Conglomerate from Setia Jasa near Temerloh, Pahang, Peninsular Malaysia: Its stratigraphic position and depositional environment

MOHD SHAFEEA LEMAN[1] AND MASATOSHI SONE[2,*]

[1]Geology Programme, School of Environmental Science and Natural Resources,
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
[2]Institute for Environment and Development (LESTARI),
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
*Present address: Asia Centre, University of New England, Armidale, NSW 2351, Australia

Abstract: A thick sequence of conglomerate, tuffaceous sandstone and shale/mudstone largely exposed at the Setia Jasa area is described. The matrix-supported conglomerate of very well rounded clasts conformably overlies pebbly mudstone and shows a gradual change in matrix grain size from clay to sand. An Anisian (early Middle Triassic) age is indicated for a whole sequence by the presence of an ammonoid *Paraceratites* sp. found in a lower shale bed. Sedimentological features suggest that the conglomerate and underlying sandstone/shale sequences were possibly deposited in a relatively deep marine environment, and probably belong to the Semantan Formation.

Abstrak: Satu jujukan tebal konglomerat, batu pasir bertuf dan syal/batu lumpur yang tersingkap di kawasan Setia Jasa diperihalkan di sini. Konglomerat sokongan matriks dengan klasta sangat bulat didapati menindih batu lumpur berpebel dan menunjukkan perubahan berterusan matriks dari saiz lumpur ke saiz pasir. Keseluruhan jujukan ditafsirkan berusia Anisian (Trias Tengah) berdasarkan kehadiran fosil amonoid *Paraceratites* sp. yang ditemui dalam syal di bawahnya. Bukti-bukti sedimentologi mencadangkan bahawa jujukan konglomerat dan jujukan batu pasir-syal di bawahnya mungkin diendapkan di sekitaran laut yang agak dalam dan mungkin merupakan sebahagian daripada Formasi Semantan.

INTRODUCTION

The occurrence of pebble to boulder conglomerate at Taman Setia Jasa (TSJ hereafter) east of Temerloh was noted by Lee (1999) who suggested that highly rounded clasts in the conglomerate were possibly shaped by transport of explosive volcanic processes.

The authors have studied on two adjacent sections containing conglomerate and shale-sandstone sequences at the Setia Jasa area. The study shows that both the conglomerate and conformably underlying shale-sandstone sequences are of a relatively deep marine origin. This paper also reports the occurrence of an Anisian (early Middle Triassic) ammonoid, *Paraceratites* sp., from the shale bed, and discusses a stratigraphic position and depositional environment of the conglomerate in the Setia Jasa area.

GEOLOGICAL SETTING

The geology of the area in between Temerloh and Kampung Awah, including TSJ, was first mapped by Burton (1973) as part of the Jelai Formation. This was later revised to as part of the Semantan Formation by Jaafar Ahmad (1976). Taman Setia Jasa is located along the Temerloh–Maran main trunk road, about 3.8 km west of Pekan Awah and about 11 km east of Temerloh Bridge (Figure 1). The geology of TSJ and surrounding area is dominated by thickly bedded to massive conglomerate, with subordinate tuffaceous sandstone and shale. Two sections are studied in this paper; namely, Section A which shows the first appearance of rounded clasts in pebbly mudstone and conglomerate and Section B which exhibits the development of the conglomerate at TSJ.

Section A

A small road-cut about 80 m NE of the TSJ main entrance along the main road reveals a sequence of shale, tuffaceous sandstone and matrix-supported conglomerate (3°28'27"N, 102°30'23"E) (Figure 2). The beds have a strike of 160° and dip 55° westerly. The lower part of the sequence is made up of thin to thickly bedded dark grey shale and yellowish grey tuffaceous fine sandstone. Graded bedding, where tuffaceous fine sandstone grades upward into mudstone, is common. Slump structures are developed within a thick shale bed in the middle of the sequence, where several fine sandstone and siltstone laminae are disharmonically folded and some thicker sandstone beds are broken into blocks (Figure 2).

