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**STATE OF ALASKA**

**Department of Natural Resources**

**Division of Geological & Geophysical Surveys**

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**DGGS gears up for Lease Sale 39**  
by Rich Kornbrath, DGGS geologist

Petroleum geologists and geophysicists in the DGGS Anchorage office are gathering and interpreting data for the state's offshore-onshore oil and gas Lease Sale 39, slated for May 1983.

Don McGee, DGGS's Chief Petroleum Geologist, said 51 tracts encompassing about 255,122 acres (not including federal-state disputed acreage) will be up for lease. A decision on 5,413 disputed acres will be announced in March.

The lease area is sandwiched between the \$1 billion 1979 Beaufort lease-sale area to the east, the \$2 billion OCS Sale 71 to the north, and the Prudhoe Bay and Kuparuk fields, Milne Point, Gwydyr Bay, and the Upper Cretaceous shallow sand accumulations to the south.

The state's evaluation of the hydrocarbon potential of the Sale 39 area is based on the interpretation of 1,200 line miles of seismic data and

on subsurface geologic mapping from available well data. Results and recommendations, including an economic evaluation by the DNR Division of Minerals and Energy Management staff, will be presented to Commissioner Wunnicke in mid-February.

Sale 39 acreage is partly underlain by a broad, regional high called the Barrow Arch. In the sale area, the high is complicated by a NW-SE-trending normal fault system (including the Eileen fault) that is also present on the west flank of the Prudhoe structure. The Eileen fault bounds the Prudhoe accumulation on the west and has down-to-the-southwest vertical displacement. It probably continues northwest through the Simpson Lagoon area into the sale area.

**Migration and source**

Cretaceous marine shales are the probable source rocks of hydrocarbons in the Prudhoe Bay field<sup>1</sup>. A truncation on the east side of the

Prudhoe complex of Permo-Triassic and Mississippian reservoir rocks by a Lower Cretaceous unconformity places the reservoirs in direct contact with the overlying Cretaceous shales. Oil from the shales may have migrated into the reservoirs from the east and southeast, updip along the unconformity. Equally possible are migrations down into the reservoirs or up from the north across major faults. Major downthrown blocks are bounded by faults with displacements of about 1,000 ft, which juxtapose Cretaceous source rocks with the reservoir rocks.

The Prudhoe Bay field contains a heavy-oil zone and a tilted oil-water contact.<sup>2</sup> In the extreme western part of the Prudhoe accumulation (the so-called Eileen area), the heavy-oil zone is absent. Regional tilting downward to the east may have enhanced the westward oil migration. Restored sections by Jones and Speers<sup>2</sup> suggest that oil did not enter the Eileen structures until post-early Tertiary time, probably because of continued eastward tilting. The accumulation in the Eileen area may not have been in existence long enough to precipitate the asphaltenes necessary to form an underlying heavy-oil zone.

The similarity of the oils in the Prudhoe, Kuparuk, and Upper Cretaceous sandstone accumulation areas tend to support the westward-migration theory, and geochemistry indicates a common origin for the oils.<sup>2</sup> The Kuparuk and Upper Cretaceous reservoirs may have been charged by oil initially migrating updip through the Prudhoe structures and then migrating vertically upsection into the Cretaceous rocks.

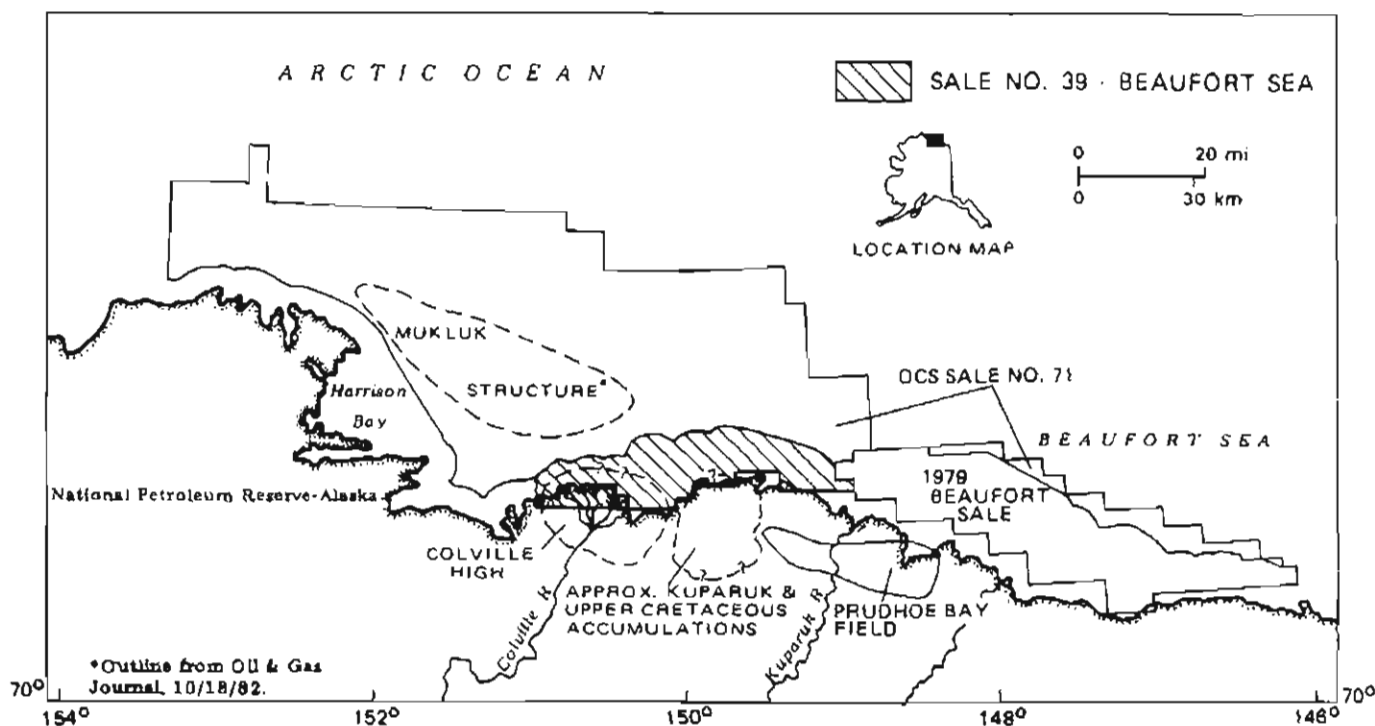
Sale 39 is generally west and northwest of the Prudhoe Bay field. Questions about the timing and quantity of oil that may have moved into or through this area must be answered before known and possible petroleum occurrences can be fully understood.

