M. Tenaille, Soc. Africaine des Petroles (Senegal)

M. A. Nicod, Soc. Petroles du Senegal (Senegal)

A. de Spengler, Soc. Africaine des Petroles (Senegal)

Petroleum Exploration in Senegal-Mauritania and Ivory Coast Coastal Basins (West Africa)

The Cretaceous and Tertiary Senegal-Mauritanian basin was almost completely unknown below the surface, before its reconnaissance was started in 1952 by the French "Bureau de Recherches de Pétrole."

The great depth of the basin was at first indicated by airborne magnetometer and refraction seismograph tests and checked by a deep stratigraphic well (3,403 m., 11,165 ft.). Active exploration was carried on since 1955, three companies being active now in the French part of the basin.

Reflection and refraction seismograph and geological core holes were effective tools for exploration, gravity having been useful only locally. A marine section of about 5,000 meters (16,400 ft.) is known in deep wells, from Lower Cretaceous (Aptian) up to Miocene, mainly shale and sands in various proportions, with some limestones, overlapping the basement toward the East. The basin is open toward the Atlantic Ocean. The regional westward dip is very low and structure is mainly controlled by deep north-south flexures and by basement uplifts. A first gas well producing $3\frac{1}{2}$ m.c.f./day was drilled near Dakar in 1959.

In Ivory Coast, a narrow coastal basin, almost as deep as broad on land, was discovered by gravity and checked by refraction-seismograph since 1952. Active exploration was started in 1957. Marine, lagoonal, and terrestrial reflection-seismograph and geological coreholes were done at first in the French part of the basin, before spudding deep exploratory tests.

The northern border of the basin is a fault system, and structures are related to plunging noses with southward dip. A marine section of about 2,700 m. (7,856 ft.) was drilled, with mainly shale, sands and conglomerates ranging from Aptian or Albian up to Miocene. Below Aptian or Albian, possibly non-marine dark shales and sandstones, or continental red-beds, were encountered. Good shows (tar sands and heavy oil seepages) occur in the eastern part of the basin, in Ivory Coast and in Ghana.

R. Thorsteinsson and E. T. Tozer, Geological Survey of Canada, Ottawa, Canada

Stratigraphy and Structural History of Canadian Arctic Islands

The islands south of Parry Channel, except Banks, have a thin, discontinuous cover of Ordovician and Silurian carbonates, relatively undisturbed except for local north trending structures adjacent to the Boothia arch. Late Silurian or early Devonian fanglomerates near the arch were deposited contemporary with these movements. On northwestern Victoria and Banks islands a monoclinal section to the northwest reaches the Upper Devonian (which is clastic as in the northern islands) followed by marine Lower Cretaceous and non-marine Tertiary.

Queen Elizabeth Islands, north of Parry Channel, record heavier sedimentation and complex structural history. From Cambrian to Upper Devonian an arc-shaped geosyncline extended easterly through Parry Islands and then northeasterly through Ellesmere. Adjacent shelf regions are south Melville and Bathurst islands, most of Devon Island and southeastern Ellesmere Island. Cambrian, Ordovician, and Silurian rocks, locally at least 20,000 feet thick, are essentially carbonate and shale with some evaporites. Ordovician and Silurian carbonates occupy outer side of arc and shale the inner. North Ellesmere and northwesternmost Axel Heiberg have metasediments and volcanics, probably the contemporary eugeosyncline. The Devonian sequence 17,000 feet thick is mainly quartzose clastics locally with carbonates in the lower part.

Cornwallis Island and neighboring coasts have northeasterly structures produced at time of movement on Boothia arch. Main body of geosyncline was deformed between Upper Devonian and Middle Pennsylvanian forming east-west structures in Parry Islands and northeasterly structures in Ellesmere. In middle Pennsylvanian the Sverdrup Basin, centered on Axel Heiberg Island, developed above the old eugeosynclinal belt and received about 50,000 feet of Pennsylvanian to early Tertiary sediments. The Permo-Pennsylvanian includes carbonates, shales and evaporites; the Mesozoic comprises alternating marine and non-marine sandstones and shales. In Meozoic thin sandy deposits characterize basin margins, and shales the axis. Section on axis is essentially conformable, on margins it is incomplete from overstep and thinning. Early Tertiary rocks are entirely non-marine with coal seams, and are followed by orogeny that produced mainly northerly thrust faults and folds, also diapiric intrusion of Upper Paleozoic evaporites.