The upper part of the section exhibits the progressive enrichment of rounded clasts. The clasts first appear in pebbly mudstone beds, which are then succeeded by thick beds of matrix-supported conglomerate. The conglomerate has a clayey matrix, except for the bottom 10–20 cm of the bed which has a more sandy matrix. In the topmost part of the sequence, thick to massive clay-supported conglomerate beds are interbedded with thick tuffaceous sandstone beds.

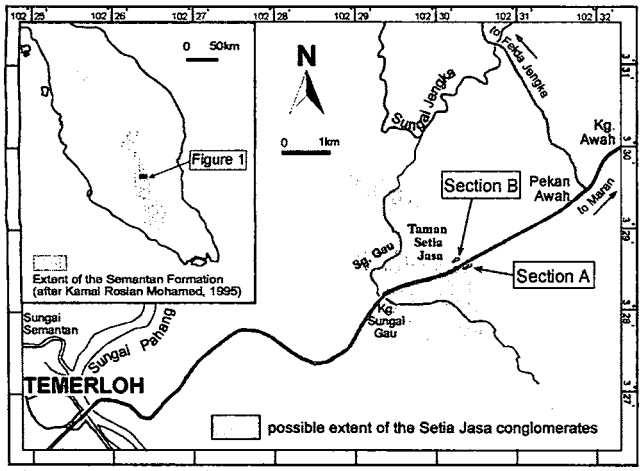

Figure 1. Location of Sections A and B and a possible extent of the Setia Jasa conglomerate.

The conglomerate contains very well rounded but poorly sorted clasts which are supported by a clayey matrix. The clasts generally range in size from pebble to cobble (between 2 and 10 cm across in average), but occasionally boulders of up to 30 cm in diameter are also present. They are made up dominantly of tuffaceous sandstone, with subordinate tuffaceous shale, quartzite, acidic tuff and vein quartz. Weathered feldspar grains are also abundant in the matrix.

Fossils were found scattered in some dark grey shale beds of Section A (Figure 4A), and include an ammonoid *Paraceratites* sp. (Figure 6), bivalves *Costatoria* sp. and *Neoschizodus* sp. and some plant fragments. *Paraceratites* is a typical Anisian genus, and is rather cosmopolitan. In Peninsular Malaysia, this genus has been reported widely from Pahang (six localities) and also from Kedah (Pokok Sena) (see Kummel, 1960; Sato, 1963; Sato and Ishibashi in Tamura *et al.*, 1975).

Section B

Taman Setia Jasa is a settlement park placed on leveled low hills, with several slope-cut remains. Conglomerates are exposed widely at most of the slope-cuts and the uncovered ground in the area, and are similar in lithology to those in several exposures between TSJ and Sungai Gau. The studied outcrop is about 200 m inside the TSJ main entrance and is on the right side of the T-junction (grid reference WF843007; the National Map Malaysia 1:50 000 Sheet 4058). Its lithology consists of thickly bedded to massive conglomerate interbedded with, or graded into, tuffaceous sandstone, with several thin beds and lenses of black carbonaceous shale (Figure 3). The lower part of the whole sequence is made up predominantly of thick beds of tuffaceous sandstone, interbedded with conglomerate and carbonaceous shale (Figure 4B). Fining upward sequence is present, where conglomerate is grading into pebbly sandstone and tuffaceous sandstone. Angular mud clasts are common at the basal part of the tuffaceous sandstone bed which overlies black shale. The upper part of the sequence consists of interbedding of conglomerates and thin tuffaceous sandstone strata.

The conglomerate of Section B also consists chiefly of well rounded but poorly sorted clasts of various sizes supported by a coarse-grained tuffaceous sandstone matrix. The clasts is composed predominantly of tuffaceous sandstone, with subordinate quartzite, acidic volcaniclasts and tuffaceous shale/mudstone. The clasts range in size from pebble to cobble (2-10 cm across in average), but boulders of up to 40 cm in diameter are also present. Whitish weathered feldspar grains are abundant in the sandstone clasts and in the matrix of the conglomerate.

