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FACIES AND STRATIGRAPHY OF THE LOWER-LOWER MIDDLE PERMIAN STRATA OF THE PETCHABUN FOLD-BELT IN CENTRAL THAILAND

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ABSTRACT The pelagic facies of the "Nam Duk Formation" (Chonglakmani & Sattayarak, 1978) was studied along the Lom Sak-Chum Phae highway in Petchabun province. Based on fossil-finds (Foraminifera in allodapic limestone) the Asselian and the Sakmarian of Lower Permian age as well as the Bolorian, and the Kubergandian to Murgabian of Middle Permian age could be proved.

The proved Lower Permian and Middle Permian strata of this geosynclinal sequence show a typical pelagic facies, predominantly build up by allodapic limestones, cherts, shales, and clastics which were sedimentated in a rather deep trough. Tuffites are recorded which were at least in part transported by turbidity currents into the basin. They are of dacitic to rhyodacitic composition. The source of this material was situated most likely to the southwest of the region studied. The pelagic sediments are linked to the roofing flysch by a transitional sequence.

INTRODUCTION

Until recently (comp. e.g. Gobbet, 1973) it was widely accepted that mainland Southeast Asia formed a tectonically stable region during Permian times. It was believed that this region was coverd to a large extent by more or less shallow shelf-seas in which a thick pile of sediments accumulated. Most famous and best studied are the limestone sequences of this age ("Ratburi Limestone" Brown et al., 1951) which form today in many parts of Thailand and adjacent countries high cliffs and impressive mountains. Thick sequences of clastics, volcanogenic sediments and volcanics are less suspicious in the field; attention centered on these strata only later ("Ratburi Group" Piyasin, 1972; Baum et al., 1970; Borax & Stewart, 1966).

Chonglakmani & Sattayarak (1978) can be credited for the discovery of a complex clastic sequence of Lower - Middle Permian age ("Nam Duk Formation") in the Petchabun fold-belt in Central Thailand. This sequence was interpreted by these authors as geosynclinal in contrast to the more calçareous sequences of the same age ("Pha Nok Khao Limestone" and "Hua Na Kham Formation") found farther to the east and west which they interpreted as shelf facies. This description was the first report of geosynclinal sediments of Permian age in the whole of mainland Southeast Asia. They also reported for the first time volcanics of Lower Permian age from the Petchabun-Phu Kradung area.

Recent investigations in the Petchabun fold-belt (Helmcke & Kraikhong, 1982; Helmcke & Lindenberg, 1983) demonstrate clearly that this region was not a stable area but a very dynamic region during the Permian times. The "Nam Duk Formation" of Chonglakmani & Sattayarak (1978) could be subdivided into several units, which show distinct sedimentological characteristics. The strata indicate a facies evolution from "pelagic" sediments (Lower - Middle Permian) via flysch to molasse strata (upper Middle Permian) thus proving an orogenic event during the Permian. According to Helmcke & Lindenberg (1983) this Permian orogenic event has to be regarded the most important orogenic event during Phanerozoic times for the central parts of mainland Southeast Asia.

Aim of this report is to contribute more detailed data on the "pelagic" sediments of Lower - lower Middle Permian age. Most data on the litho-facies of the sequence were collected by R.Winkel while working on his Masters Thesis (1983, unpublished); the paleontological and stratigraphic determinations were done by R.Ingavat.

NEW RESULTS

The "pelagic" sediments of the Lower - lower Middle Permian, which are the topic of this report, form the lower part of the "Nam Duk Formation" (Chonglakmani & Sattayarak 1978). The best outcrops of this sequence can be observed along the Lom Sak - Chum Phae highway in Petchabun province, exposed between km 16.ooo-18.5oo and km 19.285-2o.12o (the distances are calculated from the road intersection south of Lom Sak, comp. Fig.1).

