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*Short communication*

# Discussion: Late Pleistocene sedimentation and landform development in western Kalimantan (Indonesian Borneo) by M.B. Thorp et al.: *Geologie en Mijnbouw 69: 133–150, 1990*

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Thorp et al. investigated the onshore alluvial deposits of terraces and valley fills in western Kalimantan in Indonesia, and suggested relationships of their stratigraphy to the better known deposits in western Malaysia, Singapore and the Indonesian Tin Islands. Although welcoming their contribution on a much neglected topic, I disagree with the authors on their correlation and age assignment of lithostratigraphic units ('Old Alluvium', 'Alluvial Complex') in West Malaysia and the Indonesian Tin Islands, which they have correlated with their 'NW Kalimantan Late Pleistocene Alluvials'.

They believed they could correlate the 'older alluvia' of West Malaysia with the offshore 'Alluvial Complex' (AC), originally described (Aleva et al. 1973) from the Pulau Tujuh area in western Indonesia. Since they believed the NW Kalimantan alluvial terraces resemble the 'Old Alluvium' (OA) of Singapore, as well as the AC, they also proposed that the NW Kalimantan terrace and contiguous alluvials, could be correlated with the AC. Significantly, their correlation with West Malaysia and the Indonesian Tin Islands appears to be based solely on the literature and does not mention additional new data from that region.

## *1) Upper Cainozoic coastal and offshore alluvial stratigraphy in Peninsular Malaysia and the Indonesian Tin Islands*

Detailed investigations carried out in the western Malesian region (Peninsular Malaysia, Tin Islands, Sunda Shelf) allow a high level of confidence in the correlation between the alluvial sequences onland and offshore, as indicated by Batchelor (1977, 1979a, b, 1988; Fig. 1) and Ringis (1983). The present writer has investigated Upper Cainozoic land sequences throughout Peninsular Malaysia, Bangka Island in Indonesia, and Singapore Island (Batchelor 1983). Drillhole samples and shallow seismic profiles from the Lumut-Dindings (Perak) and Malacca offshore areas in Malaysia, and the Koba offshore area of SE Bangka, have also been studied in detail. Representative offshore drillhole samples of the stratigraphic units delineated by Aleva et al. (1973), were kindly provided to the writer by the company, Billiton Exploratie Maatschappij Indonesia B.V.

The standard Upper Cainozoic offshore sequence ('Younger Sedimentary Cover', 'Alluvial Complex', 'Older Sedimentary Cover') described by Aleva et al. (1973) from the Pulau Tujuh area, was recognized in the Lumut-Dindings offshore area from drill samples and seismic profiles. Because of the availability of over 1000 line kilometers of shallow seismic profiles and 204 offshore drillholes, together with excellent land exposures in immediately adjacent coastal tin mines, the Lumut-Dindings area proved the ideal locality for correlation of the Upper Cainozoic offshore sequence with coeval deposits on land.

The Lumut-Dindings coastal tin-mine sequence was subdivided into local units which were then

