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Alaska: Potential for Giant Fields

The demise of Mukluk field is forcing government and the oil industry into more remote and hostile areas of Alaska at a more rapid rate than originally envisioned. It is conceivable that even giant fields may, in some circumstances, prove marginal or noncommercial. The unexplored offshore waters in the Arctic and the Bering Sea are seen as holding the greatest promise.

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Geology and Hydrocarbon Potentials of Arafura Sea

The Arafura Sea is a continental-shelf sea located between Irian Jaya (western New Guinea) and the northern part of the Australian continent. On the south it adjoins the stable Australian craton, and on the north it is bordered by the Tertiary collision zone between the Australian craton and the northern Irian Jaya island arc. On the west and northwest it is bounded by the active Banda arc collision zone, whereas on the east it is bordered by the northern extension of the Gulf of Carpentaria that also forms the western limit of the zone of late Paleozoic granites. Shelf sediments, ranging in age from late Paleozoic to Cenozoic, predominate in the Arafura Sea continental shelf, and are underlain by granitic basement. Two tectonic styles of deformation are recognizable in the area, namely a block-faulted downwarping within stratified shelf and slope sediments of the Arafura Sea and overthrusting of chaotic sediments from the Banda arc toward the Australian continent in which the intensity of deformation increases from south to north. Gas shows have been reported from Jurassic to Cretaceous fine-grained marine limestones and sandstones, and gas and condensate also are present in Cretaceous sediments and Middle Jurassic fine-grained sandstones.

At the north, the most prospective area seems to be the hinge zone of the Aru high, where a combination of traps and reservoir rocks presumably exists. On the south, the Money Shoal area is considered a significant prospect. In the Arafura basin, stratigraphic traps seem to be the most promising target for hydrocarbon exploration as tectonics seems not to have played an important role in the area. The sedimentary area occupied by the eastern extension of the Tarera-Aiduna wrench fault should also be investigated in detail for its hydrocarbon potential.

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Oil and Gas Possibilities Onshore and Offshore Ghana

Nearly half of the total area of the Republic of Ghana is covered by sedimentary rocks. These rocks are found mainly in four different parts of the country: Tano basin, Keta basin, Voltaian basin, and the continental shelf. The possibilities of finding oil and gas onshore and offshore Ghana have thus been concentrated in these four areas.

Because oil seeps in saturated superficial sands were found in the Tano basin, efforts to find oil in Ghana started as far back as 1896 in this basin, which is located at the extreme southwestern part of Ghana and has an area of 1,165 km^2 (450 mi^2). Seventeen onshore wells have been drilled so far in this basin, which is underlain by Upper Cretaceous Apollonian sediments consisting mainly of thin alternations of sand and clay with a few thin beds of gravel and fossiliferous limestone.

The Keta basin, located at the extreme southeastern part of Ghana, has an area of 2,200 km^2 (850 mi^2). It is covered in the north by Pliocene and in the south by Holocene deposits. Since 1966, three onshore wells have been drilled in this basin.

The continental shelf of Ghana is at the southern part of the country and has an area of 27,562 km^2 (10,640 mi^2). Prospecting for oil in the shelf started in 1968. In all, 34 offshore oil wells have been drilled by foreign companies in this area, which has been divided into 24 concession blocks. At present, oil is being produced from wells in Block 10. The possibility of finding oil and/or gas at the extreme western part of the continental shelf cannot be overemphasized.

The expansive Voltaian sedimentary basin, located in the central part of Ghana, covers an area of about 103,600 km^2 (40,000 mi^2). The basin is underlain by Precambrian to lower Paleozoic epicontinental Voltaian series comprised of a thick sequence of marine and continental sediments. Although no trace of hydrocarbon was found in the only well that has been drilled so far in this basin, the presence of traces of bitumen in some parts of the basin indicates that, despite of its age, the basin might prove to be an oil province.

The recent discovery of oil in the Ivory Coast means that it is possible to find oil or gas in Ghana, inasmuch as Ghana's petroleum potential is closely associated with that of the Ivory Coast basin, which extends for 560 km (300 mi) along the entire Ivory Coast and persists eastward into Ghana for an additional 320 km (200 mi), terminating in the area directly west of Accra. The Ghanian part of the Ivory Coast basin, therefore, holds the greatest possibility of finding oil or gas in Ghana.

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Oil Possibilities of Mesozoic in Mexican High Plateau

The study area is physiographically located between the Sierra Madre Oriental (mountain range) at the east, Neovolcanic axis on the south, Sierra Madre Occidental (mountain range) at the west, and the eastern part of the Province of Chihuahua on the north and northeast.

Platform rocks that crop out in the Sierra Madre Oriental possibly limit the Tampico-Misantla basin to the east and the Mexican Jurassic-Cretaceous geosyncline to the west. It is considered that part of the Sierra Madre Occidental served as a limit to the geosyncline from the west of Jalisco to the east of Sonora. A large part of the area is covered by extrusive igneous rocks, especially the region bordering the Neovolcanic axis, the eastern part of the Sierra Madre Occidental, and the Provinces of Chihuahua and Coahuila. The rocks that were studied consist of limestones, dolomites, shales, sandstones, and marls, mostly of marine origin.

