ear and nonlinear computer-simulation models. Ideal time sections for some of these models illustrate phenomena such as dip reversal, loss of domal character, incomplete unconformity contacts, and creation of faults. Modeling also is becoming increasingly important in reflection-seismic processing and interpretation. However, true progress with models will not take place until we appreciate and understand the limitations of the method, the primary assumptions that are essential, and the consequences of violating these primary assumptions.

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NEW DIMENSIONS: AMPLITUDE AND FREQUENCY MAPPING

(No abstract submitted)

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AUTOMIGRATION OF SEISMIC DATA

(No abstract submitted)

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FOSSIL DIATOMS AND SILICOFLAGELLATES FROM NEWPORT BEACH, CALIFORNIA, STUDIED WITH SCANNING ELECTRON MICROSCOPE

With the advent of the scanning electron microscope (SEM) a new dimension was opened to the micropaleontologist. At its maximum useful magnification of 50,000 diameters, the SEM offers a depth of field of about 10 μ and a resolution of about 200 Å, whereas the optical light microscope, at its maximum useful magnification of 1,300 diameters, offers a depth of field of about 0.5 μ and a resolution of about 2,000 Å. Inasmuch as the classification of diatoms and silicoflagellates is based on the general and detailed characters observed with the light microscope, the use of the SEM must be viewed as an extension of the facilities offered by the light microscope. Ten species of diatoms and silicoflagellates from Miocene rocks, exposed at Newport Beach, California, have been studied with the light microscope and the scanning electron microscope. A comparison of the micrographs of the identical species taken with the two instruments clearly demonstrates the ability of the SEM to provide a more detailed description of taxa, a more precise circumscription of taxa, a separation of closely allied taxa, and a verification of many varieties of taxa.

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OCCURRENCES OF SILICOFLAGELLATES FROM CENTRAL NORTH PACIFIC CORES

Silicoflagellates are siliceous marine planktonic microorganisms which have never been a significant contributor to pelagic sediments. Consequently only limited investigations have been made on these microorganic remains from the deep-sea deposits of the world.

Eleven taxa and one new species of silicoflagellates were recovered from the central North Pacific cores collected above the RV *Thomas G. Thompson* in 1968. The lower lithologic unit of a gravity core, TT28-25, was assigned a Miocene age after careful comparison of previous worldwide records. This is the first time that such a Miocene assemblage has been recognized from mid-latitude North Pacific sediments. From other cores, Quaternary assemblages were noted, including a limited occurrence of *Mesocena* cf. *elliptica*. The most recent extinction of this species seems to coincide with the last appearances of *Dictyocha* cf. *ausonia* and a proposed new species, *D. subarctios*. Their stratigraphic distribution was examined critically in connection with the results of paleomagnetic-reversal records and data on other microfossils from the area.

It is suggested that silicoflagellates could become a useful tool for deep-sea biostratigraphy in the middle latitudes of the North Pacific Ocean.

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BENTHIC FORAMINIFERAL TRENDS IN PACIFIC-ANTARCTIC BASIN

Trawl samples collected in depths from 3,000 to more than 5,000 m allow the following conclusions.

1. The fauna consists mainly of large, widely distributed bathyal and abyssal Foraminifera. Most assemblages are more than 85% arenaceous, but between 3,000 and 4,000 m some assemblages are predominantly calcareous.

2. Species diversity, although variable, reaches a maximum of 37 at nearly 4,300 m. This maximum coincides with a peak in a diversity factor based on information theory; species equitability is highest at a slightly shallower level. Areal diversity trends are absent.

3. Eleven species are dominant both in abundance and consistency of appearance. Of these, only *Uvigerina peregrina disrupta* Todd is calcareous. *Hormosina robusta* (Pearcy) is the most characteristic species in the area. Other important forms are *Haplophragmoides umbilicatus* Pearcy, *Cyclammina pusilla* Brady, and *Recurvoides contortus* Earland. *Cyclammina orbicularis* Brady dominates the shallowest station (3,043 m), and *Reophax nodulosus* Brady is dominant at the deepest station (5,124 m).

4. Latitudinal and longitudinal transects indicate that *Cyclammina pusilla* and *Haplophragmoides umbilicatus* increase in relative abundance toward the south, *Reophax* spp. and *H. umbilicatus* increase toward the east, and *Psammosphaera fusca* Schulze increases toward the west.

5. On the basis of quantitative data available from the western Southern Ocean, a generalized benthic Antarctic foraminiferal zonation seems possible. Bathymetric plots of cumulative percentages of selected index species help in achieving such a zonation.

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PLEISTOCENE-HOLOCENE BOUNDARY IN SOUTHWESTERN INDIAN OCEAN

The Pleistocene-Holocene boundary has been determined in deep-sea cores from the southern Mozambique Channel area of the Indian Ocean. The boundary, dated by radiocarbon at approximately 10,000 years B.P., is defined by changes in the relative abundance of planktonic Foraminifera. These changes reflect a warming in the Holocene of a few degrees Celsius. The temperate species *Globorotalia inflata* (d'Orbigny) shows a marked decrease in relative abundance in the Holocene; it comprises about 20% of the planktonic foraminiferal population below the boundary and only 3% or less above. Simulta-

neously, the percentage of warmer water species shows an increase in the Holocene. *Neogloboquadrina dutertrei* (d'Orbigny) increases from about 5% of the population below the boundary to about 15–20% above, and *Pulleniatina obliquiloculata* (Parker and Jones) increases from less than 1% to 10%.