Lyman D. Toulmin, Florida State University, Tallahassee, Florida

Philip E. LaMoreaux, U. S. Geological Survey, Washington, D. C.

Stratigraphy along Chattahoochee River, a Connecting Link between Atlantic and Gulf Coastal Plains

The geologic section along the Chattahoochee River is one of the best and most complete in the Coastal Plain of the United States. It is the only continuous unweathered section of Cretaceous and Tertiary beds in southeastern Alabama and southwestern Georgia, and comprises a connecting link between the well-known standard section and type exposures to the west in Alabama and beds to the east in Georgia and South Carolina. It is also an important section because of its intermediate position between the clastic facies in the central and western Gulf Coastal Plain and the equivalent carbonate facies in the subsurface in Florida.

Upper Cretaceous, Paleocene, lower Eocene, and middle Eocene strata are exposed in an almost continuous section down the dip from the crystalline rocks at the Fall Line at Columbus, Ga., to upper Eocene exposures about 8 miles north of the Alabama-Florida boundary, a distance of 126 miles. This study of a part of that section supplies detailed stratigraphic and structural information on rocks of Tertiary age that are exposed southward from the Upper Cretaceous-Paleocene contact 15 miles south of Eufaula, Ala., to exposures of upper Eocene Crystal River limestone of Moore, 1955, 15 miles south of Columbia, Ala., a distance of 49 miles. The total thickness of Paleocene, lower Eocene, and middle Eocene strata in this part of the river is a little over 600 feet. The average dip is 15 feet per mile to the south, but in places the beds are horizontal for distances of as much as 3 miles.

The formations recognized in the river section are those in the standard Alabama stratigraphic section. From the bottom up they are the Clayton formation of Paleocene age, the Nanafalia formation, Tuscahoma sand, and Hatchetigbee formation of lower Eocene age, and the Tallahatta and Lisbon formations of middle Eocene age.

Stratigraphic sections for these studies were combined into longitudinal profiles for the left and right banks of the river, an arrangement that visually describes detailed lithology and structure. Horizontal control was from aerial photographs. Vertical control was from the river surface. The altitude of the river surface was determined from the stage of the river referenced to "the thalweg," as plotted by the U. S. Corps of Engineers, and bench marks of the U. S. Coast and Geodetic Survey. The use of "the thalweg" in determining altitudes of contacts permits rapid and accurate mapping of geologic sections along rivers.

PAUL B. TRUITT, Bolivian Gulf Oil Company, Cochabamba, Bolivia

Geology of Parapeti Area of Bolivian Chaco

The Chaco is a vast, very gently southeastward sloping flat plain with a dense cover of semi-arid low brush and small trees which extends from the foot of the Andes Mountains eastward to the Rio Paraguay and from the 18° parallel south into Argentina. It is underlain by Tertiary and Quaternary continental sandstones and conglomerates which bury a pre-Tertiary topography. The only relief features that break the extremely flat surface of the Chaco are occasional isolated hills of pre-Tertiary rocks which project through the Tertiary and Quaternary blanket. In Bolivia only Gondwana and younger rocks are exposed in these hills; in Paraguay, Devonian and older rocks are found.

The Parapeti River comes out of the Andes Mountains at the 20 degree parallel and swings northward across the Bolivian part of the Chaco to disappear in the Izozog swamps at parallel 19. Near the mountains it crosses a major syncline in which over 8,000 feet of Tertiary and Quaternary rocks are preserved. Its northward course runs along the east limb of that syncline and just west of a major east-west trending structural high in the pre-Tertiary rocks which projects into Bolivia from northern Paraguay. This high has been active through geologic time as evidenced by the fact that the basal Gondwana unconformity cuts down into the Devonian rocks eastward onto the high and the unconformity at the base of the Tertiary also truncates the Gondwana progressively deeper toward the east. Along a line just east of the Parapeti, the Tertiary unconformity cuts all the way through the Cretaceous and Gondwana rocks, placing the Tertiary directly on the Devonian.

