STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS

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Resource Evaluation Section

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Alaska Open File Report 26

GEOLOGY AND MINERAL EVALUATION OF THE ANIAKCHAK RIVER DRAINAGE, ALASKA PENINSULA

By
W.M. Lyle

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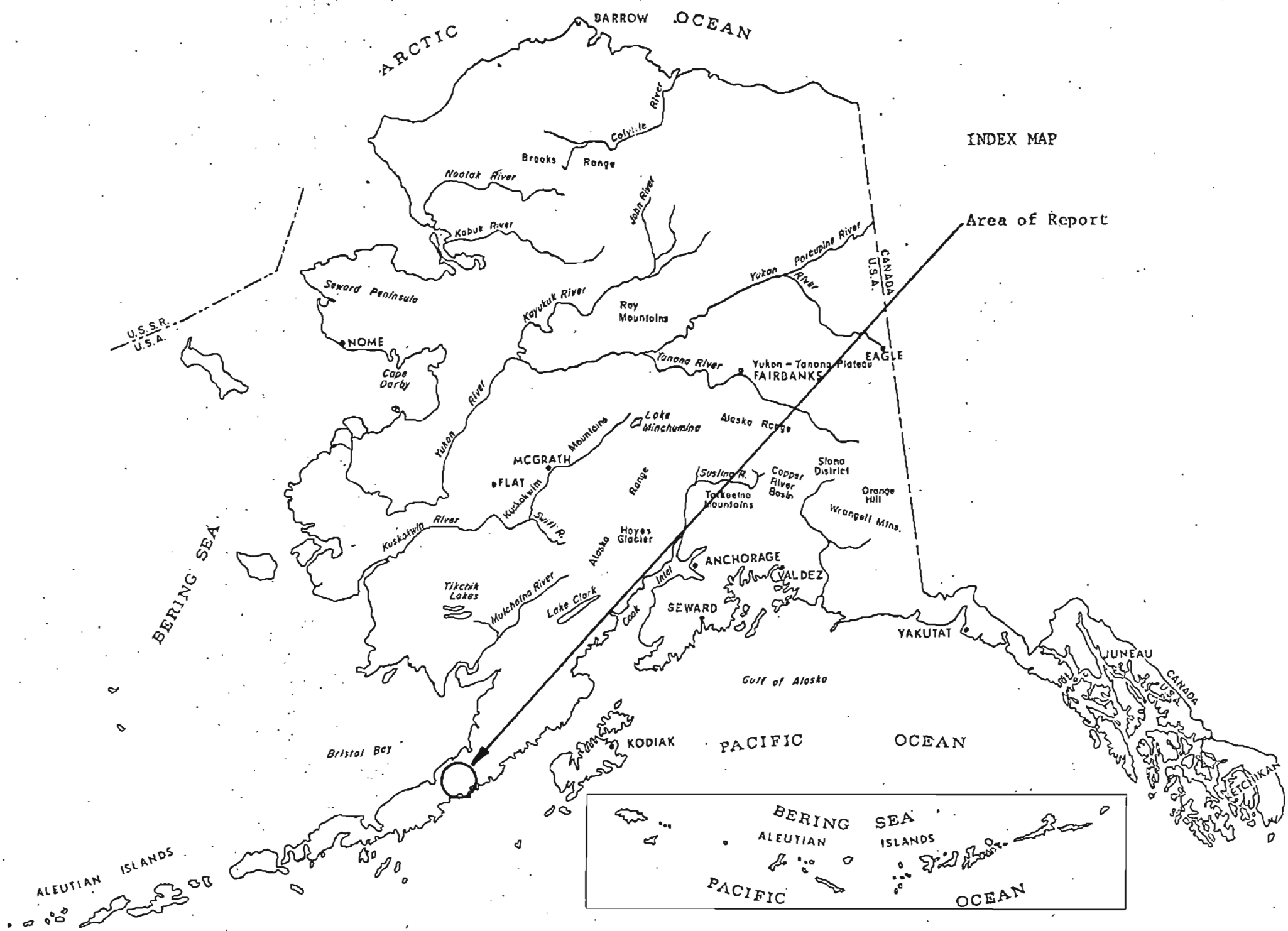
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INTRODUCTION AND SUMMARY

This report has been written to assist the Wild and Scenic River task force of the U. S. Bureau of Recreation in considering the suitability of certain priority Alaskan rivers for inclusion in the national system.