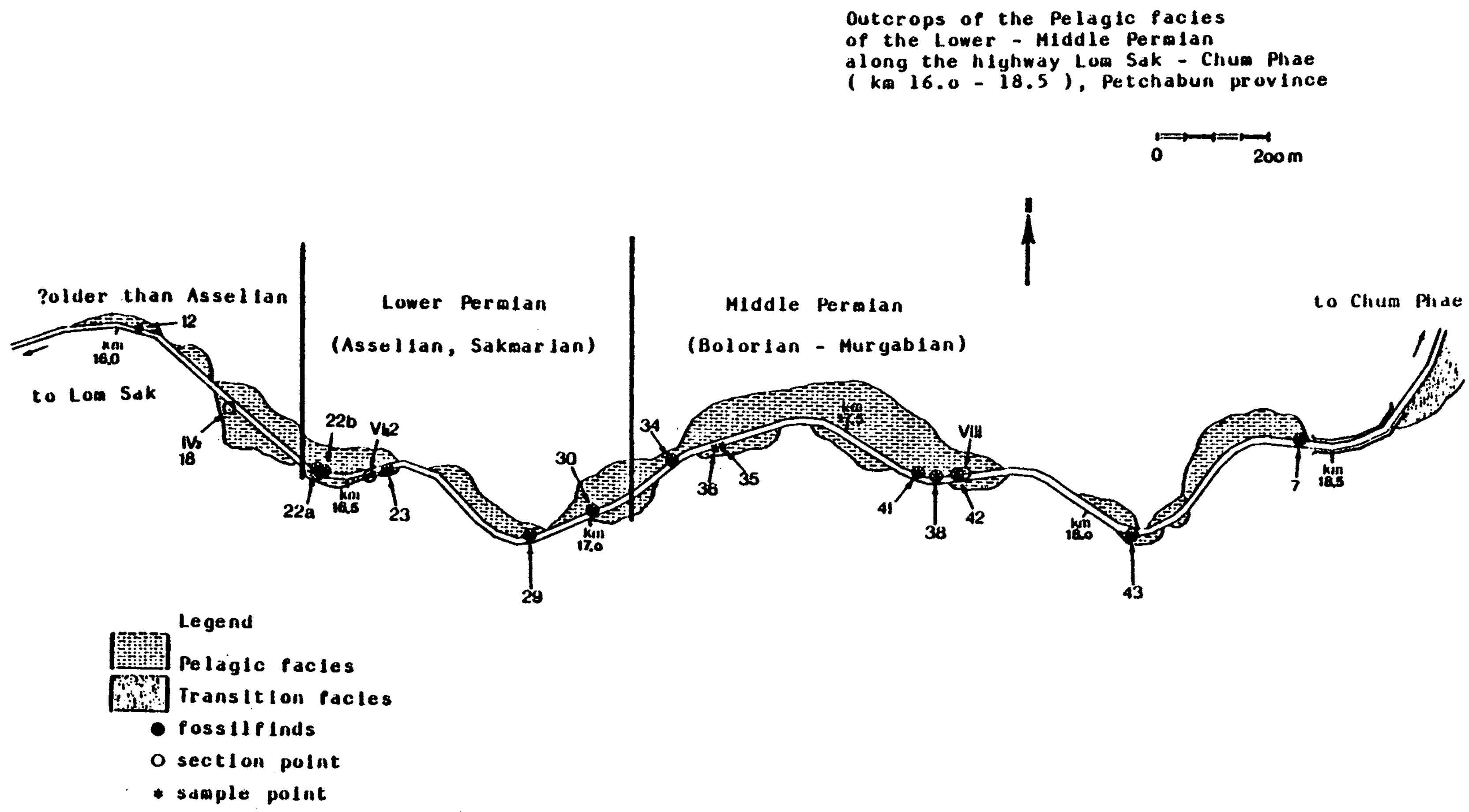

Fig. 1: Studied outcrops along Lom Sak - Chum Phae highway.

