

## **New insight into the recent evolution of the Baram Delta from satellite imagery**

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### **INTRODUCTION**

This paper summarises the information which was displayed at the poster session of the Annual Conference of the Geological Society of Malaysia in Kuching (May 4th & 5th, 1991).

The synoptical effect of remote sensing imagery allows a new vision of active environments of deposition and is now successively applied to the study of modern deltas. Two recent satellite pictures of the Baram River have been analysed in order to provide a better understanding of the recent evolution of a tropical delta.

### **SATELLITE IMAGERY OF THE BARAM DELTA**

A satellite picture covering the deltaic plain of the Baram River (Fig. 1) has been interpreted in terms of sedimentary environments (Fig. 2). The upper deltaic plain is characterised by the extensive development of freshwater swamps, mainly covered by peat deposits. The lower deltaic plain is restricted to a narrow fringe of salt-tolerant vegetation which develops on both side of the distributaries. The abandoned river network can be delineated. Reconstruction of the paleomeandering belts clearly shows the interconnection between the modern Baram, Belait and Miri rivers.

Major structural features are visible on the satellite image. A continuous flexure line, extending from the Miri Hill to the North-East is buried under the lower deltaic plain deposits. A recent fault sharply delineates the deltaic deposits and the northern flank of the Lambir Hills.

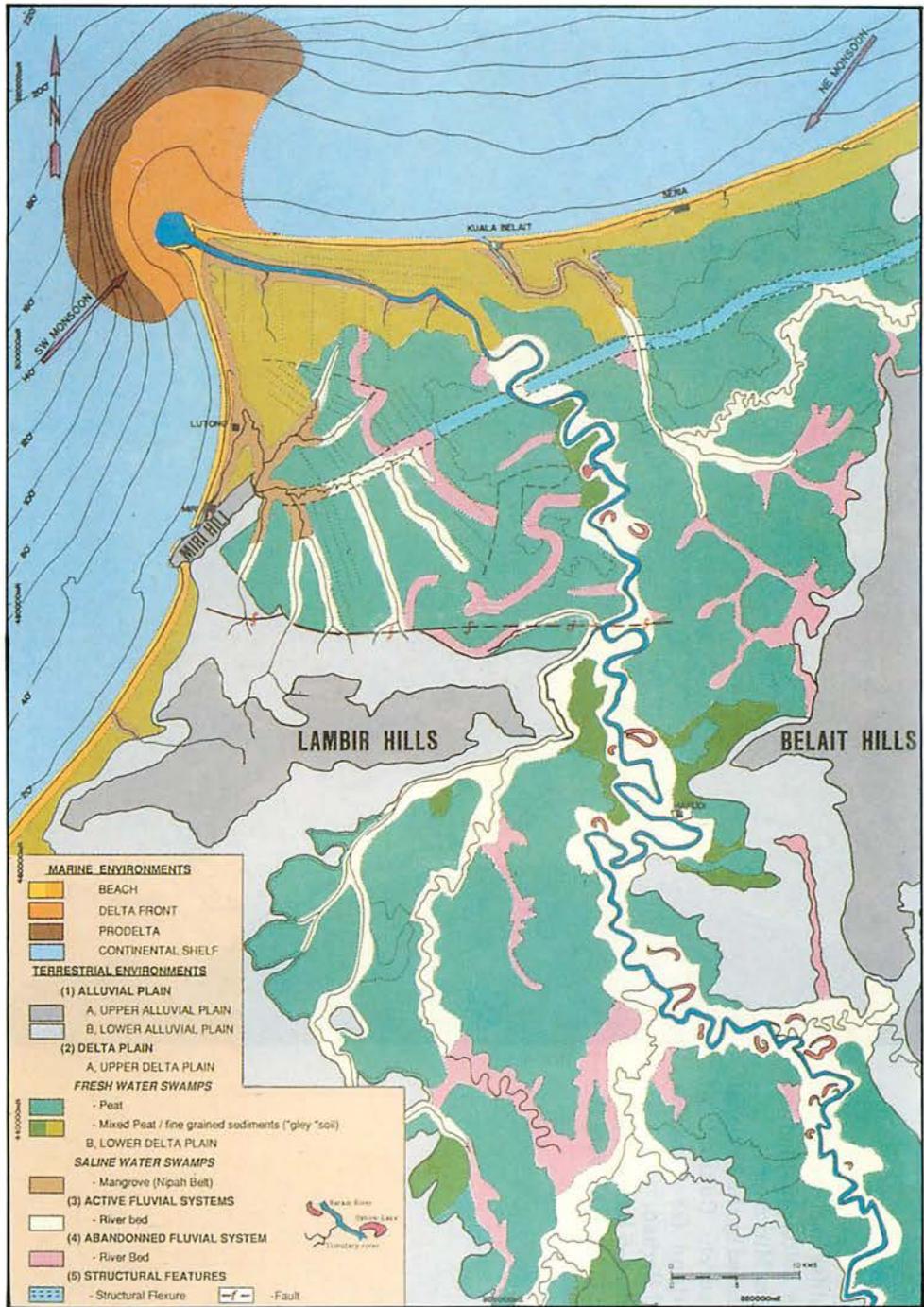
A more recent satellite picture gives a detailed view of the Baram lower deltaic plain which extends from Kuala Belait in Brunei to Miri in Sarawak (Fig. 3). The subtle colour variations are related to different vegetation covers and have been used to differentiate between mature (dome-shape) and immature peat deposits (Fig. 4). Characteristic arcuate features outline the course of abandoned meandering rivers.

