HYDROLOGIC RECONNAISSANCE OF THE EASTERN NORTH SLOPE, ALASKA

U.S. Geological Survey Open-File Report 77-492

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HYDROLOGIC RECONNAISSANCE

OF THE

EASTERN NORTH SLOPE, ALASKA, 1975

By

Joseph M. Childers, Charles E. Sloan,
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OPEN-FILE REPORT 77-492

Anchorage, Alaska
1977

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ENGLISH-METRIC EQUIVALENTS

Multiply English units	By	To obtain metric units
inches (in)	25.4	millimeters (mm)
feet (ft)	0.3048	meters (m)
square feet (ft^2)	.092990	square meters (m^2)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)
cubic feet per second per square mile [$(ft^3/s)/mi^2$]	.01093	cubic meters per second per square kilometer [$(m^3/s)/km^2$]

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ABSTRACT

Water resources of the eastern Alaskan Arctic Slope were studied by reconnaissance methods during April, August, and November 1975.

Estimates of bankfull and maximum evident flood-peak discharges by slope-conveyance methods were made for selected streams based on field evidence. Maximum evident flood-peak discharge rates averaged about 40 cubic feet per second per square mile or 0.4 cubic meter per second per square kilometer; the highest rate calculated was 185 cubic feet per second per square mile or 1.8 cubic meters per second per square kilometer and had no obvious relation to drainage basin physiography. Bankfull discharge generally exceeded 50-year flood estimates made using relations developed from Alaska stream-gaging records and multiple-regression analysis of drainage basin characteristics.

Eighteen springs, 12 lakes, and 26 streams were sampled for water analysis. Discharge of the springs ranged from less than 1 cubic foot per second or 0.03 cubic meter per second at Red Hill spring to almost 90 cubic feet per second or 2.5 cubic meters per second at the Saviukviayak and Kongakut delta springs. Temperature of spring flow ranged from about 0°C at the Clarence River spring to 33°C at Red Hill, a true hot spring. Springs were readily found by noting the location of resultant icings on Landsat imagery.

Streamflow ceases in all the streams during the late winter except in local zones of ground-water discharge that form icings downstream.

Ice thickness on lakes averaged nearly 3 feet or 1 meter by November and generally exceeded 6 feet or 2 meters by late winter. Lake water quality deteriorated during winter as the dissolved solids became concentrated when water in the shallow lakes froze. Water quality in the area, with few exceptions, was generally very good for the anticipated uses.

Fourteen springs and streams were sampled in order to gather seasonal information on aquatic invertebrate production. Production appeared to have been greatest during summer and in the warmer springs and in those whose water originated from bedrock. Summer benthic invertebrate production ranged from about 420 organisms per square foot (4,500 organisms per square meter) for the Ekaluakat River to 1,700 organisms per square foot (18,000 per square meter) for Sadlerochit Spring.

Sites satisfactory for stream-gaging stations were found on the

Colville, Hulahula, and Canning Rivers, and downstream from Saviukviayak spring and Sadlerochit Spring. These stations would provide data to help evaluate regional water resources.

INTRODUCTION

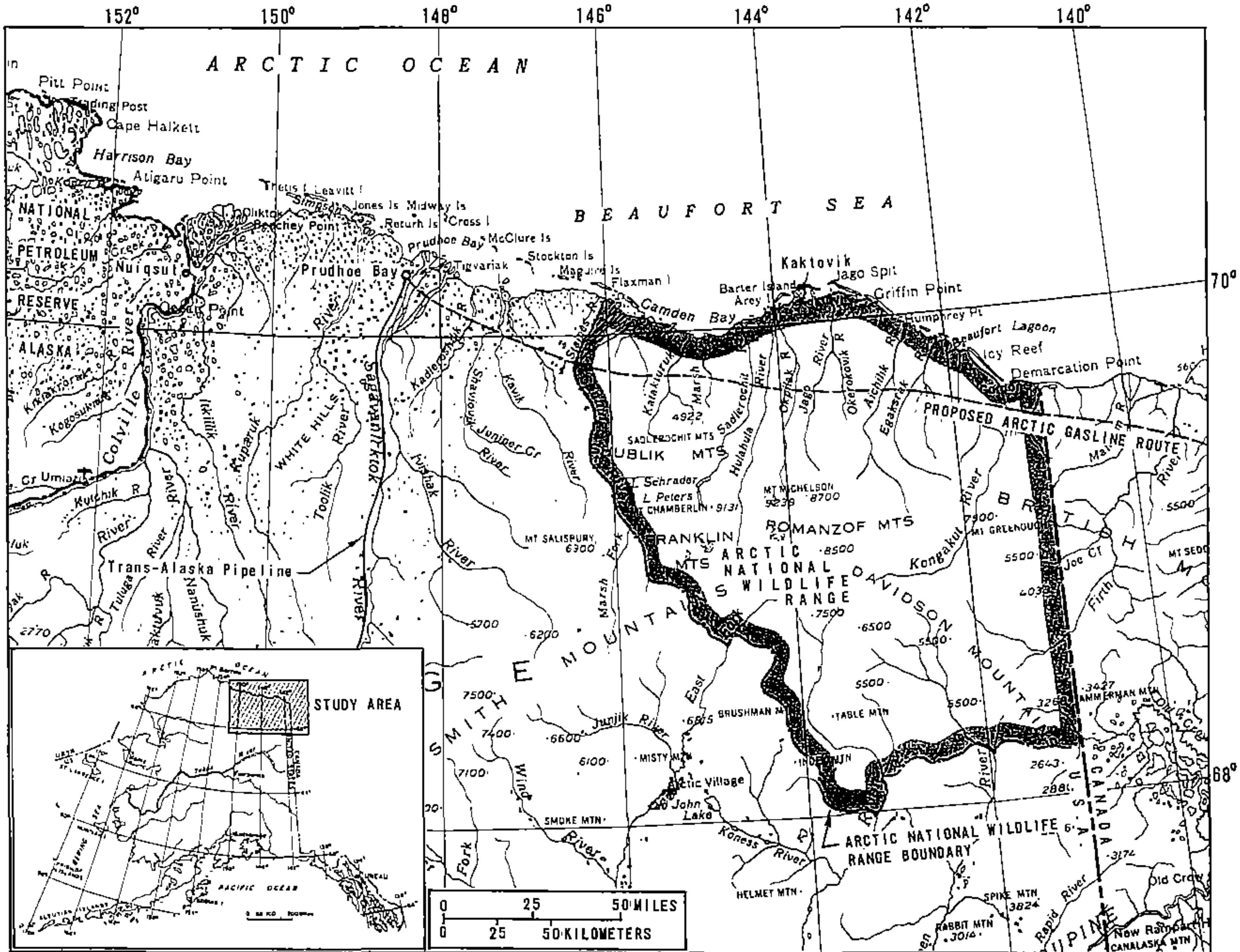
The part of the Arctic coast of Alaska between the Colville River and the Canadian boundary was visited in April, August, and November 1975. The location of the area is shown in figure 1. The proposed route of the Arctic Gas pipeline and the lower Colville River area are included in the study. The reconnaissance study area is characterized by its cold climate and is largely uninhabited, but oil and gas discoveries have spurred development of parts of the area. Sensible, coordinated development requires information about water resources, information which, until recently, has not been available.

The purpose of the April 1975 reconnaissance trip was to locate winter flow and describe its quantity and quality. A followup summer trip was made in August to determine the flood characteristics of selected streams by measuring channel geometry in relation to bankfull discharge and the maximum evident flood and by estimating channel roughness. In addition, one lake was sampled, the discharge of a few springs was measured, and samples of spring water were taken. Because streamflow in August was assumed to be representative of normal summer flow, water quality was examined in streams for which flood surveys had been made. Samples of aquatic invertebrate populations were taken from most sites on the April and August trips. Another reconnaissance trip from Prudhoe Bay east to Canada was made in November to measure discharge in selected streams and springs, to measure ice thickness and water depth in selected lakes, and to collect water samples for water-quality analyses.

FLOODS

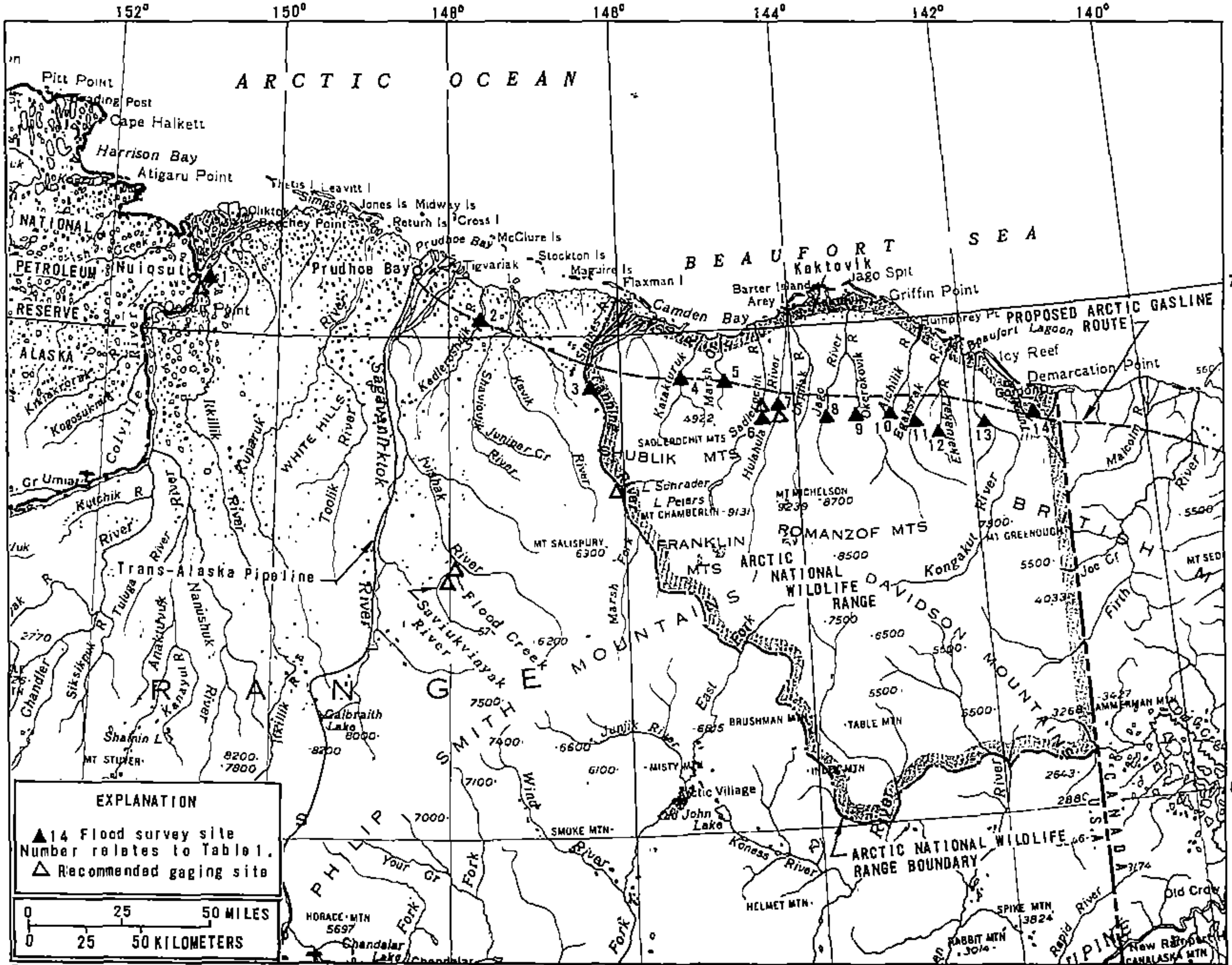
The reconnaissance party made flood surveys at 14 stream sites. These flood-survey sites are numbered on figure 2. The streams and the approximate survey sites were preselected on topographic maps and studied from the air to insure that reasonably uniform channel reaches were available for ground surveys. An oblique aerial photograph of each site was made (figs. 3-16). The party then surveyed the channel cross sections and longitudinal profiles of the water surface, the bank tops, and the maximum evident flood high-water marks upstream and downstream from the cross sections. At each site a photograph was made of an area of the streambed covered with deposits that were considered to be representative of the size of streambed material transported during floodflow conditions. The cross-section lines on the aerial photographs show the widths of the channels at bankfull and maximum evident flood stages.

The results of the stream-site studies are shown in table 1. The channel characteristics tabulated are for the bankfull main channel.



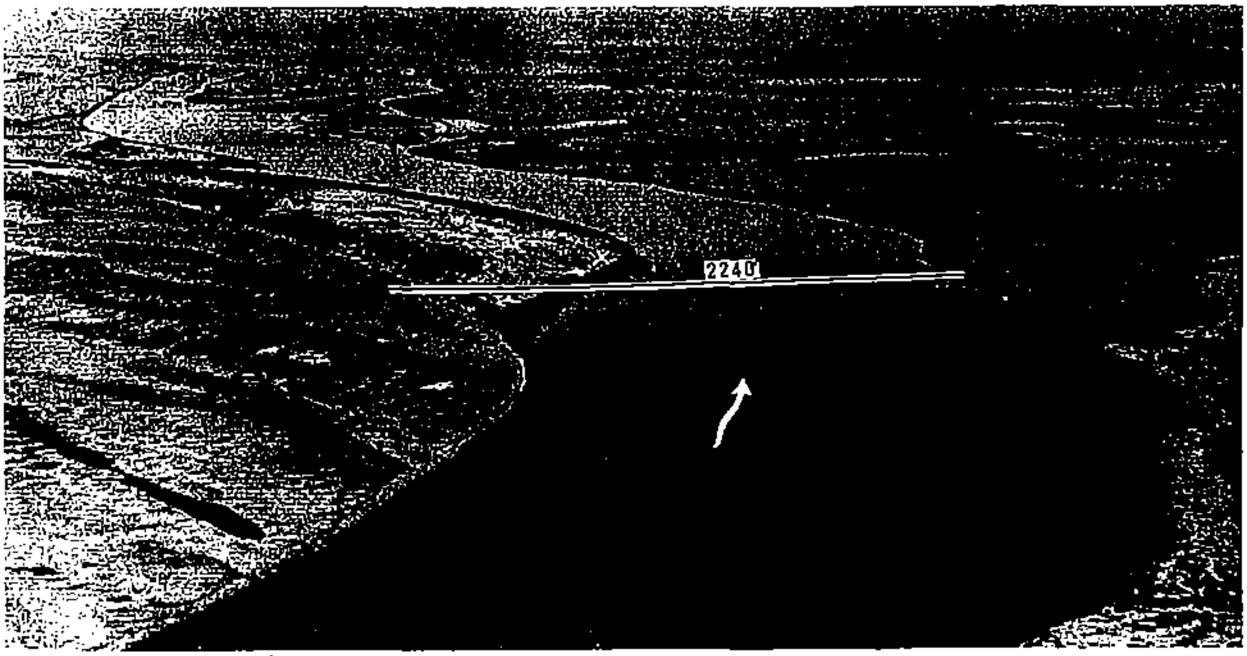
Base from U.S.Geological Survey Alaska Map E

Figure 1.--Reconnaissance study area, eastern North Slope, Alaska.



Base from U.S.Geological Survey Alaska map E

Figures 3-16.-- Photographs of flood survey sites. Upper photo shows channel width in feet. Arrow indicates direction of flow. X indicates site where bed material was photographed; ☐indicates site where biological sample was taken, if any. Lower photo shows typical streambed material; scale in centimeters except Fig. 6, which is in tenths of feet.



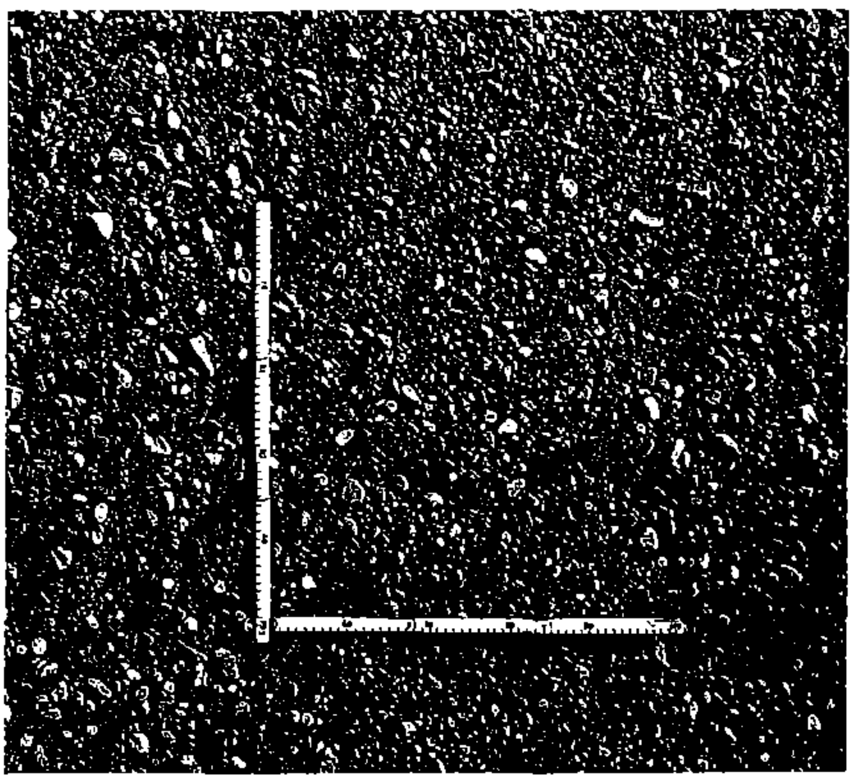


Figure 3.-- Site 1, Colville River.

