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Facies prediction in hyperpycnal systems. The Oligocene-Early Miocene Merecure Group in the Monagas area, Maturin Sub-Basin, Venezuela.

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The Oligocene – Early Miocene Merecure Group is one of the main proliferous hydrocarbon-bearing unit in the Eastern Venezuelan Basin. It is composed of more than 1,000 feet of marine shelfal clastic deposits. These deposits bound Cretaceous and Paleogene strata and are in turn covered by a thick succession of fine grained deposits of the Miocene Carapita Formation. The accumulation of the Merecure Group marks the beginning of the Tertiary foreland related to the collision of the Caribbean plate from the north (Pindell et al., 1998). These deposits were accumulated in an elongate basin oriented Northeast - Southwest, located between an active mountain front (North) and the Guayana shield (South).
A regional subsurface study of core and well log data of 30 wells over an area of 850 km2 allows reviewing the origin, stratigraphy and sediment distribution of the Merecure Group in the Maturin Sub-Basin. 12,719 feet of core data were described and analyzed in detail, allowing the distinction of 12 sedimentary facies. Main facies include massive to cross-stratified pebbly sandstones which grade basinward into massive to laminated fine grained sandstones. The characteristics of the identified facies are summarized in Fig. 1.

	facies	lithology	sedimentary structures	geometry	origin	thickness (meters)
Bedload	B1	Matrix-supported fine grained conglomerates	Massive, clay chips	Tabular to lenticular bodies	Bedload related to the overpassing of long lived turbulent flows	0.1 - 0.9
	B2	Fine-grained conglomerates to pebbly sandstones	Low angle cross-stratification *clay chips.*	Irregular bodies and channel fills	Bedload. Rolling and modified saltation. Migration of asymptotic dunes	0.2 - 7
	B2s	Medium to coarse-grained sandstones	Low angle cross-stratification *clay chips.*	Irregular bodies and channel fills	Bedload. Rolling and modified saltation. Migration of asymptotic dunes	0.2 - 1.5
	B3	Fine-grained conglomerates to pebbly sandstones	Diffuse horizontal lamination Aligned clasts. Plastic clay chips	Tabular bodies	Bedload. Rolling	0.12 - 14.75
	B3h	Fine-grained conglomerates to pebbly sandstones	Low-angle lamination *(hummocky-like)*	Tabular bodies	Bedload. Rolling. Combined flows	0.2 - 3
Fallout + traction-plus-fallout	S1	Fine grained sandstones	Massive, *clay chips, dish* (water scape)	Tabular bodies	Progressive aggradation from quasi-steady flows	0.1 - 9.5
	S1/L	Fine-grained sandstones. Thin and discontinuous siltstone levels	Massive, *clay chips, dish* load casts. Plastic clay chips	Tabular bodies	Progressive aggradation from quasi-steady flows (flow margin transition)	0.1 - 3.6
	S2	Fine grained sandstones	Parallel lamination	Tabular bodies	Progressive aggradation from quasi-steady flows	0.1 - 3
	S2h	Fine grained sandstones	Low-angle lamination *(hummocky-like)*	Tabular bodies	Progressive aggradation from quasi-steady flows (combined flows)	0.1 - 1.5
	S3	Fine grained sandstones	Current ripples	Tabular bodies	Traction-plus-fallout from quasi-steady turbulent flows	0.1 - 0.3
	L	Fine grained sandstones and siltstones, plant debris and micas	Massive to laminated	Tabular bodies	fallout from lofting plumes	0.1 - 6
	P	fine grained sandstones and mudstones	Massive to laminated	Tabular bodies	fallout (offshore/prodelta - shoreface)	0.1 - 10

Figure 1. Main characteristics of the sedimentary facies identified in the Merecure Group from core studies.

Facies analysis of these deposits revealed an origin related to the accumulation from sustained and long-lived turbulent flows derived from subaerial discharges (hyperpycnal flows) in a shelfal marine setting. Individual sandstone bodies can be up to 30’ thick and are arranged into different hierarchical orders, allowing the distinction and regional mapping of three third order depositional sequences, termed M1, M2 and M3.
Facies classification was done using a genetic and predictive facies tract especially designed for the analysis of hyperpycnal systems (Zavala et al 2006; Zavala in press, Fig 2). The recognized facies types can be in turn grouped into three main facies categories related to bedload (B), suspended load (S) and lofting (L) processes respectively (Fig. 3).