Geologic file research followed by field check and geochemical sampling will result in recommendations concerning the possible economic mineral areas of the river drainage. The final results and recommendations will be submitted as appendixes to this report before August 1973.

The Aniakchak River is located on the Alaska Peninsula east of Port Heiden. The river heads in the Aniakchak Crater at Surprise Lake and terminates in the Pacific Ocean at Aniakchak Bay. During this run of only 25 miles the river drops from an elevation of 1,055 feet to sea level. The river occupies a valley filled with Quaternary sediments and rocks ranging in age from Jurassic to Tertiary are present on both sides of the stream.

Recommendations

On the basis of existing data, no objections can be raised to classification of the river as wild or scenic under the national system. If geochemical sampling for mineral potential or geologic examination for petroleum possibilities this July reveal evidence of prospective areas, recommendations will be made immediately concerning these areas.

Geology

Regionally the gross structural trends are northeast-southwest. Sedimentary rocks ranging in age from Jurassic to Tertiary are cut by many volcanos.

The Aniakchak River flows out of Surprise Lake in Aniakchak Crater. This large (5 ½ mile wide) crater is built dominantly from Quaternary volcanic ash and lava flows. The river flows between outcrops of the Jurassic Naknek formation and the Jurassic/Cretaceous Staniukovich formation at the "the gates" where the river breaches the crater. The river then flows in Quaternary valley fill with protruding hills of Jurassic Naknek and Jurassic/Cretaceous Staniukovich rocks on either side for about six miles. Next the river winds through a 1/2 to three mile wide valley floor to the mouth, where it enters Aniakchak Bay. The tertiary Eocene Talstoi formation and Tertiary Oligocene? Meshik formation are present on both sides of the river in this zone. Pinnacle Mountain, 1 ½ miles south of the river is composed of Tertiary igneous intrusive rocks.

Jurassic Rocks

The Jurassic Naknek formation on the east side of Aniakchak Crater is composed of fine-grained arkosic sandstones and dark-gray siltstones. Smith and Barker (1924, p. 183-184). The Naknek and Jurassic/Cretaceous Staniukovich formation were recorded as one unit and no thichness has been estimated for it in this area. Exposures of the Naknek formation in the mountains above Chignik Bay are estimated to be as much as 6400 feet thick (Knappen, 1929, p. 182-180).

Jurassic/Cretaceous Rocks

The Jurassic/Cretaceous Staniukovich formation consists of fine - to medium-grained feldspathic sandstones and arkoses which weather tan or yellow brown. A section at Amber Bay, northeast of the mouth of the river has an exposed thickness of 500 ± feet but at least 1500 feet of Staniukovich is present a few miles east of Amber Bay. A section 2500 - 3000 feet thick

on the south flank of Aniakchak Crater includes both Stanlukovich and Naknek formations. Smith and Baker (1924, p. 183-184) and Knappen (1929, p. 186).

Tertiary Rocks

The Paleocene or possibly Eocene Tolstol formation consists of black siltstone and shale with interbedded fine - to coarse-grained, poorly sorted volcanic sandstones and volcanic conglomerates. The upper part of the unit contains more volcanic conglomerates, a few sills, and possible lava flows. On the south flank of Aniakchak Crater, the Tolstol rocks rest upon the Lower Cretaceous Stanlukovich formation.

Throughout the area, the Tolstol formation is conformably overlain by the coarse volcanic debris of the Meshik formation or by isolated unconformable deposits of Pliocene volcanic rocks.

