Correlation of Organic Carbon Deposition in the Monterey Formation to Miocene Climatic Events Based on an Integrated Multi-Discipline Age Model

Gregg Blake
Blake Geological Services LLC

9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

The Monterey Formation is an extremely complex lithostratigraphic unit consisting of siliceous and calcareous biogenic sediments deposited in marginal basins formed in the late Oligocene to early Miocene. Deposition of the Monterey Formation occurred during an important time in the climate and oceanic evolution of the Neogene; the transition from a relatively warm greenhouse climate in the early Miocene to cooler temperatures of icehouse climatic conditions during the middle to late Miocene. This cooling event is associated with global paleoclimatic and oceanic changes that resulted in the deposition of organic-carbon rich sediments into the marginal basins of California and around the Pacific margin. It has been proposed that deposition of these organic-rich units is one of the drivers of the cooling trend.Based on climate proxy signals $\delta^{13}C$ and $\delta^{18}O$ from several sites in the Pacific Ocean, there appears to be three distinct climate phases developed in the Miocene. Phase 1 corresponds to the early Miocene climate optimum (prior to 14.7 Ma) and consists of peak minimum values in $\delta^{18}O$. Phase 2 (~14.7 to 13.9 Ma) starts the long-term trend towards heavier $\delta^{18}O$ values associated with punctuated climate cooling and onset of the last and most pronounced $\delta^{13}C$ increase and entry into icehouse climatic conditions. Phase 3 continues after 13.9 Ma, when $\delta^{18}O$ exhibits a long term increasing trend and final entry into icehouse climatic conditions. Initially in this 3rd phase, $\delta^{13}C$ displays the highest values of whole middle Miocene at 13.8-13.6 Ma and could be related to the deposition of the organic-rich

source intervals in the Monterey. The Naples Beach section is an excellent location to test the synchronicity between the land-based Miocene depositional record and the oceanic climatic signals. The Naples Beach exposure contains the entire interval of the Monterey formation, (age range of ~ 17.85 to 7.5 Ma) and has limited diagenetic effects which provides the potential for the integration of age control from microfossils, magnetostratigraphy, tephrachronology, carbon and oxygen isotope chemostratigraphy, and strontium isotope stratigraphy. In the Naples Beach section, based on oxygen isotopic results and the integrated age model, the major increase in $\delta^{18}O$, associated with organic carbon-rich deposition, correlates to the middle Miocene oxygen isotopic increase, dated at 13.9 Ma and may represent the change into the icehouse climatic conditions. The refined age model built with the integration of this multi-discipline approach allows for oxygen isotopic correlations of these organic carbon-rich intervals within the Naples Beach section and the deep sea climatic record that suggest episodic increases in organic carbon deposition along the continental margins coincided with deep sea $\delta^{18}O$ and $\delta^{13}C$ maxima and synchronous global cooling events including the start of the major middle Miocene cooling.