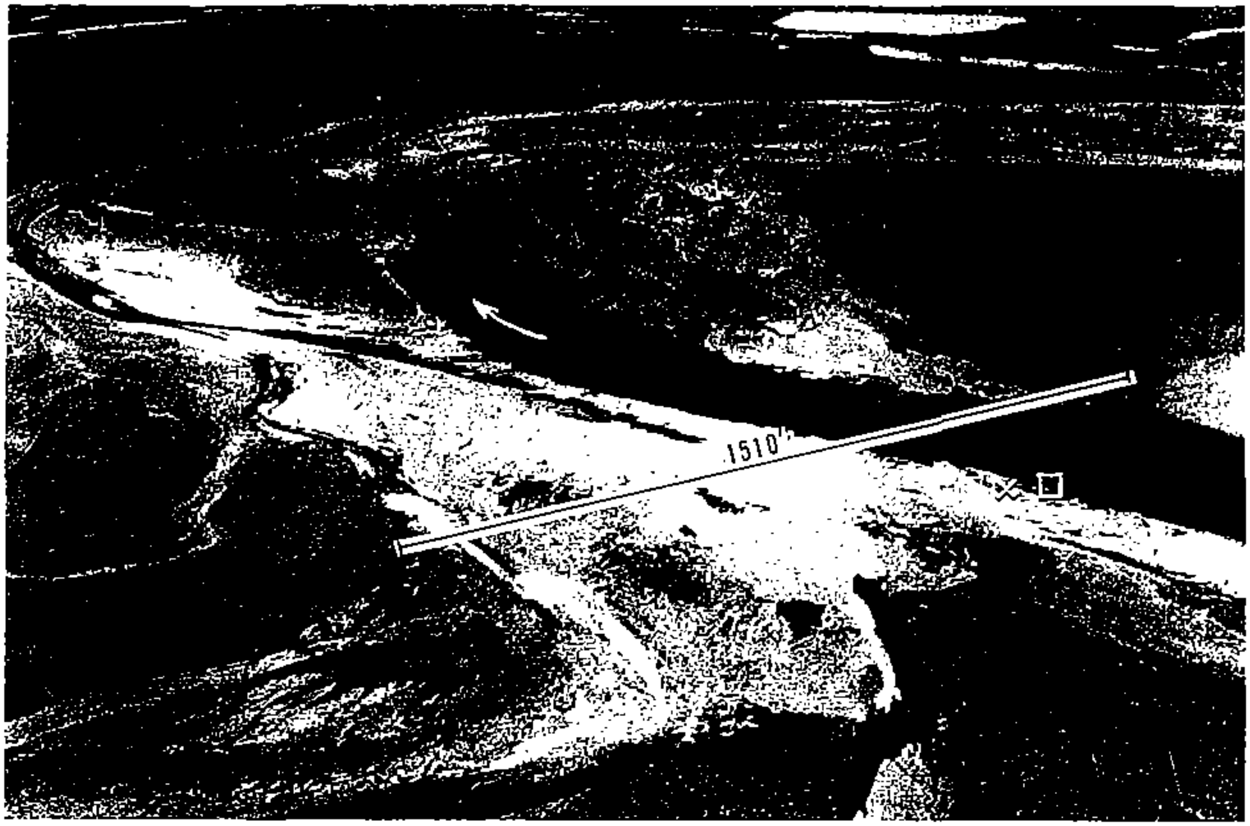


Figure 4.-- Site 2, Shaviovik River.

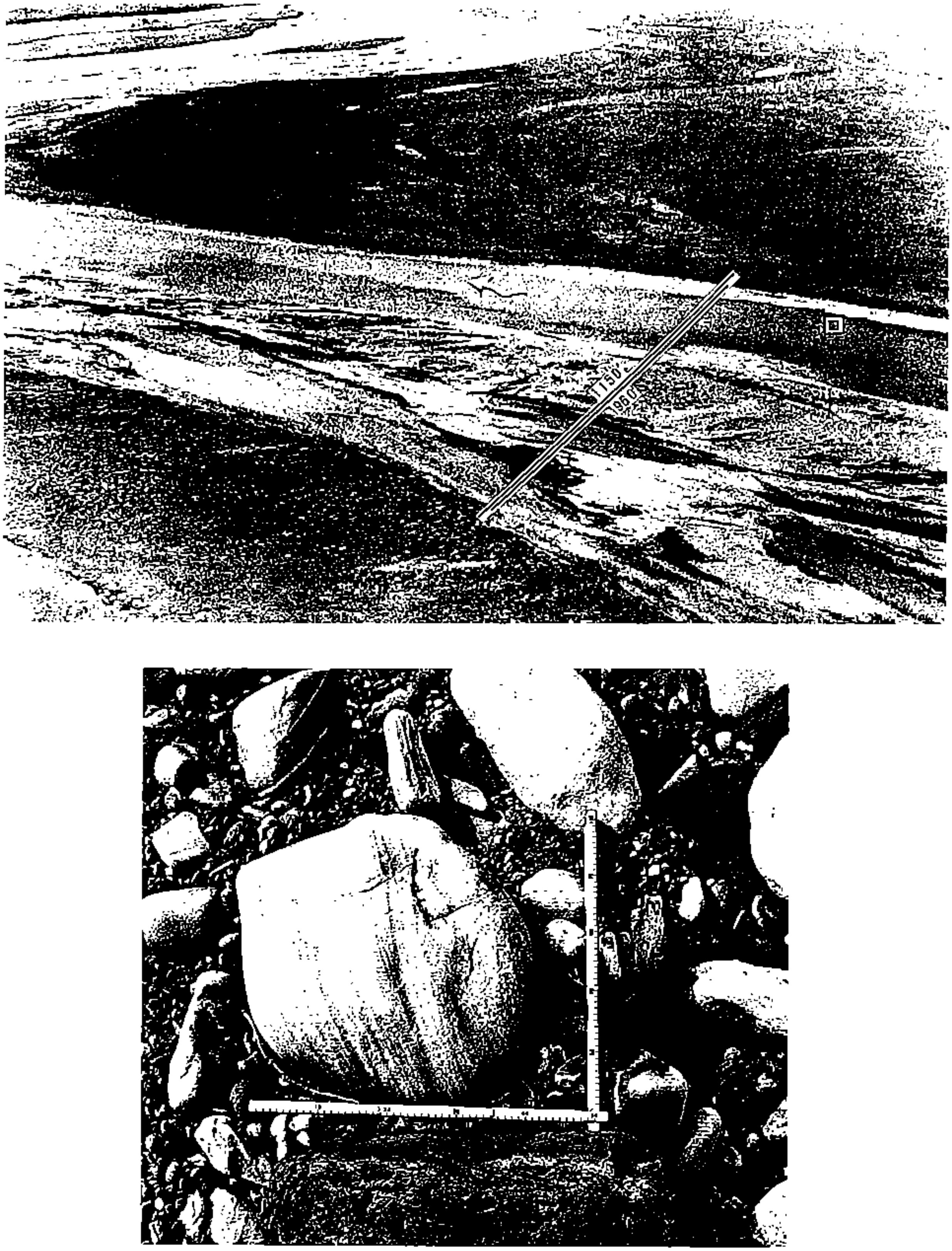
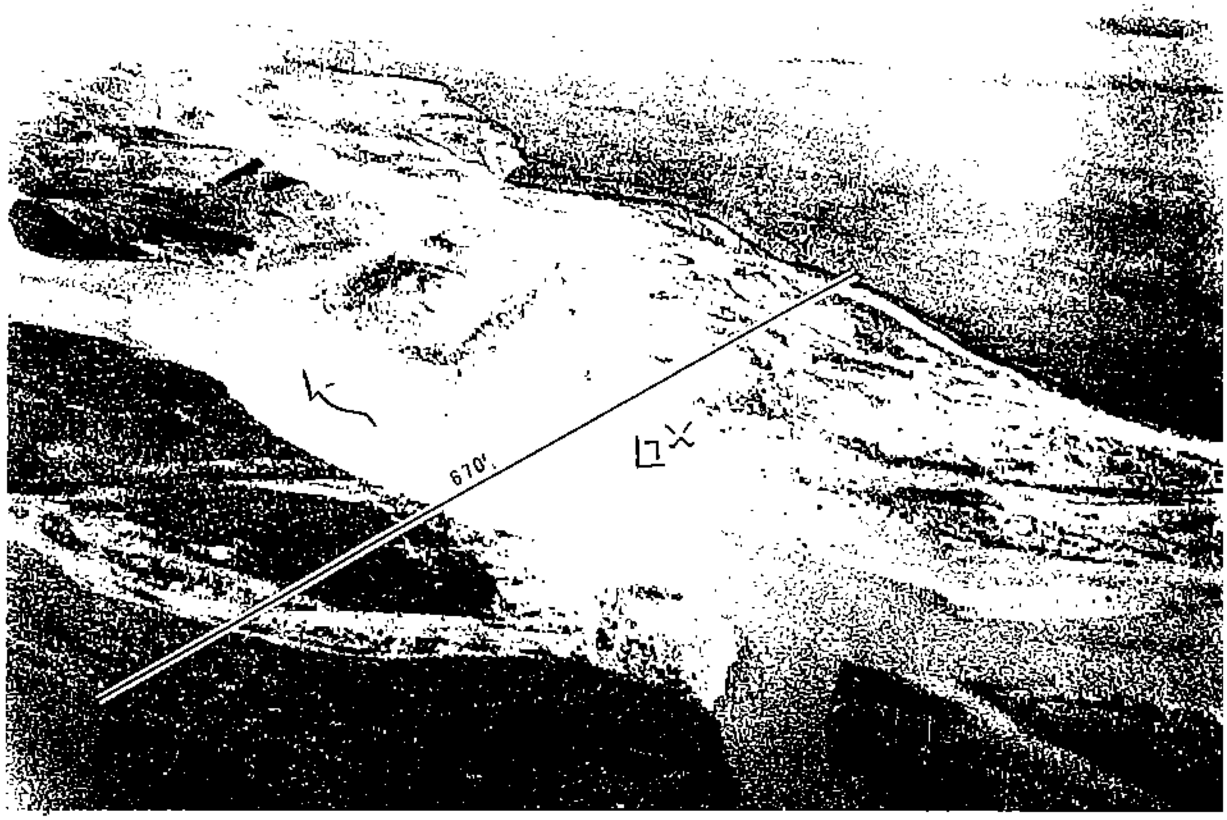


Figure 5.-- Site 3, Canning River.



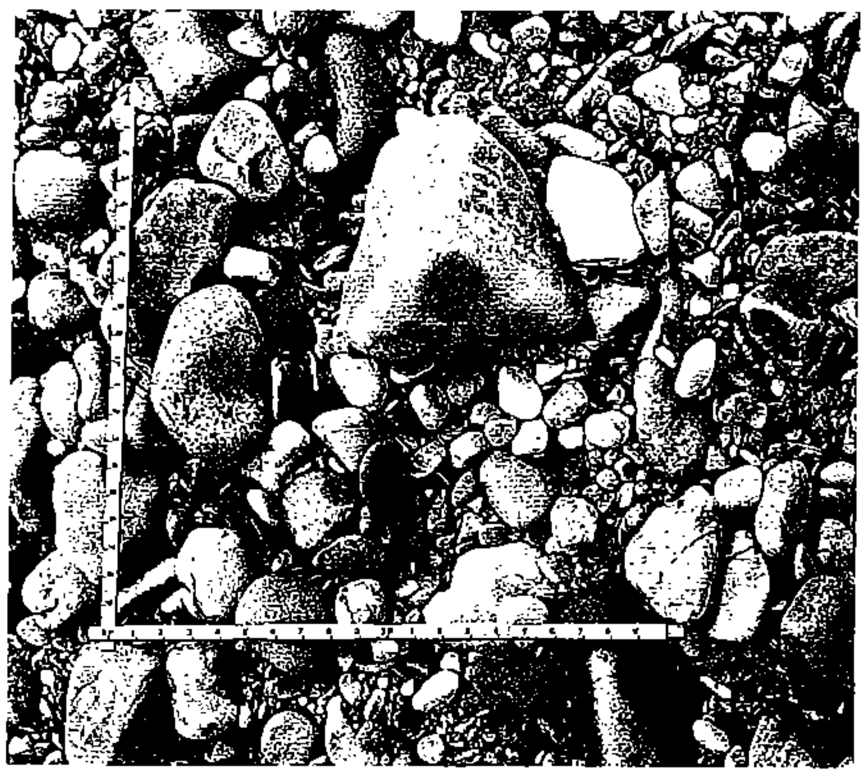


Figure 6.-- Site 4, Katakturuk River.

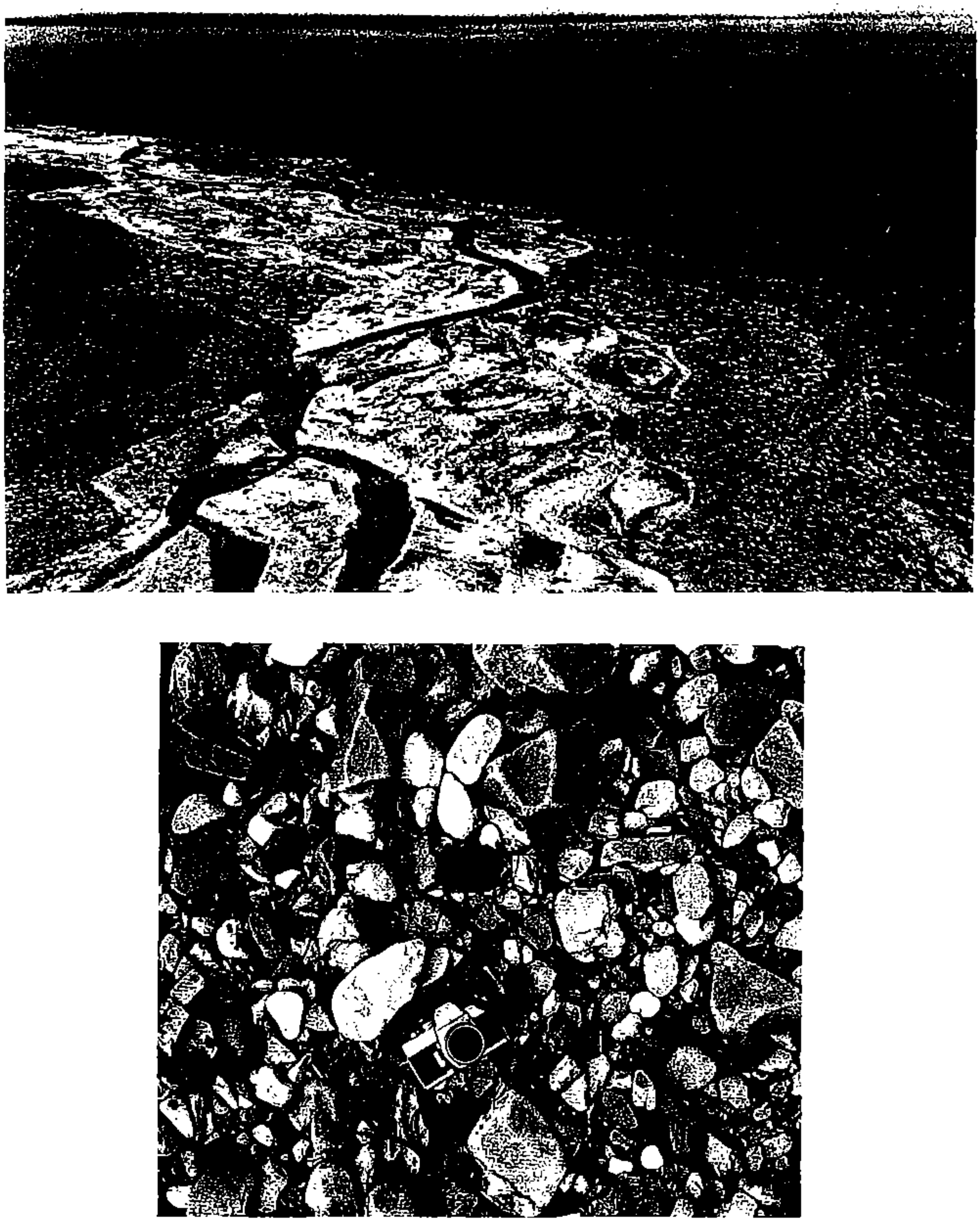


Figure 7.-- Site 5, Marsh Creek.

Figure 8.-- Site 6, Sadlerochit River.

