from the coastline to a depth of about 2,500 m, covers an area of about 1.4 million sq mi, approximately a third as large as the land area of the United States. However, knowledge of the geologic framework of this vast area is rudimentary, to say the least.

In broadest terms we know of a great prism of relatively undisturbed sedimentary rocks off the Atlantic and Gulf of Mexico coasts in contrast to a group of narrow basins of sedimentary rocks off the Pacific coast of California and Alaska. The Bering Sea and Arctic coast of Alaska also are underlain by thick accumulations of sedimentary rocks. With a total volume of about 2.5 million cu mi, these sedimentary provinces have a geologic composition, regional geologic framework, and tectonic setting that leave little doubt of a recoverable resource in excess of 100 billion bbl of petroleum liquids and 300 trillion cu ft of gas; and perhaps even in excess of 200 billion bbl of petroleum and 1,000 trillion cu ft of gas. Resources in place are many times greater than these recoverable estimates. Other known resources are salt dome sulfur on the order of several million tons, sand and gravel, shell, phosphorite, and a variety of placer deposits.

To develop these resources to the outer limit of the continental margin for the benefit of the economy of the United States will involve resolution of the worldwide problem of the seaward extent of the jurisdiction of maritime nations. It also will require geologic studies of the offshore areas infinitely more intensive than the studies of the past and the application of continually advancing techniques, both for exploration and ultimate development of the resources. Vision and bold action will be the guidelines.

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LACUSTRINE CRITERIA

Although among the least abundant of depositional environments represented in the geologic record, lakes exceed their limited occurrence in interpretive significance. Lacustrine rocks yield important information concerning paleogeography, paleoclimatology, and tectonics. Therefore geologists should seek to expand their ability to identify and interpret lacustrine environments.

Modern lakes are present in a variety of geologic settings, but most lakes are too small and ephemeral to be geologically significant. Only large, long-lived lakes, such as those in structural basins with interior drainage, can accumulate major lacustrine sedimentary sequences. The recognition of lacustrine rocks requires a variety of techniques. Inasmuch as unique criteria generally are lacking, the geologist must infer origin from scattered, commonly unrelated, and often contradictory data.

Lakes closely resemble shallow, epicontinental seas in physical properties. Large differences, therefore, in lithologic characteristics, sequences, facies relations, sedimentary structures, paleocurrent patterns, and other physical aspects should not be expected. Comparisons of these features from lacustrine and epicontinental rocks indicate the scarcity of significant diagnostic differences.

Large lakes and epicontinental seas differ mainly in size and chemistry. Size differences are evident; few lakes exceed 10,000 sq mi in area. Thus, regional stratigraphic and paleogeographic relations can be used to differentiate lakes and seas. Geochemical differences, however, are more definitive. Normal seawater has been relatively constant in composition for most of geologic history and changes related to evaporation, precipitation, or dilution are predictable. On the other hand, the chemistry of lacustrine water is not uniform, but is determined partly by lithology and climate in upland source areas. The geochemical balance of lakes, therefore, varies widely in different areas and rarely approximates that of seawater. Accordingly, lakes and seas can differ in authigenic and early diagenetic minerals. Especially useful are evaporite cycles.

Marine and nonmarine environments commonly are distinguished readily by their fauna. Paleontologic differentiation of nonmarine environments is uncertain, however, and requires further study.

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STUDIES ON SEDIMENTOLOGY OF SHELL BEDS ON BERMUDIAN PATCH REEFS

The upper surfaces of two patch reefs on the northern edge of the Bermuda platform were observed to consist of coral-coralline algal rock mounds amid a complex system of low-lying channels containing coarse- to fine-grained calcareous detritus. The rock mounds on the larger of the two reefs are noticeably concentrated toward the periphery. Detailed mapping of a part of one of these reefs indicates that the distribution of *Spondylus* valves and other coarse detritus bears a strong relation to the shape and width of the intermound channels. Oddly, 79% of the shells lay with the concave side up. The apparent preference for this generally unstable orientation is attributed to the lofting of shells during transport and the preferential burial of shells lying concave-side-downward.

The mode of the fine fractions of samples taken from shelly areas consistently is toward the right of the mode of samples taken from adjacent nonshelly areas. It thus appears that the shells act as baffles to permit the local deposition of fine sediment.

It is concluded that shell-bed sedimentology reflects the existence of two wave-energy regimes throughout the year. In winter, powerful storm waves determine the distribution of shell beds; calmer seas prevailing in summer months promote the preferential deposition of fines among the shelly material. Further, the rock-sand configuration on larger patch reefs suggests that the reefs may concentrate unimodal sand toward the center and bimodal sediments in the more narrow, circuitous, shell-rich channels toward the periphery.

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INTRA-PERMIAN CORROSION BRECCIAS, SOUTHERN CANADIAN ROCKY MOUNTAINS

An extremely widespread intra-Permian transgression eroded and successively truncated beds from Middle Permian (Guadalupian) to Mississippian (Meramecian) in age.

On this erosion surface are lag gravels in a phosphatic matrix, with associated corrosion breccias. The breccias are developed where planate beds of calcilutite, dololutite, and chert are infiltrated, corroded, and brecciated *in situ* by the phosphate and then partly or totally replaced by chalcedony. Fragments from the breccias may be incorporated in the overlying