Common Trace Fossils of the Deltaic and Turbidite Outcrops in Kutei Basin, East Kalimantan: A field note.

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Abstract

The Kutei Basin is a dominantly clastic Tertiary basin bounded by basement uplifts in the north, west and east. The basin is open towards the Makassar Strait in the east. The Paleogene sections of the basin were outcropped at the basin margin. In Muara Wahau area in the northern part of the basin, this section is dominated by turbidites with slump features. High variety and low quantity of trace fossils are found in the thin-bedded turbidites, mostly grazing structures and the assemblages suggest Nereites ichnofacies. The trace fossil associations suggest ocean basin environment of deposition and the biostratigraphic analysis indicates bathyal to abyssal zone. At the centre of the basin the Neogene deltaic sections cropped

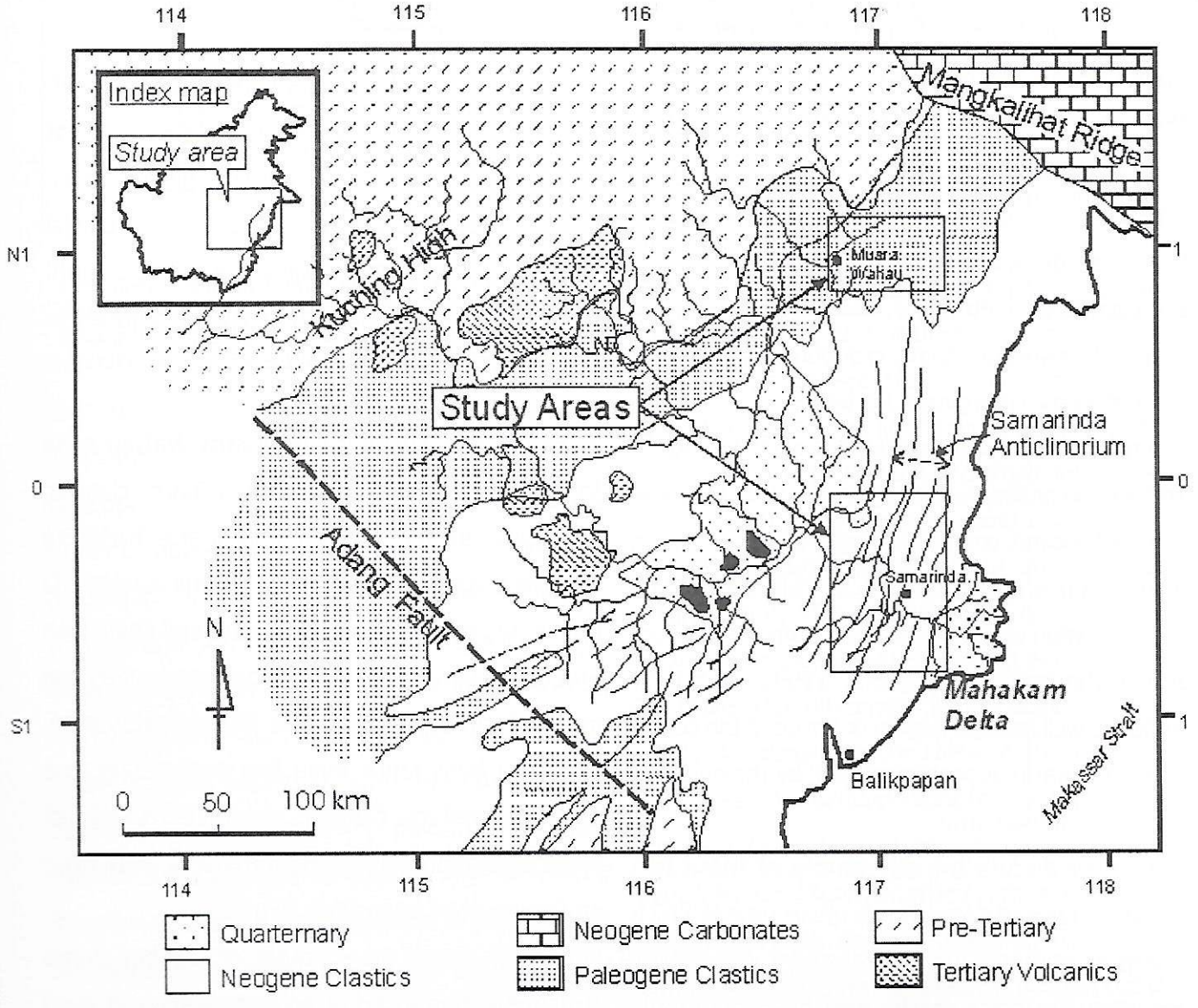


Fig. 1. Geology map of East Kalimantan, shows the Kutei Basin boundaries, the Paleogene and Neogene sediments distribution and the study areas: Muara Wahau and Samarinda.

well in Samarinda area. There is high quantity of trace fossils but low in variety. Dwelling vertical burrows of Skolithos ichnofacies are dominant in this section. The trace fossil association suggests tidal zone with inner to outer neritic biostratigraphic environment.

1. Introduction

The Kutei Basin represents one of the most important sedimentary basins in Borneo or Kalimantan region. This basin contains predominantly clastic Tertiary sediments. The basin is bounded by Mangkalihat carbonate ridge in the north, Adang Fault in the south, Kuching High basement uplift in the west and open towards the Makassar Strait in the east (Fig. 1). Tertiary deposition within the basin occurred in two distinct phases. The first phase during the Paleogene periods was dominated by the deposition of thick siliciclastics of deep water, bathyal origin. This section mainly cropped out in the basin margins, such those outcropped in the Muara Wahau area in the north. The second phase, which began in latest Oligocene to early Miocene, comprises a regressive succession from deep water through deltaic to alluvial sedimentation with progradation from west to east across the basin (Chambers, 1994). The later system is well represented by outcrops in the centre part of the basin, represented here by the outcrops of the Samarinda area.

This paper discuss the differences of these two phases in term of depositional environment which interpreted base on sedimentary structures including the trace fossils and biostratigraphic interpretation base on foraminiferal assemblages.

