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PORTAGE CREEK GOLD PLACERS, LAKE CLARK QUADRANGLE, ILIAMNA DISTRICT, ALASKA

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INTRODUCTION

The gravels and surficial geology of the Portage Creek drainage, Lake Clark, Alaska were briefly examined on September 21-22, 1977, to determine the character, genesis, and extent of gold and heavy mineral placers in Portage Creek.

LOCATION AND GEOGRAPHY

Portage Creek is a small drainage system which flows from north to south into Lake Clark, a large structurally controlled lake on the west side of the southern Alaska Range approximately 180 miles (288 km) southwest of Anchorage, Alaska (fig. 1). Portage Creek drains into the north side of Lake Clark about 35 miles (56 km) northeast of its outlet. The general region is characterized by relatively steep mountain slopes up to 4,800 feet (1,528 m) in elevation and recently incised, glacially scoured U-shaped valleys which enter Lake Clark (altitude: 254 feet; 77 m).

Boreal forest vegetation is well developed on lower mountain slopes, flood plains, river valleys, and alluvial fans, and consists of white spruce stands, black spruce muskeg and bogs, paper birch, balsam, poplar, willows, and alder (Racine & Young, 1978, p. 7).

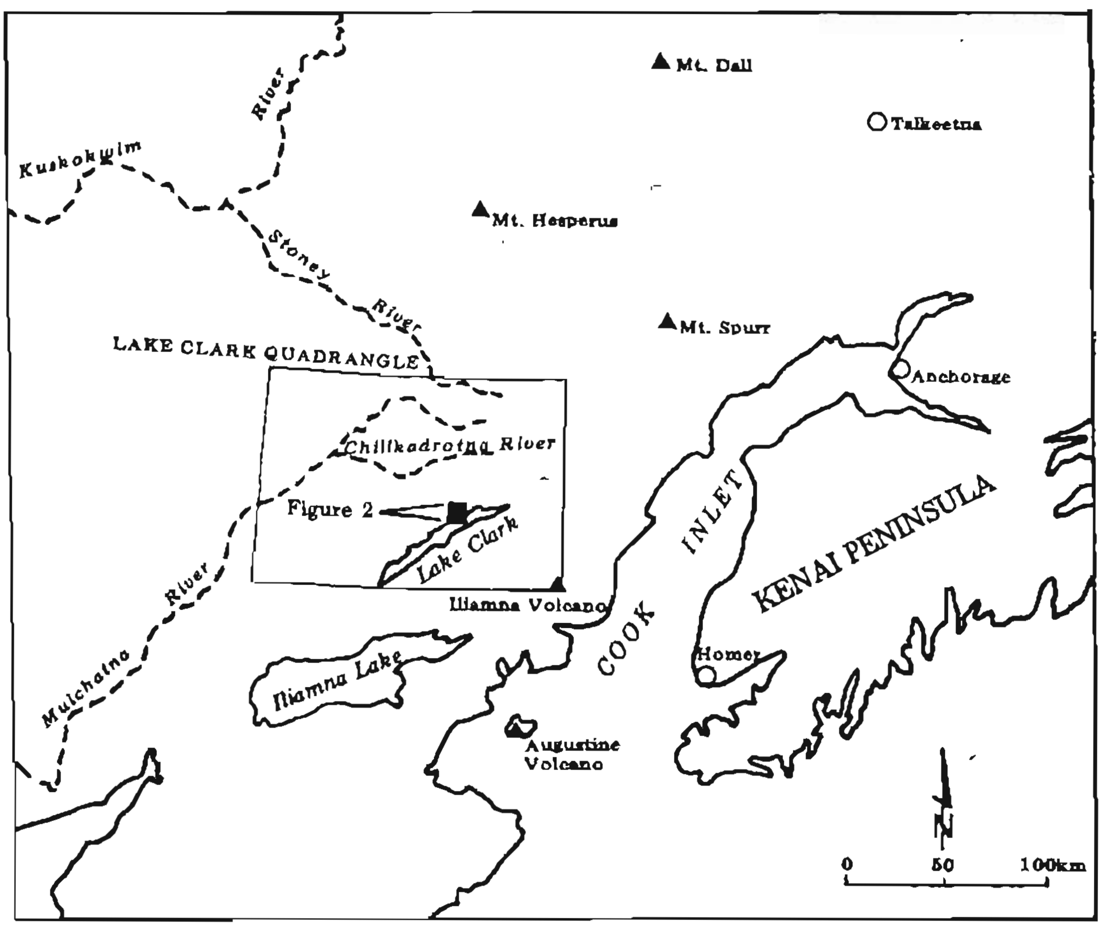

Figure 1. Location of study area.