### **MORPHOLOGY OF THE ACTIVE MOUTH OF THE BARAM RIVER**

Analysis of detailed hydrographic maps (1:10,000 scale) of the Baram River mouth is illustrated in Figure 5. The sand belt which develops at the river mouth, has an overall semi-circular shape. The preferential growth of the elongated sand



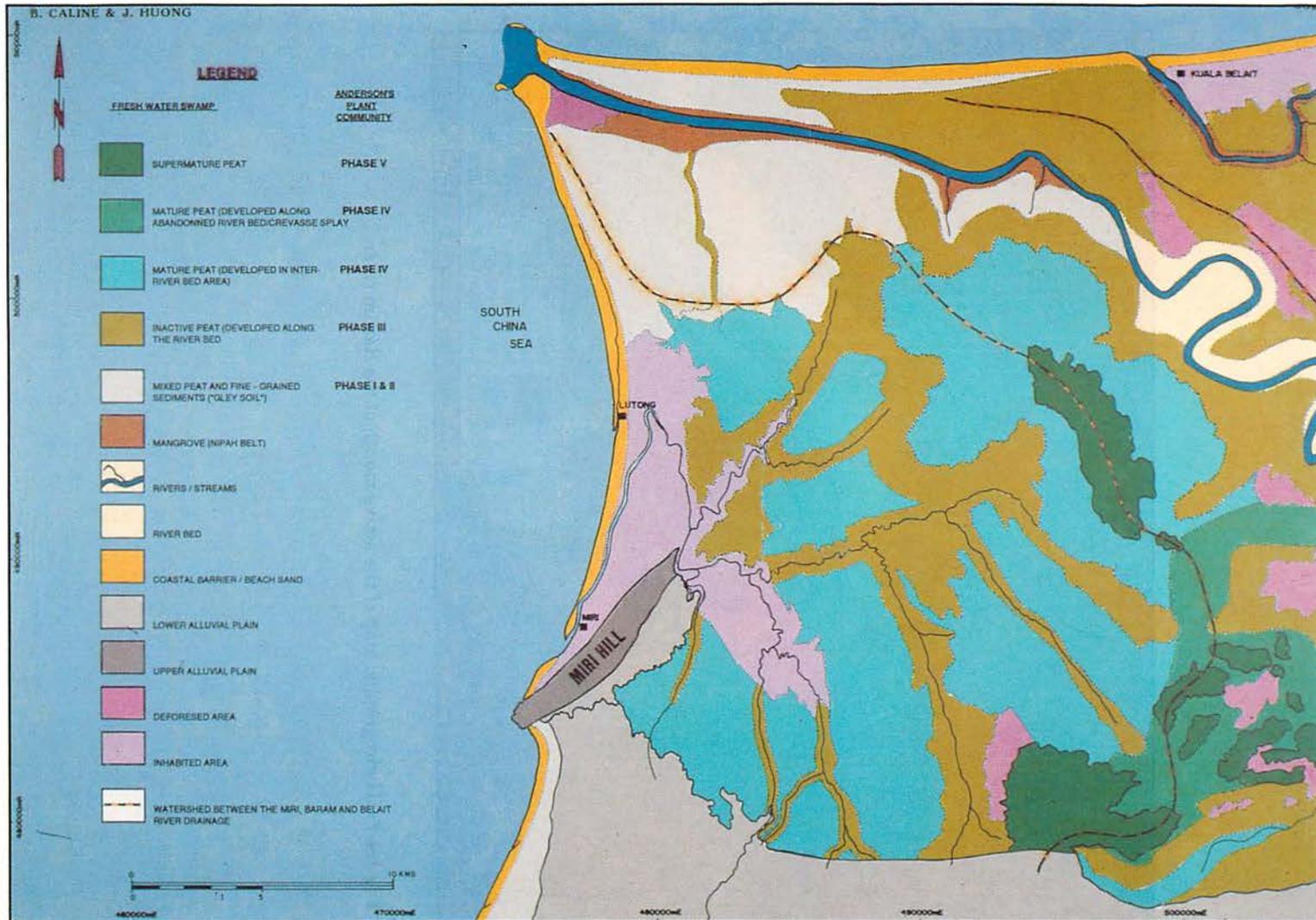
**Figure 1:** Satellite picture of the deltaic plain of the Baram Basin.  
Produced by Hunting Technical Services Limited for Shell Internationale  
Petroleum Mij. B.V.  
Landsat-4 Bands 5, 6, 7.  
Path 118 Row 57 Date 15-05-1986.  
Path 119 Row 57 Date 12-06-1985.