Results of petroleum drilling indicate that some rocks show a degree of metamorphism, especially Jurassic and Triassic rocks. In places, rocks in allochthonous blocks were drilled that showed repetition of the formations, and the drilling objectives could not be reached. In the northern part of Chihuahua, some wells were drilled in bolsons or grabens filled by Tertiary and Quaternary clastic material or overflows and volcanic rocks.

According to the results obtained from this study, the following steps should be taken: (1) increase the studies of geologic and geochemical detail, (2) determine which parts of the area, from the thickness of Mesozoic sediments, are prospects for more detailed studies, (3) use mining information to locate and classify areas of metamorphism, which will surely condemn some areas, especially near the Sierra Madre Occidental, (4) increase drilling of stratigraphic tests as well as those with petroleum objectives, (5) construct Mesozoic isopach maps of Mesozoic formations from geophysical information and surface and subsurface geology, (6) study drilling records to obtain related to geohydrology, ecology, and electrical log information from the surface to total depth of the well. The cost of this program would be very high, but is justified inasmuch as it is so large an area to be explored and the prospects are excellent.

The Mexican Plateau comprises several future oil provinces; however, the southeast of Chiapas, the Gulf of California, and the Balsas trough must be considered to be of great interest.

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Oil and Gas Fields in East Coast and Arctic Basins of Canada

The East Coast and Arctic basins of Canada have been under serious hydrocarbon exploration for over 20 years. Although the density of drilling is low, extensive seismic control has outlined a high proportion of the structures in these basins and the stratigraphic framework of the basins is known. From west to east, the basins include the Beaufort basin, the Sverdrup basin of the high Arctic and the adjacent Parry Island foldbelt, the rift basins of Baffin Bay, and the continental-margin basins offshore Labrador, the Grand Banks, and the Scotian Shelf. Each of these basins contains oil and gas fields that typify, to some degree, the pools that may be anticipated in undrilled structures. Surprises, both good and bad, await the explorer.

The physical environment of these Canadian basins ranges from severe to almost impossible. As exploration has proceeded, great strides have been made in coping with the physical environment; however, the costs are becoming increasingly onerous, and the appreciation is growing regarding the cost, risk and time that will be involved in developing production from those resources. Even from a national sense of supply security, the vast reserves of oil in the tar sands and in-situ recovery deposits of heavy oil in western Canada will provide a competitive ceiling that will limit future development of frontier basins to those where production costs are not significantly higher than those of the tar sands.

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Future Petroleum-Productive Regions of USSR and Mongolia

The potential for major discoveries of oil and gas is high in the USSR, but remote in Mongolia. Development of the USSR's potential is plagued by six factors: (1) remoteness of prospective basins from commercial markets, (2) lack of adequate infrastructure within prospective basins, (3) inadequate drilling technology for economic development below depths of 3,200-3,800 m (10,500-12,500 ft), (4) poor-quality indigenous equipment, (5) absence of offshore capabilities, not only in the warm Caspian and Black Seas, but also in the ice-plagued Arctic and Pacific Oceans, and (6) a chronic manpower shortage. Imports of foreign technology are alleviating the problems gradually, but they are far from solved.

European USSR.—The most important objectives of the future are: (1) Jurassic through Devonian in the Greater Barents basin and Svalbard platform, offshore Barents Sea, (2) deep Carboniferous-Ordovician of Timian-Pechora basin, (3) subthrust plays of western Urals, (4) pre-Kungurian salt section of the Pricaspian basin, (5) Devonian of the Dnepr-Donets graben, (6) Jurassic through Paleogene of the Black Sea shelf, (7) pre-Tertiary formations of the North Caucasus trough, and (8) deep Tertiary objectives near Baku in the central and southern Caspian Sea.

Asiatic USSR.—The most important targets are: (1) deep Mesozoic and Paleozoic (Carboniferous, Devonian, Silurian) carbonates of the Nyurol'ka, Frolovo, and other depressions in and below the West Siberian basin, including the Kara Sea, (2) late Paleozoic-Mesozoic of the Aral' Sea, the Ustyurt depression, the Chu-Sarysu basin, and the Turgay and Syrdar'ya syneclises, most of them unexplored, (3) the pre-Upper Jurassic of the central Asian basins, (4) the deep Tertiary of the Cheleken district, (5) the subthrust and pre-Tithonian salt section of the South Tadzhik basin, (6) the Proterozoic-Silurian marine sequences of the Tunguska, Lena, and Sukhana basins, and of the Nepa-Botuoba arch, (7) the Carboniferous-Lower Jurassic of the Vilyuy, Lena-Anabar, Khatanga, and Yenisey basins, with the associated subthrust plays of the Taymyr and Verkhoyansk ranges, and (8) the numerous late Paleozoic-Mesozoic offshore basins of the Arctic shelf plus the Tertiary basins of the Pacific, especially the Severny basin.