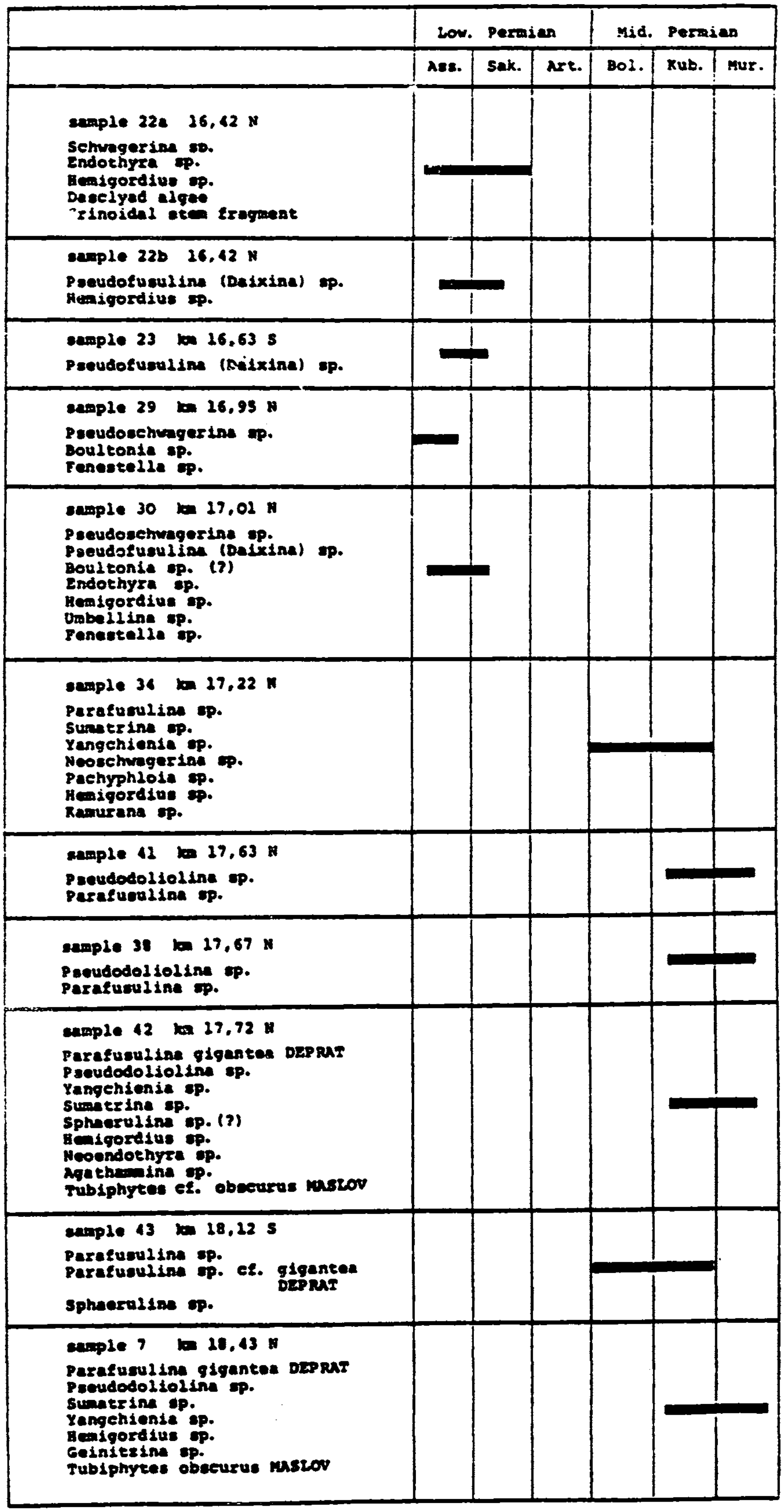

Fig. 2: Stratigraphic range of the fossil-finds.

In both sections the strata are intensively folded and severely faulted. Therefore it is impossible to describe and measure a more or less undisturbed section of the total sequence which will exceed 1ooo meters.

The survey is restricted to detailed mapping of rather short but undisturbed sections of all units which show lithological differences. These units are then arranged with the help of biostratigraphic data if available. Since the strata are pelagic and geosynclinal, they are usually very poor in fossils. All stratigraphically relevant fossils (foraminifera) were found in allodapic limestones, that means the foraminifera were transported from carbonate platforms or reefs into the pelagic realm by turbidity currents. Therefore they indicate a maximum age limit of the allodapic limestone-layer in which they were found (comp. Fig.2). Up to now foraminifera were found along the sections at 11 locations, but not all were well preserved that they could be determinated.

The oldest strata probably crop out in the westernmost parts of the western section (km 15.95o-16.4oo). Though these strata yielded no fossils it seems reasonable to ascribe an age "older than Asselian" to these strata since this section varies from the dated Permian strata quite significantly in lithology.

This section is built up predominantly by light grey siltstones and grey to greenish psammitic beds. The psammitic beds are up to 3 m thick and are rather coarse-grained in part. They consist of biogenic clasts (Echinoidea fragments) and siliceous clasts (dacitic and rhyodacitic rock fragments, plagioclase, quartz and potassium-feldspar) in varying portions. The eastern part of the section shows black shales and dacitic tuffites (comp. Fig.3, Section IV) as well as silt- and claystones (subordinate), and some thin layers of allodapic limestones (Fig. 8).

