tains approximately the same amount of those hydrocarbons that may be recovered by n-heptane elution on silica gel columns.

The abundantly available Abasand samples were subjected to detailed analysis. These samples represent the lower portion of the McMurray formation, lying a few feet above the Devonian limestone. The bitumen was found to be a complex mixture of hydrocarbon and non-hydrocarbon compounds; the character of a few of which can be indicated. The bitumen was observed to be susceptible to contaminations by microorganisms; this required precautions during analysis. The chemical composition of the samples indicates that the Athabasca bitumen is basically a crude oil.

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Exploration in Llanos of Colombia

The Llanos of Colombia, comprising the eastern portion of the country, is an alluvium-covered, featureless, grassy plain that covers an area of about 75,000 square miles. Except for a short dry season from December to March heavy rains occur almost every day. Access to the area is difficult and for the major portion of the year special track equipment or helicopters must be used for exploration operations. Structurally the Llanos form an asymmetrical basin similar to that of eastern Venezuela or western Canada. There is a shelf area to the east with sediments dipping uniformly off the Guiana shield and increasing in thickness to the west to form a major trough in front of the thrust faulted Eastern Cordillera. The entire geological sedimentary column outcrops along the western border of the Llanos with excellent reservoirs, source rocks, and attendant oil seeps. Approximately 26,500,000 acres are held in the basin by six major oil companies at this time. To date the geology of the bordering Eastern Cordillera has been mapped in considerable detail, reconnaissance seismograph, gravity, and local magnetometer surveys have been run over the more attractive portions of the basin, and 22 wells have been drilled. Although some encouraging oil shows have been encountered in wells in the southern margin of the basin, no commercial oil has been discovered to date.

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Florida-Bahama Platform

The emerged and submerged Florida-Bahama platform covers 200,000 square miles and encompasses the Bahama Islands and most of the Florida peninsula and shelf. The 35,000 square miles of exposed surface has little relief; however, relief found in deep water channels on the submerged part of the platform in many places exceeds 6,000 feet. Geologically, the area is bounded by the Ocala uplift, the overthrust sheet of the Greater Antilles, the possibly faulted west edge of the Florida shelf, and the North American ocean deep.

Mesozoic and Cenozoic carbonates and evaporites form a southward thickening wedge of sediments that attain a maximum known thickness of 19,000 feet in the Cay Sal Bank area. The youngest Paleozoic rocks encountered have been identified as Devonian; however, most of the rocks directly underlying the Cretaceous in north Florida are clastics of Ordovician age. Total thickness of the flat-lying unmetamorphosed Paleozoic section is estimated at slightly more than 6,000 feet. Precambrian age determinations have not been made on any igneous rocks encountered in the province; however, in some places the igneous rocks probably pre-date early Paleozoic sediments.

Major structural features within the province are the South Florida basin and the Bahama basin; these are separated by a more stable area that may be the southeast extension of the Ocala uplift. Local structures in Mesozoic and Cenozoic sediments should be of the basin type as there are no indications of major post-Paleozoic orogenic movements within the province.

The Sunniland field in south Florida is the only producing oil field in the province and has produced about 6 million barrels of oil from a Lower Cretaceous bioclastic zone at 11,600 feet. Problems confronting the oil seeker include shallow high-velocity and cavernous formations that make seismic and core drill prospecting difficult.

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Recent Developments in Lower Cretaceous Trend of Mississippi

The discovery of oil at Bolton in Hinds County, Mississippi, and Citronelle in Mobile County, Alabama, heralded a fairway of Lower Cretaceous production from the Rodessa, Sligo, and Hosston formations in the intervening area. To date, oil production has been established in 10 fields in Mississippi. All of the fields are within the salt basin and salt movement is believed responsible for most of the producing structures. The structures increase in complexity with depth.

Regional structure maps delineate the configuration on top of the Lower Tuscaloosa (Upper Cretaceous) and base of Ferry Lake Anhydrite (Lower Cretaceous). Structure maps and cross sections of Bolton field in Hinds County; Magee field in Smith and Simpson counties; Martinville field in Simpson County; Raleigh field in Smith County; Soso field in Jasper, Jones, and Smith counties, Mississippi; and Citronelle field in Mobile County, Alabama, are included to illustrate that most of the accumulations are controlled by structure. Reservoirs discovered thus far are a prelude to other Lower Cretaceous fields that will, no doubt, be discovered in the future.

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Yamacraw Ridge, Pre-Cretaceous Structure beneath South Carolina-Georgia Coastal Plain