DISCUSSION

Depositional environments

Section A

The lower sequence of Section A (Figures 2 and 4A) shows a thick sequence of thinly bedded, sharp, flat-based fine sandstone (or siltstone) and mudstone. The fine sandstone is graded up into mudstone. This rhythmically alternated fine sandstone–shale sequence was perhaps deposited by the force of gravity in a deep marine environment, where the lower flow regime is very weak or totally absent. This probably corresponds to the 'thin bedded facies of the clasical turbidite facies association' of Walker (1992, p.242).

In the middle sequence of Section A, sandstone and shale beds become thicker upwards, suggesting an increase in sediment supply. One of the thick shale beds (Figures 2 and 4A) contains thinly interbedded fine sandstone and shale, which are folded in a disharmonious manner, and a few broken sandstone beds. This type of slump folds in shale with relatively few sandstone beds may represent 'slumped shale and mudstone facies of the pebbly mudstone, debris flows, slumps and slides facies association' of Walker (1992, p.244). The presence of the slump folds suggests that the deposition took place on a slope, and the fold direction generally indicates the westwards sloping.

Fossils found in the thick shale beds suggest general shallow-marine faunas. Disarticulated as well as fragmented bivalve shells imply that they were reworked from their original habitat to some distance. The emplacement of these shells in the upper shale beds (Figure 4A) suggest that the fossils were probably transported by mud flows, and this is supported by the absence of bottom current generated sedimentary structures such as cross-bed, ripple-mark, groove-cast etc. Reworked fossil deposits in the deep water Semantan Formation were also noted by Jaafar Ahmad (1976) and Metcalfe *et al.* (1982), and according to them the distances of reworking were not significant.

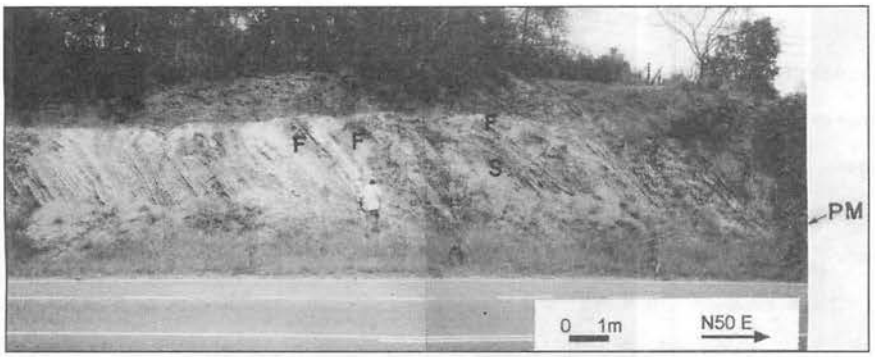

Figure 2. Road cut exposure (Section A) showing interbedded sandstone and shale overlain by pebbly mudstone. F = fossiliferous horizon, S = slump fold, PM = pebbly mudstone. Bar scale = 1 m.

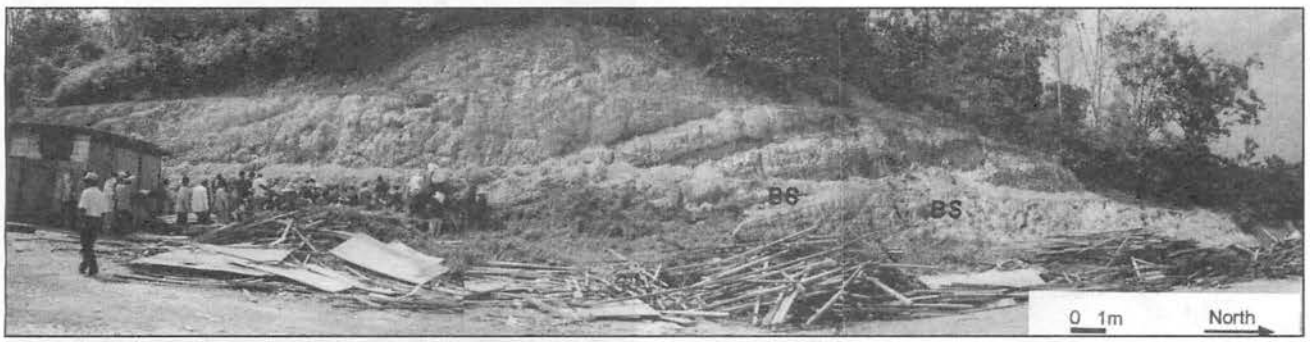

Figure 3. Hill slope outcrop (Section B) showing thickly bedded conglomerate and tuffaceous sandstone. BS = black shale; bar scale = 1 m.

