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By

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Alaska Division of
Geological and Geophysical Surveys

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ABSTRACT

The Unga Island coal field is located on Unga Island (Shumagin group), Alaska Peninsula. The coal field is limited to about 40 km^2 on the northwest peninsula of the island west of Zachary Bay. Small-scale coal mining occurred on the island during the late 19th and early 20th centuries, but no development has taken place since that time.

The Unga Conglomerate Member of the Miocene-aged Bear Lake Formation includes all coal beds on Unga Island. The geologic structure of the coal field is relatively simple with the seams at Coal Harbor dipping westward at 5° to 20°. The type Unga Conglomerate Member at Zachary Bay includes about 245-m of strata, the lower half of which consists of friable sandstones, conglomerates, claystones, shales, and thin seams of lignite and subbituminous coal. The coal measures make up about 12-m of strata in the lower half of the unit. Silicified trees are found in volcanic breccia in the upper part of the Unga Conglomerate Member on the northwest side of the island. The coals of the Unga Conglomerate Member formed in coastal swamps during a marine regressive phase.

Petrologically, Unga Island coals are very high in huminite and contain only very minor amounts of inertinite and liptinite. Mean-maximum vitrinite reflectance analysis reveals a range from 0.35 to 0.40 percent. The lignite to subbituminous C apparent rank indicates a thermal maturation index of immature to marginally mature.

It is estimated that the Unga Island coal field contains 90 million short tons (about 82 million metric tons) of inferred

coal resources in beds over 1 ft (0.3 m) thick and 70 million short tons (63.5 million metric tons) of inferred coal resources in beds over 1.6 ft (0.5 m) thick. This estimation is in line with projected total hypothetical resources of 150 million short tons (135 million metric tons) of coal. As mining of thin seams becomes more economically feasible in the future, the prospects for the development of small mines on Unga Island to supply coal for local needs are enhanced.

SCOPE OF FIELD WORK COMPLETED AND ACKNOWLEDGMENTS

Field investigations were completed over the time period of August 1 to August 5, 1984. Helicopter support was provided from an operations base station located at Sand Point, Popof Island. The time in the field and excellent weather conditions permitted a fairly complete reconnaissance exploration of all coal-bearing outcrops on the island. DGGS geologist J.G. Clough and assistant M.A. Belowich aided field investigations. Additionsl research on coals of Unga Island is in progress.

LOCATION AND ACCESS

The Unga Island coal field is located on Unga Island, which is the largest and westernmost island of the Shumagin group. This group of islands lies on the south coast, Pacific side of the Alaska Peninsula over 400 km southwest of Kodiak Island in latitude 55° (Figure 1). The Shumagin group is situated 80 km southwest of Stepovak Bay and extends about 150 km south and east from Pavlof Bay. Unga Island, which is about 24 km long, occurs in the Alaska Peninsula and Kodiak coal resource region of Alaska. It lies opposite Herendeen Bay on the Bering Sea side of Alaska Peninsula and across Unga Strait. The principal exposures of coal-bearing strata are located in the Coal Harbor area on the western shore of Zachary Bay (var. Zacharoff, Zakharefskaia, Zakhareffskaia, or Coal Bay). Zachary Bay, which is about 3.2 km across, indents the northern end of Unga Island for about 4.8 km (Figure 2).

Figures 1 and 2---NEAR HERE

Unga Island is about 880 air kilometers southwest of Anchorage, Alaska. Scheduled flights from Anchorage to Sand Point are made regularly. From Sand Point, helicopters are generally used for exploratory field investigations (Figure 3). Sand Point, a fishing village with a population of about 800, is located on Humboldt Harbor on the northwest coast of Popof Island. Coal Harbor on Unga Island is about 9.5 km west of Sand Point on Popof Island. The only inhabitants of Unga Island live at Squaw Harbor, a small native village located on the north shore of Baralof Bay on the east coast. About 75 km^2 of Tertiary coal-bearing lands have been conveyed to the Aleut Native Corporation and have subsequently been leased to Resource Associates of Alaska (a subsidiary of NERCO Minerals Company), including the Coal Harbor area.

Figure 3---NEAR HERE

PHYSIOGRAPHY

The greater portion of Unga Island is mountainous, but its northern end has rolling topography. At the eastern margin of the coal field, the upland surface is a little more than 180 m above the sea (Atwood, 1909). This steep bluff declines gradually to the west reaching sea level at the western shore of the island. The topography of the upland surface is varied somewhat by a mantle of glacial drift, in which there are numerous small depressions containing lakes or swamps. Streams flow to the west over the gentle slopes of the upland surface and through shallow valleys.

HISTORY OF DEVELOPMENT

Coal on Unga Island was first explored by Peter Doroshin of the Russian Trading Company in 1851. The Russians are reported to have taken some coal from outcrops near the beach. W.H. Dall, as a member of the Scientific Corps of the Western Union Telegraph Expedition, visited Unga Island in 1865. Orth (1967) states that Coal Harbor was probably named by members of this expedition. (The name Coal Harbor has also been applied to all of Zachary Bay on some maps.) Dall returned to Coal Harbor in 1871, 1872, 1873, and 1895.

Mining of the low-grade coals from the west side of Zachary Bay at the north end of the island began in 1871 soon after the settlement at Coal Harbor was founded. In 1872, Dall and a party of workers dug out about 13 metric tons of coal for use in the stove and galley on the U.S.S. Humboldt. The coal test was unfavorable because of the large amount of sulfur in the coal, which reportedly gave off offensive fumes while burning and produced an extraordinary quantity of ashes.

The Alaska Coal Company, a San Francisco-based corporation, was formed to work the Coal Harbor seams in 1882. This was the first significant coal mining undertaken by Americans in this part of Alaska. As many as 20 men were employed by the company to supply fuel to small steamers engaged in seal hunting (Atwood, 1909). Two cargoes of coal, amounting to about 700 tons, were shipped to San Francisco in 1883.

In addition to coal mining, lode gold mining was conducted successfully on Unga Island from 1891 to 1904 (Atwood, 1911). The chief operation of this type was the Apollo gold mine located on the south side of Unga Island near the head of Delarof Harbor.