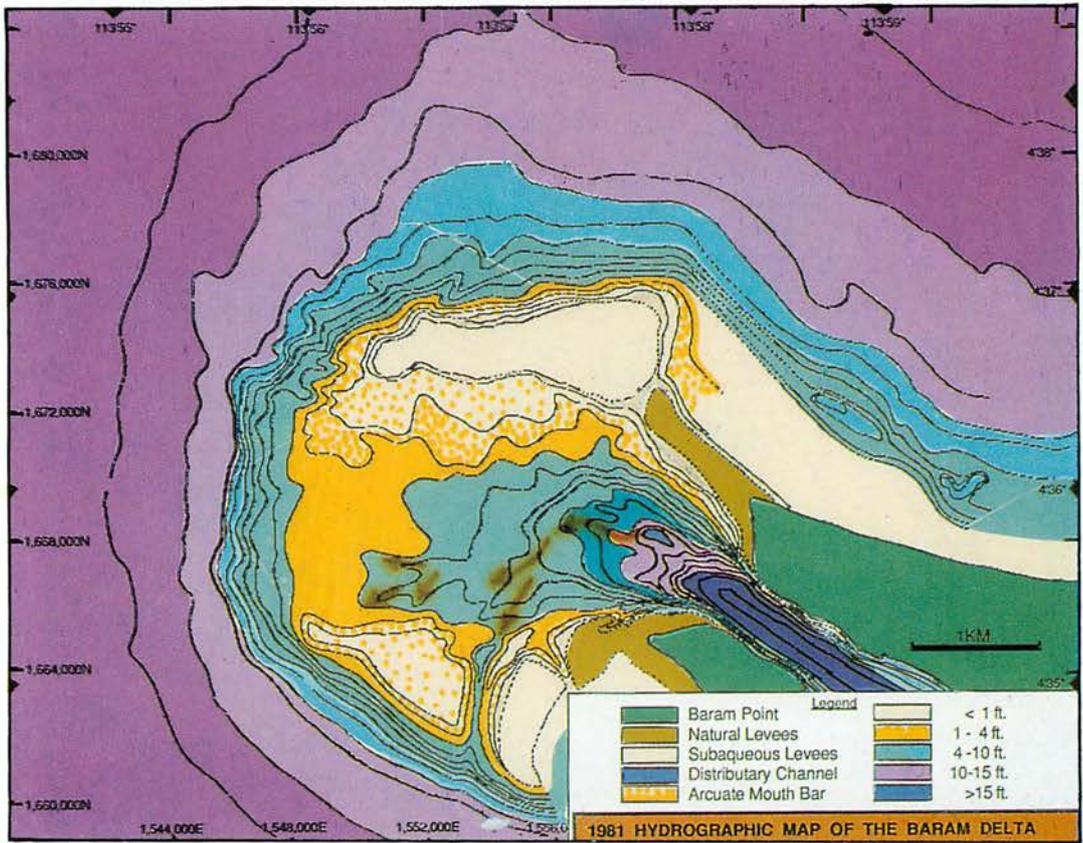
**Figure 2:** Map of sedimentary environments as interpreted from the satellite picture shown in Figure 1.