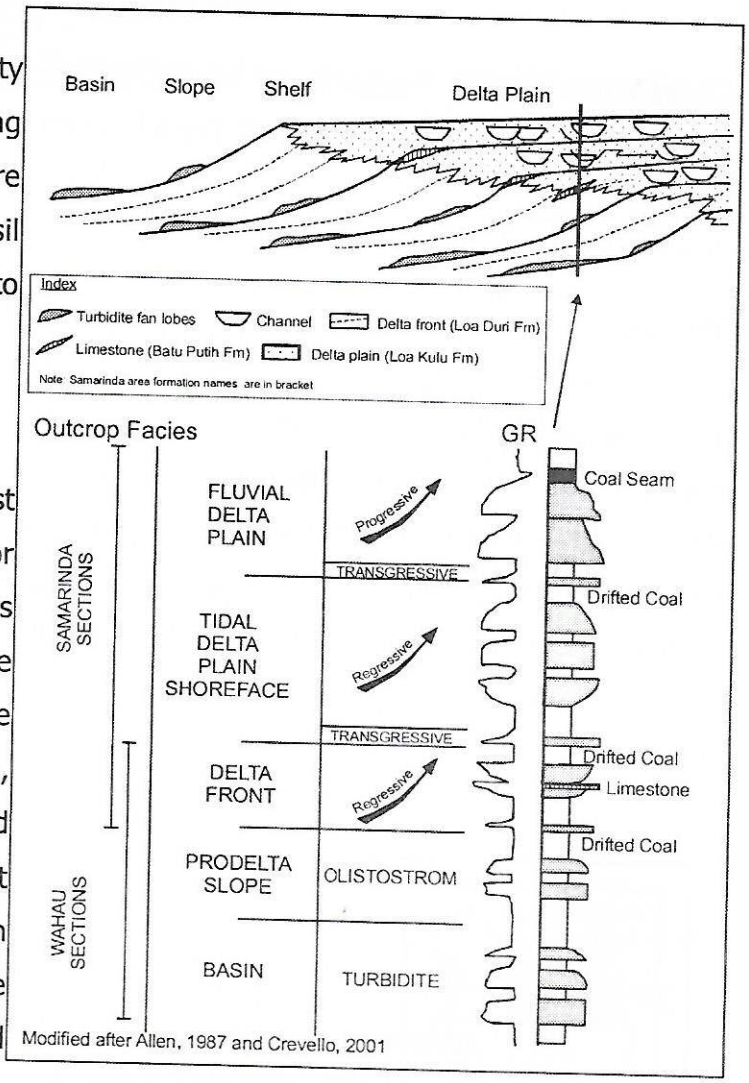


Fig. 2. Simplified model of several delta-turbidite depositional sequences shows the relationship of the outcrops facies in the Samarinda and Muara Wahau area. Modified after Allen (1987) and Crevello, (2001). Stratigraphic nomenclature of the Samarinda area is based on Land and Jones (1987).

2. Paleogene Turbidite in Muara Wahau Area

In the northern part of the Kutei Basin, close to the basin boundary, the Paleogene turbidite outcrops were exposed well. This section is dominated by intercalation of sand and shale with Bouma sequences. Thick amalgamated sands and mega slump structures were found in this area. The sand beds range from few centimeters to a couple of