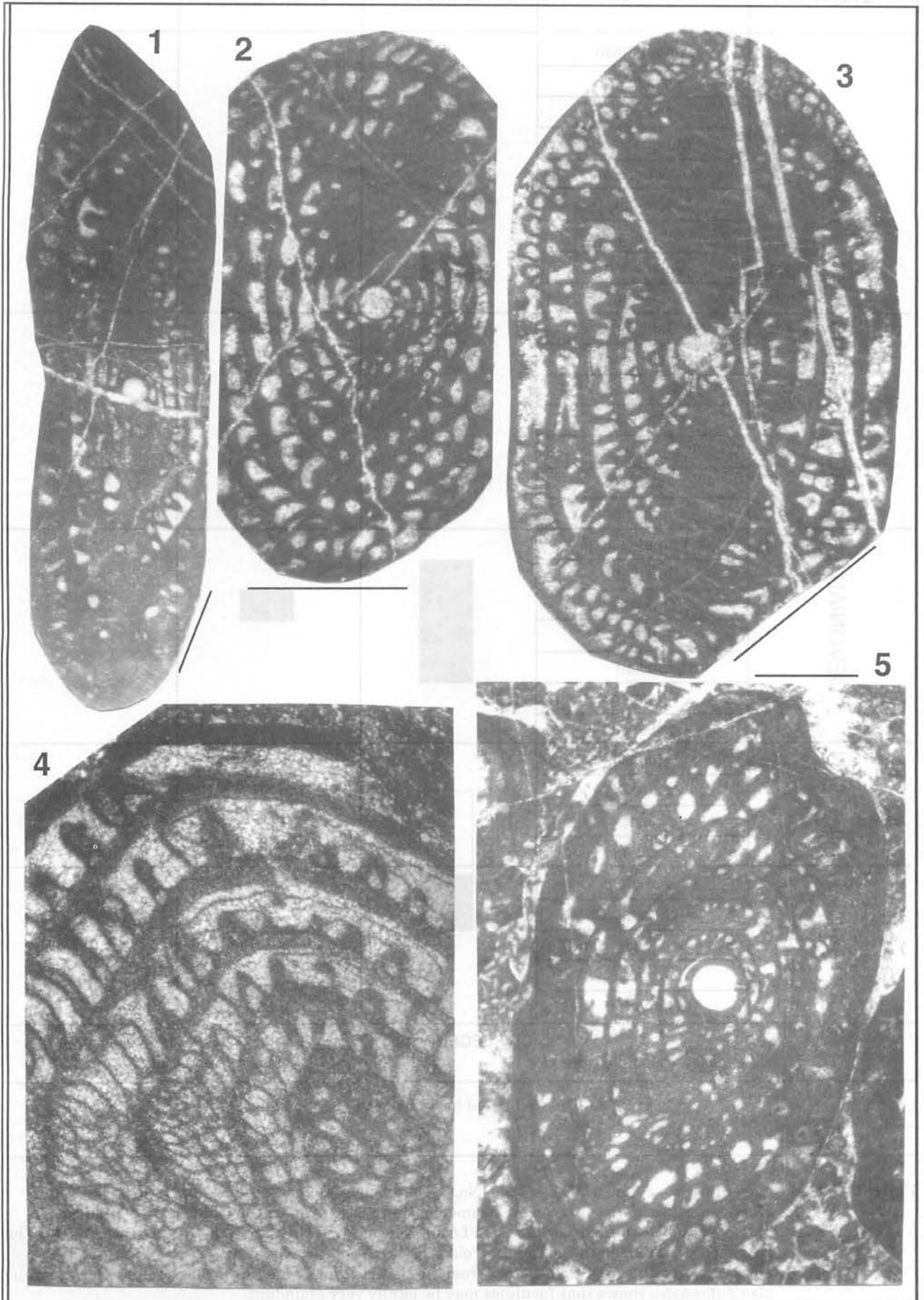
Fig. 3. Specimen 6, thin section 26.

