BIOLOGICAL AND EVOLUTIONARY RESPONSES TO TRANSGRESSIVE-REGRESSIVE CYCLES

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Transgressive-regressive cycles involve environmental change and therefore, under the predictions of the theory of natural selection, biological response is expected. The nature, magnitude, and instrumentation of that response is, however, less well understood and difficult to predict. Generally the magnitude of biological response would be expected to be a direct function of the magnitude of the environmental change produced by alterations in sea level. However, this may not be the case. Moreover, the magnitude of environmental perturbation seen may itself not be a direct function of the magnitude, range, or even rate of sea level rise or fall.

Biological responses to transgressive-regressive cycles are highly variable, yet may be empirically demonstrated. Although the reality of faunal changes can be observed, the precise forcing mechanism or mechanisms driving those changes may be hypothetical at best. The observed iterative morphological series seen in shallow water Jurassic ammonites, for example, appear to be produced by a complex interplay of species adaptation to changes in local habitat and response to immigration from oceanic realms, both of which are ultimately driven by relative sea level. Likewise, changes in diversity and species composition in Devonian shallow marine communities appear to be produced by the effect of variable sedimentation rates and shifts in the oxygen minimum zone, both of which also are related to changes in relative sea level.

Published onlap-offlap sequence curves, as such, may offer very little to the paleobiologist interested in the evolutionary behavior of marine organisms. Additional geographic and areal data are required if any rigorous quantitative relationship between relative sea level and evolutionary biology is to be formulated. In the Devonian, for example, it can be demonstrated that a total lack of correlation exists between the evolutionary biology of major benthic marine organisms (brachiopods) and relative sea level as projected from onlap-offlap curves. It could be hypothesized that the rate of change of sea level is more important to organisms than relative sea level itself, though most hypotheses concerning the biological effect of sea level are explicitly framed in terms of relative sea level (usually invoking the species-area effect). Again, onlap-offlap curves alone offer little in testing such a rate hypothesis, as it can also be demonstrated that no correlation exists between the derivative of the Devonian relative sea level curve and the evolutionary biology of the Brachiopoda.