

CONTINENTAL RISE OFF EAST COAST OF NORTH AMERICA: DEEP STRUCTURE

Gravity and magnetic measurements together with continuous seismic profiling have provided new information about the structure beneath the sediments of the continental shelf, slope, and rise off the east coast of North America. Free-air and simple Bouguer gravity anomaly charts were prepared for this region from data obtained on three cruises of the *R/V Chain* in 1968 and published submarine pendulum observations by Vening Meinesz and Worzel. The zero free-air gravity anomaly contour parallels the strike of the continental slope and is located over water depths ranging from 1,000 to 3,000 m. A continuous band of positive free-air anomaly values occurs over the landward side of the continental shelf. The maximum measured anomaly ranges from about +10 to +85 mgal along the band, and maxima occur near Cape Hatteras, off southern New Jersey, near 66° W long., and near 60° W long. Structure-model studies suggest that the positive anomaly band is caused mainly by a basement ridge beneath the edge of the continental shelf. The same structure models also suggest that the continental shelf and rise are largely in isostatic equilibrium, and that only crustal segments near the continental slope with widths of about 40–50 km are not in equilibrium.

Magnetic measurements made on various cruises of WHOI ships show that the continental rise and slope have a smooth magnetic anomaly field about 400 km wide. The anomaly amplitudes here are generally less than 200 γ except above isolated seamounts. West of this low-amplitude region, a belt of strong positive anomalies trends along the slope. East of the smooth anomaly region, an abrupt transition takes place to high-amplitude anomalies, commonly greater than 500 γ . Tentative correlation of these anomaly peaks suggests that the anomaly trend north of the New England seamount chain is toward the east and, south of the chain, toward the south-southwest. Model studies suggest that the top of the magnetic material that produces the anomalies observed across the abyssal plains could be the rough opaque seismic reflector beneath this area. Magnetic susceptibility contrasts within the basement material, rather than topographic effects, are required if the basement produces the observed anomalies. Sea-floor-spreading-type models were constructed using simple two-dimensional blocks of alternately positive and negative magnetized material and a spreading rate of 1 cm/yr. The region of low-amplitude anomalies is inferred to have a uniform negative magnetic polarity and to have formed during the Kiaman Magnetic Interval: a 50-million year period during late Paleozoic time when the geomagnetic field polarity was reversed. It is suggested that the belt of strong magnetic anomalies beneath the slope, but west of the low-amplitude anomalies, was formed during Early Permian time prior to the Kiaman Magnetic Interval.

DONALD W. BOYD, Geology Dept., Univ. Wyoming, Laramie, Wyo., and NORMAN D. NEWELL, American Museum of Natural History, New York, N.Y.

POSTMORTEM HISTORY OF A PERMIAN PELECYPOD ASSEMBLAGE FROM WYOMING

The full understanding of fossils must include consideration of their burial (taphonomy) and subsequent alteration (diagenesis). Analysis of time and mode of burial enhances interpretation of depositional environ-

ments. Furthermore, insight into diagenetic changes in fossiliferous rocks may be acquired from studies of physical changes in fossils. Yet these important aspects of the history of fossils commonly are neglected in both paleontologic and petrologic studies.

Field and laboratory studies of "silicified" Permian bivalves in Wyoming have provided a complex case history of one fossil assemblage. These surficial and shallow-burrowing pelecypods commonly are broken and randomly scattered through about 6 in. of calcarenite. Circumstantial evidence suggests that the bottom disturbance was caused by rooting predatory fish. Subsequently, valves were dissolved selectively from hardening sediment not far below the sea bottom.

Induration of sediment and removal of buried shells apparently took place during an interruption in sedimentation. At that time burrowers penetrated the bottom and introduced younger quartz sand and fine shell debris into the substrate and into some of the shallowest molds of valves. The infilling produced detrital casts. Unfilled molds then were lined with precipitated fine-grained quartz, chalcedonic laminae, and euhedral quartz crystals, as in geodes. Such "silicified" fossils are essentially silica casts rather than the result of replacement in the usual sense.

