Flume Studies of Shale Sedimentology – Implications for the Rock Record, Shale Microfabrics, and Pore Development

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Recent studies of mud deposition with racetrack flumes that preserve floccule integrity throughout the transport cycle, have shown that muds can be deposited by currents that are competent to transport sand. The muds flocculate, form migrating ripples, and the latter accrete into finely laminated clay beds. That muds can be deposited while such currents are acting on the seabed changes the way we have to consider fundamental sedimentary features in shales. Laminated shales for example, long thought to reflect quiescent conditions may now represent much more energetic depositional settings. We are finding now increasing evidence in the rock record that this is indeed a likely and common occurrence. If a mixture of clay and silt is considered, the same conditions lead to interlaminated clay and silt deposits.

Other experiments have explored the formation of shale fabrics that result from intermittent erosion of surficial muds and the mechanism of carbonate mud deposition from moving suspensions, finding that the former results in lenticular fabrics and the latter in finely laminated carbonate muds. Both of these features are familiar from the rock record, but were not previously considered to be associated with erosion and current transport. Experimental shale sedimentology is a new a research discipline, and to date every new experiment undertaken has resulted in novel insights. It is therefore likely that there will be many more surprises in store with regard to perceived notion vs physical reality for a wide variety of sedimentary features in shales.

The microfabrics of current deposited muds from these experiments were studied by SEM on ion-milled samples. Current deposited muds show a randomized fabric due to flocculation, and even floccule structures are still resolvable. Clays that deposited under quiet water conditions show a strong fabric contrast with bedding parallel alignment of clay flakes. Once compacted, the current deposited muds are expected to show abundant phyllosilicate framework pores. The latter appear common in ancient shales and range of size from tens of nm to hundreds of nm. The quietly settled muds on the other hand, due to their parallel alignment of clay flakes, should show less porosity and smaller pores once compacted. Thus, although diagenetic history is an important factor in porosity development and porosity preservation in shales, the underlying depositional processes can strongly influence the type and abundance of pores that are ultimately preserved and useable for gas extraction.