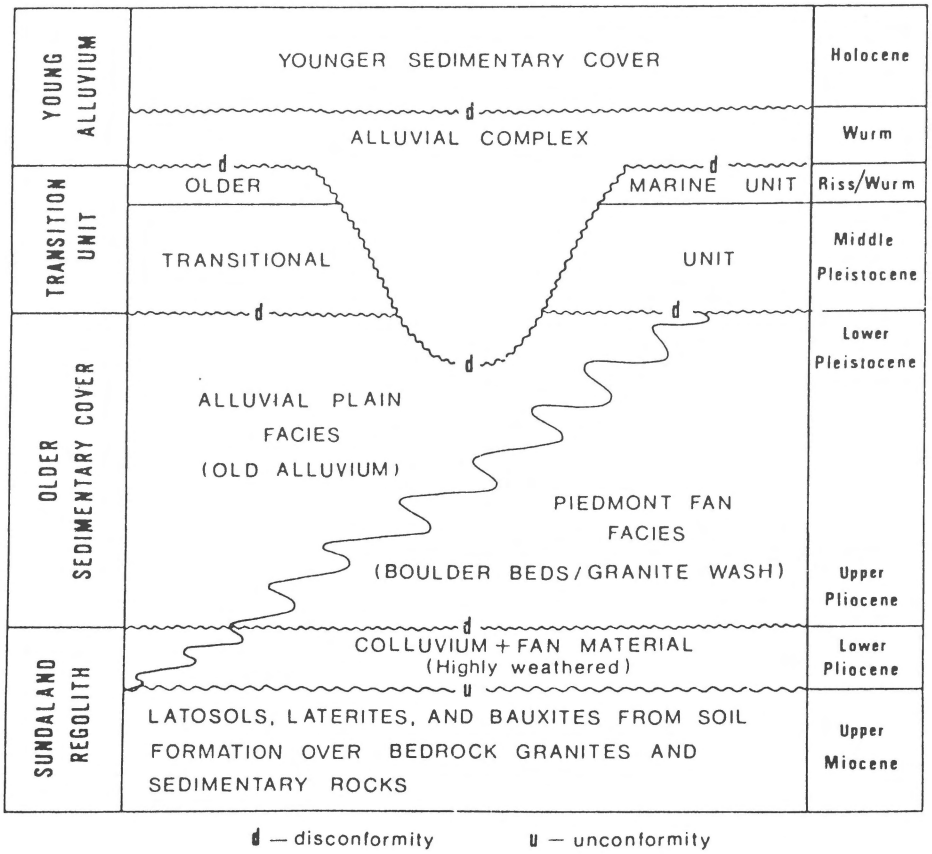


*Fig. 1.* Regional Late Cainozoic stratigraphic relationships in Sundaland, Southeast Asia (after Batchelor 1979a).

lithostratigraphically correlated with the 'Young Alluvium' (YA) and 'Old Alluvium' (OA) described from their 'type' locality in the nearby Kinta Valley, also in Perak State. The term 'Old Alluvium' was first applied by Walker (1956) for the sandy clays with sand and gravel intercalations which constitute most of the Kinta Valley alluvial fill. It was separated from the 'Young Alluvium' which is largely related to linear belts flanking present-day, major stream channels.

Close similarity in lithology (immature sediments, frequently with massive appearance), paleogeomorphic and stratigraphic position, and depositional environment, allowed correlation of the onland OA equivalents with the 'Older Sedimentary Cover' (OSC) offshore. Paleomagnetic determinations on the OA equivalents indicated deposition during the Matuyama Chron (0.70 to 2.41 Myr BP). Correlation of the OSC with the OA in Singapore, had also been indicated earlier (Batchelor 1977).

Lithological character alone is not a satisfactory basis for differentiating between the OSC and the AC since Aleva et al. (1973) wrote that the two units were rather similar lithologically, while published lithological descriptions are ambiguous. For example, the AC is described as 'largely sandy' by Aleva et al. (1973: 265), while in 1985, Aleva (1985: 819) described the AC as 'massive clays with minor, thinly stratified sandy and clayey sediments'. Other geological criteria (Table 1) can however, be applied to distinguish the two units.

On this basis, the 'Old Alluvium' of Peninsular Malaysia and Singapore is confidently correlated with the 'Older Sedimentary Cover' offshore western Malesia. The generally aggrading OA alluvial plain deposits cannot be matched with the AC which infills steep-sided incised valleys and shows

stronger differentiation of clay and sand. Furthermore, rather than being 'massive' in overall aspect like the OSC, the AC is a complex association of variable sedimentary facies, indicating environmental conditions changed rapidly during deposition.

Neither myself nor Aleva et al. (1973) have stated, as attributed to us by Thorp et al. (1990: 148), that the AC has an 'alluvial fan facies towards its landward margins'. This, in fact, is a characteristic of the proximal facies of the OSC, where it was deposited at the foot of granitic mountains.

The AC is believed to be the offshore equivalent of pre-Holocene portions of the YA (Batchelor 1979a, b). Due to an abrupt regression in the latest Pleistocene, planation of the AC surface with incipient soil formation occurred on the exposed Sunda Shelf. However, the well-developed lateritic soil formation on the OA has its counterpart, not in the thin soil found on the AC, but in the thick lateritic soils developed on top of the OSC, as seen in drillhole samples from the Lumut-Dindings and Malacca offshore areas (Batchelor 1979b).

*2) Age of the 'Old Alluvium' in Peninsular Malaysia*

A latest Pliocene to Early Pleistocene age has been determined for the OA in West Malaysia based on paleomagnetic determinations and paleontological methods (Batchelor, 1988). Paleomagnetic studies carried out in six opencast alluvial tin mine sites in Selangor and Perak states, showed that the OA was deposited either during the Matuyama Chron (for the younger OA), or an older normal polarity epoch (for older OA deposits), indicating the OA is older than 700 000 years BP.

