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GEOLOGY AND MINERAL RESOURCES OF IDITAROD MINING DISTRICT, IDITAROD B-4 AND EASTERN B-5 QUADRANGLES, WESTCENTRAL ALASKA

By

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Alaska Division of
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CONTENTS

	Page
Introduction and acknowledgments	1
Bedrock geology	1
Quaternary geology	7
Structural geology	10
Economic geology	10
Introduction	10
Mining history	12
Placer mining methods	18
Lode deposits	19
Introduction	19
Golden Horn deposit	19
Chicken Mountain gold prospects	22
Prospects north of Flat	22
Other prospects	29
Mineralized dikes	29
Coal	29
Geomorphology of placer deposits	30
Chicken Mountain stream placers	30
Placer deposits of Otter Creek drainage	33
Discussion of lode and placer deposits	35
Bibliography	37
Description of map units	39
Unconsolidated deposits	39
Sedimentary and volcanic rocks	41
Plutonic rocks	43
Metamorphic rocks	44

FIGURES

Figure 1. Schematic section of Cretaceous sedimentary rock units in Iditarod B-4 and eastern B-5 Quadrangles showing interfingering relationships of individual lithologic units	On plate
2. Otter and Black Creek valleys with Chicken Mountain in the foreground, looking south-southwest	9
3. Aerial shot of Ruby Creek area south of Iditarod-Nixon Fork fault showing anticline of 'upper' sands plunging underneath Kls section	11
4. Pre-1987 aerial shot of Golden Horn deposit showing location of shaft and trenches; keyed to table 8	20
5. Photograph of enechelon quartz-freegold ± cinnabar veins, Idaho Bench, offsite from summit of Chicken Mountain	23
6. Aerial photograph interpretation showing Chicken Mountain stream drainage evolution	On plate
7. Prince Creek drainage looking north showing older terrace or bench levels on eastern limit and modern stream on western limit	32

TABLES

Page

Table 1. Fossil identifications in the Iditarod B-4 and eastern B-5 Quadrangles, Alaska.................................... 2
2. Paleocurrent data from Cretaceous sedimentary rocks, Iditarod B-4, eastern B-5 Quadrangles, Alaska.......... 4
3. Major oxide analyses and CIPW norms of igneous rocks, Iditarod B-4, eastern B-5 Quadrangles, Alaska.......... 6
4. Analytical data for K-Ar determinations.................... 8
5. Gold and silver production in the Iditarod/Flat district, 1910-1987.. 13
6. Partial dredge statistics for Iditarod district............ 16
7. Production from the Golden Horn lode mine.................. 17
8. Analytical results from mines, prospects, and mineral occurrences, Iditarod B-4 and eastern B-5 Quadrangles, Alaska.. 24

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INTRODUCTION AND ACKNOWLEDGMENTS

The Iditarod B-4 and eastern B-5 Quadrangles lie in the central portion of the Kuskokwim Mountains, a maturely dissected upland of accordant rounded ridges and broad, sediment-filled lowlands. Elevations range from 280 feet (88 meters) in the Iditarod flats near the abandoned townsite of Iditarod (pl. 1) to a 2,850 feet (868 meters) high unnamed mountain 5 km north of Discovery (pl. 1). The study area constitutes most the Iditarod mining district, an important Alaskan gold precinct which has been in near continuous development and production since its discovery on Christmas Day, 1908. The technical results presented here are prepared in cooperation with the U.S. Geological Survey, which is completing their studies in the Iditarod Quadrangle under a program funded under the Alaska Mineral Resource Assessment Program. Publication costs of the enclosed multicolored map were provided by Doyon Regional Corporation.

We thank John and Mary Miscovich, John and Richard Fullerton, Alvin Aghoff, Ken Dahl, Ann Williams, and other residents and miners of the Iditarod district for their valuable assistance and correspondence concerning the geology and resources of the study area. The assistance of Bruce Gamble, R. Game McGinsey, and Linda Angelloni (USGS), and Mark S. Lockwood (formerly with DGGS) is gratefully acknowledged. Jason Bressler (WGM, Inc., Anchorage) who previously mapped the Chicken Mountain and Black Creek areas, shared valuable insights with the authors.

BEDROCK GEOLOGY

The oldest exposed units crop out in the western part of the study area and consist of recrystallized, black radiolarian chert, tuffaceous sandstone, andesitic basalt flows and flow breccia, and volcanic agglomerate (PzJc, pl. 1). This poorly exposed unit is believed to be equivalent to the Innoko Terrane (Patton, 1978; Patton and others, 1980; Chapman and others, 1982; Miller and Bundtzen, 1987). Based on field mapping in the Iditarod D-1, D-2, and C-3 Quadrangles (Bundtzen and Laird, 1982; Bundtzen and Laird, 1983; Bundtzen and others, 1988), we believe that Innoko Terrane lithologies underlie the Cretaceous section north of the Iditarod-Nixon Fork Fault.

The major stratigraphic units in the study area are poorly exposed sandstone, conglomerate, siltstone, and shale of the Kuskokwim Group, which was first defined by Cady and others (1955), and ranges in age from late Early to Late Cretaceous. Limited fauna collections made during this investigation are of Turonian (early Late Cretaceous) age (table 1). Two contrasting stratigraphic sections of the Kuskokwim Group are juxtaposed against the Iditarod-Nixon Fork Fault, which bisects the region into two roughly equal areas. Layered rock units southeast of the Iditarod-Nixon Fork fault consist of a folded and highly deformed section of undifferentiated turbidites (Kls) successively overlain by lithic sandstone (Ks) coarse volcaniclastic pebble sandstone (Kcs) and siliceous

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Table 1. Fossil identifications in the Iditarod B-4 and eastern B-5 Quadrangles, Alaska.[1]

Map no.	Field no.	Location and description of collection site	Fossil identification and age estimate
	84BT239	62°29'00" lat; 157°53'10" long on eastern slope of high elongate 'hornfels' mountain at 1,700 ft elevation in hornfels.	Conifer leaf similar to those described by Hollick (1930) as *Sequoia obovata*, now regarded as *Metasequoai cuneata*. Dicot leaves of platanoid affinity; vein orientation most similar to those of Late Cretaceous-Early Tertiary; could be as old as Cenomanian but probably Turonian to Paleocene in age.
	84BT97	62°21'15" lat; 157°53'50" long; in placer mine cut along Prince Creek at 380 ft elevation; in Ksh unit.	Complete *Inoceramus hobetsensis* of probable Turonian age.
	84BT17	62°26'10" lat; 157°40'00" long; along bluff on northwest bank of Bonanza Creek at 600 ft elevation. Shells found at base of turbidite cycle.	Three complete *Inoceramus* shells of probable Late Cretaceous age; specific age determination in process.

[1] Identifications by John W. Miller (USGS; fauna) and Robert Spicer (University of London Goldsmith's College, England; flora).

fine grained sublithic sandstone (Kfss) units that may indicate a coarsening and then shallowing(?) upward marine regime at least 5,000 m thick. The stratigraphic base is not exposed in the study area. The Kls, Ks, and Kcs units exhibit graded beds, flutes and other high-energy flow regime indicators whereas the Kfss unit contains stacked cosets and other cross stratification features generally lacking in high energy flow regime environments. In the Ruby Creek area, the stratigraphic succession may be a series of at least two nearly identical, large-scale, cyclic, depositional sequences. A less viable explanation for the apparent repetition of beds would be one or several poorly exposed thrust faults structurally juxtaposing the older Kls unit above younger Kcs-Ks-Kfss-Kfs lithologies. Poor exposure and lack of detailed fossil control prevented the authors from reaching any firm conclusions that could adequately explain the apparent repetition of the section. Poorly exposed, somewhat enigmatic volcanic agglomerate and brecciated chert (Kac) crop out in the Widgeon Creek drainage. The stratigraphic position of Kac unit is unknown but it may be equivalent to volcanogenic units of mid-Cretaceous(?) or Late Cretaceous-Early Tertiary age exposed in the northeastern Iditarod Quadrangle (Miller and Bundtzen, 1987; Bundtzen and others, 1988).

Northwest of the Nixon-Iditarod fault the estimated 2,200 m thick section is similar to that described near Moore Creek (Bundtzen and others, 1988) to the northeast. The oldest recognized unit consists of shale (Ksh) overlain by calcareous turbidites rich in *Inoceramus* shell fragments and plant debris (Ktls). Increasing amounts of flora rich, medium to coarse grained lithic sandstone and siltstone (Ks, Kcs) overlie the calcareous sands. In these units the presence of Ta-c Bouma intervals (Mutti and Ricci Lucchi, 1972), sand-shale ratios of about 4:1, and channeled sandstone bodies, is suggestive of multiple wedge-shaped, turbidite fan cycles. Near the top of the section, significantly 'cleaner' sublithic quartz rich sandstone, and plant-rich shale (Kfss) dominate the rock lithologies. The Kfss lithologies do not have turbidity current or high flow regime sedimentary structures and instead contain siltstone and shale interbeds with abundant stacked cosets and other low flow regime cross-stratification features. The sedimentary structures present suggest that Kfss may represent a marginal sea or shallow marine environment. The Kfss unit is believed to be equivalent to lithologies at the top of the Cretaceous section southeast of the Iditarod-Nixon Fork fault previously discussed. Sparce paleocurrent data (table 2) from high energy flow regime indicators in turbidites indicate southerly or southwestly current directions.

Quartz rich sublithic sandstone, quartz pebble conglomerate, and plant bearing shale and siltstone of the Kqs unit form the distinctive western margin of the Kuskokwim Group in the study area. The presence of leaf beds, uncommon coal seams and coquina composed of brackish-to-subtidal-to-nonmarine pelecypods suggest that the unit represents a shoreline section with nonmarine components. This very distinctive assemblage of rock types extends to Mosquito Mountain (Iditarod A-6 Quadrangle) some 65 km southwest of Flat and discontinuously to Fossil Mountain (Medfra Quadrangle) some 150 km to the northeast and represents the western edge of the Kuskokwim Group sedimentary basin (Miller and Bundtzen, 1987). Field relationships strongly suggest that the Kqs unit represents a stable shoreline sequence that successively overlaps the sedimentary sequence in the form of an upward marine regression (fig. 1, pl. 1). The absence of consistant unidirectional cross laminations, the relatively poor sorting observed in coarser siliceous conglomerate and sands, and the laminated nature of quartz rich units in both the Kfss and Kqs unit suggest that both units could represent a storm(?) dominated shoreline-shallow marine shelf section similar to that described in the present gulf of Alaska (Sharma and others, 1972) or the present day Oregon Shelf (Kulm and others, 1975).

Intruding and overlying the Cretaceous clastic rocks are Late Cretaceous-Early Tertiary subaerial volcanic rocks, comagmatic monzonitic plutons, peraluminous rhyolite

Table 2. Paleocurrent data from Cretaceous sedimentary rocks, Iditarod B-4, eastern B-5 Quadrangles, Alaska.

Map (field) no.	Azimuth (corrected for tilt)	Mean	Flow regime
1(84BT18)	190°	182°	upper (flute casts)
	185°		
	180°		
	165°		
	190°		
2(84BT17)	245°	234°	lower (crossbeds)
	220°		
	230°		
	240°		

sills and altered mafic dikes. The volcanic rocks are exposed in mine cuts at Otter Creek, as roof pendants on Chicken Mountain, and on outlier ridges east of Swinging Dome. The volcanic rocks are subdivided into porphyritic andesite and altered crystal tuff (TKvi) and minor olivine augite basalt (TKvm). Both units have been metasomatically altered by underlying and slightly younger monzonitic plutons and volcanic rocks commonly contain biotite, chlorite, and sphene replacing original mafic minerals in phenocrysts and in the groundmass. Because volcanic rocks retain much of their original extrusive textures and mineralogy, they are not depicted as hornfels on plate 1. Four separate plutonic bodies are exposed on Chicken Mountain, in the valley of Otter and Black Creeks at the head of Boulder Creek, and on Swinging Dome. The Chicken Mountain, Boulder Creek, and Black Creek bodies contain variable amounts of olivine biotite monzodiorite, biotite-diopside monzonite, and minor biotite quartz monzonite; the Chicken Mountains pluton also contains a small but significant percentage of biotite olivine gabbro and olivine-bronzite picrite--variation wehrlite. The Swinging Dome pluton appears to be composed of near equal amounts of biotite-diopside monzonite and biotite quartz monzonite. The reaction relationship olivine-clinopyroxene-orthopyroxene-biotite $\pm$ amphibole can be demonstrated in all four plutons and suggests that a well developed differentiation process occurs in the plutons. Accessory minerals include zircon, edenite, chrome spinel, and ilmenite; magnetite is nearly lacking in the plutonic samples examined and overall opaque mineral contents is low ($\leq$3 percent)--unusual for these mainly intermediate rocks. Pan concentrate data from residual sites directly on plutonic rocks also contain richterite, radioactive zircon, fluorapatite, hyperstene, hastingsite, and enstatite--suggesting these minerals also occur in the plutons (Bundtzen and others, 1987).

Feldspar geothermometry calculations by Bull (1988) show crystallization temperatures in monzodiorite on Chicken Mountain of 608-694°C; monzonite on Chicken Mountain of 583-741°C; and quartz monzonite also on Chicken Mountain of 417-1,376°C. Bull (1988) also demonstates, when plotting the feldspar crystallization temperatures on the granite minimum curve, emplacement pressures of the Chicken Mountain stock at 1.0-1.5 kilobars--equal to 1-4 km of depth. These results indicate shallow, epizonal conditions of magma formation.

The three plutonic bodies on Chicken Mountain, Black Creek, and Boulder Creek appear to be aligned in a N. 5 E. direction over a distance of 15 km, which is similar to a near identical alignment of monzonitic plutons north of the Iditarod-Nixon Fork fault (I-NF) in the Moore-Moose Creek area 75 km northeast of Chicken Mountain (Bundtzen and others, 1988).

All plutons in the study area have thermally metamorphosed enclosing host lithologies leaving prominant resistant ribs and rims of dark gray dense hornfels nearly exclusively derived from Cretaceous clastic rocks. Thermal alteration extends up to 2 km away from plutonic-sediment contacts. The hornfels aureole gradationally blends with unaltered Cretaceous clastic rocks away from the plutons.

Numerous intermediate dikes and altered mafic dikes intrude the Cretaceous sedimentary rocks north of the I-NF fault. Corundum normative, garnet-bearing, biotite alaskite sills and dikes intrude the I-NF fault strands, the Moose Creek Fault and in other areas. The alaskite dikes intruding the I-NF fault have been radiometrically dated at approximately 65 m.y. and constitute the primary evidence for a minimum age for the fault.

Whole rock major-oxide chemical analyses and CIPW norms for igneous rocks in table 3 are similar to analyses previously published for time-equivalent, igneous lithologies to the northeast (Moll and others, 1981; Bundtzen and Laird, 1982, 1983a, 1983b). On the average, volcanic rocks and monzonitic plutons in the regional sense are part of a meta-

Table 3. Major oxide analyses[a] and CIPW norms of igneous rocks, Iditarod B-4, eastern B-5 Quadrangles, Alaska.