Specimen 6 is known by 35 thin sections. It is a reworked wackestone. Fusulines are moderately abundant and are commonly micritized. Small foraminifera are almost absent. Crinoids and gastropods are occasionally present.

Fig. 4. *Cuniculinella* sp. Specimen 5, thin section 14.

Fig. 5. *Pseudofusulina* sp. aff. *P. japonica* (Gumbel). Specimen 5, thin section 20.

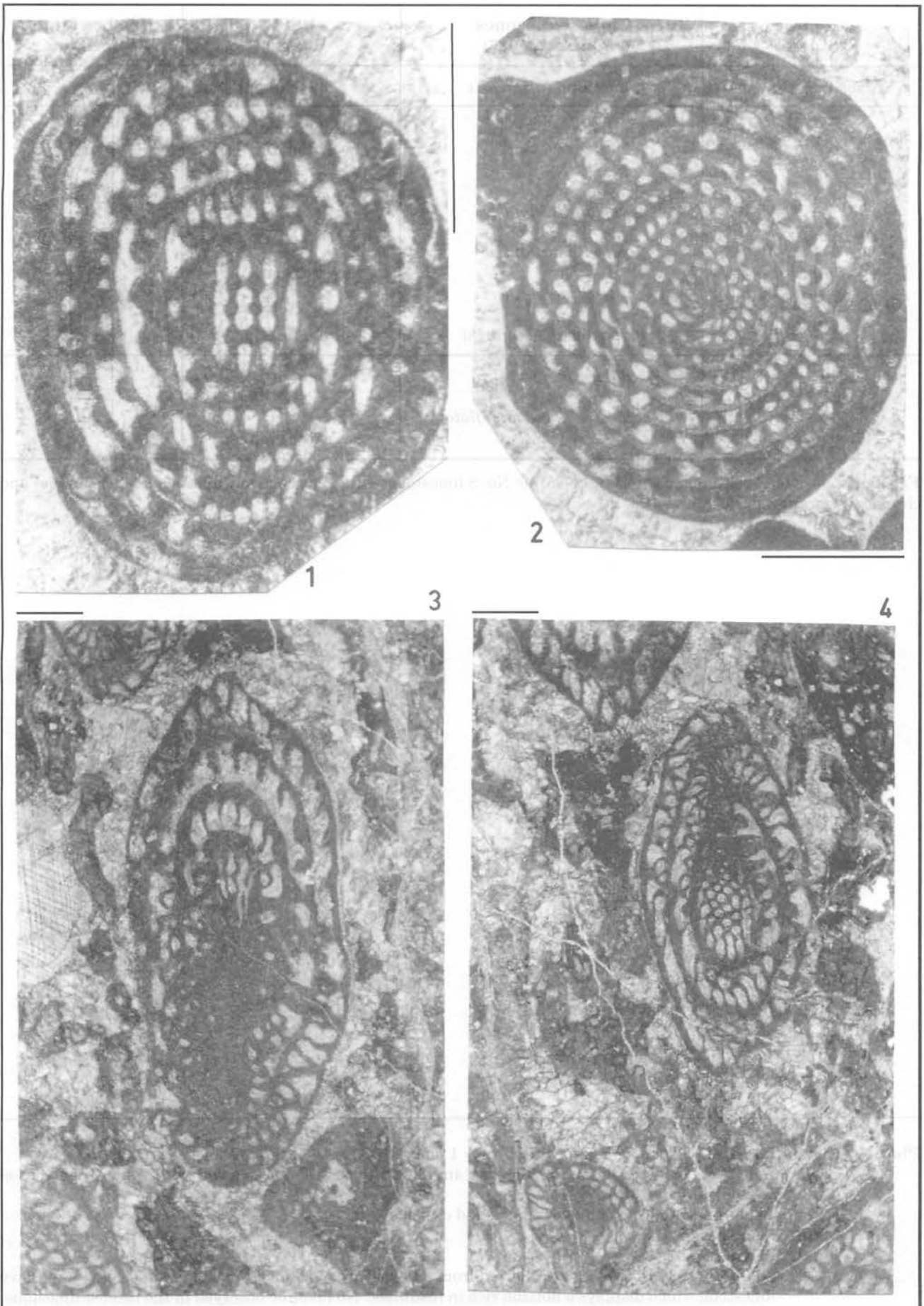
Pseudofusulina japonica (Gumbel, 1883) is a species widespread in the Far East: China, Japan, Viet Nam and Central Thailand (Saraburi area). In China, its stratigraphical position is clearly below the Maokou Limestone.