As would be expected, all C-14 dates reported for the OA exceed measurement limits for the method, with however, two apparent exceptions. A young date ($36\,420^{+1255}_{-1085}$ yr BP) was obtained by Haile and Ayob (1968) for peat from the Sungai Besi Mines near Kuala Lumpur. However, because a number of different stratigraphic units occur at Sungai Besi and the stratigraphic context of the dated horizons has not been given, it is uncertain whether the dated peat actually derives from the OA. The peat dated at Sungai Besi is probably not OA but a younger unit.

Another anomalously young date ($41\,600^{+2160}_{-1570}$ yr BP) obtained from OA equivalents at Lumut-Dindings, appears to contradict Matuyama paleomagnetic ages indicated for overlying sediments (Batchelor 1988). This C-14 date is probably incorrect since Dr. M.A. Geyh of Niedersachsisches Landesamt für Bodenforschung Laboratory, Hannover, stated that minor C-14 contamination is so common that an age $>41\,600$ yr BP for this date was quite possible. There is therefore no strong evidence contradicting the pa-

*Table 1.* Some diagnostic criteria for distinguishing 'Older Sedimentary Cover' and 'Alluvial Complex' sediments (after Aleva et al. 1973; and Batchelor 1979b, 1988).

| | Older Sedimentary Cover | Alluvial Complex |
|---|---|---|
| Paleogeomorphology | Alluvial accumulation over large areas; frequently aggrading but also filling broad valleys | Rather restricted alluvial fill, infilling relatively narrow and steep-sided valleys incised down into OSC or bedrock |
| Sediment compositional maturity | Immature sediments (often derived from decomposition of granites); clayey sands & sandy clays with less frequent reworking to form clean sorted sands or clays | More mature sediments resulting from reworking of older sediments with better differentiation into clean sorted channel/bar sands & overbank clays |
| Environmental change | Little change of environment during deposition | Frequent environmental changes during deposition |
| Stratigraphic position | Overlies bedrock nonconformably or with angular unconformity | Overlies either OSC with erosional disconformity, or bedrock unconformably |
| Upper soil development | In non-eroded portions, thick incipient laterite development on top of OSC | Relatively thin, mottled, red clay developed on top of AC |

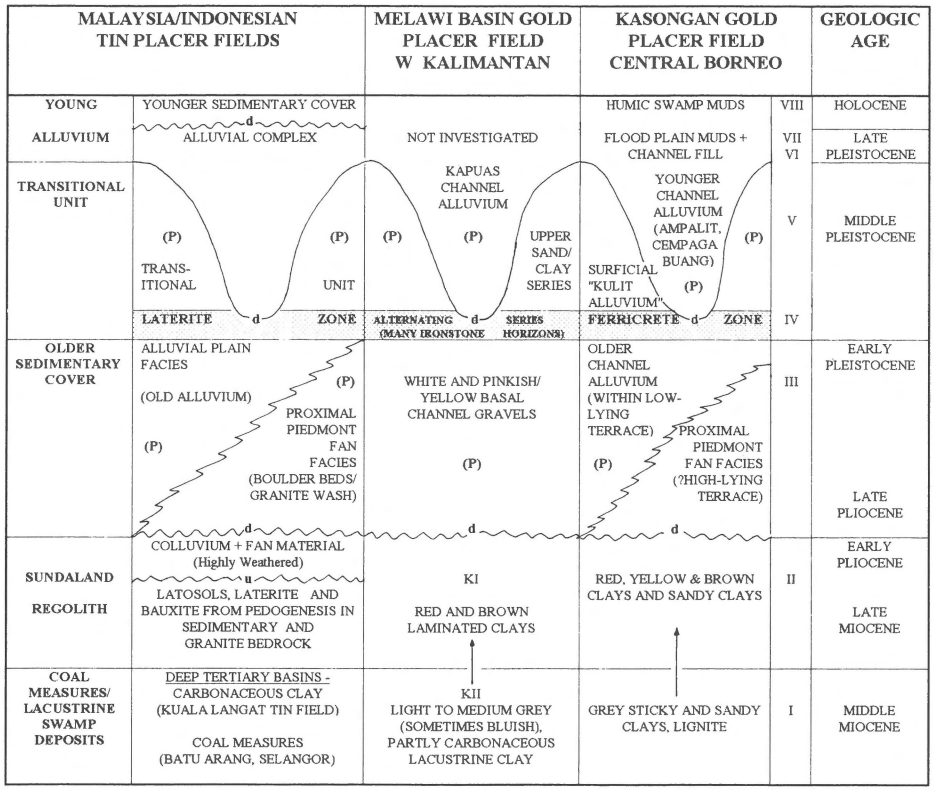


*Fig. 2.* Provisional Late Cainozoic stratigraphic correlation for Southeast Asian gold and tin placer fields. (P) indicates stratigraphic section marked by presence of economic gold/tin placer deposits. Stippled zone indicates pedogenesis on top of underlying stratigraphic unit. d = disconformity. u = angular unconformity.

leomagnetic result that the OA is older than 0.7 Myr.