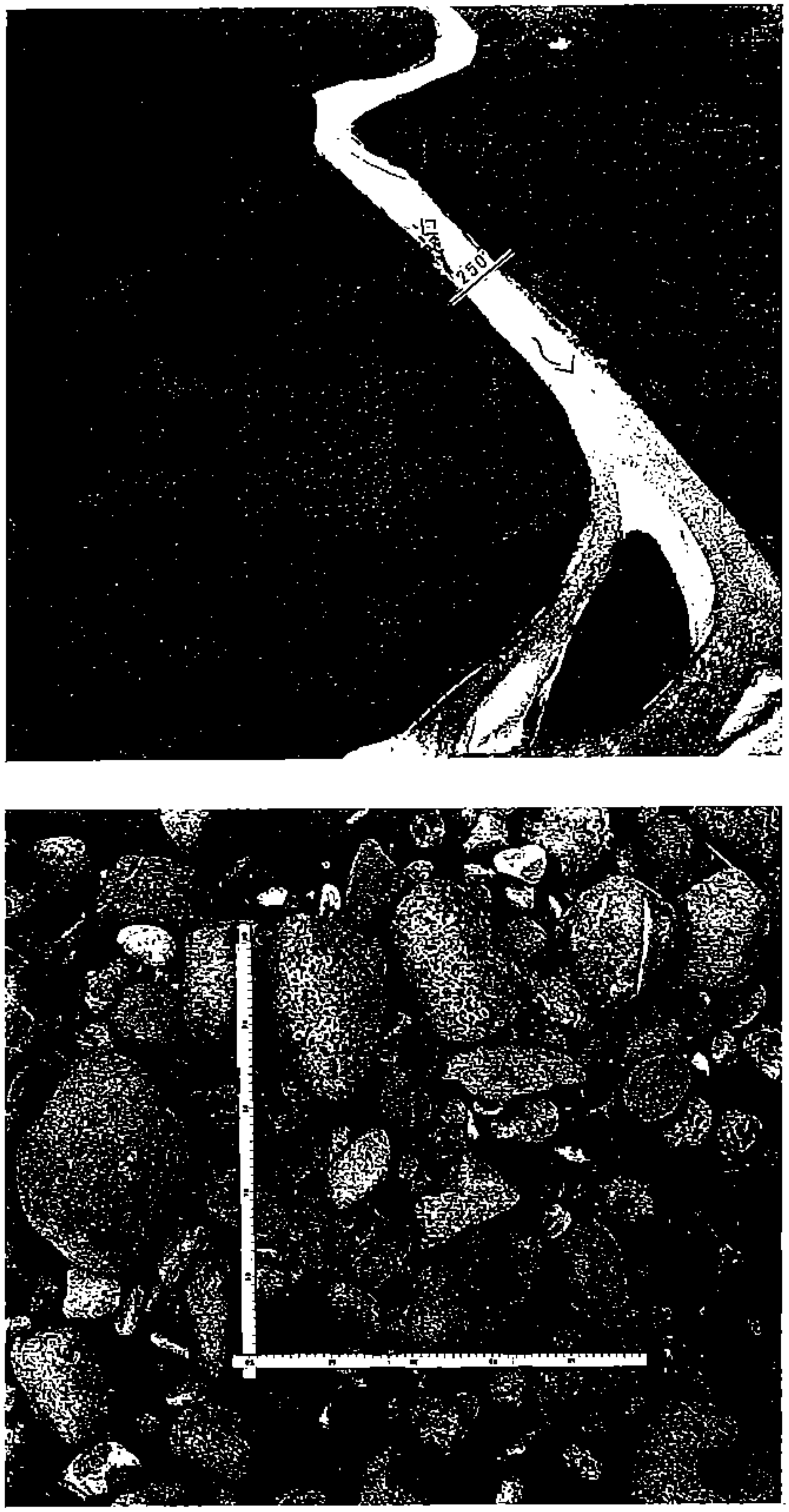


Figure 9.-- Site 7, Hulahula River

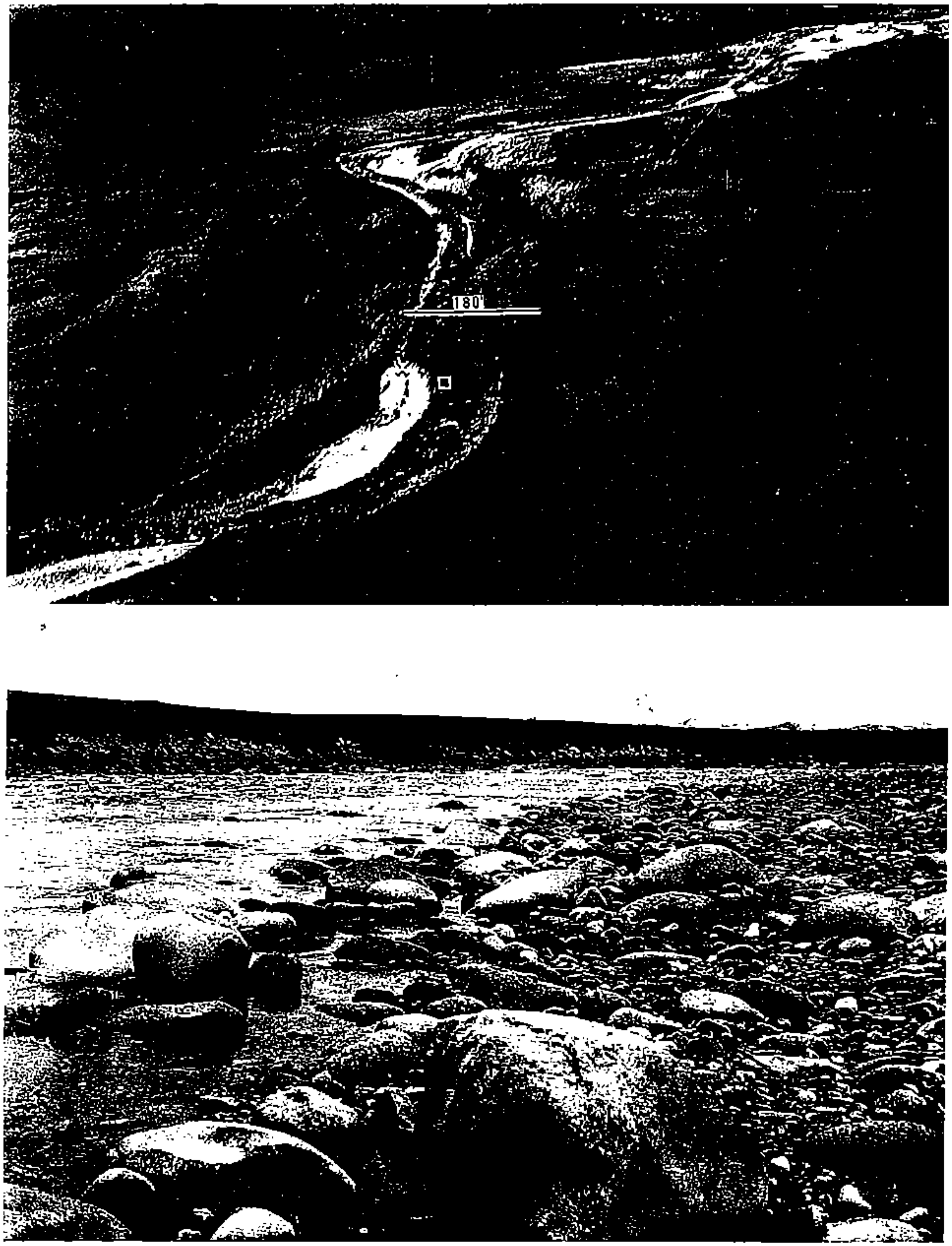


Figure 10.-- Site 8, Jago River.

Figure 11.-- Site 9, Okerokovik River.

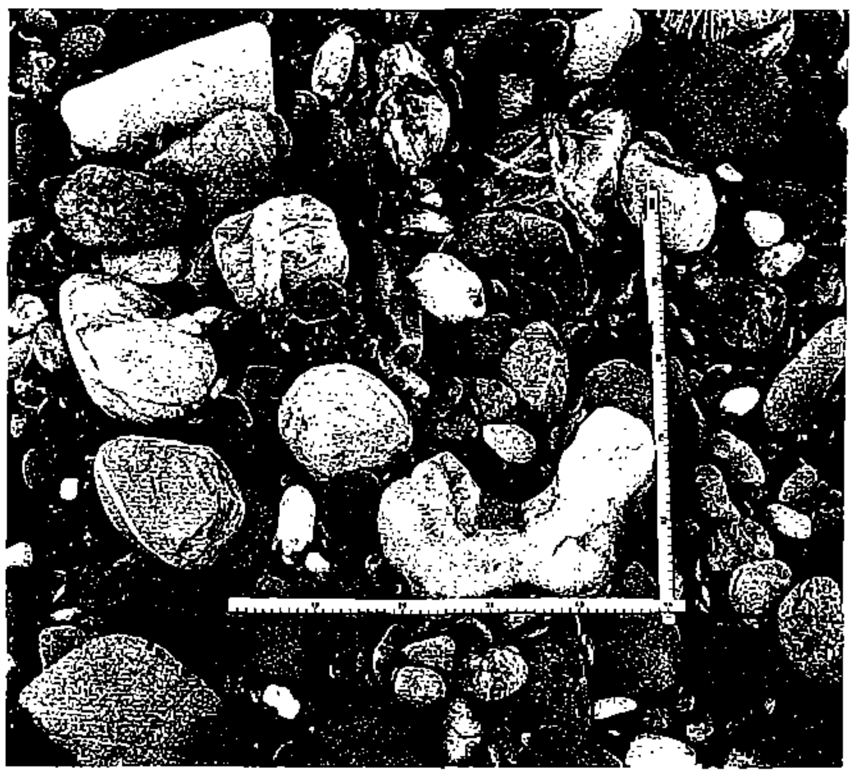


Figure 12.-- Site 10, Aichilik River.

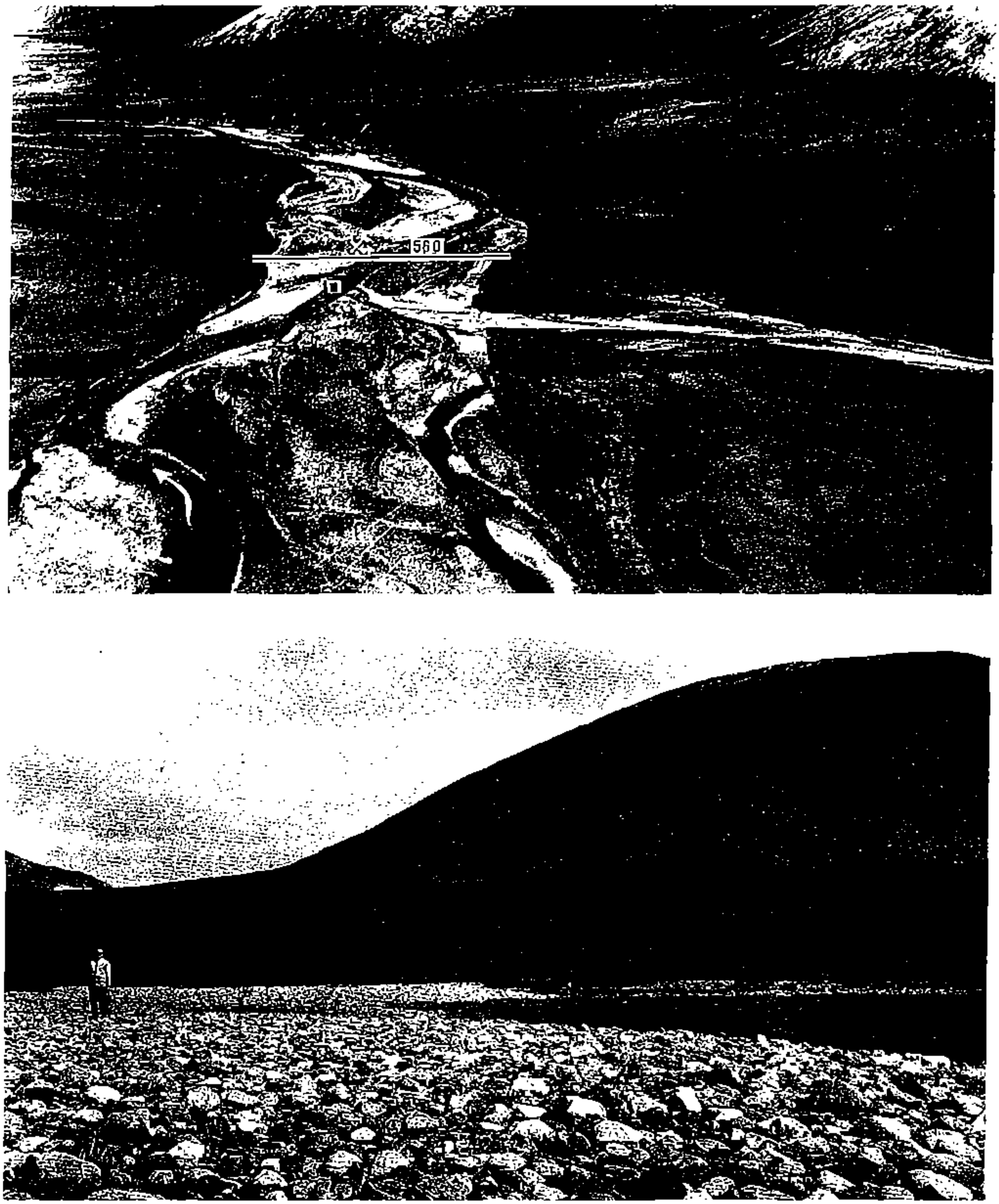


Figure 13.-- Site 11, Egaksrak River.

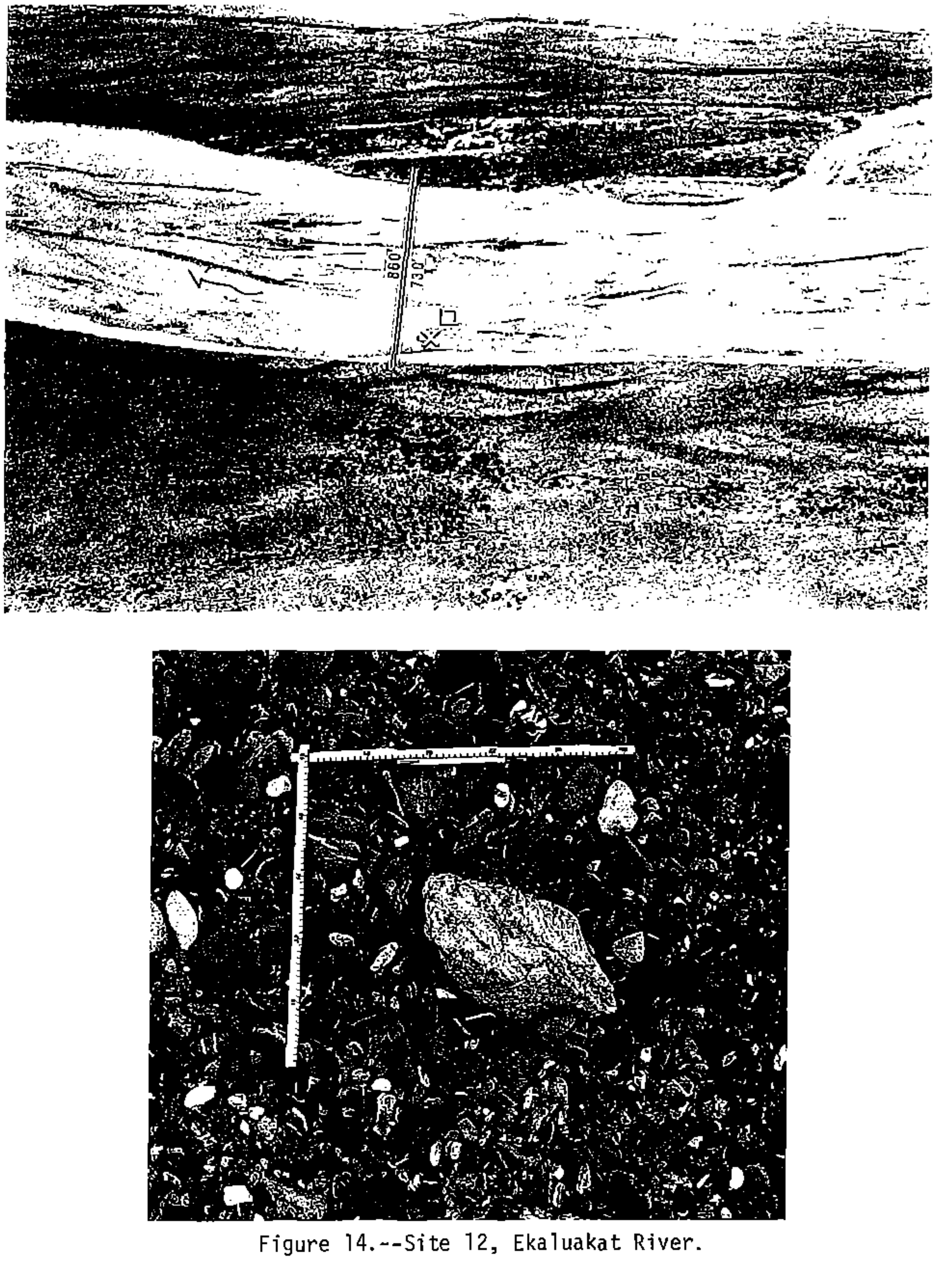


Figure 14.--Site 12, Ekaluakat River.

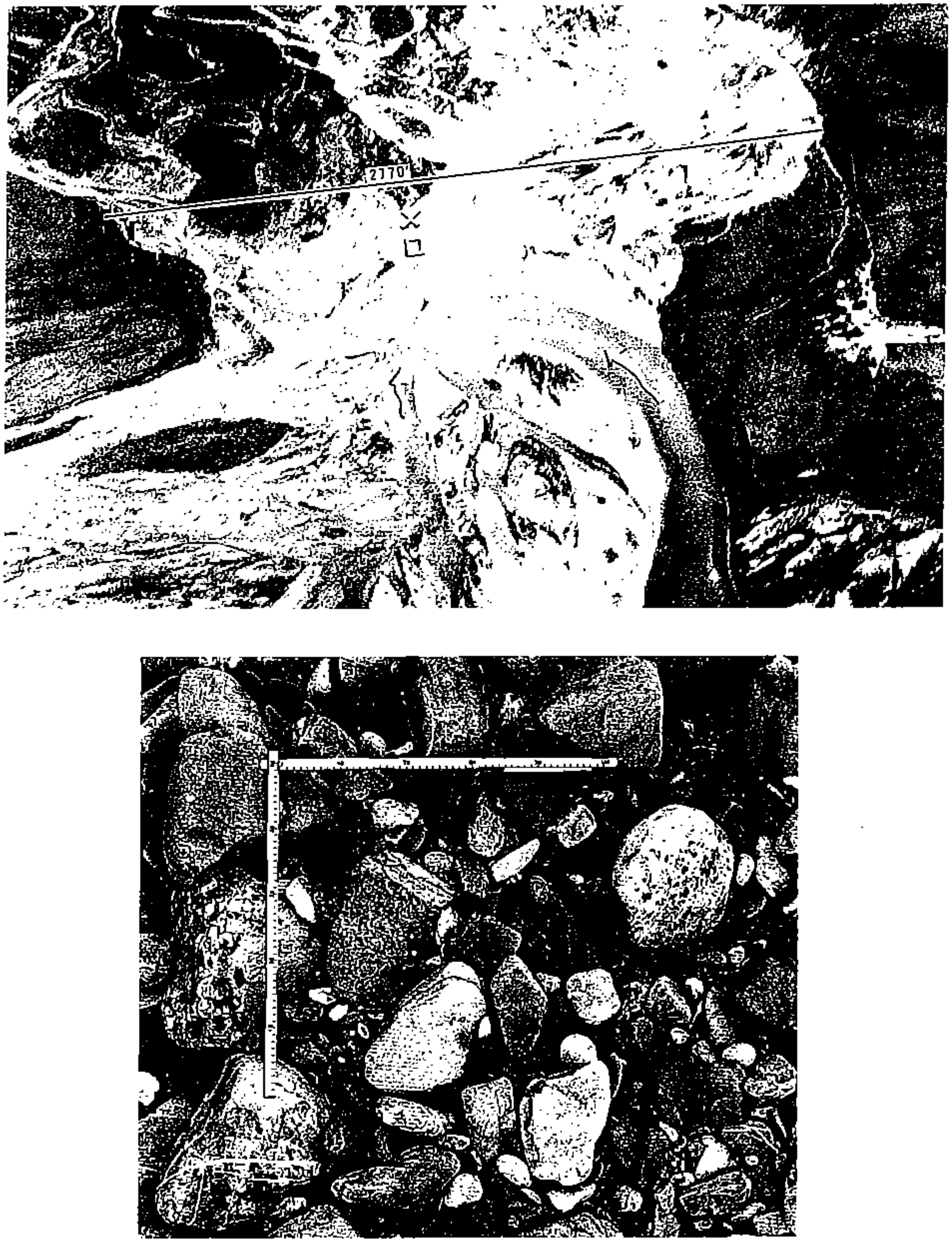


Figure 15.-- Site 13, Kongakut River.