**Figure 3:** Satellite picture of the lower deltaic plain of the Baram/Miri rivers.  
Produced by the National Research Council of Thailand for Sarawak Shell Berhad.  
Landsat-5 Bands 3, 4, 5  
Path 119 Row 57 Date 18-06-1990





**Figure 4:** Map of sedimentary environments as interpreted from the satellite picture shown in Figure 3.



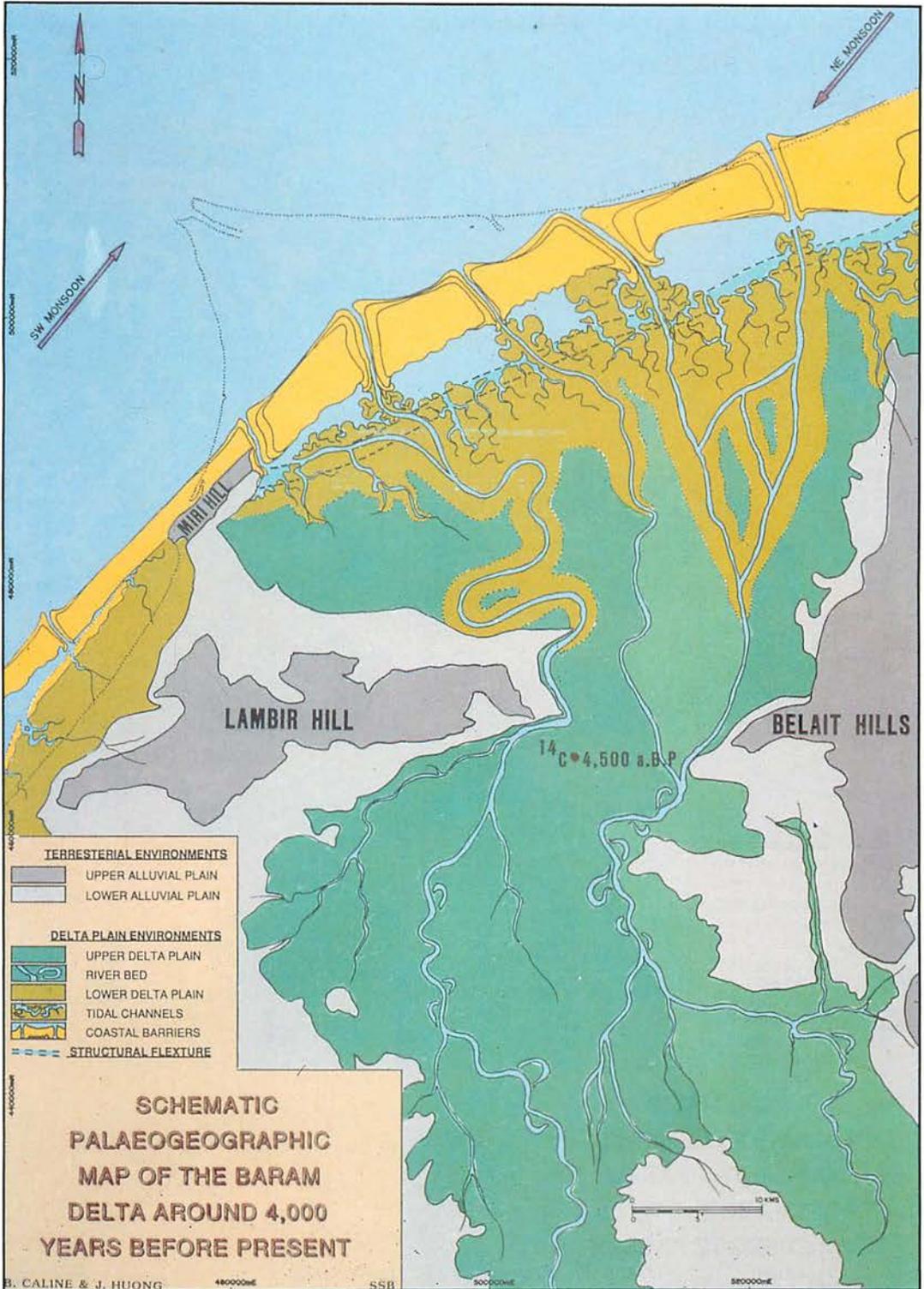
**Figure 5:** Hydrographic map of the active mouth of the Baram river.



