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RECENT EXAMPLES OF SEQUENCE STRATIGRAPHIC PATTERNS : A KEY TO THE PAST

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ABSTRACT

The late Quaternary is characterized by the existence of high-frequency eustatic cycles which have formed depositional sequences similar to those described in older sediments. Because Quaternary deposits occur at or close to the present-day surface, their facies and stratal patterns are reasonably well understood and they furnish excellent analogues for the sequence stratigraphic interpretation of older rocks.

The variable scale of depositional sequences is illustrated by a small lacustrine delta in western Alberta, Canada. In spite of its small size, it exhibits all the sequence stratigraphic patterns observed in larger-scale sedimentary systems. Cyclic variations in lake level resulted in repeated episodes of fluvial incision and progradation of lowstand deltas. These lowstand deltas illustrate the process of forced regression during a relative sea-level fall resulting in sudden basinward shifts of shoreline deposits. Successive lowstand deltas onlap landward onto a subaerial sequence-bounding unconformity. This example clearly indicates that sequence stratigraphic concepts are time and scale independent.

Present-day coastal estuaries furnish excellent analogues to study the sedimentary infill of incised fluvial valleys. The late Quaternary eustatic sea-level falls resulted in the formation of deeply incised fluvial valleys on all of the coastlines of the world and the modern Gironde estuary in SW France furnishes a full-scale model of an incised valley-fill system. This valley fill forms a depositional sequence up to 50 meters thick, which comprises lowstand, transgressive and highstand systems tracts. Each systems tract is characterized by distinct sedimentary facies and reservoir types which are separated by stratigraphic discontinuities. These discontinuities are regionally correlatable and mark the different phases of the sea-level cycle and valley-fill.

These and similar studies in other estuaries and deltas have shown that the major factor determining the facies and reservoir types within a valley-fill is the intensity of tides and waves. The higher the energy of these processes, the thicker and sandier will be the valley-fill. In low wave and tide energy settings such as the Mahakam delta, the sandy component of incised valley-fills is reduced and a large part of the valley is filled with highstand prodelta muds.

Studies of modern deltas such as the Mississippi, the Mahakam, and the Rhone also suggest that the geometry and patterns of the lowstand incised valleys and shoreline deposits is to a large extent inherited from that of the highstand. On wave-dominant deltaic shorelines characterized by few distributary channels, large isolated shelf valley systems will form and lowstand shorelines sands accumulate as widespread shoreface deposits in the interfluves. When the highstand consists of a low wave-energy delta with numerous branching distributaries, all the distributaries initially become entrenched as relative sea-level falls and a network of numerous, small incised valleys form across the shelf. Eventually however, stream capture can concentrate the fluvial discharge into a few major valley systems.

These studies clearly indicate that although sequence stratigraphic concepts are clearly valid at all scales of time and size, application of the published sequence models must be carried out with a great deal of flexibility as numerous factors, in addition to sea level, can affect stratal patterns and facies architecture. In all cases, common sense and geologic reasoning must be applied when developing a sequence model and the effects of important factors such a sediment supply, transport processes, tectonism, etc. must not be overlooked.

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