### The Colville high

The Colville high, a large structure that underlies the onshore deltaic and nearshore area at the mouth of the Colville River, was tested by three dry wells 10-15 years ago. However, the Gulf Colville Delta 1 well encountered Sag River sandstone at a subsea depth of 7,600 ft, and had good hydrocarbon shows in the Sag River and in the top of the Ivishak Formation. Depth to the top of the Sag River in the Arco-Exxon Prudhoe Bay State 1 discovery well is 8,078 ft.

Several coastal wells presumably drilled on closures in the Permo-Triassic reservoirs were also dry. These include the Placid Beechey Point 1, the Social Kavearak 1, and the Social Simpson Lagoon 32-14 and -14A wells. Clearly the concept of timing with regard to structural emplacement, tilting, and oil migration, as well as the existence of a widespread Lower Cretaceous unconformity and of large faults complicate the search for commercial oil deposits in this relatively simple and well-known geologic setting.

Why does the Colville structure appear to be dry? Morgridge and Smith<sup>1</sup> contend that the Colville high is dry because the Permo-Triassic reservoirs are overlain by a thick section of Jurassic shale that effectively separates the reservoirs from the rich Cretaceous source beds. Jones and Speers<sup>2</sup> suggest that the Colville structure is dry because it formed after oil migration into the Prudhoe structure. Easterly tilting of the Prudhoe structure may have allowed oil to flow updip through the Colville structure, as shown by the good oil shows in some boreholes in the structure. Alternatively, the oil that may have migrated out of Prudhoe might have been trapped before reaching the Colville high or might have migrated vertically to become the present Kuparuk or shallow Cretaceous accumulations.



### Mukluk structure

The Mukluk structure---a huge NW-SE-trending structure in Harrison Bay---has not been tested. OCS tracts overlying the Mukluk structure attracted \$1.5 billion in high bids in federal Lease Sale 71 last October. Two tracts on top of the structure received the second and third highest individual offshore tract bids ever received (\$227 million and \$219 million). Obviously, some industry explorationists are optimistic about the chances of discovering major resources within the structure. Estimates of oil in-place there range from about 500 million barrels to more than 5 billion barrels. Despite this, there was a noticeable absence of high bids on Mukluk by some of the majors.

The Mukluk structure is large based on the bidding, and appears to have two geologic indicators of resource potential. It may have Permo-Triassic reservoir rocks juxtaposed with rich Cretaceous source rock and is located updip along the possible oil migration route from the tilted Prudhoe structure.

On the basis of coastal NPRA well control, it is presumed that the Permo-Triassic reservoirs may be 200-700 ft higher on Mukluk than on the Colville high. In the W.T. Foran well on NPRA, the Lower Cretaceous unconformity truncates the top of the Permo-Triassic reservoir section. NPRA well control indicates that this truncation may trend roughly E-W across Harrison Bay, truncate the reservoirs in the Mukluk structure, and juxtapose rich Cretaceous source beds and Permo-Triassic reservoir rocks.

However, these important questions remain unanswered. When did the Mukluk structure form? When did oil migration occur? Are large faults associated with it and are they involved in oil generation or migration in this area? Because the acreage is located between Prudhoe and Mukluk, the answers to the questions pertaining to age and oil generation-migration have a direct relation to the assessment of the hydrocarbon potential of the state's Sale 39 acreage.