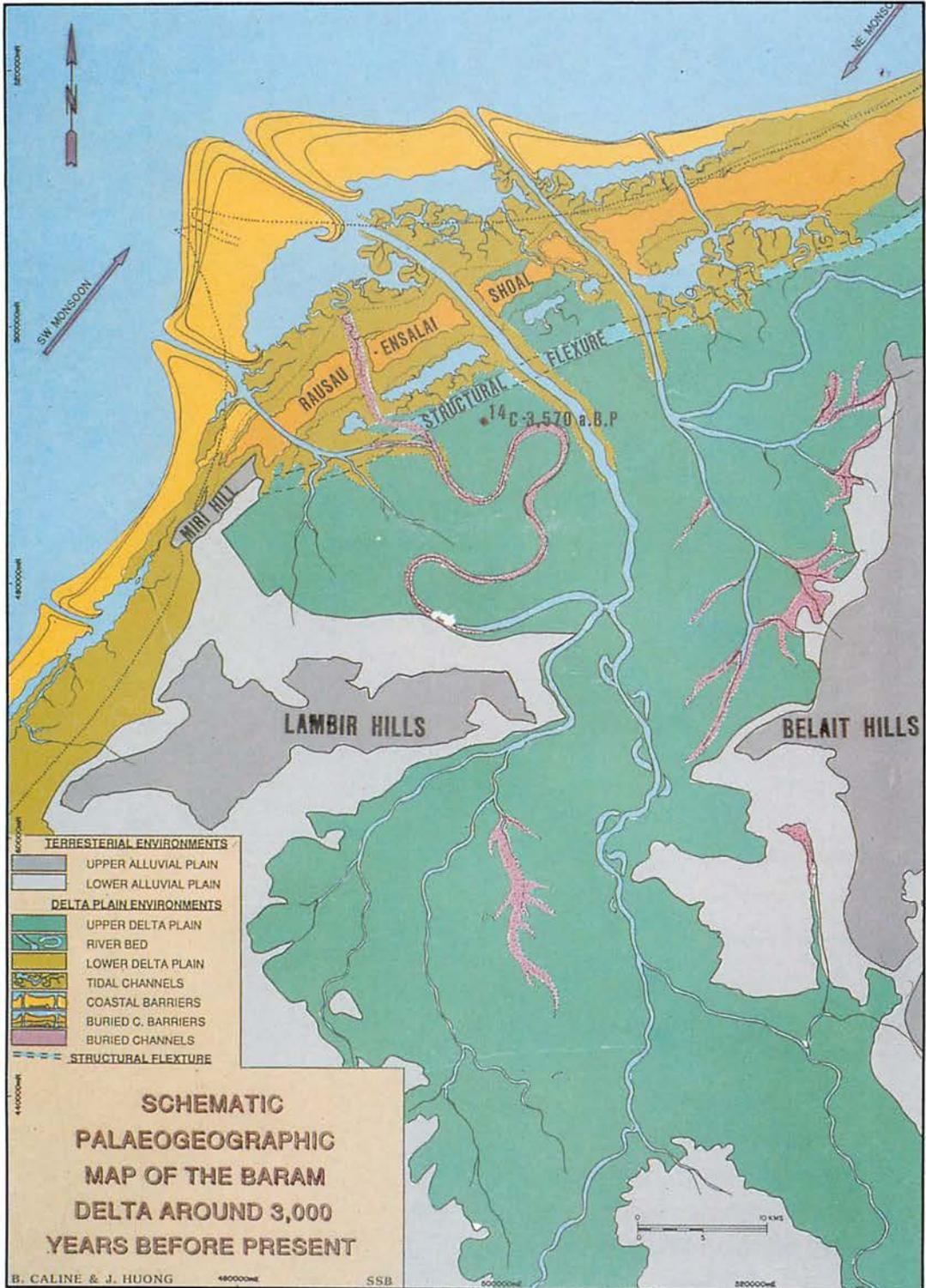
**Figure 6:** Schematic palaeogeographic map of the Baram delta around 5,400 years before present.



