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The Sanai Limestone Member — a Devonian limestone unit in Perlis

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Abstract: The name Sanai Limestone Member is proposed for the thin limestone unit located inside the Jentik Formation, previously known as Unit 4. Stratigraphically it is located near the top of the Jentik Formation, underlain by Mid or Late Devonian red mudstone beds of Unit 3, and overlain by light coloured to black mudstones interbedded with cherts of Unit 5. The lithology consists of planar bedded, grey micritic limestone, with thin shale partings and stylolites. The limestone contains abundant fossils of conodonts, styliolinids, straight cone nautiloids, and trilobites. The occurrence of the conodont *Palmatolepis glabra* indicates a Late Devonian, Fammenian age. The depositional environment of the Sanai Limestone Member is interpreted to be a deepwater pelagic limestone facies, located at the outer shelf to continental margin region.

INTRODUCTION

In the first report on the newly proposed Jentik Formation (Meor and Lee, 2002a), we briefly described a limestone bed at the base of Section 2 of Hill B of the composite stratotype in Kampung Guar Jentik (Fig. 4, Meor and Lee, 2002a), which we left informally named as Unit 4. More detailed logging and field description have produced much more information on this unit. This limestone is palaeontologically and stratigraphically distinct from the Setul and Chuping Limestones in Perlis. In this paper, we propose the name Sanai Limestone Member for this calcareous part of the Jentik Formation.

DESCRIPTION OF THE SANAI LIMESTONE MEMBER

The naming and description of the Sanai Limestone Member were made following the recommended standard procedures of the Malaysian Stratigraphic Guide.

Name

The name Sanai Limestone Member is given. The name is derived from the name Guar Sanai, referring to the hilly ridge in Kampung Guar Jentik where the stratotype is. The term Member is used for the unit, as it is part of the Jentik Formation, where it can be easily distinguished.

Locality

The Sanai Limestone seems to be limited in distribution, and is only exposed at Hill B of the Guar Sanai ridge in Kampung Guar Jentik, Beseri District, Perlis (lying between latitudes 6°33.200'N to 6°33.400'N, and longitudes 100°12.350'E to 100°12.400'E), just south of the Timah Tasoh Dam, and roughly 10 km north of Kangar (Fig. 1). The unit does not occur in other exposures of the Jentik Formation such as Kampung Binjal and Wang Kelian. The Langgun Island section is incomplete, and does not preserve the part where the Sanai Limestone Member is expected to have been located.

Stratigraphy

The Sanai Limestone Member is oriented north-northwest, south-southeast, and dips steeply towards the east (Fig. 1). Stratigraphically, it is located above Unit 3 (also known as the Langgun Red Beds) of the Jentik Formation, and is conformably overlain by chert beds of Unit 5 (Figs. 2 and 3). The actual thickness of the Sanai Limestone Member is not known, as the contact between the Sanai Limestone and Unit 3 is not exposed, but the exposure reaches about 12 m in thickness. The change in lithology from bedded limestone to white and pink coloured mudstone and black chert of Unit 5 is observed to be somewhat abrupt. The base of Unit 5 contains abundant fossils of small gastropods and orthids.

The limestone is grey in colour, and planar bedded, with beds ranging from 10 to 50 cm in thickness. The bedding planes are usually stylolitic in nature, but some are planar, with thin shale partings. One exposed bedding plane shows the presence of syneresis cracks. The logged section is only 6 m thick, but below this are more limestone which are deformed and faulted.

The limestone is also highly fossiliferous, containing abundant conodont elements and nautiloid fossils.

Petrography

Lithologically, the unit is made up of fine grained limestone. Fresh samples are light grey in colour, weathering to reddish white. Large, black coloured mottles in the rock may be impurities of either carbonaceous or intraclastic material. Large bivalve shells and cephalopod fossils are commonly found in it.

Petrographically, the limestone is a sparse biomicrite, or wackestone, with skeletal grains representing crinoid, trilobite, tentaculitid and ostracod fossils. Thin sections show little sparry calcite cementation, and few stylolites (Fig. 4).

