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Overview of the Geology and Geophysics of the Tikishla Park Drill Hole, USGS A-84-1, Anchorage, Alaska

by

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INTRODUCTION

The Anchorage metropolitan area occupies a lowland adjacent to the upper end of Cook Inlet (fig. 1). The lowland is underlain by a wedge of Quaternary deposits (Miller and Dobrovolny, 1959) that decrease in thickness from about 1,565 ft (477 m) or shallower (interpreted from Alaska Geological Society, 1969, 1970) at its western edge to essentially zero where Mesozoic metamorphic rocks crop out in the Chugach Mountains along the eastern edge of the lowland (Clark, 1972; G. R. Winkler, written commun., 1986). Beneath the Quaternary deposits is a wedge of Tertiary sedimentary rocks that also thins toward the east (Barnwell and others, 1973; Plafker and others, 1982). These Tertiary rocks, as far as is presently known, are concealed in the metropolitan area but crop out locally in the Eagle River area about 12 mi (19 km) northeast of downtown Anchorage (Miller and Dobrovolny, 1959; Wolfe and others, 1966; Zenone and others, 1974; Magoon and others, 1976).

In order to inventory and characterize for regional engineering geologic purposes some of the deep subsurface horizons of Quaternary and older age underlying Anchorage, a 760-ft-deep (232-m) hole was drilled during August 1984. It is located on an area of thin artificial fill about 345 ft (105 m) south of the alinement of East 20th Avenue in Tikishla Park in NE1/4NE1/4SW1/4 sec. 21, T. 13 N., R. 3 W. of the Seward Meridian at lat 61.202^{o} N., long 149.822^{o} W. (fig. 2). The altitude of the site is about 115 ft (35.0 m), and the Middle Fork Chester Creek flows past it about 205 ft (62.5 m) to the southeast at an altitude of about 100 ft (30.5 m).

Drilling equipment consisted of a water-circulating Mayhew 2000 rotary-drill unit operated by personnel of Exploration and Supply Company, Anchorage, Alaska. The hole was steel cased to a depth of 140 ft (42.7 m), and of nominal 0.50 ft (0.15 cm) diameter, varying locally, according to the caliper logging, from 0.44 to 0.64 ft (0.13 to 0.19 m) in actual dimension (pl. 1).

We acknowledge the assistance of numerous individuals in the Anchorage office of the U.S. Geological Survey, who helped us locate well data, which substantially aided us in selecting the site for our drill hole. We are grateful, also, to personnel of the Department of Parks and Recreation, Municipality of Anchorage, who granted permission to drill on land under their jurisdiction and facilitated access to the site.

DATA COLLECTION

Most samples were collected directly from the circulating, fine-grained slurry as it issued from the drill pipe and before the slurry entered the holding tank. Coring was attempted at various depths and was successful in bedrock because of its compact, relatively hard, and uniform nature. Coring was mostly unsuccessful where nonlithified mixtures or thin interlayerings of soft and hard materials seemed to exist. Useful core was recovered from the following six intervals which also are noted on plate 1. Nominal diameter of the core was 0.21 ft (0.064 m).

