New Insights into the Sequence Stratigraphy of Deepwater Deposits Gleaned From the Study of Quaternary Deepwater Systems

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The classic sequence stratigraphic models of Mitchum (1985) and Vail et al. (1987) placed sandy, deepwater deposits in the lowstand systems tract. The implication of these models is that the transit of sediment across the shelf through incised valleys and into the heads of submarine canyons acts as an on/off switch to sediment supply in deepwater. In a relative rise in sea level, this link is broken and sandy submarine fans are blanketed with regionally-extensive, muddy, condensed sections that are related to highstand and transgressive systems tracts on the shelf. In a relative fall in sea level, the connection is remade and there is an abrupt reappearance of coarse-grained sediment and incision/re-incision of the canyons (i.e., the manifestations of sequence boundaries in deepwater).

While this model predicts the behavior of many deepwater systems in passive margins with normal sedimentation rates, studies of modern submarine canyons and fans show that in the current high sea level conditions there are a number of systems where the link between fluvial, shelf and deepwater systems remained unbroken as sea level rose from the last glacial maximum and sedimentation is still active. In many cases this is because the shelf is narrow with high sediment supply, or where the river is structurally pinned making for a long-lived canyon that has grown headward across the shelf. In these cases, while sediment supply may vary due to climate or the quality of connection, the external on/off switch controlling sedimentation is not as strong. This opens the question of the factors controlling sequence development in this kind of system.

While these systems may not be the norm in modern “ice house” condition they may have been more typical of non-glacial “green house” periods such as the Cretaceous and Paleocene. As such, the study of active Quaternary systems provides the following valuable insights. 1) Condensed sections and sequence boundaries may be tied to large-scale avulsion of the system. 2) These systems (given enough fluvial input of sand) could be very sand-rich because the link with the sediment source is long-lived with fewer and thinner abandonment shales compared to deepwater systems deposited in continental margins with a strong eustatic control. 3) In deepwater systems that are active through multiple system tracts, changes in grain size and stacking patterns may give clues to the location of stratigraphically significant surfaces.