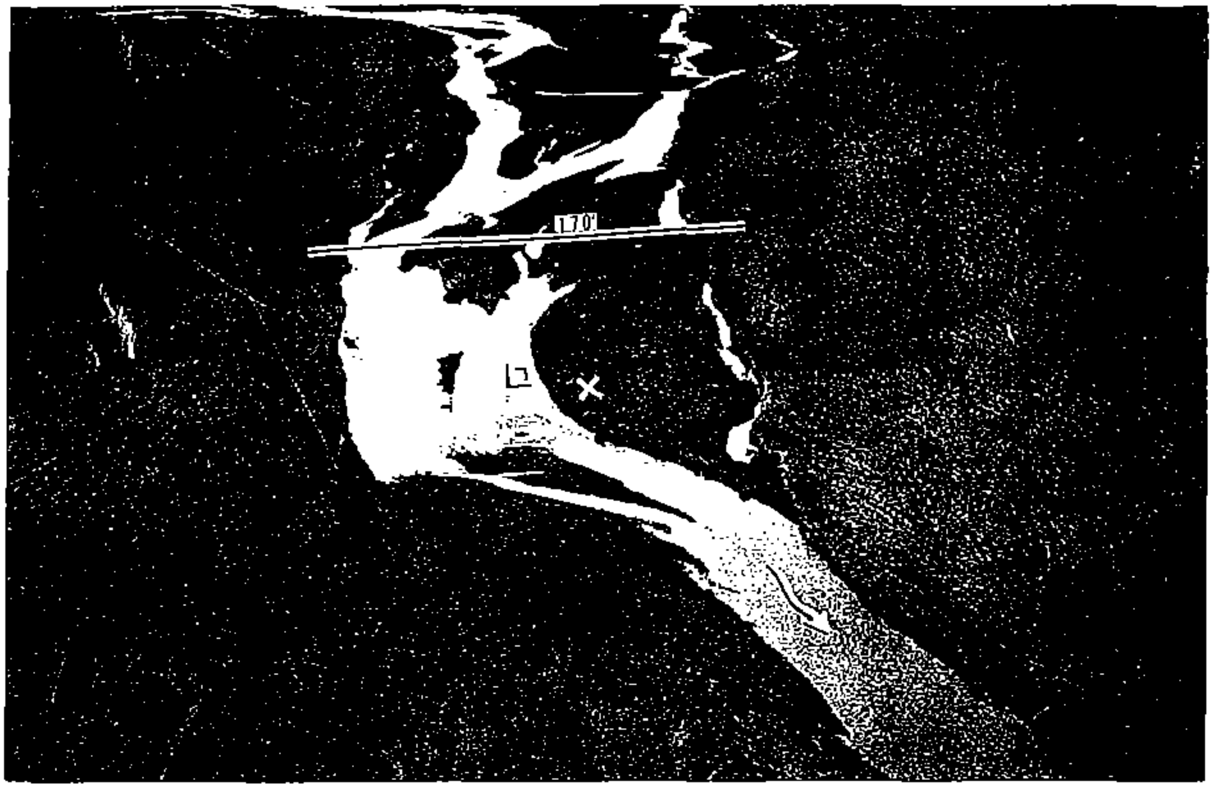


Figure 16.-- Site 14, Turner River.

Bankfull stage was determined as the observed surface of the flood plain (Leopold and Skibitzke, 1967). Discharge was estimated by slope-conveyance methods (Dalrymple and Benson, 1967).

The physical and climatic drainage basin characteristics shown in table 1 include:

Area of glaciers (G) in percentage of drainage area.

Area of lakes and ponds (S_t) in percentage of drainage area.

Drainage area (A) in square miles, the total drainage area upstream from the stream site.

Main-channel slope (S) in feet per mile, the average slope between points 10 percent and 85 percent of the distance from the gaging site to the basin divide (stream length).

Mean annual precipitation (P) in inches, as determined from Searby (1968).

Mean basin elevation (E) in thousands of feet above sea level.

Mean minimum January temperature (t_1) in °F, from Searby (1968).

Precipitation intensity (I) in inches, the maximum rainfall expected in 24 hours each 2 years, from U.S. Weather Bureau (1963).

Stream length (L) in miles, the length of the main channel between the gaging station and the basin divide measured along the channel that drains the largest basin.

Table 1 shows the flood discharges for 2-year (Q_2) and 50-year (Q_{50}) average recurrence intervals. No streamflow records are available for the streams, so the flood discharges were estimated from multiple-regression equations relating flood discharges to drainage basin physical and climatic characteristics (Childers, 1970).

Maximum evident flood-peak discharge may be divided by drainage area to give unit runoff rates. The unit runoff rates shown in table 1 average about 40 $(ft^3/s)/mi^2$ [0.4 $(m^3/s)/km^2$]; the maximum rate is 185 $(ft^3/s)/mi^2$ [1.8 $(m^3/s)/km^2$]. The maximum evident flood at Marsh Creek was much less than the bankfull discharge. This condition may be caused by lack of flood debris deposited during large floods which may occur when part of the channel is formed in snowbanks.

The calculated bankfull and maximum evident flood discharges generally exceed the estimates of Q_{50}. This indicates that the Alaska regional flood-frequency relation used to estimate Q_{50} probably should not be applied to the Arctic Coastal Plain. On the North Slope, drainage basin characteristics such as presence of continuous permafrost and the amounts and rates of precipitation and snowmelt are important, but their effects on flooding have not been evaluated.

Table 1.--*Bankfull channel, maximum evident flood, basin and flood characteristics at flood-survey sites, eastern Arctic Slope. Locations shown on figure 2.*

		BANKFULL CHANNEL						MAXIMUM EVIDENT FLOOD			* BASIN CHARACTERISTICS										FLOOD CHARACTERISTICS	
Map No.	Stream site	Streambed material	Slope (ft/ft)	Width (ft)	Mean depth (ft)	Max depth (ft)	Discharge (ft^3/s)	Width (ft)	Discharge (ft^3/s)	Unit runoff ($(ft^3/s)/mi^2$)	G	S_t	A	S	P	E	t_1	I	L	$Q_2(ft^3/s)$	$Q_{50}(ft^3/s)$
1	Colville River 70°09'56" 150°05'50"	fine gravel	0.00056	2,240	25.2	57	683,000	2,230	600,000	29.0	0	3	20,670	6.7	7	1.6	-18	.75	380	55,000	105,000
2	Shaviovik River 70°05'07" 147°16'30"	coarse cobble	0.0012	1,510	4.2	7	22,000	1,510	22,000	13.0	0	0	1,580	29.3	6	1.5	-20	.75	100	4,900	13,700
3	Canning River 69°50'38" 146°27'10"	large cobble	0.0012	960	6.9	14	31,000	1,150	53,000	28.3	0	0	1,871	33.0	5	3.3	-20	.6	106	4,400	13,500
4	Katakturuk River 69°52'25" 145°27'10"	coarse gravel	0.0064	680	3.7	7	17,000	670	10,000	43.9	0	0	228	65.8	5	2.3	-20	.6	30	660	2,800
5	Marsh Creek 69°47'32" 144°49'00"	coarse gravel	0.0148	560	3.4	6	14,000	280	500	1.9	0	0	261	36.4	5	1.5	-20	.6	11	750	3,100
6	Sadlerochit River 69°39'13" 144°12'10"	boulders	0.0062	280	4.5	7	11,000	280	11,000	20.8	0	0	529	47.5	5	3.3	-20	.6	54	1,400	5,200
7	Hulahula River 69°41'47" 144°12'10"	coarse gravel	0.0050	250	7.2	9	23,000	240	10,000	14.7	5	0	682	41.7	5	4.2	-20	.6	68	1,800	6,300
8	Jago River 69°37'02" 143°41'06"	boulders	0.0132	180	5.9	7	14,000	180	14,000	43.6	8	0	321	70.5	5	4.3	-20	.75	52	1,000	3,600
9	Okerokovik River 69°42'07" 143°14'23"	coarse gravel	0.0033	590	3.4	7	10,000	360	2,300	13.6	0	0	169	63.2	6	1.6	-20	.75	24.8	650	2,600
10	Aichilik River 69°35'23" 142°58'03"	coarse gravel	0.0054	820	5.5	8	33,000	817	27,000	48.0	0	0	563	58.0	6	3.7	-20	.75	54	1,900	6,300
11	Egaksrak River 69°32'05" 142°41'05"	large cobble	0.0093	560	2.4	6	9,000	560	9,000	41.9	0	0	215	62.0	7	2.7	-20	.75	44	910	3,400
12	Ekaluakat River 69°34'35" 142°18'38"	medium gravel	0.0109	730	3.1	6	23,000	860	27,000	185.0	0	0	146	58.3	7	2.1	-20	.75	16	640	2,600
13	Kongakut River 69°30'54" 142°42'34"	coarse gravel	0.0058	2,770	4.6	9	98,000	2,770	98,000	79.0	0	0	1,240	33.0	7	3.5	-20	.75	88	4,400	12,800
14	Turner River 69°35'56" 141°24'10"	medium gravel	0.0038	160	1.7	6	1,300	170	1,500	29.4	0	0	51	73.1	7	.481	-20	1.00	9	290	1,200

SPRINGS AND ICINGS

General Description

Springs and related icings are the most conspicuous active hydrologic features on the eastern Arctic Slope during the winter season. Streamflow virtually ceases in winter except in zones of ground-water discharge and channel reaches immediately downstream from concentrated points of ground-water discharge (springs).

During winter, spring water freezes downstream from its source to form icings. The area, thickness, and location of an icing depend basically on the volume of water supplied and to a lesser extent on water temperature, air temperature, and topography of the ice accumulation area.

The locations of several of the more conspicuous springs, such as Shublik and Sadlerochit, were known from reports in the literature (Williams, 1970). Marvin Mangus (oral commun., 1972), geologist in Anchorage with extensive field experience in the eastern Brooks Range, told us the location of several other springs, including the one at Red Hill. The location and extent of icings in the Sagavanirktok, Ivishak, Canning, Tamayariak, Katakturuk, Sadlerochit, and Hulahula River drainage basins were observed during an aerial reconnaissance. Landsat I (originally called ERTS A) satellite imagery was used to locate icings in tundra north of the Brooks Range. On Landsat I, ice or water surfaces appear black against a white snow background in winter scenes. There is very little black and white contrast in visible Band 4 (0.4 to 0.5 micrometers) of the multispectral scanner; on the other hand, the contrast is most pronounced in the near-infrared Band 7 (0.8 to 1.1 micrometers).

Icings melt more slowly than snow cover, and some large icings persist from year to year. Figure 17 shows remnants of the Ekaluakat icing in late July 1975. In summer, the remnants of icings are in bright contrast to surrounding soil and vegetation and can be readily identified on Landsat I images (fig. 18) in Band 5 (0.6 to 0.7 micrometers).

Before the reconnaissance trips were undertaken, available Landsat imagery was studied to identify and locate icings on the eastern Arctic Slope. These icing sites were used as the basis for planning the winter hydrologic reconnaissance. At each location, the expected icings and open water leads from nearby springs were found. An example of such an open water lead can be seen in figure 19. Figure 20 shows the locations of the main springs and icings in the study area.

At each spring, discharge was measured, field determinations of conductance, pH, alkalinity, temperature, and dissolved oxygen were made, and samples were collected for analysis of total organic carbon, turbidity, color, and selected inorganic chemical parameters. Aquatic invertebrates were also collected for laboratory analysis.

(Selected water-quality data for springs, streams, and lakes are presented in tables 2, 3, and 4, respectively. The map numbers in these tables refer to figures 20, 26, and 27, which show the location of the springs, stream, and lake sampling sites, respectively.)

Figure 17.-- Ekaluakat icing remnants, July 1975.

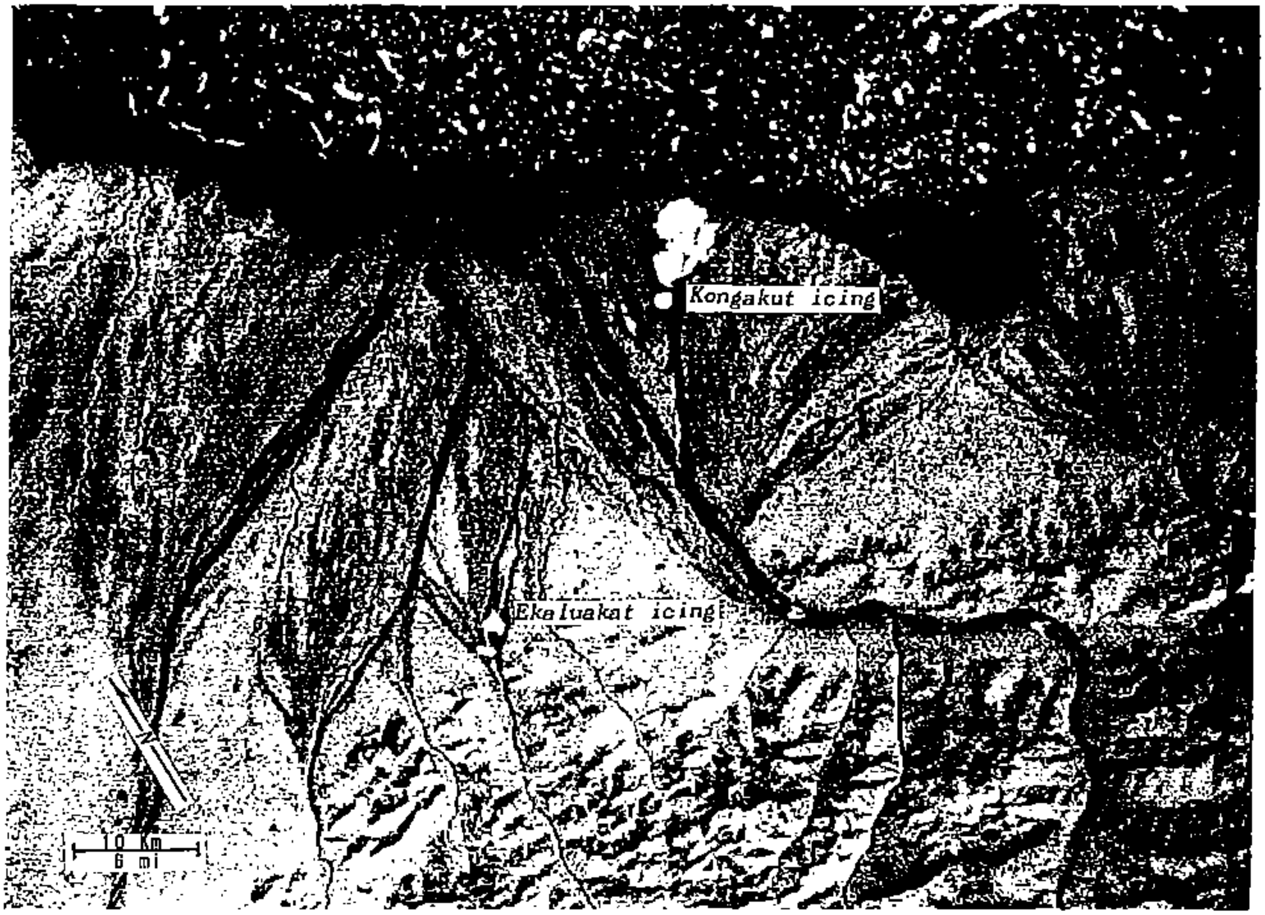
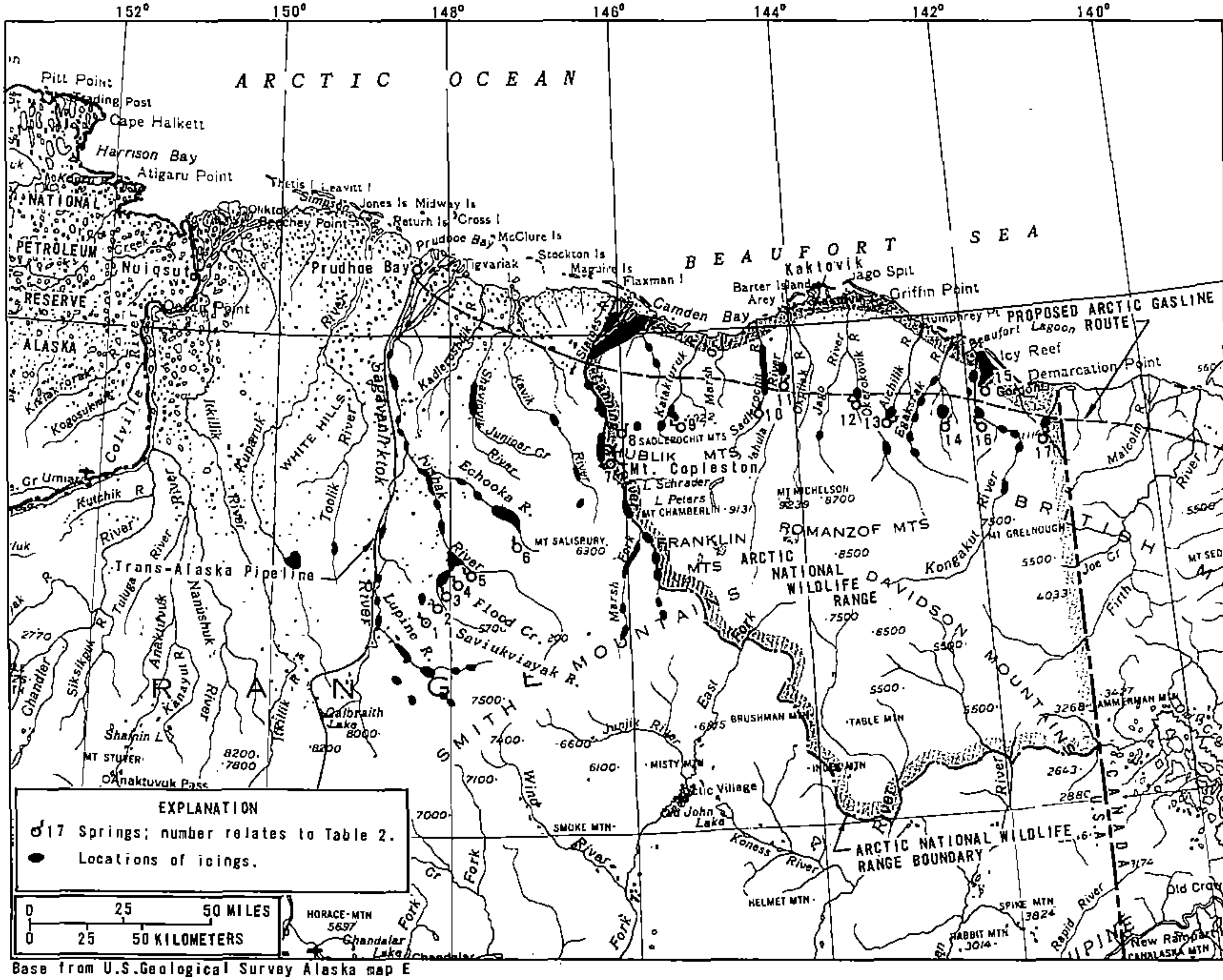


Figure 18.-- Landsat I image of Kongakut icing, August 1, 1973.