Map no. Field no. Rock type	1 84BT242 Monzo-diorite (TKm)	2 84BT241b Andesite (TKvi)	3 84BT280 Mafic dike (TKmd)	4 84AM135a Mafic dike (TKmd)	5 84AM137m Mafic dike (TKmd)	6 84AM140a Mafic dike (TKmd)	7 84AM125A Andesite (TKvi)	8 84GL003 Altered monzonite (TKmd)	9 84GL004 Mafic dike (TKmd)	10 84BT311 Andesite (TKvi)	11 84BT306a Basaltic andesite (TKva)	12 85BT117 Quartz monzonite (TKm)	13 84BT101 'Gabbro' (TKg)	14 84BT98 Monzonite (TKm)	15 84BT288 Rhyolite porphyry (TKr)
SiO_2	54.73	62.80	53.10	54.01	50.17	54.24	57.37	60.68	50.35	59.07	55.64	69.64	59.94	58.41	74.93
Al_2O_3	17.20	17.47	13.05	16.87	14.60	15.03	15.56	15.07	15.73	17.88	11.98	17.17	17.34	16.61	14.35
Fe_2O_3	2.35	2.11	2.27	2.31	2.20	2.21	2.06	2.21	2.93	2.86	7.08	1.73	2.26	2.31	0.15
FeO	3.08	1.68	5.57	4.68	4.73	4.56	2.72	2.55	4.39	2.84	5.07	0.52	3.25	2.88	1.28
MnO	0.09	0.03	0.17	0.14	0.12	0.16	0.12	0.08	0.12	0.10	0.16	0.03	0.05	0.08	0.00
MgO	5.95	1.89	7.42	6.40	8.55	8.08	2.26	2.61	4.19	2.23	9.56	0.42	3.32	4.27	0.04
CaO	6.19	0.87	8.44	5.62	6.17	5.01	5.55	4.41	7.49	5.65	6.40	0.62	2.49	3.97	0.11
Na_2O	3.46	3.28	1.72	2.75	2.30	2.55	4.14	4.41	3.46	3.78	2.05	3.81	3.02	3.55	0.61
K_2O	4.09	6.49	0.38	0.35	0.36	0.88	2.85	0.98	0.56	2.86	2.38	4.17	3.34	5.28	5.39
TiO_2	0.85	0.61	0.77	0.81	0.70	0.71	0.56	0.71	1.43	1.36	0.58	0.23	0.76	0.82	0.06
P_2O_5	0.59	0.33	0.26	0.19	0.13	0.14	0.34	0.21	0.28	0.41	0.30	0.17	0.54	0.57	0.03
LOI	1.08	1.92	6.23	6.37	9.40	5.88	6.29	5.22	8.18	1.11	1.44	1.82	1.80	0.51	2.73
Total	100.01	99.48	99.39	98.50	99.23	99.31	99.82	99.09	99.12	99.65	97.64	100.31	98.11	99.15	99.68
Norms															
Quartz	0.000	15.331	13.697	14.196	8.364	11.835	9.651	19.368	7.739	14.674	7.506	30.508	20.243	3.795	52.135
Corundum	0.000	4.364	0.000	0.221	0.000	1.185	0.000	0.000	0.000	0.098	0.000	5.755	5.733	0.000	7.617
Orthoclase	24.515	39.308	2.411	2.245	2.368	5.557	18.005	6.169	3.639	17.150	14.620	25.018	20.493	31.628	32.852
Albite	29.695	28.446	15.623	25.256	21.663	23.058	37.450	39.752	32.195	28.163	18.031	32.730	26.537	30.449	5.374
Anorthite	19.598	2.216	28.733	28.915	31.062	25.584	16.524	19.489	28.302	25.727	17.108	1.996	9.166	13.967	0.161
Diopside	6.048	0.000	11.585	0.000	1.649	0.000	8.514	1.882	8.456	0.000	11.074	0.000	0.000	1.818	0.000
Hypersthene	12.121	5.229	22.204	23.385	29.530	27.571	4.686	7.973	11.279	6.446	26.661	1.062	11.633	12.155	0.110
Olivine	2.545	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Magnetite	3.456	3.136	3.533	3.635	3.551	3.424	3.193	3.414	4.672	4.208	3.135	1.064	3.402	3.395	0.000
Hematite	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.023	0.000	0.000	1.475
Ilmenite	1.638	1.187	1.570	1.670	1.480	1.441	1.137	1.437	2.987	2.621	1.145	0.444	1.499	1.559	0.167
Apatite	1.386	0.783	0.646	0.478	0.325	0.346	0.842	0.518	0.713	0.963	0.722	0.400	1.298	1.221	0.072
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Differentiation index	54.21	83.08	31.73	- -	32.39	- -	65.11	65.28	43.59	59.93	40.16	88.26	67.26	65.87	90.41

[a]Analytical results by I.A. Benjamin and M.K. Pully using X-ray fluorescence methods, DGGS Minerals Laboratory, Fairbanks, Alaska. Ubiquitous alteration of mafic dikes (note high LOI) makes their respective norms questionable. Bull (1988) reports 18 additional major oxide analyses from igneous rocks in the study area.

aluminous, alkali-calcic suite whereas the rhyolite and alaskite sills are pre-aluminous calc-alkaline magmas. Bull (1988) presents major oxide data with stronger alkaline trends than shown in our data (table 3). Eight of Bull's plutonic rocks are quartz normative and ten are nepheline normative. Two of nepheline normative samples contain leucite as well. Hence the intrusions underlying Chicken Mountain and Black Creek are olivine bearing quartz-alkalic variants of the regional 'Kuskokwim trend' igneous suite. Potassium-argon ages from biotite, muscovite, amphibole, and whole rock sample splits of all igneous types range from 64.3 to 70.9 m.y., (table 4) typical of the 'Kuskokwim trend' summarized by Wallace and Engebretson (1984).

QUATERNARY GEOLOGY

Eight Quaternary geologic units were subdivided on the basis of photogeology and ground reconnaissance. Most of the study area was not glaciated during Pleistocene time; however, morphological features including breached divides, planated summit levels and crude 'U' shaped upper valley forms suggest that prior to 70,000 year B.P. (Early Wisconsin Age), the summits of Chicken Mountain and the head of Boulder Creek contained permanent snow fields or limited glacial ice. Accordant rounded ridges underlain by Paleozoic-Cretaceous sedimentary rocks average 1,400 feet (426 m) elevation and are in marked contrast to the igneous cored massifs averaging 2,300 feet (700 m) in elevation. In the former area, a trellis drainage system developed, whereas a radial drainage system characterizes the igneous-cored Chicken Mountain area. Terrace levels and slope deposits (Qat, Qaf, Qsf, Qc) evolved in respond to several factors including: 1) the erosion of slopes and stream valley walls during Late Tertiary and Quaternary time in a periglacial environment and 2) influence of structural controls, mainly faults and folds as they affect uplift and landform tilting in the region.

An asymmetrical valley, one in which opposing sides have markedly different inclinations, is the characteristic stream profile in the Iditarod mining district. Here the steep valley walls face north or east while the more gentle slopes face south or west. This is considered normal asymmetry (Melton, 1960) and is probably the result of greater solifluction activity on south or southwesterly slopes due to the larger intervals of thermal exposure (in contrast to valley slopes of northerly or easterly aspect which receive less thermal collection). Hence the permafrost thaws differentially and colluvial materials are moved down the south or west facing slopes and advance toward east or north-facing, frozen buttresses. This has the effect of forcing perennial streams to migrate south or west and position active channels against the steepened frozen valley wall. During migration, the stream leaves a successive series of older bench or alluvial terraces depicted as Qaf and Qat units on the map. A southwesterly or westerly stream migration is generally evident throughout the study area. The effects of asymmetrical valley evolution on distribution of heavy mineral placer deposits are discussed in the economic geology section of this report.

The summit of Chicken Mountain and the upland north of Granite Creek exhibit inactive but well preserved cryoplanation terraces (fig. 2). 'Cryoplanation' occurs on ridge crests and hilltops when nivation erodes bedrock in transverse nivation hollows causing entrenchment of the hollows. Frost action, water piping, and wind deflation act in concert with nivation to produce the terrace like rubble products of the cryoplanation feature. On Chicken Mountain both ridge crest and hilltop cryoplanation forms are present between 2,120 ft (646 m) elevation and the 2,380 ft (725 m) summit. Scarp heights vary from about 8 ft (2.5 m) to over 35 ft (10 m) and the scarps average face measures 22°. From a distance the surfaces appear planar but they are actually broad convex slopes dipping several degrees to the south that contrast with steeper surrounding surface features. Prominant monzonite tors remnant of earlier cryoplanation levels characterize the western slopes of Chicken Mountain. The main Chicken Mountain cryoplanation terrace covers some 6 km^2

Table 4. Analytical data for K-Ar determinations.

Map no. Rock type Mineral dated	1(84BT242)[a] Monzo-diorite Biotite	2(84BT240)[a] Rhyolite dike Whole rock	3(81BT'Flat')[b] Gabbro Biotite	4(83BT360a)[a] Monzo-diorite Amphibole	4(83BT360b)[a] Monzo-diorite Biotite	5(84BT288a)[a] Peraluminous rhyolite Biotite	5(84BT288b)[a] Peraluminous rhyolite Whole rock
K_2O (wt. %)	9.229	4.148	7.423	0.313	7.857	8.479	5.468
Sample wt. (g)	0.1211	1.6184	0.1892	0.9128	0.2398	0.0977	1.4318
$^{40}Ar_{(rad)}$ (moles/g) x 10^{-11}	98.7154	42.5965	68.8885	3.1500	81.80	86.2536	51.5209
$^{40}Ar_{(rad)}$/^{40}K x 10^{-3}	4.1862	4.1448	3.7466	4.0700	4.200	4.1061	3.8030
% $^{40}Ar_{(rad)}$	84.05	85.96	70.00	37.61	20.20	86.77	97.09
Age ± 1 δ (m.y.)	70.65 ± 2.12	69.97 ± 2.1	65.0 ± 3.9	68.70 ± 2.1	70.9 ± 2.1	69.32 ± 2.0	64.30 ± 1.9

Constants used in age calculations $\delta_e + _e = 0.581 \times 10^{-10}\ yr^{-1}$

$\delta_B = 4.962 \times 10^{-10}\ yr^{-1}$

$^{40}K/K$ total $= 1.167 \times 10^{-4}$ mol/mol

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[a] Analyses by Robin M. Cottrell and D.L. Turner, Alaska Cooperative Geochronology Laboratory.

[b] Analyses by D. Krummenaker, San Diego State University.

Figure 2. Otter and Black Creek valleys with Chicken Mountain in the foreground, looking south-southwest. Note flattened cryoplanation terrace on Chicken Mountain.

while the prominant upland surfaces north of Granite Creek are 2 and 4 km^2 in area. Bedrock rubble veneer ranges from 1 to 3 m in depth and is sometimes thicker on the oldest rims of the terrace levels.

Eolian silt deposits of variable thickness once covered most of the area during Pleistocene time, but subsequently silt has been retransported downslope by water mechanisms to form silt fans at valley wall apexes. These deposits are generally ribbed with ice and are continuously frozen in valley fills, although some patches on southerly slopes are thawed.

STRUCTURAL GEOLOGY

The Iditarod-Nixon Fork fault (I-NF) a major transcurrent fault in western Alaska, and the major structural feature we observed, bisects the map area diagonally in a southwest-to-northeast direction. The valley of Bonanza Creek marks its trace for most of its length in the study area.

This fault juxtaposes a thin 2,200 m thick section to the northwest against a much thicker (>5,000 m) turbidite dominated section in the southeast. Faint escarpments along Bonanza Creek suggest Quaternary activity. Since 65 to 69 m.y. old rhyolites were also emplaced along the fault, the I-NF system shows evidence of movement since that time. Miller and Bundtzen (1988, in press) have proposed a right lateral offset solution of 94 km since Late Cretaceous time for the I-NF fault. These workers suggest that volcanic stratigraphy in the Donlin Creek area (Iditarod A-5 Quadrangle) is equivalent to similar rocks in the Moore Creek area (Iditarod C-3 Quadrangle) to the northeast.

The Golden Horn fault in the north-central part of the study area juxtaposes hornfels against stratigraphically lower volcanics north of Otter Creek. The fault trends N. 5 E. and appears to control the emplacement of at least three monzonitic plutons. It is similar to a N. 5-10 E. plutonic alignment described by Bundtzen and others (1988) near Moore Creek.

Volcanic and sedimentary rocks northwest of the I-NF fault have been folded into broad, open northeast trending synclines and anticlines with amplitudes of 2 to 3 km; plunge directions of these structures appears to be to the southwest. The structural deformation southeast of the I-NF fault consists of a series of doubly folded anticlines and synclines and transcurrent high angle faults with significant right lateral drag features. An apparent repetition of the Kuskokwim Group section south of Ruby Creek (pl. 1) may be represented by several nearly identical cycles of sedimentary deposition (fig. 3). A less viable alternative would be one or a series of imbricate thrust faults poorly delineated in the rock section.

Drag features and disrupted fold axes suggest significantly more compressional stress directed at the stratigraphic section southeast of the Iditarod-Nixon Fork fault. The main Nixon-Iditarod fault may have acted as a structural buttress against which compressional stress is directed from a southeast direction.

ECONOMIC GEOLOGY

Introduction

The study area centers on the Iditarod mining district, which has been in continuous production from 1910-1987 and ranks as Alaska's third largest producer of placer gold. Total production through 1987 is estimated at 1,450,894 ounces (45,122,803 g) gold, 196,624 ounces (6,115,006 g) silver, and minor amounts of tungsten and mercury mainly from

Figure 3. Aerial shot of Ruby Creek area south of Iditarod-Nixon Fork fault showing anticline of 'upper' sands plunging underneath Kls section.

placer mineral deposits (tables 5 and 6). Some 2,706 ounces (84,156 g) of gold (or 0.182 percent of the districts total) has been derived from the Golden Horn lode deposit (table 7).

Lodes consist of vein-disseminate and shear zone deposits in both plutonic stocks and overlying cap rocks that contain gold, tungsten, mercury, antimony, and silver. A continium of residual, elluvial, modern stream and terrace placer deposits derived from the lodes have all been exploited for their gold values.

Mining History

Much of the following is discussed in further detail in Smith (1915), Brooks (1916), Eakin (1913, 1914), Mertie and Harrington (1924), Mertie (1936), and Kimball (1969), and will only be summarized here. Placer gold was first identified at Discovery near the present John Miscovich family mine on Otter Creek (pl. 1) on Christmas Day 1908, by gold prospectors W.A. Dikeman and John Beaton. During the following summer (1909), many prospectors, including several hundred from the boom towns of Fairbanks and Nome, arrived into the country. Miners and equipment traveled by boat along the Yukon River, up 900 km of the Innoko River, and 200 km of the Iditarod River to the settlement of Iditarod. Equipment was then transported overland 10 km to the mining camps, principally the settlement of Flat at the confluence of Flat and Otter Creeks. Because of these access difficulties actual production was not initiated until the winter of 1910. Rich, shallow, easily accessible placer deposits were quickly discovered, and the gold production rapidly grew to an all time high of 169,312 ounces (5,265,603 g) gold and 29,778 ounces (926,095 g) silver by 1912. Nearly 2,500 people were actively engaged in mining, prospecting, and general commence in the region during this time (Eakin, 1914, p. 34); 975 of these were miners. Based on examination of state and federal production records, Otter and Flat Creeks became the largest stream producers and accounted for 235,721 (7,330,923 g) and 477,039 ounces (14,835,912 g) of gold respectively from 1915 to 1986. These figures do not account for undistributed values of 482,382 ounces (15,002,080 g) of gold (or 33.2 percent of the total) recorded during 1910-1914, most of which was produced from Otter and Flat Creeks (Bundtzen and others, 1987). Assuming that Otter and Flat Creeks' share of this 1910-1914 undistributed production is the same as that known from other available records, Otter and Flat Creeks account for approximately 1,067,000 ounces (33,183,700 g) of gold or about 74 percent of the districts' total production. By 1912 gold had also been discovered on Happy, Willow, Black, and Chicken Creeks and Glenn Gulch; gold was discovered on Prince and Granite Creeks in 1913, Slate Creek in 1915, and Boulder Creek in 1917. Hence virtually all known commercial placer deposits within the study area had been discovered in the 9 years after the 1908 discovery. Gold production remained relatively high through 1917 but began to markedly drop off after the United States entrance into World War I, when many miners left the region to join the war effort. Production steadily fell in the late 1920s and early 1930s but picked up after President Franklin D. Roosevelt raised the price of gold to $35 per ounce from the long time standard of $20.67 per ounce. Production activities peaked for a second time in 1941 at 23,257 ounces gold (refined) but dropped off after the United States's entrance into World War II. Federal Order L208, enacted in late 1942 allowed for gold mining in the Iditarod area only on a permit basis because it was considered nonessential to the war effort. Placer mining in the Iditarod-Flat area again rose after the war for a number of years, but steadily declined in the 1950s due to inflation vs. the fixed price of gold, and the existence of more attractive, post-Korean war military and civilian construction efforts nearby such as Tatalina and Sparvohn Air Force stations, which offered experienced placer miners better paying jobs. Small levels of activity continued through the 1960s although mining records are poor for the years 1967-1979. The federal price decontrol of gold in 1972 led to a modest revival of placer mining

Table 5. Gold and silver production in the Iditarod/Flat district, 1910-1987.[1]

Year	Volume gold (oz)	Volume silver (oz)	No. of mines or mining companies reporting	Employment[13]	Total bullion value ($)	Source
1910	24,187	4,254	16	250	520,000	Mertie and Harrington (1924)
1911	120,937	21,270	30	850	2,610,000	"
1912	169,312	29,778	36	975	3,500,000	"
1913	89,977	9,551	30	750	1,860,000	"
1914	99,652	10,578	29	500	2,030,829	"
1915	99,168	10,526	24	485	2,059,000	"
1916	94,339	10,013	15	400	1,960,000	"
1917	72,568	11,050	12	NA	1,532,000	Smith (1933a)
1918	59,990	8,278	4	NA	1,255,000	"
1919	35,074	4,770	15	90	726,000	"
1920	24,400	3,347	10	NA	505,000	"
1921	16,935	2,353	22	214	354,000	"
1922	13,550	1,828	17	164	282,000	"
1923	11,030	1,544	18	144	229,000	"
1924	10,019	1,653	30	135	207,100	"
1925	10,793	1,618	9	NA	223,100	"
1926	12,143	1,687	23	120	251,000	"
1927	7,270	1,090	9	NA	151,000	"
1928	14,329	2,221	15	NA	296,200	"
1929	13,401	2,412	17	102	277,000	"
1930	8,901	1,339	11	90	184,000	Smith (1933b)
1931	11,850	1,599	10	90	231,000	Smith (1933b)
1932	17,610	2,641	18	125	364,000	Smith (1934)
1933	13,050	1,774	19	125	261,000	Smith (1934)
1934	16,400	2,205	18	NA	574,000	Smith (1937)
1935	13,085	1,724	18	150	458,000	Smith (1937)
1936	15,608	1,769	10	135	546,300	Smith (1938)
1937	19,828	2,696	8	32	694,000	Smith (1940)
1938	21,171	2,880	11	250	741,000	Smith (1940)
1939	22,171	3,325	10	NA	776,000	Smith (1942)
1940	22,942	3,120	10	NA	803,000	Smith (1942)
1941	23,257	3,232	19	142	814,000	Smith (1944)
1942	16,628	1,394	15	NA	582,000	Smith (1944)

Table 5. (con.)