Palaeontology and age

The only macrofossils found are straight cone nautiloids. Most abundant are small sized fossils observed in thin sections. Found in great abundance are small cone structures and ring shaped cross sections identified as dacryoconarid tentaculitids (based on the presence of a bulb shaped apex on some of the shells), possibly styliolinids, as the shells are unornamented (Fig. 4a). Biconvex shells and disarticulated valves filled with sparry cement, here identified as ostracods, are also common (Fig. 4b). Small, curving fragments showing sweeping extinction are fragmented trilobite carapace (Fig. 4c). The occurrence of styliolinids suggest a Devonian age for the limestone.

Of particular interest is the presence of abundant conodont remains recovered from limestone beds near the top of the type section (between interval 5 m and 6 m of the section in Fig. 2). Prof. Ian Metcalfe (personal communication) of the University of New England, Australia, has identified the specimens as species of the genus *Palmatolepis*, and some polygnathids. Two specimens are identified by the authors as *Palmatolepis glabra* (Fig. 5).

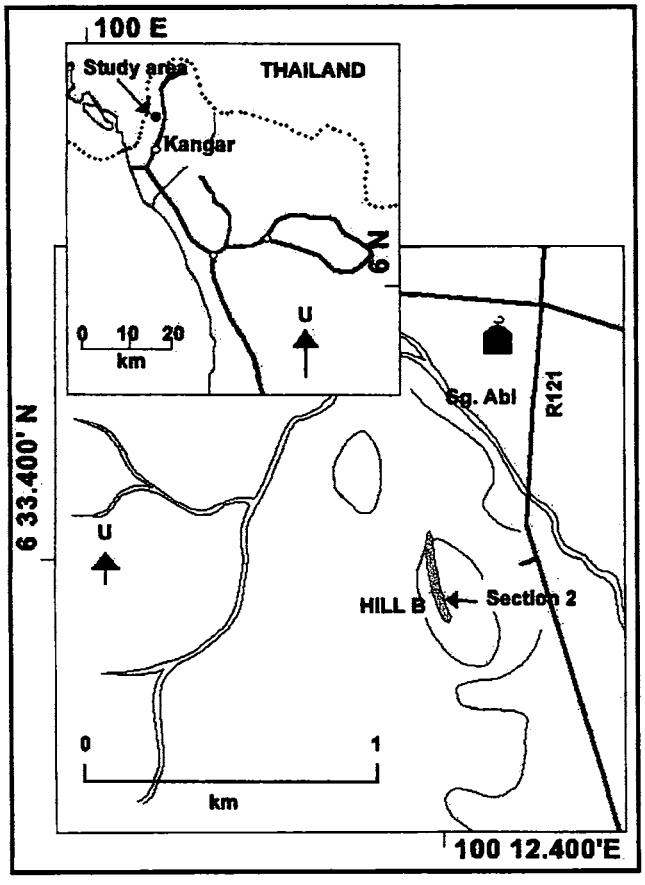

Figure 1. Map showing location and outcrop distribution of the Sanai Limestone Member.

Mapping shows that the Sanai Limestone Member is stratigraphically on top of the Langgun Red Beds, which are known to be Mid to Late Devonian in age. Overlying the Sanai Limestone Member are black cherts and thick red mudstone. The red mudstone unit (Unit 6 of the Jentik Formation) contains the trilobite *Macrobole kedahensis* which indicates an Early Carboniferous (Tournaisian) age. Thus stratigraphic bracketing limits the age of the limestone from Mid-Late Devonian to Early Carboniferous. The occurrence of the genus *Palmatolepis*, which is restricted to the Late Devonian, suggests a Late Devonian (Frasnian to Fammenian) age. *Palmatolepis glabra* ranges only from the Upper *crepida* to the Upper *trachytera* zones of the standard conodont zonation, thus indicating a Fammenian age. The occurrence of styliolinids does not actually contradict a Fammenian age for the limestone, as specimens identified as *Styliolina* have been found from the Fammenian of China (You, 2000).