The name Meshik formation was proposed by Knappen (1929, p. 198) for "a series of sediments which are primarily of volcanic origin and which are typically developed along the sides of the Valley of Meshik River and Meshik Lake". This sequence is at least 5000 feet thick and consists of interbedded volcanic conglomerates, sandstones, volcanic breccias, and occasional fine siltstone and shale. Bedding is erratic to regular and individual beds are locally 30 feet thick. These rocks are generally shades of brown or yellow with local pastel tints of green, red, and purple. The clasts are all andesitic except for occasional clasts of black to red chert and black argillite. Conglomerates and breccias locally contain clasts two feet in diameter, but more commonly of pebble size. Poorly preserved but abundant carbonaceous plant fragments are common in this unit. Pliocene and younger rocks consist of lava flows and fifteen cubic miles $\pm$ of ejecta from the disintegration of Aniakchak Crater (W. R. Smith, 1925).

Mineral Potential

There are no known mineral deposits along the Aniakchak River Drainage. To check the possibility of potential mineral deposits, geochemical sampling will be done in the summer field season of 1973. Some indications of gold, silver, lead, and zinc have been noted in the Chignik Quadrangel approximately 40 miles to the north.

Petroleum potential of the underlying Jurassic-Triassic section is considered limited on the basis of poor porosity and permeability of the sedimentary section. Sampling for source and reservoir beds will be made in the field check this summer and recommendations concerning petroleum potential added as an appendix to this report by August 1973.

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APPENDIX I

(Geology and Mineral Evaluation of the Aniakchak River Drainage)

Field Geologic Report

by

W. M. Lyle and P. L. Dobey

July 23, 1973

Report based on a field inspection with U. S. Bureau of Outdoor Recreation Wild and Scenic River System Task Force July 11-18, 1973.

Team Members:

Dave Dapkus	BOR - Leader
Keith Trexler	NPS
John Merrick	BLM
Nate Johnson	Alaska Fish & Wild Life
Rob Stern	Photographer (for John Muir Society)
Tom Flower	Asst Photographer
Bill Lyle	ADGGS
Patrick Dobey	ADGGS

INTRODUCTION TO APPENDIX I

A field inspection of the Aniakchak Caldera and River was conducted under the leadership of the U. S. Bureau of Outdoor Recreation Wild and Scenic River Task Force on July 11-18, 1973.

The purpose of the inspection was to determine the suitability of the caldera and river for classification under the Wild and Scenic River System. Scenic, recreational, biological, and mineral evaluations were conducted during the trip by members of the task force. A proffessional photographer representing the John Muir Society attempted to film the trip but was seriously handicapped by the emersion of his cameras in water, loss of film, and the development of pneumonia by his assistant.* Equipment used consisted of 4 twelve foot rubber rafts, 10 paddles, tents, and manpower. Equipment remaining at the end of the trip was less than new and reduced in quantity. It was the unanimous opinion of the team that the river is definitely "wild".

The team entered the caldera July 11 by an amphibious aircraft landing on Surprise Lake. Two days were spent in the caldera making a geologic reconnaissance. The running of the river by raft began on July 13. A difficult and time consuming exit was made through the gates of the caldera. Paddles were broken and rafts holed (one raft flooded and escaped but was caught downstream). The evening of July 13th saw the team only five miles down river, camped just short of another rough stretch of the river called the chute. Three more days were needed to reach the mouth of

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* Sincere appreciation is expressed to Shell Oil Company and its geologic party chief, Bill Polski. The Shell helicopter, after being signaled by emergency flares on the morning of July 16, off-loaded its geologic party and flew the seriously ill assistant photographer to Naknek for medical treatment.

the river, with an average of five miles completed on each day.

GEOLOGY & MINERAL RESULTS

All of the stratigraphic units adjacent to the river were sampled and examined in the field. Geochemical samples were taken at stream mouths or one mile intervals. Geologic formations sampled were:

Jurassic Naknek: The Naknek is a gray, fossiliferous marine sandstone and siltstone. It is a hard, tight, dense, and massive unit, with little or no reservoir characteristics.

