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'Storm-Flood' Coastal Systems in Relation to Delta Front-Shoreface Facies Models: Applications to Miocene Successions in the Baram Delta Province, NW Borneo

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Abstract

Offshore sediment delivery requires flows to overcome the net landward bottom stress induced by fairweather shoaling waves. Storm waves are the dominant offshore transporting flow interpreted in basic models of clastic coasts, commonly generalised as a 'shoreface': the two-dimensional coarsening and shoaling upwards succession dominated by wave-formed sedimentary structures. Yet this model is just one end-member in a continuum of shoreface and delta front models, which reflect fundamental differences in shoreline processes, energy level and textural character.

We interpret abundant upward coarsening successions in the mid-late Miocene Belait Formation, eastern Baram Delta Province of NW Borneo, to reflect mixed-process storm- and river-flood influenced delta front deposits (Fig. 1). High rates of sediment input attributed to combined fluvial and storm influence is reflected in the pervasive 0.5-2 m-thick, very-fine grained sandstone beds. The abundance of swaley, to locally hummocky cross-stratification, with exquisitely preserved mm-scale laminae, and internal discontinuity surfaces indicates repeated erosion and deposition during predominantly aggradational sedimentation. In addition, there is significant anisotropy within the swaley cross stratification, indicating subordinate unidirectional flow acting with the inferred dominant oscillatory storm-generated component. Common mud drapes at the top of beds/bedsets and the observed gradients in ichnofauna diversity and abundance attest to a return to ambient, low-energy conditions. In some cases, angular carbonaceous material, including cm-scale wood clasts, indicate minimal reworking of fluvial-derived sediment. As large tropical storms invariably cause both increased fluvial discharge and sediment delivery ('storm-floods'), as well as increased wave energy, we propose a combined storm-dominated and fluvial-influenced delta front environment for the Baram Delta Province (Fig. 2).

This is further supported by the size and frequency of erosional gutter casts that commonly define the bases of sandstone beds. These features are uniquely abundant throughout the study area and display both exceptionally large dimensions, with thicknesses up to 2 m and widths >10 m, and a wide range of geometries. Isolated gutter casts, often up to 1-2 m deep, occur with steep to overhanging walls. The abundance, dimensions and wide-variability of gutter casts observed attests to high-energy storm-floods augmenting erosion and sediment supply by offshore-directed storm surge ebb flows during tropical storms (Fig. 2B). We suggest the basinward progradation, coalescence of several small delta fronts along a multiple-sourced shoreline, are responsible for a 'ragged blanket' of river-bypassed sand. Subsequent autogenic or allogenic channel avulsion, augmented by marine reworking, would result in increased lateral continuity of facies zones, producing more typical 'shoreface-like' successions (Fig. 2C).

