Several earth-science societies—the Society of Exploration Geophysicists, Geological Society of America, Seismological Society of America, American Geophysical Union, and American Geological Institute, for example—have adopted programs designed to increase the number of black, Spanish-surname, Indian-American, and other minority groups in the geosciences. These programs include (1) special efforts to motivate minority youths of precollege age to study geology and related sciences when they leave high school; (2) providing summer and part-time jobs in industrial, governmental, and academic geoscience programs for high school and college minority students; (3) encouraging undergraduate and graduate scholarships for minority geoscience students in colleges and universities; (4) giving grants to colleges and universities that make special efforts to train minority geoscientists; and (5) eventually finding professional jobs in the geosciences in oil and mining companies, state and federal geological surveys, universities, and other institutions for qualified graduates. The aim of these programs, as for all programs of geoscience education, is to provide a continuous flow of talented young people from all racial, ethnic, and economic backgrounds into geology, geophysics, and related geosciences.

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### Sedimentary and Structural Characteristics of Lower Paleozoic Strata Adjacent to Buried Precambrian Topography in Southeastern Missouri

A mature Precambrian igneous topography in southeastern Missouri having a maximum relief of more than 2,000 ft was buried by Late Cambrian and Ordovician sediments, but is now extensively resurrected by stream erosion. Peripheral dips in sedimentary strata adjacent to the buried topography of as much as 34° are shown to be limited in lateral extent, and are interpreted as due mainly to the compaction of carbonate muds by as much as 25%.

Detrital igneous material ranging in size from fine sand to large boulders is locally abundant in some sedimentary units. Sedimentary breccias are common at the margins of depositional basins bordered by Precambrian ridges. These breccias are attributed by Snyder and Odell to submarine sliding on slopes of as little as 4°. Algal and stromatolite reef facies are developed at the margins of the depositional basins, and appear closely related to the Precambrian topography which apparently existed as islands or shoal areas in early Paleozoic seas.

Joints and fractures developed in sedimentary strata exhibit both radial and tangential orientation with respect to the configuration of the buried hills. Comparison with results of model experiments by Cloos and Beloussov, and theoretical analysis support a concept of origin in which tensional stresses developed in the sediments during compaction.

The area of these stratigraphic and structural features constitutes a unique "laboratory of exposures" which provides opportunities for comparison with facies encountered in deep drilling elsewhere in the Mid-Continent.

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### Future Plans for Deep Sea Drilling Project

The Deep Sea Drilling Project, funded by the National Science Foundation, guided by JOIDES, managed by Scripps Institution of Oceanography, and subcontracted for drilling by Global Marine, Inc., of Los Angeles, has been extended for 3 years of drilling. The 7-year period of drilling began August 11, 1968, and will extend until August 11, 1975. The present total estimated cost is approximately $70 million.

Drilling in the past has carried D/V *Glomar Challenger* into the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Caribbean and Mediterranean Seas. She is presently in the Indian Ocean and will proceed, by present plans, back into the Pacific Ocean in early 1973; in early 1974 her track will go into the Atlantic Ocean, to terminate at the end of contract in the Gulf Coast port. It is hoped that a program of drilling in Antarctic waters can be mounted satisfactorily from the *Challenger*. Such a program would involve either 2 or 3 austral summers. Additional drilling in the far North Atlantic would be visualized as part of the high-latitude work. It is hoped that penetration into 500-1,000 m of rock beneath the sediment cores can be achieved several times during this period.

Emphasis in the extension program, as assembled by the JOIDES panel structure, includes investigation of (1) chemical history of the oceans, (2) diagenesis, (3) basement rocks, (4) interaction between basement rocks and sediments, (5) history of ocean current systems, (6) organic evolution and productivity, (7) global tectonics, (8) trenches, (9) high-latitude oceans, (10) continental margins, and (11) remanent magnetism.

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### Some Case Histories in Projective Well-Log Interpretation

A decade has passed since the introduction of projective well-log interpretation, *i.e.*, of a system of quantitative geologic well-log analysis and interpretation for the purpose of exploration for oil and gas.

Such projective techniques use well logs to investigate and map physicochemical rock modifications that may have taken place in the sedimentary geologic column as a result of the migration and accumulation of oil and gas in structural as well as in stratigraphic traps. The principles on which the individual techniques of this system rest have been reviewed in scientific and trade magazines. Many example surveys and discovery data have been published, but most survey results have remained confidential. With passing years some operators have drilled and discovered oil not knowing that such surveys have been made on their prospect areas. Some example surveys made in Florida, in the Permian basin, in the Denver-Julesburg basin, and in the Williston basin are presented in which a number of producing oil and gas wells, and fields, have now been developed in areas mapped and indicated as petroliferous long before discoveries.

One feature common to all petroliferous trends delineated by projective well-log interpretation is that the exact limits of expected production are not pinpointed nor is any claim made that the indicated petroliferous trends will be economically productive. To define economically productive limits, a much greater well density is needed. With such density all the oil fields within the explored depth would have been found, but deeper production possibilities would be indicated by projective techniques.