The climate is moderately cool and wet and is influenced by maritime weather systems of Bristol Bay and Cook Inlet; however, due to mountain barriers, the area shares some of the temperature extremes typical of the interior of Alaska. Temperatures can plunge to -50°F (-45°C) in winter, but the climate is usually mild; Lake Clark exerts a moderating influence on the temperature range of the region until it freezes over (Behnke, 1978). The mean daily maximum temperature in July is about 66°F (18°C) whereas the mean daily minimum temperature in January is about 0°F (-18°C). The average annual precipitation is about 24 inches (61 cm) (Wahrhaftig, 1965). Portage Creek is currently within Lake Clark National Monument, established December 1, 1978.

HISTORY OF MINING ACTIVITY

Placer gold was discovered in the Lake Clark region shortly after 1900 and mining commenced on Portage Creek sometime prior to 1909 when several ounces of coarse gold were recovered from shallow gravel deposits on bedrock (Brooks, 1910, p. 200). Among the early prospectors of Portage Creek was Oliver B. Millett, the miner who along with William Dietering discovered the great 'white channel' deposits in the Klondike (Berton, 1977, p. 193-195; Terry Gill, oral comm.). Later, during 1910-1912, several individuals recovered about 100 ounces of coarse gold worth $2,000, all from gravels within Portage Creek canyon (Capps, 1935, p. 94). Additional gold mining ventures took place on Portage Creek in 1913 (Brooks and others, 1914, p. 64), in 1917 (Martin and others, 1919, p. 33) and 1918 (Martin and others, 1920, p. 35) but there is no record of activity during the 1920's and most of the 1930's (Capps, 1935, p. 94). Much of this early work utilized primitive 'pick and shovel' methods for gold recovery. Fred Bowman began mining the Portage Creek gravels in 1939 and continued until 1958 (Smith, 1941, p. 37, Holdsworth, 1957, p. 68) working portions of nine claims shown on plate 1 with hydraulic methods. Terry Gill, a local area placer miner, completed mining and assessment work for the Bowmans on Portage Creek in 1960. Fred's son, Howard, has continued prospecting, mining, and development work on the nine claims since the late 1950's. A total production figure for Portage Creek is not available, but probably does not exceed 1,000 troy ounces of gold.

BEDROCK GEOLOGY

No attempt was made to map the bedrock units of the area and the following discussion is based on very brief observations. The rock units in the Portage Creek area have been shown on geologic maps of the area as lower Jurassic sandstone, argillite, and volcanic rocks of the Talkeetna Formation (Martin and Katz, 1912; Beikman, 1978); however, this assignment will probably be modified when more recent work by the U.S. Geological Survey Lake Clark (AMRAP) project is released. Rock types cropping out in Portage Creek canyon include regionally metamorphosed schist, metabasite, phyllite, porphyroblastic hornfels, and granitic intrusive.

The granite or alaskite (thin section and hand specimens examination only) is a tan to pinkish, medium grained, equigranular rock containing abundant K-feldspar phenocrysts up to 5 mm long. It locally contains 1-5 percent biotite grains distributed homogeneously throughout the groundmass but mafic minerals are sometimes lacking. The pluton crops out in bluffs and stream cuts on 'Number 4 and 3 Above Discovery' claims (plate 1). Xenolithic fragments of both granite and country rock occur within the contact zone of the granitic body where pyrite is locally abundant.

An aureole of brown to gray, very fine grained porphyroblastic hornfels a few meters wide occurs adjacent to the granite on the 'Number 3 Above Discovery' claim. In thin section, the hornfels is composed of rounded porphyroblasts of chlorite and epidote group minerals in a groundmass of andalusite(?), quartz, albite, and opaque minerals. Calcite veinlets a few millimeters wide cut the hornfels zone. Downstream from the 'Number 2 Above Discovery' claims the hornfels gradually grades into dark-gray phyllite and slate, light-gray siliceous argillite, and medium- to dark-green chlorite-rich actinolitic greenschist. In thin section, the schist is composed of actinolite needles largely altered to chlorite, in a groundmass of magnetite, feldspar, epidote group minerals and quartz. This mineral assemblage probably represents a lower-greenschist facies metamorphism.