Mongolia.—Principal objectives are Jurassic and Cretaceous fluviatile and lacustrine sandstones in southeastern Mongolia, especially in the East Gobi basin and in the Hailar basin, which is shared with China. Similar basins in China have giant fields, such as Karamay in the Junggar basin and Daqing in the Songliao basin.

Resources.—Through 1983, the USSR had produced about 75 billion bbl of oil and condensate and 217 tcf of gas. Estimated proved plus probable liquids was 35-36 billion bbl and, of gas, about 800 tcf. Resource potential, above and beyond proved plus probable, is estimated at about 90 billion bbl and 1,000 tcf (these numbers will increase as offshore ice-pack technology is improved). In contrast, Mongolia's produced and proved oil is less than 2 million bbl, but the resource potential could be large.

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Oil and Gas Potential of Amazon Paleozoic Basins

The Paleozoic basins, covering an area of about 800,000 km^2 (309,000 mi^2) in the Amazon region, are elongate symmetrical intracratonic synclines filled with as much as 4,000 m (13,000 ft) of sediments, separated by basement uplifts or major arches and located in continental interior areas (as are the United States Illinois, Michigan, and Williston basins). These Amazon basins resulted from an initial crustal thinning followed by rifting with associated ultrabasic intrusions and, finally, cooling and subsidence. Gravity anomalies, coinciding with the axes of the synclines, support this genetic hypothesis.

These synclines were filled during the Silurian-Devonian with one cycle of continental alluvial sediments grading upward to deltaic marine clastics and minor periglacial deposits. A regional unconformity separates the Devonian from the Permo-Carboniferous cycle when, following fluviodeltaic sedimentation, highly restricted marine conditions developed a sequence of evaporite deposits.

Tectonics affected differentially these basins during the Triassic-Jurassic and Early Cretaceous, associated with widespread basic volcanism. A northeast-southwest thrust-fault system, branching southwest, characterizes a compressional orogenic province in the Upper Amazon basin. This compressional province, located in the Jurua River area, constitutes a major structural trend. Adjacent to those faults and extending for over 500 km (310 mi), large natural gas accumulations occur in several domal features. Sandstones of the Permian Monte Alegre Formation, sealed by evaporite strata, are the main reservoir rock. Geologic estimates of natural gas resources are presently rated at 120 billion m^3 (4.237 tcf) and exploration follows the productive trend toward the west-southwest.

The Middle Amazon basin, separated from the Upper Amazon by the Purus arch, was affected by lineament-block tectonics, also with associated volcanism and some local mild shearing. Minor domal features of Devonian periglacial Oriximina Formation sandstones comprise small subcommercial oil accumulations. In contrast with the Upper and Middle Amazon basins, the Lower Amazon basin has been the site of rifting since the Permo-Triassic. The rifting was associated with a nearby hot spot that uplifted the eastern part of the basin, forming the Gurupa arch. As a consequence of this uplift, a set of collapse grabens developed in the Lower Amazon basin. Potential reservoir rocks in Middle and Lower Amazon basins are Permian Monte Alegre and Devonian Oriximina sandstones. Major source rocks in all three basins are Devonian Barreirinha black shales. Organic geochemistry data indicate that both Upper and Lower Amazon basins are predominantly gas-prone, whereas the Middle Amazon basin shows potential for oil generation.

Forecasts for the major exploratory trends in the Upper Amazon indicate a good possibility of extending the already discovered natural gas province. In the Lower Amazon basin, further exploration will consist in drilling well-defined structural features identified for the first time by seismic methods, with a possibility of discovering another gas province. Prospects in the Middle Amazon basin are for both oil and gas, but the main problem is identification of adequate structures, as well as stratigraphic traps.

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Geology of Barents Sea

The Barents Sea is situated on the continental shelf between Norway, the Spitsbergen Islands, and Novaya Zemlya. The main structural framework of the area was formed during the Caledonian and Hercynian orogenies, whereas the western parts were reactivated by the Kimmerian and Alpine orogenies. Because of the complex opening of the Greenland-Norwegian Sea, important Tertiary reactivation of Mesozoic normal faults occurred along southwest-northeast-trending systems of wrench faults.

Owing to substantial erosion in the late Tertiary, the subsidence history and thermal development are more difficult to unravel in this area than in other places along the Norwegian Shelf. The erosion products were deposited in a huge sedimentary wedge extending onto the oceanic crust.

The hydrocarbon discoveries in the Troms area in the southern part of the Barents Sea are encouraging for further exploration. However, the petroleum potential for large areas is not well known at this stage.

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Wrench Faults as Factor Controlling Petroleum Occurrences in West Siberia

The morphology of west Siberia suggests the presence of huge wrench faults, which also can be seen on Landsat imagery. Many of these faults have been confirmed by geophysical surveys and subsurface data. However, Soviet geologists have not always recognized the importance of