CLIMATICALLY-CONTROLLED CYCLICITY IN ANCIENT FLOOD-DOMINATED FLUVIO-DELTAIC SYSTEMS

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Ancient flood-dominated fluvio-deltaic systems form huge accumulations of conglomerates, sandstone and mudstone facies whose origin and stratigraphic importance have been largely overlooked in previous literature (Mutti et al., 1996). These depositional systems can be understood only in terms of tectonically-controlled physiographic settings characterized by relatively small fluvial systems with high-elevation drainage basins and high-gradient transfer zones located close to marine basins, i.e. the "dirty rivers" of Milliman and Syvitski (1992). In settings of this type, sediment flux to the sea can dramatically increase when favourable climatic conditions (heavy rain fall, snow and ice melting, and breeching of naturally dammed lakes) provide sufficient amounts of water to produce catastrophic floods. These floods generate mixtures of water and sediment that can enter sea waters with sufficient momentum and sediment concentration to produce hyperpycnal flows and related turbidity currents. Thick and laterally extensive successions of shelfal sandstone lobes with HCS are the fundamental depositional element of these flood-dominated systems and can thus be regarded as the most genuine expression of fluvial-dominated delta systems. If not carefully framed within detailed correlation patterns of vertical and lateral stratigraphic relationships, shelfal sandstone lobes with HCS can be easily mistaken for either shelfal, storm-dominated deposits or shoreface sandstone facies. This misinterpretation has hampered, in most cases, the correct recognition of the fluvio-deltaic nature of these sediments and, therefore, led to misleading paleogeographic reconstructions.

As indicated by their overall stacking patterns, the evolution of ancient flood-dominated fluvio-deltaic systems with time is apparently controlled by the initial uplift of the drainage basin, the rate of subsequent denudation and subsidence, the gradient of each system, and the volume and sediment concentration of individual floods, the latter being a function of the amount of water and sediment made available to the system considered. A flood-dominated system of this type comes to an end when the sediment flux to the sea is progressively reduced to "normal" conditions. This occurs when relief and elevation of drainage basins and related sediment availability, as well as the gradient of transfer zones, have been substantially reduced through progressive denudation, subsidence and sediment exportation to marine depositional zones.

The occurrence of cyclic stacking patterns developed at different hierarchical orders is one of the most striking aspects of flood-dominated fluvio-deltaic systems. This cyclicity is particularly well recorded in shelfal sandstone lobe deposits, i.e. in the strata representing the terminal depositional zones of hyperpycnal flows and turbidity currents. High frequency (Milankovitch-type) cyclic stacking patterns observed in these sediments are commonly represented by facies sequences in which relatively thick and coarse-grained sandstone beds grade upward into thinner and finer-grained sandstone beds eventually capped by mudstone facies. These sequences are typically m-thick features which may stack into higher-order sequences with aggregate thickness up to some tens of meters characterized by a similar overall vertical facies trend. These high-frequency cyclic stacking patterns clearly record forestepping-backstepping episodes of sand deposition which are essentially controlled by cyclic climatic variations.Forestepping is produced by catastrophic flooding when large amounts of water are made available to fluvial source and transfer zones. The

sudden release of this water causes flood-generated mixtures of sediment-water to move basinward, removing the vaste of drainage basins and incorporating previous alluvium and marine sediments through large-scale erosion. Decrease in the amount of water available in the source zone produces a gradual backstepping of flood-generated facies with time until floods become so small to deposit most of their sediment load within upper river reaches and in progressively smaller channels.

Our data reinforce growing geomorphological and sedimentological evidence derived from the study of modern active margin settings indicating that the importance of small and medium-sized mountainous rivers in contributing sediment to marine basins has been largely underestimated in previous work, and that flood-related hyperpycnal flows and turbidity currents may play a major role in carrying fluvial sediment directly to shelfal and deeper water marine environments.

Milliman J.D. and Syvitski J.P.M., 1992 - *Geomorphic/Tectonic control of sedment disharges to the ocean: the importance of small mountainous rivers*. Jour. Geol., v. 100, pp.525-544.

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