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Towards the standardization of sequence stratigraphy

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ABSTRACT

Sequence stratigraphy emphasizes facies relationships and stratal architecture within a chronological framework. Despite its wide use, sequence stratigraphy has yet to be included in any stratigraphic code or guide. This lack of standardization reflects the existence of competing approaches (or models) and confusing or even conflicting terminology. Standardization of sequence stratigraphy requires the definition of the fundamental model-independent concepts, units, bounding surfaces and workflow that outline the foundation of the method. A standardized scheme needs to be sufficiently broad to encompass all possible choices of approach, rather than being limited to a single approach or model.

A sequence stratigraphic framework includes genetic units that result from the interplay of accommodation and sedimentation (i.e., forced regressive, lowstand and highstand normal regressive, and transgressive), which are bounded by 'sequence stratigraphic' surfaces. Each genetic unit is defined by specific stratal stacking patterns and bounding surfaces, and consists of a tract of correlatable depositional systems (i.e., a 'systems tract'). The mappability of systems tracts and sequence stratigraphic surfaces depends on depositional setting and the types of data available for analysis. It is this high degree of variability in the precise expression of sequence stratigraphic units and bounding surfaces that requires the adoption of a methodology that is sufficiently flexible that it can accommodate the range of likely expressions. The

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integration of outcrop, core, well-log and seismic data affords the optimal approach to the application of sequence stratigraphy. Missing insights from one set of data or another may limit the 'resolution' of the sequence stratigraphic interpretation.

A standardized workflow of sequence stratigraphic analysis requires the identification of all genetic units and bounding surfaces that can be delineated objectively, at the selected scale of observation, within a stratigraphic section. Construction of this model-independent framework of genetic units and bounding surfaces ensures the success of the sequence stratigraphic method. Beyond this, the interpreter may make model-dependent choices with respect to which set of sequence stratigraphic surfaces should be elevated in importance and be selected as sequence boundaries. In practice, the succession often dictates which set of surfaces are best expressed and hold the greatest utility at defining sequence boundaries and quasi-chronostratigraphic units. The nomenclature of systems tracts and sequence stratigraphic surfaces is also model-dependent to some extent, but a standard set of terms is recommended to facilitate communication between all practitioners.

Contents

1. Introduction: background and rationale

Sequence stratigraphy is considered by many as one of the latest conceptual revolutions in the broad field of sedimentary geology (Miall, 1995), revamping the methodology of stratigraphic analysis. Applications of sequence stratigraphy cover a tremendous range, from deciphering the Earth's geological record of local to global changes in paleogeography and the controls governing sedimentary processes, to improving the success of petroleum exploration and production. Multiple data sets are integrated for this purpose, and insights from several disciplines are required (Fig. 1).

Sequence stratigraphy is uniquely focused on analyzing changes in facies and geometric character of strata and identification of key surfaces to determine the chronological order of basin filling and erosional events. Stratal stacking patterns respond to the interplay of changes in rates of sedimentation and base level, and reflect combinations of depositional trends that include progradation, retrogradation, aggradation and downcutting. Each stratal stacking pattern defines a particular genetic type of deposit (i.e., 'transgressive', 'normal regressive' and 'forced regressive'; Hunt and Tucker, 1992; Posamentier and Morris, 2000; Fig. 2), with a distinct geometry and facies preservation style. These deposits are *generic* from an environmental perspective (i.e., they can be identified in different depositional settings), and may include tracts of several age-equivalent depositional systems (i.e., systems tracts).

Sequence stratigraphy can be an effective tool for correlation on both local and regional scales. The method is now commonly utilized as the modern approach to integrated stratigraphic analysis, combining insights from all other types of stratigraphic as well as several non-stratigraphic disciplines (Fig. 1). However, it remains the only