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Towards A Genetic Facies Tract for the Analysis of Hyperpycnal Deposits

Carlos Zavala[1,2]
1) IADO, CONICET. Camino la Carrindanga Km 7.6, Bahía Blanca, 8000, Argentina, czavala@criba.edu.ar
(2) PDVSA Exploración Oriente. Puerto La Cruz, Venezuela

Facies analysis performed during more than ten years in a number of lacustrine and marine basins allowed the distilling of a genetic and predictive facies tract of general application to the analysis of long-lived and coarse-grained hyperpycnal deposits. The understanding of facies types related to hyperpycnal flows represents a deep challenge for sedimentology since river discharges and their associated facies types could be very different respect to those related to conventional (surge-like) turbidity flows (Mulder & Alexander, 2001; Zavala et al., 2006a). A hyperpycnal flow has a distinctive behavior which will result in the accumulation of non-conventional beds from a classical point of view. Its origin related to a direct fluvial discharge results in a subaqueous flow having characteristics often considered as typical of alluvial sedimentation. A hyperpycnal flow is a land-derived, relatively slow moving, and fully turbulent sediment gravity flow (Mulder et al., 2003) having the ability of carrying basinward interstitial freshwater In contrast to surge like ("classical") turbidites, hyperpycnal flows have a slow moving and more diluted leading head which will be very sensitive to the pre-existing subaqueous topography. The moving of a hyperpycnal flow will not necessarily require steep slopes since the flow could be maintained as long as the high-density fluvial discharge continues. Therefore, the distance reached by a hyperpycnal flow traveling along a gentle-dipping or near-flat sea bottom will be more dependent on the duration of the related flood event. In contrast with surge-like flows where deposition is dominated by the head, in hyperpycnal flows deposition is dominated by the body (De Rooij and Dalziel, 2001; Peakall et al., 2001). These characteristics allow the preservation in the hyperpycnal deposit of evidences of flow fluctuations that occurred during the passing-by discharge resulting in the accumulation of composite beds (Zavala et al., 2007). In contrary with classical models of turbidity sedimentation, coarse grained materials are not transported at the flow head, but are dragged at the flow base as bedload related to shear forces provided by the overpassing long-lived turbulent flow (Plink-Björklund & Steel, 2004; Zavala et al. 2006b). The facies tract here discussed is composed of three main genetically-related facies groups termed B, S and L, corresponding to bedload, suspended load and lofting transport processes respectively (Fig. 1).

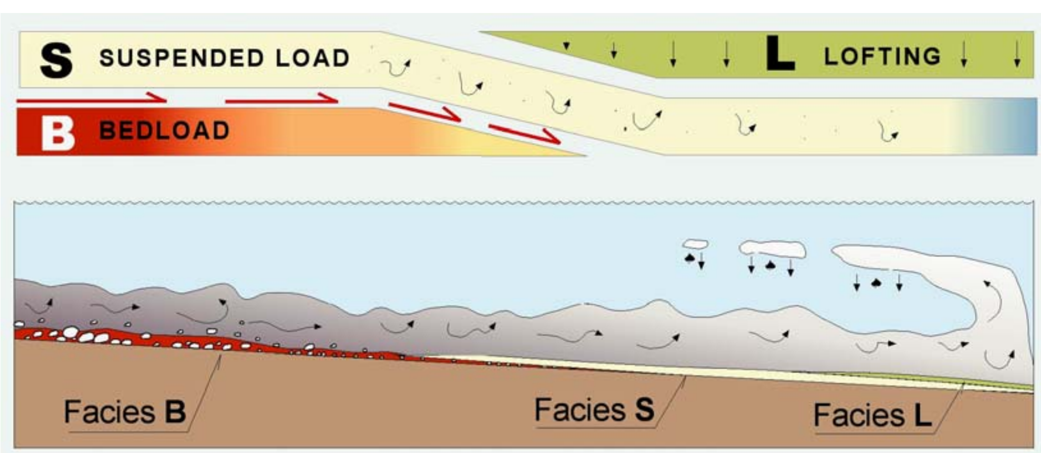

Figure 1. Basic conceptual diagram for facies analysis of hyperpycnal deposits with associated bedload in marine setting. Facies B include all those facies related to bedload processes developed at the base of an overpassing long-lived turbulent flow. Facies S correspond to the gravitational collapse of sand-sized materials transported in suspension by the turbulent flow (suspended load facies). Facies L are related to the fallout of fine grained materials lifted-up by the interstitial freshwater contained in the flow once it lost part of the sand-sized suspended load.