meters. Outcrop observations suggest basin floor to prodelta slope with minor delta front environment of deposition (Fig. 2).

Figure 3a shows an example of the big slump structures, composed of an intercalation of sand and shale beds, range from a few centimeters on

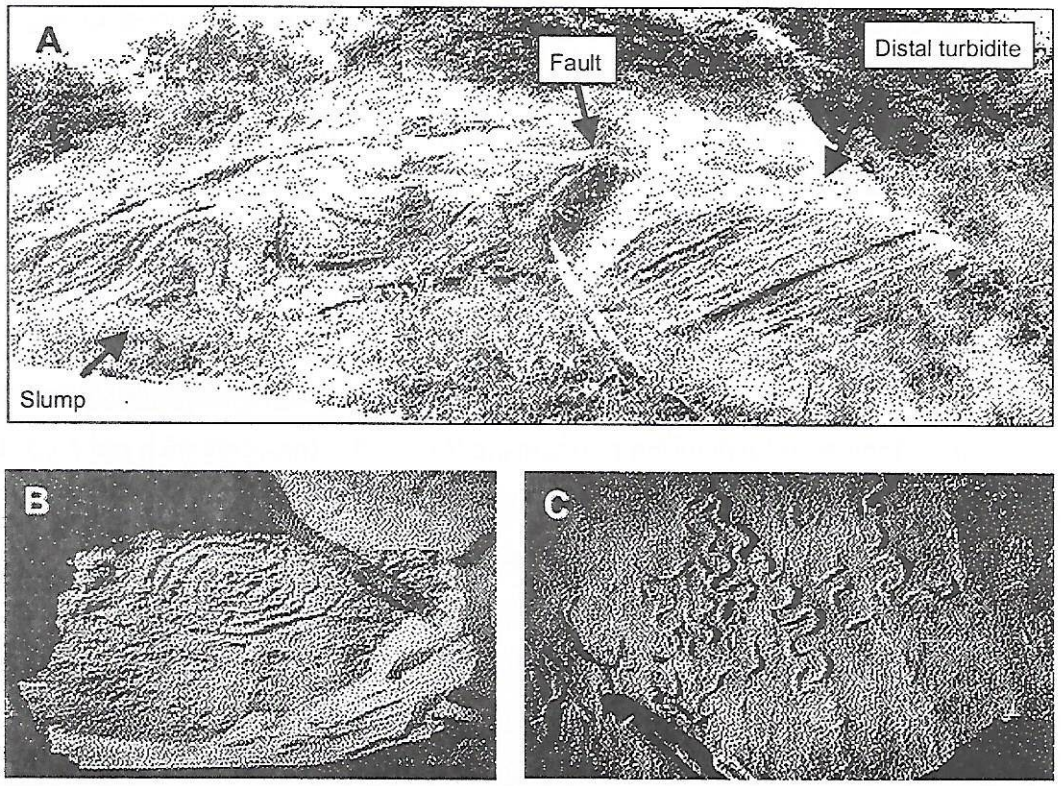


Fig. 3. An outcrop example of the Paleogene trubidites and their associate trace fossils in Muara Wahau area. A) A slump structure on the left and intercalation of thin bedded sandstone and siltstone on the right, separated by a syn-sedimentary fault. The wooden log is about 3 meters long; B) Spirophycus, a regularly single coiled burrow and C) Cosmorphaphe, an unbranched burrow with two orders of meanders.

