symmetrical, V-shaped hummocks. These vegetated ridges (up to 1 m high) are positions of former beach ridges and tidal-channel levees. Sediments in the hummocks are thin-bedded (3-15 cm), unlithified pellet sands with pronounced fenestral fabrics. Sloping flanks of the hummocks are composed of lithified crusts (up to 3 cm thick), commonly separated by unlithified sediment layers. 3. Initial infilling of the lagoons in the form of closely spaced, circular to ellipsoidal Carolina bays. Bay margins form by spit accretion of well-sorted pellet and skeletal sands. The bays themselves fill with poorly sorted, muddy pellet sands. 4. Bay sedimentation generates a mosaic of isolated small sand bodies within a muddy, pelletal, massive sediment. Vertical infilling of the lagoons in the form of laterally continuous, alternate thin beds of blue-green algae and pellet mud. (5) Capping of the sequence by laterally continuous, thin crusts of aragonite-dolomite.

GELDSETZER, HELMUT, Dept. Geology, Univ. Port Elizabeth, Port Elizabeth, S. Africa

TECTONICALLY CONTROLLED SEDIMENTATION DURING MIDDLE PALEOZOIC IN NORTHEASTERN NORTH AMERICA

The Silurian-Mississippian time interval in northeastern North America can be subdivided into major interregional, depositional, and erosional episodes, reflecting vertical movements of the North American crustal plate. A detailed analysis of the preserved depositional record indicates the presence of 6 major unconformity-bounded sequences on the eastern craton, 3 in the transitional region of New York and Pennsylvania, and 2 on the Appalachian plate margin of the New England States and the Maritime Provinces. Good biostratigraphic and lithostratigraphic control clearly demonstrates that this decrease in the number of sequences is due to an easterly increasing change in tectonic style reflected by higher rates of subsidence, less uniform erosional fragmentation, and better preservation.

The interregional pattern of preservation and the predominance of carbonate facies suggest broad epeirogenic movements during Silurian time. Pronounced facies changes and variations in thickness during Early and early Middle Devonian time characterize the transition from epeirogenic to orogenic movements of the Acadian orogeny. Isostatic uplift and foredeep development mark the late Middle and late Devonian. The Mississippian record indicates greatly increased subsidence on the craton and tensional block faulting, with renewed volcanism on the Appalachian plate margin.

GIBSON, JAMES M., Texaco Inc., Los Angeles, Calif.

FORAMINIFERAL AND NANNOPLANKTON BIOSTRATIGRAPHY, PALEOECOLOGY, AND BASINAL RECONSTRUCTION, ANITA FORMATION, WESTERN SANTA YNEZ MOUNTAINS, CALIFORNIA

The Anita Formation crops out along the crest of the Santa Ynez Mountains, California, from Santa Ynez Peak westward to Point Conception. Planktonic and benthonic foraminiferal faunas and calcareous nannoplankton floras were studied from 6 measured sections between Arroyo el Bulito and Santa Ynez Peak. In general, Anita Formation strata are assigned to the time interval from early Paleocene to early middle Eocene on the basis of prevailing planktonic correlations. Also from planktonic evidence, reported Ynezian benthonic foraminiferal assemblages appear to be early Paleocene to late Paleocene in age; Bulitian assemblages are of late Paleocene age; Penutian assemblages are late Paleocene in some sections and early Eocene in others; Ulatisian assemblages are late Paleocene to early middle Eocene. The time-transgressive nature of the benthonic provincial stages is apparent; the stages become geologically younger toward the basin margins as well as stratigraphically higher. Furthermore, strata mapped as Anita Formation by Dibblee have been found to be of late Cretaceous age in several areas.

Lithologically, the Anita Formation can be split into three gross members, which can be mapped throughout the Western Santa Ynez Range. The unit is divisible into the following stratigraphic units, all of which are typed in the upper Arroyo el Bulito area: Gato siltstone (upper member); Augustin mudstone (middle member); and Bulito siltstone (lower member).

The Anita Formation is thickest south of the present Santa Ynez fault system, whereas northward, telescoped sections occur, and the Anita gradually disappears. This relation suggests that the Santa Ynez fault may have been a prominent structural feature in early Paleogene time. Eastward the Anita wedges into "Matilija" type clastics, which were shed from the nearby San Marcos high. Southward the Anita disappears under the Santa Barbara Channel.