Figure 19.-- Open water at spring that feeds the Ekaluakat icing, April 22, 1975.



Base from U.S.Geological Survey Alaska map E

Figure 20.--Location of springs and icings.

A distinctive feature of most of the springs on the North Slope is the luxuriant growth of vegetation, both aquatic and riparian, much of which stays a bright green even in winter. Willow growth is thick near many springs, and at some of the springs are stands of balsam poplar up to 40 ft (12 m) tall.

Some of the springs that flow from alluvial deposits are surrounded in winter by bare gravel which makes them relatively easy to spot from the air. There is apparently enough heat in the water and in the ground to melt any snow that falls there.

The discharge measurements of spring systems were made at a point downstream so as to integrate the flow of all upstream springs. Samples for chemical analysis were taken at a single representative orifice that could be readily identified and resampled. Temperature and dissolved-oxygen measurements of each spring were made as close to the discharge point as possible.

Sagavanirktok River System Springs

Many springs occur in tributary basins of the Sagavanirktok River along the northern edge of the Brooks Range. A general description of these springs is given in Childers and others (1973).

Echooka springs at the edge of the mountains supply the largest icing in the Sagavanirktok drainage basin, one of the largest icings in Alaska. Echooka springs were discharging about 100 ft^3/s (2.83 m^3/s) in May 1973.

In winter months discharge from springs in the Saviukviayak River, Flood Creek, and in Ivishak River drainages near the mountain front (fig. 21) coalesces to form a large and conspicuous icing near their confluence. Cumulative discharge from these springs in May 1973 amounted to nearly 370 ft^3/s (10.5 m^3/s). Measurement of these same springs in April 1975 indicated a total discharge of about 200 ft^3/s (5.7 m^3/s). This wide difference in flow was probably the result of early snowmelt runoff in 1973. Use of the 1975 data (table 2) gives a more conservative figure for minimum spring discharge.

The Saviukviayak tributary has a drainage basin of about 32 mi^2 (83 km^2) and had a spring-flow discharge in April of 45 ft^3/s (1.3 m^3/s). If this value is a representative figure for minimum ground-water discharge in the basin, it would be equivalent to an annual basin yield of about 1.6 ft (0.5 m) of water over the entire basin, assuming that the ground-water basin coincides with the surface-water basin. This assumption is probably not valid because the adjacent Flood Creek basin [drainage area 80 mi^2 (207 km^2)] had a spring-flow discharge of 53.6 ft^3/s (1.5 m^3/s) in April 1975. This is equivalent to an annual basin yield of about 0.8 ft (0.2 m) of water. If this is combined with the adjacent Saviukviayak tributary basin, a yield of about 1.0 ft (0.3 m) of water for the two basins results. Estimated average annual precipitation for the area is between 1.5 and 3 ft (0.5 and 1.0 m). Thus it can be seen that ground-water discharge is a very significant part of the hydrologic regime of this part of Alaska.

Table 2.--*Dissolved chemical constituents and physical parameters for springs, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

Map No. from fig. 20	1	2	3		4	
Station name	Lupine spring	Saviukviayak R. west spr.	Saviukviayak trib. spring		Flood Creek spring	
Latitude	68°51'45"	68°54'10"	68°56'20"		68°58'40"	
Longitude	148°12'20"	148°05'10"	147°58'45"		147°51'30"	
Date	05-09-73	05-05-73	05-10-73	04-20-75	05-10-73	04-20-75
Time	--	--	--	10:00	--	14:15
Discharge (ft^3/s)	1.5	89	54	45	83	54
Silica	3.7	4.8	4.6	4.8	6.3	5.3
Iron (µg/L)	30	60	50	--	30	--
Manganese (µg/L)	0.0	0.0	10	--	0	--
Calcium	51	40	39	52*	38	52*
Magnesium	7.7	9.2	7.3	--	8.8	--
Sodium	0.4	0.7	0.3	0.8	0.4	0.3
Potassium	0.1	0.1	0.1	0.5	0.1	0.5
Bicarbonate	177	155	137	145	136	131
Carbonate	0.0	0.0	0.0	--	0	--
Alkalinity, total ($CaCO_3$)	145	127	112	--	112	--
Sulfate	12	8.5	12	9.1	14	11
Chloride	2.8	0.7	0.5	0.9	1.3	0.9
Fluoride	0.3	0.5	0.5	0.3	0.6	0.4
Nitrate and nitrite as N	0.13	0.05	0.05	0.11	0.05	0.11
Orthophosphorus as P	0.00	0.00	0.00	0.03	0.00	0.01
Dissolved solids (sum of determined constituents)	166	141	132	--	137	--
Hardness, total	160	140	130	130	130	130
Non-carbonate hardness	14	11	15	--	20	--
Specific conductance (micromhos/cm at 25°C)	298	259	239	247	240	222
pH (units)	7.8	7.8	7.9	8.2	8.2	8.0
Water temperature (°C)	2.5	5.0	3.5	6.5	8.5	7.2
Color (platinum-cobalt units)	1.0	1.0	1	0	1	0
Turbidity (Jackson Turbidity units)	--	--	--	1	--	2
Dissolved oxygen	--	--	--	8.9	--	9.0
Total organic carbon	--	--	--	--	--	9.9

*Calcium and magnesium (calculated as calcium)

Table 2.--*Dissolved chemical constituents and physical parameters for springs, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

Map No. from fig. 20	13	14	15	16	17	18	
Station name	Aichilik R. spring	Ekaluakat R. spring	Kongakut R. delta spring	Kongakut R. above delta	Kongakut R. spring	Clarence R. spring	
Latitude	69°31'06"	69°35'27"	69°43'36"	69°42'50"	69°32'36"	69°30'44"	
Longitude	143°02'00"	142°18'00"	141°46'07"	141°47'30"	141°49'38"	141°11'37"	
Date	04-27-75	04-22-75	04-27-75	11-18-75	04-27-75	04-27-75	11-18-75
Time	13:30	10:00	12:00	--	10:00	10:50	--
Discharge (ft^3/s)	1.5	5.1	37	88.4	13	0.5	4.7
Silica	2.4	3.9	2.7	3.0	2.3	2.3	2.2
Iron (μg/L)	--	--	--	--	--	--	--
Manganese (μg/L)	--	--	--	--	--	--	--
Calcium	65*	69*	46*	--	50	53*	--
Magnesium	--	4.5	1.1	--	1.0	--	0.7
Sodium	2.8	.6	1.1	1.1	0.5	0.5	0.3
Potassium	2.1	--	--	0.1	--	--	--
Bicarbonate	148	165	122	62	134	124	86
Carbonate	--	--	--	--	--	--	--
Alkalinity, total ($CaCO_3$)	--	--	--	--	--	--	--
Sulfate	39	25	17	17	25	12	26
Chloride	2.0	3.6	0.5	1.0	0.9	0.7	1.4
Fluoride	0.2	0.4	0.1	--	0.1	0.0	--
Nitrate and nitrite as N	0.08	0.07	0.14	0.16	0.08	0.05	.16
Orthophosphorus as P	0.19	0.00	0.11	0.00	0.00	0.00	0.00
Dissolved solids (sum of determined constituents)	--	--	--	--	--	--	--
Hardness, total	162	172	116	--	--	132	--
Non-carbonate hardness	--	--	--	--	--	--	--
Specific conductance (micromhos/cm at 25°C)	338	350	215	210	276	--	250
pH (units)	8.0	7.9	7.9	6.7	7.9	7.9	6.8
Water temperature (°C)	3.6	6.4	1.0	0.5	1.0	--	0.0
Color (platinum-cobalt units)	0	0	0	--	0	--	--
Turbidity (Jackson Turbidity units)	2	1	1	--	1	--	--
Dissolved oxygen	12.4	8.1	12.2	--	13.0	--	--
Total organic carbon	1.2	4.9	0.9	34	3.9	6.3	--

*Calcium and magnesium (calculated as calcium)

Figure 21.-- Ivishak hillside spring, April 20, 1975.

No single spring orifice in the Sagavanirktok drainage system discharges a very large volume of water. Instead, numerous springs discharge at or near the valley bottoms from exposed bedrock or stream-channel alluvium. In some places, springs such as the Ivishak hillside spring (fig. 21) and some springs in Flood Creek valley issue from steep banks several tens of feet above the adjacent stream.

Canning River System Springs

The cumulative discharge of springs in the Canning River and its tributaries is probably greater than in any other river system on the North Slope in Alaska. Shublik Spring, which discharges about 24 ft^3/s (0.68 m^3/s) on the southwest end of Copleston Mountain, emerges from two main orifices and descends in a channel about 300 ft (90 m) in half a mile to the point where it plunges the last 40 ft (12 m) into the Canning River (fig. 22).

In late winter, icings formed by these springs are almost continuous from the upper reaches of the Marsh Fork of the Canning River throughout the entire length of the main river channel. One of the largest icings in the area forms in the distributary channels of the Canning and the Staines Rivers upstream from their delta.

Red Hill Spring

Red Hill spring at the west end of the Sadlerochit Mountains is one of the few known hot springs on the Arctic Slope. Water temperature at the main orifice was 32.8°C in April 1975 and 29.3°C in August. Gases bubble to the surface in the orifice pool, and there is a strong odor of hydrogen sulfide at the spring. Lavender and cream-colored algae coat the rocks and bottom of the pool. The water has a slightly bluish, turbid appearance. The spring water flows across and through a rubble slope for about 300 ft (90 m) to join the spring-fed headwaters of the Tamayariak River. The headwater stream contains an unidentified suspended "precipitate" and appears black. Discharge in the stream was measured at 0.85 ft^3/s (0.02 m^3/s) in April 1975. Water quality was sampled at the spring orifice.

Sadlerochit Spring

Sadlerochit Spring at the east end of the Sadlerochit Mountains (fig. 23) is the largest known spring on the Arctic Slope to issue from a hillside bedrock source. Fairly constant discharge of about 37 ft^3/s (1.05 m^3/s) issues at nearly 13°C from a primary orifice and one secondary orifice in talus derived from the Sadlerochit Sandstone (fig. 35). The spring maintains an open channel for nearly 50 mi (80 km) downstream even during the coldest part of the year because of its high discharge and temperature. A narrow, thick and elongated icing develops about 5 mi (8 km) downstream from the spring and extends for another 5 mi (8 km) down the valley.

Figure 22.-- Shublik Spring where it discharges to Canning River, April 28, 1975.

Kongakut River Springs

The largest icing known in Alaska occurs in the lower distributary reaches of the Kongakut River (fig. 18). This fan-shaped icing develops from several large springs that emerge from an alluvial fan surface. In November 1975, a combined discharge of 88.4 ft^3/s (2.5 m^3/s) was measured in two channels at the head of the icing, and another channel was flowing at an estimated 15 ft^3/s (0.42 m^3/s). In April 1975, a flow of 37 ft^3/s (1.05 m^3/s) was measured in a single channel near the head of the icing. Freshwater from the springs overflows sea ice in the lagoon behind Icy Reef and extends the icing laterally for at least 10 mi (16 km) along the coast. The size of the icing as delineated on Landsat I imagery is estimated to be about 50 mi^2 (130 km^2).

Some springs, such as those that feed the Kongakut, Canning, Okerokovik, and Hulahula icings near the proposed Arctic Gas pipeline route, emerge from alluvial deposits and have no apparent relationship to any bedrock outcrops or structure. Furthermore, there is no apparent geomorphic setting such as a channel constriction or change of slope to explain the location of the springs. Thus the question is raised whether these springs have their source in buried bedrock at or near the places where they emerge.

Water Quality of Springs

The springs are, with few exceptions, remarkably uniform in their water quality (table 2). The water is of excellent quality for almost any use. The water is clear and turbidity is very low; pH ranges from 6.7 to 8.2. Dissolved-oxygen concentration is high, generally near saturation. For those springs in which discharge can be isolated from general runoff, such as the Sadlerochit and Shublik Springs, discharge and temperature seem to remain nearly constant. The water is a dilute calcium bicarbonate type, and dissolved-solids concentrations range from about 130 to 225 mg/L.

Red Hill spring is the principal exception to the above generalities. Its thermal waters are a sodium bicarbonate type, high in both chloride and sulfate. (The water in Sadlerochit Spring contains more sulfate than most other springs in the study area.)

Because their flow regime is relatively stable compared to streamflow, the springs support a varied and abundant flora and fauna. The springs are a source of water for overwintering habitats for fish, including Arctic char.

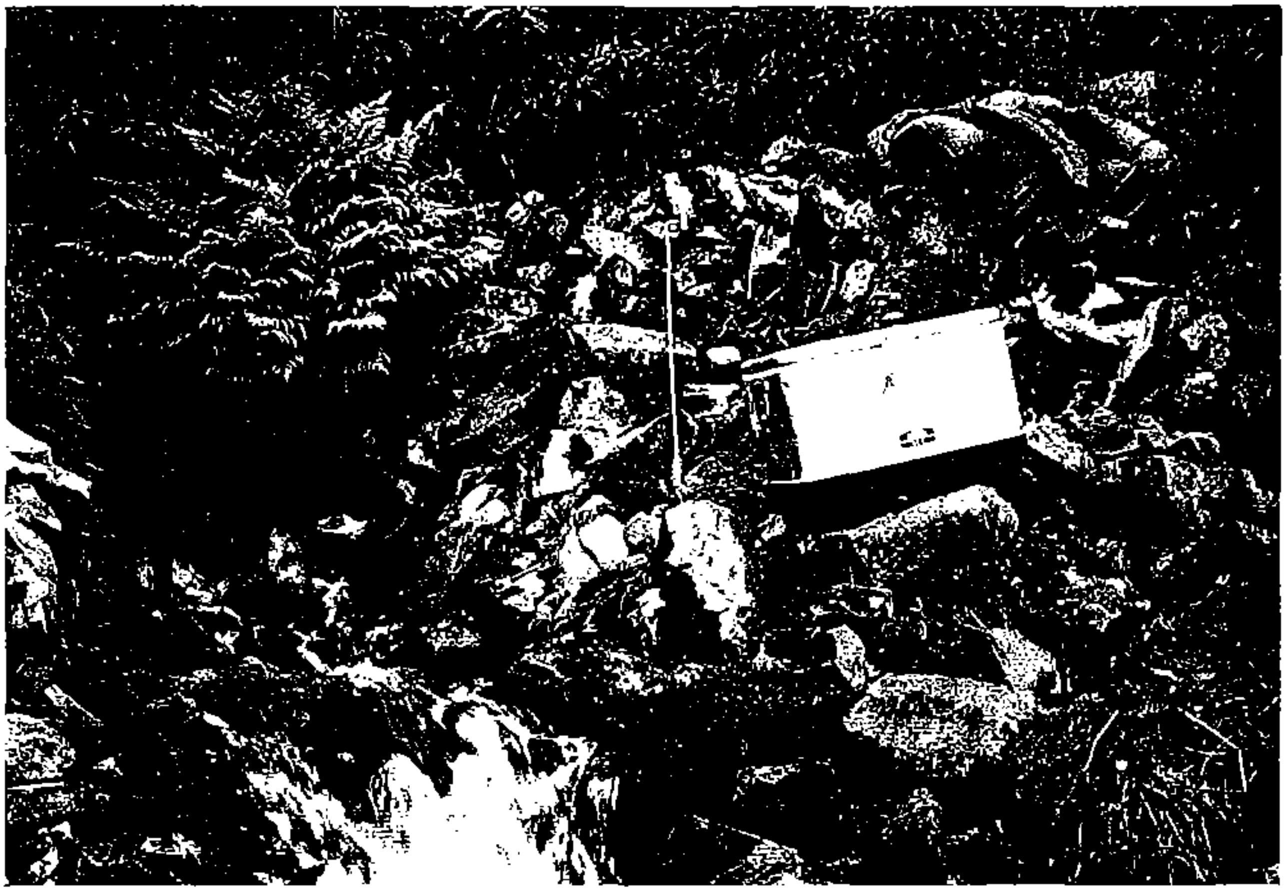


Figure 23.-- Sadlerochit Spring main orifice, August 7, 1975.

STREAMS

Streamflow is virtually nonexistent in most Arctic streams during the winter. Attempts to find and measure streamflow in the Colville River, the largest river on the North Slope, in April 1975 were unsuccessful. Water was found pooled under ice at Umiat and at the head of the delta near Nuiqsut (fig. 24), but movement could not be detected with a current meter. At another site near the mouth of the Anaktuvuk River, no water could be found in a section across the main channel, and ice above the gravel averaged less than 2 ft (0.6 m) thick.

During November 1975 intensive efforts to find and measure streamflow along the proposed Arctic Gas pipeline route revealed only seven locations with measurable flow. Five of these were in open leads at or near springs (see table 3). Figure 25 shows the locations of stream sites with no measurable winter flow.