Year	Volume gold (oz)	Volume silver (oz)	No. of mines or mining companies reporting	Employment[13]	Total bullion value ($)	Source
1943	4,225	659	6	NA	147,875	Unpublished U.S. Mint Records
1944	NA	NA	NA	NA	NA	"
1945	1,114	171	8	NA	38,990	"
1946	8,301	1,178	12	NA	290,535	"
1947	10,550	1,392	13	NA	369,250	"
1948	9,850	1,008	NA	NA	344,750	"
1949	8,268	1,314	11	62	289,380	"
1950	8,183	975	12	59	286,405	Williams (1950)
1951	6,096	909	9	NA	213,360	"
1952	6,778	1,058	8	NA	237,230	"
1953	8,423	1,354	14	NA	294,805	"
1954	6,798	1,088	7	NA	237,930	"
1955	6,142	910	8	NA	214,970	Unpublished U.S. Mint Records
1956	8,784	1,225	7	NA	307,440	"
1957	8,434	1,252	5	NA	295,190	Unpublished State of Alaska Records
1958	7,187	1,025	7	NA	251,545	"
1959	5,762	837	6	NA	201,670	"
1960	7,576	1,093	6	NA	267,200	U.S. Mint Rec.
1961	5,911	871	5	NA	206,885	"
1962	4,918	707	5	NA	172,130	State of AK. Rec.
1963	5,219	743	5	NA	182,665	"
1964	5,490	777	4	NA	192,150	"
1965	4,662	672	4	NA	163,170	"
1966	4,319	660	3	NA	151,165	"
1967	NA	NA	NA	NA	NA	"
1968	2,241	314	5	NA	78,435	"
1969	760	101	2	NA	26,600	"
1970	458	51	1	NA	16,030	"
1971-79	11,150	1,732	3	NA	3,200,000	"
1980	2,820	375	3	3	1,201,320	"
1981	3,535	445	3	22	1,452,885	"
1982	4,560	638	4	24	1,824,000	"
1983	4,400	590	4	23	1,760,000	"

Table 5. (con.)

Year	Volume gold (oz)	Volume silver (oz)	No. of mines or mining companies reporting	Employment[13]	Total bullion value ($)	Source
1984	2,500	315	3	20	900,000	"
1985	3,630	486	5	20	1,179,750	"
1986	4,180	468	5	22	1,588,400	"
1987	4,500	612	4	23	2,025,000	"
Undistributed	35,728	NA	NA	NA	NA	
Totals	1,450,894	196,624	- -	- -	48,681,399	

[1]Production compiled using cited references above. Much of the data from 1910-42 is from U.S. Geological Survey records; production in the late 1940's and 1950's are from the U.S. Bureau of Mines and U.S. Mint returns, and 1959-87 are mainly State of Alaska records. Gold prices were $20.67 from 1910-33; $35/oz from 1934-72; and variable prices since then.
NA = records not available or not applicable.

Table 6. Partial dredge statistics for Iditarod district.
Yukon Gold Company (Flat Creek), from Brooks (1916).

Season	Duration	Number of days	Cubic yards handled	Yield total ounces gold	Ounce/ yd^3	Operator costs
1912	8/15-10/29	75	172,333	19,547	0.113	$ 79,114
1913	5/8-11/25	201	496,756	40,029	0.081	$319,560
1914	5/4-11/11	191	668,737	35,782	0.054	$335,560
1915	5/4-11/17	196	926,956	40,928	0.044	NA

Riley Creek Investment Co. dredge

Season	Duration	Number of days	Cubic yards handled	Yield total ounces gold	Ounce/ yd^3	Operator costs
1926	6/1-10/25	146	260,290	NA	NA	NA

North American Dredging Cr. dredge

Season	Duration	Number of days	Cubic yards handled	Yield total ounces gold	Ounce/ yd^3	Operator costs
1926	NA	175	208,220	NA	NA	NA

NA = not available.

Table 7. Production from the Golden Horn Lode Mine.[1]

Year	Ore (tons)	Gold (oz)	Silver (oz)	Lead (lb)	Zinc (lb)	Value at time of sale ($)
1925	11.1	371.4	23.5	--	--	4,160
1926	11.0	131.5	14.0	--	--	2,719
1934-35	250.0	1,390.0	1,403.0	--	--	50,000
1936	21.0	103.8	107.0	--	--	3,634
1937	40.0	196.0	202.0	--	--	6,452
Undistributed	194.9	514.1	871.0	9,336	653	6,790
Total	528.0	2,706.8	2,620.5	9,336	653	73,755

[1] Does not include development and production tests of tailings from Golden Horn dump by Golden Horn Mining Co. in 1986 and 1987.

in the area. At present (1987) five placer mines employing 20 individuals actively produce gold, and several mineral firms engage in exploratory activities.

Lode production and exploration have been confined to the Golden Horn shear zone on Black Creek, in the Granite Creek Drainage, and on the summit of Chicken Mountain. The Golden Horn gold-tungsten-antimony deposit near the confluence of Black and Otter Creeks was discovered in 1922 by John Warren, who installed a small stamp mill and processed surface and underground ores. The property was later acquired and developed by W.E. Dunkle. From 1925 to 1937 extraction of 528 tons of high grade ores from underground workings yielded 2,706 ounces (84,156 g) gold, 2,620 ounces (81,482 g) silver, and 9,336 pounds (4,243 kg) of lead (table 7). No further production from underground workings are known. Extensive subsurface rotary drilling (3,000 m) and trenching of the Golden Horn lode deposit was undertaken by a consortium of Union Carbide, WGM, Inc., General Crude, and GCO minerals beginning in 1977, but inconclusive results caused the exploration to cease in 1981. The present owner, John Miscovich, has processed and shipped tungsten-rich scheelite-gold concentrates from placer mining activities directly overlying or adjacent to the Golden Horn mine and dumps.

Several veins were explored with underground drifting and surface trenches in the Granite Creek drainage between 1926-1934, but production (if any) is unknown.

A number of enchelon, quartz-gold-cinnabar veins on Chicken Mountain have been explored since 1926. In 1956, the U.S. Bureau of Mines collected 276 soil samples and conducted limited auger drilling over a 3 km^2 area but came up with inconclusive results (Kimball, 1969). James Walper staked the properties for gold, rare earth elements and zirconium in 1960, and in 1970, WECO Mining Corporation staked, trenched, and again sampled some of the properties worked on earlier by the USBM work. In 1987, Electrum Resources, under option agreement with Doyon Regional Corporation, conducted extensive trenching and sampling of the Chicken Mountain gold properties.

Placer Mining Methods

The first mining methods employed were those utilizing pick and shovel and open-cut mining methods, which worked placer deposits averaging 3 m deep (shallow), and covered by 0.5 to 1 m of muck overburden. Because the placers were generally, thawed, expensive drift mining methods such as those used in the deeper districts of the interior (Fairbanks, Tofty, Richardson, Ruby, and Tolstoi districts) were unnecessary. Mechanized methods soon were employed to remove overburden and heavy steam machinery including large 'scraper' plants were utilized on virtually all streams---especially Otter and upper Flat Creeks---during the first two decades of mine activity.

In 1912 the Yukon Gold Dredging Company, headquartered in Dawson, Yukon Territory, installed the first floating, bucketline, stacker dredge in the district. The dredge was positioned for initial production on the Marietta claim group, a large bowl-shaped area at the head of Flat Creek immediately below mineralized source rock on Chicken Mountain. The dredge worked its way back and forth across the bowl eventually moving downstream to the confluence of Flat and Otter Creeks, where in 1918 it was permanently shut down and dismantled. The 6 ft^3 bucket capacity, electric dredge worked extremely rich virgin ground throughout its 7 years of production and over 136,000 ounces of gold were recovered in the first four years of operation (table 6).

In 1914, a small 2-1/2 ft^3 flume dredge was constructed and operated by the Riley and Marston Co. at Discovery on Otter Creek. This dredge worked ground upstream to the mouth of Granite Creek but details of these early operations are unknown. In 1916 a 2-

1/2ft^3, revolving, screen dredge was built by the Union Construction Company for Otter Dredging Company and installed at the mouth of Black Creek. In 1917, the North American Dredging Company moved a 2-1/2 ft^3 bucket-line dredge from Black Creek to lower Otter Creek. It is not clear from historical records whether or not this the latter 'gold boat' was the Otter Dredging Company unit or whether it was a separate installation. There are no historical records of more than two dredges operating in the Otter Creek drainage. The North American Dredging Company dredged through the original townsite of Flat in 1929 moving houses and other structures on timbers. The dredge was shut down in 1931 but later resumed operations in 1937. The Riley Creek Investment Company operated continuously on upper Otter Creek from 1914 until 1938, when it underwent a major overhall and was equipped with a new diesel power plant. Except for the World War II shutdown, both dredges on Otter Creek were in more-or-less continuous production until 1957; the Flat townsite was dredged at least two more times (J. Miscovich, personal commun., 1985). Afterward the North American and Riley Creek Investment Company 'boats' were operated intermittently, the former finally mothballed in 1963 and the latter in 1968.

In 1936, Sunshine Mining Company, based in Coeur d'Lane, Idaho, entered the district and attempted to develop a large low grade placer resource on Willow and Flat Creeks. Their efforts ultimately failed, but a number of large pieces of equipment including a 1-3/4 yd^3 capacity dragline were later sold to mine operators. Since the early and mid 1930s, the small placer mining activities have used bulldozer/dragline or bulldozer/hydraulic operations to remove overburden and process pay gravels. In 1987, five mine operations (John and Richard Fullerton, Flat Creek; Otter Dredging Company, Otter Creek; Alvin Aghoff, Prince Creek; Ann Williams, Granite Creek; Ken Dahl, Idaho Bench) utilized various mechanized, nonfloat, mine methods to economically extract gold deposits of the area.

LODE DEPOSITS

Introduction

Metal bearing hard rock deposits are known principally for their gold and silver values, but elevated or anomalous values of tungsten, tellurium, zirconium, bismuth, tin, antimony, mercury, and niobium have also been discovered. Most deposits and occurrences are confined to monzonitic stocks and associated hornfels and metavolcanic strata overlying or adjacent to the former plutons. Additionally anomalous concentrations of chromium, cobalt, and nickel have been identified within altered mafic dikes.

Golden Horn Deposit

The Golden Horn deposit is a series of more-or-less enchelon, vertical-dipping, quartz-gold-scheelite + cinnabar-stibnite veins that intrude hybabyssal phases of the Black Creek stock. Its production history, dating back to 1924, was previously summarized (table 6). The zone is best exposed on a gradual slope 1 km south of the center of Otter Creek valley (fig. 4). The mineralizing structures appear to continue in a N. 5 E. direction for at least 2 km as exposed in a series of old and new trenches and more recently in a wide mine cut completed by Otter Creek Dredging Company. Recently excavated surface exposures show a series of veins and shears centimeters to 2 m thick each that occur within a 100 m wide zone in monzonite. The veins strike N. 10 E. to N. 35 E. and generally dip steeply or vertically; uncommonly, veins strike N. 65 E. (John Miscovich, personal commun., 1988). The polymetallic deposit has a complex history of formation probably related to the crystallization of the monzonite and related intrusions. Bundtzen and Swanson (1984) Swanson and others (1987), and Bull (1988) have described evidence for extensive magma

Figure 4. Pre-1987 aerial shot of Golden Horn deposit showing location of shaft and trenches; keyed to table 8. View to the south.

differentiation throughout the Innoko-Iditarod igneous belt. Both the Chicken Mountain and Black Creek stocks show: 1) successive rimming of olivine by clinopyroxene by biotite, 2) the replacement of zoned plagioclase by orthoclase, 3) several biotite phases including a late stage biotite alteration throughout the groundmass, and 4) ubiquitously late amphibole rimmings other mafic minerals. The sequence of events seen in outcrops and float samples show that medium grained phaneritic monzonite is altered by porphyro aphanitic monzonite porphyry, which is in turn cut by a pegmatitic aplite. Thin and polished section analysis indicates the following phases of mineralization and alteration in order of occurrence:

1) 'griesen-like' or muscovite-biotite-quartz as thin enchelon veinlets cutting monzonite
2) extensive sericite-ankerite-quartz with minor chrome-phengite mainly as veinlets or massive replacement in all igneous lithologies.
3) black sulfide(?)-clast-supported breccias (black material originally thought to be dravite) and minor chalcopyrite in both monzonite and altered monzonite porphyry.
4) arsenopyrite-scheelite-gold-quartz accompanied with extensive chlorite alteration along structural conduits.
5) lead sulfosalt-(gold?) introduced in shears and faults accompanied by sericite(?) alteration in monzonite
6) quartz-stibnite $\pm$ cinnabar (in 10 cm in 1 m thick veins) sometimes indistinguishable from phase 5).

Bull (1988) examined intact drill core from the Union Carbide consortium exploration efforts of 1978-1981 and provides additional detailed information concerning the alteration paragenesis. Her work shows dolomite veining and dolomite-quartz matrix brecciation phases occurring as distinct alteration phases between phases 3 and 4 above. During field investigations, black breccias within phase 3 were thought by the senior author to be composed of tourmaline; however Bull (1988) demonstrated through laboratory identification that the amorphous-like black infilling material is undetermined sulfides mainly rich in iron. Bull also found rare purple fluorite crystals in sericitized monzonite and disseminated scheelite as a primary (magmatic) mineral phase in monzo-diorite.

Fluid inclusion measurements by the senior author on quartz believed to be from phase 5 alteration-mineralization (sample from Golden Horn dump) yield low NaCl, high CO_2 values with narrowly bracketed 148°C average temperatures of hemogenation (N=14). After plotting arsenopyrite-pyrite mineral compositions on a fS_2-T plot (after Kretshmar and Scott (1976), Bull (1988) arrived at equilibrium temperatures of 300-350°C---suggesting the arsenopyrite-scheelite-gold (phase 4) mineralization is within the mesothermal range. This limited data suggests multiple mineralized pulses spanning the mesothermal and epithermal temperature ranges.

Assays of selected mineralized zones from Golden Horn are summarized in table 8. Gold grades from our work range from $\leq$0.01 to 11.5 oz/ton; no definite average grade could be determined for specific channel sample intervals. Gold grades reported by Andrews and others (1978) and Adams and Siems (1982) seem to suggest that large areas of ankeritic-sericite alteration adjacent to the main Golden Zone mineralized zone ranges from 0.005 to 0.03 oz/ton gold. They report their best drill intersections as 1) 31 ft (95 m) of 0.056 oz/ton gold; 2) 202 ft (616 m) of 0.024 oz/ton gold; and 3) 109 ft (33.0 m) of 0.018 oz/ton gold---all within 200 m of the Golden Zone shaft.

Besides the gold our data---mainly U.S. Geological Survey laboratory results---show anomalous or elevated levels of bismuth, tellurium, zirconium, chromium, fluorine, tin, and yttrium. Andrews and others (1978) report 'scattered' occurrences of tin, platinum, and uranium in placer concentrates from Black Creek. Bundtzen and others (1987) reported 0.8 to 1.3 ppm platinum metals, cassiterite, ilmenorutile (niobium), cinnabar, and argentopyrite (silver sulfide) from Black Creek mine concentrates.

Chicken Mountain Gold Prospects

The flat, cryoplanation surface covering the upper part of Chicken Mountain is underlain by a crudely north-south, irregularly defined zone containing thin, stockwork-like, auriferous quartz veins hosted in medium-grained monzonite. The most conspicuous areas of vein concentration occur in the Idaho Bench at the headward bowl of Flat Creek and 250 m to the east, in the head drainage of Chicken Creek (fig. 5). The two exposed areas of veins (prior to 1987) comprise 110 m^2 and 272 m^2 respectively; most of the remaining slopes (including the area in between the two prospect areas) is buried and overlain by colluvium and vegetation. In both prospect areas thin auriferous veinlets occur in conjugate vein orientations with N. 45-20 E., 60-70 NW. being dominant and N. 50-60 W., 80 NE. being secondary. Vein density varies widely; they are as close as 50 cm or separated by as much as 2 m. The veins range in thickness from 1/2 cm to 5 cm and average 2 cm. The veins are composed of quartz and ankerite(?) and minor amounts of cinnabar, stibnite or antimony sulfosalt(?), and free gold. Additionally, geochemical analyses (Nos. 103-107, 108, pl. 1, table 8) of samples show elevated levels of bismuth, beryllium, arsenic, yttrium, lead, and zinc besides anomalous gold, mercury, and antimony.

The vein stockworks are conspicuously localized in the cupola phase of the monzonite directly below a thermally altered andesite-basalt roof pendant that forms the summit of Chicken Mountain. The paucity of vein density in the overlying volcanics suggest they served as a 'cap' for the mineralization. Overall, both the Idaho Bench and Chicken Creek prospects appear to be gold-base metal stockwork zones superficially similar to those encountered in protore or distal phased porphyry copper systems (Titley and Hicks, 1966).

