# Minutes of the ISSC Workshop on "New developments in stratigraphic classification"

WSS-11 at the 33rd International Congress, Oslo, Norway, August 10, 2008, 2 - 5.30 pm

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| Secretary: | Strasser, André |
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**Background**: Following the symposium HPS-12 on "New developments in stratigraphic classification", this workshop concentrated on sequence stratigraphy. The goal was to reach a consensus concerning sequence-stratigraphic nomenclature and definition of sequence-stratigraphic elements. The ultimate outcome should be a publication in the *Newsletters on Stratigraphy*, as for the other stratigraphic disciplines. This is part of an effort towards an update of the International Stratigraphic Guide as initiated by Maria Bianca Cita, outgoing chair of the International Subcommission on Stratigraphic Nomenclature (ISSC) of the International Commission on Stratigraphy (ICS).

## 1. General procedure

We hope to determine common terms, standard hierarchy, and uniform methodology in sequence stratigraphy so users and teachers have a uniform understanding of this tool. At the same time we recognize that some interpretation is involved when naming a surface or a sedimentary package.

The classification proposed encompasses facies evolution, stratal geometries, and stacking patterns. Lateral *and* vertical relationships are to be considered. We recognized the importance of the lateral continuity of a surface if it is to be of sequence-stratigraphic significance (as for example the unconformities displayed on seismic sections or wide-spread stratigraphic markers in outcrop). We recognized that in many cases the maximum-flooding surfaces are the most useful of correlation horizons.

All features used for interpretation have to be **observation-based**, whether using outcrop, core, well logs, and/or seismic sections. Systematic changes in the patterns that are correlatable and define an evolution of the sedimentary system are of prime significance.

***Consensus 1: Start with observable features in outcrop, core, well-log, and/or seismic sections.***

A **stacking pattern** is represented by vertical stacking of facies. All observational data that characterize facies evolution, including surfaces, have to be considered in the analysis. Geometries can be seen because of contrasts in fabric and facies (grain-size trend, lithological contrast, seismic discontinuity, well-log characteristics). This is valid for all scales.

The **lateral correlation** is based on the observation of the continuity of surfaces and/or facies pattern. Random surfaces and facies patterns are generally related to local processes, whereas consistent patterns probably have a sequence-stratigraphic significance. Lateral correlation is an iterative process that optimizes the observations ("objective description"). It is recommended that one should start with the large-scale features, then work down into the detailed ones.

***Consensus 2: First describe the large-scale features of stacking and geometry to establish a framework, within which the details can be later worked on and added.***

The procedure for defining stacking pattern and lateral geometries is strongly dependent on the type of data. As the identification of stacking patterns is an interpretive process and the procedure cannot be generalized, examples should be provided (in the form of figures) that demonstrate how the stacking patterns were identified. This is valid for all types of data and for all scales. Additional data (e.g., biostratigraphy, chemostratigraphy, magnetostratigraphy, radiometric ages) can be added at this or at a later stage.

## 2. Defining surfaces

**Subaerial unconformities** are identified by a break in sedimentation. They may truncate underlying strata, form incised valleys, display karst and palaeosol features, and/or show evidence of continental facies. Local subaerial exposure may be related to random processes, but a wide-spread extension is significant for sequence-stratigraphic interpretation.

***Consensus 3: In order to have sequence-stratigraphic significance, a subaerial discontinuity must have an obvious lateral continuity.***

**Maximum-flooding surfaces** are characterized by a granulometric change from fining-up to coarsening-up, a facies change from deepening-up to shallowing-up, enrichment in organic matter, high gamma-ray, hardgrounds, enrichment in certain minerals (P, Fe, Mn, glauconite), intense bioturbation, and/or downlap seen on seismic profiles. On a basin-scale, they define the turn-around from retrogradation to progradation. They generally indicate maximum condensation through sediment starvation. Maximum flooding may be expressed by a discrete surface, and/or by an interval of maximum condensation (possibly containing a series of surfaces).

**Comment [OC1]:** Fining-up/coarsening-up do not necessarily correspond to deepening-up/shallowing-up. These terms are not interchangeable. The former are correct criteria, because they are based on **observation** and relate to sediment supply, but we should avoid making **inferences** in terms of bathymetric changes. Bathymetric changes do not necessarily mean facies changes.