The country rock is foliated but compositional banding generally parallels the most pervasive foliation observed in the rocks. The foliation generally strikes N. 40-70° E. and dips steeply to vertically although secondary cleavage locally obscures this general relationship.

LATE QUATERNARY HISTORY

Most of the following discussion on Quaternary history is based on photogeologic and ground reconnaissance. Portage Creek is in the process of readjusting its longitudinal profile following extensive late Quaternary glaciation of the region. Rapid stream incision and headward erosion by Portage Creek subsequent to glaciation have notched a canyon 50-150 m deep into the former glacial valley floor. Incision is in response to a relative lowering of the local base level by greater deepening of the main Lake Clark trough relative to its tributaries. This situation is common in areas of extensive valley glaciation and produces the classic hanging-valley form.

In the upper Lake Clark valley several vigorous convergent ice streams originating in the crest of the Alaska Range caused ice to thicken and top divides at the heads of several down-valley tributaries, allowing diffluent[1] ice streams to escape into the heads of adjacent watersheds. The height and inclination of lateral moraines and sideglacial channels on the walls of the main valley and on the sides of Portage Creek valley indicate that ice from the Lake Clark trough breached the drainage divide at the head of Portage Creek, forming a complex of diffluent and transfluent[2] glaciers (fig. 2). Some of these ice streams joined with ice streams occupying the Kijik River drainage to the north. Lowering and broadening of the drainage divide and the lower portion of the former glacial valley floor of Portage Creek by the transfluent ice streams was fairly extensive. Most (if not all) preglacial alluvium and colluvium was scoured out and removed.

1Diffluent as defined in Embleton & King (1968) refers to distributary ice streams which diverge from a trunk glacier.

2Transfluent refers to ice streams which breach divides between two trunk glaciers and form a connection between them.