the right up to one meter of sand bed on the left. Initially these sediments were deposited in a low energy environment and produced a series of thin layered sediments with some thicker sediment lobes in the slope. The slump structures and associated syn-sedimentary faults developed afterwards when the system was disturbed by slope instability due to tectonic uplift of the basement.

Trace fossils in this turbidite setting are relatively rare but with high variety. Occasionally there are rather complicated Spirophycus and Cosmorhaphe grazing traces on relatively thin-bedded sediments (Fig. 3b and 3c). Spirophycus is a regularly single coiled burrow and Cosmorphaphe is an unbranched burrow with two orders of meanders. Rhizocorallium traces, which is the horizontal U-tube with spreite, are found in places. These trace fossils assemblage is typical for Nereites ichnofacies, which occurs in bathyal to abyssal quiet but oxygenated water, commonly influenced by turbidity currents (Pemberton et al, 1992). This interpretation of depositional environment is also supported by the foram analysis, which indicate bathyal to abyssal zone.

3. Neogene Deltaic System in Samarinda area

The Tertiary deltaic section of East Kalimantan is the most prolific part of the basin. This interval is well exposed in the southern part of the Kutei Basin, along the Samarinda anticlinorium trends (Fig. 1). Intercalation of sandstone and shale dominate this section with some limestone and coal interbeds, deposited mainly in delta front and delta plain environment. The delta front to turbidite unit is known as the Loa Kulu Formation and dominated by shale and siltstones. These shale-dominated sections normally occur close to the axis of the anticlines. The sandier delta top unit is known as the Loa Duri Formation occurs close to the synclines. Coal seam interbeds are common in this formation with thickness up to 6.5 meters. Batuputih Limestone reefs built in parts at the shelf edge, which is the transition from the Loa Kulu formation slope setting to the deltaic Loa Duri Fm

i(Fig. 2; Land and Jones, 1987; Allen & Chambers, 1998).

3.1 Loa Duri Formation

The Loa Duri slope facies exposed in relatively a narrow band along the anticline axis. Outcrop condition is relatively poor as they are more dominated by shale and heavy weathering make it worst. Ophiomorpha dwelling burrows are the most common trace fossils in this setting. They normally occur in the sandstone beds as straight burrow with clay pelleted walls. Indicative deepwater trace fossils such as those observed in Muara Wahau are not found in this area. Depositional environment of this formation is probably still in the relatively shallower water with a lot of sediment influx from the river. The foraminifera analyses mostly indicate outer-neritic environment and late Lower Miocene in age.

3.2. Loa Kulu Formation

Trace fossils in the Loa Kulu delta plain setting are abundant mainly in the lower delta plain and mouth bar facies. Structureless straight tubes burrow called Skolithos and pelleted-wall burrows known as Ophiomorpha, are the most common trace fossils n these depositional environment. These trace fossils are typical for Skolithos Ichnofacies, which is indicative of relatively high levels of wave or current energy, and developed in slightly muddy to clean, well sorted, loose or shifting particulate substrates (Pemberton, 1992). The Skolithos normally occur in outcrops with coarsening-upward sand bodies that have the characteristics of mouth bars (Fig. 4a). It is also common in lower delta plain facies. Sometime these burrows are filled with better-cemented sandstone compare to the bedrock so they can stick out from the outcrop surfaces (Fig. 4b). The cementation process is probably helped by the biological activity. Many thick sandstone beds are completely bioturbated and all sedimentary structures were completely destroyed. This indicates a healthy living environment for the animals during or slightly after deposition.