Small-scale coal mining also continued after the turn of the century. Much of the coal produced was used for domestic purposes, particularly in conjunction with a local fish cannery. Natives and white residents on Unga and neighboring islands prospected along certain of the thin seams and found some 'high-grade lignite.' The coal on Unga Island was conveniently located for use by steamers running to Dutch Harbor from Cook Inlet or Kodiak. At one time, there was an established U.S. post office at Coal Harbor, and a passenger steamer service visited the port on its monthly voyages between Seward and points on the Alaska Peninsula.

In the early 1900's, plans were made to increase coal production from Unga Island by installing new machinery and coal bunkers. Bunkers were built in 1904 about 30 m from the shore, and a steel conveyor connected them to a mine developed in a seam located about 60 m above tidewater. However, these efforts were abandoned shortly after 1904. The property came under the control of the Tide Water Consolidated Company which drove several drifts and put one mine into operation on a shipping basis in 1911. No large production resulted however, and most coal mining on the island ceased in 1912. No further coal development on Unga Island has taken place since that time.

DISTRIBUTION AND EXTENT OF COAL-BEARING ROCKS

Tertiary coal-bearing rocks of the Unga Island field underlie an area of about 100 km^2 on the northwest part of the island. Coal beds of commercial value are probably limited to an area of 40 km^2 on the peninsula at the west side of Zachary Bay (Hillegas and others, 1976; Holloway, 1977). Although sedimentary rocks cover most of the western half of Unga Island, the area of the coal field itself is relatively small. The coal beds are best exposed on the shore at Coal Harbor. Other minor beds can be seen at points along the northwest coast of the island and in a little strip along the west coast of the island (Atwood, 1911). Although much of the area west of Zachary Bay may contain coal similar to that exposed in the cliffs at the east margin of the field, no seams of economic value have been observed along the west coast of Unga Island.

GENERAL GEOLOGY

Unga Island formed as a result of Early to Middle Tertiary volcanic activity. No outcropping rocks are known to be older than Oligocene. Basalt stacks, tuffs, volcaniclastic sandstones, agglomerate, and breccia of the Oligocene-aged Stepovak Formation crop out locally on the southern and eastern portions of the island. Other Tertiary volcanic rocks formed on the eastern half of the island consist largely of andesitic and dacitic lava flows, fine-grained tuffs, lahars, coarse breccias, and ash. The tuffs, breccias, and ash are fragmental rocks formed by explosive volcanic activity. Tertiary intrusive centers occur at scattered localities on the island.

Sedimentary rocks of the Bear Lake Formation are exposed over most of the western half of the island (Figure 2). This unit includes the coal measures of the Unga Conglomerate Member.

Unconsolidated Quaternary deposits mantle the Tertiary bedrock in many areas. These surficial deposits include Pleistocene glacial materials.

STRUCTURAL GEOLOGY AND TECTONICS

The Unga Island-Port Moller area of the Alaska Peninsula has been dominated by convergent-plate tectonics from at least the Jurassic period to the present. The associated trench of a Late Cretaceous arc front was located along the northern margin of the Alaska Peninsula and migrated seaward in the vicinity of the present-day Shumagin Islands (Figure 1; Mancini and others, 1978). The Bear Lake Formation reflects a hiatus in volcanic activity and possibly a change in the subduction regime of the proto-Aleutian Trench. The sediments of the Bear Lake Formation were derived by reworking a variety of pre-existing sediments, and are probably reflective of a marine regression followed by a minor transgression (Wilson, 1980).

The coal beds of the Unga Conglomerate Member, Bear Lake Formation, Unga Island field occur in nearly flat-lying to uniformly shallow-dipping sedimentary rocks on the peninsula west of Zachary Bay. The geologic structure in the area is fairly simple. The seams outcropped at Coal Harbor are inclined westward from an elevation of about 60 m at the east margin of the field and evidently pass below sea level before reaching the west margin of the island (Atwood, 1911). The strata dip from 5° to 20°, and are monoclinally folded in a north and south direction. Measured strikes vary from N. 20°E. to N. 45°E. The low angle of dip of the coal beds and the evidently simple structure may facilitate commercial thin-seam mining locally.

AGE OF COAL-BEARING ROCKS

The Tertiary Bear Lake Formation unconformably overlies Paleogene rocks on Unga Island. The formation is believed to be middle to late Miocene in age (Figure 4; Burk, 1965). On the basis of palynological investigations, Smirnoff and Connelly (1980) have dated the Unga Conglomerate Member at late Miocene.

Figure 4---NEAR HERE

LITHOSTRATIGRAPHY

Burk (1965, p. 89) named the Bear Lake Formation after a thick sequence of sandstone, conglomerate, minor dark-gray siltstone and carbonaceous shale exposed along the eastern shore of Port Moller and in the mountains to the northeast around Bear Lake. The type section, designated by Detterman and others (1981), consists of 1525 m of strata containing thin coal beds. The section is rhythmically bedded in units 1 to 10 m thick with individual beds ranging from 6 cm to 1 m thick (Wilson, 1980).

The Bear Lake Formation is characterized by reworked, largely nonvolcanic clasts and grains, poorly consolidated, but better rounded and sorted than other Tertiary units in the region (Wilson, 1980). In the conglomerates, the clasts are about one third quartz and chert, one third volcanic fragments, and one third sedimentary lithic clasts (Detterman and others, 1981). The rocks are generally dark-brown to pale-yellowish-brown in color, although some conglomerates contain abundant iron and weather black on cliff faces. Burk (1965) was the first to note that the Bear Lake Formation contains an abundance of tuffaceous siltstone, and that the ratio of quartz to feldspar grains and to volcanic fragments in sandstones is higher than in the Tolstoi and Stepovak Formations.

The porosity and permeability of Bear Lake Formation sandstones have been investigated in relation to petroleum investigations on the Alaska Peninsula. Tests by McLean (1977) show that its upper part has the best reservoir characteristics of the three principal sedimentary formations of Tertiary age on the Alaska Peninsula (that is, Bear Lake, Tolstoi, and Stepovak Formations). Above 1920 m in one well, Bear Lake Formation sandstone had porosity values as high as 36.5 percent and permeability as high as 1268 mds. Below 1920 m, high values for porosity and permeability were 29 percent and 43 mds, respectively.

