The claystones are indurated and characteristically possess oölitic textures, although vermicular crystals and brecciated fragments are present in most samples. Well-crystallized kaolinite is the only clay mineral present and is associated invariably with anatase and locally with abundant (> 50 percent) boehmite or siderite. Quartz, either as discrete grains or as chalcedony, is rare or absent.

The unit ranges in thickness from 1 to 6 ft and can be traced for more than 50 mi along the southeastern margin of the basin. However, extensive boring downdip has shown that it thins out abruptly in that direction.

The underlying sediments consist of red claystones, known locally as the "chocolate shales." Apart from well-crystallized kaolinite and anatase, these claystones contain appreciable quantitites of hematite (15–25 percent), but quartz and clay minerals, other than kaolinite, are sparse or absent. The overlying sediments, however, are composed of quartz, illite, and degraded illite as well as kaolinite.

The "chocolate shales" are believed to represent a transported laterite or lateritic bauxite and the flint kaolins are considered to be the reduced equivalent, formed by the advent of swampy conditions at the close of deposition of the sedimentary sequence.

MAGLOIRE, P. R., S.N. REPAL, Algiers, Algeria

Triassic Gas Field of Hassi er R'mel, Algeria

After the first important Saharan stratigraphic test (Berriane) had shown encouraging results, S.N. REPAL intensified its reconnaissance studies. Seismic refraction and reflection, carried out together with field geology, located the structure of Hassi er R'mel, about 60 mi southwest of Laghouat oasis. In 1956 the HR-1 well was spudded, and led to the discovery of the gas field of Hassi er R'mel.

Located on the Cretaceous high zone of the M'zab area, the structure of Hassi er R'mel is a part of a zone which has been stable tectonically since the Cambrian.

Above the granitic basement, are Cambrian and Ordovician formations, which are covered by Silurian where pre-Triassic erosion was less important.

The oldest Mesozoic deposits lying unconformably on the Paleozoic, consist of Triassic sandstones, which are, from base to top: (1) a lower series (with andesite flows) which fills the topography of the pre-Triassic erosion surface. The top of the lower series is the C reservoir, which exhibits important lateral variations; and (2) two separate sandstone reservoir zones: B (noncontinuous) and A (continuous). Above the reservoirs are the salt-bearing Triassic (1,300 ft thick), Jurassic (3,000–3,300 ft), and Cretaceous.

The structure at the top of the Triassic reservoir is anticlinal and has a north-northeast-south-southwest axis; its areal extent is about 1,000 sq mi.

An oil-water contact is at 5,016 ft (below sea level). Oil shows and minor production have been found in the Ordovician quartzites and Triassic sandstones. It is possible that there is a very narrow oil ring but so far this is unproved.

Though the structure is old, evidence has been found that the gas was trapped definitely during the Early Cretaceous.

Operated by SEHR (a subsidiary of S. N. REPAL and CFP[A]), the gas field of Hassi er R'mel has produced 380 Bcf of condensate gas since 1958. The reserves are now estimated at 70 trillion cu ft. Production could be increased considerably should the market requirements for gas be increased; because of the limited use for the gas at present, only five wells are now producing.

MALONEY, NEIL J., Instituto Oceanográfico, Universidad de Oriente, Cumaná, Venezuela

Continental-Shelf Sediments off Eastern Venezuela

The continental shelf between Carúpano and Barcelona, Venezuela (63° to 64° 45′ W. long.), exhibits large variations in size and topography. East of Margarita Island the shelf is 80–100 km wide. The southern, landward part is an east-sloping depression which extends from a depth of 20 fm east of Margarita to more than 63 fm west of Trinidad. The northern border of the depression is formed by the bank passing from Margarita to Los Testigos Islands. It is 12 to 20 fm deep except at Daring Shoal which shallows to 4 fm.

The depression is covered with olive-green silt containing 20–40 percent sand. Calcareous sand, rich in shell material, occurs on the bank. Algae and corals are abundant in the samples from Daring Shoal. Silty sand is present north of the bank to a depth of 100 fm. Silts with less than 5 percent sand occur below this depth.

An open shelf, 40 km wide, is north of Margarita. The sediments range from clayey silt to silty sand. Narrow, shallow straits characterized by strong currents are south of Margarita. Sand and gravel are the dominant sediment types in the straits.

West of Cumaná the shelf is less than 5 km wide. The shelf and upper slope to 110 fm are covered with calcareous sand; olive-green, clayey silt with less than 5 percent sand occurs below this depth. The highest concentrations of sand are on the central and outer parts of the shelf, suggesting that it is a relic sand.

Islands, bays, and gulfs are the main topographic features on the shelf between Mochima Bay and Barcelona. The outer parts of the bays contain calcareous sand, and the inner, more protected, parts are covered with sandy to clayey silts. The alluvial sand is being deposited on intrabay deltas. North of the islands the shelf is 4 to 8 km wide. Sands are present in the east but grade into silt and clayey silt on the west opposite Barcelona.

The sediment distribution is related to the bottom topography, ocean currents, and depth. Fine-grained sediments have accumulated in the depressions and protected areas. The topographic highs and open-shelf areas contain calcareous sand. No sand occurs in the surface sediment at depths greater than 110 fm.