### Sale 39 geologic plays

Three geologic plays are being assessed in the Oil and Gas section's evaluation of the Sale 39 acreage. Stratigraphically from top to bottom these are the Upper Cretaceous sandstones, the Kuparuk sandstones, and the Permo-Triassic and Mississippian reservoirs.

The oil accumulation west of Prudhoe in the Upper Cretaceous sandstones is poorly defined. According to Jamison and others,<sup>4</sup> the deposit extends from the coastline (where it appears in the Simpson Lagoon 32-14, the Social Kavearak 1, and the Milne Point 18-1 wells) south to the Arco West Sak River State 5 well. The deposit appears to be at least as large, areally, as the Kuparuk accumulation, and overlies it for the most part. Depth to the oil-saturated sands ranges from 2,500 to 4,500 ft. The oil properties are unfavorable, with gravities in the 17° to 23° API range and viscosities from 25 to 50 centipoise.

The economics of the deposit may be marginal at best, and no accurate information is available on in-place oil or estimated recoverable oil using enhanced recovery techniques.

The Kuparuk River Formation consists of three sandstone members separated by shales. The accumulation(s) are not well defined to the north and south, and like the Upper Cretaceous sand deposits, presumably trend offshore into the Sale 39 area.

Current estimates by Arco and BP-Alaska of in-place oil in the known accumulation area are 4.4 billion barrels, with 1.0 to 1.5 billion barrels recoverable.<sup>5</sup> Depths to the reservoirs range from 5,800 to 9,000 ft, with wells producing from 600 to 2,500 barrels per day of 24° API gravity oil. The combined Kuparuk River sands are generally 10 to 150 ft thick and probably average 25-45 ft thick. Although this is not a large amount of pay, the fair to good recovery rates,

infrastructure, and extensive offshore gravel or sand islands in the sale area make this an attractive play.

A Permo-Triassic and Mississippian section of rocks is present in wells along the coastline adjacent to the sale area. Oil accumulations in the Permo-Triassic rocks are known in the Hamilton Brothers Point Storkersen 1 and Kup Delta 51-2 and in the Mobil-Socal Gwydyr Bay State South 1 wells; these appear to be fault-separated from the Prudhoe accumulation. The excellent reservoir rocks that contain the huge Prudhoe accumulation should provide attractive targets in the sale area if specific closures can be seismically defined. Whether these rocks are truncated by the Lower Cretaceous unconformity within the sale area as occurs at Prudhoe and presumably on the Mukluk structure is subject to the exploratonists' interpretation of the data.

### Summary

Proximity to known accumulations and to expensive untested leases, the presence of good reservoir rocks along the coastline, and the structural setting along the Barrow Arch indicate a highly attractive Sale 39 area. However, the existence of distinct closures and the incomplete understanding of both structural timing and oil-generation and migration timing are important unknowns in the discovery formula. The latitude in possible interpretation should make for a lively and interesting oil and gas lease sale.

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#### Esther Wunnicke assumes DNR helm

Esther Wunnicke, a former director of the Department of Interior Outer Continental Shelf Office, was sworn in as Commissioner of Natural Resources Jan. 3, 1983. Although she was appointed to the post by Governor-elect Bill Sheffield in late November, John Katz continued serving as Commissioner until Wunnicke could leave her position at OCS.

Wunnicke, 60, brings a wealth of experience to the post. The new Commissioner moved to Anchorage in 1963 with her husband Bill, a retired petroleum engineer. From 1967-71, she served as an attorney-adviser for the Federal Field Committee for Development Planning, a group working to help Alaska recover from the 1964 Good Friday Earthquake. From there the former Aztec, New Mexico attorney spent a year as an assistant attorney general with the Alaska Department of Law before being named co-counsel for the Federal-State Land Use Planning Commission. President Carter named

her chairman 5 years later, a post she held until mid-1979, when she was named manager of the Alaska Outer Continental Shelf Office, an agency recently reorganized into the Minerals Management Service. Overseeing a staff of 200, Wunnicke was charged with managing 360 million acres of OCS lands and the federal government's oil and gas leasing program.

"My background gives me a good general view not only of oil and gas resources in Alaska, but also of fisheries, forestry, agriculture, and hard-rock mining," Wunnicke said. "I consider this appointment a tremendous challenge and a real opportunity to help Alaska manage its natural resources to the benefit of all Alaskans."

Reaction was positive to the new commissioner. At the time of her appointment, both industry and environmental groups praised her reputation for fairness and compromise.

Dave Cline, regional vice president of the Audubon Society, said, "Wunnicke is a proven resource pro and a very warm person. She will listen to all concerns and be very fair."

William Hopkins, executive director of the Alaska Oil and Gas Association, said, "She is enough of a universalist and can't be labeled with bias on either side."

The Alaska Journal of Commerce stated, "A sterling testament to how she ran the office and the confidence she gave to the industry in terms of what to expect from the federal agency was no more clearly demonstrated than in last October's Diapir (Beaufort Sea) oil and gas lease sale, which netted a whopping \$2 billion plus in bonus bids."



"Sediments that settle in the subduction zones are folded and elevated when the spreading of the mid-ocean ridge reaches more than 4 km per year."--The N.Z. Geological Society Newsletter