SYSTEMS	STAGES	CHEMOR	BATU GAJAH	KAMPAR
PERMIAN	Dorashamian			
	Dzhulfian			
	Midian			
	Murghabian			
	Kubergandian			■
	Bolorian			
	Yahtashian			
	Sakmarian	■		■
	Asselian			
CARBONIFEROUS	Gshelian			
	Kasimivian			
	Moscovian		□	
	Bashkirian			
	Serpukovian	□		
	Visan		□	□
	Tournasian			
DEVONIAN	Famennian			
	Frasnian	■		
	Givetian		■	■
	Eifelian			
	Emsian			
	Pragnian			
	Lochkovian			
SILURIAN	Pridoli			
	Ludlow			
	Wenlock			
	Llandovery	□		
ORDOVICIAN	Ashgill	■		
	Caradoc			
	Llandeilo-Llanvirn			
	Arenig			
	Tremadoc			
LEGEND				
		■ accurately dated	□ less accurately dated	

Figure 3. The well dated horizons of the Kinta Valley.

- Plate 3.** Old H.S. Lee Mine No. 8, new H.S. Lee Mine No. 8, Nam Loong Kongsu Mine No. 1. Scale bar = 1 mm
- Fig. 1. *Maklaya ex gr. pamirica* Leven. Specimen 5, thin section 2 from the Old H.S. Lee Mine No. 8.
- Fig. 2. *Maklaya ex gr. pamirica* Leven. Nam Loong Kongsu Mine No. 1. Specimen 5, thin section 10. This specimen is similar to those from the "old H.S. Lee Mine No. 8".
- Figs. 3 and 4. *Parafusulina* sp. Sample M535 from the New H.S. Lee Mine No. 8. This sample which contains also *Tubiphytes* shows that fusulines may be locally very abundant.



Chinese Stages	Chinese Biozones (Wei <i>et al.</i> , 1987)	USSR Stages	H.S. Lee Mines Limestone
Maokouan (Early)	<i>Cancellina liuzhiensis</i>	Kubergandian	
Chihhsian	<i>Maklaya elliptica</i>	Kubergandian or Bolorian	
	<i>Shengella simplex</i>	Bolorian	
	<i>Misellina claudiae</i>		
	<i>Misellina termieri</i>		
	<i>Brevaxina dyhrenfurthi</i>		
Houchangian	<i>Pamirina darvasica</i> + <i>Chalaroschwagerina inflata</i>	Yahtashian	□ □

Figure 4. Possible age range of the H.S. Lee Mine No. 8 limestones with reference to Chinese and Russian bio- and chronostratigraphic scales.