Jurassic-Cretaceous Staniukovich: The Staniukovich consisted of banded beds of light gray green sandstone and gray pebble to boulder conglomerate. The sandstone is composed of quartz, feldspar and dark rock fragments. The marine fossils (belemnoids and pelecypods) are indicative of a marginal marine environment. The sandy conglomerates were deposited by alternating high and low energy streams. Wood fragments, high angle crossbeds, lack of sorting and rhythmic bedding all lead to this conclusion.

Paleocene-Eocene Tolstoi: The Tolstoi formation was sampled and examined. The sandstones are gray to gray green, medium to coarse grained, festoon crossbedded. The unit is friable and weathers into loose sand grains.

The mudstones are gray with an abundance of carbonaceous trash.

The Tolstoi has fair to good reservoir potential and fair to poor source potential.

Oligocene Meshik Formation: The Meshik is exposed along the lower reaches of the river and is dominantly water laid volcanic sediments with beds of agglomerate and some flows. It has no potential for source or reservoir beds.

In summary, the Jurassic Naknek and Staniukovich are not considered

prospective in this area. They are dense, hard, and tight and have been subjected to deep burial.

The Tolstoi formation has fair to good source rock and fair to poor reservoir rock potential.

The Meshik is not considered potential.

The petroleum potential along the river is very low. The lower five to six miles could have "surprise oil" in the Eocene.

MINERAL EVALUATION

Mineral potential along the river drainage is limited on the basis of observed geology.

Outcropping rocks sampled in the caldera and along the river were volcanic in origin or sedimentary sandstones, conglomerates, and mudstones of Jurassic and Tertiary age.

River float consisted mostly of volcanic rock fragments, and rocks of the Jurassic Naknek and Staniukovich formations.

Granite and quartzite cobbles were observed in the float at stations 148 and 149. The North Fork of the Aniakchak River is probably responsible for this float and the area north of station 148 might have prospective possibilities.

The large tertiary intrusive (Ti) south of the river was not sampled or observed at close range.

Geochemical sampling was conducted in the caldera and along the Aniakchak River. A total of 41 samples were taken at approximately one mile intervals and at stream intersections. Three samples were lost when a raft overturned leaving 38 for analysis.

Because of the limited time given for reporting results, the atomic absorption analysis for copper, lead, zinc, silver, and gold was utilized

by the DGGS laboratory to process the samples.

Results of the sampling are NEGATIVE. There were no anomalous values for the above listed elements. Only one location had a trace of gold (station 136). Silver was below mean background or not present. Copper, lead, and zinc values all were near the average crustal abundance in PPM.

Field observation and geochemical results indicate a very low prospective mineral potential for the Aniakchak River Drainage, and the volcanic caldera.

CONCLUSIONS

The petroleum and mineral potential of the Aniakchak Caldera and River is limited. The unique character of the river (originating in a volcanic caldera), the beauty of the valley and surroundings, the excitement and danger of traversing it by raft, all recommend it as truly a "Wild and Scenic River".

APPENDIX II

GEOTHERMAL EVALUATION

Hot springs were observed at station #109 and other areas in the Caldera. Recent volcanic activity, and the large size of the Caldera, all give the Aniakchak Caldera high geothermal potential.

This possible future economic geothermal development must be considered within any park or wild and scenic system proposals.