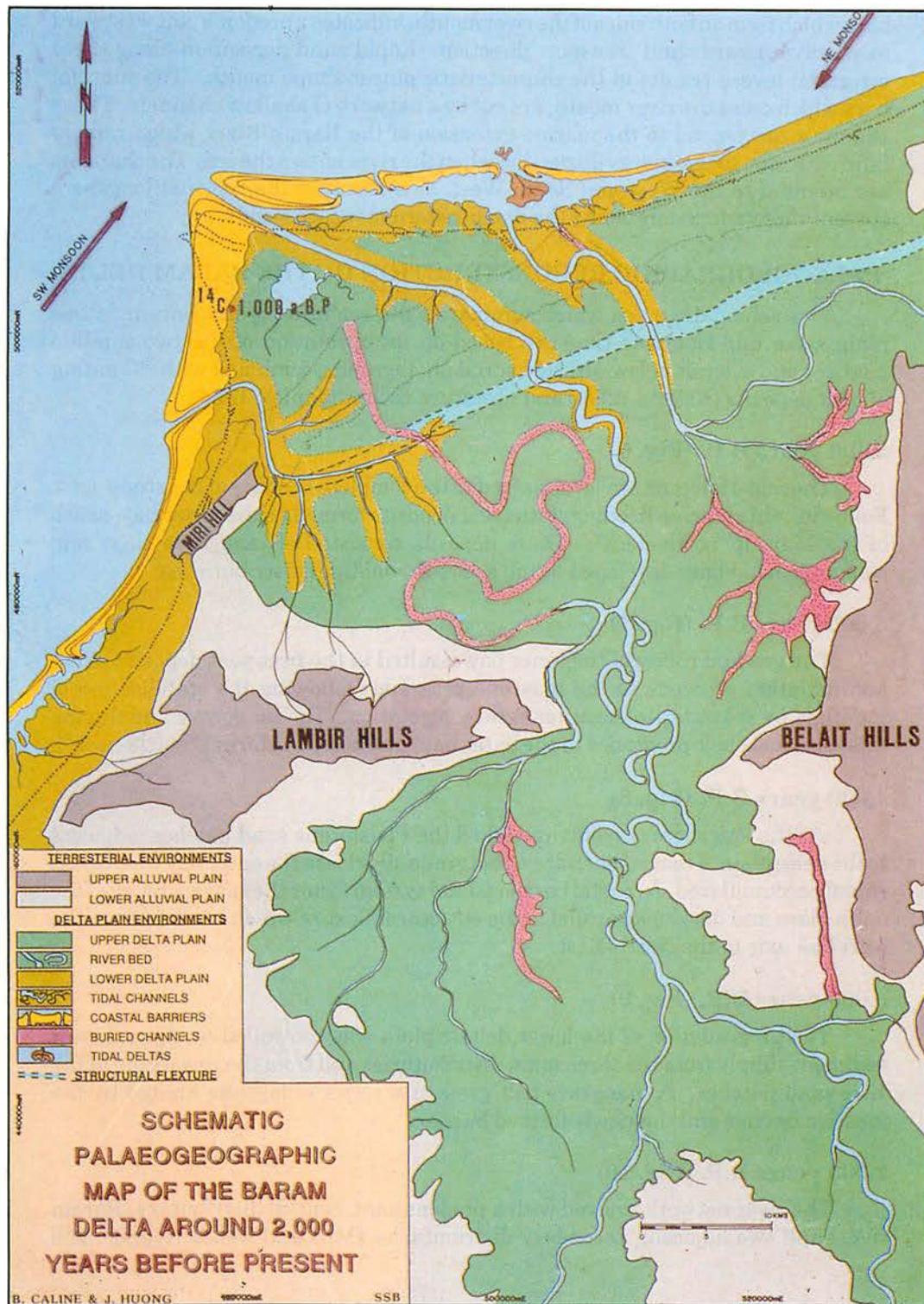
**Figure 7:** Schematic palaeogeographic map of the Baram delta around 5,000 years before present.



