Lessons from the Lower-Middle Triassic Sequence Boundary

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A sequence boundary, which is dated as very near the Early-Middle Triassic boundary, can be recognized throughout the Sverdrup Basin of Arctic Canada. On the basin margins the boundary is a significant erosional surface which separates fluvial strata below from transgressive, shallow shelf strata above. On the basis of these relationships, plus the occurrence of large cobbles to boulders of sandstone and chert in the basal transgressive beds, the unconformity surface is interpreted to be a shoreface ravinement which has eroded through a subaerial unconformity. Notably, no trace of the preceding subaerial unconformity has ever been found and the preserved, unconformable portion of the boundary is everywhere a shoreface ravinement.

Farther basinward, the unconformity separates shoreface strata below from shallow shelf strata above. Eventually the unconformity disappears basinward and one is left with the problem of deciding what stratigraphic horizon is best used as the "correlative conformity" portion of the boundary. The only stratigraphic horizon which can be objectively recognized at every locality, has a low diachroniety and joins the basinward terminus of the unconformity is the maximum regressive surface which separates regressive strata below from transgressive strata above. Thus there is little choice but to use this stratigraphic surface as the correlative conformity. A short distance basinward of the terminus of the unconformity, the maximum regressive surface lies within a shoreface sandstone unit and is placed at the horizon where a deepening-upward (i.e. transgressive) trend begins near the top of the unit. Basinward, the surface lies within shelf strata and can be readily determined through sedimentological analysis. Notably a thin shelf sandstone unit is found quite far basinward beneath the boundary indicating that the progradation rate directly before the start of transgression may have been relatively high.

Another feature of the Lower-Middle Triassic sequence boundary in the Sverdrup Basin is that it separates two very different depositional regimes. A high influx of clastic sediments and the progradation of thick deltaic units dominated the entire Lower Triassic. This regime ended abruptly at the sequence boundary and was replaced by a low sedimentation shelf regime characterized by dark, organic rich shale and calcareous sandstone.

The question of whether tectonic uplift or eustastic sea level fall was the dominant factor in the generation of the boundary can be approached by examining detailed correlations of small scale stratigraphic surfaces in the area where the boundary passes from an unconformity to a correlative conformity. It is seen that most of the correlation lines parallel each other with almost all of the landward thinning occurring in the sandstone unit at the top of the sequence. This indicates that tectonic tilting rather than eustatic fall was most likely responsible for the exposure of the basin margin and that uplift occurred over a very short time interval compared with the length of the sequence. The very dramatic and abrupt shift in the depositional regime and subsidence patterns across the boundary also strongly suggests that the boundary was mainly or entirely the product of short-lived tectonics.

These insights lead to the interpretation that the base level curve for this interval was not sinusoidal as is usually assumed, but rather was one of slow base level rise in the Early and Middle Triassic with a significant spike of rapid fall followed by rapid rise in the boundary interval. This interpretation has important implications for basin modeling if such a motif characterizes long-term base level movements in other basins.

The Lower-Middle Triassic sequence boundary has been recognized in numerous basins and on most continents. Notably, in almost all instances, it separates two very different depositional regimes. The global occurrence of the boundary might at first suggest that eustasy played a major role in its development. However, the characteristics of the unconformity in the Sverdup Basin and elsewhere indicate that tectonics was the main factor in its origin. This leads to the inescapable conclusion that "global" sequence boundaries can be generated by tectonics and do not necessarily require eustatic sea level falls for their generation. A significant change in the direction and/or rate of sea floor spreading at the edge of one plate might well translate into a global readjustment of tectonic stresses and the occurrence of marginal uplifts on the flanks of numerous basins on different plates.

In conclusion, the Lower-Middle Triassic sequence boundary teaches us a few interesting lessons. These include:

1) The unconformable portion of a major sequence boundary may be entirely of shoreface ravinement origin.
2) The maximum regressive surface, which separates regressive strata below from transgressive strata above, is the logical and practical choice for the correlative conformity portion of a sequence boundary.
3) The shape of a long-term base level curve may be one completely dominated by rise with intervals of fall being very short-lived.
4) A sequence boundary that is found on most continents may be generated mainly or entirely by tectonic uplift. Eustatic fall does not necessarily play a role in the occurrence of a "global" sequence boundary.