In the petroliferous areas indicated on the maps of areas not yet fully explored, it is suggested that electrotelluric surveys are a means of pinpointing and of delineating the actual subsurface oil and gas accumulations within the broad probable oil-bearing regions.

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GEOPETAL FABRICS: IMPORTANT AIDS FOR INTERPRETING ANCIENT REEF COMPLEXES

The term "geopetal fabric" was introduced by Sander for fabrics in sedimentary rocks "which record the direction of the earth's surface at the time they were being formed." Geopetal fabrics thus can be used to determine the orientation of these rocks (*i.e.*, top, bottom, horizontal, and vertical) when the fabrics developed.

The importance of geopetal fabrics in the interpretation of reef complexes is illustrated by examples from the Devonian of the Canning basin in Western Australia. The most useful geopetal fabrics in these limestones are formed by the carbonate mud and spar fillings of fossils, especially closed brachiopod shells. These shells commonly were partly filled by horizontal layers of carbonate mud, the remaining upper part of each cavity being filled subsequently by sparry calcite. The spar and carbonate-mud layers thus demonstrate top and bottom, and the contact between them usually marks the horizontal at the time of deposition. Similar geopetal fillings occur in gastropods, nautiloids, ammonoids, and (on a microscopic scale) in the cellular structure of stromatoporoids, corals, and bryozoans. Other geopetal features of these limestones include birdseyes and other voids that were partly filled by carbonate mud, stromatactis structures, umbrella structures (below laminar stromatoporoids or algae), heliotropic algae and stromatolites, certain coral and stromatoporoid growth forms, and bedded fillings of neptunian dikes.

Steep depositional dips commonly are developed in facies associated with reefs, especially in forereef facies, and geopetal fabrics can be used to demonstrate the amount of depositional dip and to distinguish it from subsequent tectonic dip. Reefs themselves are commonly unbedded, and geopetal fabrics may be the only means of determining attitude in these rocks. In addition, allochthonous blocks of reef that have been incorporated in forereef and basin deposits can be distinguished from in-place bioherms through the use of geopetal fabrics. These can show that bioherms are in their original growth positions, whereas allochthonous blocks have haphazard orientations.

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DEVONIAN ALGAL STROMATOLITES FROM CANNING BASIN, WESTERN AUSTRALIA

Algal stromatolites are present in the reef, backreef, and forereef facies of Devonian reef complexes in the Canning basin of Western Australia. The most varied of these forms are in the forereef facies, where they grew on slopes as steep as 55° and in places that were at least 45 m below sea level. These occurrences negate the common belief that algal stromatolites are diagnostic of intertidal and near-intertidal environments.

Sediment-binding stromatolitic algae played an important role in maintaining the steep upper parts of the forereef slopes. Forms represented in the forereef facies are described as columnar, longitudinal, undulatory, contorted-bulbous, mound-shaped, planar, reticulate, and nodular stromatolites. Nonskeletal algae are believed to have been dominant in forming these stromatolites, but recognizable skeletal species (especially of the genera *Sphaerocodium, Girvanella, Frutexites*, and *Pleurocapsites*) also are present, and bacteria may have contributed to certain forms. Holdfasts of crinoids and corals are encrusted on some stromatolites, and other conspicuous elements of the associated open-marine fauna include ammonoids, nautiloids, and conodonts.

Stromatolites in the reef and backreef facies are generally irregular columnar types, commonly showing birdseye textures. Oncolites are also common in parts of the backreef facies. The reef and backreef stromatolites are believed to be analogous to modern intertidal and near-intertidal forms.

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SUBSIDENCE AND ITS CONTROL

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BIOGENIC PELLETIZATION AND ALTERATION OF SUSPENDED ARGILLACEOUS SEDIMENTS

The feeding activities and excretory products of the marine decapods *Callianasa* and *Upogebia* and the marine annelid *Onuphis* have been studied in the natural environments of the southern Atlantic and eastern Gulf of Mexico coasts and in controlled aquarium experiments. These organisms produce depositionally significant quantities of argillaceous fecal pellets which are transported with hydraulically equivalent sand grains and deposited as viable, granular clays in relatively high-energy environments. The organisms also significantly alter clay minerals taken into their digestive systems and the organic-rich, argillaceous fecal pellets serve as sites for postdepositional alteration of the clay minerals.

The fecal pellets are more than 90% mineral matter, largely clay minerals. The decapods produce rod-shaped fecal pellets about 2 mm long and 0.75 mm in diameter. The specific gravity and water content of these pellets yield a fall velocity in seawater equivalent to that of 0.25 mm quartz grains. The annelids produce ovoid fecal pellets, about 0.5 mm in diameter, with fall velocities in seawater equivalent to coarse silt and fine quartz sand.

The argillaceous fecal pellets exhibit a clay mineralogy significantly different from that of the related suspended sediments. In fecal pellets the crystallinity of muscovite is disordered, the crystallinity of interlayered minerals is reduced, chlorite is largely destroyed, and the illite/montmorillonite ratio is reduced. There is a clay mineral difference between fecal pellets produced by decapods and annelids in the same environments. The argillaceous fecal pellets also are recycled in the coprophagic chain and the clay minerals are further altered.