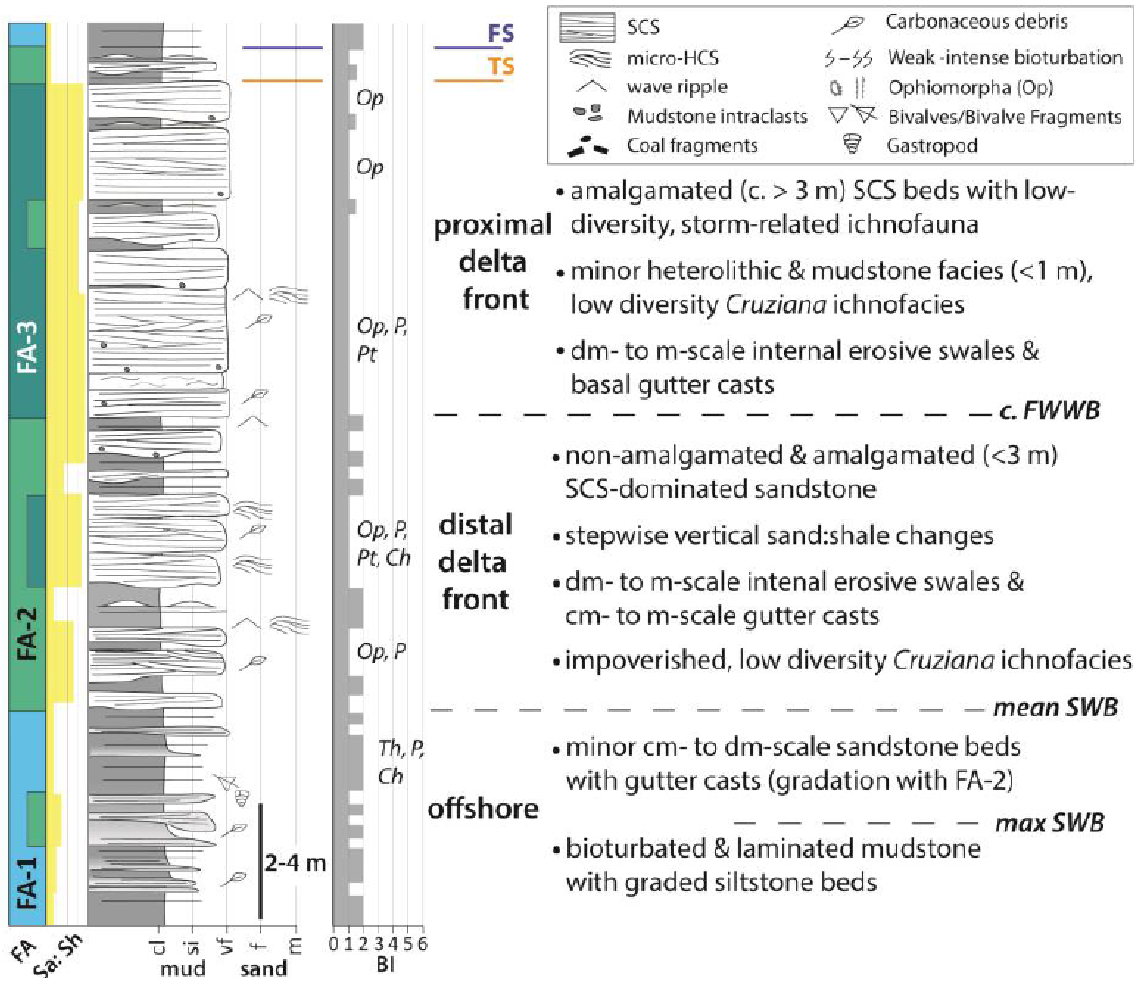

Figure 1. Generalised shallowing-upward facies associations (FA) for a storm-flood dominated shoreline. FA-1 is mudstone dominated, FA-2 heterolithic and FA-3 sandstone dominated.

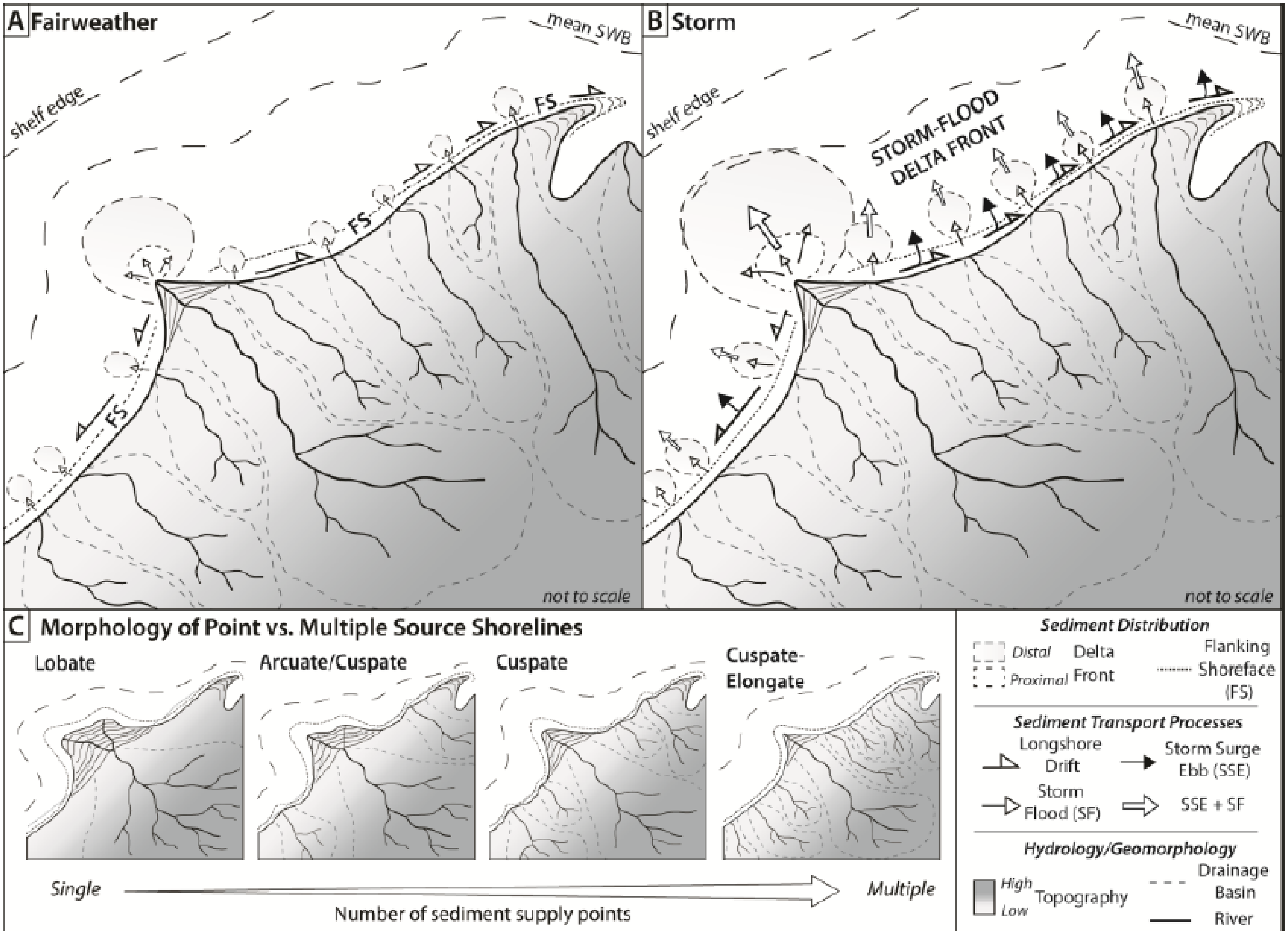

Figure 2. Coastal-shelf processes acting during fairweather (A) and storm (B) periods in the Baram Delta Province. (C) Impact of changing the number of sediment supply points on shoreline geometry.