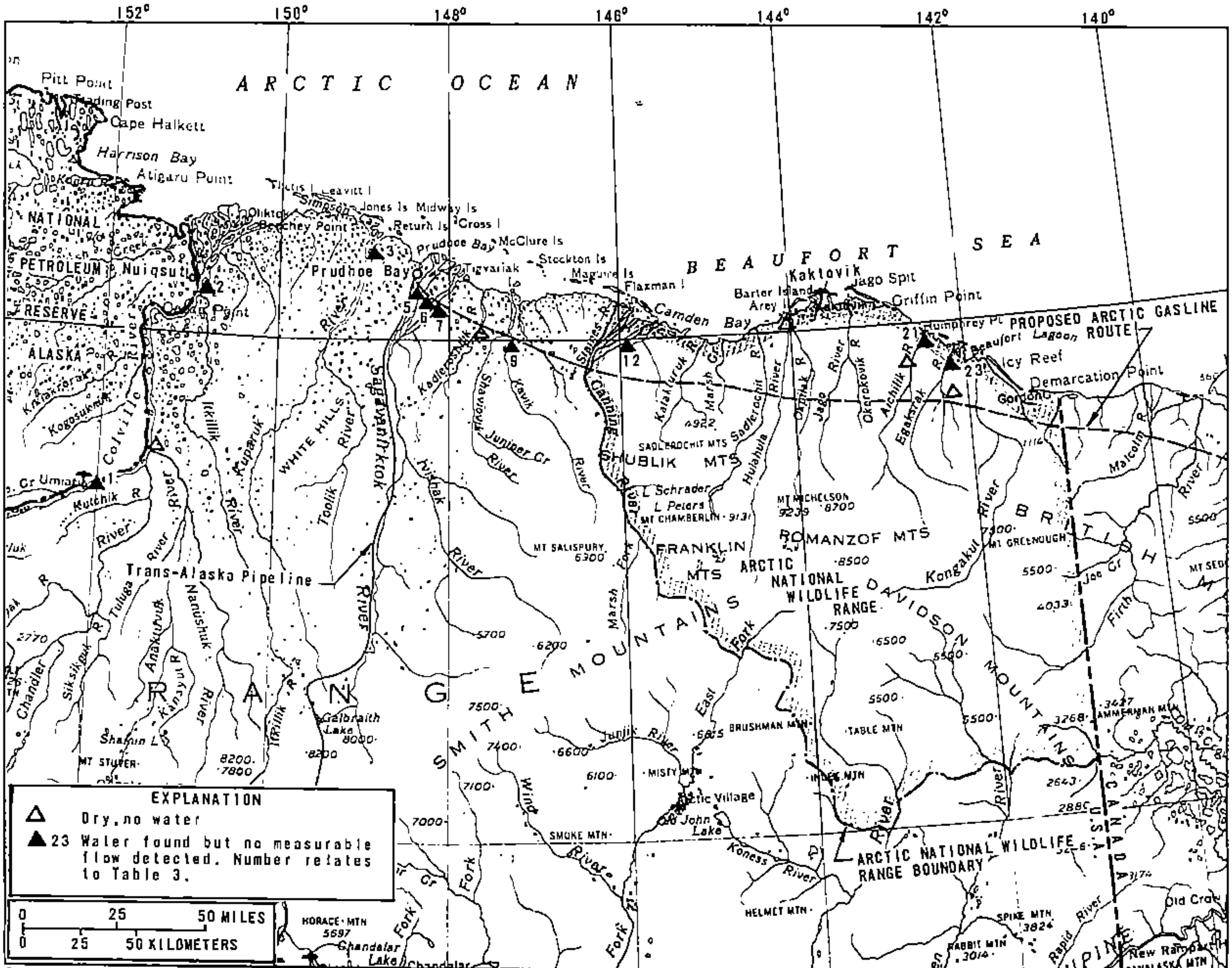
During the reconnaissance trip in August 1975, streamflow was fairly low and the stream water was clear. The only noticeable turbidity found was in the Katakturuk River and resulted from a rainstorm in its headwaters on the preceding day. The streams in the eastern Arctic Slope have extremely coarse beds which are well armored with gravel, cobbles, and boulders. Even the banks consist of coarse material. Thus clear water conditions are probably the rule rather than the exception. The chemical quality of water in streams sampled during the summer visit was remarkably similar to that of the springs sampled in the same basins. The difference between specific conductance values in streams and springs in the same basin averaged less than 10 percent.

Streams in the area are in a pristine natural state. The locations of streams sampled are shown in figure 26 and water-quality data are shown in table 3. Dissolved oxygen is at or near saturation during open-water flow and becomes reduced only in stagnant pools under ice cover. Water temperature in August ranged from 2.7°C in the Katakturuk River to 9.8°C in the Colville; it averaged 6°C for the 14 streams measured. Except for the Turner and Colville Rivers, the streams sampled were virtually colorless.

LAKES

There are numerous shallow thaw lakes in the coastal plain region between the Colville and the Canning Rivers. To the east of the Canning River the area is fairly well drained; it has low rolling uplands and very few lakes. The locations of the lakes sampled are shown in figure 27. Most of the lakes in the coastal plain range from 3 to 6 ft (1 to 2 m) in depth and freeze to the bottom. Water depth listed in table 4 is the total depth of the lake at the point of sampling. Dissolved solids in the water of shallow lakes that do not freeze to the bottom become concentrated during the winter so that the water is unusable for most purposes bu late winter. Ice on Barter Island Lake was about 6 ft (2 m) thick in April 1975, leaving about 0.5 ft (0.2 m) effective depth beneath the ice. At that time the water had a specific conductance of 7,130 micromhos/cm at 25 °C and contained 1,600 mg/L of

Figure 24.-- Ice drilling on the Colville River near Nuiqsut, April 25, 1975. Ice thickness is about 7.3 ft (2.2 m).



Base from U.S. Geological Survey Alaska map E

Base from U.S.Geological Survey Alaska map E

Figure 26.--Stream-sampling sites for water quality and channel geometry data.

Table 3.--*Dissolved chemical constituents and physical parameters for streams, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

Map No. from fig. 26	1	2		3	4
Station name	Colville R nr Umiat	Colville R nr Nuiqsut		Kuparuk R nr Deadhorse	Sagavanirktok R nr Sagwon
Latitude	69°21'45"	70°09'56"		70°16'54"	68°05'15"
Longitude	152°05'40"	150°55'00"		148°57'35"	148°45'10"
Date	04-19-75	04-29-75	08-14-75	04-29-75	04-20-75
Time	16:30	09:30	12:15	11:30	12:00
Discharge (ft^3/s)	0	0	12,700	0	1.2
Silica	3.3	4.0	2.1	4.4	2.7
Iron (μg/L)	--	--	20	--	--
Manganese (μg/L)	--	--	0	--	--
Calcium	44*	117*	22	93*	62*
Magnesium	--	--	5.0	--	--
Sodium	3.9	160	2.5	4.6	3.5
Potassium	1.1	6.1	0.6	1.3	0.5
Bicarbonate	134	198	78	246	180
Carbonate	--	--	0	--	--
Alkalinity, total ($CaCO_3$)	--	--	64	--	--
Sulfate	23	65	9.5	4.8	12
Chloride	1.0	290	1.5	4.1	1.0
Fluoride	0.0	0.1	0.1	0.0	0.2
Nitrate and nitrite as N	0.55	0.29	0.09	0.01	0.19
Orthophosphorus as P	0.01	0.00	0.00	0.03	0.00
Dissolved solids (sum of determined constituents)	--	--	82	--	--
Hardness, total	110	292	76	--	156
Non-carbonate hardness	--	--	12	--	--
Specific conductance (micromhos/cm at 25°C)	238	1,520	160	426	310
pH (units)	6.9	7.5	8.1	7.5	8.0
Water temperature (°C)	0.0	1.0	10.0	0.0	0.5
Color (platinum-cobalt units)	0	0	10	0	0
Turbidity (Jackson Turbidity units)	2	2	1.5	--	1
Dissolved oxygen	3.6	14.4	11.3	1.4	6.7
Total organic carbon	4.2	5.7	3.6	16	--

Table 3.--*Dissolved chemical constituents and physical parameters for streams, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

Map No. from fig. 26	5	6	7	8
Station name	Sagavanirktok R W Chnl nr Deadhorse	Sagavanirktok R W br of E Chnl	Sagavanirktok R E br of E Chnl	Shaviovik R
Latitude	70°12'16"	70°09'38"	70°09'22"	70°05'07"
Longitude	148°24'10"	148°10'43"	148°08'38"	147°16'30"
Date	11-11-75	11-11-75	11-11-75	08-13-75
Time	--	--	--	09:00
Discharge (ft^3/s)	0	0	0	E335
Silica	3.7	3.4	2.7	--
Iron (µg/L)	--	--	--	--
Manganese (µg/L)	--	--	--	--
Calcium	--	--	--	81*
Magnesium	--	--	--	--
Sodium	2.1	0.9	1.2	--
Potassium	0.2	0.1	0.2	--
Bicarbonate	257	126	114	110
Carbonate	--	--	--	--
Alkalinity, total ($CaCO_3$)	--	--	--	--
Sulfate	30	17	25	--
Chloride	3.2	0.8	1.4	--
Fluoride	--	--	--	--
Nitrate and nitrite as N	0.24	0.16	0.21	--
Orthophosphorus as P	0.00	0.00	0.00	--
Dissolved solids (sum of determined constituents)	--	--	--	--
Hardness, total	--	--	--	--
Non-carbonate hardness	--	--	--	--
Specific conductance (micromhos/cm at 25°C)	400	--	330	235
pH (units)	7.7	7.7	6.8	7.6
Water temperature (°C)	0.0	0.0	0.0	8.0
Color (platinum-cobalt units)	--	--	--	5
Turbidity (Jackson Turbidity units)	--	--	--	.25
Dissolved oxygen	--	--	--	12
Total organic carbon	5.5	--	--	4.2

*Calcium and magnesium (calculated as calcium)

Table 3.--*Dissolved chemical constituents and physical parameters for streams, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

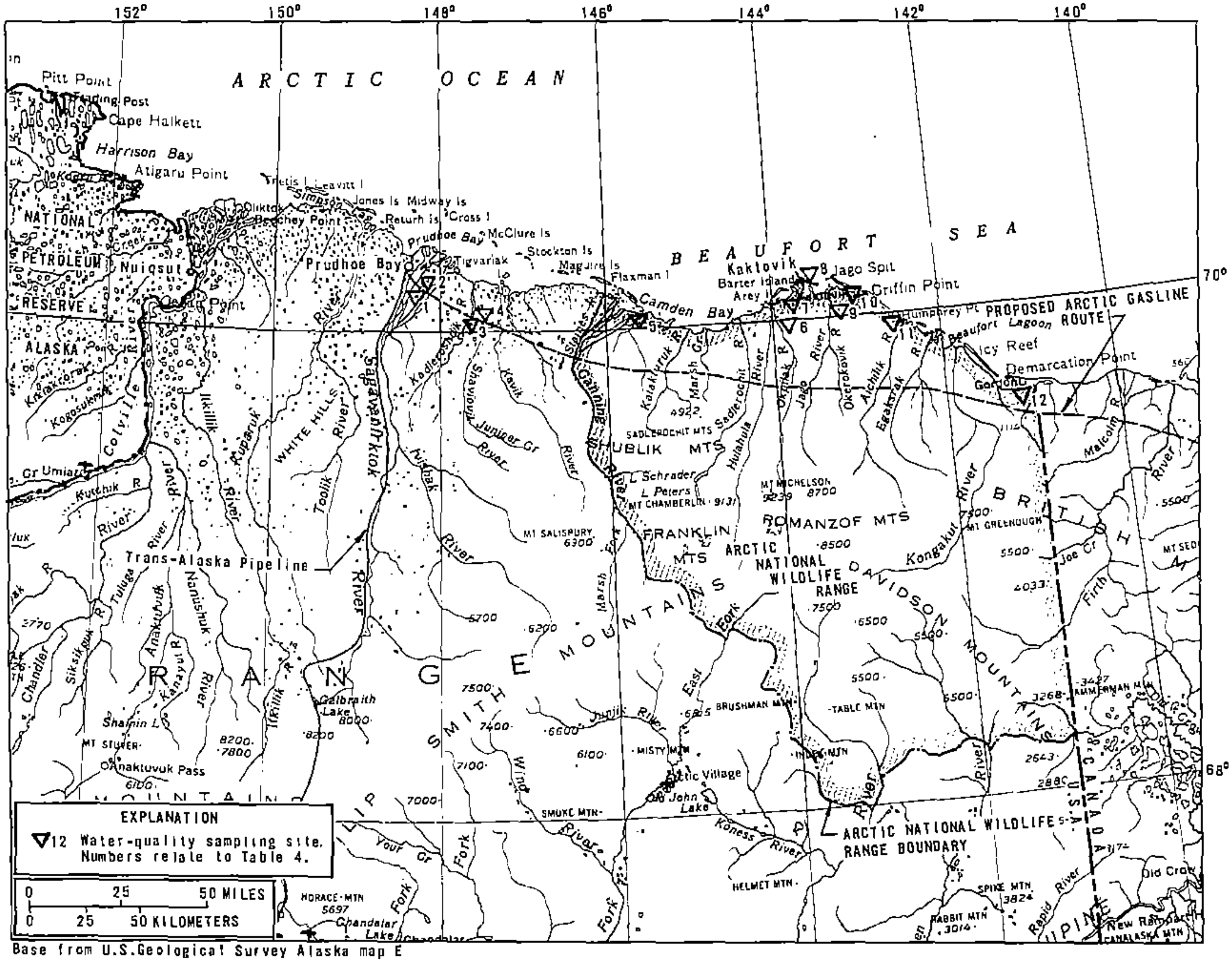
Map No. from fig. 26	9	10	11	12	13	14
Station name	Kavik R nr Deadhorse	Canning R nr Kaktovik	Canning R	Canning R delta E Chnl	Katakturuk R	Marsh Cr
Latitude	70°01'50"	69°48'29"	69°50'38"	70°04'38"	69°52'25"	69°47'33"
Longitude	147°18'05"	146°23'25"	146°27'10"	145°42'35"	145°12'00"	144°49'00"
Date	08-13-75	11-08-75	08-12-75	11-30-75	08-10-75	08-10-75
Time	--	--	16:00	--	09:30	12:30
Discharge (ft^3/s)	0	228	E2500	0	E400	E15
Silica	2.5	2.6	--	2.3	--	--
Iron (µg/L)	--	--	--	--	--	--
Manganese (µg/L)	--	--	--	--	--	--
Calcium	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--
Sodium	1.8	1.5	--	1.4	--	--
Potassium	0.4	0.2	--	0.3	--	--
Bicarbonate	165	162	107	123	120	112
Carbonate	--	--	--	--	--	--
Alkalinity, total ($CaCO_3$)	--	--	--	--	--	--
Sulfate	28	31	--	34	--	--
Chloride	1.6	1.3	--	0.9	--	--
Fluoride	--	--	--	--	--	--
Nitrate and nitrite as N	0.18	0.12	--	0.15	--	--
Orthophosphorus as P	0.01	0.00	--	0.01	--	--
Dissolved solids (sum of determined constituents)	--	--	--	--	--	--
Hardness, total	--	--	--	--	--	--
Non-carbonate hardness	--	--	--	--	--	--
Specific conductance (micromhos/cm at 25°C)	390	320	240	--	250	425
pH (units)	7.2	7.7	7.7	6.7	7.8	7.5
Water temperature (°C)	0.0	0.0	9.0	0.0	3.0	3.5
Color (platinum-cobalt units)	--	--	5	--	5	5
Turbidity (Jackson Turbidity units)	--	--	1.3	--	20	2
Dissolved oxygen	--	--	11.8	--	13.2	12.2
Total organic carbon	--	--	27	8.9	3.7	6.0

Table 3.--*Dissolved chemical constituents and physical parameters for streams, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

Map No. from fig. 26	15	16	17	18	19	20
Station name	Sadlerochit R nr Kaktovik	Hulahula R	Jago R	Okerokovik R	Aichilik R	Aichilik R site 2 nr Kaktovik
Latitude	69°39'13"	69°41'47"	69°50'38"	69°42'07"	69°35'23"	69°40'30"
Longitude	144°22'56"	144°12'10"	146°27'10"	143°14'23"	142°58'03"	142°46'52"
Date	08-07-75	08-07-75	08-08-75	08-08-75	08-11-75	11-25-75
Time	16:00	09:30	09:00	14:00	09:30	--
Discharge (ft^3/s)	--	739	267	85.2	E800	0
Silica	--	--	--	--	--	3.0
Iron (µg/L)	--	--	--	--	--	--
Manganese (µg/L)	--	--	--	--	--	--
Calcium	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--
Sodium	--	--	--	--	--	1.6
Potassium	--	--	--	--	--	0.5
Bicarbonate	50	76	70	123	96	180
Carbonate	--	--	--	--	--	--
Alkalinity, total ($CaCO_3$)	--	--	--	--	--	--
Sulfate	--	--	--	--	--	45
Chloride	--	--	--	--	--	0.9
Fluoride	--	--	--	--	--	--
Nitrate and nitrite as N	--	--	--	--	--	0.19
Orthophosphorus as P	--	--	--	--	--	0.24
Dissolved solids (sum of determined constituents)	--	--	--	--	--	--
Hardness, total	--	--	--	--	--	--
Non-carbonate hardness	--	--	--	--	--	--
Specific conductance (micromhos/cm at 25°C)	155	210	193	275	235	370
pH (units)	7.1	7.5	7.7	7.5	7.5	7.2
Water temperature (°C)	7.0	4.0	4.5	8.0	3.5	0.0
Color (platinum-cobalt units)	--	5	5	5.0	5	--
Turbidity (Jackson Turbidity units)	0.25	2	1	0.0	1	--
Dissolved oxygen	11.6	12.9	12.8	11.6	12.9	--
Total organic carbon	3.8	5.7	6.6	14	1.8	--

Table 3.--*Dissolved chemical constituents and physical parameters for streams, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

Map No. from fig. 26	21	22	23	24	25	26
Station name	Aichilik R nr mouth	Egaksrak R	Egaksrak R nr mouth	Ekaluakat R	Kongakut R	Turner R
Latitude	69°48'50"	69°32'05"	69°48'47"	69°34'35"	69°30'54"	69°35'56"
Longitude	142°10'00"	142°41'05"	142°05'23"	142°18'38"	141°42'34"	141°24'10"
Date	11-23-75	08-11-75	11-23-75	08-09-75	08-09-75	08-09-75
Time	--	12:00	--	16:00	09:00	13:30
Discharge (ft^3/s)	0	E500	0	101	E2000	227
Silica	5.5	--	5.0	--	--	--
Iron (µg/L)	--	--	--	--	--	--
Manganese (µg/L)	--	--	--	--	--	--
Calcium	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--
Sodium	4.2	--	15	--	--	--
Potassium	0.6	--	0.7	--	--	--
Bicarbonate	296	84	139	146	110	150
Carbonate	--	--	--	--	--	--
Alkalinity, total ($CaCO_3$)	--	--	--	--	--	--
Sulfate	84	--	41	--	--	--
Chloride	5.1	--	23	--	--	--
Fluoride	--	--	--	--	--	--
Nitrate and nitrite as N	0.37	--	0.40	--	--	--
Orthophosphorus as P	0.00	--	0.00	--	--	--
Dissolved solids (sum of determined constituents)	--	--	--	--	--	--
Hardness, total	--	--	--	--	--	--
Non-carbonate hardness	--	--	--	--	--	--
Specific conductance (micromhos/cm at 25°C)	700	175	--	325	250	305
pH (units)	7.2	7.5	6.8	7.7	7.7	7.6
Water temperature (°C)	0.0	5.5	0.0	6.5	6.5	6.5
Color (platinum-cobalt units)	--	5	--	5	5	10
Turbidity (Jackson Turbidity units)	--	0	--	1	1	0
Dissolved oxygen	--	12.2	--	11.6	11.9	11.7
Total organic carbon	--	7.9	--	1.8	2.4	6.7



Base from U.S.Geological Survey Alaska map E

Figure 27.--Location of lakes sampled for water quality.