Prospects North of Flat

Auriferous quartz veins cut monzonite and altered volcanic rocks in the Granite Creek drainage and in Malemute pup. The Malemute Gulch (loc. 46, pl. 1) occurrence was staked in 1926 by Fred Lurber, a local Flat prospector. Mine development was reported for the years 1929-1934, but production (if any) is unknown. The mine workings were completely overgrown with vegetation at the time of our visit and the following discussions are based on examination of rubble and summaries by Mertie (1936) and Meyer (1984). An adit explored a N. 25 E. (striking) 80 SE. (dipping) vein system in the northern edge of the Black Creek monzonite north of Otter Creek valley. Just west of the dump, rubble of mafic volcanic rock forms hillslope scree. The vein system contains thin quartz stringers and shears 1 to 4 cm thick over a 1/2 m width; the veins contain arsenopyrite, minor cinnabar, and carry gold values. A sample of mineralized material from the dump was analyzed (table 8, no. 46).

The Granite Creek prospects near the head of Granite Creek consist of thin, 1 to 2 cm thick quartz-arsenopyrite veins in olivine metabasalt of the TKvm unit (no. 8-11, y, pl. 1). Two adits 80 vertical meters apart have been driven into the zone, and it is uncertain whether or not the adits explores the same or dissimilar veins. Based on material in the dumps, the tunnels are judged to be approximately 15 to 20 m long and two veins are identified: one vein in outcrop strikes N. 15 E. and dips 80 SE. while the other in outcrop strikes N. 22 E and dips 70 SE. Both are similar to the Malemute Pup and Golden Horn systems. Analyses of material from the upper zone show (no. 8-a, pl. 1) weak, gold, arsenic, and antimony anomalies.

Figure 5. Photograph of enechelon quartz-freegold ± cinnabar veins, Idaho Bench, offsite from summit of Chicken Mountain.

Table 8. Analytical lts from mines, prospects, and mineral occurrences, Iditarod and eastern B-5 Quadrangles, Alaska*
(all in ppm, except Au in ppb)

Map no.	Field no.	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	Sb (ppm)	As (ppm)	Co (ppm)	Ni (ppm)	Cr (ppm)	Sn (ppm)	W (ppm)	Be (ppm)	Nb (ppm)	Bi (ppm)	Cd (ppm)	B (ppm)	La (ppm)	Y (ppm)	Th (ppm)
1	86ACE39[2]	ND	200	200	<20,000	310	ND	<2,000	1,600	15	30	<10	50	ND	ND	ND	18	100.0	ND	ND	ND	ND
2	86ACE38A[2]	ND	0.5	<5	200	ND	ND	140	90	5	5	ND	15	ND	2	ND	2	<0.1	1,000	ND	20	ND
3	84BT238[2]	- -	ND	ND	20	50	ND	10	30	ND	ND	ND	10	ND	7	30	ND	ND	1,000	ND	70	ND
4	86ACE37[2]	ND	ND	ND	20	65	ND	4	ND	ND	5	ND	10	ND	3	ND	ND	>0.1	1,000	ND	20	ND
5	86ACE36[2]	ND	ND	30	ND	95	ND	400	330	20	150	200	ND	ND	ND	ND	ND	0.1	10	ND	ND	ND
6a	86ACE35A[2]	ND	ND	<5	ND	65	ND	18	250	5	10	ND	ND	ND	ND	ND	ND	0.4	20	ND	ND	ND
6b	86ACE35B[2]	1,000	1	7	10	130	ND	66	>2,000	5	20	50	ND	ND	1	ND	ND	3.6	2,000	ND	10	ND
7	86ACE34[2]	ND	0.5	5	50	95	5	650	>2,000	7	30	50	ND	50	1	ND	ND	0.7	1,500	ND	20	ND
8a	86ACE33A[2]	50,000	500	300	10,000	80	ND	>2,000	>2,000	ND	10	20	ND	ND	ND	ND	10	>100.0	10	ND	ND	ND
8b	86ACE33B[2]	150	5	300	30	70	ND	72	350	20	100	500	ND	ND	1	ND	ND	3.3	10	ND	10	ND
9	84BT300[2]	- -	1	700	10	65	5	12	100	50	200	1,000	ND	ND	2	ND	ND	1.8	10	ND	30	ND
10a	86ACE32A[2]	3,900	<.5	70	10	75	ND	4	>2,000	50	150	200	ND	ND	1	ND	ND	0.4	20	ND	10	ND
10b	86ACE32B[2]	ND	0.5	200	10	20	ND	4	40	20	100	500	ND	ND	1	ND	ND	0.5	200	ND	10	ND
11	84BT301[2]	- -	0.5	70	30	25	ND	12	ND	50	200	1,000	ND	ND	2	ND	2	.2	20	ND	30	ND
12	85AA1694[2]	- -	ND	10	15	70	ND	ND	10	20	30	30	ND	ND	1	ND	ND	.1	20	30	30	ND
13	85AA1696[2]	- -	ND	7	10	70	ND	ND	10	10	15	20	ND	ND	ND	ND	ND	.2	50	ND	20	ND
14a	85AM287a[2]	ND	ND	15	ND	50	5	ND	30	50	100	200	ND	ND	ND	ND	ND	ND	200	ND	20	ND
14b	85AM287c[2]	ND	ND	20	50	A60	ND	ND	ND	50	100	100	ND	ND	3	ND	ND	1.6	30	ND	30	ND
15	86BT335A[1]	ND	ND	70	20	ND	ND	ND	ND	50	700	750	ND	ND	1	ND	ND	ND	50	ND	20	ND
16	85KB228[1]	ND	- -	- -	- -	20	- -	ND	- -	- -	- -	- -	- -	- -	- -	- -	ND	0.1	- -	- -	- -	- -
19	85KB229[1]	ND	- -	- -	- -	40	- -	ND	- -	- -	- -	- -	- -	- -	- -	- -	ND	ND	- -	- -	- -	- -
20	85KB230[1]	ND	- -	- -	- -	100	- -	ND	- -	- -	- -	- -	- -	- -	- -	- -	ND	0.4	- -	- -	- -	- -
21	84BT310[2]	- -	ND	70	ND	70	ND	4	10	30	30	70	ND	ND	ND	ND	ND	.3	50	ND	50	ND
22	86BT423[3]	11	- -	59	9	68	ND	4	20	12	45	190	4	ND	- -	21	ND	- -	- -	- -	38	7
23	86BT421[3]	ND	- -	33	12	110	ND	3	ND	24	56	230	7	ND	- -	19	ND	- -	- -	- -	30	4
24	86BT425[3]	8	- -	50	12	140	ND	8	12	22	60	170	6	ND	- -	21	ND	- -	- -	- -	38	10
25	85KB74[2]	11,300	5	200	300	20	ND	64	9,100	15	70	300	ND	ND	1	ND	4	2.2	ND	ND	20	ND
26	86BT428[3]	20	- -	79	10	37	2	4	25	12	42	200	7	ND	- -	13	ND	- -	- -	- -	16	5
27	85KB60[2]	7,500	100	200	50	ND	ND	100,000	3,200	10	20	30	ND	ND	1	ND	ND	1.9	150	50	10	ND
28	86KB61[3]	33	5	- -	- -	ND	ND	3	330	45	300	830	- -	ND	- -	- -	- -	1.9	- -	20	- -	4
29	86KB69[3]	55	ND	- -	- -	100	ND	2	110	20	120	210	- -	9	- -	- -	- -	ND	- -	31	- -	19
30	85KB108[2]	490,000	3	15	15	ND	ND	34	10,000	20	10	150	ND	ND	2	ND	82	0.9	50	ND	10	ND
31	86KB1[3]	58	ND	- -	- -	100	ND	7	90	ND	28	20	- -	3	- -	- -	- -	ND	- -	25	- -	36
32	85KB97[2]	1,300	5	150	30	30	ND	14	17,000	15	50	100	ND	100	2	ND	4	1.4	30	30	20	ND
33	85KB75[2]	47,000	200	500	1,500	35	ND	200	6,000	10	50	300	ND	ND	1	ND	34	15.0	ND	ND	50	ND
34	85KB44[2]	1,100	1.5	50	ND	45	ND	100	2,700	10	30	70	ND	50	1.5	ND	ND	0.5	150	ND	30	8
35	85KB45B[2]	15,000	20	50	100	10	ND	72,000	5,200	7	50	50	- -	50	1	ND	ND	1.2	70	ND	10	ND

Map no.	Field no.	Ba (ppm)	Hg (ppm)	Remarks
1	86ACE39[2]	20	1.4	Gossan in sandstone-shale rubble
2	86ACE38A[2]	70	0.08	Rhyolite dk (quartz porphyritic rhyolite)
3	84BT238[2]	50		Hornfelsed quartzose sandstone sample
4	86ACE37[2]	20	0.20	Rhyolite dike
5	86ACE36[2]	50	0.20	Hornfels sed with quartz vein
6a	86ACE35A[2]	ND	.35	Brecciated quartz vein
6b	86ACE35B[2]	150	1.6	Brecciated hornfels
7	86ACE34[2]	500	>10	Brecciated hornfels plus dike rubble
8a	86ACE33A[2]	30	>10	Vuggy quartz from caved adit area
8b	86ACE33B[2]	500	.12	Mafic volcanics-Fe stained
9	84BT300[2]	700	- -	Quartz vein in metabasalt
10a	86ACE32A[2]	200	.10	Quartz-tour[illegible] vein cutting mafic volcanic (from dump)
10b	86ACE32B[2]	300	.02	Iron stained mafic volcanic (from dump)
11	84BT301[2]	1,000	- -	Random sample olivine metabasalt
12	85AA1694[2]	500	- -	Quartz rich sandstone chip sample
13	85AA1696[2]	500	- -	Quartz rich sandstone chip sample
14a	85AM287a[2]	200	.04	Intermediate dike? chip sample
14b	85AM287c[2]	240	- -	Limey sandstone chip sample
15	86BT335A	1,000		Altered mafic dike
18	85KB228[1]	- -	- -	Monzonite, trench UC-15
19	85KB229[1]	- -	- -	Gray sandstone
20	85KB230[1]	- -	- -	Gray sandstone
21	84BT310[2]	1,500	- -	Background metabasalt chip sample
22	86BT423[3]	1,200		Background, Ksh unit
23	86BT421[3]	1,000		Background, Ksh unit
24	86BT425[3]	1,400		Background, hornfels
25	85KB74[2]	1,000	0.54	Quartz-cinnabar-stibnite vein
26	86BT428[3]	2,300		Background, monzodiorite
27	85KB60[2]	500	1.30	Stibnite vein
28	86KB60[3]	1,400	1.3	Background, 'Flat gabbro'
29	86KB69[3]	1,700		Monzonite, fine grained (background)
30	85KB108[2]	1,500	2.8	Pan concentrate from Chicken Creek trench near KB108
31	86KB1[3]	1,300		Monzonite, medium grained (background)
32	85KB97[2]	2,000	0.18	Quartz-cinnabar vein, trench B-1
33	85KB75[2]	2,000	1.21	Quartz-cinnabar-stibnite vein
34	85KB44[2]	1,000		Mineralized hornfels (sandstone)
35	85KB45B[2]	1,000	.74	Quartz-stibnite vein

Map no.	Field no.	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	Sb (ppm)	As (ppm)	Co (ppm)	Ni (ppm)	Cr (ppm)	Sn (ppm)	W (ppm)	Be (ppm)	Nb (ppm)	Bi (ppm)	Cd (ppm)	B (ppm)	La (ppm)	Y (ppm)	Th (ppm)
36	85KB2[2]	240,000	20	150	1,000	10	ND	5,000	45,000	ND	ND	ND	ND	ND	ND	ND	8	5.2	10	ND	ND	ND
37	85KB5[2]	84,000	20	100	700	30	ND	880	3,800	ND	ND	<10	ND	10,000	ND	ND	24	3.0	<10	ND	ND	ND
38	85KB18[2]	210,000	50	20	1,000	10	ND	120	48,000	ND	<5	ND	ND	ND	ND	ND	11	4.9	<10	ND	ND	ND
39	85KB94[2]	200	0.5	5	ND	ND	ND	2	1,100	ND	7	ND	ND	>5,000	ND	ND	ND	0.2	15	ND	ND	ND
40a	85KB95[2]	2,600	100	150	100	ND	ND	15,000	12,000	10	10	ND	ND	<50	ND	ND	ND	3.1	20	ND	ND	ND
40b	86KB12[3]	23	ND	- -	- -	ND	ND	7	54	7	28	59	- -	3	- -	- -	- -	ND	- -	21	- -	7
41	87BT Flat trench[3]	9,000	- -	54	4	10	ND	51,000	6,100	3	14	110	ND	ND	- -	3	ND	- -	- -	- -	1,400	ND
42a	86BT431[3]	11	- -	45	11	97	ND	7	75	46	100	230	7	ND	- -	22	ND	- -	- -	- -	38	8
42b	86BT430[3]	ND	- -	24	17	69	3	ND	13	25	120	340	ND	ND	- -	16	ND	- -	- -	- -	23	8
43a	84MSL159[1]	13	18	- -	- -	ND	ND	50.3	25	75	100	64	- -	ND	- -	- -	- -	ND	- -	59	- -	7.1
43b	84MSL123[1]	12	ND	- -	- -	200	ND	23.0	33	350	260	140	- -	ND	- -	- -	- -	ND	- -	14	- -	1.3
43c	84MSL122[2]	1,150	ND	30	ND	65	ND	6	40	30	100	200	ND	ND	1.5	ND	ND	.4	70	50	50	ND
44	84BT305[2]	- -	ND	50	ND	70	ND	48	100	15	150	200	ND	ND	2	ND	ND	.1	500	ND	50	ND
45	86BT371[2]	- -	ND	20	15	90	ND	ND	ND	20	50	100	ND	ND	1	ND	ND	0.1	100	ND	20	ND
46	86BT417[2]	- -	ND	20	30	65	ND	ND	ND	20	5	20	ND	ND	1	ND	ND	ND	30	ND	30	ND
47	86BT416[2]	- -	ND	20	ND	90	ND	10	ND	20	50	150	ND	ND	1	ND	ND	0.1	50	ND	20	ND
49	86BT414[2]	- -	ND	20	ND	75	ND	ND	ND	20	100	150	ND	ND	ND	ND	ND	0.2	50	ND	15	ND
50	86BT418[2]	- -	ND	10	ND	45	ND	ND	ND	10	30	100	ND	ND	ND	ND	ND	ND	50	ND	10	ND
51	86BT413[2]	- -	ND	20	ND	85	ND	ND	ND	20	50	100	ND	ND	1	ND	ND	ND	50	ND	10	ND
52a	84AM141A[1]	7	5	- -	- -	ND	ND	1.1	10	48	290	810	- -	ND	- -	- -	- -	ND	- -	11	- -	3.3
52b	84AM141B[1]	ND	ND	- -	- -	ND	3	0.7	6	21	83	130	- -	ND	- -	- -	- -	ND	- -	26	- -	7.7
53	84AM139A[1]	ND	ND	- -	- -	ND	8	0.9	5	41	170	560	- -	ND	- -	- -	- -	ND	- -	8	- -	2.4
54	84AM126[1]	ND	ND	- -	- -	ND	ND	0.9	14	13	53	67	- -	4	- -	- -	- -	ND	- -	26	- -	7.3
55	84AM124a	ND	ND	30	30	ND	ND	ND	ND	50	200	1,000	ND	ND	ND	ND	ND	ND	10	ND	20	- -
56	84AM12a	ND	ND	30	50	ND	ND	ND	ND	50	100	200	ND	ND	1.5	ND	ND	ND	100	50	50	- -
57a	84AM138A[1]	ND	ND	- -	- -	ND	ND	0.7	3	35	120	420	- -	ND	- -	- -	- -	ND	- -	14	- -	3.3
57b	84AM138A[2]	- -	ND	30	30	85	ND	ND	ND	50	150	700	ND	ND	1	ND	ND	ND	15	ND	20	ND
58	84BT11[2]	ND	ND	30	<10	75	ND	ND	10	30	100	200	ND	ND	1	ND	ND	ND	100	20	30	ND
59	846L14[2]	ND	ND	100	20	95	ND	ND	ND	70	700	1,500	ND	ND	1.5	ND	ND	ND	20	ND	30	ND
60	84BT279[2]	- -	ND	20	10	80	ND	10	10	50	100	200	ND	ND	1	ND	1	.2	150	ND	30	ND
61	84BT280[2]	- -	ND	15	ND	75	ND	8	ND	20	50	70	ND	ND	1	ND	ND	.1	150	ND	30	ND
62	84BT17c[2]	ND	ND	50	ND	10	5	ND	ND	10	100	200	ND	ND	ND	ND	ND	ND	70	ND	10	ND
63	84AM17a	ND	ND	30	ND	100	ND	ND	ND	50	100	300	ND	ND	1.0	ND	0.2	ND	100	ND	50	- -
64a	84AA1593A[2]	50	ND	20	15	55	ND	ND	ND	30	100	200	ND	ND	1	ND	ND	0.1	200	ND	20	ND
64b	84AA1593b[2]	ND	ND	50	ND	65	ND	ND	ND	100	100	2,000	ND	ND	ND	ND	ND	0.2	15	ND	30	ND
65a	84AA1592a[2]	ND	ND	50	10	50	ND	ND	ND	15	70	200	ND	ND	1	ND	ND	0.2	150	<20	20	ND
65b	84AA1592b[2]	ND	ND	20	ND	45	<5	ND	ND	10	50	30	ND	ND	ND	ND	ND	0.1	70	ND	ND	ND
66	84AA1590[2]	ND	ND	50	30	90	ND	ND	ND	50	100	200	ND	ND	1	30	ND	0.2	100	<20	50	ND
67	84MSL143[2]	ND	ND	10	10	25	ND	ND	ND	15	5	20	ND	ND	ND	ND	ND	0.2	150	20	ND	ND

