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Interrelation between tectonism, climate, geomorphology and sedimentary deposits: a view from the eastern Himalayan foredeep

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In the continental basin-fill models, tectonically driven rejuvenation/quiescence of the hinterland, rate of basin subsidence and climate are considered as important controls of sedimentation. In applying this model-derived knowledge to the interpretation of ancient sedimentary successions, it has become common to relate the caliber of clastic sedimentary units (conglomerate, sandstone or mudstone) to the climatic or tectonic events. However, any of the modern continental basins will show coexistence of an array of different geomorphic elements in the same time plane defining a landscape (similar to the concept of systems tract. Sediments of different type and caliber are deposited in each of these geomorphic environments. A three dimensional view of the basin incorporating lateral coexistence of different geomorphic niches and their influence on the sedimentary facies has been neglected in many of these basin-fill models or interpretation of stratigraphic successions based on a single-line transect of basin-fill. Although tectonism will affect both sediment supply and discharge, their quantitative value will vary from point to point in the same basin. This variation will be controlled by the drainage basins morphology, or in other words the geomorphic setting.

Major geomorphic elements recognized in the Ganga-Brahmaputra alluvial plain include proximal high-gradient alluvial fans (AF), megafans (MF), major channel belts (CB) and interfluve or intermegafan plains (IP). Each of these geomorphic settings has distinctive geomorphic forms and features, and comprises characteristic deposits. Study of the late Quaternary near-surface deposits of the eastern part of the alluvial plain reveals that the contrasting facies associated with different geomorphic units coexist laterally at the same stratigraphic level and locally intertongue with each other. A few OSL age obtained shows overlapping time of their deposition. These sediments have a high likelihood of being preserved as the foreland basin-fill. An orogen parallel transect of this succession, will show a mosaic of laterally coexistent alluvial-fan conglomerate, megafan or braided river sandstone and mudstone-dominated successions deposited in the interfluve or intermegafan areas. Different orogen-perpendicular sections drawn at different points of the foreland basin will show remarkable variation from the idealised succession generated by two dimensional basin models.

In the modern Himalayan foredeep, spatial organization of the drainage networks probably controls the distribution of fans, megafans, major channel belts and muddy interchannel or intermegafan areas. Drainage basin configurations are known to respond to different tectonic and climatic perturbations over a period of ∼104 - 106 years. In a foreland basin setting, tens of meters sediment may accumulate over this period in each of the geomorphic niches identified from the present landscape. In the central Ganga Plain thick inter-megafan mud deposits flank sandy deposits of the megafans. In the eastern part of the alluvial plain, megafan sand and fan gravels laterally intertongue. All these lithofacies have accumulated under similar climatic and tectonic regime. In this scenario relating a particular bed lithology to tectonic or climatic forcing might be misleading.

It is suggested that a three dimensional reconstruction of the landscape comprising a mosaic of geomorphic domains and depositional environments, together with age data from the sediments and hinterland tectonic events, should be considered together for confident analysis of basin tectonics.