DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

COAL INVESTIGATIONS
MAP C-139-A

NW — 45 MILES — SE

DH-1 MOBIL WEST KUPARUK STATE No. 1 SEC. 3, T.11 N., R.11 E.
DH-2 ARCO/HUMBLE S.E. EILEEN STATE No. 2 SEC. 26, T.11 N., R.12 E.
DH-3 SOHIO DRILL SITE Q-1 SEC. 16, T.11 N., R.13 E.
DH-4 SOHIO DRILL SITE Q-6 SEC. 12, T.11 N., R.13 E.
DH-5 SOHIO DRILL SITE GC-3B SEC. 30, T.11 N., R.14 E.
DH-6 ARCO DRILL SITE 2-1 SEC. 25, T.11 N., R.14 E.
DH-7 ARCO/HUMBLE LAKE STATE 1 SEC. 24, T.10 N., R.15 E.
DH-8 BP BP 31-10-16 SEC. 31, T.10 N., R.16 E.
DH-9 MOBIL KADLER STATE No. 1 Sec. 15, T. 9 N., R.16 E.
DH-10 SHELL LAKE 79 FEDERAL No. 1 SEC. 1, T. 8 N., R.17 E.

TERTIARY
SAGAVANIRKTOK FORMATION
CRETACEOUS–TERTIARY BOUNDARY UNDETERMINED
CANNING FORMATION
CRETACEOUS

LOG MARKER A
LOG MARKER B
LOG MARKER C
UPPER COAL ZONE
LOWER COAL ZONE
COAL ZONE
UPPER
LOWER
COAL
ZONE
MKKELSEN TONGUE OF THE CANNING FORMATION
STAINES TONGUE OF THE SAGAVANIRKTOK FORMATION

NG DEN SON

200 FEET
100
0
Approximate scale

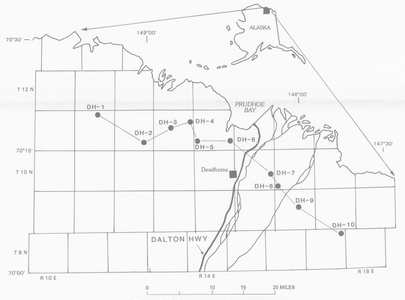

Figure 1. Index map showing well locations

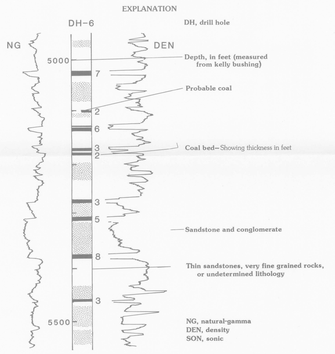

Table 1. *Types of geophysical logs used for interpreting coal beds and other lithologies*

DRILL HOLE	SP	RES	NG	DEN	SON	N	C
DH-1	●	●	●	●	●		●
DH-2	●	●	●	●			
DH-3	●	●	●	●	●	●	●
DH-4	●	●	●	●	●	●	●
DH-5	●	●	●	●		●	●
DH-6	●	●	●	●	●		●
DH-7	●	●	●	●	●		●
DH-8	●	●	●		●		●
DH-9	●	●	●	●	●		●
DH-10	●	●	●	●	●		●

SP Spontaneous potential
RES Resistivity
NG Natural gamma
DEN Density
SON Sonic
N Neutron
C Caliper