The available evidence indicates a pre-Brunhes age for the OA in Peninsular Malaysia, which does not support the correlation of the Alluvial Complex with the 'older alluvia' of W Malaysia as suggested by Thorp et al. (1990: 148) who implied an age span of 140 000 to 20 000 yr BP for these formations.

### *3) Some considerations on the age and correlation of the NW Kalimantan alluvials and other gold-bearing alluvial deposits in Kalimantan*

Within Thorp et al.'s paper there is often ambiguity as to which alluvial units are being referred to. For instance, it is uncertain whether the reported radiocarbon dates for palaeo-alluvial bodies of Sungai Mandor, Sungai Raya and Pasir Panjang, represent material derived from the so-called 'Late Pleistocene/Early Holocene alluvial sediments', from the 'Late Pleistocene "white" sand alluvial terraces', or from the 'Dissected alluvial terraces'. Sections showing the stratigraphic positions of the dated material, are really quite essential, and need to be provided.

Although, Thorp et al. (1990) believed the age of the 'NW Kalimantan Alluvials' was only 60 000 to 50 000 yr BP, based on two radiocarbon dates obtained within this age interval, care should be taken in immediately accepting such dates near the upper limit of the method. Significantly, Yim et al. (1990) found, by comparing the ages of samples from Hong Kong, dated by both C-14 and U-series methods, that C-14 dates greater than 25 000 years BP

had a significant young age bias, probably due to minor contamination which is generally difficult to avoid completely.

Thorp et al. (1990) believed that the 'NW Kalimantan terraces' show close similarities with the OA of Singapore which Gupta et al. (1987) interpreted as the 'proximal facies of an extensive, braided river deposit'. However, perhaps contradictorily, Thorp et al. (1990: 142) mentioned that in NW Kalimantan, the inland 'Pleistocene river terraces ... exhibit classical features of meandering floodplain sediments'. Alternatively, these are different terraces than those which they correlated with the Singaporean OA.

The '"white" sand alluvial terraces' in NW Kalimantan, were considered by Thorp et al. (1990) to be 'giant' podzols, 'not a sedimentary unit per se', with humicrete usually developed in a lower soil horizon. On the other hand, similar structureless white sands, developed above a planation surface of regional extent in the lower portions of the Katingan Drainage Basin of Central Kalimantan, are believed by the present writer (Batchelor ms) to be mainly sheet-wash alluvium (subsequently podzolized), in which alluvial gold has concentrated. Gold-bearing portions were rich enough to attract the first mining activity by local people in the important Kasongan-Ampalit Gold-field during the 'gold-rush' of the early 1980s. Underlying the 'white sands', a widespread planation surface often carries ferricrete (and humicrete) development which corresponds in geomorphological and stratigraphic setting with a phase of planation and lateritization of the OA in Peninsular Malaysia, which is dated as early Middle Pleistocene. Therefore, the white sand sheets found disconformably overlying eroded ferricrete in Kalimantan, could well be older than the Late Pleistocene age suggested by Thorp et al. (1990).

### *4) Provisional Upper Cainozoic stratigraphic correlation of Southeast Asian gold and tin placer fields*

Since the main topic being discussed is the correlation of Upper Cainozoic alluvium between the Kalimantan gold-fields and the tin-fields of W Malaysia and Indonesia, some new results are also included here from parts of Kalimantan different from those investigated by Thorp et al. (1990). Supporting evidence will be provided in a subsequent publication (Batchelor ms).

Investigations of placer deposits in the Melawi and Barito basins of W and C Kalimantan (Batchelor 1984, ms), allow provisional correlations (Fig. 2) with the standard Upper Cainozoic Sundaland sequence, based on close similarity of geomorphological development and the presence of a ferricrete zone (C Kalimantan) and ironstone zones (W Kalimantan), which are believed to be coeval with lateritic soil developed on top of OA and OSC in W Malaysia and Indonesia. The implication of such a correlation is that the gold- and tin-fields have apparently experienced a similar Late Cainozoic geomorphological history favourable for placer development.

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