GINSBURG, ROBERT N., NOEL P. JAMES, and DONALD S. MARSZALEK, Rosenstiel School Marine and Atmospheric Sci. Univ. Miami, Miami, Fla.; LYNTON S. LAND, Dept. Geol. Sci., Univ. Texas, Austin, Tex.; JUDITH LANG, Discovery Bay Marine Lab., Univ. West Indies, Discovery Bay, Jamaica; and JOHN L. WRAY, Colorado School Mines, Golden, Colo.

SEDIMENTATION AND DIAGENESIS IN DEEP FOREREEF, BRITISH HONDURAS BARRIER AND ATOLL REEFS

The top of a near-vertical escarpment at 70 m marks the change from luxuriant organic growth that typifies the shallow forereef, to physical and chemical sedimentation that characterizes the deep forereef. Off the southern barrier reef and the leeward side of Glovers Atoll, this escarpment extends to 120 m; on the seaward side of Glovers Atoll, it continues to abyssal depths. Where the base of the escarpment is at 120 m, it is buried by the forereef rise, a wedge of talus and sediment whose slope flattens basinward.

The escarpment has numerous projecting ledges, caves up to several meters deep, and occasional near-vertical fissures tens of meters high. Sediments from above mantle and infill all irregularities on the escarpment; sticks and plates of coral are stacked on projecting ledges; algal-plate *(Halimeda)* sand and "lime" mud cloak ledges and floor caves and small cavities. Rock samples from the outer meter of the escarpment, between 95 and 110 m deep, are well-cemented mixtures of algal-plate *(Halimeda)* sand, "lime" mud, whole and fragmented reef corals, and crustose, coralline algae. Specimens show multiple generations of sponge and mollusk borings, sediment infill, and cementation by magnesium calcite and aragonite that almost obliterates many primary depositional fabrics. Two specimens of unaltered reef corals from this rock have radiocarbon ages of 2,340 and 7,835 years B.P.

On the barrier reef the upper forereef rise at the base of the escarpment is a talus slope of blocks, surrounded by algal-plate (*Halimeda*) sand and "lime" mud. Talus blocks as large as 20 m clearly are derived from the escarpment; all stages of formation, from jointed rock face to large blocks of limestone slightly displaced from the wall, are visible. Within 100 m of the base of the escarpment, the blocks of talus decrease abruptly and algal-plate *(Halimeda)* sand is increasingly diluted by pelagic muds.

GREENE, H. GARY, WILLIAM H. K. LEE, DAVID S. McCULLOCH, and EARL E. BRABB, U.S. Geol. Survey, Menlo Park, Calif.

FAULTS AND EARTHQUAKES IN MONTEREY BAY REGION, CALIFORNIA

The structure of the continental margin, between Monterey Bay on the south and Point Reyes on the north, is dominated by a northwest-trending belt of rocks composed of continental crust (Salinian block) that is separated from oceanic crust on the east by the active San Andreas fault system, and on the west by the Sur-Nacimiento fault zone. Recent marine geophysical investigations have shown extensive faulting within this crustal block—some of which appears to have locally offset Holocene deposits. Most of the faults within the Salinian block in the Monterey Bay region occur in two major intersecting fault zones; the northward-trending Carmel Canyon fault zone, extending offshore from Point Sur (oriented N25°W), and the northwest-trending Monterey Bay fault zone, extending offshore from the town of Monterey (oriented N50°W). The Carmel Canyon fault zone appears to connect the Palo Colorado fault in the south with the San Gregorio fault in the north. The Monterey Bay fault zone appears to be the offshore continuation of the Sur-Nacimiento fault zone.

Epicenters of many recent earthquakes are concentrated at the intersection of the Carmel Canyon and Monterey Bay fault zones, in the central part of Monterey Bay. First-motion studies of 8 earthquakes indicate right-lateral strike-slip displacement on these offshore faults. The cessation of a 10-day period of rapid tectonic creep along the adjacent San Andreas fault in 1970 coincided with a 4.3-magnitude earthquake in the Monterey Bay fault zone. This, as well as first-motion studies of the earthquakes and mapping of the offshore faults and seismicity, suggests a direct coupling between the San Andreas fault and the adjacent fault zones.

GROSS, M. GRANT, Natl. Oceanic & Atmospheric Administration, Rockville, Md.

GEOLOGIC EFFECTS OF CITIES

Human activities in an industrial society are geologically significant in coastal cities because of the amounts of sediment and wastes moved and resulting topographic changes. Small streams are altered or destroyed, many becoming sewers. Large streams are dredged to accommodate ocean-going vessels and nearby river banks are bulkheaded. Shallow areas (including wetlands) are filled to provide space for city growth. Sewer, industrial, and sediment discharges are deposited in navigation channels which eventually require extensive dredging and waste disposal operations. The volume of wastes, and the sediment yield per unit area of the city, equals or exceeds the discharge of many rivers. Dams and public water-supply systems change river flows and dredging can change tidal regimes in the estuaries. Sand and gravel production and construction of groins, bulkheads, and other structures change ocean shorelines and disturb beach processes.