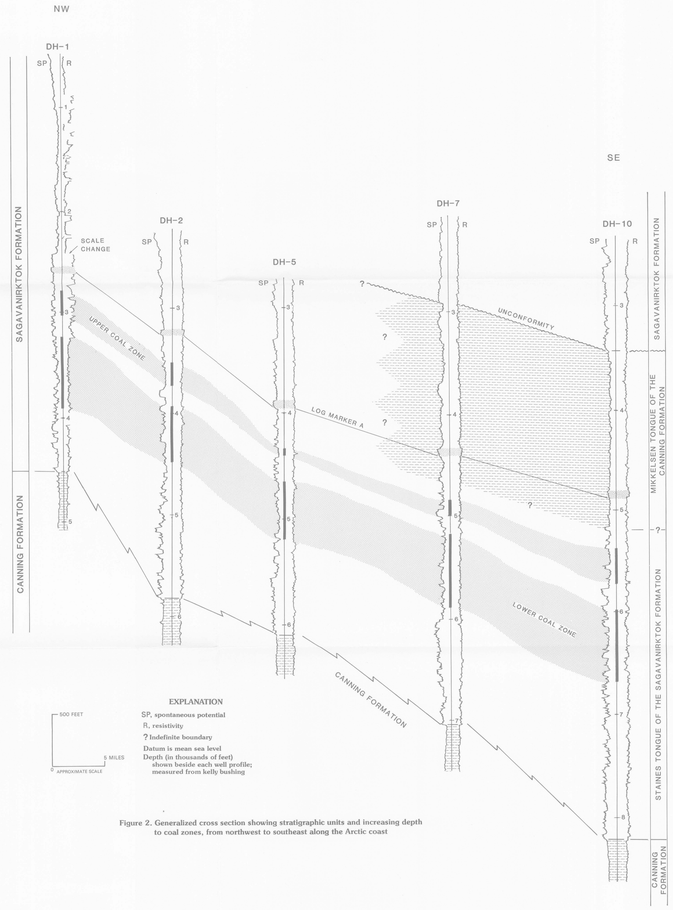

Figure 2. Generalized cross section showing stratigraphic units and increasing depth to coal zones, from northwest to southeast along the Arctic coast

INTRODUCTION

Substantial coal deposits occur in rocks of Late Cretaceous and Tertiary age that underlie a region of more than 6,000 sq mi on the east-central North Slope of Alaska. Reports of lignite in Tertiary rocks exposed along the Sagavanirktok River date back to the early 1950's, and more recent oil and gas test wells in the Prudhoe Bay area have penetrated numerous coal beds in Upper Cretaceous and Tertiary strata. There are few published data on the thickness, distribution, and quality of the coal in the region, and interpretations of resources are speculative due to the scarcity and poor quality of surface exposures and the low density of subsurface control in many areas. The cross section presented here, showing subsurface coal beds and geophysical logs from 10 wells near the Arctic coast, results from U.S. Geological Survey investigations that focus on a regional assessment of coal resources in Upper Cretaceous and Tertiary strata in this region.

GEOLOGIC SETTING

Upper Cretaceous and Tertiary rocks in the Prudhoe Bay region are the products of basinal, slope, shelf, and subaerial-plain deposition in an east to northeast prograding deltaic system (Molenaar, 1983). The coal beds shown in the cross section occur within the Sagavanirktok Formation, named by Gryc and others (1951) for rocks exposed along the Sagavanirktok River at Franklin Bluffs, about 25 mi south of Deadhorse (fig. 1). From additional outcrop studies, Detterman and others (1975) included all beds above the Upper Cretaceous Prince Creek Formation and below Quaternary surficial deposits in the Sagavanirktok Formation and divided the formation into three members: Sagwon (coal-bearing), Franklin Bluffs, and Nuwok. They reported a minimum thickness of 3,780 ft for the Sagavanirktok Formation, and estimated a maximum thickness of from 5,000 to 6,000 ft. Using subsurface information, Molenaar and others (1987) redefined the Sagavanirktok Formation to include beds as old as Late Cretaceous. They noted that as a lithologic unit, the lowermost part of the Sagavanirktok Formation is older to the west and south. They proposed redefining the base of the Sagavanirktok Formation as the base of the main shallow marine–nonmarine sandstone sequence overlying the thick offshore shale unit (Canning Formation). This change, from the base of the Canning Formation to the sandstone of the Sagavanirktok Formation, is recognized by a marked deflection to the left on both the natural-gamma and spontaneous-potential log traces used in this report, and the base of the Sagavanirktok Formation is placed at that point of deflection. The maximum thickness of the Sagavanirktok Formation (including one or more tongues of the Canning Formation) is about 9,000 ft in the area south and southeast of Prudhoe Bay (Bird and Molenaar, 1987). The Staines Tongue of the Sagavanirktok Formation, and the Mikkelsen Tongue of the Canning Formation were defined in the subsurface in the Mobil Oil Corporation West Staines State No. 2 well (sec. 25, T. 9 N., R. 22 E.), about 31 mi east of DH-10 (Molenaar and others, 1987). At the type locality, the Staines Tongue is 880 ft thick, the Mikkelsen Tongue is 1,880 ft thick, and both tongues grade southward and westward into the main body of the Sagavanirktok Formation.

The areal extent of the Mikkelsen Tongue is open to interpretation and its delineation, as shown here, is quite subjective. The top of the Mikkelsen Tongue in DH-7 and DH-10 (fig. 2) is extrapolated from subsurface studies of Molenaar and others (1986). In this area, the Mikkelsen Tongue is from 1,700 to 1,800 ft thick, and consists primarily of shale and subordinate sandstone. The shales and sandstones occur in distinct, coarsening-upward sequences, recognized by an upward decrease in shaliness as interpreted from the natural-gamma and spontaneous-potential log traces. The base of the Mikkelsen Tongue designated here reflects the change from sand-rich, coal-bearing strata into overlying non-coal-bearing, shale-rich units, and is arbitrarily placed at the base of the first laterally continuous sandstone succession (log marker B) overlying the upper coal zone of the Sagavanirktok Formation and underlying the thick, dominantly shale interval interpreted to be the Mikkelsen Tongue.

The lateral demarcation between the Mikkelsen Tongue and the main body of the Sagavanirktok Formation is also gradational, and is characterized by a general increase in sandstone as the Mikkelsen Tongue grades from deeper marine shales to nearshore and shallow-marine sandstone sequences (C.M. Molenaar, oral commun., 1987). Because this change is transitional, the westward limit of the Mikkelsen Tongue is difficult to pinpoint, and its continuation west of DH-7 is arbitrary.

The Sagavanirktok Formation was determined by Gryc and others (1951) to be Tertiary in age. Molenaar (1983) interpreted the Sagavanirktok Formation to be Late Cretaceous and Tertiary, becoming younger to the east and northeast, as a result of deposition within a time-transgressive prograding deltaic sequence. It is therefore inferred that the Sagavanirktok Formation becomes younger from DH-1 to DH-10. Since no palynomorph data are available for the sections used in this report, it is difficult to place the Cretaceous-Tertiary boundary. The ages shown adjacent to DH-1 and DH-10 apply only to those wells, and are based solely on log correlations with sections in the regional study of Molenaar and others (1986). An approximate interval in which the Cretaceous-Tertiary boundary is estimated to occur has been designated for DH-1. The Tertiary age assigned to the Sagavanirktok Formation in DH-10 is extrapolated from palynomorph data reported by Molenaar and others (1986), which indicate a Paleocene age for the Staines Tongue of the Sagavanirktok Formation, and an Eocene age for the Mikkelsen Tongue of the Canning Formation.

The Gubik Formation, which unconformably overlies the Sagavanirktok Formation, is less than 200 ft thick and is considered to be Pleistocene in age in the Prudhoe Bay area (Detterman and others, 1975); it may be as old as Pliocene farther west near the Colville River (R.J. Bird, written commun., 1988).

Log marker A, used as a datum in the cross section showing coal beds, is interpreted to be a sandstone that occurs very near the base of the Mikkelsen Tongue of the Canning Formation (DH-7 through DH-10). This log marker, as well as log markers B and C, are correlative over a distance of at least 50 mi.

GEOPHYSICAL LOGS

In the accompanying cross section, natural-gamma and density log traces are shown for each drill hole except DH-7 and DH-8, which show the sonic log because no density log was available. Other logs used for recognition of coal beds and associated lithologies are listed in table 1. Coal beds labeled as "probable coal" represent queried interpretations either because of the lack of certain geophysical log types or less-definitive log responses for those intervals. Coal-bed thicknesses for all wells were determined from the density and sonic logs.

COAL

The coal-bearing stratigraphic interval ranges in thickness from about 720 to 1,340 ft, and is informally divided into upper and lower coal zones. The upper coal zone ranges in thickness from 50 to 350 ft, and contains from two to seven coal beds. The lower coal zone is thicker, ranging from 380 to 840 ft thick, and contains six to twelve coal beds. The coal zones are separated by an interval of 130 to 320 ft that consists mainly of sandstone.

The net coal thickness for individual coal beds ranges from 2 to 22 ft for the upper coal zone, and 2 to 14 ft for the lower coal zone. Fifty percent of all coal beds are 5 ft or greater in thickness.

Depth to the top of the upper coal zone ranges from 2,800 ft (DH-1) to 5,400 ft (DH-10), increasing from northwest to southeast. The coal beds in this study occur within the Staines Tongue of the Sagavanirktok Formation, or its lateral (log correlated) equivalent and, hence, most coal beds are considered to be Paleocene in age.

Lithologic logs from other wells near Prudhoe Bay show that some minor coal beds occur at stratigraphic positions well above the upper coal zone, in rocks of probable Eocene age or younger. However, the coal beds seem to be local and discontinuous, and the data do not indicate any significant coal development in strata above the coal zones defined in this report.

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SUBSURFACE CROSS SECTION SHOWING COAL BEDS IN THE SAGAVANIRKTOK FORMATION, VICINITY OF PRUDHOE BAY, EAST-CENTRAL NORTH SLOPE, ALASKA

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