Map no.	Field no.	Ba (ppm)	Hg (ppm)	Remarks
36	85KB2[2]	20	1.8	Quartz sulfide vein Golden Horn
37	85KB5[2]	<20	2.2	Quartz sulfide vein Golden Horn
38	85KB18[2]	20	10.0	Quartz sulfide vein Golden Horn
39	85KB94[2]	20		Scheelite bearing vein Golden Horn
40a	85KB95[2]	150	14.	Sulfide sample Golden Horn
40b	86KB12[3]	2,800		Background, monzonite
41	87BT Flat trench	ND		From high grade vein, 12 in. channel; 76 ppm Selenium
42a	86BT431[3]	1,600		Background, metabasalt
42b	86BT430[3]	1,900		Background, metabasalt
43a	84MSL159[1]	ND	- -	Mineralized hornfels; iron rich
43b	84MSL123[1]	ND	- -	Mineralized vein in hornfels tailings
43c	84MSL122[2]	1,000	0.06	Hornfels in tailings
44	84BT305[2]	1,000	- -	[illegible] with tourmaline greisen
45	86BT371[2]	500		Background, K[illegible]s unit
46	86BT417[2]	1,000		Background, [illegible] unit
47	86BT416[2]	300		Background, Klls unit
49	86BT414[2]	300		Background, Kcs unit
50	86BT418[2]	200		Background, Kls unit
51	86BT413[2]	300		Background, Klls unit
52a	84AM141A[1]	380	- -	Mafic dike chip sample
52b	84AM141B[1]	570	- -	Shale chip sample
53	84AM139A[1]	2,500	- -	Mafic dike chip sample
54	84AM126[1]	780	- -	Limey sandstone chip sample
55	84AM124a	500	ND	Mafic dike
56	84AM12a	1,000	ND	Background diorite
57a	84AM138A[1]	880	- -	Mafic dike? chip sample
57b	84AM138A[2]	700		Altered intermediate(?) dike
58	84BT11[2]	1,000	1.7	Background sandstone chip sample
59	846L14[2]	1,000	4.0	Altered mafic dike chip sample
60	84BT279[2]	500	- -	Background sandstone sample
61	84BT280[2]	500	- -	Fresh andesite dike
62	84BT17c[2]	700	.02	Altered mafic dike with calcite veins
63	84AM17a	700	ND	Background Kcs
64a	84AA1593A[2]	1,000	.02	Lithic sandstone
64b	84AA1593b[2]	1,500	.02	Altered mafic dike
65a	84AA1592a[2]	1,000	.32	Iron stained fine sandstone
65b	84AA1592b[2]	500	.50	Quartz veins in sandstone
66	84AA1590[2]	2,000	.26	M-C sandstone
67	84MSL143[2]	3,000	1.70	Background Kls unit

Map no.	Field no.	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	Sb (ppm)	As (ppm)	Co (ppm)	Ni (ppm)	Cr (ppm)	Sn (ppm)	W (ppm)	Be (ppm)	Nb (ppm)	Bi (ppm)	Cd (ppm)	B (ppm)	La (ppm)	Y (ppm)	Th (ppm)
68	84MSL146[2]	ND	ND	50	ND	60	ND	54	100	50	100	1,000	ND	ND	<1	ND	ND	.3	20	ND	15	ND
69	86AGE69[2]	- -	ND	10	ND	100	ND	ND	ND	10	70	30	ND	ND	<1	ND	ND	ND	100	ND	10	ND
70	86AGE68[2]	ND	ND	10	ND	95	ND	ND	60	15	70	50	ND	ND	ND	ND	ND	0.2	100	ND	15	ND
71	86AGE65[2]	ND	ND	20	ND	100	ND	ND	ND	20	70	150	ND	ND	ND	ND	ND	ND	20	ND	15	ND
72	84AA1567[2]	- -	ND	50	30	95	ND	ND	ND	30	100	100	ND	ND	1	ND	ND	0.3	200	ND	50	ND
73	84AA1568[2]	- -	ND	70	50	95	5	ND	10	30	150	200	ND	ND	1.5	ND	ND	0.3	300	20	50	ND
74	86BT406[3]	25	- -	19	10	130	ND	5	150	10	18	130	12	ND	- -	- -	ND	- -	- -	- -	33	63
75	84AA1565[2]	- -	ND	50	30	60	ND	ND	ND	20	100	150	ND	ND	ND	ND	ND	ND	200	ND	50	ND
76	84AA1566[2]	- -	ND	50	20	80	ND	ND	ND	50	150	500	ND	ND	ND	ND	ND	ND	200	ND	30	ND
77	86BT404[2]	ND	ND	7	20	90	ND	ND	ND	20	50	300	ND	ND	ND	ND	ND	ND	50	ND	10	ND
78	84AA1563[2]	- -	<.5	50	10	70	ND	ND	ND	20	100	100	ND	ND	1	ND	ND	0.2	200	<20	50	ND
79	86AGE72[2]	- -	ND	15	ND	110	ND	ND	10	15	70	70	ND	ND	ND	ND	ND	0.3	50	ND	15	ND
80	84AM93A[2]	ND	ND	5	30	80	ND	ND	20	5	5	<10	ND	ND	2	ND	<1	<.1	500	50	20	ND
81	86AM341[2]	- -	ND	30	10	110	ND	ND	10	10	70	70	ND	ND	1	ND	ND	0.3	2,000	ND	20	ND
82	86BT409[2]	ND	ND	10	15	70	ND	170	180	10	50	30	ND	ND	1	ND	ND	<.1	100	ND	10	ND
83a	86BT392b[2]	<50	ND	20	20	60	ND	28	ND	10	50	150	ND	ND	1	ND	ND	ND	200	ND	10	ND
83b	86AGE73b[2]	ND	ND	5	30	50	<5	>1,000	10	ND	<5	<10	ND	ND	2	ND	ND	ND	150	ND	<10	ND
83c	86AGE73a[2]	<50	1	10	300	50	ND	>1,000	120	7	20	50	ND	ND	1.5	ND	ND	ND	200	ND	<10	ND
84	85AM08A[1]	8	ND	- -	- -	ND	ND	1.0	3	ND	ND	ND	- -	ND	- -	- -	- -	ND	- -	13	- -	3.6
85a	86BT391a[2]	2,900	ND	20	15	80	ND	ND	ND	20	50	100	ND	ND	1	ND	ND	ND	100	ND	20	ND
85b	86BT391b[2]	2,400	ND	50	15	85	ND	ND	10	20	50	50	ND	ND	1	ND	ND	ND	100	ND	20	ND
86	86BT390[2]	ND	ND	<5	20	65	ND	ND	ND	ND	5	<10	ND	ND	1	ND	ND	ND	30	20	ND	ND
87	86DB263	ND	ND	5	20	85	ND	ND	ND	5	10	10	ND	ND	1.5	ND	ND	0.1	70	30	ND	ND
88	84BT98[1]	3,400	10	100	ND	ND	5	2.1	4	ND	ND	ND	ND	1,380	ND	ND	78	ND	50	ND	ND	0.7
90	84RB2[2]	ND	ND	100	70	65	ND	ND	ND	100	1,000	2,000	ND	ND	ND	ND	ND	.2	30	ND	30	ND
91	84AM06[1]	ND	ND	- -	- -	ND	ND	0.5	3	40	150	700	- -	ND	- -	- -	- -	ND	- -	11	- -	3.2
92	84BT06[2]	ND	ND	70	ND	75	<5	ND	ND	100	70	200	ND	ND	ND	ND	ND	ND	20	ND	50	ND
93	84AM03[1]	ND	ND	- -	- -	ND	ND	0.2	3	56	380	1,000	- -	ND	- -	- -	- -	ND	- -	14	- -	3.5
94	86BT403[3]	69	- -	14	13	55	ND	6	4	20	26	130	10	ND	- -	14	ND	- -	- -	- -	18	5
95	86BT393a[2]	ND	ND	10	<10	45	ND	ND	ND	30	200	500	ND	ND	1	ND	ND	ND	10	ND	20	ND
96	86BT393b[3]	ND	- -	15	9	42	ND	ND	9	22	37	150	ND	ND	- -	17	ND	- -	- -	- -	37	9
97	86BT401[2]	ND	- -	34	9	89	3	ND	12	21	53	200	8	ND	- -	21	ND	- -	- -	- -	26	4
98	86BT399[3]	ND	- -	6	6	24	ND	ND	ND	15	23	150	6	ND	- -	16	ND	- -	- -	- -	28	9
99	86BT394[2]	ND	ND	50	50	55	ND	ND	ND	30	100	500	ND	ND	ND	ND	ND	ND	10	ND	30	ND
100a	86BT395a[3]	15	- -	19	18	97	ND	ND	22	42	150	570	12	ND	- -	11	ND	- -	- -	- -	19	ND
100b	86BT395b[3]	12	- -	50	14	66	4	ND	31	45	210	670	7	ND	- -	14	ND	- -	- -	- -	20	6
101	86BT396a[2]	ND	ND	30	30	40	ND	ND	10	30	150	300	ND	ND	2	ND	ND	ND	10	<20	15	ND

Map no.	Field no.	Ba (ppm)	Hg (ppm)	Remarks
68	84MSL146[2]	500	.90	Altered mafic dike
69	86AGE69[2]	200	- -	Mg sandstone
70	86AGE68[2]	300	1.1	Iron stained chips in sandstone rubble
71	86AGE65[2]	1,000	.06	Felsic dike rubble
72	84AA1567[2]	1,000	- -	Sandstone
73	84AA1568[2]	1,000	- -	Sandstone
74	86BT406[3]	230	- -	Background Kls
75	84AA1565[2]	1,000	- -	Sandstone
76	84AA1566[2]	700	- -	Sandstone
77	86BT404[2]	700	1.4	Background, rhyolite dike
78	84AA1563[2]	1,000	- -	Sandstone
79	86AGE72[2]	300	- -	F-M sandstone
80	84AM93A[2]	2,000	2.0	Rhyolite chip sample (background)
81	86AM341[2]	200	- -	Mg sandstone
82	86BT409[2]	300	1.4	Mineralized rhyolite with quartz
83a	86BT392b[2]	500	1.4	Mineralized rhyolite with quartz
83b	86AGE73b[2]	100	0.7	Quartz-stibnite vein
83c	86AGE73a[2]	500	0.35	Quartz-stibnite vein chip sample
84	84AM08A[1]	2,300	- -	Intermediate dike chip sample
85a	86BT391a[2]	500	.18	Mineralized rhyolite with quartz
85b	86BT391b[2]	300	.10	Mineralized rhyolite with quartz
86	86BT390[2]	500	1.7	Mineralized rhyolite
87	86DB263	1,000	4.7	Tkf grab sample
88	84BT98[1]	<20	.82	Stockwork veinlets in monzonite; cinnabar recognized
90	84RB2[2]	1,500	0.42	Altered mafic dike chip sample
91	84AM06[1]	680	- -	Mafic dike chip sample
92	84BT06[2]	300	.12	Background, sandstone
93	84AM03[1]	1,800	- -	Mafic dike chip sample
94	86BT403[3]	300		Background, Kfs unit
95	86BT393a[2]	1,000	.06	Background hornfels
96	86BT393b[3]	1,200		Background, hornfels
97	86BT401[3]	930		Background distal TKhf unit
98	86BT399[3]	820		Background, hornfels near GH Fault
99	86BT394[2]	1,500	.12	Background meta-andesite
100a	86BT395a[3]	2,200		Background, biotite gabbro
100b	86BT395b[3]	1,500		Background, monzonite (TKm)
101	86BT396a[2]	1,000	.12	Background meta-basalt

Map no.	Field no.	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	Sb (ppm)	As (ppm)	Co (ppm)	Ni (ppm)	Cr (ppm)	Sn (ppm)	W (ppm)	Be (ppm)	Nb (ppm)	Bi (ppm)	Cd (ppm)	B (ppm)	La (ppm)	Y (ppm)	Th (ppm)
102	86BT396b[3]	ND	- -	40	14	69	ND	6	19	30	180	560	12	ND	- -	19	ND	- -	- -	- -	18	7
103	84BT102[2]	2,400	10	50	300	130	ND	470	760	ND	5	50	ND	ND	20	ND	2	4.5	100	ND	<10	ND
104	84BT102A[2]	55,000	5	50	700	140	ND	76	1,600	20	70	200	ND	ND	5	ND	110	1.6	200	ND	10	ND
105	84BT102B[2]	1,350	1	50	100	50	ND	24	220	20	50	200	ND	ND	3	ND	5	0.9	200	ND	10	ND
106a	85KB158A[2]	50	1	100	30	45	<5	18	360	15	70	200	ND	ND	5	ND	ND	0.8	200	20	15	ND
106b	85KB158D[2]	ND	1.5	100	50	60	<5	18	230	20	100	300	ND	ND	5	ND	ND	0.6	1,000	ND	20	ND
106c	85KB158E[2]	1,200	10	200	2,000	300	5	110	520	30	100	500	10	50	5	ND	ND	1.2	500	20	30	ND
106d	85KB158G[2]	8,700	5	100	100	50	ND	10	150	20	70	100	ND	ND	5	ND	4	0.4	500	ND	20	ND
106e	85KB158H[2]	950	5	300	70	65	ND	6	60	30	200	500	ND	ND	10	ND	ND	0.2	100	ND	20	ND
106f	85KB158I[2]	8,200	7	100	100	50	ND	44	880	30	100	500	ND	ND	7	ND	14	1.8	50	50	30	ND
106g	85KB158J[2]	100	1	100	50	65	ND	16	150	30	100	500	ND	ND	5	ND	ND	0.6	500	50	20	ND
106k	86KB126	200	1.5	200	1,500	1,000	ND	ND	230	20	70	300	ND	ND	2.0	ND	ND	2.8	500	30	15	ND
106l	86KB127	1,100	2.0	150	70	ND	ND	ND	190	20	100	300	ND	ND	2.0	ND	ND	1.4	100	30	20	ND
106m	86KB125	ND	1.0	200	1,000	300	ND	ND	80	50	100	300	ND	ND	2.0	ND	ND	0.7	100	ND	20	ND
107	85KB120[2]	150,000	15	200	100	30	<5	360	>2,000	20	30	200	ND	<50	10	ND	70	5.2	<10	100	100	ND
108	86BT398[3]	ND	- -	2	10	31	ND	ND	16	21	21	120	10	ND	- -	20	ND	- -	- -	- -	22	14
109	85BT118[2]	- -	<.5	70	20	25	7	4	30	30	100	200	ND	<50	2	ND	ND	ND	200	ND	20	ND
110a	86BT410[3]	12	- -	41	16	84	2	ND	22	16	40	250	4	ND	- -	17	ND	- -	- -	- -	20	2
110b	86KB2[2]	ND	ND	- -	- -	ND	1.3	- -	4	120	1,040	2,050	- -	2	- -	- -	- -	ND	- -	19	- -	5
111	86BT411[3]	ND	- -	16	7	90	ND	ND	8	18	52	210	5	ND	- -	2	ND	- -	- -	- -	26	8
112	86AGE74[2]	ND	ND	20	20	65	ND	86	60	20	70	100	ND	ND	1	ND	ND	ND	1,500	ND	20	ND
115	84BT288[2]	- -	ND	ND	50	50	ND	12	ND	<5	5	<10	ND	ND	2	ND	ND	<.1	300	ND	ND	ND
116	86AGE75[2]	ND	ND	30	30	65	ND	30	ND	30	100	200	ND	ND	ND	ND	ND	ND	100	ND	10	ND
117	85BT258[2]	ND	ND	10	10	25	ND	12	ND	10	10	20	ND	ND	1	ND	ND	ND	ND	20	20	ND
118	85BT260[2]	ND	ND	10	10	30	ND	6	40	20	30	50	20	ND	1	ND	ND	ND	2,000	30	30	ND
119	86BT400[3]	85	- -	6	8	28	ND	ND	46	18	47	220	3	ND	- -	18	ND	- -	- -	- -	21	6
121	86BT402[3]	ND	- -	6	10	65	ND	ND	ND	18	34	120	5	ND	- -	16	ND	- -	- -	- -	23	6
122	84L02[2]	ND	ND	70	50	75	ND	ND	ND	50	200	1,000	ND	ND	ND	ND	ND	ND	30	ND	50	ND
123	84GL03[2]	ND	ND	30	30	45	<5	ND	ND	30	70	200	ND	ND	ND	ND	ND	ND	50	50	30	ND
124	84BT301	ND	0.5	70	30	25	ND	12	ND	50	200	1,000	ND	ND	2.0	ND	2.0	0.2	20	30	ND	ND
128a	84AM137a	- -	ND	100	70	120	ND	2	ND	70	200	1,000	ND	ND	ND	ND	ND	ND	15	ND	30	ND
128b	84AM137b[2]	ND	ND	30	ND	75	ND	ND	10	30	70	150	ND	ND	1.5	ND	ND	0.2	100	<20	30	ND
128c	84AM137c[2]	- -	ND	150	50	65	ND	2	10	50	150	200	ND	ND	1	ND	ND	ND	100	<20	50	ND
133	85DB265	ND	ND	7	10	60	ND	ND	60	ND	5	ND	ND	ND	1.5	ND	ND	ND	100	50	ND	ND
134a	86AGE62a[2]	- -	ND	7	10	90	ND	ND	ND	30	50	500	ND	ND	ND	ND	ND	0.1	10	ND	10	ND
134b	86AGE62c[2]	ND	ND	20	<10	110	ND	ND	ND	15	50	100	ND	ND	ND	ND	ND	ND	70	ND	ND	ND
135	86AGE61[2]	- -	ND	20	ND	80	ND	ND	ND	20	50	100	ND	ND	ND	ND	ND	0.1	50	ND	15	ND