APPENDIX III

ANALYSES OF STREAM-SEDIMENT SAMPLES FROM THE ANIAKCHAK RIVER

(Analyses by quantitative atomic absorption methods. N = no detected)

Station Number	Field Sample Number	Parts per Million					Remarks
		Au	Ag	Cu	Pb	Zn	
108	L-238-73	N	N	15	10	20	
109	L-239-73	N	N	15	5	30	
112	L-242-73	N	N	20	35	50	
114	L-244-73	N	N	20	15	60	
115	L-245-73	N	N	20	10	40	
118	L-248-73	N	N	30	20	95	
120	L-250-73	N	N	25	15	75	
121	L-251-73	N	N	15	5	50	
122	L-252-73	N	N	15	5	50	
123	L-253-73	N	N	20	5	40	
128	L-258-73	N	N	15	10	50	
129	L-260-73	N	N	20	10	50	
127	L-261-73	N	N	20	10	70	
130	L-262-73	N	N	20	5	45	
131	L-263-73	N	N	25	10	50	
132	L-264-73	N	N	10	5	50	
133	L-266-73	N	N	20	10	55	
134	L-267-73	N	N	20	10	50	
135	L-269-73	N	N	35	10	100	
136	L-270-73	N	N	15	5	50	
137	L-272-73	N	N	20	15	80	
138	L-273-73	N	.3	25	10	65	
139	L-274-73	1.2	N	15	20	20	Wood
		N	.8	50	35	90	Loose material
*139	L-277-73	N	.4	40	15	120	277A rock
140	L-278-73	N	N	20	10	55	
141	L-279-73	N	N	20	10	50	
142	L-280-73	N	N	20	10	75	
143	L-281-73	N	N	25	10	100	
144	L-282-73	N	N	20	10	55	
145	L-283-73	N	N	30	10	50	
146	L-284-73	N	N	15	10	25	
147	L-285-73	N	.2	25	10	50	
148	L-286-73	N	.2	25	10	80	
149	L-287-73	N	N	25	10	70	
150	L-288-73	N	.2	30	10	80	
151	L-289-73	N	N	15	5	70	
152	L-290-73	N	.2	20	10	60	
153	L-291-73	N	N	20	10	65	
124	L-254-73		N	10	5	50	
125	L-255-73		N	10	10	50	
126	L-256-73		N	20	5	40	

Field Notes - Aniachak

June 11, 1973

Walking traverse in Caldera to sample volcanics. Weather overcast, cool, temperature 45 to 50 degrees wind from the east at 20 knots.

Station 106 - Top of plug in Caldera, elevation 1445'±, altimeter reads 1502. Outcrop is a volcanic plug within Aniachak-Caldera.
L-235-73 - Basalt Black - viscular, vesicules are elongate, vesicules from 1 mm to 5 mm. Porosity approximately 33 to 35%. Sample taken for age date.

Station 107 - Volcanic plug. Northwest of station 106, appears to be an old vent.
L-236-73 - Basalt, black, very small viscules, 1 to 2 mm, taken for age date.

Station 108 - Geochemical, from bank of river that feeds Surprise Lake in the Caldera.
L-238-73 - Geochem

Station 109 - Geochem. Small hot springs next to old volcanic vent.
L-239-73 - Stream is a hot spring between two plugs, sample is black volcanic sand. Stream is approximately 5' wide, temperature of water is approximately 70 to 80 degrees, which is quite warm for this environment.

July 12, 1973

Surprise Lake, Aniachak Caldera

Walking traverse to gates of crater, plan on sampling Jurassic Naknek and Staniukovich formations. Party consists of Bill Lyle, P. Dobey, R. Sterns, Tom Flower, Dave Dapkis, Keith Treler, and John Merrick.

Station 110 - Outcrop is JKS on south side of gates. Float is volcanic debri and pebble conglomerate.
L-240-73 - Appears to be Jurassic Staniukovich, dark green weathered, light gray fresh, very fine grained, felspathic sandstone similar to previous samples of Staniukovich. The sample was taken from float immediately to the east of outcrop on steep face.

Station 111 - Sample L-241-73. Outcrop near the gates taken from base of cliff, conglomerate sandstone cliff, ± 500 foot high alternating sandstone and conglomerates. Sandstones are overlain by massive conglomerate beds near the top. (Photograph was taken of this outcrop), fine to coarse, mostly quartz, 20% dark rock fragments. Some pebbles to very large grain size matrix. Beds are 2" to 3' thick. Conglomerate is dominately rounded cobbles, some boulders. Cobbles are quartzite, 70% granite, cherts make up the remainder. Matrix same as sandstone unit. Average size of the cobbles is 2 to 3".