Two opinions are expressed regarding the terminology:

a. "Maximum-flooding surface" (MFS) is popular and should not be changed, although it already implies an interpretation related to relative sea-level change.

b. "Maximum condensation surface or interval" is purely descriptive. Once the sequence-stratigraphic interpretation is established, it can become a MFS. However, condensed intervals also occur in other settings (e.g., top lowstand in the basin). On shallow platforms, maximum-flooding conditions are commonly not expressed by condensation but by maximum accommodation gain. The turn-around from retro- to progradation, however, is visible in grain-size and facies evolution.

***No consensus is reached on this issue.***

**Ravinement surfaces** occur in coastal environments and are expressed by an erosional break between underlying shallow-marine, intertidal, or supratidal facies and overlying marine facies. The overlying sediment package may have a coarse-grained base and fines (deepens) upward. These surfaces may, however, be difficult to identify in seismic sections since they have limited lateral extent.

***Consensus 4: this definition of ravinement surface is accepted.***

**Maximum-regressive surfaces (= transgressive surfaces)** form at the change of facies from coarsening-up to fining-up, respectively from shallowing-up to deepening-up. The same turn-around is expressed in the stacking pattern. These surfaces can be conformable but may also contain a hiatus. In some cases there is not a well-defined physical surface developed but the rapid turn-around indicates the position.

***Consensus 5: this definition of maximum-regressive surface (= transgressive surface) is accepted.***

**Correlative conformities** are prolongations into the basin of surfaces developed on platform, ramp, and slope. On seismic profiles, the reflectors can be followed and are important for basin analysis (although they may not be exact time lines). However, correlative conformities are not identifiable in outcrop or well log.

***Consensus 6: this definition of correlative conformity is accepted.***

A **basal surface of forced regression** cannot be identified in outcrop, nor in seismic sections and well logs. The term should be abandoned.

***Consensus 7: "basal surface of forced regression" is not a good term and should not be used.***

A **slope onlap surface** (*sensu* Embry) is difficult to define because surfaces on the slope may be created by slope failure, contour-current erosion, and other processes. The definition is not clear; at the most it could correspond to a sequence boundary (*sensu* Vail).

***No consensus is reached on this issue.***

## 3. Defining sequences

To define sequences, surfaces have to be correlated and boundaries have to be established. A sequence is a template, depending on and varying with the type of depositional setting and the type of sediment. The goal is to provide a generic definition that is applicable to the different types of sequences.

***Consensus 8: a 1-day workshop is needed to work out the definition of sequences.***

This workshop could be held in conjunction with the AAPG Meeting in Denver in June 2009.

The PP-presentations of Symposium HPS-12 concerning sequence stratigraphy may be sent to Chris Kendall to be put on his web site (http://strata.geol.sc.edu/kendall.html).

AS / Fribourg, 21 August 2008

**Comment [OC2]:** This is acceptable here because we are talking about a setting that is close to the coastline, where grading correlates well with bathymetry.

**Comment [OC3]:** Again, reference to bathymetry (which is pure **inference** until calibrated with fossils such as benthic forams) needs to be eliminated. The equivalence between grading and bathymetry is most likely incorrect in offshore areas.

**Comment [OC4]:** This is incorrect. The reason Posamentier and others use this surface as a type of « correlative conformity » is because its mappability on seismic lines. This is perhaps the easiest surface to identify on seismic lines in the deep-water setting, among all types of surfaces that may form in that setting.

**Comment [OC5]:** This is the correlative conformity of Posamentier et al. This surface cannot be abandoned, as it is used by a significant proportion of the stratigraphic community. All comments made above under "Correlative conformities" are valid here as well. This BSFR falls under the family of correlative conformities.

**Comment [OC6]:** This « consensus » needs to be validated by people who use this surface, such as Posamentier, Bhattacharya, Plint, Nummedal, and many others. I must have missed this discussion during the workshop. It is difficult to reach a **meaningful consensus** unless all groups are represented in the discussion. This is why it is so important that working groups need to be **inclusive**.