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Modeling parameter space and stability domains of contrasting patterns in sequence stratigraphy

W. Schlager (1), Warrlich G.M.D. (2)

(1) Vrije Universiteit/Earth & Life Sci., Amsterdam, Netherlands, (2) PDO, Muscat, Oman (wolfgang.schlager@falw.vu.nl, georg.warrlich@pdo.co.om)

Sedimentation, erosion and the formation of sedimentary structures are governed by the interplay of various control parameters. Numerical modeling programs are now sufficiently versatile to determine the stability domains of many sedimentary features in the multidimensional space of their control parameters. We illustrate this approach with an example from carbonate sequence stratigraphy. The modeling was done in C3D (Warrlich et al., 2002).

The standard model of sequence stratigraphy (STM) assumes that deposition in the shallow-water settings occurs principally during rise and stillstand of sea level, and that erosion prevails in these settings during sea-level fall (Vail et al. 1977; Sarg, 1988). The falling-stage systems tract model (FST) postulates significant deposition also during sea-level fall (Hunt & Tucker, 1992; Plint & Nummedal, 2000). Which model is realized depends on the balance of the rates of erosion, sea-level fall and carbonate production. The falling-stage systems tract is favored by high production (or sediment supply), low erosion and slow sea-level fall. The rates required for the falling-stage systems tract in our modeling runs (and in well-documented natural examples) are common in the geologic record. Consequently, the falling-stage systems tract should occur more frequently in the carbonate record than reports currently indicate. One reason for the observed “FST deficit” may be the limited resolution of seismic data. However, the FST deficit may also indicate that we currently tend to underestimate the rates of sea-level fall or erosion.

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