Cyclammina cancellata Brady shows marked variations of diameter and thickness in Holocene sediments from depths of 500 m to more than 3,500 m in the Peru-Chile Trench area. The mean diameter increases consistently to a maximum of 5 mm at 2,000 m. Fluctuations between 4 and 5 mm follow from 2,000 to 3,500 m, and a decreasing trend characterizes deeper samples. The mean thickness increases steadily downward to about 3,500 m where a slight decrease sets in.

Using mean diameter, thickness, and a ratio between both, populations of this study can be characterized as to depth zones. Thus, small and relatively thick forms appear at about 500 m; larger and proportionally thinner forms live deeper than 1,000 m; large but relatively thick specimens characterize depths of about 2,000 to 3,500 m; and somewhat smaller and thicker ones are typical for depths below 3,500 m.

Temperature may be the principal factor affecting size, because it increases markedly to about 2,000 m—which coincides with the greatest size change in the populations. In deeper water other factors may play a role. Oxygen, salinity, and nitrate values do not show significant trends. Pressure alone is not directly involved, because off southern California similar size variations occur in different depth zones.

ORVILLE L. BANDY, Dept. of Geological Sciences, Univ. of Southern California, Los Angeles, Calif., RICHARD E. CASEY, Dept. of Geology, San Fernando Valley State College, Northridge, Calif., and RAMIL C. WRIGHT, Dept. of Geology, Beloit College, Beloit, Wis.

GEOLOGIC SIGNIFICANCE OF *Prunopyle Titan* CAMPBELL AND CLARK

The radiolarian *Prunopyle titan* Campbell and Clark has been shown by Ingle to be an index of the upper Miocene in California. Its greatest abundance is within the upper Mohnian of southern California where it occurs with sinistrally coiled populations of *Globigerina pachyderma* (Ehrenberg), a cold-water index. In deep-sea cores from high latitudes, *Prunopyle titan* has an upper stratigraphic limit within what is termed by some authors the "Gauss Normal Magnetic Epoch" and a bottom limit below what has been termed the "Gilbert Reversed Magnetic Epoch." The range of *Prunopyle titan* is below the zone of *Pterocanium prismatium* Riedel; the latter is considered to be an index of the Pliocene.

In land sections, K-Ar dates indicate that the upper limit of *Prunopyle titan* is about 9–10 m.y. before the present; in deep-sea cores the upper stratigraphic level of *P. titan* is equated with an age of about 3 m.y. or less. At least three upper Miocene radiolarians are associated with *P. titan* in both its occurrences in deep-sea cores and in the upper Miocene of southern California. No Pliocene radiolarian indices occur in the *P. titan* zone of deep-sea cores. If the paleomagnetic record of deep-sea cores is correctly related to that of volcanic rocks, and the radiometric dates of the latter are valid, the radiometric dates for the later Tertiary marine section of California are about three times too old.

RICHARD P. STAPLETON, Dept. of Geological Sciences, Univ. of Southern California, Los Angeles, Calif.

ULTRASTRUCTURE STUDIES OF SELECTED BENTHIC FORAMINIFERA

Electron microscopy of benthic calcareous Foraminifera reveals the presence of a calcite layer on both external and internal test surfaces. This layer is analogous to the calcite crust which has been reported on external surfaces of planktonic Foraminifera. The crust was observed on two granular-walled species, *Nonionella scapha* and *Nonionella miocenica,* and on two radial-walled species, *Cancris indicus* and *Bolivina spissa.* On these four species, the crust is a very thin layer which occurs only on specimens from the greater depth ranges. Where no crust is present, test surfaces of granular- and radial-walled species have different appearances at high magnifications. However, crusts may cause surfaces on both groups to appear similar. On the radial-walled species *Bolivina argentea,* crust is noticeable on specimens from shallow water and becomes progressively thicker, reaching a maximum thickness of more than 4 μ at the lower end of the depth range. Specimens of *B. argentea* from a low oxygen environment have thinner crusts than specimens from a normal environment of the same depth. The crust is not a postmortem feature because it is found on specimens which have absorbed a rose bengal stain. The crust is generally thicker on early than on late chambers, indicating its probable secondary origin.

GERALD A. FOWLER and GARY E. MUEHLBERG, Dept. of Oceanography, Oregon State Univ., Corvallis, Ore.

TERTIARY FORAMINIFERAL PALEOECOLOGY AND BIOSTRATIGRAPHY OF PART OF OREGON CONTINENTAL MARGIN

Several thousand feet of late Tertiary marine sediments crop out across Heceta Bank on the central Oregon shelf. Rock samples from two east-west profiles (44°05′ and 44°10′ N) have yielded large, well-preserved foraminiferal faunas. The stratigraphic sequence of the samples has been determined using sparker subbottom profiles.

Two possible stratigraphic units are delineated on the basis of their foraminiferal content, seismic-reflection characteristics, and lithology. The older is characterized by *Bolivina seminuda foraminata, B. semiperforata, B. spissa, Bulimina subacuminata, B. subcalva, Buliminella* cf. *B. exilis, Epistominella pontoni californica,* and *Uvigerina peregrina;* less than 10 percent planktonic foraminifers; and right-coiling *Globigerina pachyderma.* This fauna represents paleodepths of 500–1,000 m and is dated as Pliocene. The younger unit is characterized by *Cassidulina minuta, Eilohedra levicula, Epistominella exigua, Nonionella* spp., *Trifarina angulosa,* and *Uvigerina juncea;* more than 50 percent planktonic foraminifers; and left-coiling *G. pachyderma.* This unit was deposited at depths of 100–200 m. This fauna could be Pliocene or Pleistocene. Paleoenvironmental data require minimal uplifts ranging from approximately 1,000 m for the oldest sampled strata to 100 m for the youngest. There was a general shoaling throughout the deposition of the units.

ORVILLE L. BANDY, Dept. of Geological Sciences, Univ. of Southern California, Los Angeles, Calif., and JAMES A. WILCOXON, Chevron Oil Field Research Co., La Habra, Calif.

CORRELATION OF MARINE MIDDLE TERTIARY STAGES OF CALIFORNIA WITH TROPICAL PLANKTONIC ZONES

The Oligocene-Miocene boundary is equated with