The section between km 16.4oo and approx. km 17.o5o shows a typical pelagic sequence of Lower Permian age (Asselian to Sakmarian). It is built up by light to medium grey allodapic limestones alternating with black shales and cherts. The allodapic limestones show many features characteristic of sedimentation by turbidity currents (BOUMA-cycle). Tuffites and siltsones occur subordinately. Fig.3 (Section VI) shows a typical part of a measured section in which allodapic limestones alternate with black shales.

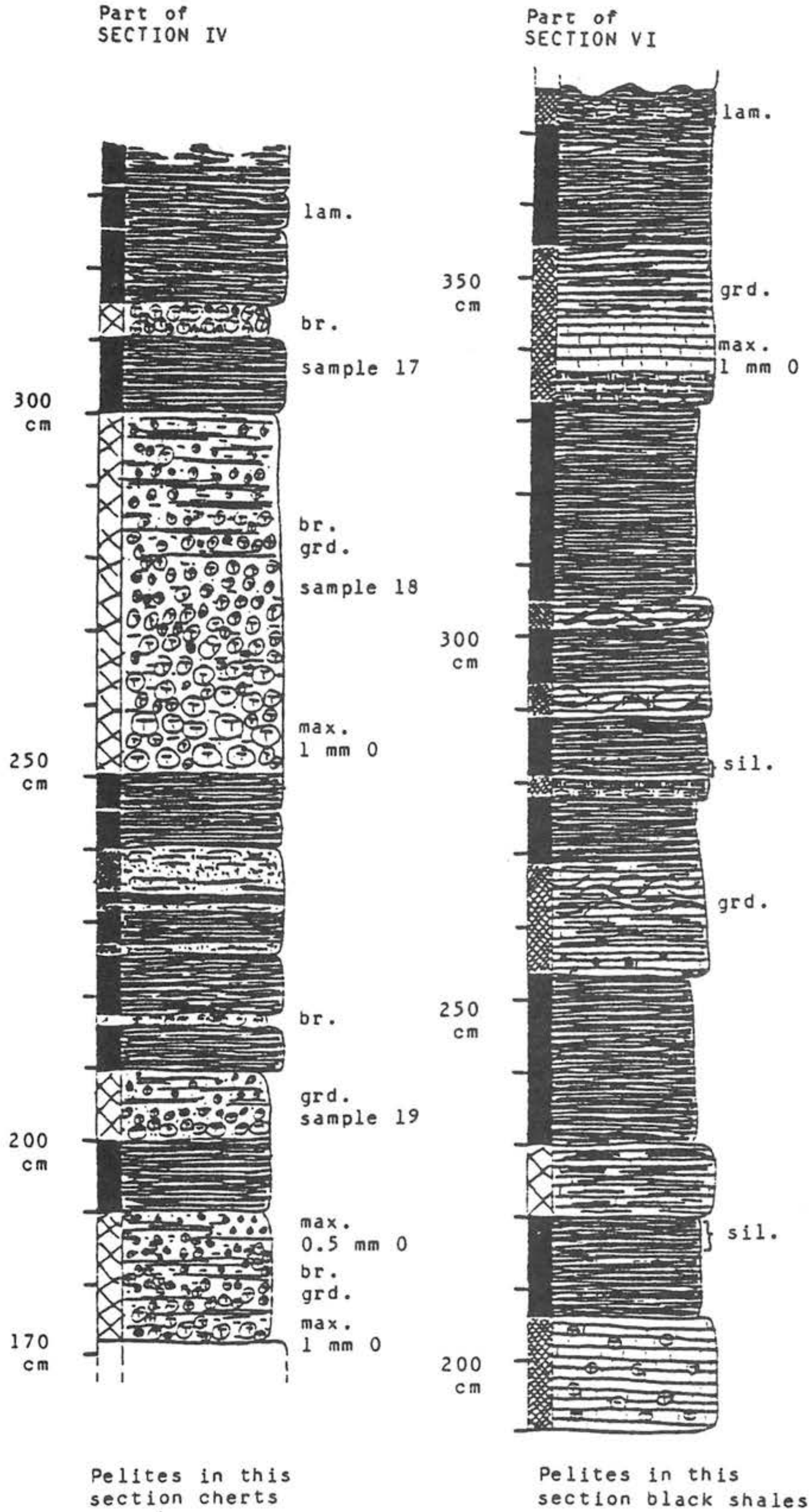

Fig. 3: Part of Section IV (km 16.210), ?older than Asselian; part of Section VI (km 16.610), Lower Permian.