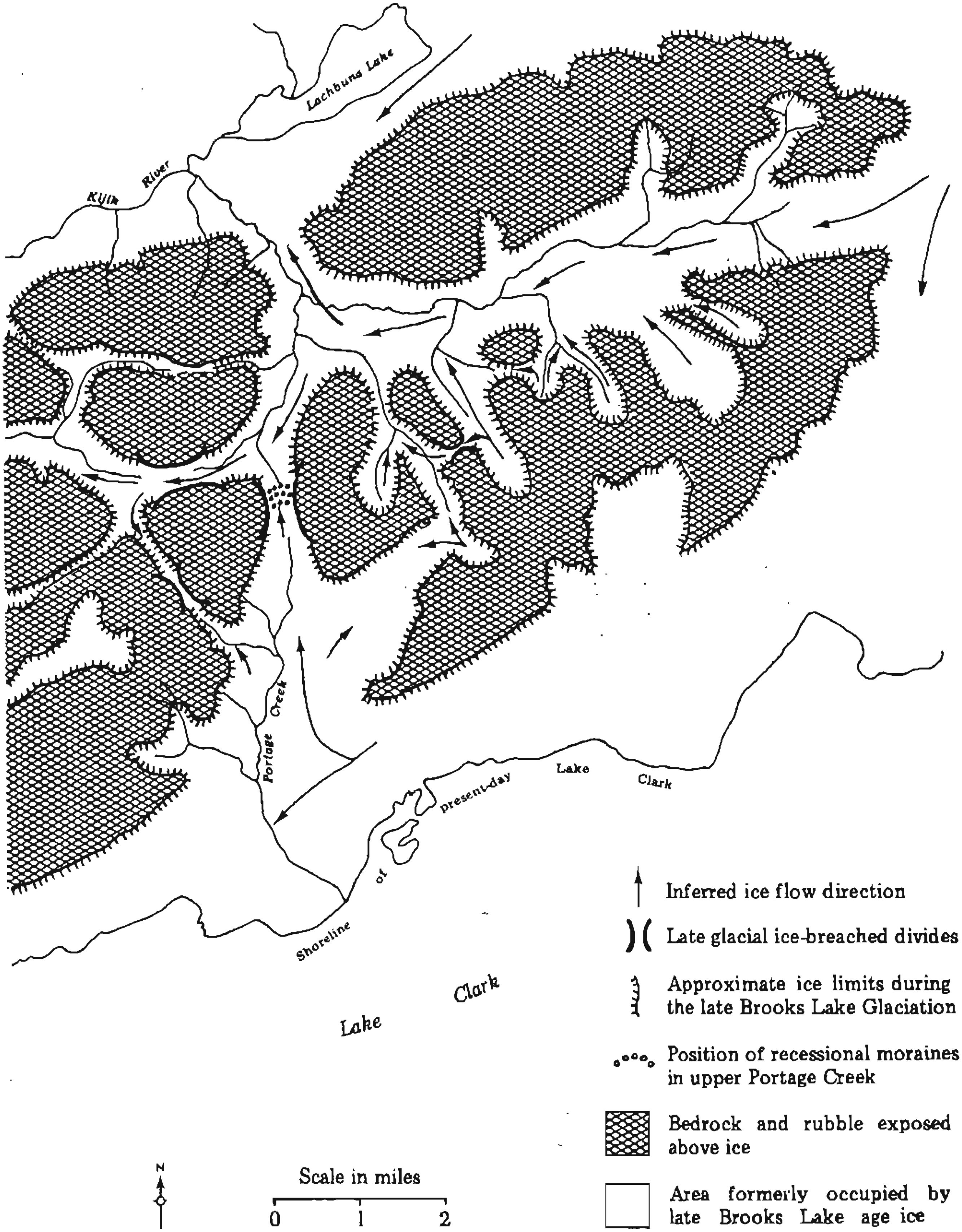

Figure 2. Glacier limits and ice flow directions during late Brooks Lake Glaciation in the vicinity of Portage Creek, as interpreted from aerial photographs.

During the waning phases of the Brooks Lake Glaciation, defined by Detterman and Reed (1973), in the Iliamna Lake region, thinning of the main valley ice allowed ice to withdraw from the Portage Creek trough. Three or more small recessional moraines in the divide (fig. 2) record this withdrawal and indicate that at this time the ice flow was up Portage Creek from the south rather than from the Kijik River drainage to the north. When full glacial conditions existed earlier, the direction of flow in transfluent glaciers probably reversed several times, depending upon the relative vigor of the Kijik and Lake Clark trunk glaciers.

Evidence throughout the Lake Clark and Iliamna Quadrangles indicates that deglaciation of the entire area occurred rapidly and was precipitated by sudden cessation of ice flow out of the source areas in the core of the Alaska Range, causing valley ice to stagnate. Deposits related to ice stagnation are common throughout most of the Lake Clark Quadrangle; for example, they occur locally in an unnamed tributary to the Kijik River immediately north of the head of Portage Creek. Small wave-planed and notched fan deltas were deposited there in a small ice-dammed lake that existed for a short time during deglaciation. There is no evidence of ice damming on the Portage Creek side of the divide; however, an esker on the glacial valley floor sloping into the Lake Clark trough at the mouth of Portage Creek canyon was apparently deposited beneath stagnant ice during deglaciation.

Till is moderately thick in the trough at the head of Portage Creek. It is being stripped by headward erosion and contributes significantly to the sediment load of Portage Creek and its tributaries.