Map no.	Field no.	Ba (ppm)	Hg (ppm)	Remarks
102	86BT396b[3]	1,300		Background, metabasalt
103	84BT102[2]	200	1.80	Mineralized stockwork Idaho claim
104	84BT102A[2]	1,000	0.78	Mineralized stockwork Idaho claim
105	84BT102B[2]	1,000	0.26	Mineralized stockwork Idaho claim
106a	85KB158A[2]	1,000		Chip channel, mineralized vein stockwork in monzonite
106b	85KB158D[2]	1,000		Chip channel, mineralized vein stockwork in monzonite
106c	85KB158E[2]	1,000		Chip channel, mineralized vein stockwork in monzonite
106d	85KB158G[2]	1,000		Chip channel, mineralized vein stockwork in monzonite
106e	85KB158H[2]	1,000		Chip channel, mineralized vein stockwork in monzonite
106f	85KB158I[2]	1,000		Chip channel, mineralized vein stockwork in monzonite
106g	85KB158J[2]	1,000		Chip channel, mineralized vein stockwork in monzonite
106k	86KB126	2,000	ND	Dahl claim veins
106l	86KB127	1,500	0.90	Dahl claim vein
106m	86KB125	1,500	0.16	Dahl claim vein
107	85KB120[2]	2,000	>6.0	Chicken Creek trench mineralized stockwork in monzonite
108	86BT398[3]	900		Background, TKm monzonite
109	85BT118[2]	1,000		Quartz vein in Chicken Mt. stock
110	86BT410[3]	590		Background, hornfels
110	86KB2[2]	190	ND	Ultramafic (background)
111	86BT411[3]	1,200		Background hornfels
112	86AGE74[2]	500	0.30	Hornfels sandstone
115	84BT288[2]	500	- -	Mineralized rhyolite chip sample
116	86AGE75[2]	500	0.10	Hornfels shale
117	85BT258[2]	700	0.2	Porphyry phase of monzonite
118	85BT260[2]	700	ND	Tourmaline rich monzonite
119	86BT400[3]	660		Background, slightly hornfelsed Kfss unit
121	86BT402[3]	790		Background Kfss unit
122	84L02[2]	500	.02	Altered monzodiorite chip sample
123	84GL03[2]	1,000	0.14	Intermediate? dike
124	84BT301	1,000	ND	Mafic dike
128a	84AM137a	700	- -	Altered intermediate dike
128b	84AM137b[2]	500	.28	Iron stained altered dike
128c	84AM137c[2]	500		Altered siltstone
133	85DB265	150	0.72	Background sediments
134a	86AGE62a[2]	500	- -	Px monzonite-dk?
134b	86AGE62c[2]	200	2.30	Iron stained Fg sandstone
135	86AGE61[2]	300	- -	Fg sandstone

Map no.	Field no.	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	Sb (ppm)	As (ppm)	Co (ppm)	Ni (ppm)	Cr (ppm)	Sn (ppm)	W (ppm)	Be (ppm)	Nb (ppm)	Bi (ppm)	Cd (ppm)	B (ppm)	La (ppm)	Y (ppm)	Th (ppm)
136	84AAi570[2]	- -	ND	20	20	90	ND	ND	ND	50	100	200	ND	ND	ND	ND	ND	ND	200	ND	30	ND
137a	84AAi569a[2]	- -	ND	50	50	70	ND	ND	10	50	150	700	ND	ND	ND	ND	ND	0.2	100	20	20	ND
137b	84AAi569b[2]	- -	ND	70	70	100	<5	ND	20	50	100	200	ND	ND	ND	ND	ND	ND	200	ND	30	ND
138	86AGE78[2]	ND	ND	10	15	70	ND	ND	ND	20	50	70	ND	ND	1	ND	ND	0.1	70	ND	10	ND
139a	86AGE77A[2]	ND	ND	30	10	100	ND	10	ND	50	50	500	ND	ND	ND	ND	ND	ND	10	ND	20	ND
139b	86AGE77B[2]	ND	ND	20	15	85	ND	ND	ND	20	50	70	ND	ND	1	ND	ND	02	50	ND	15	ND
140	86AGE76A[2]	ND	ND	15	ND	70	ND	6	ND	10	50	50	ND	ND	ND	ND	ND	ND	100	ND	10	ND
141	84RB08[2]	ND	ND	70	20	55	ND	ND	ND	50	700	5,000	ND	ND	ND	ND	ND	ND	20	ND	30	ND

*Samples collected by Marti L. Miller, 1984-86 (AM); T.K. Bundtzen, 1984-86 (BT); G.M. Laird, 1984-85 (GL); Linda Angeloni, 1984 (AAi); Katherine F. Bull, 1985-86 (KB); Bruce Gamble (AGE) and Bob Betts (RB).

[1] Analyses by Bondar-Clegg and Company Ltd., North Vancouver, British Columbia, Canada using induced neutron activation method.

[2] Analyses by J. Hoffman and J.T. Ryder, U.S. Geological Survey, Denver, Colorado; Au, Zn, Sb, As, Bi, Cd, and Hg by atomic absorbtion spectrophotometry. Remaining elements by emission spectrophotometry. Detection limits as follows (all in ppm except for ppb on Au): Au(50), Ag(.5), Cu(5), Pb(10), Zn(5), Mo(5), Sb(2), As(10), Co(5), Ni(5), Cr(10), Sn(10), W(spec-50), AA-5), Be(1), Nb(20), Bi(1), Cd(.1), B(10), La(20), Y(10), Th(100), Ba(20), Hg(.02).

[3] Analyses by Tom Laird, Neutron Activation Services, Ltd., Hamilton, Ontario, Canada, using induced neutron activation methods.

ND = not detected or below standard limits of detection.

- - = Not analyzed.

Map no.	Field no.	Ba (ppm)	Hg (ppm)	Remarks
136	84AA1570[2]	1,000	- -	Sandstone
137a	84AA1569a[2]	3,000	- -	Intermediate(?) dike
137b	84AA1569B[2]	1,000	- -	Siltstone
138	86AGE78[2]	200	- -	Sandstone
139a	86AGE77A[2]	500	.04	Intermediate dike
139b	86AGE77B[2]	200	.06	Hornfels sandstone
140	86AGE76A[2]	200	.14	Hornfels ss with quartz veins
141	84RB08[2]	700	0.78	Altered mafic dike with quartz veins

Other Prospects

A large Fe stained quartz vein intruding hornfels 2 km southwest of the mouth of Black Creek was explored with an adit and two small trenches (fig. 2, pl. 1). The gold vein varies from 3 to 25 cm thick, strikes N. 41 E., dips 60 SE. and yielded anomalous gold and silver from a selected grab sample (no. 26, table 8).

Gossaneous zones and thin quartz stockwork is conspicuous in hornfels and igneous rubble on the prominent 2,840 ft peak northeast of Flat. Bedrock exposures are rare and its difficult to ascertain the specific parameters of individual mineral occurrences; however, chip and grab assays show anomalous beryllium, niobium, arsenic, copper, bismuth, and silver in a 2 km^2 area at the head of Boulder Creek. The mineralization is localized just above a monzonitic stock which underlies the hornfels; hence the mineralized cupola and hornfels deserve further exploratory work.

Thin arsenopyrite veins in metabasalt were discovered in mine cuts about 1 km west of the Golden Horn deposit. The veinlets strike N. 15-20 E. and dip vertically, but have an unknown or small strike length. Besides elevated gold, antimony, and arsenic, the sample (map no. 4) contains 1,400 ppm yttrium.

A quartz-cinnabar vein was discovered in earlier years during gold dredging activities at the west end of the Flat airstrip. Only occasional chips of mineralized rubble were found during our work, but according to Ken Dahl (personal commun., 1985), the vein was up to 1 m wide and extended in a northerly direction across most of the dredged valley bottom. Several pieces of cinnabar float were found about 50 m on the west end of the airstrip, but it is not clear whether this sporadic material represented 'in place' mineralization.

Mineralized Dikes

Stibnite-quartz stockwork and fracture fillings occur in quartz porphyry (Tkf) along the Nixon-Iditarod fault about 4 km on northeast of the mouth of Prince Creek (loc. 82-86, pl. 1). Extent of stibnite mineralization is limited to a small 1 m^2 stockwork zone, but a larger zone of silicification some 100 m wide was noted during sampling. Gold anomalies (up to 2,900 ppb Au) are associated with the antimony occurrence.

Altered mafic dikes throughout the study area are consistently anomalous in chromium, nickel, and occasionally cobalt. Average chromium values of 1,250 ppm and nickel values of 600 ppm (N=8) are three times above normal background for mafic rocks (Krauskopf, 1969).

Coal

Thin coal seams were exploited in early years on the old tramway between Flat and Iditarod, about 1 km south of the ridge crest (loc. 'Coal,' pl. 1). According to Brooks (1914), the bed was 0.3 to 0.8 m thick, had a N. 60 E. strike, and dipped 50° SE. The bed occurs in the Kqs unit, and the now vegetated pits show plant rich, quartz arenite and shale as dominant bedrock lithologies. Mertie (1936) reported calorific values averaging 7,983 and an average Btu value of 14,369 or anthracite by rank. The extremely poor exposures that typify the site prevented any further examination by the authors.

GEOMORPHOLOGY OF PLACER DEPOSITS

The gold placers of the study area are derived from the erosion of mineralized monzonite plutons, volcanic rocks and adjacent hornfels. The style of gold placer concentration differ from drainage to drainage and is dependent on distance from lode sources, stream aspect and degree of bedrock disintegration. The Iditarod-Flat district is one of Alaska's best examples of a progressive evolution from residual to elluvial to stream heavy mineral placer concentrations from mineralized source rock. The streams that have yielded commercial amounts of placer gold are confined to a small 50 km^2 region centered on Chicken Mountain. The gold-cinnabar-antimony veins, disseminations, and stockworks in the Chicken Mountain monzonite, the Golden Horn deposit, the hornfels aureole north of Otter Creek, and mineralized bedrock within the valley of Otter Creek previously described are the probable sources of placer gold.

Gold fineness data from placer deposits throughout the study area is summarized by Smith (1941) Metz and Hawkins (1981), and Bundtzen and others (1987). The fineness values districtwide range from 822 to 891 and average about 864, based on 112 weighted determinations. Principal heavy minerals include cinnabar, chromite-magnesiochromite, magnetite, radioactive zircon, ilmenite and scheelite, ilmenorutile, garnet, and cassiterite. The overall provenance is somewhat puzzling because mineral assemblages range from epithermal to hypothermal temperatures and from gold-mercury-antimony associations to gold-arsenic-tin-niobium-tungsten metallic suites. The existence of chromium and nickel is unusual because very minor amounts of rocks of ultramafic affiliations have been recognized.

Chicken Mountain Stream Placers

Prince, Slate, Chicken, Flat, and Happy-Willow Creeks, radially drain Chicken Mountain, and all have their headward sources in a small 3 km^2 region near its summit. These first order streams range in length from 6 to 12 km in length and have asymmetrical profiles with steepest sides on their southern or western limits (fig. 6). Stream gradiants range from 200 m/km near their heads, slowly maturing to 80 m/km at midstream to 40 km/km where the enter major trunk streams off the flank of Chicken Mountain. On modern stream flood plains, the overburden, which is covered by vegetation and overlain by decomposed rock rich regolith, averages 3 to 6 m in thickness mid-stream and 5 to 8 m near stream heads. The thickened overburden occurs near the tops of the drainage basins in the steep ($\geq 15^\circ$ gradient) 'drop-off' zones and bowl shaped depressions that characterize Flat, 'Happy' and Slate Creeks. In these areas it consists of large slide rock slabs which have moved downslope from the summit area of Chicken Mountains. Older terrace levels have significantly thicker overburden than active flood plains. For instance the overburden in mine cuts on Prince and Willow Creeks ranges from 6 to 9 m in thickness and consists of varved frozen silt with up to 50 percent ice content.

Mineralized monzonitic bedrock on Chicken Mountain, the presumed source of placer gold, is hosted in deeply weathered, sandy 'grus' that ranges in depth from 1 to 6 m and averages 4 m in many areas. The physical and chemical disintegration of the monzonite into sand sized particles frees gold and other heavy minerals from vein and other deposits; these heavy minerals tend to sink into the rock debris. Continued removal of light specific-gravity rock-forming minerals and gangue material by wastewater and mechanical disintegration produces an enrichment in gold and in favorable areas, an economically exploitable deposit. These classic residual placers are best observed in the headward slopes of the Happy, Chicken, and Flat Creek drainages such as the Idaho Bench, and the Mohawk and Upgrade claim groups (fig. 6). Much of the original residual gold-heavy mineral accumulations later move downslope under the influence of frost action, gravity, and in part, water transport. These modified hillslope or 'elluvial' placers are found on steep slopes at the headward bowl of Flat Creek and in the sloped cryoplanation terraces of the Chicken Creek drainage. With continuing influence of stream hydraulics, the hillslope deposits are eventually worked into the auriferous stream placer deposits that have been historically exploited.

A general westward migration of streams during assymetrical valley formation played an important role in the evolution of stream placer deposits around Chicken Mountain. As described previously in the Quaternary geology section, the ground thaws differentially on the more thermally irradiated southern or westerly (afternoon) slopes causing solification activity to move colluvium toward northerly or easterly frozen buttresses (fig. 7). Thus older eastern bench deposits or strath terraces exist on Prince, Slate, Flat, Willow, and Chicken Creeks. Aerial photographic interpretation augmented with field observations have shown that, in one case, stream pyracy has resulted from the westerly migration process. Remnants of high level (1,250 ft; 380 m) bench deposits at the divide between Prince and Chicken Creeks indicate that the upper portion of Prince Creek was captured by Chicken Creek. Consequently it seems probable that the original lode sources of both streams lie in the cupola-stockwork area of the general 'Idaho and Mohawk bench' area and that present configuration of the Prince Creek drainage is not eroding this lode source. Further down Prince Creek, evidence of at least three bench levels have been identified. The two oldest bifurcate a low bedrock rib 1 to 2 km east of the present confluence with Bonanza Creek while the youngest terrace level closely parallels the present stream (fig. 6).

Westerly or southwesterly stream migration best explains the present configurations of Willow and Happy Creeks. The paleo-stream bed of Happy Creek is now preserved as a series of prominent terrace or bench levels on the eastern or northeastern limits of its valley. The ancestral 'Happy' Creek moved westerly leaving various terrace levels on Willow Creek. The terrace levels indicate an ancestral stream course that is markedly to the east of the current position of Willow Creek. In similar fashion Chicken, Flat, and Slate Creeks migrated in mainly a westerly direction leaving bench levels on eastern limits. Midway in Chicken Creek, a massive colluvial landslide has buried an earlier channel of the stream forcing a sharp curvilenear stream diversion around the obstruction.

Gold in bench terrace or bench deposits on Willow and Prince Creeks generally show higher fineness values when compared to that from active floodplains of the modern stream. Two fineness tests of gold from benches on Prince Creek average 876 while gold from the modern stream yields a fineness of 838. According to Mertie (1936), gold bullion from the Willow Bench, the presumed ancestral course of Happy Creek, averages 871, whereas gold fineness down the course of the modern stream valley of Happy Creek averages 864. There appears to be a more typical fineness change on Flat Creek where gold progressively worked downstream increases some 25 to 35 points in fineness (854-881) probably as a result of silver and base metals leaching out of the placer bullion leaving the geochemically stable gold.

In streams where data is available, bench placers contain more gold than modern stream placers. On Prince Creek the bench levels contain about twice the gold grade (0.03 to 0.04 oz gold yd^3) than the average of modern stream gravels .015-0.20 oz gold yd^3. In the upper bowl of Flat Creek, much of the extremely rich ground worked by the dredge of Yukon Gold Co. and later smaller operators were on the eastern benches. Some 2.8 million yards processed by the dredge during the first 4 years of operation in the basin averaged 0.09 oz gold yd (table 6). The western limit moderns stream gravels yielded grades about 1/4 as high.

