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ICHNOLOGY AND SEDIMENTOLOGY OF A MUD-DOMINATED DELTAIC COAST: UPPER CRETACEOUS ALDERSON MEMBER (LEA PARK FM), WESTERN CANADA

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ABSTRACT: **Current depositional models largely promote the perception that all open-coastal distal (sea)–proximal (land) gradients are reflected by upward-coarsening grain-size trends, and that shoreline deposits are represented by prominent sand bodies. Although commonly the case, significant departures from this model may occur when the availability of coarser sediment calibers (sand-sized and larger) is limited. This is especially true where alongshore sediment-transport-influenced depositional systems are associated with rivers that supply abundant suspended sediments. Underestimating the role of grain-size segregation may lead to misinterpretations of energy levels and water depths, especially in some shale-dominated sedimentary units.**

The Upper Cretaceous Alderson Member (Lea Park Fm) is an up to 180-m-thick, gas-charged shale unit that we interpret as an ancient analogue for modern offshore and mud-dominated deltaic coasts. Sedimentological and ichnological data collected from 27 cores indicate that much of the sediment volume of the Alderson Member was deposited in relatively shallow water under the influence of tidal and wave processes in a deltaic coastal setting. Characteristic features reflecting these depositional affinities include: (1) increased proportions of terrestrially derived organic matter; (2) indications of thixotropic to soupy substrates (e.g., fluid mud) coupled with rapid depositional rates; (3) an impoverished ichnological signal (*Planolites*-dominated suites); (4) micro-laminated shale; (5) shale-on-shale erosional contacts; (6) scour-and-fill structures; and (7) intervals of low-angle cross-stratification. The interpretation of relatively shallow-water settings is also supported by recurring root-bearing horizons, *Glossifungites* Ichnofacies-demarcated transgressive surfaces of erosion, and conglomeratic surfaces at particular stratigraphic levels. The deposits are interpreted to include offshore, "subaqueous deltas," muddy shoreface and/or tidal flat, and aggradational muddy coastal plain (chenier plain) sub-environments.

The results of this study improve our knowledge of ichnological and sedimentological characteristics of shallow-marine shale units, and are potentially useful for recognition of similar nearshore mud-prone deposits elsewhere.

INTRODUCTION

Mud-dominated, open-coast shorelines form typically as interdeltaic muddy shorefaces, tidal flats, or down-drift deltaic environments (e.g., chenier plains) that are sourced by wave- and/or tide-agitated, hyperpycnal and hypopycnal mud plumes. Compared to their sand-dominated counterparts, mud-dominated coastlines are sedimentologically and ichnologically poorly understood. As a result, their recognition in the geological record is hindered. In fact, despite the growing number of reported present-day examples (e.g., coast of Brazil–Guayana, Louisiana [USA], Kerala [India], East China, and Carpentaria [Australia]), documented ancient examples are still rare (see Catskill Formation for an exception) (Beall 1968; Walker and Harms 1971; Rhodes 1982; Rine and Ginsburg 1985; Mallik et al. 1988; Augustinus 1989; Allison and Nittrouer 1998; Bentley et al. 2003; Neill and Allison 2005).

Recently, it has been suggested that a parsimonious locale for mud accumulation is actually the coastal zone, and that only a part of mud supply "escapes" to deeper-water environments in low-gradient and low-energy settings. This view is based on the observation that few sedimentary processes account for the transportation of fine-grained sediment to distal offshore (below storm-weather wave base) settings (Nittrouer and Wright 1994). Nearshore locales strongly favor the deposition of fine-grained sediment, as they are prone to the formation of fluid mud via various depositional processes (e.g., wave and tide agitation, estuarine flow convergence) and the tendency for non-flocculated (hypopycnal) plumes and fluid mud to move in alongshore directions such as promoted by longshore currents and Coriolis forces (e.g., Nittrouer and Wright 1994; Wright and Nittrouer 1995; Geyer et al. 2004; Khan et al. 2005). Accordingly, it has been proposed that the formation of thick basinal shale units may actually require considerable changes in shoreline position (Dalrymple and Cummings 2005). However, the notion that mudrocks are *primarily* deposited in nearshore positions, especially in foreland basins, makes the paucity of recognized coastal shale units in the geological record suspicious.

Lately, Schieber et al. (2007) demonstrated by flume experiments that mud floccules form under highly variable experimental conditions (water chemistry, clay mineralogy, sediment concentration) and accumulate at flow velocities that transport and deposit sand. Their observations further point out the need to reevaluate published paleoenvironmental interpretations of ancient shale successions (Macquaker and Bohacs 2007).

The main problems regarding recognition of shallow-marine mudrocks from the sedimentary record may relate to inferring the depositional energy levels and the initial water depths of shale-dominated strata. The