Station 112 - Geochem Sample L-242-73

Station 113 - Outcrop is a recent basalt flow appearing to originate behind Vent Mountain originate from behind Vent Mountain.
L-243-73 - Black basalt with alternating units of flow agglomerate. Sample is black fresh and weathered, less than 2% vesicals. There is some rust coloring weather surfaces.

Station 114 - Geochem
L-244 - Geochem - Small stream 4' wide near basalt flow.

Station 115 - Geochem, another small stream flowing westward.
L-245-73 -Geochem

Station 116 - Campsite outcrop, basalt flow, black approximately 50' high, photograph taken of this flow.
L-246-73 - basalt black, same as described above.

Station 117 - Basalt outcrop primival crater.
L-247-73 - Basalt and scorizceous type material described before.

July 13,1973

Raft traverse from Surprise Lake camp down Aniachak River. Will sample JKS and JN when passing through gates and then take geochemical samples the length of the River approximately every one mile. Wild and Scenic Task Force consists of Bill Lyle, P. Dobey, first raft, Tom Flower, R. Stern, second raft, N. Johnson, J. Merrick, Third raft, D. Dapkis and Keith Texler, fourth raft.

Station 118 - Geochem -
L-248-73 - Geochem - Taken from small stream just past the gates.

Station 119 - Staniukovich formation just southeast of the gate, massive cliff, alternating gray and light gray strata. Three samples taken from three levels of beds. Samples bagged as L-249-73 upper, middle and lower in 3 bags. Bedding approximately 3 foot thick. Upper sandstone unit sandstone, gray green, weathered, green fresh, felspathic and arkosic. Middle unit is sandstone, light gray, weathered and fresh. Fine grained telspathic. 20% dark rock fragment,plus quartz and feldspar. Lower unit is a sandstone, weathers gray green, light gray fresh, feldspathic, arkcosic. Similar to the previous samples of JKS and Herendeen Bay.

Station 120 - Geochem - Sample L-250-73 - Geochem.

Summary of days activity for July 13, 1973 - Stopped at gates, inside of caldera to prepare for rapids and take samples. It was decided that Lyle and Dobey would take lead raft, Merrick and then Dapkas taking up the rear in case there was any problem. After the first 50 yards we ran into a bad place and broke one paddle, bailed out water, then decided to line the raft around a boulder but the raft swamped jerking Bill into the river. 100

yards downstream I was able to beach the raft using the stern line. Bill was not badly injured although he had some cuts and bruises from his swim. Two more rafts were able to get past this place but the photographers raft swamped and got loose. I was the last down the river and was able to run and catch before it got out of sight. By this time, practically all of the party members were soaking wet and we had a large hole in Dapkises raft which we had to repair,so we had lunch. Finally stopped at 7:30 P.M. after making only five miles on the river. (We had to stop at least every half mile to bail out water and repair holes in one or more of the rafts and of course Bill and I had to take samples.)

Station 121 - Geochem -
L-251-73-

Station 122 - Geochem -
L-252-73

Station 123 - Geochem -
L-253-73 - Mile 6 on the river

Station 124 - Mile 7 on the river - Geochem -
L-254-73 - Campsite for the night. All of these samples were along the main river on either small bars in the center or bars along the side of the bank. River is around 80 foot wide, very fast, float for all Geochem stations has been Naknek, Stanukiovich, JK Naknek, or volcanics.

July 14, 1973

Seven mile camp on the Aniakchak River. This morning we will pack our equipment down the river about 1 mile to get around the area we are calling the Chute. After lightning the boat we will try to run the rough stretch with empty rafts.