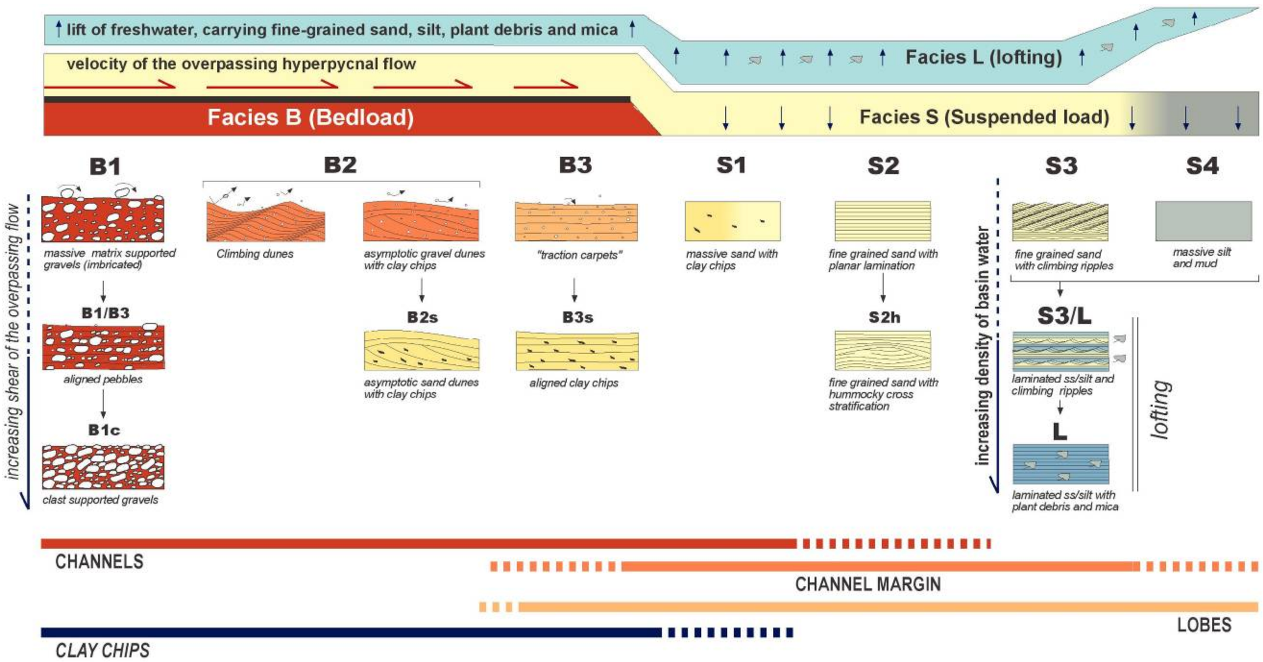

Figure 2. The genetic classification of hyperpycnal facies used in this work. Facies B relate to bedload while facies S are related to the gravitational collapse of the coarsest fraction of the suspended load, as the flow wanes. Lofting facies (L) are related to the gravitational flow onset provoked by the uplift of the freshwater contained in the flow. After Zavala et al., 2006.

Figure 3. Main facies types recognized in the Merecure Group.

B facies are coarse grained and related to drag forces provided by an overpassing turbulent flow. S facies are composed of fine grained sandstones and are related to the gravitational collapse of the suspended load as the long-lived flow progressively wanes basinward. L facies are the result of the fallout of very fine grained sands, silts, plant debris and micas from lofting plumes mainly in flow margin areas. Lofting plumes are the result of the buoyancy inversion of the turbulent flow provoked by lift-up forces provided by the interstitial freshwater as the flow progressively loses their suspended load. The analysis of the relative abundance of B, S, and L facies allowed the definition of proximity and laterality indexes for facies prediction (Zavala et al., 2007; Zavala et al., this volume).