Plate 4. New H.S. Lee Mine No. 8, Kampar. Scale bar = 1 mm

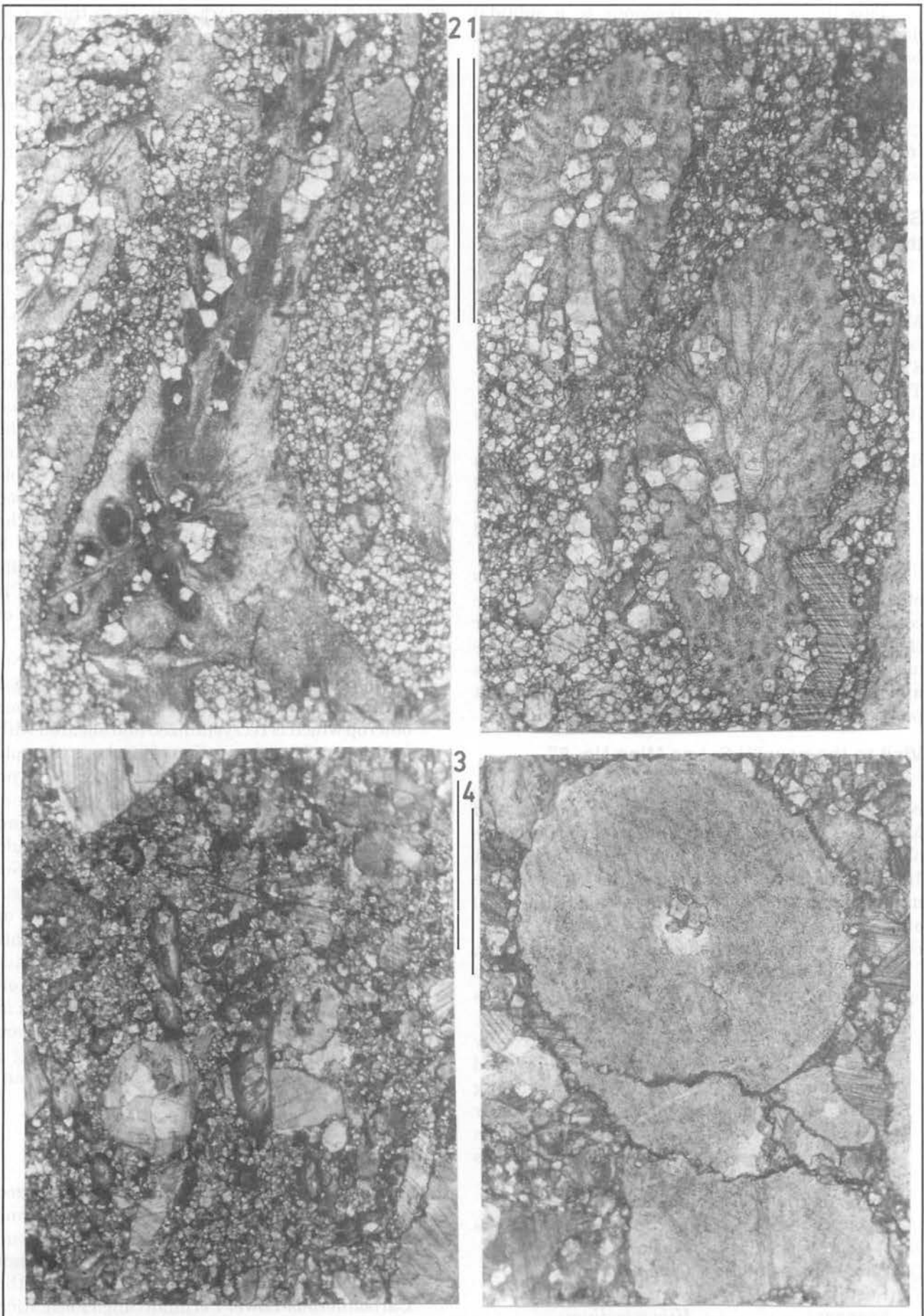
Figs. 1 and 2. Limestone containing Bryozoa and dolomite crystals, associated with some fragments of crinoids. Sample M533.

Figs. 3 and 4. Limestone with Fenestellidae and crinoids.

Fig. 3. Sample M532

Fig. 4. Sample M531

Samples M531 to M533 was collected from an exposure of bedded limestone underlying a massive limestone which displays a horizon rich in fusulines. No fusuline observed in the bedded limestone.



This limestone Leecorresponds to a subtidal deposition with bioaccumulation and hydrodynamic buildup. Hydrodynamic action is marked by a regular traces of reworking. Fauna is diverse, including large pelecypods and abundant gastropods, and fusulines are concentrated mainly in the lowest part of the limestone which is only 50 feet thick (Suntharalingam, 1968, p. 10).