The Unga Conglomerate Member of the Bear Lake Formation is widely exposed over the western half of Unga Island. The unit was first named by Dall and Harris (1892), who applied the name only to the coarse beds exposed along the western shore of Zachary Bay. Atwood (1911) included the lignite-bearing strata in the 'Kenai Formation.' Burk (1965) applied the name 'Unga Conglomerate' to all rocks exposed west of Zachary Bay, and considered it as the basal member of the Bear Lake Formation. The type Unga Conglomerate Member at Zachary Bay contains about 245 m of strata, the lower half of which consists of friable sandstones, conglomerates, claystones, shales, and thin seams of lignite and subbituminous coal (Figure 5). Coal measures make up about 12 m of strata in the lower half of the section (Figures 6 and 7). The upper half of the Unga Conglomerate Member is a thick unit of volcanic breccia composed of coarse, angular fragments of volcanic rock that average 15 cm but range to 1.8 m in size. Silicified logs are found locally in the unit (Figure 8).

Figures 5-8---NEAR HERE

FOSSILS

The Bear Lake Formation is locally abundantly fossiliferous, containing pelecypods, gastropods, and echinoids of late Miocene age. The fossiliferous beds are most common in the upper part of the formation (Wilson, 1980). Overlying conglomerates contain shells of marine life including a widespread and characteristic pelecypod fauna. No marine shells have been obtained from the coal measures of the Unga Conglomerate Member, although the beds contain some plant remains (for example, leaf beds), which have been described.

A petrified forest engulfed by agglomerate is exposed along the seacliffs of north Unga Island. The tree fossils are most abundant along 6.5 km of coast on the northwest side of Unga Island south of Unga Spit (Eakins, 1970), about 20 km west of Sand Point, Popof Island. Many of the trees have been identified as belonging to the genus Sequoia or Metasequoia. The trees are found in volcanic breccia of the upper part of the Unga Conglomerate Member, and individual stumps are oriented approximately normal to bedding indicating that they grew on near-level surfaces. Similar large silicified stumps are present at the base of the lower sequence along the shore of Zachary Bay (Burk, 1965).

DEPOSITIONAL ENVIRONMENTS

Sediments of the Bear Lake Formation were deposited in transitional marine to nonmarine environments. The Unga Conglomerate Member is a nonmarine, subaerial deposit including fluvial sandstones and conglomerates and paludal thin coals (Figure 9). The unit is reflective of a marine regression. Marginal marine (nearshore, inner neritic) volcaniclastic conglomerates, sandstones, and claystones make up the remaining portion of the Bear Lake Formation and probably represent a minor transgressive phase of deposition.

Figure 9---NEAR HERE

COAL CHARACTER

PHYSICAL PROPERTIES

Unga Island field coals are predominantly of lignitic character, being brownish black and displaying a distinct woody or uniform claylike texture. Subbituminous coals are hard, black, and exhibit a splintery fracture on fresh surfaces (Figure 10). Upon weathering, these coals slack into small cubical fragments and fine chips, and may show a semi-woody appearance on surfaces.

Figure 10---NEAR HERE

COAL PETROLOGY

General quantitative maceral analysis results for three Unga Island coal samples are given in table 1. It shows that the coals are very high in huminite and contain only very minor amounts of inertinite and liptinite. Since the coals are of lignite to subbituminous C rank, the macerals have not been strongly altered and typically are well preserved. The petrology of the coals is indicative of their formation from peats predominantly consisting of woody bark and tissues of trees and shrubs.

Table 1---NEAR HERE

Although the mineral matter content was not quantified petrographically, the relative types and abundances of pyrite in the samples were studied. Sample UI1-1 contained both fine-grained primary (including framboidal) and massive secondary pyrite varieties. Sample UI2-1 appeared to contain the least amount of pyrite. Sample UI4-1 contained abundant massive grains of pyrite, but no primary pyrite was observed. The pyrite content of the samples is consistent with the interpreted depositional environment of the coals in coastal swamps.

Mean-maximum vitrinite reflectance analysis of the samples reveals a range from 0.35 to 0.40 percent (Table 2). The sample from locality UI2 showed the highest value and the sample from UI4 on the west side of the island showed the lowest value. All the samples have an apparent rank from lignite to subbituminous C. This indicates a thermal maturation index of immature to marginally mature.

Table 2---NEAR HERE

COAL QUALITY

Most coals of the Unga Island field are lignites, but some beds rank as high as subbituminous C (Table 2). Very few analyses of Unga Island coal have been published. Data quoted by later workers have generally been abstracted from earlier reports. Analyses of Stone (1905) and Atwood (1909), which are the only known prior to this current study, are listed in table 3. The coals show high moisture and ash contents, and a heating value less 8,000 Btu/lb. Locally iron pyrites have been noted in the coals but these are irregularly distributed. Analyses of samples collected during recent field work are listed in table 4 (A-C). These coals appear in general to be of higher quality than those analyzed in previous studies.

Tables 3-4---NEAR HERE

COAL RESOURCES

The Unga Island field contains numerous seams of lignite and subbituminous coal to 3 ft (0.9 m) in thickness. Most outcropping seams are too thin to be of commercial value, and thicker seams often contain one or more measurable partings (Figure 11). However, a few exposed seams may be of sufficient thickness for mining, and it is possible that thicker seams exist at relatively shallow depths.

Figure 11---NEAR HERE

Although the reliability of resource information from Unga Island has been generally poor, various workers have attempted to quantify the magnitude of coal resources in the field. Atwood (1911) stated that the quantity of lignite above sea level was probably sufficient to supply the demand for such material from the field for a long time. Hillegas and others (1976) stated that the reserves of stripping coal were minor. Holloway (1977) found insufficient data to form a resource estimate. The Alaska Division of Energy and Power Development (1977) and the Institute of Social and Economic Research (1978) estimated total remaining resources (undiscovered, hypothetical category) at 150 million short tons.

Based on thickness information obtained from sections measured during recent field investigations, it is estimated that the Unga Island field contains 90 million short tons of inferred coal resources in beds over 1 ft (0.3 m) thick and 70 million short tons of inferred coal resources in beds over 1.6 ft (0.5 m) thick (Table 5). This calculation makes no assumption as to the suitability of these beds for thin-seam mining. This estimation is in line with the projected total hypothetical resources of 150 million short tons of coal.

Table 5---NEAR HERE

CONCLUSIONS

The Alaska Division of Energy and Power Development (1977) ranked the Unga Island field seventh among all Alaska coal fields in terms of projected order of development. Their estimated timing for development was from 1990 to 1995. Although they concluded that there were no immediate prospects for developing the Unga Island field, they stated that it possibly could be developed by the Natives for local use and limited export.

After conducting recent reconnaissance explorations, it is believed that the Unga Island field has a near-term low coal development potential. There are only about three seams of coal known that are of marginal economic importance. However, as mining of thin seams becomes more economically feasible and attractive, the prospects for the development of small mines to supply coal for local needs may be improved.

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FIGURE CAPTIONS

Figure 1...Location of Unga Island and the general configuration of the Late Cretaceous tectonic framework and subduction complex (modified from Burk, 1965; and Mancini and others, 1978). Regional tectonics is discussed briefly in a later section.

2A...Generalized geology map for Unga Island, Alaska Peninsula. Sedimentary rocks outcrop over most of the western half of the island. Significant coal resources are limited to the northwest peninsula of the island west of Zachary Bay. Solid triangles indicate sites studied in detail during recent field investigations.

2B...Legend and explanatory notes for geology map.

3...Helicopter in front of southern part of outcrop at locality UI2, the main coal-bearing section at Coal Harbor.

4...General stratigraphy of Cenozoic rocks in Unga Island-Port Moller area of the Alaska Peninsula (from Burk, 1965).

5...Generalized stratigraphic section of coal-bearing Unga Conglomerate Member, Bear Lake Formation at Zachary Bay, Unga Island (from Burk, 1965). The inset map indicates the specific location of the described section.

6...Detailed stratigraphic section at locality UI2 showing the main coal measures of the Unga Conglomerate Member, Bear Lake Formation. The specific lignite bed sampled is also indicated (UI2-1).

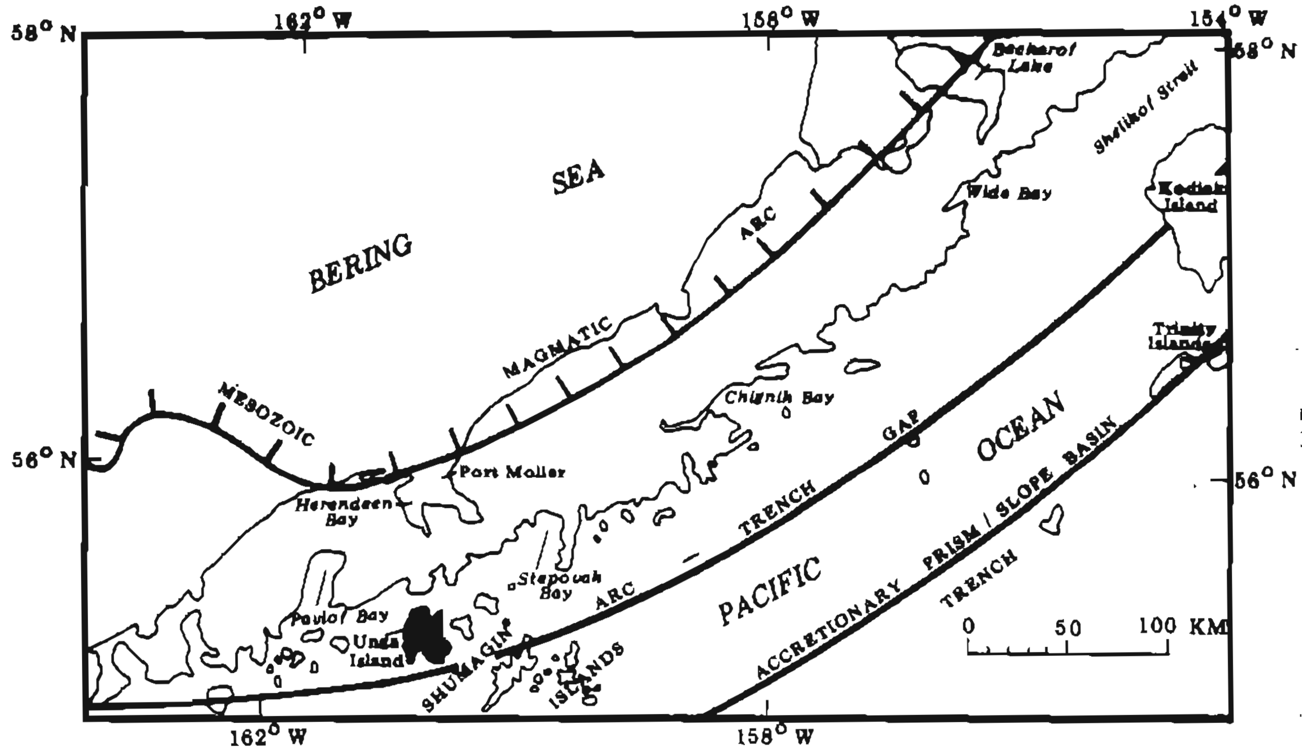
7...Type section locality for the coal-bearing Unga Conglomerate Member of the Bear Lake Formation at Coal Harbor, Unga Island. The coal measures include about 12 m of the section seen near middle of photograph.

8...Silicified log in section of the Unga Conglomerate Member of the Bear Lake Formation at locality UI3 on the west coast of Unga Island.

9...Schematic block diagram showing the general paleoenvironment of coals of the Unga Conglomerate Member of the Bear Lake Formation, Unga Island.

10...General view of the physical character and surface appearance of the 0.3-m-thick subbituminous coal seam at locality UI1 on the west shore of Zachary Bay, Unga Island.

11...Close-up view of several coal seams at the main outcrop (locality UI2), Coal Harbor, Unga Island.



58° N
162° W
158° W
154° W
58° N
Becharof Lake
Shelikof Strait
SEA
BERING
ARC
Wide Bay
Kodiak Island
MAGMATIC
Trinity Islands
MESOZOIC
Chignik Bay
56° N
GAP
OCEAN
Port Moller
56° N
Herendeen Bay
TRENCH
Stepovak Bay
ARC
PACIFIC
ACCRETIONARY PRISM / SLOPE BASIN
TRENCH
Pavlof Bay
Unga Island
SHUMAGIN
ISLANDS
0 50 100 KM
162° W
158° W

Figure 1

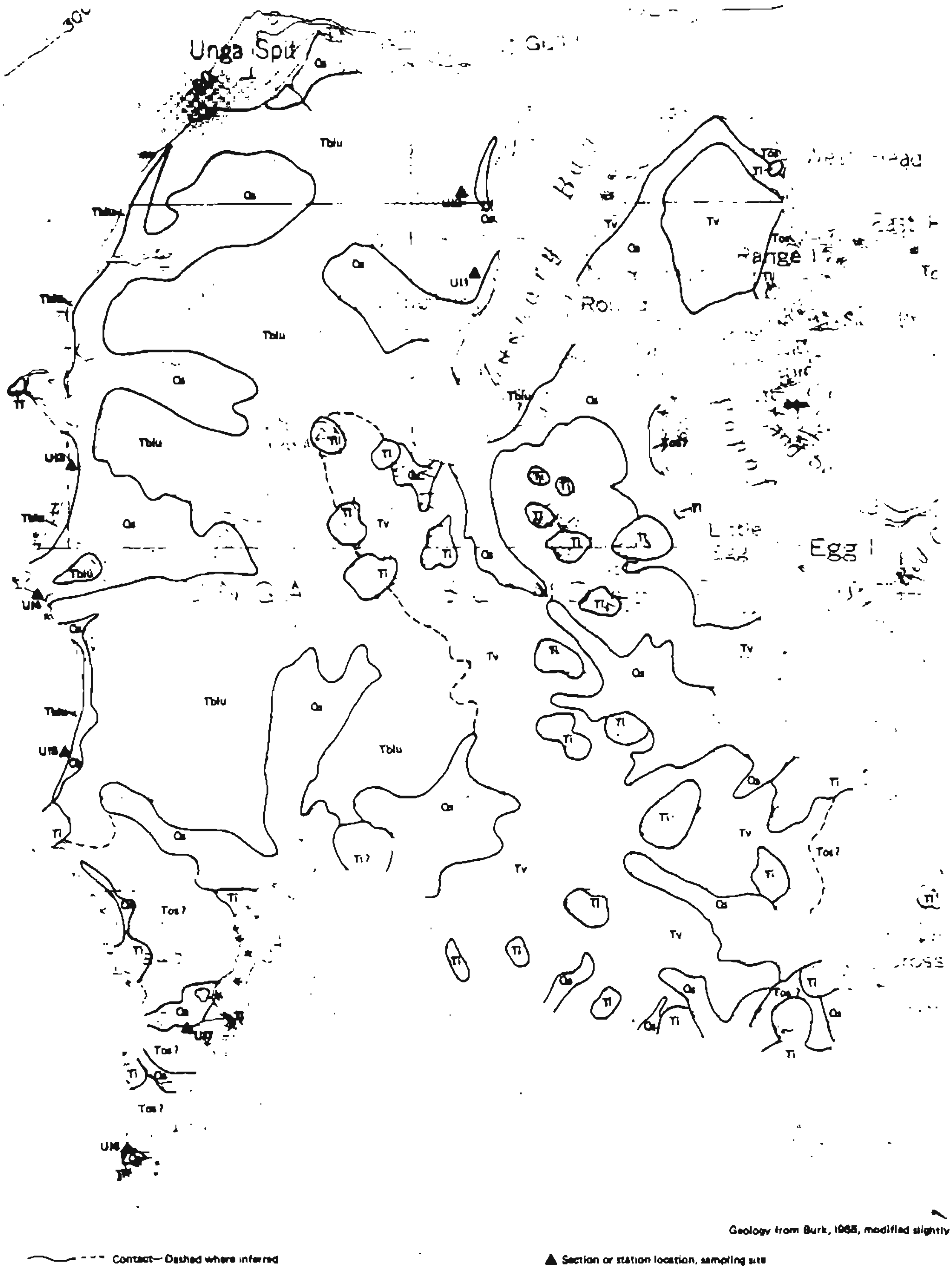

Unga Spit
Egg I
Geology from Burk, 1965, modified slightly
Contact—Dashed where inferred
Section or station location, sampling site

Figure 2A

UI1--Sampling site, 0.3-m thick subbituminous coal bed (sample UI1-1)
UI2--Coal Harbor section, numerous thin lignite and subbituminous coal beds less 1-m thick (sample UI2-1)
UI3--Station, thin carbonaceous shale and lignite lenses, coalified and petrified logs
UI4--Coal section, few thin lignite to subbituminous coal bands (sample UI4-1)
UI5--Station, outcrop of Unga Conglomerate Member, includes folded shale and claystone
UI6--Station, basalt stacks, other tuffs, volcaniclastic sandstones, and agglomerate abundant
UI7--Station, rocks similar to UI6 but with thin lenses of coal to 10-cm included

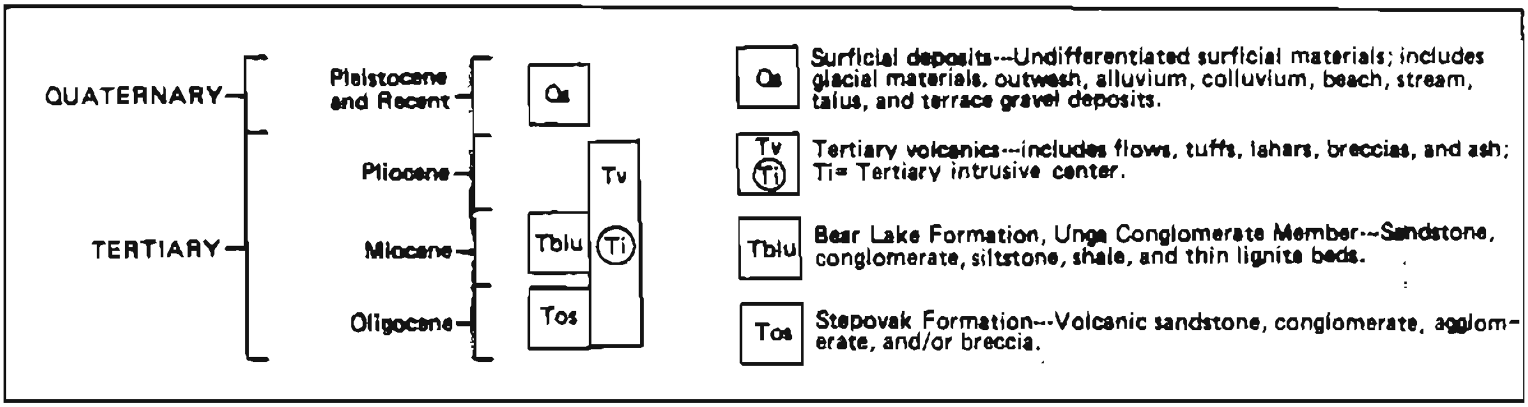


Figure 2B

Figure 3

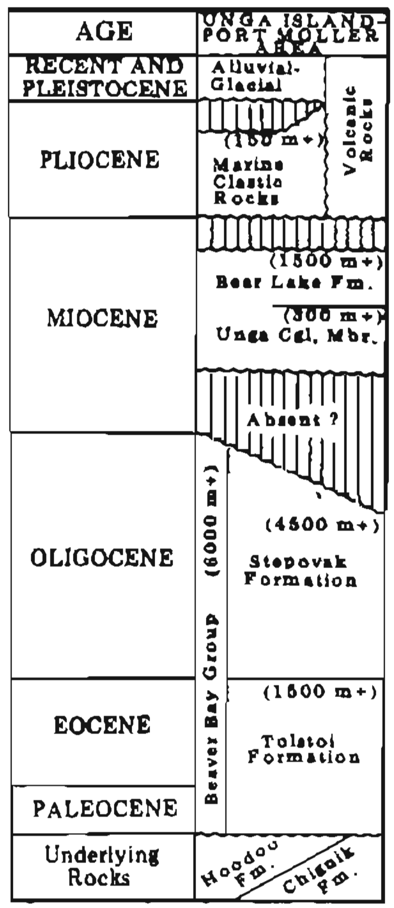
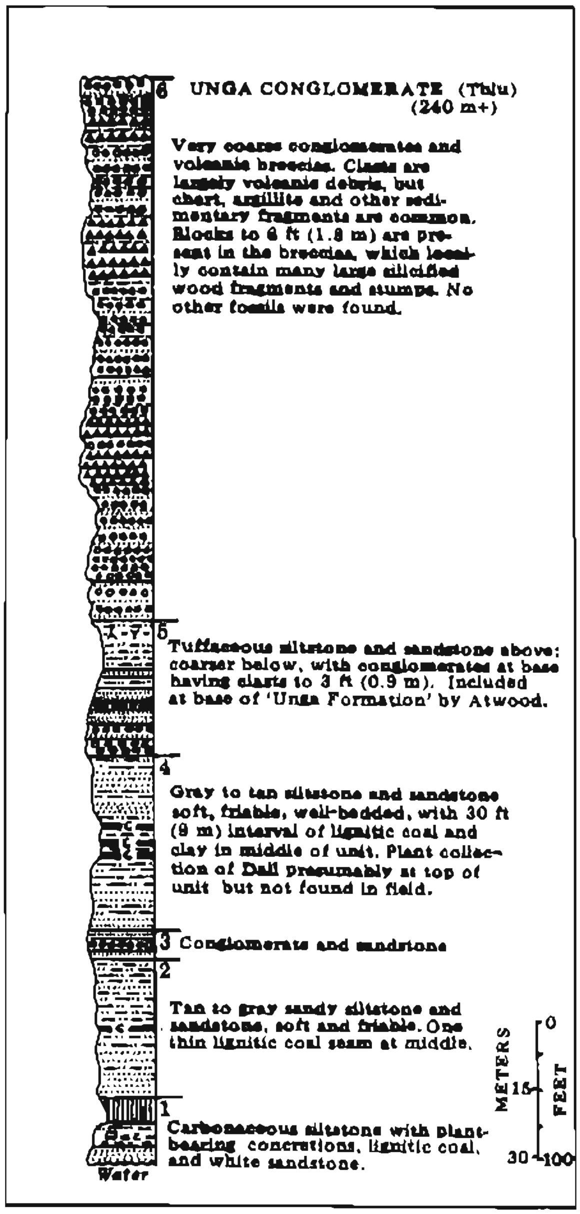

AGE
UNGA ISLAND-PORT MOLLER AREA
RECENT AND PLEISTOCENE
Alluvial-Glacial
Volcanic Rocks
PLIOCENE
Marine Clastic Rocks
MIOCENE
(1500 m+)
Bear Lake Fm.
Unga Cgl. Mbr.
Absent ?
OLIGOCENE
(4500 m+)
Stepovak Formation
Beaver Bay Group (6000 m+)
EOCENE
(1500 m+)
Tolstoi Formation
PALEOCENE
Underlying Rocks
Hoodoo Fm.
Chignik Fm.

Figure 4


6 UNGA CONGLOMERATE (Tblu) (240 m+)
Very coarse conglomerates and volcanic breccias. Clasts are largely volcanic debris, but chert, argillite and other sedimentary fragments are common. Blocks to 6 ft (1.8 m) are present in the breccias, which locally contain many large silicified wood fragments and stumps. No other fossils were found.
5 Tuffaceous siltstone and sandstone above; coarser below, with conglomerates at base having clasts to 3 ft (0.9 m). Included at base of 'Unga Formation' by Atwood.
4 Gray to tan siltstone and sandstone soft, friable, well-bedded, with 30 ft (9 m) interval of lignitic coal and clay in middle of unit. Plant collection of Dall presumably at top of unit but not found in field.
3 Conglomerate and sandstone
2 Tan to gray sandy siltstone and sandstone, soft and friable. One thin lignitic coal seam at middle.
1 Carbonaceous siltstone with plant-bearing concretions, lignitic coal, and white sandstone.
Water
METERS
FEET
0
15
30
100

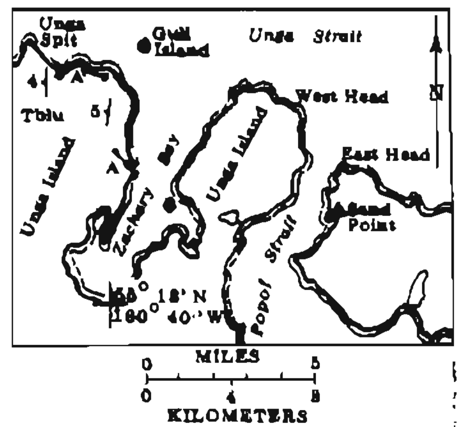
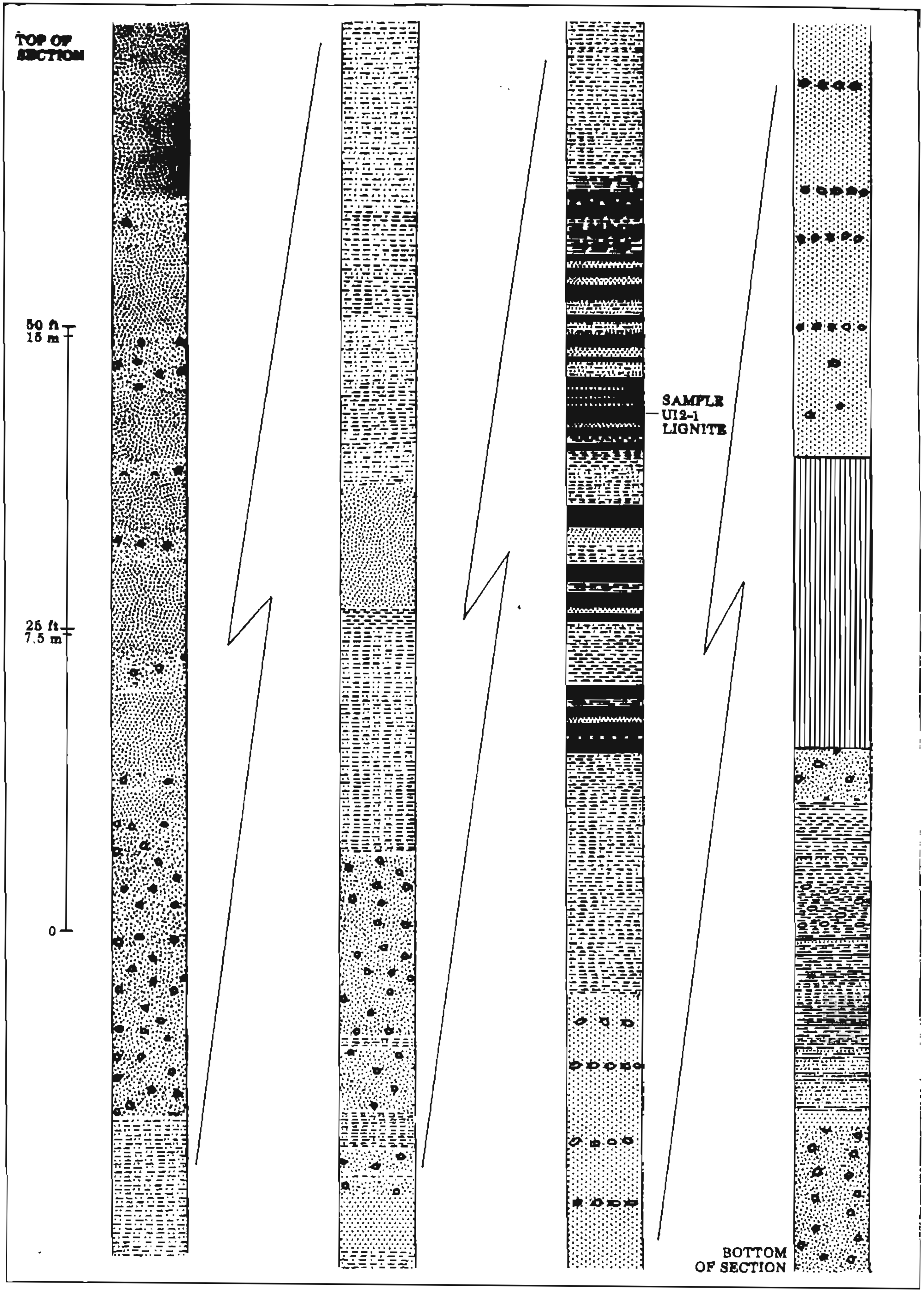

Unga Spit
Gull Island
Unga Strait
West Head
East Head
Sand Point
Tblu
Unga Island
Zachary Bay
Unga Island
Popof Strait
55° 18' N
160° 40' W
N
MILES
0
5
0
4
8
KILOMETERS