Finally, the fossiliferous stratum was buried under a new increment of pebbly, calcareous quartz sand similar to that of the detrital casts below the now-obscure stratigraphic discontinuity.

DANA B. BRAISLIN, Union Oil Co. of California, Los Angeles, Calif.

GEOLOGY OF PART OF OUTER CONTINENTAL SHELF OFF OREGON

Since 1960 the outer continental shelf off Oregon has been actively explored by petroleum companies. Initial surveys between Cape Blanco and the Columbia River established the presence of a thick Tertiary rock sequence within a framework of several composite offshore basins. Gravimeter and magnetometer results indicate the existence of more than 20,000 ft of relatively homogeneous section in Tertiary depositional centers beneath the shelf. A decrease in the amount of interbedded volcanic rock offshore has encouraged exploration of the offshore Tertiary basins.

Detailed exploratory programs, including conventional seismic, sparker, and gas-exploder surveys, reveal numerous well-defined structural trends and many large-size anomalies. Shallow core drilling and ocean-bottom sampling established a composite thickness of more than 8,000 ft of late Miocene, Pliocene, and Pleistocene deposits which are not present in the adjacent coastal area. Diagnostic foraminiferal assemblages have been found in much of the Tertiary column. Absence of overburden on submarine banks off the central and southern parts of the coast makes it possible to map the formations exposed on the ocean floor. The oldest rocks penetrated on the shelf are believed to be of middle Eocene age. Several important unconformities are recognized in the offshore stratigraphic column.

In October 1964 the Federal government offered 1,090,000 acres off Oregon and Washington for competitive oil and gas lease. The total bonus received from this sale was \$35.6 million, of which \$27.8 million was for leases off Oregon.

To date, eight exploratory wells have been drilled totaling 71,149 ft of hole; however, no commercial production has been reported. Many large structures re-

main untested, but most lands acquired at the 1964 sale have been quitclaimed. Although source rocks are distributed throughout the section, a lack of permeable reservoirs has been discouraging. Despite the negative aspects, the writer believes that the area has much exploratory potential. Another industry exploration cycle is anticipated in the not too distant future.

R. G. BRAY and J. R. BEERBOWER, Dept. Geology, McMaster Univ., Hamilton, Ont.

PALEOECOLOGICAL ANALYSIS OF SOME MIDDLE DEVONIAN FOSSIL AGGREGATIONS

Fossil clusters in the Ludlowville Shale near Buffalo, New York, are nearly circular in bedding-plane outline and plano-convex (convex down) in cross section, the dimensions being about 1 m across and 2 cm thick. The clusters contain several brachiopod species and less abundant bryozoans, trilobites, crinoids, ostracods, bivalves, gastropods, and solitary corals. Their consistent presence across a considerable geographic area and their high diversity suggest that they are an *in situ* "life" assemblage, but their shape and distinct boundaries may be interpreted as evidence that they are not an *in situ* "life" assemblage.

The spiriferid brachiopod *Ambocoelia umbonata* was sampled quantitatively in successive 0.5-cm layers within the fossil clusters. Shell distortion, shell fragmentation, and valve ratios illustrate no vertical trends. Therefore these phenomena must be related to factors that have acted uniformly throughout the clusters. Consistent trends in shell disarticulation, shell position, shell density, and pyrite content are related to factors controlling cluster development. This relation, together with random beak orientations and bimodal size-frequency distributions, favors a biologic origin. The clusters apparently record establishment and succession of organisms on a soft substrate.

JAMES E. BROOKS, Dept. Geological Sciences, Southern Methodist Univ., Dallas, Tex., E. G. WERMUND, Mobil Research and Development Corp., Dallas, Tex., and THOMAS E. WILLIAMS, Dept. Geological Sciences, Southern Methodist Univ., Dallas, Tex.