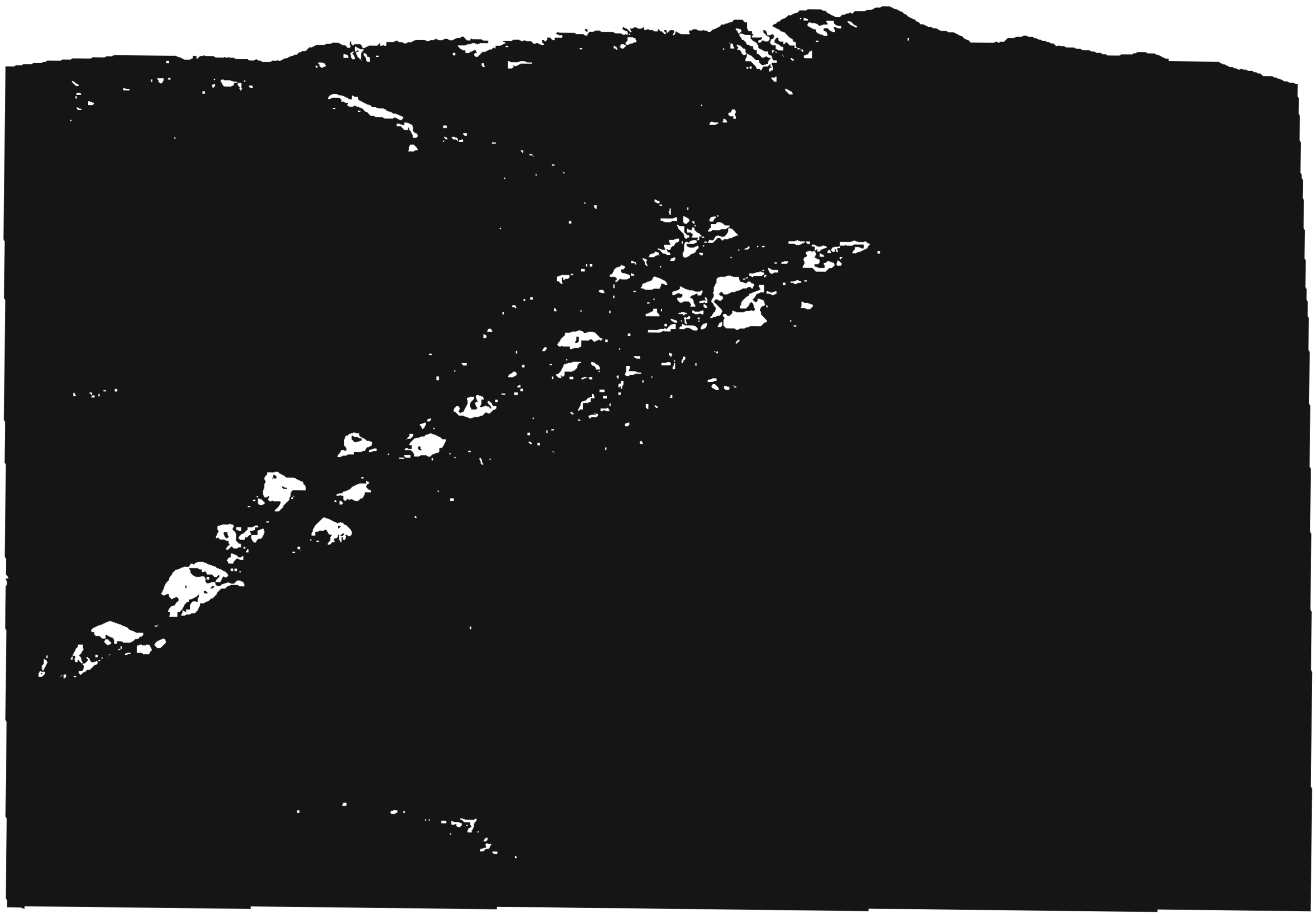

Figure 7. Prince Creek drainage looking north showing older terrace or bench levels on eastern limit (right side of photo) and modern stream on western limit (left side of photo).

Placer gold concentrations on various terrace levels of the 'Willow Bench' have been further modified from crosscutting by eastwest tributaries entering Willow Creek (fig. 6). Gold concentrations appear to be enriched at the intersection of each pup with the older terrace levels. Furthermore fineness values also appear enriched by 10-25 points at these points of intersection.

On Prince Creek heavy mineral concentrate analyses of bench and stream gravels significantly differ. Bench deposits contain a major component of cinnabar, garnet (below garnet bearing rhyolite sills of the lower stream) chrome spinel, stibnite, diopside, tremolite, ilmenite, and zircon. Modern stream gravels on the other hand have a somewhat lower amount of cinnabar, chrome spinel, ilmenite, and diopside, but also have scheelite, and trace cassiterite. Assuming the chrome spinel, ilmenite, diopside, and zircon present in both deposit types are accessory minerals of the pluton, the ore minerals represented in the modern stream deposits could be interpreted as being mesothermal to hypothermal in origin while an epithermal assemblage is represented in ore minerals of the bench deposits. If these assumptions are correct, then mineralization on Chicken Mountain has been progressively stripped away by erosion.

The grain size and physical dimension of placer gold from different streams draining Chicken Mountain are remarkably similar. Placer gold in all drainages exhibit similar sizes and shapes. Nearly 90 percent of the gold consists of small, equant grains in the -80 to -20 mesh range; flake gold is uncommon to rare (fig. 8). The largest nuggets average 25 grams (3/4 ounce). The largest Chicken Mountain area nugget reported by Mertie (1936) was a 57 grams (1-2/3 ounce) piece recovered from the Willow Bench. Fineness values in bench deposits are 862 (Chicken Creek), 871 (Willow), 862 (Happy Creek), 876 (Prince Creek), 855 (Slate Creek), and 878 (Flat Creek). The remarkably similar fineness values for all the streams (range = 23 points for all the placer deposits), strongly indicates a similar if not identical lode source. Additionally heavy minerals identified in concentrates by White and Killeen (1953) and Bundtzen and others (1987) all contain similar mineral species---scheelite, chrome spinel, zircon, amphiboles, cinnabar, and diopside. The specific known lode sources are thin 1/2 to 2 cm thick, auriferous quartz veinlets in the Chicken Mountain monzonite discussed previously; this also explains the uniform sized distribution of the placer gold present in the streams.

Placer Deposits of Otter Creek Drainage

Placer gold deposits in the Otter Creek drainage differ in morphology, gold fineness, size distribution and trace element (heavy mineral content) from those formed around Chicken Mountain. The westerly flowing Otter Creek heads at a major stream divide with the Dishna River 25 km northeast of Flat. Unlike the streams radially draining Chicken Mountain, valley asymmetry is reversed with a steepened northwall and a gradual southern rim underlain by bench gravels which gradually merge with modern stream alluvium. Auriferous gravels are confined to 1) Otter Creek from its confluence with Granite Creek and extending 8 km to a poorly defined area about 3 km downstream from Flat townsite, 2) the last 3 km of Granite Creek, 3) 4 km of Black Creek and its nearby tributary Glenn Gulch, and 4) Boulder Creek (where production of gold was modest). Placers on both Otter and Black Creeks begin on the upstream end of the Black Creek monzonite body which hosts the Golden Horn gold-tungsten shear zone previously described. Placers on Granite and Boulder Creeks, and Malemute Gulch are also immediately below a mineralized monzonite pluton exposed north of Otter Creek. Prior to exploitation, the overburden thickness varied from 3 to 6 m with 1 to 2 m being stream gravel and the remainder organic muck/silt deposits.

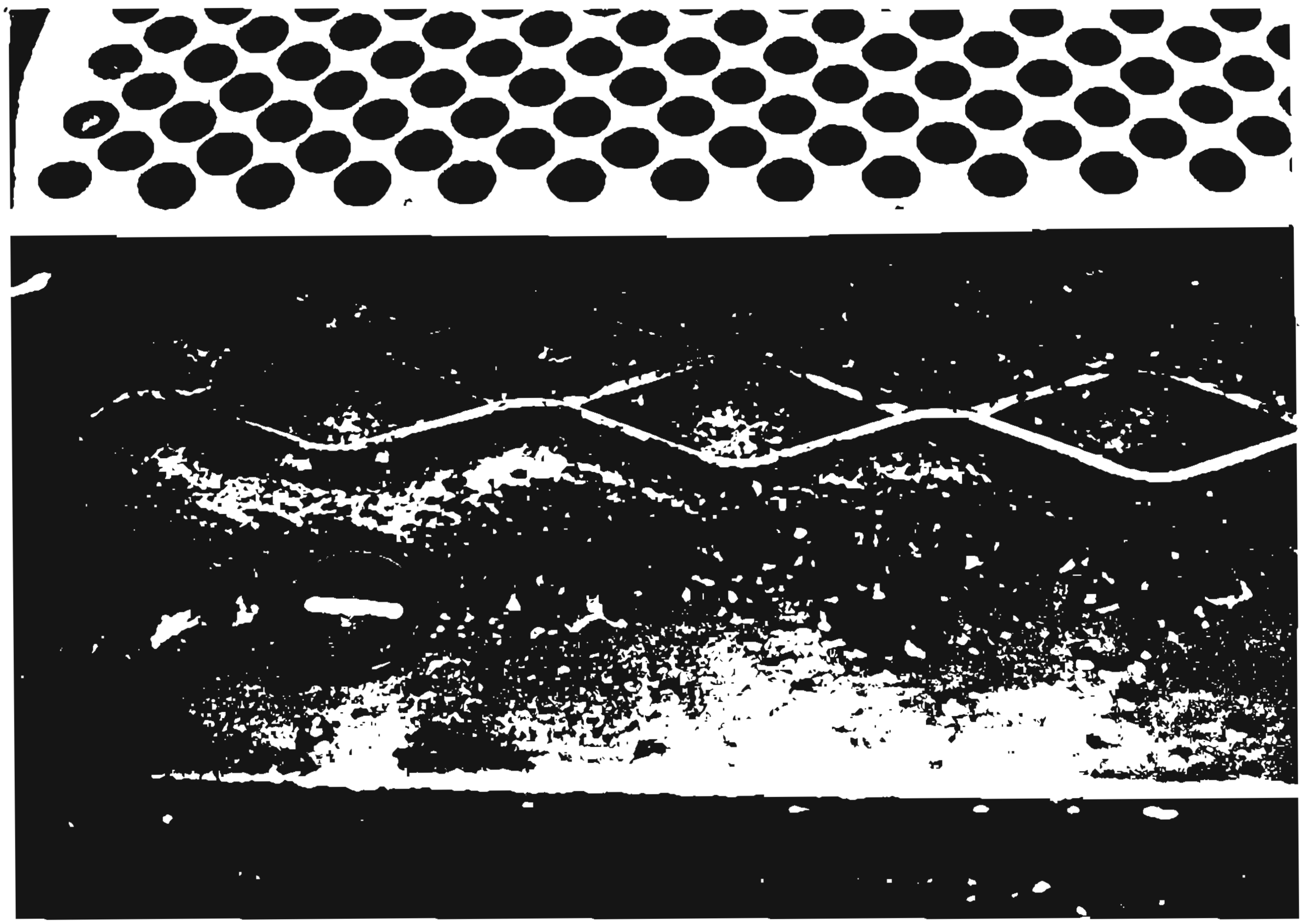

Figure 8. Placer gold from Happy Creek, 1983 Fullerton operation. Note generally fine equant nature gold grains.

Reproducible platinum anomalies (0.8-1.3 ppm) were discovered while analyzing gold bullion from Black Creek. This re-enforces earlier accounts by Andrews and others (1971) and Miscovich (personal commun., 1981) of platinum in the Otter Creek drainage. Although not in economic concentrations, its presence suggests further detailed work with bullion and concentrates is warranted.

In Otter Creek gold fineness decreases downstream from an average of 854 near the Golden Horn deposit to 838 near the Flat Airstrip to about 824 below the town of Flat (Mertie, 1936). The decreasing fineness values in a downstream direction is the opposite of what would be expected by silver-base metal leaching effects and could suggest multiple lodes sources in the valley of Otter Creek. We hypothesize that the high fineness gold is derived from veins and shears in the Black Creek monzonite (which we collectively refer to as the Golden Horn deposits) and the lower fineness bullion emanates from undiscovered deposits in placer cuts downstream.

Otter Creek placer gold is significantly coarser than that found in streams draining Chicken Mountain. Two distinctive types of placer gold from the Otter Creek drainage have been noted over the years: 1) angular fine gold with abundant quartz gangue, 2) rounded nugget gold with an absence of quartz or gangue mineralogy. A 16 oz nugget (548 grams) was recovered in Glenn Gulch in 1933 (Mertie, 1936) and in 1987, John Miscovich found the largest gold nugget in the district's history---a rounded 28 oz (960 gram) piece virtually free of gangue impurities. The larger veins averaging 0.5 m in thickness that are found in the Golden Horn mineralized system are the logical source for the coarse nugget gold found in the Black and Otter Creek drainages.

DISCUSSION OF LODE AND PLACER DEPOSITS

The Golden Horn, Chicken Mountain, Malemute Gulch, and Granite Creek prospects in the Iditarod district can be classified as gold-polymetallic deposits that have characteristics of alkaline related, precious metal systems of the western United States. All four deposits and other occurrences in the study area consist of shallow level, cupola hosted, vein disseminate shear zone, and stockwork concentrations of gold, silver, arsenic, antimony, ± mercury, ± and tungsten that also contain elevated levels of bismuth, uranium, zirconium, tellurium, yttrium, and platinum metals. Principal gangue minerals are quartz, tourmaline, and very minor fluorite, but tourmaline is notably absent in the Golden Horn deposit. Virtually all other volcanic-plutonic rocks of the Kuskokwim Igneous Belt contain tourmaline and locally axinite in breccia pipes, veins, and as abundant accessory mineral concentrations (Bundtzen and Swanson, 1984).

Work by Swanson and others (1987) and Bull (1988) show that host plutons at Flat belong to the metaluminous, alkali calcic series. Mafic phases of both the Black Creek and Chicken Mountain stocks are slightly alkaline or 'quartz alkalic' with Peacock indexes of about 51 and feldspathoidal minerals common in CIPW norm calculations (table 3; Bull, 1988).

Limited fluid inclusion homogenation temperatures, trace element chemistry, analyses, ore textures, and crosscutting field relationships indicate that metals in the Golden Horn deposits precipitated in both mesothermal and epithermal temperature environments. The gold-cinnabar-quartz veins in the Idaho Bench on Chicken Mountain were probably exclusively precipitated in epithermal conditions, although conditions of formation in the nearby Chicken Creek veins remain uncertain.

Heavy mineral placer deposits downslope and downstream from the known lode sources in the study area reflect the overall hard rock style of mineralization. The grain size, fineness, trace element geochemistry, and distribution of placer gold of all streams draining the Chicken Mountain stock are remarkably similar suggesting a near-identical lode source for placers in Prince, Happy, Chicken, Slate, Willow, and Flat Creeks. Microscopic examination of placer gold reported by Bundtzen and others (1987) show cinnabar attached to gold grains which suggests the epithermal conditions of lode formation observed in the Idaho Bench and related occurrences. Likewise the coarse placer gold in Otter and Black Creeks reflect the large shear-veins present in the presumed lode sources at the Golden Horn property. Alkali amphiboles and pyroxenes including edenite, richterite and hastingsite in placer concentrates in the streams also reflect the alkalic nature of the source plutonic rocks. Elevated platinum, niobium, uranium-rich zircon, and bismuth values in placer concentrates can suggest an alkalic metallogeny.

Several inconsistencies between between placer and lode mineral content remain. The trace amounts of cinnabar found in lodes within the Black Creek stock do not account for the abundance of cinnabar found in the nearby placer deposits on Otter and Black Creeks. This may suggest that the shallowest or lowest temperature portions of the mineral deposits have already been removed by erosion or that there are lode cinnabar sources in the area yet to be discovered. Bull (1988) could not find appreciable magnetite and only trace ilmenite in igneous rocks of the area; however, magnetite and ilmenite are abundant in most of the placer concentrates studied by Bundtzen and others (1987). Like the cinnabar question, either magnetite rich lode or rock unit sources remain undiscovered or magnetite rich mineral deposits or igneous rocks have been removed by erosion.

The Late Cretaceous-Early Tertiary volcano-plutonic system and associated mineral deposits at Flat are similar to other alkaline-subalkaline gold districts in the western United States that include Yellow Pine, Idaho, several volcanic plutonic related districts in central Montana, Rosita, Colorado, Ortiz and White Oaks, New Mexico, and to a lessor degree, Cripple Creek and Central City, Colorado (Rich and others, 1985; Thompson and others, 1985; Mutschler and others, 1984; Rogers and Enders, 1982; Segerstrom and Ryberg, 1982; Sims, 1983). Allen and Duttweiler (1988, in process) incorporate these and others into their Rocky Mountain Alkalic Province (RMAP). Igneous complexes in the RMAP most similar to the Flat area, appear to be in the early Tertiary central Montana alkalic province described by Mutshler and others (1985) and Giles (1983). The central Montana igneous complexes 1) are crudely aligned in a north-northeast direction for a distance of 400 km; 2) contain multiple volcanic and plutonic phases that range from mafic to felsic and calc-alkaline to alkaline in chemistry; 3) contain monzonite and monzodiorite as principal plutonic phases; and 4) in many instances, syenite plutons appear to have differentiated in place. Like the Flat-Kuskokwim igneous belt, the Montana igneous complexes have been the source of several million ounces of gold production.