In the process of making alongshore and offshore seismic refraction studies of the geologic structure beneath the submerged Atlantic Coastal Plain from north of the Cape Fear arch in North Carolina to the vicinity of the Florida-Georgia boundary, it was noted that the measurements between Charleston, South Carolina, and Doboy Sound, Georgia, indicated that the basement (pre-Cretaceous) surface sloped towards the continent rather than towards the ocean. This reversal in the normal seaward slope of the basement surface was interpreted as being caused by a basement ridge, and named the Yamacraw Ridge of Meyer and Woollard. This past year it was possible to investigate this area

more fully and 12 reversed seismic refraction measurements were made in the emerged Coastal Plain area lying between Ridgeland, South Carolina, Walthourville, Georgia, and the coast. These measurements plus the previous seismic measurements in the submerged Coastal Plain area and well data, show that the Yamacraw Ridge is a well defined topographic feature on the buried pre-Cretaceous surface and that it forms the eastern boundary of the northern portion of the South Georgia basin. The ridge has an overall length of about 90 miles and a width of about 25 miles. It strikes about 22° west of south and its axis coincides roughly with that of the present coastline. The ridge originates at the general basement level near Charleston, S. C., and has the form of a spur which plunges to the south with about 2,000 feet change in elevation along its length. The cross-section relief over most of its length is about 1,200 feet. On the basis of the observed seismic velocity values (16,000–19,500 feet per sec.), the ridge is composed of varying crystalline rock material. On the landward side of the ridge there is a marked basement embayment and local deepening alongside the ridge. This trough-like depression on the basis of the seismic velocity value (15,000–19,000 ft. per sec.) appears to be floored with crystalline rock material. The basement surface at the head of the trough is very irregular with indications of two incised valleys extending southward from the basement plateau area in South Carolina that stands about 3,000 feet above the floor of the trough in Georgia. In view of the relief and physical form of the Yamacraw Ridge it is suggested that it is of tectonic origin.

The available well data suggest the ridge was completely buried before the end of Lower Cretaceous time. Because of the discontinuous nature of the seismic horizons in the overlying sediments plus the scarcity of well data it is not clear whether there has been any tectonic movement associated with the ridge since its burial.

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Sand Trends and Paleoslope in Mississippi Embayment and Illinois Basin

Relationships between major sand body trends and facies distributions of the Cretaceous Gulf series in the Mississippi embayment and the Mississippian Chester series in the Illinois basin have been investigated. This study indicates that trends of major sand bodies in these two depositional basins are intrinsically related to their paleoslopes and depositional strikes. Major sand bodies in the Gulf and Chester series have southwesterly trends that parallel the respective paleoslopes, and that are normal to depositional strikes. Studies of directional properties enhance the predictability of these trends.

An impressive similarity exists between the sediments in the Gulf series of the Mississippi Embayment and the Chester series of the Illinois basin. Both basins were open-ended to the south and sediments were introduced longitudinally at the northern end; the paleoslopes were to the southwest and parallel with the basin axis; the depositional strikes were northwest-southeast, normal to the basin axis; sediment transport directions were to the southwest; and the depositional patterns are those of deltaic deposition in the north, becoming increasingly marine to the south.

Based on the parallelism exhibited by these features, a depositional model has been developed for this type of sedimentation in an intracratonic basin. Within the model, trends of major sand bodies are oriented parallel to the basin axis, paleoslope, and sediment transport direction; are normal to the depositional strike; and are the result of a deltaic pattern of sedimentation.

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Effect of Fault-block Structures on Sedimentary History of Coastal Plain in North Carolina

Evidence of a major steeply dipping normal fault is provided by recent field studies in the Atlantic Coastal Plain of North Carolina. The fault extends N. 20° E. from near Clinton in the southeastern part of the state more than 100 miles through Weldon, N.C., and possibly northward into Virginia. The fault is in the crystalline basement rock, which is downthrown to the west. In northern North Carolina the fault marks the west boundary of the Coastal Plain sediments along the "fall zone."

Linear structural features caused by, or related to, faulting of the basement rock beneath sediments of the Coastal Plain also are discussed, as are the stratigraphic features of these sediments. It is suggested that these linear features are evidence of faults in the basement rock and that the blocks between faults were tilted eastward.

The presence beneath the Coastal Plain of sediments similar to deposits of Triassic age found in the Deep River basin to the west indicate that faulting was active during late Paleozoic time. Displacement of beds in the Tertiary formations and the presence of isolated sedimentary basins suggest that faulting continued intermittently until middle or late Cenozoic time. The amount of displacement of the basement rock that occurred prior to the deposition of the Coastal Plain sediments has been obscured by erosion, which planed down the uplifted blocks, and by subsequent deposition.

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Significance of Certain Distinctive Zones of Sub-Pyrenaic Region and Ebro Basin to Petroleum Geology of Northern Spain

The marginal mountain chains that frame the Ebro Basin in the northern and northeastern parts of the Iberian Peninsula show the existence of certain areas of sedimentation which are distinctive because of the local development of particularly thick, complete, and continuous stratigraphic sections. These are of particular importance with respect to the current renewal interest in the petroleum geology of northern Spain. The structure of these areas is probably related primarily to localized Hercynian folding, but is most clearly the result of movements in Upper Jurassic time. The final tectonic setting was achieved only during the Alpine folding during Oligocene time.

A manifest relation is apparent between some of these anomalous areas and the extensive diapiric phenomena surrounding them. In some cases the forces involved appear to be mainly gravitational and the diapirism is more clearly due to conditions of sedimentation than to tectonic processes, thus giving diapirs of the columnar or salt-plug type. In other cases on the contrary the diapirs are more clearly related to lines of faulting. A recently discovered and hitherto undescribed diapir near Pamplona has a very elongate laminar outcrop of saline materials of Keuper age and constitutes a novelty among the more classic diapirs of the region.