Depositional environment

The depositional environment is interpreted as relatively deepwater marine. The Sanai Limestone Member has many features of a deeper water, pelagic limestone facies, including the fine grained, thin bedded nature of the limestone with shale partings and the predominance of pelagic fossils (Scholle *et al.*, 1983). The micritic texture indicates deposition (possibly from suspension as there are no indications of resedimentation and current activity) in a low energy environment, with insufficient wave or current energy to winnow away fine matrix. The biomicrite contains only sparse fossil remains. It contains mostly pelagic fossils, especially cephalopods, dacryoconarid tentaculitids, conodonts, and ostracods, and very little benthic fossils (trilobites). Skeletal grains clearly show a marine environment, and sparse benthic fossils show an inhospitable substrate, possibly explained by deposition below the photic zone. Stylolites and marly seams are caused by later pressure dissolution and compaction. The depositional environment is interpreted as relatively deeper water, possibly on the outer continental shelf or even at the continental margin. The lack of coarser grained carbonates and abundant benthos excludes the possibility of shallow to intermediate depths (although we realize that the evidence here is only negative). The association with overlying radiolarian cherts is very interesting. This sort of association indicates a transgressive event, either through rise in sea level or subsidence.

The conodonts give further support to this interpretation. Based on the conodont biofacies classification of Sandberg and Dreesen (1984), a polygnathid – palmatolepid association (the two taxa found abundantly in the Sanai Limestone) is restricted to their biofacies II, which is indicative of a slope to basinal environment.

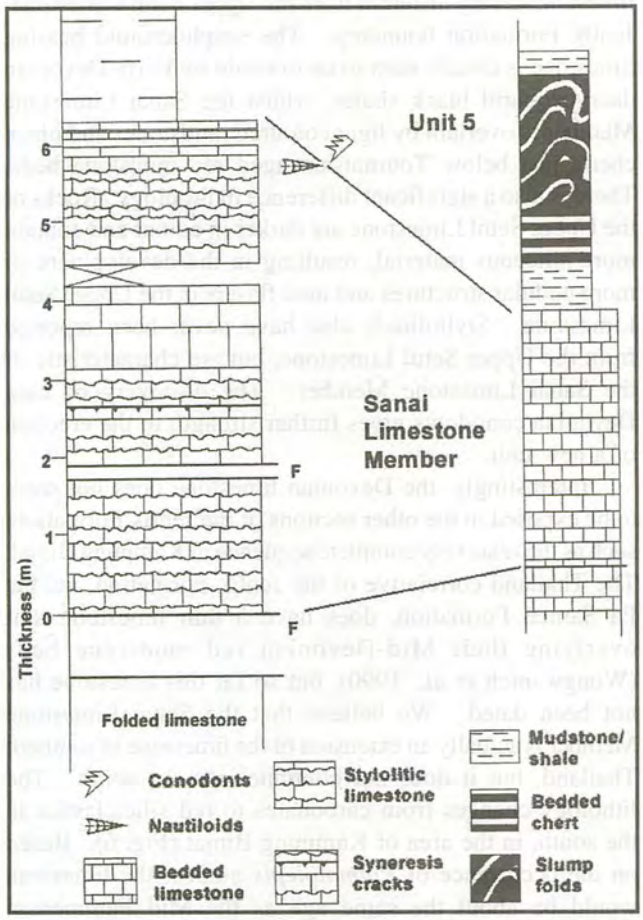

Figure 2. Logged section of the Sanai Limestone Member and its position in Section 4 of the Jentik Formation stratotype (Meor and Lee, 2002a).

Figure 3. Photo of Section 4 outcrop on Hill B, Kampung Guar Jentik, showing the Sanai Limestone Member on the left, being overlain by mudstone and black cherts of Unit 5 of the Jentik Formation.

