Facies Relationships in a Simulated Fan-delta System

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Intrinsic relationships between associated sedimentary facies have been proven to be existed during the depositional process, such as channel-mouth bar systems in deltaic settings. However, little attention has been paid to the developmental patterns of such associated sand bodies, i.e., channel, mouth bar, and slide-slump deposit, which are favorable for the development of high quality hydrocarbon reservoirs if preserved. Therefore, we conducted a flume experiment to simulate a fan-delta under controlled boundary conditions and hope to explain the genesis of these associated sand bodies.

The delta was simulated in a flume. Volume of sediments and flowrate were variables and were strictly controlled. Sediments mixed with the water supply at the sand pool outflowed from the feeder outlet. Meanwhile, the water volume and tectonic setting were kept constant, without tidal or wave interactions.

The experiment showed developmental relationships between different facies. Subaqueous channels are the underwater extension of subaerial braided channels. As water and sediment were fed into the flume, the subaqueous channel was eventually replaced by a mouth bar. During this evolution process, the mouth bar first prograded, followed by accretion, backstepping and widening, with an increasing to decreasing depositional rate, influenced by backwater effect. After the mouth bar emerged, it caused the flow to bifurcate. The two branches would be bifurcated again by subsidiary mouth bars. Nevertheless, several bars might almost simultaneously develop basinward of the outlet if the channel was wide and shallow. Progressive deposition around the bar increased the angle of bifurcation and the original mouth environment evolved into fan-delta plain. It is worth mentioning that sediment failures would form in front of torrential and highly loaded channels.

The conclusions are: 1) the mouth bar first develops progradationally, then aggradationally, retrogradationally and transversely from the initial formation of the subaqueous channel; 2) there are two modes of channel bifurcation, i.e., multi-stage bifurcation by sequentially formed mouth bars and simultaneous bifurcation by arrays mouth bars; 3) slide-slump deposits are more easily formed in flood periods; 4) in the process of fan-delta development, sedimentary slope break is formed, which is favorable for the development of high quality reservoirs.

Keywords: facies relationships, flume experiment, fan-delta system, channel-mouth bar system

