

cellent knowledge of Scandinavia and North Atlantic affairs, which among other things is revealed in many of his latitude provisions.

Smaller Misunderstanding: Maps belonging to this group also have American localities placed in Scandinavian regions. According to Enterline, they should be placed this way because the cartographic information about America that accrued to the south European map makers, reached them via connections from the Scandinavian peninsula. Because of lack of reports on where the information came from and what it depicted, the map makers believed that it might concern cartographic reports appertaining to Scandinavia. Since the Dane Clavus, who is also mentioned above, possessed an excellent knowledge of Scandinavia, his maps naturally cannot be grouped in this box either.

According to the above, the Dane Claudius Clavus' map does not fit into either of Enterline's two groups. Clavus' map is, in my opinion, the worst possible map example that Enterline could point out as proof for his theory about the Norse immigration to Arctic Canada and Alaska. However, even though Enterline's theory seems somewhat far-fetched to me, and even though the map examples by no means prove his theory, I nevertheless was delighted to read his account. It is rather refreshing to see problems illuminated in an untraditional manner.

*Ib Rønne Kejlbo*

**MARINE SEDIMENTS OF THE SOUTHERN OCEANS.** BY H. G. GOODELL *et al.* *Antarctic Map Folio Series No. 17.* New York: American Geographical Society, 1973. 11 x 17 inches, 18 pages, illustrations. \$11.00 U.S.

The publication last year of this long-awaited folio on the *Marine Sediments of the Southern Oceans* is a welcome addition to the fast growing knowledge of the seas surrounding Antarctica. It seems logical and appropriate that the publication of this folio followed those on hydrography, chemistry, topography and biology of the Southern Ocean. These folios have set the stage for the material included in the present folio; one wishes to commend the publishers of the Series for such good planning. For, as we learn from this folio, in order to study the oceanic sedimentary deposits around Antarctica, it is essential to know the topography and structure of the sea floor, as well as the circulation of the water masses above and the planktonic orga-

nisms living in the water column. In recent years, it has become increasingly difficult to isolate marine geology from the province of marine geophysics, or from the domain of the water above. The present folio is a good example of the close interrelatedness of the physical/chemical/biological disciplines and their bearing on some of the unique phenomena of the Southern Ocean.

The folio is divided into four sections: *The Sediments*, by H. G. Goodell; *Sediments Isopachs in the Indian and Pacific Sectors (105° E. to 70° W.)*, by R. Houtz *et al.*; *Distribution of Foraminifera in the Surface Sediments*, by R. J. Echols and J. P. Kennett; and *Distribution of Planktonic Diatoms in Surface Sediments of the Southern South Pacific*, by J. G. Donahue. Each section is separate with its own introduction, historical background, discussion, references and data sources.

Although marine sedimentological investigations of the oceans surrounding Antarctica date back to the H. M. S. *Challenger* Expedition (1873-1876), it was not until the arrival of the U.S.N.S. *Eltanin* on the scene a little more than a decade ago that research in marine geology and sediments of the antarctic and subantarctic regions gained considerable momentum and intensity.

Based on the extensive material taken by the *Eltanin*, which is by far the most comprehensive bottom samples ever collected by a ship in the Southern Ocean, Goodell provides a detailed map of the bottom sediments of the circumantarctic. The sediments distribution, arranged concentrically, is as follows: (a) shelf and coastal deposits; (b) clayey silts and silty clay; (c) silicious ooze, mostly diatoms with radiolarians; (d) calcareous silicious ooze with both types of test exceeding 30%; and (e) calcareous ooze, mostly foraminiferal. The map shows the significant effect of the Antarctic Convergence in delineating the silicious ooze to the south from calcareous ooze to the north, with a zone of intermixing up to 600 kilometres wide south of Australia. Also, with regard to the convergence, it is stated that "the highest rates of productivity are along the Antarctic Convergence". This view is shared by other marine geologists, but it lacks accuracy. The extensive productivity data collected by this reviewer, and by many others during the past decade, have shown that, by and large, the most productive waters are near the Antarctic continent, and the least productive along the Antarctic Convergence. However, it is possible that the instability of the water column at the convergence, together with other factors militating against growth of phytoplank-

ton and leading to their eventual death, could have contributed to the heavy sedimentary deposits at the convergence. One also should not rule out the shifting of the Antarctic Convergence during geological history<sup>1</sup>.