Study of the limestone thin sections from the "old Nam Loong Kongsu Mine No. 1"

Study on the 39 thin sections from 4 samples of the limestone from the "Old Nam Loong Kongsu Mine No. 1" (Fig. 2) indicates that one of the sample is similar to those from the "old H.S. Lee Mine No. 8" and it contains *Cancellina (Maklaya) pamicra*. The other samples represent two different facies:

- i) facies rich in *Pseudovermiporella nipponica* Endo.
- ii) facies rich in crinoids containing Bryozoa (Fenestellidae and others), rare small foraminifera (*Tetrataxis*), a few gastropods and two tiny corals belong to *Lophophyllidium* and maybe *Pavastehphyllum*.

Suntharalingam (1968) estimated the thickness of this limestone to be more than 500 feet and he considered that this limestone was partly older than the "Old H.S. Lee Mine No. 8" limestone. His idea is supported by the presence of the microfossils and the small corals observed in the present palaeontological studies.

Visit to the new "H.S. Lee Mine No. 8"

The new "H.S. Lee Mine No. 8" (= No. 356, recent mine number given by the Directorate of Mining) is situated about 600 m southeast of the old one. A bedded and massive limestone, about 100 m thick is widely exposed at the bottom of the mining pit and it consists (from the top to the base) of:

- i) Massive limestone (wackestone to packstone), about 60 m thick, rich in fusulines at a horizon which is about 25 m above its base (Samples M534, M535, M543 to M548; 10 thin sections). It is a wackestone to packstone, locally strongly recrystallized (M546 and M547) and occasionally dolomitised (M546, along fractures). Stylolites and calcite veins occur and may hinder study of fossils. Dissolution features are common. The following fossils were noted:

Crinoids (the most common fossil)	
Algae	: <i>Tubiphytes obscurus</i> Maslov
Small foraminifera	: <i>Climacammina</i>
Fusulines	: <i>Parafusulina</i> sp.
Sponges	: <i>Hikorocodium</i>

- ii) Bedded limestone, dark grey, 10 m thick, rich in crinoids and bryozoa (Fenestellidae and dendroid bryozoa). It also contains very rare *Tubiphytes obscurus* Maslov, some fragments of brachiopods (shells and spines) and rare pelecypods, very rare sea urchin spines and some ostracods (Samples M531 to M533; 5 thin sections, see pl. 4).

This limestone is commonly a packstone with rare to abundant dolomite crystals. Stylolites are common. This limestone differs from the above massive limestone because of the absence of fusulines and in the abundance of bryozoa.

- iii) Massive limestone, poorly exposed, locally rich in crinoids.

Based on the geographic position, the new H.S. Lee Mine No. 8 should be slightly older than the old one because it is located to the southeast of the old one. Another evident is that the absence of abundant gastropods and giant pelecypods at the new mines indicates a possible age difference between the limestone exposed at the new and old "H.S. Lee Mine". The limestone of the new H.S. Lee Mine No. 8 appears to be Bolorian (lower part of Middle Permian) in age or a little older, and it corresponds to the "Nam Loong Beds" of Suntharalingam (1968).

To the northeast of the new H.S. Lee Mine No. 8, another mine (Syarikat Lombong Maja No. 1 = Mine No. 808) displays a small limestone outcrop which is recrystallized and sheared with rotation and fragmentation of bioclasts (Sample M530; 8 thin sections). There is no dolomitisation observed in the limestone. Fragments of bryozoa (Fenestellidae) and crinoids are recognizable. This limestone should be older than that of the new H.S. Lee Mine No. 8 but it is still in the range of the Permian age. A Bolorian (lower part of Middle Permian) or older age is inferred only from the geographic position of the mine. To date, there is still inadequate palaeontological information available on the presence of Lower Permian in the Kampar area. According to Suntharalingam (1968), the "Nam Loong Beds" are overlying a sequence of shales and sandstone which are barren of fossils.

