associated with certain geologic provinces. Recent gravity and magnetic studies suggest a possible structural relationship between the Lake Superior syncline and the Michigan basin and suggest the presence of basalt flows along the Cincinnati arch similar to the Keweenawan flows of Michigan.

Configuration of the basement surface is conventionally interpreted from well data, aeromagnetic surveys, and projection of dips. Recent development of the continuous velocity log, however, has led to a resurgence of spot correlation seismic surveys. The technique, based on widely spaced seismic shot points, has been successfully applied in Illinois, Indiana, and Ohio as a low-cost method of regionally mapping the basement. In general, preliminary seismic results and gravity and magnetic studies show close relation between the major sedimentary structures of the midwestern United States and the regional configuration of the basement surface.

SAITO, TSUNEMASA, Lamont Geological Observatory, Columbia University, Palisades, New York

Miocene-Recent Planktonic Foraminifera from Ampere Bank, Northeastern Atlantic Ocean

Eight submarine cores, obtained by the Lamont Geological Observatory from Ampere Bank (a sunken island located at 35°00′ N. Lat. and 13°00′ W. Long. about 630 km. WSW of Gibraltar), were studied with the purpose of long-distance correlation of mid-Tertiary stratigraphic sequences by means of planktonic Foraminifera. Ampere Bank rises from the floor of the ocean at a depth of about 4,000 m. to a minimum depth of 53 m. from the sea-level.

The core sediments consist of white or light brown calcareous sand and lutite, except for one core taken from the western slope of Ampere Bank where the coarse fraction includes particles of volcanic rock and pyroxene. Planktonic foraminiferal tests are a major component of these calcareous sediments with a few benthonic species representing various habitats from shallow to deep water.

Miocene planktonic foraminiferal faunas occur in 4 out of 8 cores. The Miocene sediments are usually very thinly covered (10–20 cm.) by the younger sediments. Based on the stratigraphic distribution and species composition of planktonic Foraminifera, three concurrent-range zones were recognized. These are in ascending order: *Globorotalia mayeri/Globigerina nepenthes*, *Globorotalia menardii/Globigerina nepenthes*, and *Sphaeroidinellopsis seminulina* zones. However, no single core contains more than two of these zones. The boundary between the *G. mayeri/G. nepenthes* zone and *G. menardii/G. nepenthes* zone indicates that of the Helvetian-Tortonian stages. The planktonic faunas as found in Ampere Bank are very similar to those of the Donni sandstone in Saipan, the Nobori formation in SW Japan, and the Pozón formation in Venezuela. This evidence confirms the supposed value of planktonic Foraminifera for long-distance stratigraphic correlation.

In this region *Globorotalia hirsuta*, which has not yet been reported from equivalent zones of the Pacific regions, makes its first appearance at the top of the *G. mayeri/G. nepenthes* zone and occurs abundantly in the overlying two zones.

The post-Miocene sediments are distinguished by the predominance of *Globorotalia truncatulinoides*, sparsity of *G. menardii*, and dominant dextral coiling of *G. hirsuta*. Several phylogenetic trends of Recent planktonic foraminiferal species are found within these three zones. Since many Recent species appear near the end of the Miocene, more refined biostratigraphic subdivision of the post-Miocene sediments is a difficult task and requires further studies.

SANDERS, JOHN E., Department of Geology, Yale University, New Haven, Connecticut

Primary Sedimentary Structures Produced By Turbidity Currents

Turbidity currents produce numerous primary sedimentary structures, depending on mechanism of particle movement and sediment load-current-bottom interaction. Because the sediment is responsible for the current, depositional loss of load systematically changes conditions and structures produced. Only a few sediment-current-bottom combinations are unique to turbidity currents; many combinations, hence sedimentary structures, also occur in other current-sediment systems.

Two types of collective behavior in cohesionless sands are inferred to occur in turbidity currents: (1) high-velocity sheet flow, where grains, probably not in true suspension, shear over the bottom below and underneath the truly suspended load above, outrunning the latter; and (2) traction-carpet flow, in which the grain layer may become relatively passive with respect to underlying bottom, but is subjected to shear, with or without sand fallout, from the overlying current with suspended sediment. Drag relationships between turbidity currents and traction carpet have not been investigated in the laboratory, but probably could be. Bagnold's analysis indicates that drag varies inversely with grain size and is a minimum in very fine sand. When the current has covered the bottom with fine sand, therefore, the decreased drag may trigger an abrupt increase in current velocity. This possible "autoacceleration" might explain the otherwise enigmatic increase in current velocity without change in grain size, which the writer previously invoked in analysis of convoluted laminae.

SCHMIDT, VOLKMAR, Socony Mobil Oil Company, Dallas, Texas

Facies, Diagenesis, and Related Reservoir Properties in the Gigas Beds (Upper Jurassic), Northwestern Germany

The Gigas beds were studied in a subsurface area adjacent to the northern subcrop limits of the Lower Saxony basin, west of the Weser River. Fossiliferous beds were deposited, in supersaline epicontinental seas as the basal beds of a major saline cycle. Isopach maps reflect a pattern of low-thickness sills and near-shore areas adjacent to basins of greater thickness. Shale and sulfates predominate in the basins. Bioclastic and oölithic calcarenites and micrites form most of the shallow-water deposits.

Early diagenetic protodolomite replaced more than 50 per cent of the total sedimentary calcium carbonate. The extent of dolomitization varies from a trace to complete replacement. Dolomitization increases: (1) as the northern boundary of the Lower Saxony basin is approached, (2) as thickness decreases, and (3) as clay content increases. The three parameters are interdependent.

Dolomitization of the shallow-water carbonates postdates initial lithification. Here, protodolomite replaced calcium carbonate volume per volume, but due to dolomitization part of the calciclastics have been dissolved, creating voids. Dolomitization of basinal carbonates predates lithification and created no porosity. In both environments, protodolomite originated