Station 125 - Geochem - Near mile seven, stream is 4 foot wide, fast. Sample from bottom, no float, gravel, sand, JN outcrop about 1/2 mile away.
L-255-73 - Geochem -

Station 126 - Geochem - location after rapids in canyon. Approximately mile 8, small stream 1 foot wide, flows on bedrock which appears to be Jurassic Naknek. Much organic matter, fine sand and sandstone.
L-256-73 - Geochem.

Station 127 - outcrop is cliff forming banks of Aniakchak River. Walls of canyon 5 to 30 foot high, about 1/2 mile long. Outcrop is dark gray to black, highly jointed weathers platy, no apparent bedding.
L-257-73 - Sandstone - dark gray to black, weathered, gray fresh, Arkosic, fine grained, angular to subangular. Much felspar, looks like Jurassic Naknek, hard, dense, no apparent porosity or permeability.

Station 128 - Geochem -
L-248-73 - Mile 8, stream 4 foot wide, fast, south bank of Aniakchak River.

Station 129 - Outcrop north side of river, small river cliff 20 foot high 100 foot long. Outcrop is light tan with white streaks on bedding Plains high fractured.
L-259-73 - Sandstone, light tan fresh, weathers white to very light tan, very fine grained, subangular, well sorted, many crystal faces, some felspar, 20% dark rock fragment, quartz, hard,dense, no porsority or apparent permeability. Appears to be Jurassic Naknek.
Note: After leaving lower part of canyon, a mountain can be seen to the north with an excellent outcrop of Jurassic stanukovich, photographs were taken of this outcrop.
Geochem - Aniakchak River mile 8 1/2.
L-260-73 - Geochem

Station 127 - Geochem - mile 8 3/4, small stream 4 foot wide at mouth leading into Aniakchak River.
L-261-73

Station 130 - On Aniakchak River - Geochem
L-262-73

Station 131 - Aniakchak River - Geochem
L-263-73 - Creek is draining valley between two large Naknek mountains. Creek is 10 to 21 feet wide, fast flowing, float is boulders and cobbles of sandstone, (Jurassic Naknek) no outcrop nearby.

Station 132 - Geochem - past a location called the Boulders, small stream 10 foot wide on bedorck. Sample taken at base of water fall, where stream enters Aniakchak River.
L-264-73 - Geochem

Station 133 - Geochem, river bank Aniakchak River.
L-266-73 - Geochem

Station 134 - Campsite No. 3 - Geochem
L-267-73 - Samples taken from bar at side of river.

Station 135 - Outcrop of tolstol formation, south side of river, outcrop is massive sandstone, 20 to 40 foot thick beds weathered out in large blocks, many fractures, outcrop color is brown, cross-bedding.
L-268-73 - Sandstone, brown weathered, brown fresh, medium coarse, sub-angular to round, poorly sorted, 40 to 50% quartz, 20% feldspar, matrix is clay, non-calcarious, some porosity,could be a reservoir rock. Dip $\pm$ 20 degrees, direction estimated south 45 degrees east, compass filled with water and will not give directions.

July 15, 1973

Station 135 - sample L-289-73 - Geochem
Steep 70 to 80 degree dip JKS
1/2 hour delay to repair raft 1 1/2 x 1 1/2 hole, 1 shape in rear.

Station 136 - L-270-73 - Geochem, river sample, 40' wide, steep base of very fast rapids. SS, boulder beds, Tom JKS bedrock.

Station 137 - L-272-73 - Geochem - 2-6' wide, slow SS

Station 138 - L-273-73 - Geochem- 4' wide, fast, SS and fn SS Tom and TV float.

Station 139 - L-274-73 - wood, base of Meshik on left (Tom) L-275-73 and L-277 not taken.

Station 140 - Geochem
L-278-73 - on bank of Aniakchak River

Station 141 - Geochem -
L-279-73 - South of Aniakchak River

Station 142 - From a small stream which feeds into the Aniakchak River. The stream is 5 foot wide, medium grade, float is volcanic, and sandstone. Sample is sand and mud, medium grain size, some organic matter.
L-280-73 - Geochem.