There is a significant increase in the radiolarian number in sediments of the Holocene.

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LATE QUATERNARY BIOSTRATIGRAPHY OF CORES FROM BENEATH CALIFORNIA CURRENT

A study of deep-sea cores, which approximate the extent of the California Current, indicates that faunal changes occur at or near the lithologic Pleistocene-Holocene boundary off San Francisco and Los Angeles, California, but generally below this boundary off Cedros Island, Baja California. In upper Pleistocene rocks there are (1) a marked increase of radiolarian tests per gram of dry sediment; (2) a sharp decrease in both planktonic foraminiferal tests per gram of dry sediment and in the median size of *Turborotalia pachyderma,* except off Los Angeles, where the trend is reversed; (3) an increase in the percentage of dextral-coiling *Turborotalia pachyderma;* (4) an influx of several rare planktonic foraminiferal species; and (5) a decrease in the relative abundance of *Globigerina bulloides* off San Francisco, of *Turborotalia pachyderma* off Los Angeles, and of *Globigerina quinqueloba* off Cedros Island, with a corresponding increase in relative abundance of *Globigerina quinqueloba* off San Francisco and Los Angeles and an increase of both *Neogloboquadrina dutertrei* and *Turborotalia pachyderma* off Cedros Island.

A period of seasonal warming in the early Wisconsin is indicated in the temperate Pacific Ocean. This assumption is based on the abundance of large temperate planktonic foraminiferal species per gram of dry sediment in the cores from off Los Angeles. This warming period correlates with the "warm interval" reported elsewhere.

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PRELIMINARY REVALUATION OF LATE MIOCENE BIOSTRATIGRAPHY OF CALIFORNIA[1]

Preliminary studies of the type Mohnian and Delmontian Stages and regional biostratigraphic studies of other late Miocene sections of California by the use of benthonic Foraminifera and fish indicate the following.

1. The Delmontian Stage of Kleinpell is correlative with his Mohnian Stage on the basis of the occurrence of (a) *Epistominella gyroidinaformis* (Cushman and Goudkhoff) in the lower part of the type Delmontian (this species does not range stratigraphically above early Mohnian in California); (b) *Bolivina hughesi* Cushman (=*Bolivina sinuata alisoensis* Cushman and Adams of others), *Bulimina delreyensis* Cushman and Galliher, and *Etringus scintillans* Jordan in the upper part of the type Mohnian in California; and (c) Late Miocene megafossils in the Santa Margarita Sandstone, which overlies with apparent conformity beds that are near, and correlate with, the upper part of the type Delmontian.

2. Kleinpell's *Bolivina obliqua* Concurrent-range Zone (Delmontian) overlaps the range of species characteristic of his subjacent *Bolivina hughesi* Zone in the type area of the Mohnian Stage and all other Mohnian zones at other localities in California.

3. Many of the species characteristic of his late Mohnian *Bolivina hughesi* Zone overlap both his subjacent *Bulimina uvigerinaformis* Zone and his superjacent *Bolivina obliqua* Zone.

4. Many of the species characteristic of his *Bulimina uvigerinaformis* Zone overlap both his subjacent *Bolivina modeloensis* Zone and his superjacent *Bolivina hughesi* Zone.

5. *Bulimina uvigerinaformis* Cushman and Kleinpell and *Bulimina delreyensis* Cushman and Galliher have the same stratigraphic range and appear not to range above "middle" Mohnian in California.

Therefore, all of Kleinpell's late Miocene concurrent-range zones are in need of revision or redefinition.

[1] Publication authorized by the Director, U.S. Geological Survey.

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FORAMINIFERA AND RUGOSE CORAL ZONES OF MISSISSIPPIAN-PENNSYLVANIAN LISBURNE GROUP, BROOKS RANGE, ARCTIC ALASKA[1]

Thin-section studies of outcrop samples from the Brooks Range show that the Lisburne Group ranges in age from Osagean (Early Mississippian) to Atokan (Middle Pennsylvanian), and can be divided into 15 microfossil zones (Bernard Mamet's zones 8 through 21). Although the foraminiferal fauna is impoverished, the resolution of the foraminiferal zones is finer than zones based on rugose corals. Also, the Foraminifera are in a much wider range of carbonate paleoenvironments than are the rugose corals.

Colonial rugose corals are relatively abundant in the Lisburne Group in shelf carbonates of Meramecian and Atokan ages. These beds can be subdivided by use of corals into faunal zones and used for regional correlation within the Cordillera of North America. In the Brooks Range, Lisburne Group shelf carbonates of Osagean, Chesteran, and Morrowan ages are relatively poor in colonial rugose corals and are zoned exclusively by Foraminifera.

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LUNAR REGOLITH AT TRANQUILITY BASE

(No abstract submitted)

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BUILDING AND USING COMPUTERIZED WELL-COURSE FILE IN OFFSHORE, GEOLOGICALLY COMPLEX FIELD

Computerization of the directional surveys for the Huntington Beach offshore field aided materially in successful secondary-recovery operations under adverse conditions. A very detailed and accurate geologic study of the reservoirs was necessary for waterflooding and steam-stimulation operations in the thick, intensely faulted sandstone sections.

The computer was used to recalcu'ate the directional surveys, interpolate the geologic markers, and establish

[1] Publication authorized by the Director, U.S. Geological Survey.