Following deglaciation of Portage Creek valley, stream erosion incised a canyon at the lip of Portage Creek's hanging valley. For a short period Portage Creek was apparently diverted sharply to the west through a bedrock channel. As alluvial fan deposits accumulated at the mouth of the youthful canyon, the stream took a more southerly course, building a fan into Lake Clark. Three postglacial episodes of eolian deposition produced a loess mantle of up to 25 inches (.64 m) thick on the fan surface. At least two paleosols occur in the loess. The top of the lower paleosol is approximately 10 inches (25 cm) above the base of the loess. This paleosol characterized by a 2-inch (5-cm) thick A_1 horizon containing numerous wood fragments overlying a well-developed 1.70-inch (4-cm) thick A_2 horizon having an ashy-gray color. There is no apparent B horizon in this soil. A second period of loess deposition followed this earliest soil-forming interval. The top of the upper paleosol is about 7 inches (17.5 cm) above the lower paleosol. The younger paleosol displays a 4-cm-thick A horizon and a 3-inch (7.5-cm) thick red-orange B horizon. The poorly developed A horizon lacks the copious woody material found in the older soil. No A_2 horizon is present and the B horizon is weakly developed. It is inferred from these characteristics that the younger paleosol represents a shorter soil-forming interval under a different climatic regimes than does the older one. The second soil-forming interval was ended by a third period of loess deposition during which 8 inches (20 cm) of loess accumulated. The surface soil consists of 4 to 8 inches (10-20 cm) of organic matt and humus over a 4-inch (10-cm) thick pale-orange weakly developed B horizon. No A_2 horizon is present; however, wet climatic conditions and mature, open coniferous forest vegetation are conducive to podzol development. The lack of significant leaching may indicate a relatively short soil-forming interval since the last major episode of loess accumulation. No tephra horizons were recognized in the loess exposures along

Portage Creek, although they have been observed at other localities throughout the Lake Clark region west of Portage Creek. Their absence is puzzling and may be related to local variations in the prevailing wind direction. The loess source was probably the outwash plains at the head of Lake Clark which presently are largely vegetated. Some wind-borne silt can occasionally be seen over the upper end of the lake, especially during periods of low water. No material was collected from the paleosols for C^{14} age dating at the time of the authors' visit to Portage Creek but future sampling attempt will be made.

PORTAGE CREEK PLACER DEPOSITS

The Portage Creek placer deposits have formed in response to relatively short-term hydraulic events and contrast with older, more developed heavy mineral placers of interior Alaska.

The upper five claims (plate 1) occur in the creek canyon where stream gravels are undergoing rapid transport by periodic torrential floods which have moved large amounts of gravel, boulders, and debris. Auriferious gravel bars and low terraces a few meters thick in the canyon are subject to extensive reworking during these periodic floods. For example, a 1970 flood (H. Bowman, pers. comm.) erased signs of much of the former mining activity on the upper three claims, although a few artifical boulder piles remain. Large angular boulders of intrusive and metamorphic rocks up to 3 feet (1 m) in diameter are locally abundant in both terrace gravels and bars. Former placer operators have piled impressive amounts of boulders from washing or sluicing relatively small yardages of gravel. Local cut banks contain as much as 20 percent cobbles and boulders over 4 inches (10 cm) in diameter. The stream gradient in the canyon is steep, dropping an average 500 feet/mile (100m/km).

The four lower claims occur on a large alluvial fan delta which has built out from the mouth of the canyon. Starting at the Rabbit Foot Two claim (plate 1), the presence of recent flood deposits, natural levees composed of sand and gravel, and recently abandoned anastomosing and distributary channels indicate modern stream aggradation and fan building. In some cases flood deposits have covered the boles of standing live trees to a depth of 1-1/2 feet (0.5 m). Gravel thickness in the central part of the fan are variable as deposits overlie an irregular bedrock surface. Former bedrock channels may be 120 feet (40 m) or more in depth. Evidently all gravel deposits in the Portage Creek drainage are thawed. The stream gradient on the fan-delta complex is not as steep as in the canyon and drops approximately 200 feet per mile (40 m/km).

To the west of the modern stream course, abandoned stream channels from Portage Creek flowed southwest into Lake Clark. The abandoned channels were observed on aerial photographs following a visit to the site. They do not appear to have been occupied for long periods and perhaps were only active during high water. Their apparent old age indicates they were active immediately following deglaciation of the area.

SAMPLING PLACER DEPOSITS

Twenty-two pan concentrates were collected from selected localities throughout the nine claims shown on plate 1. From three to five "standard" pans (gold pan with 16-inch-diameter top) were taken at each sample site. This type of sample taken could be called a 'grab sample' as defined by Wells (1973) and it is emphasized that the sampling in no way accurately assesses the reserves of gold within the gravel exposures; they are simply guides to future sampling and prospecting ventures.