Facies B (bedload) are the coarsest grained and relate to shear and frictional drag forces provided by the overpassing long-lived turbulent flow. Three main sub-categories are recognized (Fig. 2), termed B1 (massive or crude bedding conglomerates), B2 (pebbly sandstones with low angle asymptotic cross-stratification) and B3 (pebbly sandstones with diffuse planar lamination and aligned clasts). Facies S are almost fine grained, and relate to the gravitational collapse of sand-size materials transported as suspended load. Four facies types are recognized, denominated S1 (massive sandstones), S2 (parallel laminated sandstones), S3 (sandstones with climbing ripples) and S4 (massive siltstones and mudstones). Facies L (lofting) relates to the buoyancy reversal of the hyperpycnal flow provoked by the lift-up of a less dense fluid (in the case freshwater) typically in marine and other saline basins. Finest materials suspended in the flow (very fine grained sand, silt, plant debris and mica) are lifted from the substrate and settle down forming silt/sand couplets of great lateral extension. Facies L develops only in marine/saline environments while facies S3 and S4 are more common in lacustrine environments.

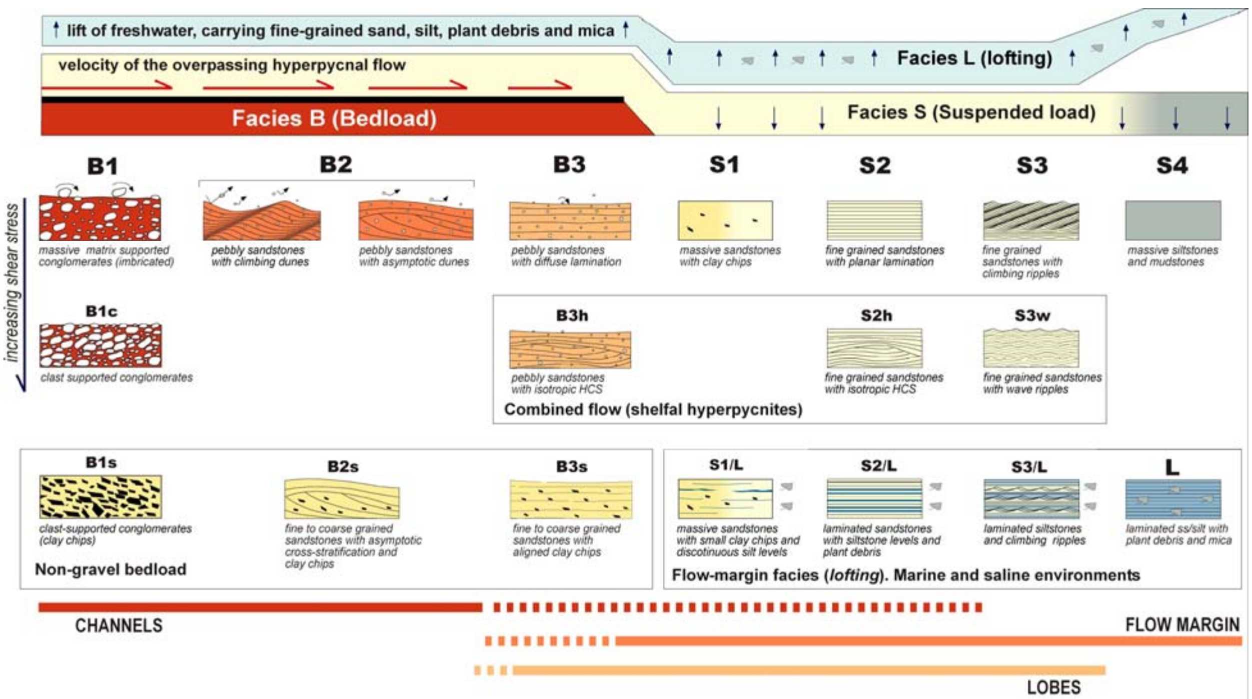

Figure 2: Conceptual schema for the genetic interpretation of clastic facies in hyperpycnal systems. Type B facies relate to bedload processes at the base of an overpassing long-lived turbulent flow. Type S facies originate from the gravitative collapse of sand-sized suspended materials carried in the turbulent flow. Facies L are composed of very fine grained sandstones interbedded with laminated silts with abundant plant debris and mica, accumulated by fallout from a lofting plume. Facies L are exclusive of marine/saline environments.

Hyperpycnites are often very complex showing internal erosional surfaces and gradual facies recurrences related to deposition from long-lived and highly dynamic (fluctuating) flows. This complex behavior results in the accumulation of composite beds, having an internal facies arrangement which strongly departs from conventional facies models built-up from surge-like flows. Facies B characterize transfer zones and its occurrence allows to predict sandstone deposits (facies S) basinward. Facies L are mostly developed in flow margin areas.

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