Maximum flooding surface; the ultimate correlator.

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ABSTRACT

'Sequence stratigraphy' claims to be a method that describes the 3D/4D basin-fill. However, it comes short in a number of ways: there is no concensus on its concepts and terminology, some of the assumptions are known to be incorrect, there is no general model that fits all environments and locations. The scientific community has been working hard on these issues and the latest joint effort (Catuneanu et al., 2009) gives an excellent overview of the present state of the method. The authors make a wise distinction between model-independent and model-independent features of the technique. Although impressive in its review of existing models and including a range of techniques, areas and environments, it continues to build on the same assumptions and hence leaves the same shortcomings as all previous models, even though it mentions them explicitly.

The main assumptions on which sequence stratigraphy seems to be built are the following. (1) The base level curve is cyclical. This is very unlikely the case, the more so since it is known that base level is a combination of tectonic, eustatic, and climatic signals. Added to this is the fact that although the insolation curve can be calculated there is no adequate high-resolution model for the other three signals. It is highly unlikely of any of the individual signals to by cyclic or symmetric, let alone the compound signal. A look at the insolation curve itself shows us its irregular shape. As a result, it is unlikely for the succession of geometric elements to be regular. (2) Length translates directly to time. The behaviour of a sedimentary system is known to be extremely variable in both space and time, and both on larger and smaller space and time scales. It is therefore highly unlikely that a geometric element will be laterally continuous in both facies and time. The natural migration of sedimentary systems makes timelines naturally cut through lithological boundaries and the diachronicity of the same geometric element within a sedimentary system can be substantial. This is even enhanced by the fact that sedimentation and erosion most probably occur in only a fraction of the entire time. As a result a sequence at one place is unlikely to correlate with a similar one some space away.

The basic concepts of 'sequence stratigraphy' are relatively straightforward and have been proposed as early as 1949 (Sloss et al., 1949), all concepts thereafter have intended to expand and improve the method. However, there is to date no concensus on many of those concepts. This means that either the concepts are not sufficiently general, or that there is disagreement on the assumptions. One thing is sabotaging all attempts and that is the fact that we study the output signal and try to reconstruct the input signal from it. One of the main differences between the alternative models is the choice of main correlative surface. All but one (Galloway, 1989) use the erosional unconformity.

The question is: if we don't know the input-to-output relationship, can we employ the output-to-input interpretation? To answer this question we concentrate our studies on the growth of deltaic systems with and without external forcing. To that end we simulate a deltaic system in a scaled environment for a selection of prototype scenarios and we intend to run numerical models for a large range of scenarios. Our preliminary results show that the erosional unconformity is a strongly diachronous local phenomenon, whereas the maximum flooding surface is a weekly diachronous regional phenomenon.

From our findings we recommend the following: the maximum flooding surface as correlator; the shoreline migration to establish purely geometric behaviour like e.g. aggradation, progradation, retrogradation; a combination of geometric behaviour and lithofacies to establish 'stratotypes' or elements. We recommend to not use the following: orders of cyclicity (e.g. 4^{th}, 5^{th}, 6^{th}), unless the period is known through age-control; systems tracts or socalled 'genetic' elements. Overall we recommend the use of well-established existing techniques like sedimentary structure analysis, facies analysis, basin analysis to establish the areal extent of 3D geometric elements like lithofacies and their bounding surfaces.

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