**Figure 8:** Schematic palaeogeographic map of the Baram delta around 4,000 years before present.



**Figure 9:** Schematic palaeogeographic map of the Baram delta around 3,000 years before present.



**Figure 10:** Schematic palaeogeographic map of the Baram delta around 2,000 years before present.

bars which form on both sides of the river mouth, indicates a predominant westward to southwestward sand transport direction. Rapid sand deposition along these intertidal levees results in the characteristic pincer-shape mouth. The subtidal bars which cross the river mouth, are cut by a network of shallow channels. These channels correspond to the marine extension of the Baram River which rapidly bifurcates due to the energy dispersion when the river enters the sea. The channels are oriented to the West and South-West, as a result of the regional longshore current direction generated by the northeastern monsoon winds.

## **PALEOGEOGRAPHIC RECONSTRUCTION OF THE BARAM DELTA**

Five schematic maps which summarise the evolution of the Baram deltaic plain since mid-Holocene time are based on interpretation of the two satellite pictures and a series of low-altitude aerial photographs, combined with <sup>14</sup>C dating of peat deposits (Esterle, 1990) and literature review (James, 1984).

### **5,400 years B.P. (Fig. 6)**

The mid-Holocene sea level rise led to the complete flooding of the study area. Following this marine flooding, estuarine deposits formed in the inner bay, south of the Marudi "bottle-neck". These deposits consisted of mangrove clays and elongated sand bars developed in the active fluvial/tidal distributaries.

### **5,000 years B.P. (Fig. 7)**

The gradual filling of the inner bay resulted in the first peat deposits. Peat accumulation proceeds as the coastline progrades following the stabilisation of mudflats by seawater-tolerant mangrove vegetation. The mangrove and fluvial/tidal channels belt progrades to the outer bay (north of the Marudi "bottle-neck").

### **4,000 years B.P. (Fig. 8)**

As the longshore currents reworked the Pleistocene sand patches, adjacent to the delta plain, a coastal barrier system gradually closed the outer bay where peat rapidly accumulated. A coastal barrier island system forms the seaward edge of the delta plain and develops parallel to the structural flexure which extends from the Miri Hill axis to the North-East.

### **3,000 years B.P. (Fig. 9)**

The progradation of the lower deltaic plain was controlled by the constant sediment supply from the three main distributaries and from the reworking of the relic sand patches. A mangrove belt grew in a series of lagoons limited by the inactive barrier and the newly formed barrier.

### **2,000 years B.P. (Fig. 10)**

The river network evolved with a predominant, central distributary (Baram river) and two adjacent, secondary distributaries (Miri and Belait rivers). The

abandonment of the meander belt, north of Lambir Hills, was probably related to a moderate uplift/tilting of the area as indicated by the presence of an active fault.

### DEPOSITIONAL REGIME AND DELTA EVOLUTION

The mid-Holocene oscillation of relative sea level produced a facies sequence which consists of:

- estuarine sediments deposited during an early transgressive phase (marine flooding at around 5,400 a B.P.), and are overlain by
- deltaic sediments deposited during the later regressive phase at a time the rate of sea level rise was slower than the rate of sediment input. The deltaic deposition resulted in the rapid progradation of the coast.

At the present time, the coast is retrograding once more. The present transgression is destroying the mid-Holocene record of the nearshore delta and is replacing it with a ridged, transgressive sand sheet.

Similar mid-Holocene depositional regimes have been interpreted from the Rhine estuarine/delta sequence and the resulting evolution of the Dutch coast (Van Straaten, 1965) as well as from the Doce River strandplain along the Brazilian coast (Dominguez & Wanless, 1991).

### ACKNOWLEDGEMENTS

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