SHALLOW SHELF SEDIMENTATION IN ROCK RECORD—INTRODUCTION TO SYMPOSIUM

A shelf is defined in *Webster's Third International Dictionary* as "1 a : a thin, flat, usually long and narrow piece of wood or other material fastened horizontally at a distance from the floor (as on a wall or in a frame) to hold objects"; and "2 : something resembling a shelf in form or position."

"Something resembling a shelf" in the contemporary geologic scene cannot be well defined. For example, modern continental shelves are defined in different ways by hydrographers, by geographers, and by geologists. Some describe the continental shelf as a surface marginal to continents and lying between the strandline and that place where the sloping surface of the lithosphere steepens toward a deeper part of the ocean basin, regardless of water depth. Others define the shelf as that surface between sea level and a particular depth (commonly 100 fm), irrespective of steepening of the surface. Still others apply the term "shelf" to surfaces formed under the control of erosional, depositional, or structural agencies, or by various more specific biologic or sedimentologic agencies. In most cases, a surface so defined displays the same topographic

habit for a distance in either direction from the strandline. With so many apparent variations, can any consensus definition of "shelf" be established within the geologic community?

The presumably representative *AGI Glossary* and the pertinent literature demonstrate that the term "shelf" is applied to any shallow marine sediment. Examples include deposits formed in a great range of physical and tectonic environments. Among these are continental shelves, broad shallow intracontinental basins (epeiric seas), "stable shelves" at cratonic margins, shallow intracratonic basins, and various types of geosynclines. Physical environments in which shelf deposits form are neritic, littoral, and paralic.

For the purpose of this symposium, "shelf" is used in a broad sense. Shelf sediments are subaerial and submarine sediments which were deposited on a relatively shallow, uniformly, gently sloping surface which includes the marine-land interface of the strandline. The zone of shelf sedimentation as here defined is terminated landward and seaward by a perceptible change in the slope and topographic character of the depositional interface.

The purpose of this symposium is to bring together various contemporary viewpoints on shelf sediments. To this end authors representative of the various schools of thought and subdisciplines of shelf studies have been invited to contribute basic papers related to the geology, biology, and chemistry of shelves, or papers illustrating "typical" shelves from various parts of the rock record. It is hoped that such an enunciation of principles and examples will bring into focus the parameters that have controlled sediment accumulation in shallow seas associated with the continental masses and will lead to the construction of reliable theoretical models for their interpretation.

WILLIAM P. BROSGÉ, IRVIN L. TAILLEUR, and GEORGE GRYS, U.S. Geol. Survey, Menlo Park, Calif.

MINERAL RESOURCES OF NORTHERN ALASKA¹

Recent production tests near Prudhoe Bay on the Arctic coast show that northern Alaska is a potential major oil province. This potential was first recognized when oil seeps were reported in 1900. By 1930 favorable structures and rocks were known. During exploration of Naval Petroleum Reserve No. 4, gas was discovered in Lower Jurassic rocks at Barrow, oil in Lower Cretaceous rocks at Umiat, and gas in Upper Cretaceous rocks at Gubik. Now oil and gas have been found in Triassic and Mississippian rocks at Prudhoe Bay.

The oil-bearing section consists of Mississippian through Lower Jurassic shelf deposits derived mainly from a northern source, and of up to 20,000 ft of Jurassic and Cretaceous geosynclinal deposits derived mainly from the south.

The Jurassic and Cretaceous Colville geosyncline is bounded on the south by the Triassic and upper Paleozoic rocks of the Brooks Range and on the north by a rise in the pre-Mississippian(?) basement to a depth as shallow as 2,500 ft near Barrow. The stratigraphy of the geosyncline is characterized by northward regression of intertonguing marine and nonmarine detrital sedimentary rocks shed from a southern orogenic source. The structural complexity of the geosyncline

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