CONCLUSIONS

1. Lithologically, the Kinta Valley is characterized by a very thick accumulation of limestone ranging in age from Ordovician to Permian. On the contrary, the Kinta valley also does not display a sedimentary sequence similar to the Carboniferous-Lower Permian Singa Formation

- in the northwestern part of Peninsular Malaysia (Langkawi Islands, Perlis) which includes the famous diamictites described by several authors.
2. Even though the biostratigraphy of the Kinta Valley area ranges from the upper Ordovician to Permian age (Fig. 3), the Permian is more well-dated (Fig. 4) (Fontaine *et al.*, 1986). The presence of *Maklaya* (fusuline) at H.S. Lee Mine is interesting because this genus and other taxa found at this locality are unknown in the northwest Peninsular Malaysia and Peninsular Thailand. In contrast, the brachiopods found in the Kinta Valley display similarities with those from Peninsular Thailand. However, they can only suggest a special Permian geographic position for the Kinta Valley which allowed penetration of some Fusulinidae. Palaeontologically, the presence of *Maklaya* indicates stronger affinities between the Kinta Valley with the eastern part of Peninsular Malaysia or East Thailand rather than with the northwestern part of Peninsular Malaysia or Peninsular Thailand. *Maklaya* indicates the highest horizon of Bolorian or for some authors to the base of Kubergandian. Moreover, the Bolorian limestone at the H.S. Lee Mine No. 8 possibly extends into the Yahtahsian and it may correspond to a period without limestone deposition in the northwest Peninsular Malaysia and Peninsular Thailand.
 3. Great differences in lithology and palaeontology between the Kinta Valley and the northwest Peninsular Malaysia area seem to be contradict with the general idea (commonly highlighted in most of the publications on the paleogeographic reconstructions of Peninsular Malaysia) which consider "west Peninsular Malaysia is formed by a single palaeobiographic unit stretching from Perlis to Melaka, and separated from the eastern block of Peninsular Malaysia by the Bentong Line"
In contrast, the lithology and palaeontology of the Kinta Valley may support the hypothesis of two "geologic domains" which have been recognized by Tjia and Zaiton Harun (1985) based on the structural grounds. They have managed to differentiate the "west Peninsular Malaysia" and "northwest Peninsular Malaysia" blocks. However, these two authors admit that the boundary between the two domains is not well defined.
 4. In terms of stratigraphy, the limestones of the old and new H.S. Lee Mines No. 8 as well as the limestone of the Nam Loong Kongsu Mine No. 1 contain fusulines which clearly indicates a Bolorian age and maybe the base of the Kubergandian. The older part of these

limestones which have yielded no stratigraphical marker may belong to the Lower Permian. Shi and Waterhouse (1991) described Sakmarian brachiopods collected from a horizon which is overlain by a non-fossiliferous layer and a gastropod-bearing layer below the richly fossiliferous the "old H.S. Lee Mine No. 8" beds. Accordingly, this result fits very well with our lithological and palaeontological data.

The Sakmarian brachiopods of the Kinta Valley display similarities with the Sakmarian fauna collected from the clastic beds underlying the Ratburi Limestone at Ko Yao Noi in Peninsular Thailand. The brachiopods are also similar to the fauna of west Timor, and rarely but significantly, with peri-Gondwana faunas. In contrast, links with the Chihhsia Limestone of south and southwest China are very scarce. A discrepancy seems to exist between the studies of Fusulinidae and that of brachiopods. It is due to a difference in age. Fusulinidae are younger (Bolorian) than the brachiopods (Sakmarian). Shi and Waterhouse (1991) indicate that some elements of the Sakmarian brachiopod fauna of Kinta Valley are moderately comparable with the Tethyan and Uralian faunas whereas Asselian faunas from Peninsular Thailand had stronger affinities with eastern Australian faunas.

5. In terms of sedimentology, the Permian limestones of Kampar area which have been studied in this paper originated from a deposition in a relatively quiet environment (subtidal), from a bioaccumulation with some hydrodynamic buildup. This limestone has undergone a strong diagenesis with recrystallization, dolomitization and appearance of stylolites.

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