Rudaceous sediment in the upper half of Section A first appears as pebbly mudstone (Figure 4A). Rare pebbles and cobbles are poorly sorted, randomly distributed and floated in a clay-sized matrix. This is characteristic of a sub-aqueous debris (or mud) flow deposit, which according to Middleton and Hampton (1976) was resulted from transport (or rafting) of large clasts by highly buoyanced clay-rich fluid. According to Bouma (1990), debris (or mud) flows commonly occur along open continental slopes, particularly in delta-front valleys. A thickening and coarsening upward sequence on an upper horizon of Section A marks a likely rapid increase in sediment supply. No sedimentary channel structures are observed. Hence, this is probably a result of the progradation of a submarine delta fan rather than shifting of a channel.

Section B

Section B (Figure 4B) shows a continuous increase in conglomeratic sediment supply. This is also clear with the total absence of a shale bed in an upper sequence. The matrix of the conglomerate is made up predominantly of coarse-grained tuff. In a lower sequence, the conglomerate is graded up into coarse-grained tuffaceous sandstone. The graded conglomerate sequence can be referred to the 'graded facies of conglomerate facies association' described by Walker (1992, p. 243). An inverse - to - graded facies bed (Figure 5) are also present in the conglomerate, probably referable to one of the 4 turbidite conglomerate facies of Walker (1992, p. 243). Both the normally graded and inverse - to - normally graded facies are the two common types of tubidite conglomerates deposited on the inner sub-marine fan environment in Walker (1979)'s facies model. Small-scaled channel structures in the massive conglomerate and tuffaceous sandstone may also represent channel deposits of the inner fan (Figure 4A).

In the middle part of the sequence, mud chips are commonly found in the basal part of tuffaceous sandstone overlying black shale. This suggests that high density turbidity currents scraped off semi-consolidated mudstones and re-deposited them as imbricated mud clasts. The imbrication direction of the mud clasts indicates that the turbidity current flowed to the west. Ripped-up mud clasts are also very common within tuffaceous sandstone of the Semantan Formation in Lanchang area (Metcalfe *et al.*, 1982).

Age and stratigraphic position of the conglomerate unit

In Section A (Figure 2, 4A), the pebbly mudstone shortly succeeded by the matrix-supported conglomerate overlies conformably on the sandstone/shale sequence. The whole sequence was possibly formed in relatively deep marine environments, ranging from a continental margin to an inner submarine fan. The sediment was deposited by turbidity currents and debris flows. The fossil-bearing lower shale beds (Section A) are tentatively considered part of the whole conglomerate unit, since it has a transitional feature upwards and its true thickness is not known. The sequences of Sections A and B are continuous without unconformity, and the Anisian ammonoid *Paraceratites* sp. occurs in the lower shale bed