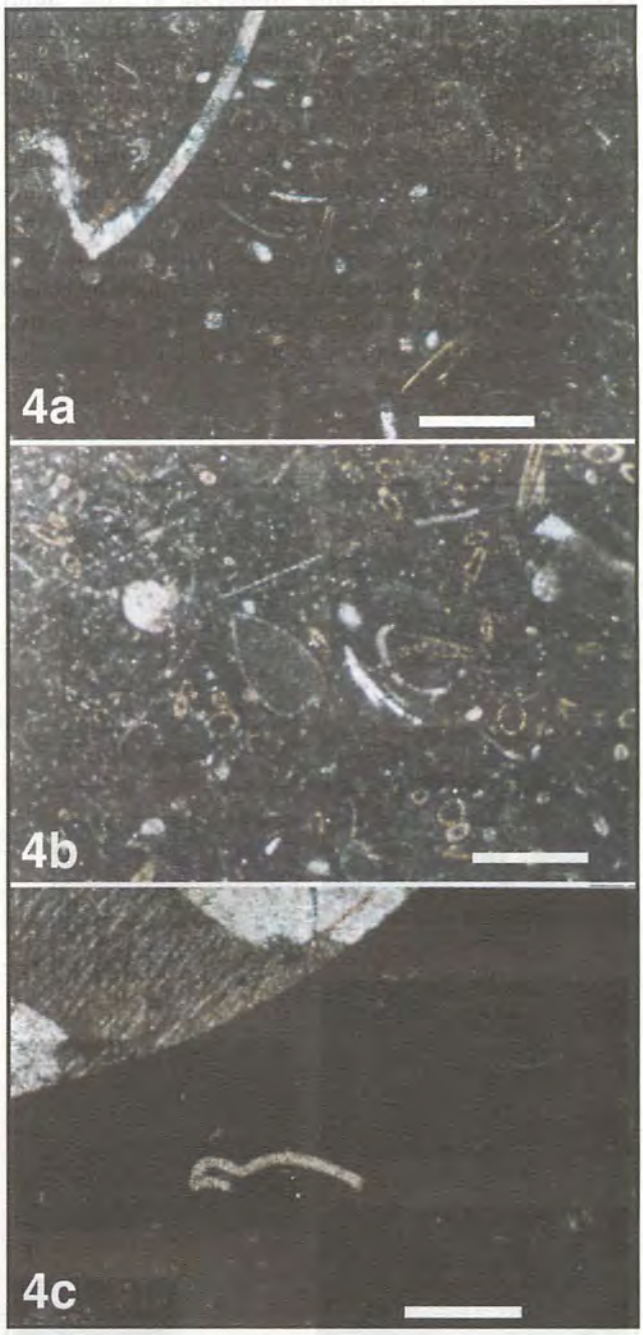

Figure 4. Thin sections of rock samples from the Sanai Limestone Member: (a) Biomicrite packed with fossils of dacryoconarid tentaculitids. Note the specimen in the middle, which has a bulb shaped tip at the end of the shell; (b) Biomicrite packed with tentaculitids. Most of the tentaculitids are observed in cross section (the ring-like structures). Also preserved is an articulated ostracod shell; (c) Trilobite fragment in biomicrite. Scale bars are 1 mm each.