MARTINEZ, ANIBAL R., Organization of Petroleum Exporting Countries, Vienna, Austria

Giant Fields of Venezuela

Only 44 out of the nearly 300 oil fields discovered in Venezuela to the end of 1965 could be classified as giants, *i.e.*, fields having resources of at least 100 million bbl of oil. Giant fields have been discovered in three of the sedimentary basins of the country. The average time lag for the recognition of an oil field as a giant is 8 years and [illegible] months. The estimated resources of all giant fields in Venezuela are 27.6 billion bbl. The average for the country is 628 million bbl per giant. Even if the resources of the Bolívar Coastal field were only 500 million bbl, the average resources would be 264 million bbl of oil per giant field. It is possible to combine the data on the giant Venezuelan fields with the study of the oil resources of the country. The ultimate number of giants is 78; ten giant fields had been discovered but had not been recognized by the end of 1965, leaving 24 giants undiscovered. It is estimated that 40 percent of the oil resources of Venezuela are in the giant fields alone.

MARTINI, I. P., Shell Canada, Ltd., Edmonton, Alberta

Grain-Orientation and Paleocurrent Systems in Medina Formation

Several sedimentological parameters were examined to define the paleoenvironments of the Medina Formation (Lower Silurian; outcrops along the Niagara Escarpment in Ontario and New York State). The diverse sedimentological parameters change regionally as well as vertically in a quasi-regular manner. The trends of such changes are similar in all the properties examined. The consistency within the basin of the variations of the variables suggests a deltaic paleoenvironment for the Medina sediments.

Two of the sedimentological parameters, grain orientation and directional sedimentary structures, were studied in the Thorold and Grimsby Sandstone Members of the Medina Formation.

Determination of grain orientation yielded a complex pattern of directions hardly explainable except by a "mixed environment" model. It was found that the total sampled population of the grain orientations of the Thorold and Grimsby Sandstones was nonhomogeneous. Utilizing a trial and error methodology homogeneous subpopulations were distinguished:

1. Subpopulations related to the type of sedimentary structure present in the sampled bed: (a) cross-bedded (subpopulation); (b) laminated (subpopulation); and (c) massive (subpopulation).
2. Subpopulations related to the stratigraphic location of the samples: (a) Thorold plus upper third of the Grimsby; and (b) lower two thirds of the Grimsby.
3. Subpopulations related to the geographic location of the samples: (a) east of the Niagara River (New York region); and (b) west of the Niagara River (Ontario region).

The various subpopulations evidently are interrelated and they are partly duplicated in the behavior of the azimuths of the cross-beds and other directional sedimentary structures.

The directional data obtained from the Thorold and Grimsby Sandstones suggest the existence of two major paleocurrent systems:

1. A first system, trending northwest, was measured in the azimuths of cross-beds and in the cross-bedded grain orientation subpopulation of primarily the New York region.
2. A second system, trending northeast, was measured in the azimuths of cross-beds in the Ontario region and in the laminated grain orientation subpopulation.

The characteristics of the paleocurrent systems and the results obtained from other sedimentary properties which better define the subenvironments composing the "Medina delta," suggest that the first paleocurrent system is related to distributary channel complexes and the second to marine currents.

MAYUGA, M. N., Long Beach Harbor Dept., Long Beach, Calif.

Geology of California's Giant—Wilmington Oil Field

The Wilmington oil field is in the Los Angeles basin of southern California, one of the most prolific oil-producing basins of the world and considered to be an example of optimum conditions in the habitat of oil. The Wilmington structure, discovered in 1936, is a broad, asymmetrical anticline broken by a series of transverse normal faults which divide the producing beds into many separate pools. The seven major producing zones range in age from middle Miocene (Topanga) to early Pliocene (Repetto). Deposition of approximately 1,800 to 2,000 ft of nearly horizontal beds on top of the unconformity between the lower Pliocene Repetto beds and the upper Pliocene middle Pico Formation conceals the Wilmington anticline from the surface. The effectiveness of the faults as barriers to oil and gas accumulation in the field is shown by significant variations in edgewater conditions, subsurface pressure, gas-oil ratio, and oil gravity from one fault block to another. In general, the development program in the field has been based primarily on segregation of the pools by fault blocks and zones.

The problem of land subsidence in the Wilmington oil field has been attributed by many investigators to the reduction of pressures in the reservoirs due to the production of oil and gas. Total subsidence to date in the center of the bowl of subsidence is 29 ft. A massive water-injection program has reduced the subsidence in the area and increased oil recovery. The rate of subsidence at the center of the bowl has been reduced from an annual rate of 2.4 ft in 1951 to 0.1 ft in 1967. The area of subsidence has been reduced from 20 sq mi to less than 4 sq mi.

The Wilmington oil field has produced more than 1.1 billion bbl of oil, primarily from the old developed area. With waterflooding, it is estimated that another 700 million bbl of oil will be recovered from the old area of the field and an estimated 1.2 billion bbl of oil will be produced from the new area on the east (known as the Long Beach Unit or East Wilmington) within the next 35–40 yr under a pressure-maintenance program. Recent developments in the eastern area of the field revealed some lateral lithologic changes in the formations. To date, six of the seven known productive zones in the old area are also productive in the new area, but somewhat limited in extent.

MCCOY, SCOTT, JR., Phillips Petroleum Co., Bartlesville, Okla.

Paleontology and Paleoecology of Wann Formation, Northeastern Oklahoma

The Wann Formation (Missourian) of northeastern Oklahoma is primarily a regressive marine sequence of calcareous shale, shale, and sandstone with a characteristic molluscan fauna traceable along much of the outcrop. The replacement of a crinoid-brachiopod fauna by the molluscan fauna in Washington County