Autostratigraphic Responses of Deltaic Clinoforms to Sea Level Forcing

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A common belief in conventional genetic stratigraphy is that given steady external forcing by constant sediment supply (rate Qs) and constant relative sea level rise (rate Rslr), a deltaic system grows to achieve an equilibrium configuration, produces a particular sediment-stacking pattern, and maintains a constant rate of shoreline migration in a particular direction. This presumed mode of stratigraphic response is referred to as equilibrium response, by which steady external forcing results in a steady and uniform stratigraphic pattern of deposition. Theoretically there can be three other modes of stratigraphic response in such a cause-and-effect relationship. These are nonequilibrium autogenic response (unsteady stratigraphy, or stratigraphy with breaks/changes, caused by steady forcing), nonequilibrium allogenic response (steady stratigraphy by unsteady forcing), and general response (unsteady stratigraphy by unsteady forcing). Conventional genetic stratigraphy inherently relies on the recognition of equilibrium response, and consequently is apt to prefer the interpretation that any large-scale facies breaks or changes in stratigraphic pattern of deltaic successions reflect unsteady forcing such as temporal changes in Rslr or Qs (i.e. general response). We suggest that this happens because of some lack of awareness of nonequilibrium responses. New understanding and insights on how the deltaic clinoform reacts to steady and unsteady forcing, through physical and numerical experimentation, promotes a radically new view (known as autostratigraphy) that (1) though equilibrium response is certainly possible, it is limited to a very specific geomorphic condition and does not generally hold, (2) nonequilibrium autogenic response is much more likely than equilibrium response to steady sea level forcing, and (3) deltaic systems can have different stratigraphic responses to the same forcing depending on basin configuration and clinoform geometry. Autostratigraphy, encompassing equilibrium and nonequilibrium autogenic responses, suggests that abrupt stratigraphic breaks/changes and discrete geomorphic features of deltaic clinoform are not necessarily associated with sudden changes in Rslr or Qs but can be the purely autogenic response of the system to steady forcing of sea level and supply. Full appreciation of autostratigraphic responses provides an improved basis for stratigraphic interpretation and for exploring the autogenic dynamics of deltaic clinoforms.