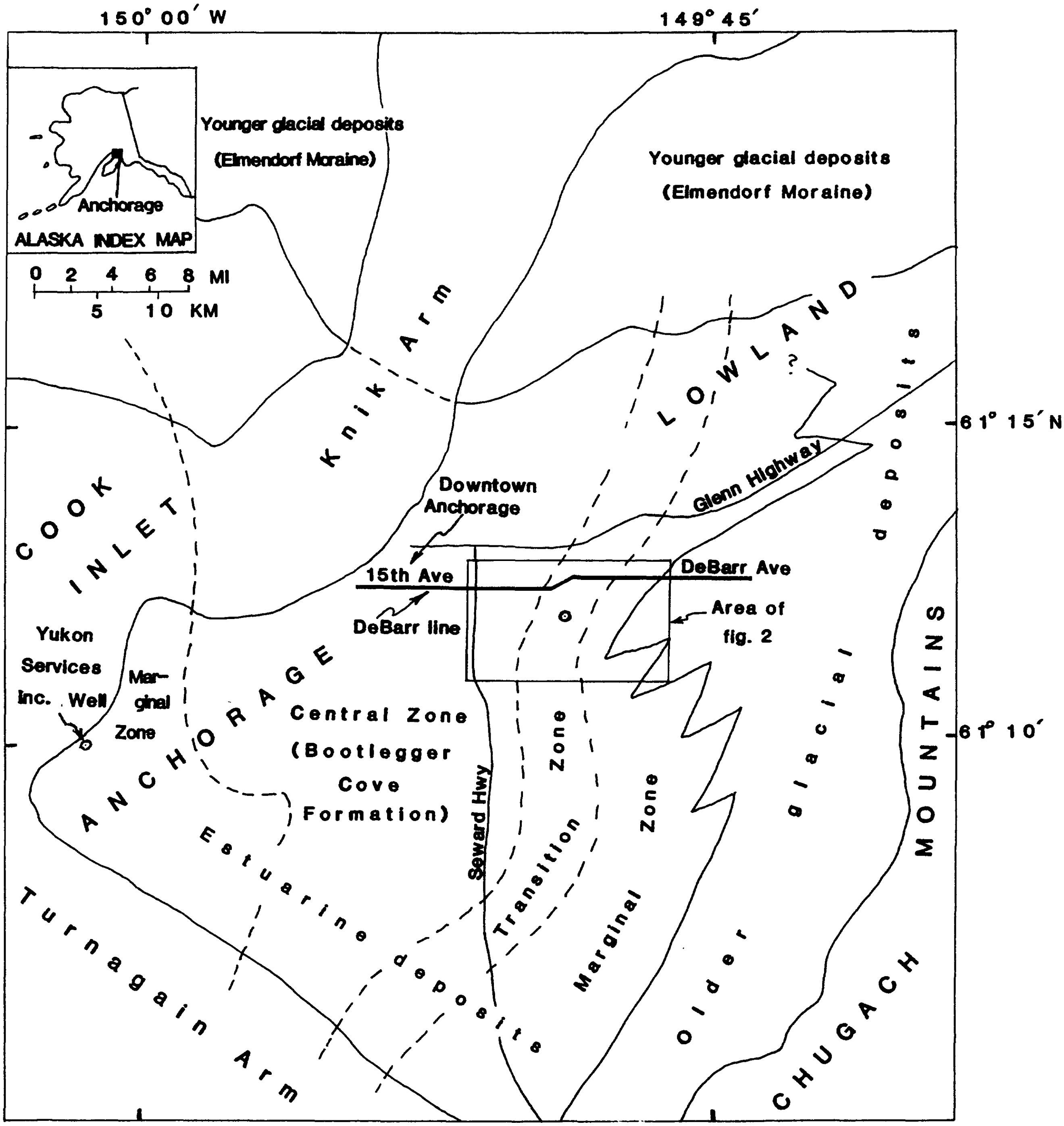

Figure 1.--Map of Anchorage metropolitan area and vicinity, Alaska, showing location of Tikishla Park drill hole (circle within outline of fig. 2), Yukon Services, Inc., well, generalized physiography, and typical distribution of Quaternary glacial and estuarine deposits in the upper subsurface. The Debarr line, a geologic cross section, is described in Schmoll and Barnwell (1984).