Pan concentrate information is given in tables 1, 2, and 3. Visible gold was discovered at 10 sample sites (table 1, fig. 2), but laboratory analyses could detect greater than 0.1 ppm gold in only five of these samples (table 2). This probably reflects the small sample size used in atomic absorbtion spectrophotometric methods. Only 10 grams of samples are analyzed and the potential for losing free gold during sample preparation is high. No anomalous amounts of copper, lead, molybdenum or nickel were detected in the samples although threshold to anomalous zinc values were obtained from samples 21 and 22, on the 'Number Three Below Discovery' claim.

Four of the 22 pan concentrates were selected for mineralogical identification by X-ray diffraction techniques; the mineral fractions with ≥ 3.3 specific gravity were analyzed (table 3). The results show a preponderance of magnetite in all samples, minerals typical of mafic igneous parentage within the canyon, and barite in two samples below the contact zone of the granitic body. Barite is a common gangue of mineral deposits and its presence as a major heavy mineral in two pan concentrates (greater than 10 percent of total analyzed fraction) implies a nearby bedrock source, possibly the contact zone of the granite or the metamorphic rocks below the granite. A gold fineness of 734 (table 4) was determined from gold found in sample 8; however, a large amount of undetermined impurities (19.35 percent) makes this a suspect analysis.

DISCUSSION

Field observations of the surficial deposits, studies of aerial photographs, inspections of past mining ventures, and sampling results indicate that the best placer gold prospects occur as locally rich pockets in 1-to 3-meter-thick terrace gravels and bars on the inside of meanders within the Portage Creek canyon and occasionally in the alluvial fan and terrace deposits below the canyon. A number of both positive and negative factors can be considered in assessing the Portage Creek gold placers:

1. The stream is actively downcutting, a condition not generally condusive to long-term preservation of placers. Heavy mineral concentrations existing in the erosion zone of the canyon are generally migrating downstream due to a steep stream gradient (100 m/km) and periodic torrential flooding. However, some of the more stablized, heavily vegetated terrace deposits in more or less 'permanent' inside meander systems (i.e., 'Number Three Above Discovery' and 'Number Two Above Fraction' claims) may have been in place for as long as several hundred years. Gold within pan concentrates 1-4, 7, 8, and 11-12 shows that the terrace deposits are good prospective placer gold deposits.

2. Large boulders within known paystreaks and prospective mining areas pose a problem for any placer mining operation (fig. 3).

3. Large volumes of water are available in the creek for hydraulic mining methods. This type of mining has been used successfully in the past by Fred Bowman and Terry Gill. Stripping of barren overburden

