

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 REEVALUATION OF LATE MIOCENE BIOSTRATIGRAPHY OF CALIFORNIA¹

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 Goudkoff) 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.

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

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.

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FORAMINIFERA AND RUGOSE CORAL ZONES OF MISSISSIPPIAN-PENNSYLVANIAN LISBURNE GROUP, BROOKS RANGE, ARCTIC ALASKA¹

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 recalculate the directional surveys, interpolate the geologic markers, and establish

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