Table 4.--*Dissolved chemical constituents and physical parameters for lakes, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

Map No. from fig. 27	1		2	3	4
Station name	Unnamed Lake nr Deadhorse		Unnamed Lake nr Deadhorse	Unnamed Lake nr Kadlerochilik R	Unnamed Lake nr Kadlerochilik R
Latitude	70°11'00"		70°12'30"	70°04'30"	70°06'10"
Longitude	148°12'46"		148°10'30"	147°42'10"	147°30'50"
Date	08-13-75	11-10-75	11-08-75	11-10-75	11-10-75
Time	11:30	--	--	--	--
Water depth	1.6	--	4.0	2.2	2.5
Ice thickness	2.2	--	1.5	2.6	2.5
Silica	0.3	0.2	0.0	0.0	0.0
Iron (µg/L)	20	--	--	--	--
Manganese (µg/L)	0	--	--	--	--
Calcium	40	--	--	--	--
Magnesium	3.5	--	--	--	--
Sodium	9.9	23	28	11	8.2
Potassium	1.0	1.7	0.9	0.6	0.2
Bicarbonate	113	122	102	125	80
Carbonate	0	--	--	--	--
Alkalinity, total ($CaCO_3$)	84	--	--	--	--
Sulfate	1.1	3.6	5.1	2.4	2.4
Chloride	26	64	85	69	68
Fluoride	0.1	--	--	--	--
Nitrate and nitrite as N	0.02	0.08	0.07	0.04	0.07
Orthophosphorus as P	0.00	0.04	0.02	0.01	0.01
Dissolved solids (sum of determined constituents)	132	--	--	--	--
Hardness, total	110	--	--	--	--
Non-carbonate hardness	31	--	--	--	--
Specific conductance (micromhos/cm at 25°C)	275	--	--	510	372
pH (units)	7.6	6.7	6.8	6.7	7.5
Water temperature (°C)	9.0	0.0	0.0	0.0	0.0
Color (platinum-cobalt units)	15	--	--	--	--
Turbidity (Jackson Turbidity units)	3.5	--	--	--	--
Dissolved oxygen	11.4	--	--	--	--
Total organic carbon	9.4	8.5	--	--	--

Table 4.--*Dissolved chemical constituents and physical parameters for lakes, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

Map No. from fig. 27	5	6	7	8	
Station name	Unnamed Lake nr Canning R Delta	Unnamed Lake nr Kaktovik	Unnamed Lake nr Kaktovik	Barter Island Lake	
Latitude	70°01'37"	69°59'55"	70°03'13"	70°07'15"	
Longitude	145°31'26"	143°43'51"	143°43'51"	143°38'18"	
Date	11-30-75	11-22-75	11-25-75	08-18-72	04-27-75
Time	11:30				22:00
Water depth	3.5	2.6	3.0	--	0.5
Ice thickness	3.8	3.6	3.2	--	6.0
Silica	0.0	0.0	0.0	2.1	0.0
Iron (µg/L)	--	--	--	.01	--
Manganese (µg/L)	--	--	--	.00	--
Calcium	--	--	--	35	--
Magnesium	--	--	--	13	--
Sodium	4.7	5.0	3.7	46	800
Potassium	0.2	0.6	0.2	2.1	15
Bicarbonate	44	53	26	97	--
Carbonate	--	--	--	--	--
Alkalinity, total ($CaCO_3$)	--	--	--	--	--
Sulfate	1.8	2.6	1.8	3.1	16
Chloride	11	11	8.9	120	1600
Fluoride	--	--	--	0.1	0.3
Nitrate and nitrite as N	.06	0.06	0.00	0.02	0.03
Orthophosphorus as P	0.02	0.01	0.09	--	0.07
Dissolved solids (sum of determined constituents)	--	--	--	270	--
Hardness, total	--	--	--	140	--
Non-carbonate hardness	--	--	--	61	--
Specific conductance (micromhos/cm at 25°C)	106	115	96	543	7,130
pH (units)	7.1	7.4	7.1	7.0	7.3
Water temperature (°C)	0.0	0.0	0.0	--	--
Color (platinum-cobalt units)	--	--	--	--	--
Turbidity (Jackson Turbidity units)	--	--	--	--	--
Dissolved oxygen	--	--	--	--	--
Total organic carbon	--	--	--	40	--

*Calcium & Magnesium (calculated as carbon)

Table 4.--*Dissolved chemical constituents and physical parameters for lakes, eastern Arctic Slope (all constituents reported in mg/L unless otherwise specified).*

Map No. from fig. 27	9	10	11	12
Station name	Unnamed Lake nr Jago R	Unnamed Lake nr Jago R	Unnamed Lake nr Aichilik	Unnamed Lake nr Demarcation Point
Latitude	70°02'10"	70°04'50"	69°49'50"	69°38'10"
Longitude	143°13'40"	143°10'00"	142°07'15"	141°04'30"
Date	11-17-75	11-17-75	11-24-75	11-18-75
Time	--	--	--	--
Water depth	4.8	7.2	7.3	4.2
Ice thickness	2.7	2.8	3.4	2.8
Silica	0.0	0.3	0.1	0.0
Iron (μg/L)	--	--	--	--
Manganese (μg/L)	--	--	--	--
Calcium	--	--	--	--
Magnesium	--	--	--	--
Sodium	5.4	16	35	3.5
Potassium	0.8	0.4	1.2	0.1
Bicarbonate	32	29	147	69
Carbonate	--	--	--	--
Alkalinity, total ($CaCO_3$)	--	--	--	--
Sulfate	1.3	2.0	1.8	1.8
Chloride	11	57	69	6.9
Fluoride	--	--	--	--
Nitrate and nitrite as N	0.04	0.09	0.02	0.02
Orthophosphorus as P	0.02	0.01	0.01	0.00
Dissolved solids (sum of determined constituents)	--	--	--	--
Hardness, total	--	--	--	--
Non-carbonate hardness	--	--	--	--
Specific conductance (micromhos/cm at 25°C)	80	280	--	170
pH (units)	6.9	7.1	6.8	7.6
Water temperature (°C)	0.0	0.0	0.0	0.0
Color (platinum-cobalt units)	--	--	--	--
Turbidity (Jackson Turbidity units)	--	--	--	--
Dissolved oxygen	--	--	--	--

dissolved chloride and 800 mg/L of dissolved sodium. Total organic carbon was measured at 40 mg/L. A sample taken on August 18, 1972, from the lake on Barter Island had a specific conductance of 543 micromhos and contained 120 mg/L of dissolved chloride and 46 mg/L of dissolved sodium.

Lakes near the coast tend to have higher sodium and chloride concentrations than lakes farther inland, presumably because of aerosols derived from the nearby Beaufort Sea.

AQUATIC INVERTEBRATES

Aquatic invertebrates were collected during April and August 1975 trips, but no collections were made during the November 1975 trip.

Biological sampling was conducted at 8 spring sites during the April trip. Ten-rock samples were collected from all springs except Red Hill springs where only a 2-rock sample was collected because of the abundance of organisms present. Drift net samples were obtained from the Katakturuk River tributary spring and Kongakut River spring along the delta.

During the August trip, 2 springs and 10 stream sites were sampled. Drift net samples were taken at all sites, except for Sadlerochit Spring. Surber samples were collected from Sadlerochit Spring and the Ekaluakat River.

Five Surber samples from Sadlerochit Spring and four from the Ekaluakat River were collected. Each sample was collected from a different area, thus making up a diverse set of samples for the site; the data was then arranged for the site.

Each rock sample consisted of 10 rocks ranging from about 6 to 12 in (150 to 300 mm) in diameter collected at random in the vicinity of the spring source. The method of collection of organisms from rocks is described in Nauman and Kernodle (1974).

Drift-net samples were taken with a modified Surber stream-bottom sampler used as a drift net. Use of the Surber sampler is described by Slack and others (1973). A drift net site in the Ekaluakat icing is shown in figure 28. A 1-hour drift-net collection was obtained from an area of swift flow at each of the stream sites sampled. The drift net, made of nylon screen cloth netting with a 210-μ mesh, had a 12x12-in (305 x 305-mm) opening which was held perpendicular to the current by rods driven into the streambed. The bottom of the net frame was in contact with the streambed and the top extended above the water surface in order to collect the surface film. Drift-net samples do not collect all the taxa present; however, this method has proven to be a useful tool for comparing biological communities in streams. It should be noted that not all streams visited were sampled for aquatic invertebrates.

The samples collected from the Kongakut River, Egaksrak River, Sadlerochit Spring, and Red Hill spring contained greater numbers of aquatic invertebrates and more taxa (table 5) than the other sites sampled. Diptera (two-winged insects), mostly Chironomidae (midges), were the most abundant aquatic invertebrates collected, comprising from 10 to 100 percent of the samples (table 5). Red Hill spring had the

Figure 28.-- Biological-sampling site in Ekaluakat icing, July 1975.

Table 5a.--*Occurrence of aquatic invertebrates in percent of sample at each spring site.* P = present but constituting less than 1 percent of sample

Map No. from fig. 20	4	8		9		10	
Station name	Flood Creek spring	Red Hill spring		Katakturuk R trib. spring		Sadlerochit spring	
Collection date	4/20/75	4/28/75	8/12/75	4/22/75	4/22/75	4/27/75	8/7/75
Sample type	10-rock	2-rock	drift	10-rock	drift	10-rock	*Surber
Worms:							
Nematoda - round worms	74	--	P	P	--	1	1
Oligochaeta - aquatic worms	3	--	P	P	2	2	2
Turbellaria - flat worms	P	--	--	--	--	P	P
Crustacea:							
Amphipoda - fairy shrimp	--	--	1	--	--	1	3
Cladocera - water fleas	--	--	10	--	--	--	--
Copepoda - copepods	3	--	2	--	--	P	2
Ostracoda - seed shrimp	2	--	--	--	--	--	18
Mollusca:							
Gastropoda - snails	--	--	--	--	--	1	P
Pelecypoda - clams	--	--	--	--	--	--	15
Immature Insecta:							
Diptera - two-winged insects	--	--	--	--	--	--	--
Anthomyiidae - anthomyiids	--	--	--	--	--	--	P
Chironomidae - midges	10	>99	81	89	95	81	50
Empidae - dance flies	--	--	P	--	--	--	P
Ephydridae - Shore flies			P				
Phoridae - hump-backed flies	--	--	--	--	--	--	--
Simuliidae - black flies	--	--	--	P	--	--	P
Syrphidae - flower flies	--	--	P	--	--	--	--
Psychodidae - moth flies	--	--	P	--	--	P	P
Tipulidae - crane flies	--	P	P	P	1	1	P
Ephemeroptera - mayflies	--	--	2	4	1	P	1
Plecoptera - stoneflies	6	--	--	P	--	8	3
Trichoptera - caddisflies	1	--	--	5	--	4	3
Miscellaneous organisms:							
Coleoptera - beetles	--	--	P	--	--	--	P
Collembola - springtails	1	--	P	--	--	--	P
Acarina - mites	P	--	1	--	--	P	1
Total aquatic invertebrates collected	854	6,569	10,456	1,496	225	3,620	1,629
Number of taxa collected per sample	10	2	15	8	4	13	20
Total taxa collected per station	10		15		8		20

*Average of 5 Surber samples

Table 5a.--*Occurrence of aquatic invertebrates in percent of sample at each spring site.* P= present but constituting less than 1 percent of sample

Map No. from fig. 20	11	13	14	16	
Station name	Hulahula R spring	Aichilik R spring	Ekaluakat R. spring	Kongakut River spring above delta	
Collection date	4/28/75	4/27/75	4/22/75	4/27/75	4/27/75
Sample type	10-rock	10-rock	10-rock	10-rock	drift
Worms:					
Nematoda - round worms	--	--	6	--	--
Oligochaeta - aquatic worms	--	--	1	P	2
Turbellaria - flat worms	--	--	--	--	--
Crustacea:					
Amphipoda - fairy shrimp	--	--	5	--	--
Cladocera - water fleas	--	--	--	--	--
Copepoda - copepods	--	--	15	--	--
Ostracoda - seed shrimp	--	--	5	--	--
Mollusca:				--	--
Gastropoda - snails	--	--	--	--	--
Pelecypoda - clams	--	--	--	--	--
Immature Insecta:					
Diptera - two-winged insects	--	--	--	--	--
Anthomyiidae - anthomyiids	--	--	--	--	--
Chironomidae - midges	95	95	58	99	95
Empidae - dance flies	--	--	--	--	--
Phoridae - hump-backed flies	--	--	--	--	--
Simuliidae - black flies	--	--	--	--	--
Syrphidae - flower flies	--	--	--	--	--
Psychodidae - moth flies	--	--	--	--	--
Tipulidae - crane flies	--	--	P	P	1
Ephemeroptera - mayflies	2	4	6	--	1
Plecoptera - stoneflies	3	1	3	--	--
Trichoptera - caddisflies	--	--	P	P	--
Miscellaneous organisms:					
Coleoptera - beetles	--	--	--	--	--
Collembola - springtails	--	--	--	--	--
Acarina - mites	--	--	P	--	--
Total aquatic invertebrates collected	1,199	1,098	649	1,872	225
Number of taxa collected per sample	3	3	11	5	4

Table 5b.--*Occurrence of aquatic invertebrates in percent of sample at each stream site.* P = present but constituting less than 1 percent of sample

Map No. from fig. 26	8	11	13	14	16	17	18
Station name	Shaviovik River	Canning River	Katakturuk River	Marsh Creek	Hulahula River	Jago River	Okerokovik River
Collection date	8/13/75	8/12/75	8/10/75	8/10/75	8/7/75	8/8/75	8/8/75
Sample type	drift	drift	drift	drift	drift	drift	drift
Worms:							
Nematoda - round worms	--	--	--	--	--	P	--
Oligochaeta - aquatic worms	--	--	1	P	P	5	3
Turbellaria - flat worms	--	--	--	--	P	P	--
Crustacea:							
Amphipoda - fairy shrimp	--	--	--	--	--	--	8
Cladocera - water fleas	1	--	--	--	--	--	--
Copepoda - copepods	15	3	6	2	P	1	3
Ostracoda - seed shrimp	--	--	P	P	--	--	P
Mollusca:							
Gastropoda - snails	--	--	--	--	P	P	--
Pelecypoda - clams	--	--	--	--	--	--	--
Immature Insecta:							
Diptera - two-winged insects	--	--	--	--	--	--	--
Anthomyiidae - anthomyiids	--	--	--	--	--	--	--
Chironomidae - midges	41	90	20	41	67	53	32
Empidae - dance flies	--	--	2	P	P	2	P
Phoridae - hump-backed flies	--	--	--	--	--	--	--
Simulidae - black flies	P	P	4	--	22	19	1
Syrphidae - flower flies	--	--	--	--	--	--	--
Psychodidae - moth flies	--	--	--	P	--	--	--
Tipulidae - crane flies	2	4	1	3	P	--	3
Ephemeroptera - mayflies	10	1	32	36	5	8	7
Plecoptera - stoneflies	8	--	28	16	2	10	31
Trichoptera - caddisflies	P	--	--	--	--	--	--
Miscellaneous organisms:							
Coleoptera - beetles	P	--	P	P	--	--	P
Collembola - springtails	1	--	1	1	P	P	P
Acarina - mites	22	1	4	1	2	1	10
Total aquatic invertebrates collected	1,036	301	836	4,445	2,431	835	708
Number of taxa collected per sample	12	6	12	12	12	12	13
Total taxa collected per site							

Table 5b.--*Occurrence of aquatic invertebrates in percent of sample at each stream site.* P = present but constituting less than 1 percent of sample

Map No. from fig. 26	19	22	24		25	26
Station name	Aichilik River	Egaksrak River	Ekaluakat River		Kongakut River	Turner River
Collection date	8/11/75	8/11/75	8/9/75	8/9/75	8/9/75	8/9/75
Sample type	drift	drift	drift	**Surber	drift	drift
Worms:						
Nematoda - round worms	P	1	--	P	P	4
Oligochaeta - aquatic worms	3	1	4	40	--	--
Turbellaria - flat worms	--	P	--	--	--	--
Crustacea:						
Amphipoda - fairy shrimp	--	P	P	--	P	1
Cladocera - water fleas	P	P	--	--	--	--
Copepoda - copepods	1	2	2	--	--	3
Ostracoda - seed shrimp	--	P	--	3	1	2
Mollusca:						
Gastropoda - snails	--	--	--	--	--	--
Pelecypoda - clams	--	--	--	--	--	--
Immature Insecta:						
Diptera - two-winged insects	--	--	--	--	--	--
Anthomyiidae - anthomyiids	--	--	--	--	--	--
Chironomidae - midges	85	86	64	51	83	44
Empidae - dance flies	P	P	--	P	P	--
Phoridae - hump-backed flies	--	--	--	--	P	--
Simulidae - black flies	P	P	P	P	1	P
Syrphidae - flower flies	--	--	--	--	--	--
Psychodidae - moth flies	--	--	--	--	--	--
Tipulidae - crane flies	P	1	1	P	P	P
Ephemeroptera - mayflies	4	1	6	4	5	7
Plecoptera - stoneflies	4	5	16	1	6	36
Trichoptera - caddisflies	--	--	--	--	--	--
Miscellaneous organisms:						
Coleoptera - beetles	--	--	--	--	P	--
Collembola - springtails	P	1	P	1	P	P
Acarina - mites	1	1	6	P	2	3
Total aquatic invertebrates collected	997	815	804	501	2,038	1,046
Number of taxa collected per sample	12	15	10	11	13	11
Total taxa collected per site			13			