DISCUSSION

This is the first reported occurrence of a Devonian limestone unit from Perlis. The only known limestone from Northwest Peninsular Malaysia are the Setul Limestone and Chuping Limestone (Jones, 1981). Indeed, when first studied, we erroneously thought that it was part of the Upper Setul Limestone, as it was located near the Upper Silurian scyphocrinoid bearing rocks in Kampung Guar Jentik (Lee, 2001). It must be noted here that the age of the plate loboliths of the scyphocrinoids found in the Upper Setul Limestone is now believed to be younger, that is uppermost Pridoli to lowermost Lochkovian and not just Upper Silurian. This is based on the observation by Haude (1992) that the plate loboliths overlie the older cirrus loboliths which are restricted to the Pridoli only. Detailed mapping has shown that the stratigraphy of the Section 4 limestone is very different from the Upper Setul Limestone-Jentik Formation boundary. The scyphocrinoid bearing limestone is clearly seen to be overlain by Early Devonian dacryoconarid black shales, whilst the Sanai Limestone Member is overlain by light coloured mudstones and black cherts just below Tournaisian aged red mudstone beds. There is also a significant difference in lithology. Rocks of the Upper Setul Limestone are darker in colour and contain more siliceous material, resulting in the development of more nodular structures and mud flasers in the Upper Setul Limestone. Styliolinids also have never been reported from the Upper Setul Limestone, but are characteristic of the Sanai Limestone Member. The discovery of Late Devonian conodonts gives further strength to the erection of a new unit.

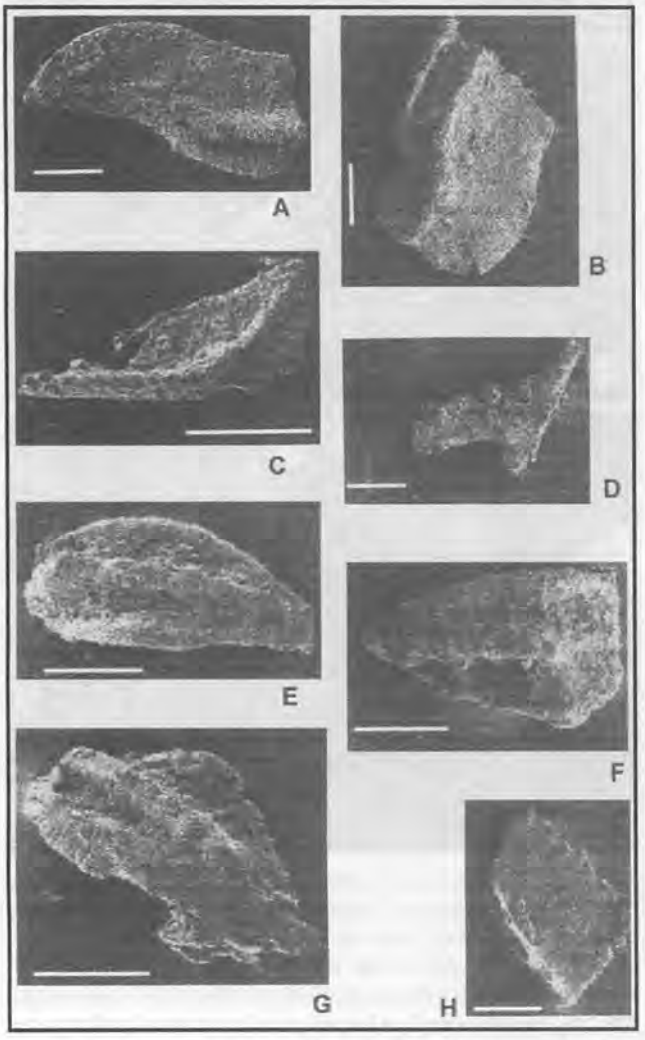

Figure 5. Conodonts extracted from the Sanai Limestone Member. A-B, *Palmatolepis glabra*, GSBU4S001, GSBU4S011; C, *Palmatolepis* sp.; D, palmatolepid M element, GSBU4S009; E, *Polygnathus* sp. GSBU4S007; F, *Palmatolepis* sp. GSBU4S004; G, *Polygnathus* sp. GSBU4S005; H, unidentified blade, GSBU4S013. Scale bars are 200 microns each.