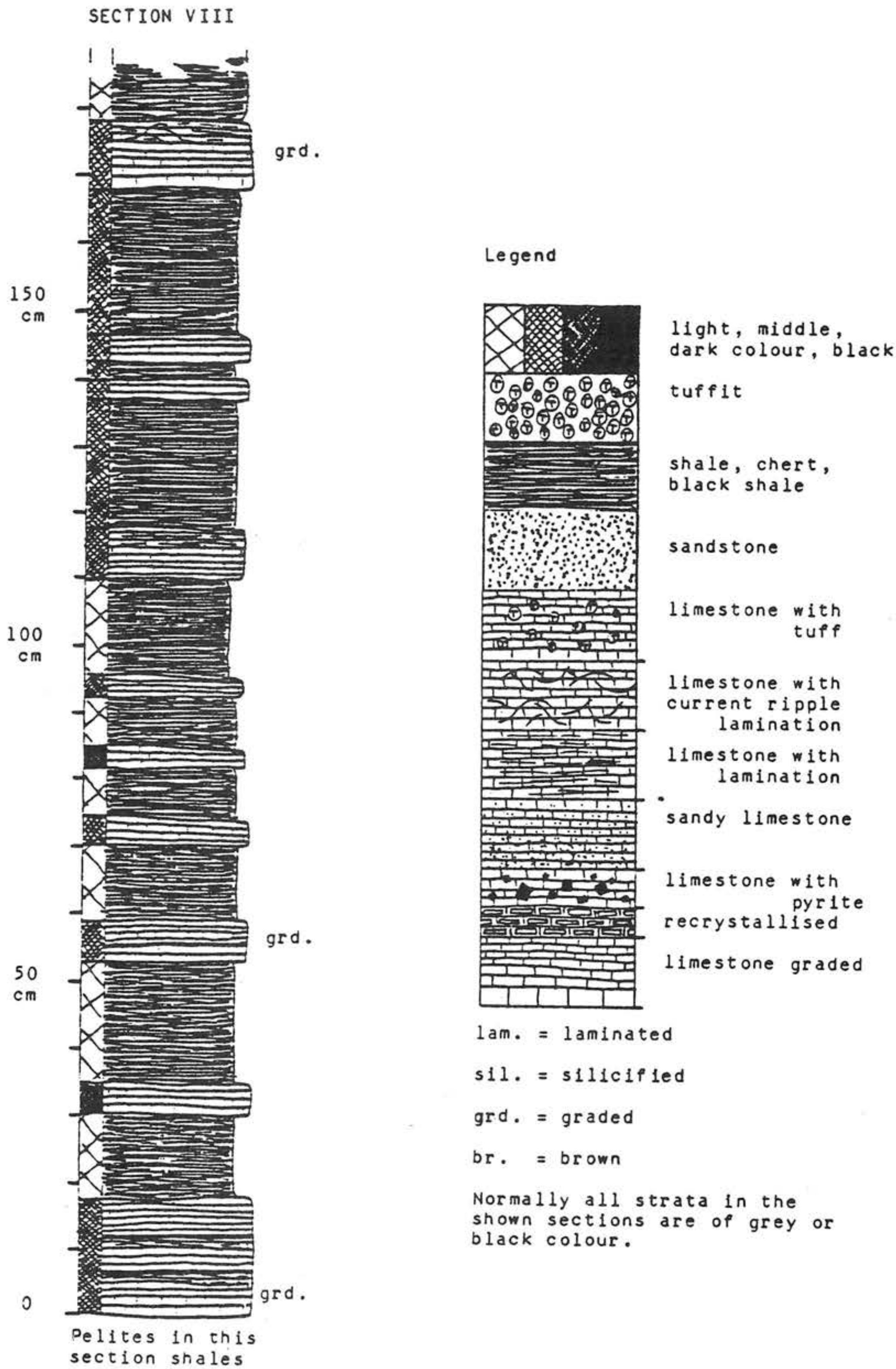

Fig. 4: Part of Section VIII (km 17.730), Middle Permian.

During Bolorian to Kubergandian times (lower Middle Permian) the sedimentation by turbidity currents reached a maximum: individual layers of allodapic limestones with a thickness up to 24o cm were deposited (at the outcrops of approx. km 17.2oo). This section is found within a sequence which built up the area between approx. km 17.o5o and the bridge upon the River Tong at km 18.5oo. According to the foraminifera found this section is of Bolorian to Murgabian age (Middle Permian), but apparently older than Verbeekina-Zone since these conspicuous fossils were never detected in this section. Usually grey allodapic limestones alternating with light grey shales predominate in this section (comp. Fig. 4, Section VIII) but in some outcrops only pelitic sediments were found.