Occasionally there are cylindrical burrows forming 3-dimentiosnal branching systems consisting of horizontal networks connected to surface by more or less vertical shafts called Thalasinoides (Fig. 4c).

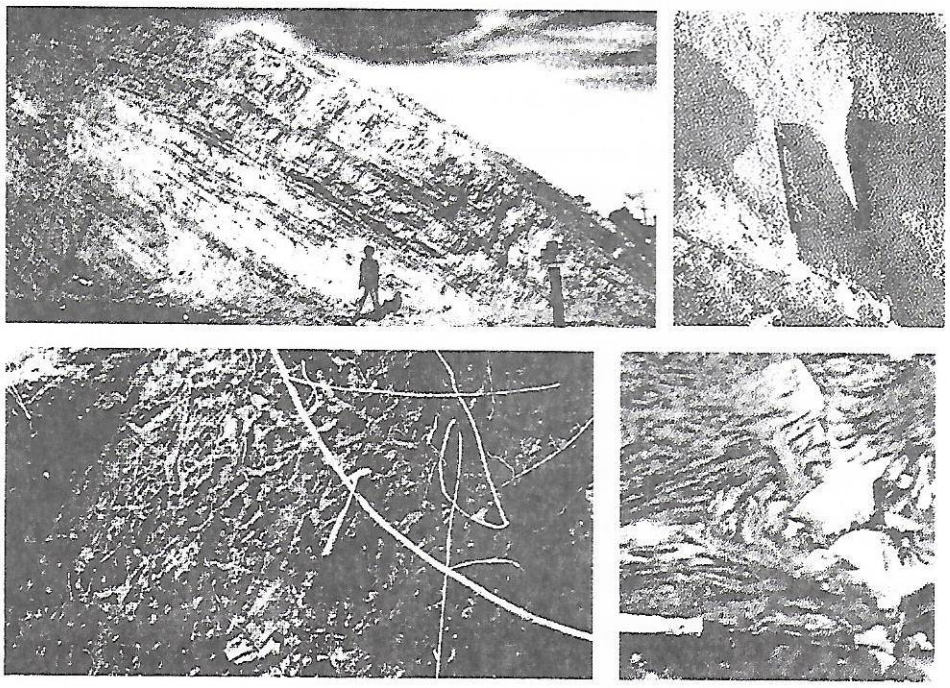


Fig. 4. Outcrop and trace fossils of the deltaic Loa Kulu formation. A) A coarsening-upward sand sequence found in Samarinda area, which have the characteristics of mouth bars; B) Skolithos which came out from the outcrop surface because it is better cemented compare to the bed rocks; C) Thalasinoides branching burrows; D) An escape structure within an intercalation of thin sands and silts.

They are about 3-5 cm in diameter and structureless. These burrows are a result of animal feeding and dwelling activities, which live in sublittoral environment. Thalasinoides and skolithos are two of the indicative burrows for Glossifungietes Ichnofacies, which developed in a wide range of depositional environment. However, they only developed in firm, unlithified substrates such as dewatered mud (Pemberton, 1992). The diameter of these burrow is up to 1.5 cm and infilled by sands.

Planolites and Teredolites trace fossils are found in places within Loa Kulu formation. Planolites is a sylindrical, straight to gently curved burrows, with infilled sediment. It occurs in the shallow marine facies outcrops. Whereas Teredolites burrows were found in root fossil fragments which rafted into the channel sandstones. Figure 4d shows an escape structure, which developed when an animal try to reach the surface and left an open hole behind. Sediments from the bed sediment filled the hole afterwards, as the condition was still unstable. This structure is also common in Loa Kulu formation.

Summary

Trace fossils found in the Muara Wahau area characterize Nereites ichnofacies, which occurs in bathyal to abyssal quiet but oxygenated water, associated with Paleogene turbidite outcrops. In Samarinda area most trace fossils are found in the Loa Kulu formation. The trace fossils found here are associated with Skolithos ichnofacies, which is indicative of high levels of wave or current energy and is typical for the delta mouth bar and lower delta plain facies.

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