Two Categories of Unconformity-Bounded Stratigraphic Units Require Nomenclatural Clarity

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As unconformities became recognized as integral parts of the stratigraphic record, multiple terminologies have developed to describe/define rock bodies whose main characteristic is being bounded by unconformities. The International Stratigraphic Guide (Salvador, Ed., 1994) has adopted the term *synthem*, while the North American Code on Stratigraphic Nomenclature (1983) has adopted the term *allostratigraphic unit*. While both acceptance and terms have seen moderate application, the literature is replete with a third term, *sequence*, which has given its name to an overwhelmingly successful methodology to analyze (part) of the stratigraphic record, i.e., sequence stratigraphy. While at its inception the term sequence was applied strictly to unconformity-bounded units (Sloss, 1963), the concept behind the word has involved to now describe a stratigraphic unit that is complex, and comprises two parts, a part which is unconformity-bounded plus its basinward extension said to be bounded by the "correlative conformities". Although generally referred to as sequence, this is fully described under the name of *depositional sequence* (Mitchum, 1978; Van Wagoner et al., 1988).

Although slightly different from one another, the concepts of synthem and allostratigraphic unit are close enough to be encompassed by the single concept of stratal sequence (Berggren et al., this volume) which differs markedly from that of depositional sequence. The former are strictly and solely recognized on the basis of their bounding unconformities. The latter is defined additionally by its correlative conformities, and also comprises a characteristic succession of beds referred to as systems tracts. The correlative conformity is however the element of the depositional sequence that makes it a complex stratigraphic unit, fundamentally different from the stratal sequence. In addition to being an unconformity-bounded unit, a depositional sequence is a chronostratigraphic unit, because depositional history is postulated to be linked to the history of global sea level change.

Unconformities, either clearly marked by a lithologic contact or inferred through integrated stratigraphic methods (e.g., graphic correlation, temporal interpretation method), are easily discovered and documented in the stratigraphic record. They can be said to be objectively discovered. The correlative conformities on the other hand, are not easily delineated. Ideally, as in the model of a depositional sequence, the correlative conformity is discovered as the stratigraphic gap between two successive sequences narrows basinwards. Contrary to a widely held belief, the correlative conformity does not need to be located in a continuous conformable succession. The role of the correlative conformity is to constrain the timing of the sea level fall that caused the sequence boundary to form in the first place. The shorter the hiatus associated with the gap, the more precise the timing of the eustatic event. If the gap can be reduced to a single horizon, the horizon dates the event itself. In this perspective the conformity is genetically correlative with the unconformity at the sequence boundary. In no circumstance should the correlative conformity be seen as stratigraphically correlative with the unconformity itself.

While the depositional sequence is modeled as a predicted response to the dynamics of relative sea level change, direct analysis of the stratigraphic record has not demonstrated that the model holds. The tracing of unconformities in downslope transects has not produced the decreasing stratigraphic gaps predicted by the model. Indeed, in many instances, the stratigraphic gaps increase downdip, and unconformities in the deep sea (~1000 to 4000 m) would appear to correlate with unconformities on the margins. In such circumstances, the timing of the sequence boundary formation may be deduced through the use of proxy-indicators for global sea level change. This methodology has been quite successful in linking Neogene depositional sequences to eustatic history. Eustatic events are signaled by $\delta^{18}O$ enrichments in deep sea records. When these correlate with stratigraphic gaps at sequence boundaries in marginal settings, they provide an explanation for the sequence boundary formation. In such cases, the stratigraphic level where a $\delta^{18}O$ enrichment occurs constitutes, by extension, the correlative conformity of the sequence boundary. If so, the correlative conformity can be said to be subjectively discovered. It can also be said that the model of a depositional sequence is not so much an architectural model as a genetic one. This implies that the correlative conformity is not an integral part of the sequence in the descriptive sense, but a stratigraphic horizon inferred from a depositional mechanism. In other words, the correlative conformity does not need to be mappable as part of the depositional sequence. It may be as virtual as parallels of latitude and meridians of longitude, but like them it serves a critical purpose. While acceptable, at least in principle, for times when global sea level changes unquestionably

occurred, this purpose may be dubious when eustatic changes are unproven for lack of a sound mechanism. It remains to be demonstrated that depositional sequences formed simultaneously worldwide during times when ice caps were minimal or nonexistent (e.g., in the late Paleocene-early Eocene). In the absence of a driving mechanism for eustatic changes it is unclear how to recognize a correlative conformity, if this concept has any significance at all in a greenhouse world. Because the same pattern of depositional sequences is seen on continental margins throughout the Phanerozoic, whether under ice-, doubt-, or greenhouse conditions, it appears premature to explain the architecture of this stratigraphic record essentially in terms of eustasy. Yet, it is postulated that eustasy gives sequence stratigraphy its chronostratigraphic significance, and this significance is entirely rooted in the concept of the correlative conformity.

If the correlative conformity is not a mappable part of the depositional sequence, this latter is best described as an unconformity bounded unit, perhaps similar to a stratal sequence (read synthem). There are at least three elements, however, that differentiate the two. First, the depositional sequence has a characteristic structure, described as systems tracts. Second, the depositional sequence is described in terms of changes in base level. In contrast, the stratal sequence has no intrinsic structure and its genesis is unstated. Third, unlike the depositional sequences, the stratal sequence comprises sedimentary packages that extend from the shelves to the deep sea basin and are deposited through unrelated sedimentary processes. Regrouping all unconformity-bounded units under a single term would thus blur the subtle but fundamental differences that exists in the manner in which the stratigraphic record is described by these two categories of stratigraphic units. Furthermore, the use of the single term sequence to encompass all unconformity-bounded units would demand serious alteration to the practice of sequence stratigraphy, and necessitate the formal recognition that this methodology has no chronostratigraphic significance. Extending the concept of a depositional sequence to include deep sea packages appears premature, as this would require that a depositional sequence be deprived of its correlative conformity, which in turn would deprive sequence boundaries of their chronostratigraphic significance, which is the essence of sequence stratigraphy as practiced by many workers.

Accepting assumptions about the relationships between sedimentary packages bounded by unconformities and eustasy, is delaying a true understanding of the forcing mechanism(s) that shapes the stratigraphic record. Depositional sequences are fit to describe sedimentary packages on continental margins, but sequence stratigraphy fails to describe their relationship with deep sea sediments, at least for the Cenozoic. The discussion above suggests that a dual terminology is needed to encompass the two categories. One category is the depositional sequence, the other the stratal sequence (or synthem, or orthosequence) as discussed in Berggren et al. (this volume).

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