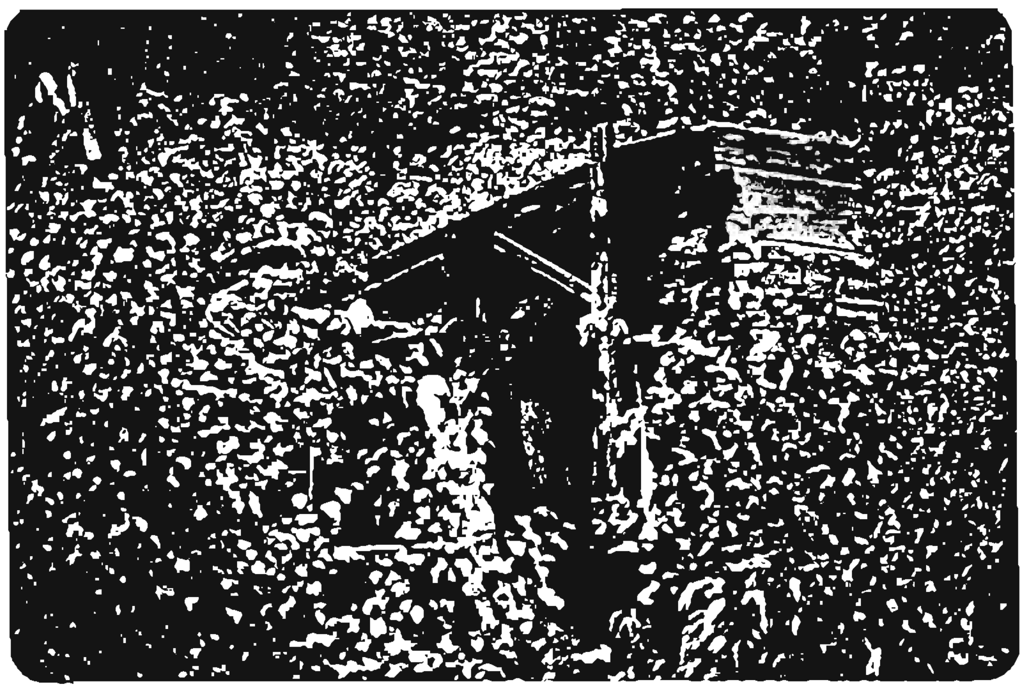

Figure 3. Hydraulic winch on 'Number Three Above Discovery' claim; Howard Bowman left center. The winch was used to remove large bedrock slabs and glacial erratics from the paystreaks. To operate, a stream of water from a nozzle is directed into a Pelton water wheel that is in turn geared to a winch whose cable is hooked to the obstruction in question. During past operations, the hydraulic winch was 'deadmanned' but was sometimes uprooted when the boulders were too large to pull out.

could be cheap and inexpensive. Relatively low amounts of fine material present in the overburden would seem to indicate that hydraulic mining methods in Portage Creek would pose less of an environmental problem than in other regions of Alaska.

4. Most or all of the gravels are thawed; thus expensive thawing techniques are not necessary.

5. The volume of gravel within the canyon is limited and a large-scale operation is probably not feasible in the canyon. In addition the rugged nature of the canyon makes the use of heavy equipment somewhat impractical. Future mining activities on the upper four claims involving hydraulic methods and limited mechanization could 'snipe away' locally rich placer-gold-bearing gravels.

6. Large volumes of gravel occur in the alluvial fan system below the canyon. These gravels are relatively free of large boulders and other debris and large yardages of gravel could be processed through a washing plant. However, the existence of commercial quantities of gold has not been proven. Much dilution of the heavy-mineral placers from the canyon has taken place in the alluvial fan, and placer gold deposited on bedrock is deep, as much as 120 feet (40 m) below the present stream level. Considerable aggradation has occurred in the fan. On the other hand, limited sampling during this study (tables 1, 2; samples 18, 19, 21, 22) and prospecting by Bowman and previous mine operators indicates that gold is present in the terrace and fan deposits below the canyon, particularly on the 'Discovery' and 'No. 3 Below Discovery' claims. Bedrock is fairly shallow downstream to the 'No. 1 Below Discovery' claim. Older stream terraces and cutbanks along the headward reaches of the alluvial fan (fig. 3) are capped by paleosol horizons. This type of loess surface, if buried rapidly by stream gravels, could form a "false bottom" placer (Wells, 1973) in the alluvial fan system and concentrate economic quantities of gold.

7. The existence of barite and abundant sulfides in pan concentrates, the relatively low gold fineness value (table 4), the angularity and coarseness of the gold, and the ephemeral nature of the gravels all suggest a close lode source of the placer gold. There may have been a continual source of gold during downcutting of Portage Creek although erosion may have only recently exhumed such a source. It might be worthwhile to examine the lode potential of the area.

8. West of the modern stream course, abandoned stream channels of Portage Creek flowed southwest into Lake Clark (fig. 3). Prospecting these channels could disclose additional placer gold deposits.

ACKNOWLEDGMENTS

The authors would like to thank Howard and Tische Bowman for their hospitality, informative discussions of past history, and use of their mining cabins during the field study. Terry Gill, a long-time Lake Clark area resident, briefly discussed with us some of his observations on mining activities within Portage Creek. Mark Robinson (UA Mineral Industry Research Laboratory) and Cleland Conwell (DGGS) reviewed the report.