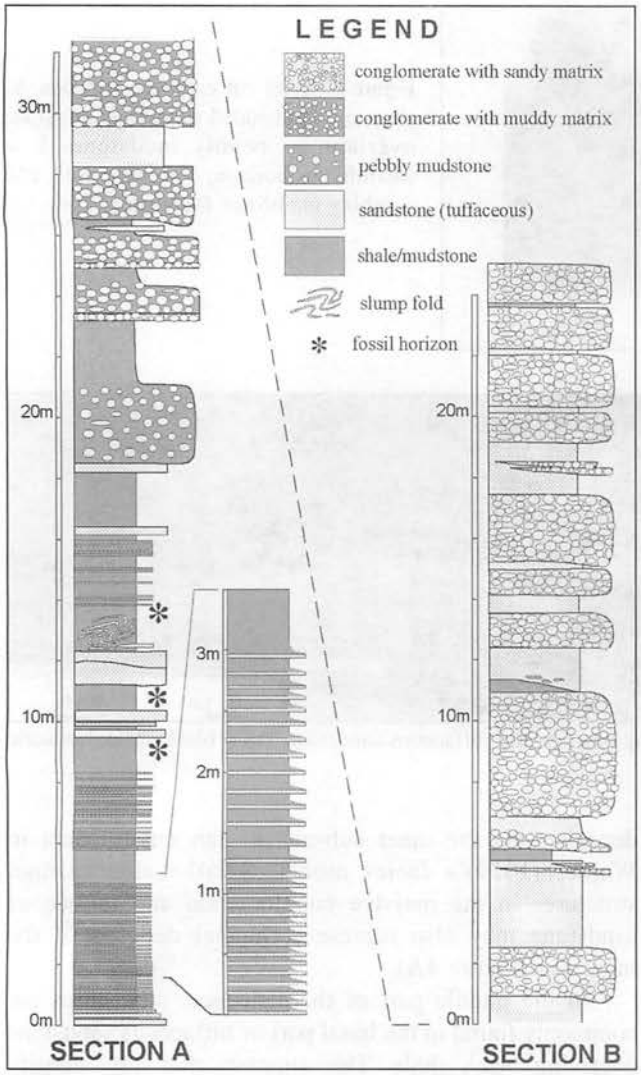

Figure 4. Lithologic logs of Sections A and B.

Figure 5. Conglomerate with inverse to normal grading. Notebook is 22 cm long.

in Section A. Thus, the sediments of Sections A and B are securely assigned to an Anisian age.

Middle–Late Triassic sediments around Temerloh Town have been recognised as part of the Semantan Formation by Jaafar Ahmad (1976), Metcalfe and Chakraborty (1994) and Kamal Roslan Mohamed (1996). Jaafar Ahmad (1976) interpreted depositional environments of the formation to range from inner to outer neritic zones. Metcalfe *et al.* (1982), however, later suggested that the formation was deposited at moderate depth, as in a deeper outer neritic zone, and also possibly as deep as a bathyal slope. They also described the Semantan Formation as turbidites. Metcalfe and Chakraborty (1983) reported another conglomerate unit, of which they defined as 'intra-formational', from SW of Temerloh, and implied that it may represent proximal turbidites within the Semantan Formation. The present conglomerate consists predominantly of very well rounded clasts, and cannot be defined as an intra-formational conglomerate. A relationship of the two units seems unlikely.

Lee (1999) questioned a correlation between the conglomerate in TSJ and Late Triassic Murau Conglomerate of the Tembeling Group, because no fossil to indicate an age had been known from those conglomerates at the time of his study. Koopmans (1968) proposed the Murau Conglomerate as the basal conglomerate of the Tembeling Formation (now Tembeling Group), deposited under parallic to continental conditions. However, Burton (1973) suggested that the Murau Conglomerate should have been restricted to those conglomerate found in the eastern coast of Johore, and should not have been included into the Tembeling group. The conglomerate of Tembeling Group unconformably overlies Permian–Triassic rocks, whereas the Murau conglomerate unconformably overlies Carboniferous rocks. In contrast, the conglomerate in the Setia Jasa area is a deep-water sediment resting conformably on the Anisian shale. Thus, it seems unlikely that the conglomerate in TSJ is correlated with the Murau Conglomerate or those of the Tembeling Formation. In addition, the conglomerate in Setia Jasa area is not comparable with other volcaniclastic conglomerates reported by Lee (1999) from Jerantut Town, Jalan Gelanggi, Taman Perwira and from Kg. Dato' Sharif, because of its minor amount of volcaniclasts.

Figure 6. Ammonoid *Paraceratites* sp. lateral (right) view. Bar scale = 1 cm.

CONCLUSIONS

The occurrence of the ammonoid *Paraceratites* sp. in Section A sugggests an Anisian age for the whole, or most, conglomerate sequences in the Setia Jasa area. Both the conglomerate and the underlying fossiliferous beds were probably deposited in a relatively deep marine environment such as a continental margin and an inner submarine fan, and possibly represent one of proximal deposits of the Semantan Formation. The discussed conglomerate unit extends to a wide area between Taman Setia Jasa and Sungai Gau. Thus, with further investigation, this large sedimentary unit may stand for a member of the Semantan Formation with a proper stratigraphic denomination.