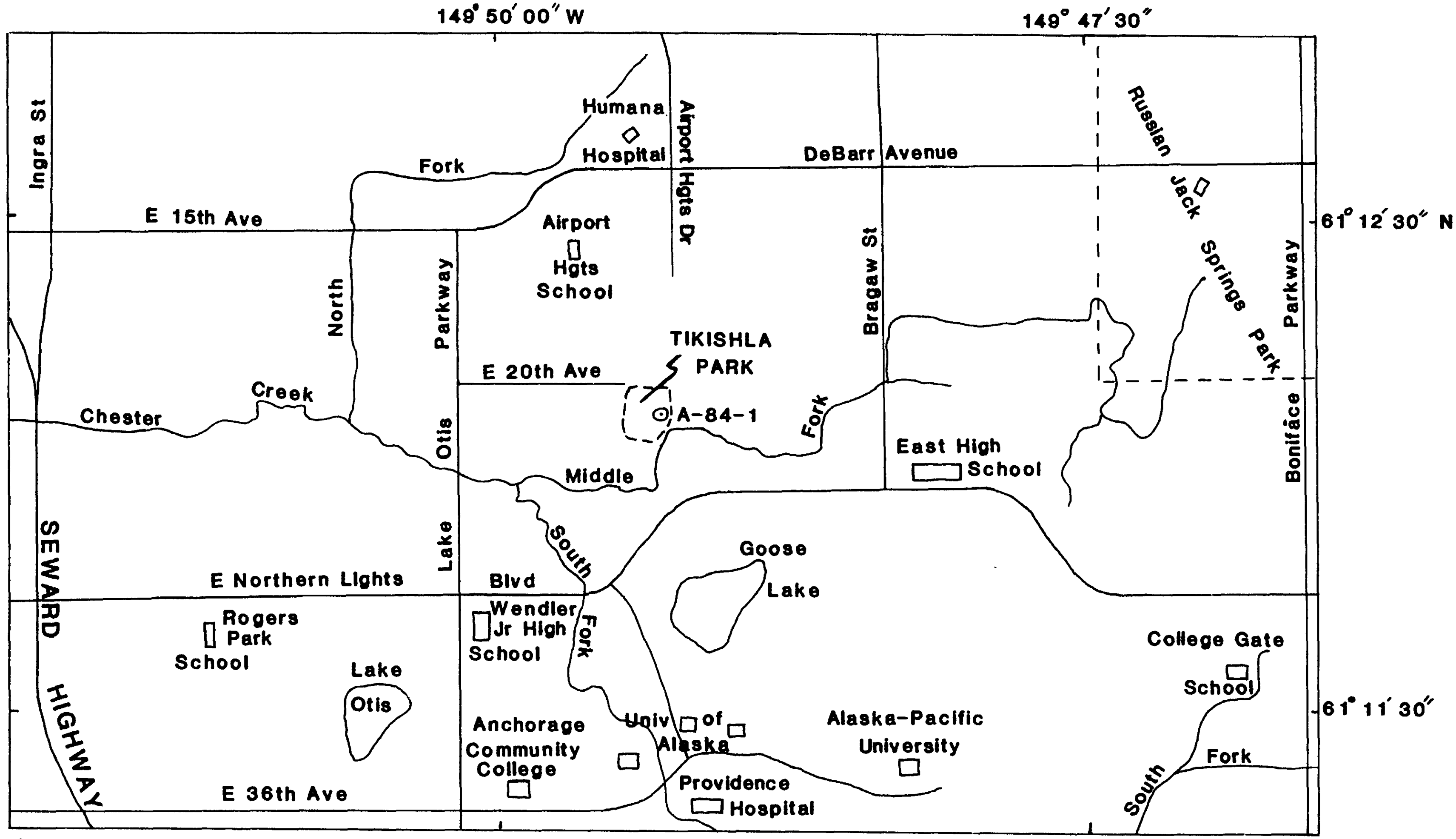

Figure 2.--Map of part of Anchorage, Alaska, showing location of drill hole USGS A-84-1. Base from U.S. Geological Survey, Anchorage (A-8) NE and (A-8) NW, 1979, scale 1:25,000, (1 in. = 0.4 mi, 1 cm = 0.25 km).

Nonlithified deposits (Quaternary).	341-344 ft (103.9-104.8 m) 414-415.5 ft (126.2-126.6 m)
Kenai Group, Tyonek Formation (Tertiary).	545.5-553 ft (166.3-168.6 m) 604-608 ft (184.1-185.3 m) 693-696.5 ft (211.2-212.3 m) 753-759 ft 2(29.5-231.3 m)

A few small samples were retrieved directly from the rotary bit assembly during either bit replacement or during other phases of the drilling operation. Initial descriptions of geologic materials and the packaging of samples were completed chiefly in a mobile laboratory established near the drill unit. A generalized description of materials is shown in table 1 along with stratigraphic and lithologic unit designations; a full description of units is given in plate 1 along with geophysical logs.

Geophysical logging began soon after completion of drilling and utilized a Mount Sopris Model II borehole logger with digital cassette recorder. Geophysical parameters measured included hole diameter, temperature, single-point electrical resistance, and three radiation parameters: natural gamma, gamma-gamma, and neutron. Procedures used mostly followed methods described by Keys and MacCary (1971) and Dearborn (1984). All geophysical measurements could not be obtained to the bottom of the hole in August 1984 because of equipment malfunction, delay in equipment repair, and subsequent caving and (or) squeezing of the hole, first at 406 ft (123.7 m), and later at 350 ft (106.7 m). During June 1985, however, the remaining geophysical logging was completed to the depth possible.

DISCUSSION

Drilling penetrated 510 ft (155.4 m) of Quaternary nonlithified deposits and 250 ft (76.2 m) of Tertiary rocks. An east-west geologic cross section through this part of the Anchorage lowland was identified as the DeBarr line (fig. 1) by Schmoll and Barnwell (1984), who present an initial log of the Tikishla Park drill hole in relation to other well logs. Schmoll and Barnwell's report also provides a stratigraphic framework within which the Quaternary deposits can be placed, using letters to designate principal deposit types and numbers in increasing sequence for successively lower stratigraphic units, as shown in table 1 and used here.