In Bolivia, all oil production to date is located in the extreme eastern fringe of the Andes Mountains in Devonian and Lower Gondwana sandstones. The Gondwana production is concentrated in the south of the country where suitable Devonian reservoir sands are not developed and where a thick section of impermeable gritty shales is present in the top of the Lower Gondwana. Various possibilities for production in the Parapeti area exist. Except in the very axis of the frontal syncline, the Devonian is within economic reach of the drill. Closed structures are present in the area and are especially attractive east of the Parapeti River where the Devonian lies within 1,000 feet of the surface. There is also the chance of updip pinch-outs and accumulations against the Gondwana unconformity. In the Gondwana, oil may be present in local structural traps within the major syncline, in updip sand pinch-outs or updip against the overlying unconformity.

JAMES TRUMBULL, and JOHN E. JOHNSTON, U. S. Geological Survey, Washington, D. C.

Continental Shelf of East Coast as Possible Future Petroleum Producing Province

Despite the negative results of more than 200 test wells drilled to date on the emerged coastal plain north of Florida, the sedimentary section as much as 17,000 feet thick that underlies the 1,100 mile-long continental shelf on the east coast of the U. S. appears from several points of view to be a likely petroleum target. A northern coastwise extension of the Paleozoic sedimentary rocks found in the subsurface of Florida and Georgia, although conjectural at present, may be of considerable size, and the strata there may also be relatively unmetamorphosed. Parts of the shelf area have probably been receiving sediments nearly continuously since the Paleozoic. Unconformities and successive updip wedge-outs of Mesozoic and Tertiary marine sediments that perhaps include reefs must be common, especially offshore, and granite washes are probably present near basement. Downfaulted Triassic basins apparently similar to those in the Piedmont are known to underlie the emerged coastal plain; other down-faulted basins containing sediments of Triassic and other ages might also be expected beneath the continental shelf. Although large structural features are present along the shoreline, for example the Cape Fear arch and the Southeast Georgia basin, there is as yet little evidence available as to smaller-scale structures. The large seismically-determined ridge with flanking troughs located near and subparallel to the outer edge of the continental shelf must have had a pronounced effect on the shelf strata either during sedimentation, by later deformation, or both.

Near-shore marine sediments interfingering updip with continental sediments, deposited in what may have been the shelf and hinge line of a mobile belt, and totalling 175,000 cubic miles (emerged coastal plain included), seemingly constitute a setting favorable for the accumulation of oil.

RAY P. WALTERS, Atherton, California

Surani, Rumania, Anticline with Two Erosion-Depleted, Non-Contemporaneous Oil Reservoirs

The Surani anticline has two formations exposed with sands containing a residue of oil—Meotic of the Pliocene and Kliwa of the Oligocene. These represent oil reservoirs which have been depleted by erosion. The oil sands of the upper reservoir bear a normal relation with the anticline but those of the lower do not.

The sand series in which the lower reservoir occurs is oil-free along the crest of the anticline at its highest point and down the north flank, but in going down the south flank and down the plunge to the northeast these sands suddenly are found to carry the oil residue. The break from white "barren" sand to oil sand is along a sharply defined plane. This plane, where it can be seen clearly in a bed dipping 15° south, is inclined 45° to the bedding plane and 60° to the horizontal, with the oil sand being on top and on the downdip side. The plane is thought to represent a former oil-water contact.

These conditions are interpreted to mean that the oil was originally collected in some trap to the south of the Surani anticline and furthermore that this reservoir was formed and depleted before the Surani anticline came into existence. This latter event took place in pre-middle Miocene time. The oil sands one sees today were