Table 1. Notes on pan-concentrate samples

Sample	Remarks
1-4	Sampled gravel terrace 1 m above active stream channel (west side of creek) containing about 2,500 yd^3 gravel. Concentrates contained visible gold, sulfides and abundant black sands. The float is nearly 90 percent granite and quartz, 10 percent metamorphic rocks. Locally, large boulders 1 m in diameter found in adjacent stream channel.
5	Sampled terrace 2 m above active stream channel (west side of creek) on inside of meander. Bench contains about 2,000 yd^3 gravel. Creek float is predominantly granite and quartz.
6	Sampled across from old flume on bedrock (granite); concentrate has largely sandy fraction; abundant black sands and several flecks of gold in concentrate. Creek float is predominantly granite.
7	On small terrace on inside meander, southwest side of Portage Creek; contains 200-350 yd^3.
8	Sampled terrace 2-3 m above active stream channel near Gill's bedrock drain and open cut, on inside meander west of Portage Creek. Abundant visible gold (including a 1-pennyweight 'nugget') and sulfides (pyrite?) in concentrate. Best panning found in Portage Creek; 4 pans contained about 2.5 g of gold.
9-10	Flood-plain grab samples. No gold observed.
11-12	Sampled large terrace 2-3 m thick near old rocker on west side of creek. Terrace vegetated and probably older than previously sampled localities; contains more than 5,000 yds^3 gravel.
13	Grab sample in flood plain of creek. Much evidence of recent flooding, levee formation, and immature stream braiding. No visible gold; minor black sand in concentrate.
14	Vegetated terrace sampled. Potential large volume of gravel, no visible gold, some black sands.
15	Flood-plain grab sample. No visible gold, minor black sands.
16	Flood-plain sample. No visible gold, minor black sands.
17	High terrace sampled below mining camp. Very large yardage of gravel 3 m thick extending across flood plain; 2 flecks of gold in sample, black sands relatively abundant.
18-20	Samples taken on or near greenschist bedrock contain abundant black sand, no visible gold. Samples of large terrace near rocker box contain abundant black sands and several flecks of gold.

Sample	Remarks
21	Flood-plain sample near rapidly aggrading fan contains black sand and 1 fleck of gold.
22	Flood-plain sample in area of rapidly aggrading fan. Taken above log-jam damming of sandy; containing abundant black sand; several flecks of gold.

Table 2. Geochemical results of pan concentrates, Lake Clark, Alaska[1] (ppm)

Sample	Gold	Silver	Copper	Lead	Zinc	Nickel
1	1.87	0.00	37	5	83	64
2	0.33	0.00	45	6	140	82
3	0.38	0.00	37	4	76	68
4	0.03	0.00	26	7	68	43
5	<0.02	0.00	36	5	78	58
6	0.84	0.32	29	16	87	57
7	<0.02	0.00	28	4	67	49
8	(2)	0.00	46	6	78	74
9	<0.02	0.00	33	8	88	60
10	<0.02	0.00	37	10	126	69
11	<0.02	0.00	38	6	105	60
12	<0.02	0.00	28	17	102	41
13	<0.02	0.00	27	8	86	43
14	<0.02	0.00	28	6	125	47
15	<0.02	0.00	30	6	73	56
16	<0.02	0.00	36	7	83	65
17	<0.02	0.00	36	6	95	77
18	0.04	0.00	27	6	78	52
19	0.04	0.00	33	5	77	57
20	<0.02	0.00	32	12	114	60
21	0.07	1.11	49	9	201	83
22	0.24	1.77	47	27	334	77

[1]Analyses by N.D. Coursey, DGGS geochemical analyst, and D.R. Stein, DGGS assayer.
[2]Gold in part extracted for gold fineness test (table 4).
All samples contained less than 1 ppm Mo.

Table 3. Mineralogical analyses of selected pan concentrates from Bowman placer group, Iliamna district, Alaska

Sample	Minerals present[1]
1	Major: magnetite, ilmenite, clinoenstatite, hypersthene, titanite. Minor: epidote.
8	Major: magnetite, hypersthene, epidote, diopside, titanite hornblende. Minor: tourmaline, chlorite. Gold grains: one coarse nugget (1 pennyweight).
10	Major: magnetite, hematite, hypersthene, epidote, pyrite, barite. Minor: garnet, zircon.
22	Major: magnetite, hematite, pyrite, epidote, barite. Minor: zircon.

[1]X-ray work by N.C. Veach, DGGS assayer chemist; only minerals with ≥3.3 specific gravity analyzed. Major ≥10 percent, minor ≤10 percent of sample.

Table 4. Gold fineness test, Portage Creek gold, Lake Clark, Alaska[1]

Sample weight (g)	1.11743
Gold fineness	734
Silver (wt %)	8.25
Other impurities (wt %)	19.35

[1]Atomic absorption spectrophotometry by N.D. Coursey, DGGS geochemical analyst.

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