A second section of pelagic sediments which are strongly deformed is situated east of the Tong River approx. between km 19.36o and km 20.120 along the highway. This section is bound to the south by an important E - W running fault. The foraminifera found in this section are strongly recrystallized that it was not possible to date this section up to now. Also in this section allodapic limestones alternate with dark grey shales.

An important result of the investigations is the proof that siliceous clastics are widely distributed in the non pelitic parts of the pelagic facies (comp. Chonglakmani & Sattayarak, 1978). These clastics are built up by rock-fragments of dacitic to rhyodacitic composition, plagioclase (oligoclase only), quartz, and potassium-feldspar. The quartz- and feldspar-clasts are interpreted as phenocrysts of (rhyo-) dacitic volcanics which are detached from the matrix.

At least in two sections measured (Fig. 3, Section IV for example) these volcano-clastic beds are tuffites which were sedimentated by subaerial ashfall into the pelagic regime. They are well stratified and graded. But in general the siliceous clastics are mixed to different degrees with biogen carbonate-clasts of allodapic limestones which implies a common transport by turbidity currents into the basin. In those cases in which more than 50% of the clasts are siliceous the term "allodapic tuffite" is used here for these turbiditic sediments instead of a term like "allodapic limestone with strong tuffitic affinities".

Below the bridge upon the Tong River, at the confluence of the Tong River and the Nam Duk River and in many outcrops along the Nam Duk River the sediments of the pelagic realm show a development which is interpreted as a transitionary facies to the roofing flysch. Strong influx of detritic quartz is typical for this transitionary type. Next to pure allodapic limestones all rock-types (limestones with some quartz-detritus, greywackes with some lime-content) grading to pure greywackes of the flysch facies were found.

This facies differs from the above described pelagic sediments in the following characteristics:

- lower interval of parallel lamination and interval of current ripple lamination (and convolute lamination) are well developed,
- flute casts on the base of the beds are often developed which indicate transport from south (Fig. 10) as well as from north,
- some soles show trace fossils,
- no indications of euxinic environment were detected,
- foraminifera were not found.

Due to the lack of foraminifera this transitionary facies can not be dated yet. Therefore the possibility cannot be excluded that this facies is a time-equivalent of the pelagic facies sedimentated in a different part of the basin.

SUMMARY AND INTERPRETATION

During (?Upper Carboniferous) Lower Permian and most of the Middle Permian a marine basin occupied the area which is now known as the Petchabun fold-belt. The basin was certainly much wider than todays fold-belt - 100 to 200 km might be a reasonable estimate. The basin was deep enough to host a pelagic sequence which is build up predominantly by allodapic limestones and shales of an estimated minimum thickness of over 1000 m. The pelagic sequence is followed by a facies of transition and by a thick flysch sequence (the thickness of the flysch cannot be estimated) which also requires a rather deep basin. Only during the sedimentation of the roofing molasse facies the basin became more and more shallow (Altermann, 1983).

Taking into account that the basin was subsiding during the time of sedimentation it is not necessary to assume that this basin was floored by true oceanic basement. According to Ziegler (1982) some 3000 m of sediments can accumulate in a basin with an initial water depth of 1000 m.

The allodapic limestones were transported from south and from north in the direction of the axis of the basin. These turbiditic limestones derived from carbonate-platforms which are mapped in the eastern as well as in the western parts of the Petchabun fold-belt ("Pha Nok Kao Limestone" Chonglakmani & Sattayarak, 1978).

The siliceous clastics of the non-pelitic parts of the pelagic facies derived from dacitic to rhyodacitic subaerial volcanism which has to be located - according to the data given for example by Bunopas & Vella (1978) - on a land-area west of the Petchabun region or from volcanic-islands within the geosyncline.

Two different mechanisms for the transport of the volcanic clasts could be detected:

- direct subaerial ashfall into the pelagic regime,
- subaerialashfall on land, erosion and transport of the pyroclasts by rivers into the near-shore regions of the basin and onwards by turbidity currents into the deeper parts of the basin. During the transport by turbidity currents this material was mixed with biogen carbonate-clasts.