Figure 5



TOP OF SECTION
50 ft
15 m
25 ft
7.5 m
0
SAMPLE
UI2-1
LIGNITE
BOTTOM
OF SECTION

Figure 7

Figure 8

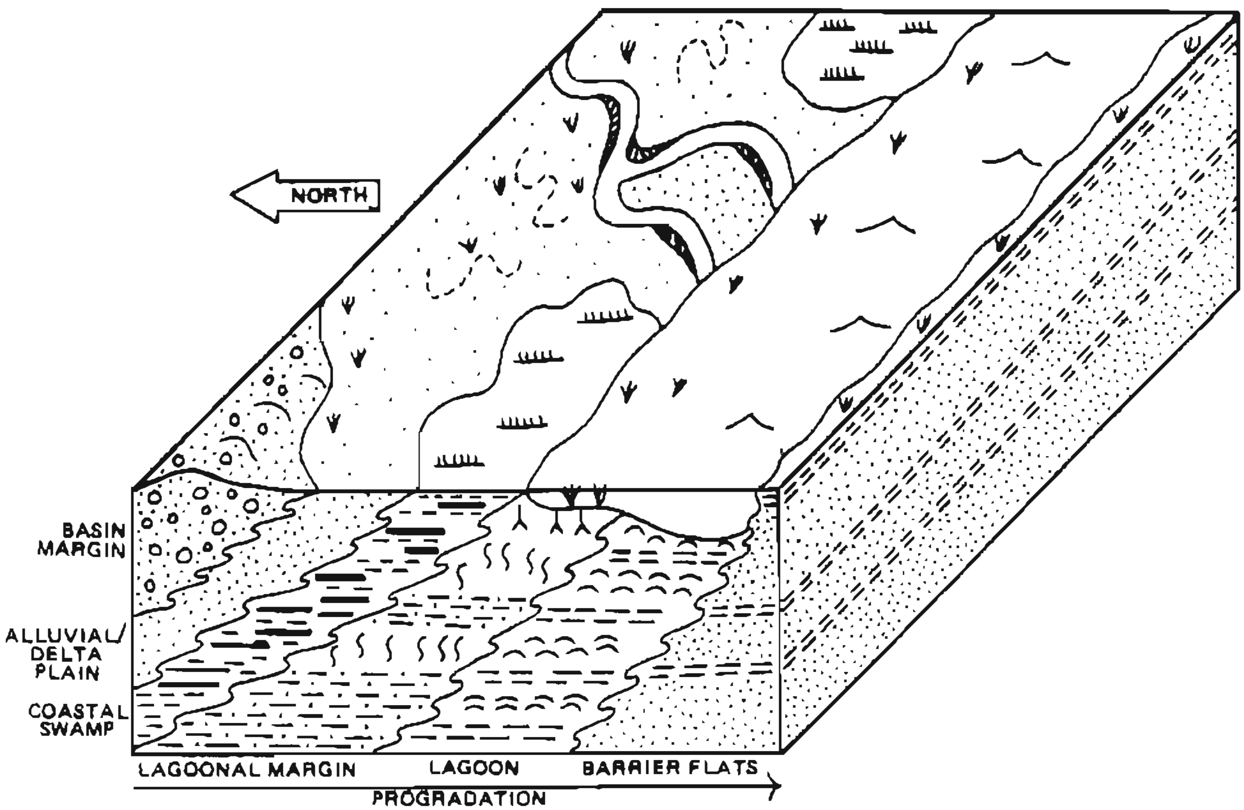

NORTH
BASIN MARGIN
ALLUVIAL/ DELTA PLAIN
COASTAL SWAMP
LAGOONAL MARGIN
LAGOON
BARRIER FLATS
PROGRADATION

Figure 9

Figure 10

Figure 11

Table 1. Petrologic composition of three Unga Island coal samples (volume, mineral-matter free basis).

MACERAL GROUP	SAMPLE NUMBER/ MACERAL	UI1-1	UI2-1	UI4-1
Huminite	Ulminite	85.8	77.8	90.0
	Porigelinite	5.4	5.6	1.8
	Levigelinite	0.0	0.0	0.0
	Phlobaphinite	1.8	5.2	0.4
	Pseudophlobaphinite	0.6	1.0	0.2
	Humodetrinite	3.2	6.2	5.6
	Total % Huminite	96.8	95.8	98.0
Inertinite	Fusinite	0.2	0.0	0.0
	Semifusinite	1.4	0.4	0.4
	Sclerotinite	0.0	0.0	0.0
	Macrinite	0.2	0.0	0.0
	Inertodetrinite	0.2	0.8	0.2
	Total % Inertinite	2.0	1.2	0.6
Liptinite	Cutinite	0.2	0.2	0.0
	Sporinite	0.6	0.6	0.0
	Resinite	0.4	0.8	0.4
	Exsudatinite	0.0	0.8	0.8
	Suberinite	0.0	0.4	0.2
	Alginite	0.0	0.2	0.0
	Liptodetrinite	0.0	0.0	0.0
	Total % Liptinite	1.2	3.0	1.4

Table 2. Summary of vitrinite reflectance data for Unga Island coal samples.

Sample Number	$\bar{R}o_{max}$	Class Frequency V1	V2	V3	V4	Apparent Rank
UI1-1	0.36		4	34	12	lig/sub C
UI2-1	0.40			21	29	sub C
UI4-1	0.35		8	34	8	lig/sub C

Table 3. Proximate and ultimate analyses of Unga Island coal from Stone (1905) and Atwood (1909).

A. Analyses of Stone (1905):

Locality	Seam	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Recalculated Fuel Ratio	Recalculated Fuel Elements V.M.	Recalculated Fuel Elements F.C.
Unga I.	Upper (bright lignite)	11.26	40.51	41.24	6.99	2.17	1.02	49.55	50.45
Unga I.	Lower (dull lignite)	10.58	66.21	15.26	7.95	0.56	0.23	81.27	18.73

B. Analyses of Atwood (1909):

1. As received basis

Proximate Analysis					Ultimate Analysis					Calorific Value	
Loss on air drying	Total Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu
12.50	23.27	25.42	25.13	26.18	0.53	5.27	34.76	0.52	32.74	3227	5809

2. Air-dried basis

Proximate Analysis				Ultimate Analysis					Calorific Value	
Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	British thermal units
12.31	29.05	28.72	29.92	0.60	4.44	39.73	0.59	24.72	3688	6638

Table 4A. Proximate analysis of Unga Island coal samples analyzed during current study.

Sample No.	Basis*	Moisture,%	Volatile Matter,%	Fixed Carbon,%	Ash,%	Heating Value Btu/lb
UI1-1	2	9.73	39.95	42.60	7.72	10005
	3	--	44.26	47.19	8.55	11083
	4	--	48.39	51.61	--	12120
UI2-1	2	11.80	37.05	38.28	12.87	8896
	3	--	42.01	43.40	14.59	10086
	4	--	49.18	50.82	--	11809
UI4-1	2	17.01	35.83	35.35	11.81	8486
	3	--	43.17	42.60	14.23	10225
	4	--	50.34	49.66	--	11922

Table 4B. Ultimate analysis of Unga Island coal sample analyzed during current study.

Sample No.	Basis*	Carbon,%	Hydrogen,%	Nitrogen,%	Oxygen,%	Sulfur,%	Ash,%
UI2-1	2	49.59	4.59	0.71	31.52	0.72	12.87
	3	56.22	3.71	0.80	23.86	0.82	14.59
	4	65.83	4.34	0.94	27.93	0.96	---

Table 4C. Total sulfur and sulfur forms for Unga Island coal samples analyzed during current study.

Sample No.	Basis*	Pyritic Sulfur	Sulfate Sulfur	Organic Sulfur	Total Sulfur
UI1-1	2	0.40	0.01	0.39	0.88
	3	0.44	0.01	0.43	0.97
	4	0.48	0.01	0.47	1.07
UI2-1	2	0.21	0.03	0.48	0.72
	3	0.24	0.03	0.54	0.82
	4	0.28	0.04	0.64	0.96
UI4-1	2	--	--	--	0.93
	3	--	--	--	1.12
	4	--	--	--	1.31

*2=as received basis; 3=moisture free; 4=moisture and ash free

Table 5. Summary of estimated coal resources of the Unga Island field, Alaska Peninsula (million short tons; 0-500 ft overburden).

Bed thickness category	1 ft + (0.3 m +)	1.6 ft + (0.5 m +)
Total aggregate coal thickness	10 ft (3 m)	7 ft (2 m)
Estimated inferred resources	90	70