In the future, human activities will extend to the continental shelf where sand and gravel deposits will be exploited, offshore electrical power plants will be built, and port facilities will be constructed for deep-draft vessels requiring extensive dredging across the shelf. Even offshore airport centers have been proposed.

These urban processes and their geologic effects are well documented in the New York metropolitan region.

GUTHRIE, JOHN J., Mandrel Canada Ltd., Calgary, Alberta

PROBLEMS OF A NEW FRONTIER

It is becoming generally accepted that in the near future North America will be faced with a serious energy crisis. The Canadian Arctic will play a most important part in satisfying the Western Hemisphere's energy needs. A new frontier in exploration has opened. Because of its location and environment, it poses new problems. Some of the prevailing exploration methods do not work efficiently in this new environment. The costs of mobilization and demobilization and logistical support have mushroomed to staggering proportions. Inflationary trends have caused further cost increases.

The application of previously accepted geophysical exploration field methods in this high-cost area dictates concerted investigation into improved efficiency of field operations, use of highly portable accommodations, reduction of costs for expendable supplies, and the need for adequate time for preplanning of projects.

Several new approaches have been applied to these inherent problems, with varying degrees of success. New approaches in Arctic transportation, camp accommodations, and surface-energy sources are being developed, and must be considered in relation to today's mushrooming costs, while maintaining man's safety as a prime consideration.

HALLEY, ROBERT B., Dept. Earth & Space Sci., State Univ. New York at Stony Brook, Stony Brook, N.Y.

REPETITIVE CARBONATE-BANK DEVELOPMENT AND SUBSEQUENT TERRIGENOUS INUNDATION; CAMBRIAN CARRARA FORMATION, SOUTHERN GREAT BASIN

Three times during the deposition of the Lower and Middle Cambrian Carrara Formation, shallow-water carbonate banks developed in southern Nevada and southeastern California. Each bank attained a minimum width of 150 km normal to the depositional strike. Eastward the banks were bordered by terrigenous clays, silts, and sands from the stable craton, and westward they were bordered by siliceous "lime" muds lacking shallow-water depositional features. The position of rock units with respect to 5 trilobite faunules within the Carrara suggests that carbonate deposition waxed and waned subsequent to eastward and westward migrations of areas of detrital sedimentation.

During each of the 3 episodes of carbonate deposition, a sequence of 4 lithologic changes is repeated as follows: (1) upward fining and thinning of terrigenous clastic deposits; (2) the beginning of carbonate deposition, first as scattered skeletal grainstones, later as oolitic grainstone, oncolite packstone, and "lime" mudstone accumulating as a shallow subtidal bank; (3) the deposition of loferites, bird's-eye and mudcracked limestones, cryptalgal laminites, and stromatolites as low carbonate islands on the western half of the banks; and (4) the relatively abrupt termination of carbonate deposition with renewed sedimentation of detrital clay and silt. Each sequence is repeated farther east during succeeding episodes of carbonate sedimentation.

HANSEN, C. P., U.S. Senator (Wyoming), Washington, D.C.

GOVERNMENT AND THE ENERGY CRISIS: COLLISION OR COLLABORATION

In recent years the Federal Government has begun to recognize and come to grips with our national energy crisis. Contributing to improved government understanding of the problem was the National Petroleum Council's report released last December.

The National Fuels and Energy Study being conducted by the Senate Interior Committee, on which I serve, has made great progress in attempting to develop our own recommendations for national energy policy. We have been especially assisted by the expert testimony of The American Association of Petroleum Geologists.

President Nixon earlier this year announced his proposals for abating our energy crisis. The Congress has been asked to act. However, the question remains whether the Congress will cooperate with the President, as I believe it should, or whether a matter as important to our national security and economic well-being as our energy supply will be turned into a political football by an uncooperative Congress.

HARRIS, DONALD G., and J. O. SZABO, Esso Production Research Co., Houston, Tex., and F. B. WILLIAMS, British Petroleum Co., Anchorage, Alaska

KEYS TO RECOGNITION OF CARBONATE RESERVOIR ROCKS

A 4-step procedure has been developed that provides key information for recognizing the reservoir facies in carbonate