Our results suggest that the volcanism was active during the whole time of the sedimentation of the pelagic facies with peaks of activity during ?Upper Carboniferous to Asselian and during the lower Middle Permian.

The stratigraphic results obtained permit a more precise dating of the onset of flysch sedimentation in the area under study. The graphs provided by Helmcke & Kraikhong (1982, Fig. 21) and Helmcke & Lindenberg (1983, Fig. 4) show the assumption that the flysch starts at some point of time during the Middle Permian. Now it is proved that the pelagic regime lasted until Kubergandian - Murgabian and that the flysch must have been sedimentated very quickly during a rather short period of time during the Murgabian since the roofing molasse strata are also of Murgabian age (Verbeekina zone).

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DESCRIPTIONS FOR FIGURES 5 - 10

Fig. 5: Coarse grained quartz-bearing biosparite with lithoclasts (Folk), packstone (Dunham). Thin-section, sample 30 Wi, Nic. +, Lom Sak - Chum Phae highway, km 17.000 (N), Asselian - Lower Sakmarian.
Description of figure: Matrix of calcareous-lumps (containing some larger calcite spars and fragments of algae-crusts), myrmekitic grain, some quartz and magnetite.

Fig. 6: Coarse-grained carbonaceous volcanoclastic psammite (allodapic tuffite). Thin-section, sample 36 Wi, Nic. +, Lom Sak - Chum Phae highway, km 17.320 (S), Middle Permian. Description see Fig. 7.

Fig. 7: Drawing of thin-section sample 36 Wi shown in Fig. 6. V = volcanics, P = plagioclase, Q = quartz, Ca = Calcite.

Fig. 8: Silt- and claystones (partly silicified) alternating with sandstones, Lom Sak - Chum Phae highway, km 16.150 (N) ?older than Asselian.

Fig. 9: Allodapic limestones alternating with black shales (partly silicified), Lom Sak - Chum Phae highway, km 16.610 (S), Section VI, Lower Permian.

Fig.10: Sandstone layer (6 cm) with flute-casts on base. The flute-casts indicate transport from south (in figure from right). Confluence of Tong River with Nam Duk River. Transition from pelagic facies to flysch.

Fig. 5:

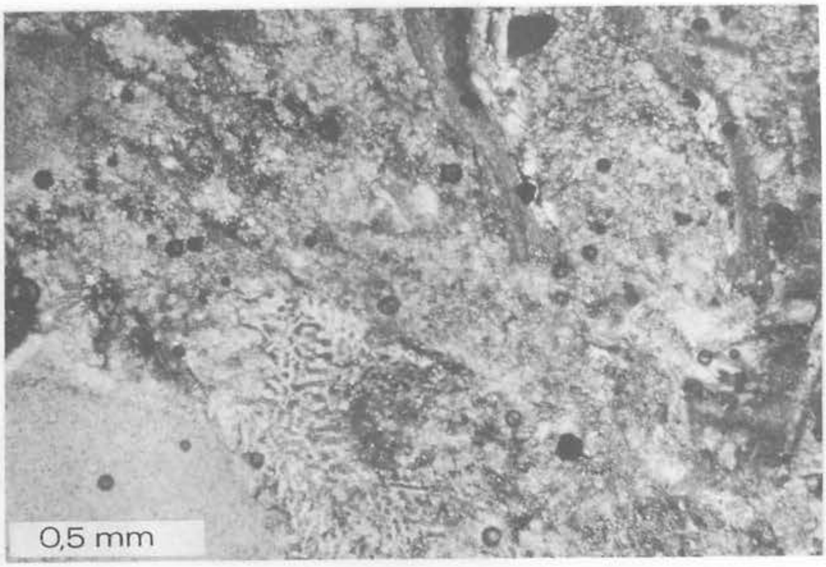

Fig. 6:

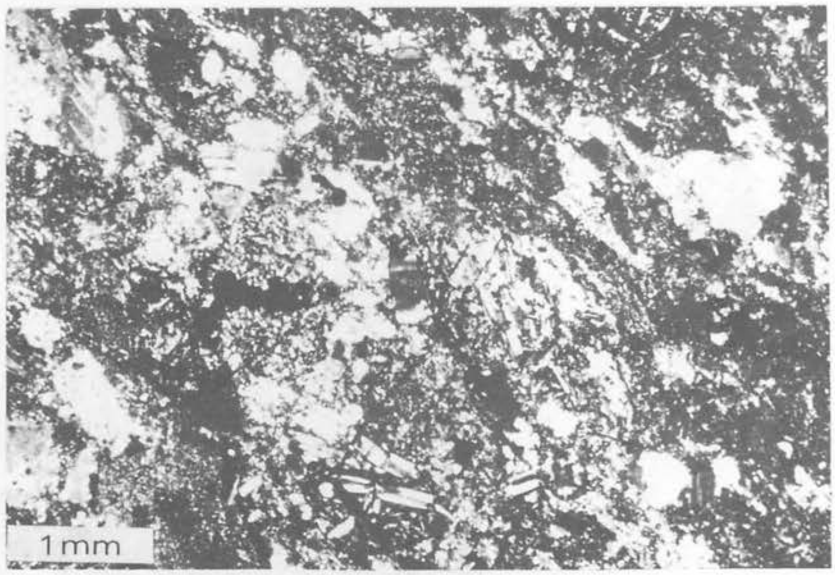

Fig. 7:

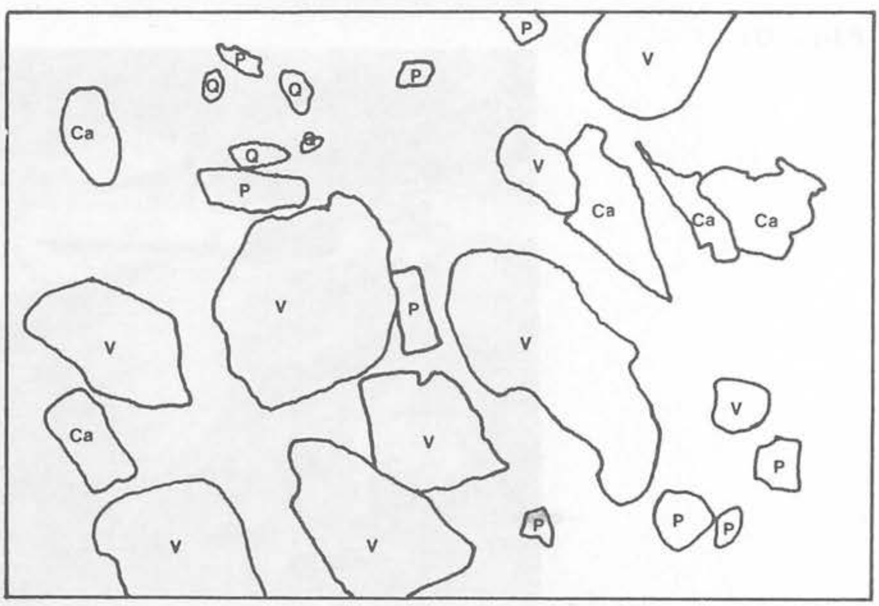

Fig. 8:

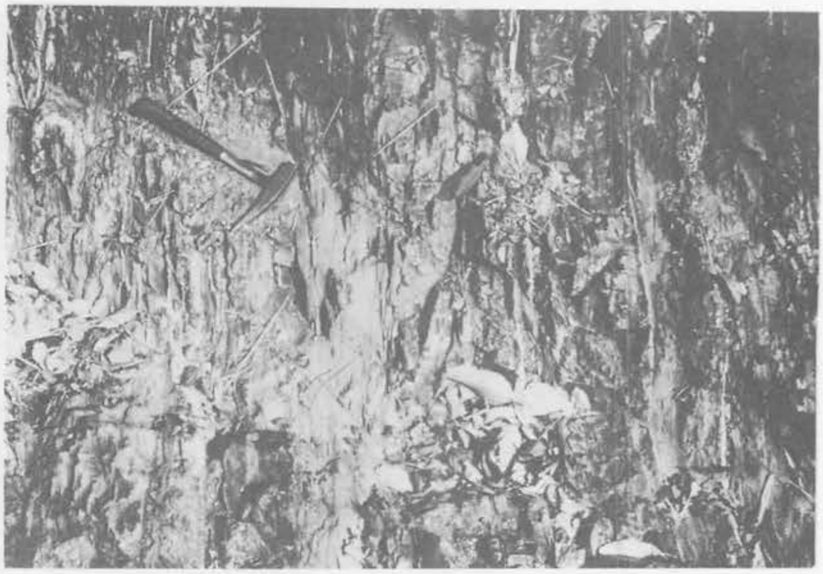

Fig. 9:

Fig.10: