Development and Evolution of the Tertiary Benthic Foraminiferal Stages of California

Richard J. Behl[1] and Gregg H. Blake[2]

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[1]Professor Emeritus, California State University Long Beach, richard.behl@csulb.edu
[2]President, Blake Geological Services LLC, former Unocal and Murphy Oil, ghblake51@gmail.com

Abstract

In the early 20th century, oil and gas exploration initially found productive reservoirs in certain stratigraphic intervals that could extend across fields and basins. After the surficial structural features had been explored in the 1920s, the utility of foraminiferal biostratigraphy was demonstrated, and soon after, it was applied to the development of petroleum fields in California. The role of foraminiferal biostratigraphy became increasingly important in understanding subsurface structure and stratigraphic correlation between reservoirs. The tectonic imprint on California stratigraphy created a challenge for early exploration, especially where identifying and correlating key strata was difficult because of dramatic changes in lithologic character, depositional extent, thickness, and structural position of important reservoir units.

For the remainder of the century, petroleum geologists in California relied chiefly on identifying assemblages of benthic foraminiferal microfossils extracted from core, cuttings, and outcrop to identify biostratigraphic zones and date important stratigraphic intervals. However, because of commercial competition between oil companies, these biostratigraphic correlations and zones were proprietary and remained confidential.

It wasn't until Kleinpell (1938) divided the Miocene, Natland (1952) for the Pliocene and Pleistocene, and Mallory (1959) for the Lower Tertiary was a “public” biostratigraphic framework developed for the Cenozoic of California, consisting of 16 stages that are defined by a series of unique benthic foraminiferal provincial zonations (Figure 1). These stages have formalized names based on their type localities where stratigraphic relationships with subjacent and superjacent assemblages are well preserved, sedimentation is conformable, and the zones can provide intra- and inter-basin correlations.

With the advent of deep-sea drilling during the 1960s and 1970s, the stratigraphic significance of other microfossil groups, such as planktonic foraminifera, calcareous nannofossils, and siliceous microfossils (diatoms and radiolarians), became important. Zones were developed and applied, providing worldwide correlations, and eventually tied to radiometric dating. Several integrated biostratigraphic and

chronostratigraphic studies of the California Cenozoic stages have resulted in high-resolution stratigraphic correlations between the stages and the ability to correlate to deep-sea sequences.

This presentation will also be a virtual field trip to many of the type locations of the Cenozoic stages found throughout central and southern California. It will include a presentation of their geographic, stratigraphic, and historical context, with historical maps, modern outcrops, and aerial imagery.