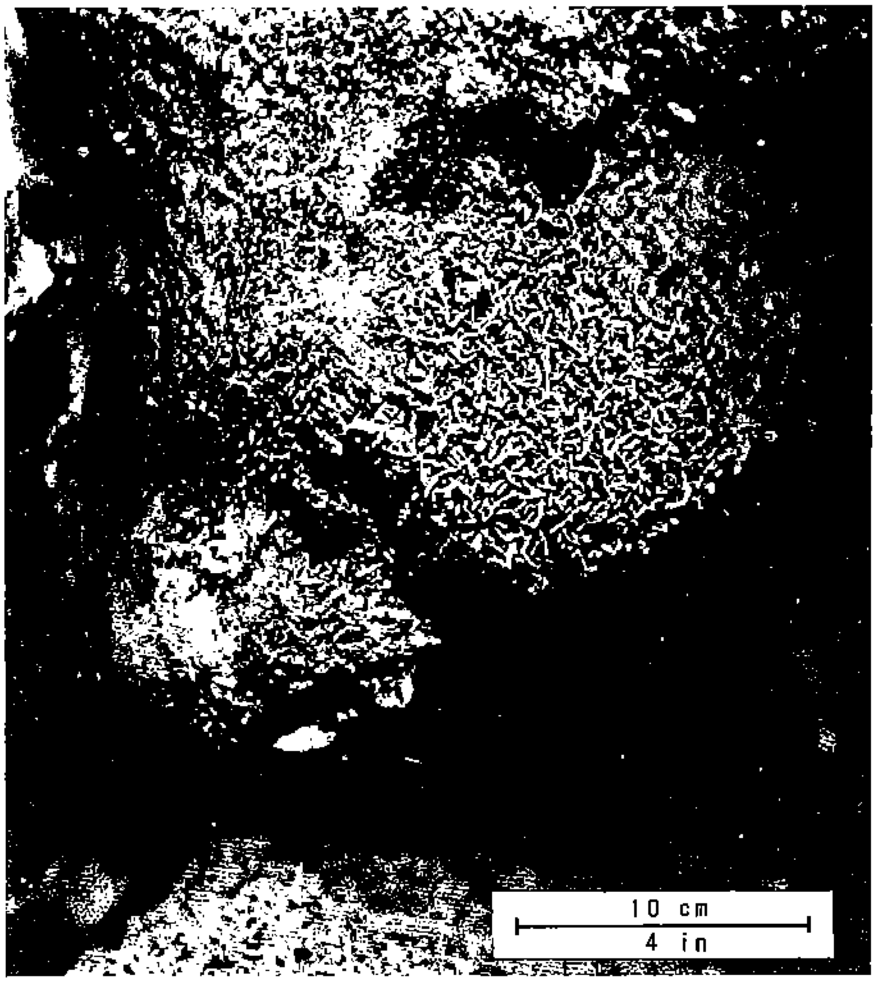


Figure 29.-- Midge larvae in Red Hill Spring; scale is approximate.

greatest number of invertebrates, the sample consisting of almost 100 percent midges and less than 1 percent crane flies. It also had the greatest organism density; midges there numbered approximately 92,900/ft^2 (1,000,000/m^2) (fig. 29). Because of the large number of midges present, only 2 rocks, each approximately 10 in (254 mm) in diameter, were collected

Red Hill Spring is unusual as it is a hot sulfur spring and only thermophilic algae are present near the water's source; however, aquatic invertebrates were collected approximately 600 ft (180 m) downstream where the individual small springs combine into a single main channel.

A photograph of a quiet pool at Saviukviayak tributary spring (fig. 30) indicates that aquatic invertebrate density may approach that of Red Hill spring. The aquatic invertebrate concentration at the Ekaluakat and Sadlerochit springs may be more representative of typical North Slope conditions. Organisms there numbered from 400 to 1,600/ft^2 (4,000 to 17,000/m^2), respectively.

Larger streams such as the Canning River are difficult to sample because of their size. The drift sample from the Canning River was collected in a shallow reach with slow flow; therefore, the six taxa collected may not be indicative of the drifting invertebrate populations in other parts of the river.

Although different methods of sampling were used during the two trips, it appears that total production and number of taxa were greater during summer. Furthermore, aquatic invertebrate production evidently is greater in springs with elevated water temperatures and with water that originates from bedrock.

Further sampling is needed in order to describe better the seasonal variation in aquatic invertebrate population; however, the samples collected provide a useful baseline for analyzing the aquatic invertebrate populations in the streams and springs sampled.

RECOMMENDATIONS FOR DATA COLLECTION SITES

The water resources of the Alaskan Arctic Slope are unique in the United States because of the climate and occurrence of continuous permafrost. The streams and perennial springs along the north flank of the Brooks Range are vital to the existing ecosystem and can be of significant value to man's use of the area. Construction on the fragile tundra vegetation poses an environmental problem. Permafrost decay caused by thermal alterations associated with construction or other activities can initiate erosion, the effects of which would be irreversible. This erosion would add sediment to the naturally low sediment load of the stream water. Further, the absence of flow during the long winters and the distribution of water in isolated pools beneath thick ice, place severe natural stresses on fish. Withdrawals of water or additions of polluted water to the limited receiving waters during winter could place intolerable stresses on and endanger the resident species. More information on the water resources of the North Slope is needed to assess the environmental impact of additional development. Monitoring of the water resources during man's use of the area may provide information useful in minimizing the impact.

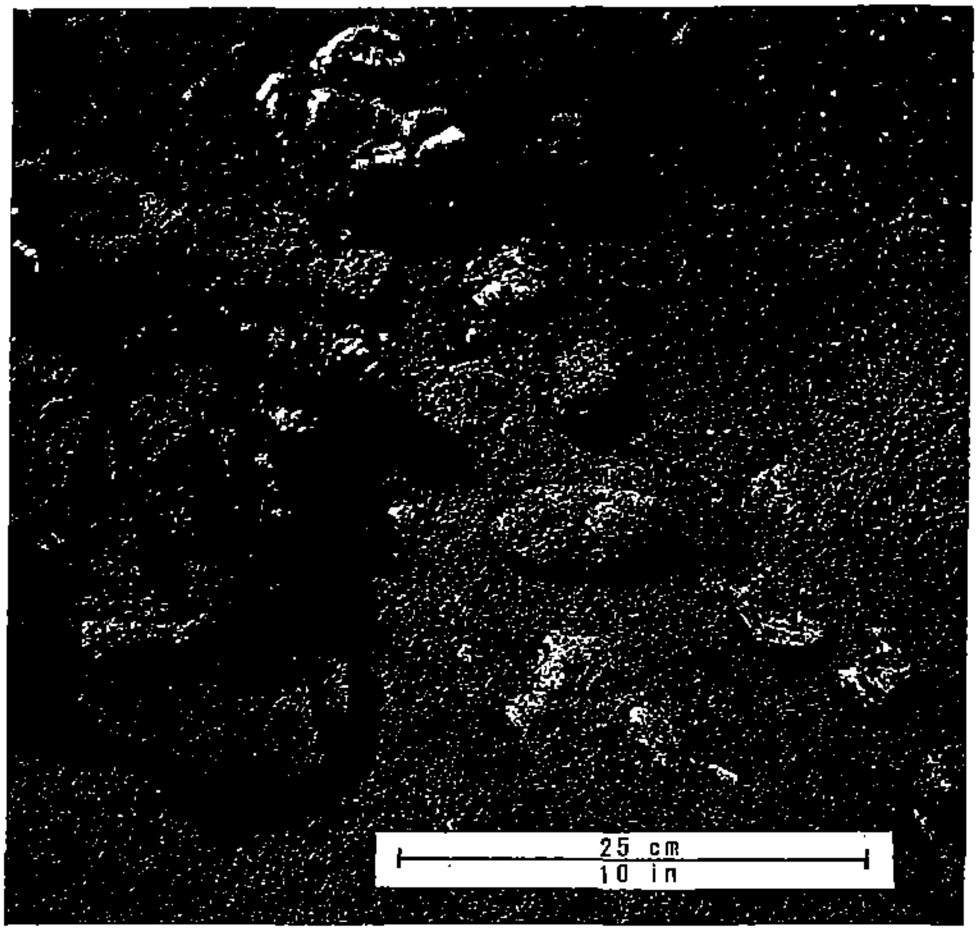


Figure 30.-- Aquatic invertebrates at Saviukviayak tributary springs, April, 1975; scale is approximate.

Twelve principal streams with drainage areas exceeding 1,000 mi^2 (2,600 km^2) drain into the Beaufort Sea from Alaska. Of these, six are in this reconnaissance study area and two are now (1976) being gaged (the Kuparuk River near Deadhorse and the Sagavanirktok River near Sagwon). The Kuparuk River gage provides a hydrographic record for a large basin primarily on the Arctic Coastal Plain and foothills, whereas the Sagavanirktok River gage provides a record for a basin primarily in the Brooks Range and Arctic foothills. On the basis of these records, a comparison of runoff from the mountains and lowlands in large streams is possible.

The Colville and Canning Rivers are streams which form parts of the natural boundaries of National Petroleum Reserve Alaska and the Arctic National Wildlife Range, respectively. The hydrocarbon fuel resource of the Colville River area may be developed in the future. Because the Colville River is the largest stream in arctic Alaska and drains a basin wholly in the continuous permafrost zone, a gaging station near its mouth would provide valuable records for improving the inventory of water resources in this region.

Streams

Few reaches on the principal streams on the eastern Alaska Arctic Slope offer acceptable sites for continuous streamflow data collection. However, acceptable sites were found on the Canning River near the Shublik Mountains, on the Hulahula River in the foothills of the Brooks Range, and on the Colville River at the head of its delta (fig. 2).

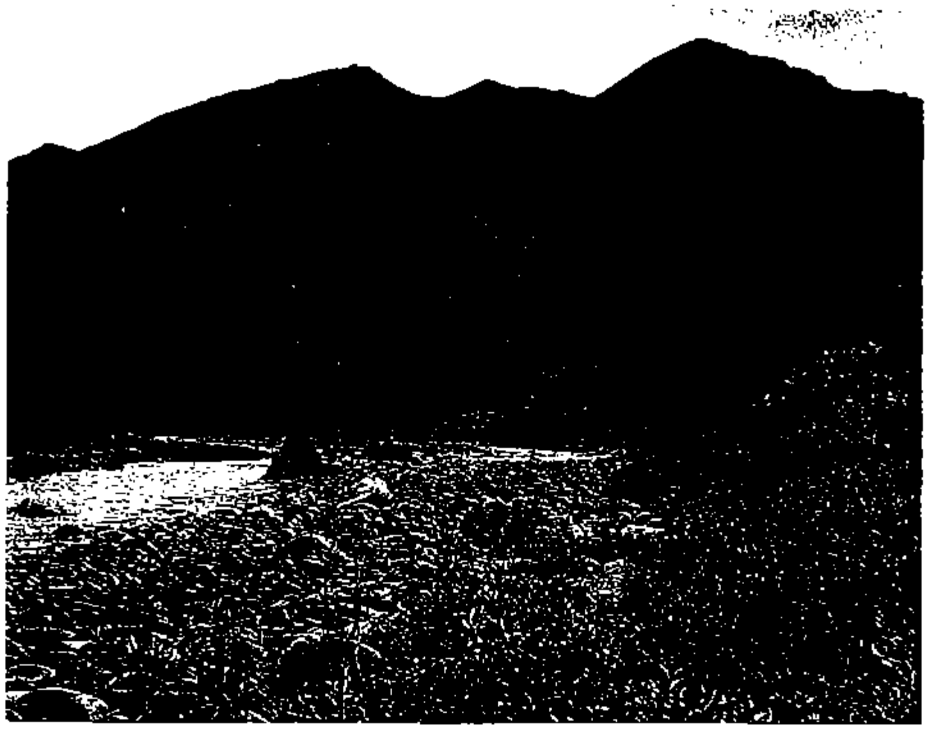
At the site on the Canning River the water is confined to one channel by steep banks of bedrock. The reach consists of pools and riffles (fig. 31). The streambed is composed of loose cobbles and sand and is subject to shifting. Conditions for streamflow measurements and water-quality sampling are acceptable for the open-water season. This site was not visited during the winter, but it probably is in an area of active aufeis (icing) formation and has little or no flow under ice.

An acceptable site for data collection on the Hulahula River is near a fishing and hunting camp traditionally used by the Eskimos from Kaktovik (fig. 32). The left bank at this site is steep bedrock that forms nearly vertical walls. The right bank is a low, vegetated terrace. The stream flows in one channel. The bed material is large cobbles and angular rocks and probably subject to minor shifting. Streamflow measurement and sampling conditions are acceptable for summer and winter. An alternative data-collection site on the Hulahula River (fig. 9) is downstream from that shown in figure 32 and is at the flood survey site.

A gage at the recommended site on the Hulahula River would measure the runoff from an area on the north flank of the eastern Brooks Range. No part of its basin is on the coastal plain. The Hulahula River is an important stream for the production of Arctic char.

The Colville River at the head of the delta has a short, straight reach (fig. 33) confined to a single channel. The channel is fairly uniform and bed material consists of silt, sand, and small gravel. The

Figure 31.-- Recommended data-collection site at Canning River near Shublik Island; view downstream, August 13, 1975.



32a.-- View upstream.

32b.-- View downstream.

Figure 32.-- Recommended data-collection site at Hulahula River at traditional fishing site, August 13, 1975.

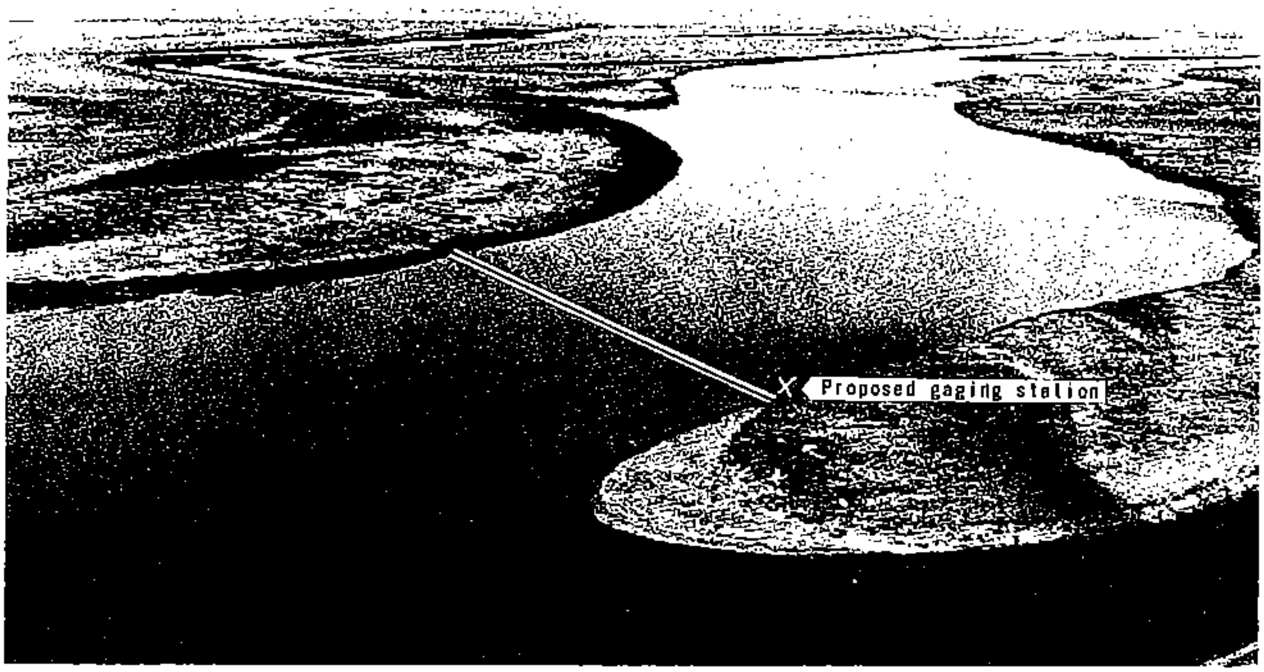


Figure 33.-- Recommended data-collection site on Colville River at head of delta near Nuiqsut, August 14, 1975.

banks are steep and high. This reach has a nearly flat slope and may be subject to wind tide during low flow in the summer. Water was found at this site in April, but no flow velocity could be detected. It is doubtful whether there is streamflow at this site in late winter. Conditions for streamflow measurements are acceptable for the open-water season.

The Hulahula and Colville Rivers are recommended as streams for long-term data collection. These data would facilitate calculation of the regional flood frequency, and analyses of quantity and quality of streamflow would be useful for present and future planning.

Springs

Springs are the primary source of streamflow during most of the winter on the North Slope. Discharge from the springs appears to be relatively stable, but their variability in flow is unknown at present. Acceptable sites for continuous data collection exist at Sadlerochit Spring (fig. 34), at Flood Creek springs, and at the Saviukviayak springs. These sites have similar characteristics. The channels are fairly uniform and straight, and the streambeds are composed of medium-size cobbles. Except for Flood Creek springs, there is no evidence of significant icing formation at the springs.

A data-collection site on the Saviukviayak springs (fig. 35) would best define local drainage because it has a small drainage area [about 32 mi^2 (83 km^2)] in the high foothill area. Therefore, important data on runoff characteristics as well as spring discharge could be obtained at one site.

Figure 34.-- Sadlerochit Spring at east end of Sadlerochit Mountains, April 27, 1975.

Figure 35a.-- Recommended data-collection site at Saviukviayak tributary spring, April 20, 1975.

Figure 35b.-- Aerial view of recommended stream-gaging site.

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