The Quaternary deposits along the DeBarr line cross section are interpreted as being dominated by complexly interrelated deposits (table 2) consisting mainly of clay and silt (B) in the informally identified central or estuarine zone of deposits of the Anchorage lowland (fig. 1) and consisting mainly of diamicton (D) toward the margins of the lowland; interbedded silt and fine sand (M), and stony silt and stony clay (S) occur as transitional

TABLE 1.--Generalized log of drill hole USGS A-84-1, Tikishla Park, Anchorage, Alaska

[Lettered stratigraphic units modified from Schmoll and Barnwell (1984), numbered lithologic units described individually on pl. 1]

Strati-graphic unit	Litho-logic unit	Description	Thickness (ft)	Thickness (m)	Depth to base of unit (ft)	Depth to base of unit (m)
		Nonlithified deposits (Quaternary)				
C	1	Artificial fill	13	13	4	(4)
A-1	2-5	Peat overlying fine pebble gravel and coarse sand	10	(23)	3	(7)
D	6	Diamicton	13	(36)	4	(11)
M	7-13	Silty fine sand and fine sandy silt	42	(78)	13	(24)
D	14-18	Diamicton	36	(114)	11	(35)
A-2	19-20	Sand and gravel	9	(123)	3	(38)
D	21-26	Stony silt and stony clay, and diamicton	48	(171)	14	(52)
A-3	27-28	Gravel and sand	18	(189)	6	(58)
C	29-32	Silty gravel and possibly diamicton	10	(199)	3	(61)
A-3	33-34	Gravel	10	(209)	3	(64)
D	35	Diamicton	16	(225)	5	(69)
A-4	36-37	Gravel	12	(237)	3	(72)
D	38	Diamicton	15	(252)	4	(76)
G	39-40	Sandy gravel	8	(260)	2	(78)
S	41-43	Stony silt and stony clay; diamicton(?)	27	(287)	9	(87)
A-5	44-45	Sand and gravel	12	(299)	4	(91)
M	46-49	Silty fine sand and fine sandy silt; possibly some diamicton	16	(315)	5	(96)
D	50-52	Diamicton	22	(337)	7	(103)
M	53-56	Silty fine sand and fine sandy silt, locally stony(?)	20	(357)	6	(109)
D	57-59	Diamicton	29	(386)	9	(118)
M	60-65	Silty fine sand and fine sandy silt	18	(404)	5	(123)
A-6	66-68	Interbedded(?) gravel, sand, and some silt	15	(419)	5	(128)
M	69-70	Silty fine sand and fine sandy silt, locally stony(?)	21	(440)	6	(134)
A-7	71-76	Gravel and sand; some interbeds of diamicton(?)	19	(459)	6	(140)
I	77-86	Interbedded gravel, sand, and silt	51	(510)	15	(155)
		Kenai Group, Tyonek Formation(?) (Tertiary)				
si	87-91	Siltstone, sandstone, and minor claystone	34	(544)	11	(166)
sc	92-100	Siltstone, claystone, and some sandstone; minor carbonaceous zones and a thin coal bed	62	(606)	19	(185)
cs	101-106	Siltstone and claystone, variably carbonaceous; several thin coal beds	87	(693)	26	(211)
sc	107	Siltstone and claystone	37	(730)	12	(223)
cs	108	Carbonaceous siltstone with numerous thin coal beds	20	(750)	6	(229)
ss	109	Fine sandstone with minor claystone	10	(760)	3	(232)

TABLE 2.--Relationship between typical depositional areas and stratigraphic units that characterize the Anchorage lowland, Anchorage, Alaska

Typical depositional areas as shown on figure 1	Typical stratigraphic units used in the DeBarr cross section (Schmoll and Barnwell, 1984)
Estuarine deposits:	
Central zone	B, clay and silt.
Transitional zone	M, silt and fine sand. S, stony silt. D, diamicton.
Marginal zone	G, gravel and sand. M, silt and fine sand. D, diamicton.
Glacial deposits	D, diamicton. G, gravel and sand.
Alluvial deposits (not shown on fig. 1).	A, sand and gravel. C, colluvium.

zone depositional units. In a general way, the clay-silt-diamicton complexes are interpreted as having formed in mixed estuarine and glacial environments, with the boundaries portrayed on figure 1 shifting with time, so that in any given stratigraphic column, such as the Tikishla Park drill hole, representation of any of the zones are likely to be present. Beds of gravel and sand (A) occur stratigraphically between clay-silt-diamicton complexes, and are considered marker beds on the DeBarr cross section, unit 1 occurring at the surface, and units 2 through 7 occurring successively lower stratigraphically. The gravel and sand beds are thought to represent mainly alluvial conditions, such as those of the present, not portrayed on figure 1.