ACKNOWLEDGEMENT

Fieldworks were supported by the IRPA Projects (nos. 02-02-02-0004 and 02-02-02-0015) granted to Dr. Che Aziz Ali and Prof. Ibrahim Komoo, respectively. M. Sone was supported by a research fellowship from LESTARI.

REFERENCES

BOUMA, A. H., COLEMAN, J. R. AND ROBERTS, H. H., 1990. Submarine fans: diagnostic criteria for exploration. Schlumberger/ Geological Society of Malaysia Short Course Note. (compiled by Schlumberger and the Geological Society of Malaysia for honorary lecture of A.H. Bouma).

BURTON, C. K., 1973. Mesozoic. *In:* D. J. Gobbett and C. S. Hutchison (eds.), *Geology of the Malay Peninsula*. Wiley-Interscience, New York, 97-141.

JAAFAR AHMAD, 1976. Geology and mineral resources of the Karak and Temerloh areas, Pahang. *Geological Survey Malaysia District Memoir* 15, 138 p.

KAMAL ROSLAN MOHAMED, 1996. Taburan Formasi Semantan Semenanjung Malaysia. *Sains Malaysiana*, 25(3):91-114.

KOOPMANS, B. N., 1968. The Tembeling Formation - A litho-stratigraphic description (West Malaysia). *Geological Society of Malaysia Bulletin*, 1:23-43.

KUMMEL, B., 1960. Anisian ammonoids from Malaya. *Breviora Museum of Comparative Zoology* 124, 1–8.

LEE, C. P., 1999. Volcaniclastic conglomerates of central Pahang. *Geological Society of Malaysia Annual Conference 1999 Program and Abstract of Papers*, 21-22.

METCALFE, I. and CHAKRABORTY, R., 1983. Occurrence of a thick intraformational conglomerate horizon within the Semantan Formation (Triassic) near Temerloh, Pahang. *Warta Geologi*, 9(5):194-195.

METCALFE, I. and CHAKRABORTY, R., 1994. A stratigraphic log of the Semantan Formation along part of the Mentakab–Temerloh bypass, Pahang. *Geological Society of Malaysia Bulletin*, 35:37-46.

METCALFE, I., SIVAM, S. P. and STAUFFER, P. H., 1982. Stratigraphy and sedimentology of Middle Triassic rocks exposed near Lanchang, Pahang, peninsular Malaysia. *Geological Society of Malaysia Bulletin*, 15:19-30.

MIDDLETON, G.V. and HAMPTON, M. A., 1976. Subaqueous sediment transport and deposition by sediment gravity flows. *In:* D. J. Stanley and D. J. P. Swift (eds.), *Marine sediment transport and environmental management*. John Wiley, New York, 197-217.

SATO, T., 1963. Ammonites du Trias de la Malaisie. *Japanese Journal of Geology and Geography* 34(2–4):93–99, pl. 4 (also in 1964, *Geology and Palaeontology of Southeast Asia* 1, 43–51) (in French).

TAMURA, M., HASHIMOTO, W., IGO, H., ISHIBASHI, T., IWAI, J., KOBAYASHI, T., KOIKE, T., PITAKPAIVAN, K., SATO, T. AND YIN, E.H., 1975. The Triassic System of Malaysia, Thailand and some adjacent areas. *Geology and Palaeontology of Southeast Asia* 15:103–149.

WALKER, R. G., 1979. Turbidites and associated coarse clastic deposits *In:* R. G. Walker (ed.), *Facies models.* Geoscience Canada Reprint Series 1. Geological Association of Canada, Hamilton, 91-103.

WALKER, R. G., 1992. Turbidites and submarine fans. *In:* R. G. Walker and N. P. James (eds.), *Facies models: Response to sea level change*. Geological Association of Canada, Hamilton, 239-263.