Station 143 - On the Aniakchak River north bank - Geochem. - Small stream draining from northerly direction about 15 foot wide, meandering. Sample was taken in mountain house food bags. Sample bags lost when raft overturned.

Station 144 - Geochem - On Aniakchak River bank.
L-282-73 - Sample in plastic bag used to contain dried peached.

Photographers raft collapsed upon colliding with vertical rock face around 5 P.M. this afternoon. All of their equipment is wet and their film bag was torn loose, later located down river on a rock. Tom Flower, the photographer assistant very ill. We have had to start a fire and wrap him in a sleeping bag and try to dry out equipment and gave him some hot soup. Have decided to take one raft lightly loaded with strongest man, Bill Lyle, and send him ahead with sick man and attempt to reach mouth of river and get help. Remaining three rafts will take majority of equipment and few remaining paddles and follow. Campsite made at 10 P.M. when high winds had forced the rafts to progress by twoing only, and darkness created hazards finding channel. Equipment wet, sleeping bags wet, only one tent will stand up and six men are now sleeping in one tent (3 man tent) using life jackets to lay on with two dry sleeping bags stretched across the top for warmth. Did not catch up with Lyle, assumed he is ahead of us.

July 16, 1973

Broke camp early, no breakfast, trying to make time to catch up with Lyle. At about 8 A.M. this morning, sighted helicopter and signaled it to our location using red flares. Helicopter belonged to Shell Oil Company and party chief, Bill Polsky agreed to fly on ahead and try to locate Lyle and give assistance to sick man.

Station 145 - Geochem - small creek feeding into Aniakchak River.
L-283-73 - Creek is 30 foot wide, slow, no float seen, considerable premice on river bank, sample is medium sand.

Station 146 - Mouth of Mystery Creek - Geochem - Creek is 30 foot wide, fast meandering, float is volcanics and sandstone, sample of sand and mud.
L-284-73 - Geochem - Taken in clear plastic bag.

Station 147 - Geochem - Next creek on river, 10 foot wide, slow, clear, float is pebeles with volcanic material and sandstone, sample is sandstone and mud.
L-285-73 - Taken in white plastic bag.

Station 148 - Creek, mouth on Aniakchak River, north bank, 40 foot wide, fast creek is the north fork of the Aniakchak River draining a large valley to the north first float we have seen with granite and quartzite, also sandstone and volcanics.
L-286-73 - Geochem - taken in peach bag.

Station 149 - Creek on north side of Aniakchak River 30 to 40 feet wide, fast, flowing, float is sandstone volcanics, some granite and quartzite.
L-287-73 - Geochem

Station 150 - Geochem - Small creek about 15 foot wide and not on map, creek is apparently broken through a new channel and is now feeding into the river northwest of previous mouth. No float sighted, everything is mud.
L-287-73 - Geochem -sample was taken in a white wool stocking.

Station 151 - Geochem - creek on Aniakchak River, creek is 6 foot wide and very slow, sample from river bank at mouth, all sand and mud, no float.
L-289-73 - Geochem

Station 152 - Geochem - bank of Aniakchak River.
L-290-73 - again taken in white sock.

Still 5 miles from mouth of river, very difficult to pull raft, have made small camp and built fire. Waiting for helicopter to return and pick up the Shell geologists. Skiff from motor vessel, Ivanof has come up river and will raft to fishing boats motored in mouth of river.

July 17, 1973

Aniakchak Bay on board motor vessel Johnny B., spent night on floor, very comfortable. Good weather, Equipment on sandbar for aircraft to pick up.

Station 153 - Geochem - Aniakchak River at mouth on north bank. 30 foot from outcrop of tolstoi formation.
L-291-73 - aircraft is flying overhead and do not have time to describe sample.
L-292-73 - Age date, Basalt intrusion of tet

July 18, 1973

Aircraft unable to land because of high winds. Final pick-up was by small plane on beach at 21:30 P.M.