MILAM, ROBERT, and JAMES C. INGLE, Stanford Univ., Stanford, CA

Paleo-Oceanographic Significance of Eocene Diatomites in Kreyenhagen Formation of California

Diatomaceous shales of the Kreyenhagen Formation underlie much of the western San Joaquin valley of California and contain a remarkable record of middle and late Eocene paleo-oceanographic events along the evolving continental margin of this region. The Kreyenhagen Formation is similar in many respects to the much studied Miocene Monterey Formation of California with both units constituting known or potential sources of mature hydrocarbons due largely to their unusual biogenic character and similar but not identical depositional histories. Lithofacies and biofacies patterns within the Kreyenhagen indicate that it was deposited at upper and middle bathyal depths with the occurrence of laminated diatomites marking the intersection of a well-developed oxygen minimum layer against continental slopes and basin sills analogous to Holocene continental margin settings off Peru, California, and in the Gulf of California. Quantitative analysis of benthic Foraminifera within a 565 ft (172 m) thick sequence of Kreyenhagen shale in the Tumey Hills area of Fresno County illustrates that three low diversity-high abundance biofacies, dominated respectively by *Bulimina corrugata, B. microcostata,* and *Bolivina spiralis,* are indicative of various slope and base-of-slope environments characterized by differing levels of dissolved oxygen as dictated by the thickness and intensity of Eocene oxygen minima. Moreover, *Bolivina spiralis* appears to be homeomorphic with *Suggrunda eckisi,* a Neogene species with an apparent affinity for oxygen minimum facies. The sequential appearance of massive and laminated diatomites and associated low oxygen megafaunal and microfaunal associations within the Kreyenhagen Formation allows estimates to be made of dissolved oxygen values in the Eocene water masses which, in turn, imply variations in climatically tuned rates of upwelling, siliceous productivity, and mid-water circulation as a function of the deteriorating global climate during middle and late Eocene time. Finally, the biogenic character of the Kreyenhagen diatomites within a Paleogene stratigraphic sequence otherwise dominated by terrigenous clastics suggests that deposition of this unit was coincident with a period of reduced flux of diluting terrigenous sediment to the continental margin likely induced by eustatic and/or tectonic adjustment of the Eocene strandline.

MILLER, PETER L., Chevron U.S.A. Inc., Concord, CA

Point Arena Coccolith Correlations with Mid-Tertiary California Stage Stratotypes

Previous provincial California stage designations for the Iversen-Skooner Gulch-Gallaway-Point Arena sequence do not appear to be the correct geologic age for these rocks in the Point Arena area of northern California. Time-transgressive "pseudo-Saucesian" benthic foraminiferal assemblages show little change in their gross composition through much of the deep-water Gallaway-Point Arena sequence near Point Arena, which includes middle Miocene strata.

About 30 mid-Tertiary coccolith taxa were recovered from 120 localities near Point Arena from Iversen-Skooner Gulch--Gallaway-Point Arena strata. The first occurrence (biohorizon) of *Sphenolithus heteromorphus* marks the base of the *Helicosphaera ampliaperta* Zone within the middle Gallaway Formation and serves as an important datum for correlation with California stage stratotype localities in central and southern California.

The Iversen Basalt appears to span the Oligocene-Miocene boundary. Revised radiometric dates for the Iversen Basalt indicate an average age of 23.8 Ma which is younger than the world Oligocene-Miocene boundary estimate of 24.6 Ma. Fossiliferous interbeds believed to occur within the lower part of this volcanic unit at inland localities contain the highest occurrence of *Dictyococcites bisectus* and *D. scrippsae.*

The stratigraphic distribution of coccolith taxa and the recognition of the *Sphenolithus heteromorphus* datum suggest that the Skooner Gulch and lower to middle Gallaway sequence is the early Miocene equivalent of the type Saucesian of Los Sauces Creek; that the middle and upper Gallaway and lower Point Arena Formations are the late early Miocene equivalents of the type Relizian section at Reliz Canyon; and that part of the Point arena Formation is equivalent in age to the early middle Miocene type Luisian Stage.

MOSELEY, CRAIG G., Arco Exploration Co., Denver, CO, DON A. WILLIAMSON, Exxon Co., U.S.A., Los Angeles, CA, and SUSAN T. MILLER, 135 Hedge Rd., Menlo Park, CA

Stratigraphy of Northeastern Cady Mountains and Its Implications for Cenozoic Volcanic Evolution of Mojave Desert

The Cenozoic rocks of the northeastern Cady Mountains can be divided into two separate sequences—an unnamed volcanic succession in the eastern Cady Mountains, and the volcanic and sedimentary strata of the Hector Formation in the northern Cady Mountains. In the eastern Cady Mountains, approximately 3,280 ft (1,100 m) of volcanic flows, flow breccias, domes, and laharic breccias overlie a basement complex of Mesozoic quartz diorite and quartz monzonite. These volcanic rocks have a continuous compositional variation from basaltic andesite to rhyodacite, although dacites and rhyodacites predominate. The age of this sequence is probably Oligocene and/or Miocene.

In the northern Cady Mountains, approximately 2,395 ft (730 m) of strata assigned to the Hector Formation (Oligocene? to Miocene) lie unconformably on a basement complex of Mesozoic quartz monzonite and metamorphic rocks. The upper part of the Hector Formation also unconformably overlaps the volcanic rocks of the eastern Cady Mountains. The Hector Formation consists of alluvial sandstone and conglomerate plus lacustrine and paludal sandstone, siltstone, mudstone, and limestone. Laharic breccias, ash-flow and air-fall tuffs, and andesitic to basaltic lava flows are interbedded with the sedimentary rocks.

Geochemical data indicate that the volcanic rocks from both areas are part of a calc-alkalic suite. The model proposed by various authors for the Cenozoic tectonic evolution of the western United States suggests that there should have been a transition from andesitic-type volcanism to basaltic-type volcanism, concurrent with the termination of subduction and the initiation of regional faulting. No such volcanic transition, however, can be identified within the northeastern Cady Mountains, nor has one been clearly identified in other late Oligocene to Miocene volcanic sequences within the Mojave Desert region. If this type of transition did take place within the Mojave Desert, it must have occurred after 18.6 ± 0.2 m.y.B.P. This is the date obtained from the youngest dated volcanic rock that is unquestionably part of the calc-alkalic suite observed in the northeastern Cady Mountains.