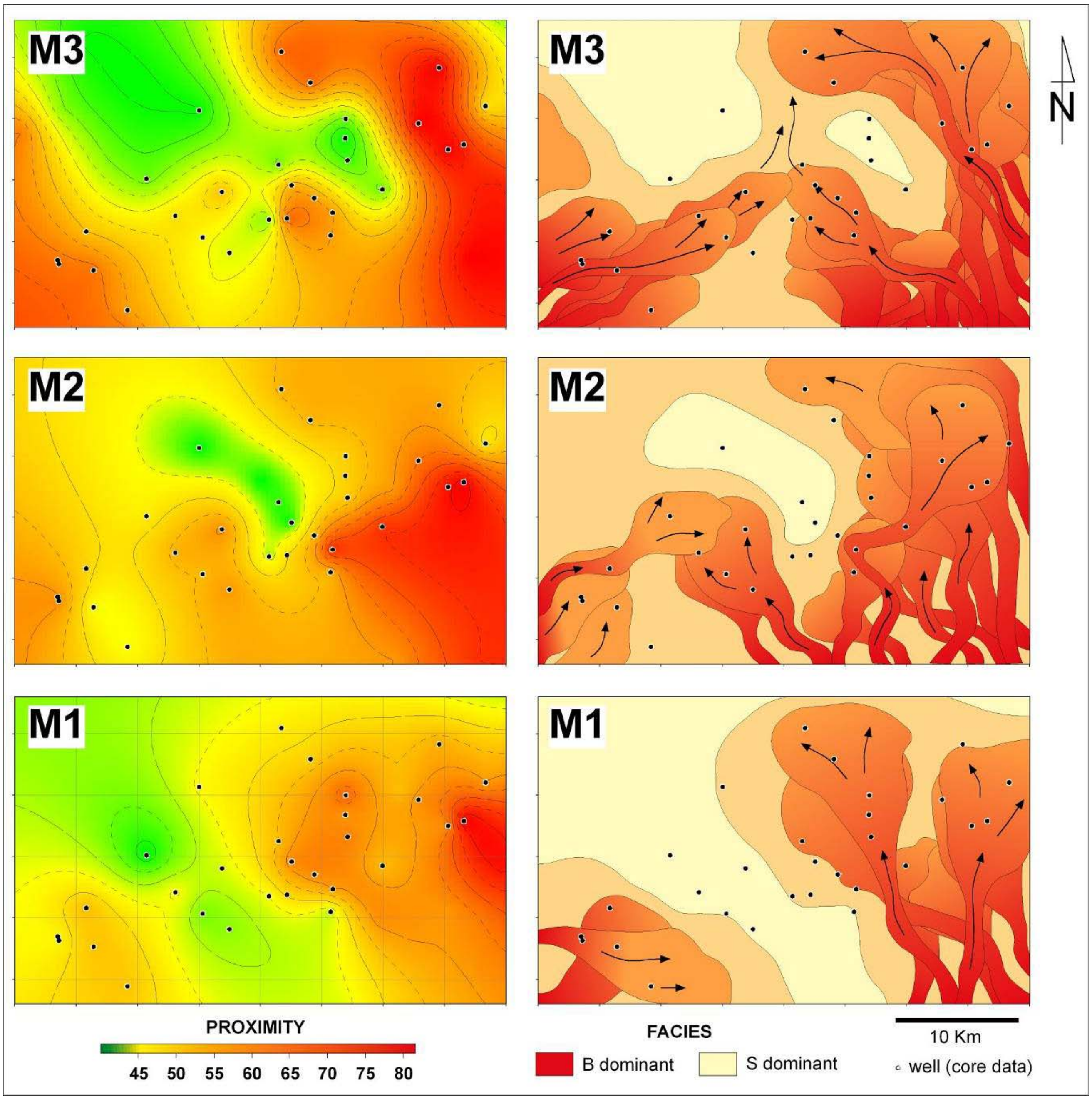

Figura 4: Proximity maps and facies prediction for sequences M1 to M3, Merecure Group.

The proximity (Pt) and Laterality (Lt) indexes are adimensional numbers that fluctuate from 100 to 0. Pt index measures how proximal the core is located respect to the hyperpycnal system as a whole. Lt index gives an indication of how lateral the core is located respect to the flow axis. Pt and Lt indexes were calculated in the whole study area and within a sequence stratigraphic framework. The mapping of genetic indexes allowed to determine source areas, predict facies distribution and reservoir quality in undrilled areas (Fig. 4).

The analysis of genetic indexes in the Merecure Group revealed that the system could be more extended than previously considered with a main sediment source from cratonic areas located in the south and south-east. Index mapping suggest also a syntectonic accumulation during the Oligocene – Early Miocene, which have controlled the subaqueous topography and the distribution of sandstone bodies.

Preliminary data suggest a close relation between reservoir properties and facies. In the system considered, B facies show the overall best pertrophysical properties. S1 facies have good porosities related to an original open packing, but permeability can be reduced according to the existence of fine grained materials in pore spaces. In a decreasing order of quality, the best facies are the B2, followed by B3, S1, S2, S3 and L. As B facies have the better properties, the facies maps of Fig. 4 can be used to predict the reservoir quality in undrilled areas.

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