Table 1 presents a refined but still generalized version of the geologic log, grouping the more detailed, numbered lithologic units shown in plate 1. It also shows the lettered stratigraphic unit designations used on the DeBarr cross section as applied to material from the Tikishla Park drill hole. All of the A units that were identified from other holes along the DeBarr line are present in the Tikishla Park log at approximately their expected positions, and an additional lower unit, A-7, is identified only from this drill hole.

As the Tikishla Park site occupies a transitional position between the central and marginal deposition zones of the Anchorage lowland, it was expected that both stratigraphic unit types B and D would be well represented, as well as a relatively large proportion of the transitional M and S units. However, no thick B units were found in the drill hole. Thus, no clay and silt units typical of the Pleistocene age Bootlegger Cove Formation (unit B-1 on the DeBarr cross section) were found except for lithologic unit 8, only 4 ft (1.2 m) thick. Instead, that formation is apparently represented by a facies consisting of silt and fine sand, an M unit, and perhaps by some possibly discontinuous diamicton (D) units. Most of the intervals between the A units consist of D and M units, with the exception of one zone, consisting of lithologic units 41-43, which was generalized as an S unit. From a depositional standpoint, it thus appears that throughout the Quaternary Period, glacier and estuary-margin conditions prevailed at this site, punctuated by times of subaerial conditions such as the present.

Below stratigraphic unit A-7, the relatively thick sequence of beds comprising lithologic units 77-86 has been grouped as an I unit. This sequence lacks diamicton, which is common higher in the stratigraphy of the hole; consequently, the sequence may represent a dominantly alluvial environment of deposition as opposed to a glacial environment of deposition. Because the I-unit beds occur only beneath glacial units, the I beds may represent preglacial environments.

A major lithologic change is present below unit 86 and the geologic materials exhibited unmistakable drilling characteristics of firm, relatively hard materials which are correlated with bedrock. Based upon good examination of cores, bedding throughout this interval of bedrock is either flat lying or at a very low angle to the horizontal.

All of the geophysical logs had not been run by the time the DeBarr cross section was developed. When run and available, after June 1985, the logs were used to refine the initial geologic interpretations presented in the cross section. In particular, the resistance and natural gamma logs were utilized for many different depths to provide both general and specific refinement of various stratigraphic units, especially for intervals where carbonaceous material was indicated. Several coal beds as much as 3 ft (0.9 m) in thickness were interpreted from the geophysical logs.

The temperature log shows chiefly a gradual downhole reduction of temperature to a minimum of about 40.5 ^{o}F (4.7 ^{o}C) at 235 ft (71.6 m) and then a gradual increase in temperature to about 43.7 ^{o}F (6.5 ^{o}C) near the bottom of the hole at 754 ft (229.8 m). The temperature gradient below 480 ft (146.5 m) is almost identical at similar depth intervals to the gradient of the Yukon Services, Inc., well (Campbell Point Unit No. 1) sited 8.0 mi (12.8 km) to the southwest (fig. 1) where a value of 0.00932 ft/ ^{o}F (0.0158 m/ ^{o}C) was obtained (Keys and MacCary, 1971). Two relatively near-surface increases in temperature of about 0.3 ^{o}F (0.5 ^{o}C) occur, one near 76 ft (23.2 m) and another near 120 ft (36.6 m). Both of these increases may relate to the presence of relatively coarser and probably more permeable materials that probably contribute minor inflows of water. A possible water inflow noted by the driller at about 510 ft (155.4 m) was not reflected in the temperature profile, possibly because no difference in temperature existed between groundwater and the drill-hole fluid.

The age of the nonlithified materials above unit 77 is undoubtedly Quaternary. However, the I interval consisting of lithologic units 77 through 86 are somewhat enigmatic and could be either relatively old Quaternary or young Tertiary in age. For deeper units, those below lithologic unit 86, we do not have as yet any new age determinations. Therefore, the assumption is continued that these rocks, as interpreted on the DeBarr cross section (Schmoll and Barnwell, 1984), are part of the Kenai Group (Wolfe and Tanai, 1980) and probably lie within the Tyonek Formation, as are similar rocks exposed in the Eagle River area (Wolfe and others, 1966). There is a possibility, however, that these rocks may belong to the next younger formation, the Beluga Formation or the even younger Sterling Formation.

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