The sediment cover is less than 100 metres over the ridges, but about 2 kilometres or more adjacent to the antarctic continent. The rate of sedimentation varies from zero in the regions where the circumpolar current coincides with the mid-ocean ridge system, to as high as 2.5 cm./1000 years on the Antarctic continental rise (glacial marine sediments), and in the regions of the biogenic oozes.

The distribution of the ferromanganese nodules, plotted in one plate, is of considerable potential value though the prospect of their exploitation still seems remote; a second plate is devoted to photographs of the sea floor. These nodules occur in a belt as much as 500 km. wide and are found on top of all types of sediments, in depths of water between 1000 and 5000 metres.

In the section on *Sediment Isopachs*, the Lamont-Doherty investigators provide us with a hitherto unpublished map of the isopachs for the central Tasman Sea, Ross Sea, Balleny Islands regions and the Bellingshausen Sea. Land-derived sediments are generally transported downslope along the sea floor as turbid flows, covering the basement surface, and forming abyssal plains of nearly horizontal layers. The volume of these sediments exceeds that of pelagic sediments in the Southern Ocean, though an undetermined portion of the abyssal plain sediments consists of biogenic materials.

In the *Distribution of Foraminifera in the Surface Sediments* Echols and Kennett give a succinct history of foraminiferal studies in the Southern Ocean. They indicate that up until 1960 all studies were primarily taxonomic and descriptive in nature. It is only in the last decade or two that research in the taxonomy of these organisms has given way to quantitative studies of benthic foraminiferal distribution, and the environmental factors affecting their distribution. As a result, the importance of carbonate solution in determining the distribution of Antarctic fauna was recognized. Thus, assemblages made up almost entirely of tests composed of calcium carbonate are restricted in their areal and depth distribution, while assemblages made up almost entirely of arenaceous tests are more widespread. The depth of effective solution was recognized at about 500 m. in the Ross Sea.

From the two maps showing the distribution of the planktonic foraminifera it is clear

that the areal distribution of these organisms is strongly controlled by the Antarctic Convergence. In comparing the living planktonic foraminiferal assemblages of the South Pacific and Southern Atlantic Oceans, which were discussed by Bé in Folio 11, one notes significant differences in the distribution patterns of living and dead planktonic foraminiferal assemblages; this the authors believe to indicate a recent climatic warming.

In the final section of this folio, Donahue discusses the *Distribution of Planktonic Diatoms in the Surface Sediments of the Southern South Pacific*. His main objective is to study the species distribution of the diatoms in surface sediments, and to compare them with established planktonic data.

Of the 66 samples of surface sediments (from the Pacific sector) studied by Donahue, 17 were barren of diatoms; these were taken north of the Antarctic Convergence. Donahue finds that, unlike foraminiferal assemblages, the distribution of the diatom species in the water column and in the sediments is essentially the same. A similar finding was arrived at by the late Kozlova<sup>2</sup> based on the diatom materials collected in the Indian and Pacific sectors of the Antarctic. Using statistical methods, Donahue is able to show that no single diatom community characteristic of the Antarctic Convergence exists.

In summary, the publication of this folio fills an enormous void in our knowledge of the sea floor of the Southern Ocean. The folio should have a wide appeal to marine sedimentologists, plankton students, physical and chemical oceanographers, not to mention those who wish to speculate on manganese nodules! Its modest price is a welcome surprise today.

It is indeed fitting that the publication of this review will coincide with the resumption of research programs on the *Eltanin* after nearly two years of dormancy. One would look forward with great anticipation to more new findings and new discoveries as the ship completes her circumpolar exploration of a region that has so much to offer the field of marine sciences.

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#### REFERENCES

- <sup>1</sup>Hays, James D. 1970. The climatic record of antarctic ocean sediments. *Antarctic Ecology*, 1:20.
- <sup>2</sup>Kozlova, O. G. 1966. Diatoms of the Indian and Pacific sectors of the Antarctic. Translated from Russian and published by U.S. National Science Foundation (originally published in Moscow, 1964).