Estimating the Magnitude of Sea Level Change

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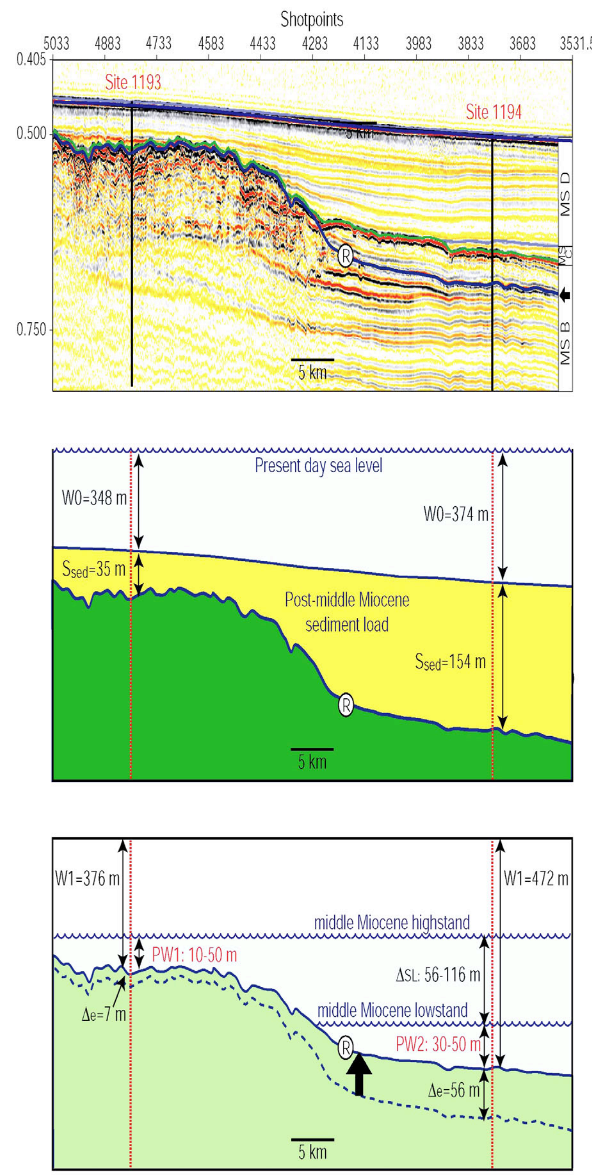
Throughout geologic time, ocean shorelines have repeatedly advanced and retreated. Scientists have used many methods to study these sea level changes. These analyses often agree on the timing of changes, but significant differences remain between estimates for the amount of sea level change that occurred during these events. Quantifying the magnitude of global sea-level fluctuations has proven to be a difficult problem, whose resolution is essential for establishing an accurate global sea-level curve and interpreting sediment sequences on continental margins.

A primary goal of Leg 194 drilling was to provide an accurate estimate for the magnitude of the major late middle Miocene sea level fall that occurred between 11.8 – 5.6 million years ago using carbonate platform sediments from the Marion Plateau off northeast Australia. Carbonate platform sediments (e.g. algae, corals) are highly sensitive to changes in environmental conditions, such as water depth, and thus provide fundamental information on sea level change. The estimate provided by Leg 194 sediments enables the calibration of an important part of the global sea level curve.

The diagram illustrates the relationship used to calculate the magnitude of the late middle Miocene fall using ODP Sites 1193 and 1194. The top panel displays the relevant seismic section used to determine the relationships between sediment packages. On this section, the middle Miocene carbonate platform penetrated at Site 1193 appears on the left. In addition, this image shows the early-middle Miocene shallow-water carbonate ramp, which interrupts intervals of deeper water sedimentation, drilled at Site 1194. This ramp occurs above the older early Miocene depositional surface labeled "R" and was deposited during a period of low sea level in the middle Miocene that exposed the carbonate platform top at Site 1193. Thus, this ramp was deposited subsequent to the top of the adjacent carbonate platform.

The middle panel shows the present day relief between the top of the high sea level (highstand) platform at Site 1193 and the base of the low sea level (lowstand) system at Site 1194. The lower panel shows the adjustment of the relevant depositional boundaries (the top of the carbonate platform at Site 1193 and "R") as a result of sediment expansion after removal of the post-middle Miocene sediment load. Paleo seafloor depths during the middle Miocene highstand and lowstand were predicted using the skeletal remains of organisms contained in the sediment. The results demonstrate a sea level lowering of 86±30 meters in the late middle Miocene.

A sea level fall of approximately 86 meters during the late middle Miocene estimated from these sediments recovered by Leg 194 is similar to estimates derived from other evidence, such as oxygen isotopes, yet is greater than the magnitudes estimated from sediment sequences off the New Jersey margin. Thus, although the sea level estimate determined from Leg 194 drilling has provided an important calibration for the global sea level curve, questions still remain as to why values calculated from different depositional environments do not agree.



W1=present day water depth; S=thickness of post-middle Miocene sediment load; PW=paleowater depth estimated from biotic assemblage; De=sediment expansion (reduced water depth); DSL=magnitude of eustatic fall.