Interestingly, the Devonian limestone does not seem to be exposed in the other sections of the Jentik Formation, such as the relatively complete sequence in Kampung Binjal. The Thailand correlative of the Jentik Formation, i.e. the Pa Samed Formation, does have a thin limestone unit overlying their Mid-Devonian red mudstone beds (Wongwanich *et al.*, 1990), but so far this limestone has not been dated. We believe that the Sanai Limestone Member is actually an extension of the limestone in southern Thailand, but it does not continue into the south. The lithology changes from carbonates to red siliciclastics in the south, in the area of Kampung Binjal (Fig. 6). Based on the occurrence of *Palmatolepis glabra*, the limestone would be about the same age as the Mid Fammenian *Waribole* bearing, red to grey mudstone at the upper part of Unit 3 of the Jentik Formation exposed in Kampung Binjal (Kobayashi 1966; Meor and Lee, 2002b). Lee (1983) has shown that the palaeo shoreline was roughly north-northwest south-southeast during the Palaeozoic. Therefore what we are seeing in the Devonian sequence of Malaysia is a lateral transition in lithology parallel to shoreline. The transition from pelagic limestone to red turbiditic mudstone towards the south may indicate deepening of the basin (the red mudstone deposits may have been located nearer the depocentre), or may even suggest that the source of terrigenous material was closer to northern Peninsular Malaysia than to southern Thailand.

CONCLUSION

The palaeontological evidence discussed above confirms the presence of an Upper Devonian limestone unit in Northwest Peninsular Malaysia, which we name here as the Sanai Limestone Member, which is positioned inside the Jentik Formation. The limestone may possibly be correlated with undated limestones in the Pa Samed Formation of southern Thailand. The depositonal setting is interpreted to be relatively deeper waters at the outer continental shelf to continental margin region. Similar limestones have so far not been found in southern Perlis and northern Kedah.

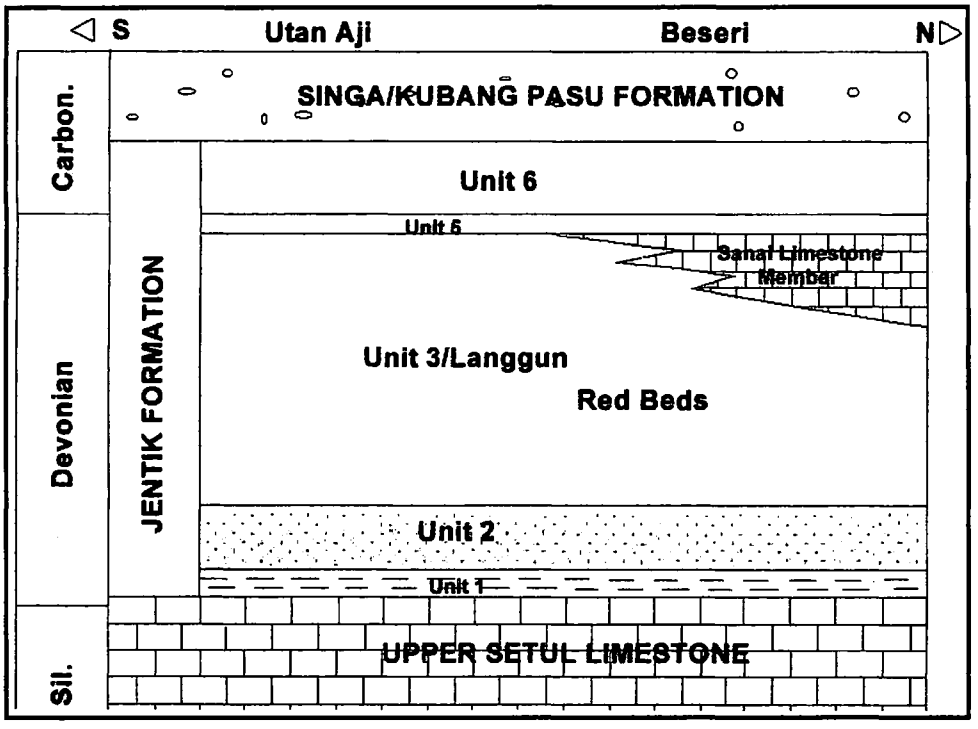

Figure 6. Generalized diagram showing the stratigraphy of the Devonian – Lower Carboniferous in Northwest Peninsular Malaysia.

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