The Zortman-Landusky gold deposits in central Montana area similar to those in the Flat district. The Zortman-Landusky mine contains shear-zone controlled, sericitically altered, quartz-pyrite-fluorite-free gold-telluride deposits hosted in cupola phases of syenite and monzonite. Ankerite-fluorite alteration is ubiqutous and vein disseminate forms of mineralization are reminiscent of occurrence in the Flat study area. Significant differences include 1) Golden Horn is, in part, a mesothermal system while Zortman-Landusky is clearly a low temperature epithermal system; 2) telluride rich zones are common in Zortman lodes while only slightly elevated tellurium values have thus far been recognized in the Flat properties); 3) mercury and tungsten, which are abundant at Golden Horn, do not appear as major constituents in the Zortman-Landusky system even though Thompson and others (1985) list elevated tungsten and molybdenum values in many alkalic gold properties; and 4) igneous protolith ages are 52 million years (K-Ar) at Zortman-Landusky compared to the 63-70 million year ages obtained in our study area (table 4).

In conclusion, both placer and lode mineral deposits can assist in the classification of mineral deposits in the Iditarod-Flat district. Mineralization in the study area has similarities to those in the Rocky Mountain Alkalic Province---specifically those in the central Montana subprovince---but enough differences exist with known deposits to suggest that lode-gold deposits in the Flat district may deserve a separate classification.

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DESCRIPTION OF MAP UNITS

Unconsolidated Deposits

Qa — STREAM ALLUVIUM---Unconsolidated silt, sand, and gravel deposited by modern streams; includes flood plain deposits. The latter is commonly covered by sphagnum moss, while extensive willow-alder thicket concentrations occur in mature valley fills. Based on measurements made in mine and road cuts near Chicken Mountain, thickness ranges from 3 to 10 m thick, but is highly variable.

Qht (Qht-hf) (Qht-m) — PLACER MINE TAILINGS---Symmetrical or irregular stacked piles of water washed, sorted gravels and 'in-situ' slab rock derived from bedrock---essentially artificially modified stream alluvium. Cobbles are dominantly resistant metabasalt, monzonite, and hornfels derived from Chicken

Mountain and Otter Creek drainage. Fine silt and clay fractions in part removed during the placer mining process. Most Qht tailings in Otter, Black, and Flat Creeks appear as stacked, curvilinear ribs 2 to 6 m high and 1 to 2 m thick derived from three floating, bucketline, stacker dredges in operation from 1912 to 1968. Qht-hf and Qht-m are tailings composed primarily of hornfels and monzonite respectively. Because the dredges dug up to 1 m into bedrock and because the last material to land on tailing piles is bedrock rubble, depiction of these two units probably indicates bedrock type underneath the processed alluvium. Qht tailings on Prince, Chicken, Willow, Black, Upper Otter, Happy, Granite, and Slate Creeks are cone shaped, gravel piles, 3 to 6 m high and 8 to 15 m in diameter, that were stacked by draglines or tractors during non-float, mechanized placer mining activities. Amount of fine material remaining in Qht unit dependant on number of times reworked on placer mining process. Tailings vary from 2 to 6 m thick throughout map area.

Qsf — SILT-FAN DEPOSITS---Moderately stratified silt, sand, and very minor stream gravels deposits produced mainly by water gullying action and incision in loess covered hillslopes; generally involves the subsequent reworking of loess (eolian) deposits. Heavily vegetated and contacts with other Quaternary units largely based on air-photo interpretation.

Qat' — YOUTHFUL TERRACE ALLUVIUM---Moderately to well sorted, well stratified sand and gravel weakly cemented by iron oxides. Unit is 5 to 10 m above active river floodplains and probably includes some stripped strath terraces in Bonanza Creek valley. Surfaces are generally vegetated, dissected by Holocene streams and mantled with eolian silt. No absolute age control is available but unit is believed to be equivalent to Late Wisconsin(?) terrace and glacial deposits in Beaver Mountains to the northeast (Bundtzen and Laird, 1982; Kline and Bundtzen, 1986). Estimated 2 to 5 m thick.

Qat — OLDER TERRACE ALLUVIUM---Moderately to well sorted, well stratified sand and gravel generally cemented by iron oxides to a greater degree than Qat'. Unit is 10 to 30 m above active river floodplains and includes stripped strath terraces throughout map area. Unit is covered by mature vegetation matte consisting of eolian silt and other poorly drained soils. Extensively dissected by Quaternary streams. No absolute age control is available but believed to be equivalent in age to Early or pre-Wisconsin glacial terrace levels exposed regionwide (Kline and Bundtzen, 1986). Estimated 5 m thick.

Qaf — ALLUVIAL FAN DEPOSITS---Poorly sorted, partially stratified, channelized silt, sand, and gravel in alluvial fans. Locally contains significant colluvial component and generally localized at intersection of tributary and trunk streams. Ages not differentiated and can range from pre-Wisconsin to Early Holocene. Thickness variable and ranges from 3 to 20 m.

Qls — LANDSLIDE DEPOSITS---Unsorted diamictic material consisting of angular bedrock blocks, vegetation mattes, stream gravels, and colluvium believed to be transported downslope by mass failure. Largest unit exposed on south side of Chicken Mountain.

Qc — COLLUVIAL DEPOSITS---Composite unit of poorly sorted, generally unsorted silt, sand, and minor gravel in alluvial-colluvial fans, in colluvial debris slopes, and purely eolian silt. Usually forms on slopes and has experienced some downslope movement as a result of water action. Heavily vegetated and general thicknesses variable.

Qu QUATERNARY DEPOSITS UNDIFFERENTIATED---Unconsolidated alluvial, colluvial, and eolian deposits. Eolian deposits are usually ice rich in valley fills. Colluvial and alluvial deposits are bedrock-derived talus and alluvial aprons. Unit almost always obscured by vegetation but good exposures appear in mine cuts on Willow and Happy Creeks, on Bonanza Creek, and in upland areas headward of Moose Creek.

Sedimentary and Volcanic Rocks

TKvm MAFIC VOLCANIC ROCKS---Mainly dark greenish gray to maroon, fine-grained to porphyritic, pyroxene-rich, basaltic andesite, and mafic volcanic breccia. Dominant pyroxene is titanoaugite, with minor component of hyperstene present. Rare olivine grains and phenocrysts from 0.1 to 5 mm in diameter are usually altered to secondary minerals including antigorite. Unit has ubiquitously undergone contact metamorphism by adjacent or underlying plutons and contains secondary biotite, chlorite, and locally amphibole, with metamorphic grades up to the hornblende hornfels facies. Unit very resistant and forms prominent knobs and ridges. Estimated 150 m thick.

TKvi INTERMEDIATE VOLCANIC ROCKS---Light to medium-greenish gray, aphanitic to fine grained, biotite pyroxene andesite and hornblende dacite. Locally contains mafic to intermediate coarse-grained volcanic breccia and greenish siliceous tuff layers 1 to 4 cm thick on Chicken Mountain. Like the TKvm unit, unit has undergone contact metamorphism from adjacent and underlying plutons and secondary white mica, biotite, and hornblende recognized. Less resistant than TKvm and forms rubble-blocky slopes and ridges. Estimated 100 m thick.

Kqs QUARTZOSE SUBLITHIC SANDSTONE AND SILICEOUS SHALES---Gray to light gray, fine-to-coarse-grained, locally conglomeratic, well sorted subangular to subrounded, quartz-rich sandstone and shale and siltstone of similar composition. Fine sand layers are locally crossbedded and lack graded sequences. Presence of coal, leaf beds, and coquina beds containing nonmarine or brackish water pelecypods (table 5) suggest that the Kqs unit represents a shoreline section with nonmarine, beach, and subtidal deposits present. Unit extends from the map area in both northeasterly and southwesterly directions for over 200 km but only appears northwest of Nixon-Iditarod fault. Petrographic studies indicate that monocrystalline quartz, polycrystalline quartz fragments, and metamorphic rock fragments predominate, but volcanic-lithic components are present in several samples. Metamorphic clasts may be derived from nearby Precambrian Idaho sequence (Miller and Bundtzen, 1985). Estimated maximum thickness is 800 m but may thin to 200 m to the southeast.

Kfss FINE-GRAINED SUBLITHIC SANDSTONE AND SILTSTONE---Light to dark gray, sometimes olivine-green, fine to very fine grained (minor medium grained), tight, siliceous sublithic sandstone and medium gray, plant rich siltstone and shale. Limited point count analysis (N=3) indicates clast compositions of tightly packed quartz and polycrystalline quartz (50-65 percent), sedigenic sand to shale riprap clasts (10 to 15 percent), and variable amounts of radiolarian chert, metamorphic fragments, volcanic debris and limestone clasts. Stems and fragments of dicot leaves found in shales and siltstones but invertebrate fossils rare to absent. Crossbeds occur as several stacked costs 3 to 10 cm thick; graded bedding is rare. Kfss unit occurs just below Kqs unit northwest of Iditarod-Nixon Fork fault and near the stratigraphic top of the Kuskokwim group southeast of the Iditarod-Nixon Fork fault. Probably formed in shallow marine conditions. Estimated to be 400 m thick near Flat and 200 m thick on Ruby Creek anticline (pl. 1). Forms conspicuous black lichen covered resistant rubble and individual beds are traceable for 10-20 km along strike.

Kcs — COARSE SANDSTONE AND PEBBLE CONGLOMERATE---Gray to medium greenish gray, indurated, fine grained to coarse grained, volcaniclastic sandstone interbedded with beds up to 5 m thick of pebble sandstone and pebble conglomerate. Clast composition based on eight samples shows angular clasts of volcanic lithics (20 percent), chert (20 percent), polycrystalline quartz (20 percent) mixed felsic igneous rocks (12 percent), chlorite (6 percent), white mica (2 percent), limestone (6 percent), opaque minerals (4 percent), and amphiboles and pyroxenes (10 percent) in an oxidized matrix of undetermined composition. Coarse Bouma Tab intervals recognized locally *Inoceramus* prisms locally common. Thickness varies widely 50 to 200 m thick and Kcs unit is often wedge-shaped in cross section. Observed on both sides of Iditarod-Nixon Fork fault but stratigraphic correlation between the two fault separated sections is uncertain.

Ktls — TAN CALCAREOUS SANDSTONE AND SILTSTONE---Heterogeneous unit consisting of gray to tan, locally tan weathered, fine to coarse grained, subangular to subrounded (clasts), lithic rich, distinctly calcareous sandstone with lessor amounts of noncalcareous sandstone and interbedded micaceous siltstone. Limited point count analysis (N=2) shows subangular to subrounded clasts of altered carbonate (5 percent), chert (15 percent), polycrystalline quartz (15 percent), clinopyroxene(?) and amphibole (3 percent), white mica (9 percent), undetermined mafics and opaques (8 percent), and matrix (35 percent). Unit conspicuously contains *Inoceramus* prisms, plant stems, and occasional dicot leaf fragments. Rip-up clasts, graded Bouma Tabcd intervals, and scour features suggest deposition by turbidity currents. Local distinct tan weathering is believed to be caused by one or several features: 1) extent of oxidation in outcrop, 2) Fe rich fluid flow in sediments, or 3) alteration caused by dike swarm density, which is locally conspicuous. The unit is probably 400 m thick northwest of Iditarod-Nixon Fork fault. Ktls unit is very similar to Kls unit southeast of Iditarod-Nixon Fork fault but latter unit lacks conspicuous tan weathering; hence correlation between the fault separated sections remains speculative.

Ks — LITHIC SANDSTONE---Light to medium gray, subangular to subrounded, generally medium-grained lithic sandstone, with minor siltstone and shale. Three thin sections contain quartz, polycrystalline quartz, radiolarian chert, metamorphic rock, white mica chlorite, biotite, and very minor metavolcanic clasts and fragments. Calcareous clasts generally absent and clast provenance is dominantly sedigenic. Exhibits high energy flow regime indicators such as graded bedding Bouma Tabc intervals, and flute casts suggestive of deposition by turbidity currents. Occurs as a thin 100 m thick unit near base of Cretaceous section northwest of Iditarod-Nixon Fork fault and interbedded throughout section southeast of Iditarod-Nixon Fork fault.

Ksh SHALE AND SILTSTONE---Medium to dark gray, finely laminated siltstone and shale. Traces of burrowing organisms found locally in micaceous shale. Forms base of Cretaceous section northwest of Iditarod-Nixon Fork fault and is estimated to be 250 m thick.

Kfs GRAY FINE TO MEDIUM SANDSTONE---Medium to dark gray, fine grained siliceous sandstone similar to those of Kfss, but lacking siltstone and shale. Outcrops are more massive in appearance and clast of sand composition very similar to that summarized in Kfss unit.

Kac VOLCANIC BRECCIA, CHERT, TUFF, AND SANDSTONE---Dark green to gray, aphanitic to very fine grained, massive to brecciated, distinctly tan oxide weathering, volcanic breccia with minor tuffaceous sandstone and chert. Stratigraphic relationship with enclosing Kuskokwim Group clastic rocks is very uncertain, and we speculate that unit is equivalent to units west of Ganes Creek in Iditarod-2 Quadrangle and north of Moore Creek in Iditarod C-3 Quadrangle; in both locations, volcanic agglomerate and flow rocks are interbedded midway through Cretaceous sedimentary section.

Kls LIMEY SANDSTONE AND SHALE---Thick heterogeneous unit of medium greenish gray, bleached to dark brown weathered, fine to coarse grained calcareous lithic sandstone and interbedded shale. Unit is similar to Ktls unit northwest Nixon-Iditarod fault except that coarse grained facies less dominant than in Ktls and distinctive Fe-stained, tanned zones that typity Ktls much less intense in Kls. Nevertheless, Kls may be equivalent to Ktls. Kls forms the bulk of sedimentary rock section southeast of Nixon-Iditarod fault and is equivalent to undifferentiated units (Kus) mapped by Bundtzen and Laird (1983) and Bundtzen and others (1987). Total thickness unknown, but the basal unit is at least 5,000 m thick in eastcentral part of map area. Characteristically nonresistant and forms low, rounded hills.

Plutonic Rocks

TKf RHYOLITE TO DACITE---Light gray bleached, aphanitic to fine grained, locally garnet-bearing, quartz porphyritic, muscovite, biotite dacite, rhyolite, and alaskite. Color index ranges from 3 to 5. K-Ar separates from three samples show radiometric ages of 69.97, 69.32, and 64.30 m.y. (table 4).

TKm MONZONITE AND MONZODIORITE---Light to dark gray, porphyritic hypidiomorphic granular, tourmaline bearing, olivine, biotite, diopside monzonite and monzodiorite. Includes both fine and coarse grained variants (C on plate 1). A typical monzonite on Chicken Mountain contains normally zoned plagioclase (30 percent, An_{35-45}), interstitial and poikilitic orthoclase and sanadine (20 to 25 percent), clinopyroxene; typically diopside (15 percent), biotite (15 percent), olivine (5 to 8 percent), and minor or trace tourmaline, sphene, hornblende, and zircon. K-spar contains inclusions of plagioclase, biotite, hornblende, and diopside. Color index ranges from 15 to 35. Opaque minerals are very minor ($\geq$2 percent) and where present, appear to be dominantly ilmenite and chrome spinel. Tkm north of Granite Creek and west of Golden Horn fault is very coarse grained with biotite and augite grains up to 1 cm in diameter. Tkm in upper Prince Creek contains crystallization 'nuclei' of diopside and olivine rimed by biotite (rarely amphibole) and surrounded by medium grained normal groundmass of leucocratic minerals. Not unlike 'orbicular' textures described elsewhere. Apparently intrudes and partially assimilates more mafic Tkg and Tku phases. Bull (1988) mapped separate quartz monzonite phases in northcentral portion of Chicken Mountain stock lumped here in TKm unit.

TKg ALKALI GABBRO---Medium to coarse grained, dark gray, hypidiomorphic granular, olivine, edenite, diopside, bronzite, biotite gabbro. Color index ranges from 30 to 60. Forms a discontinuous rim around Chicken Mountain stock and has been partially assimilated by monzonite and monzodiorite (Tkm). Bull (1988) maps eastern rim of TKg unit on Chicken Mountain as monzodiorite.

TKu WEHRLITE---Coarse grained olivine, diopside, bronzite, edenite, green biotite picrite---variant wehrlite---found only on Chicken Mountain. Small pod in southeast corner of Chicken Mountain stock. Orthopyroxene occurs as reaction rim around diopside and olivine; amphibole is edenite (Bull, 1988). Opaque mineralogy is ilmenite ($FeTiO_3$) and minor chrome-spinel. TKu unit appears to be related directly to alkali gabbro (TKg); both are believed to be partially assimulated by younger(?) monzonite and monzodiorite on Chicken Mountain.

TKmd, TKid Tkd DIKES AND DIKE SWARMS---Variety of mafic (TKmd), intermediate (TKid) and undifferentiated (Tkd) dikes and dike swarms most of which are extensively altered to calcite, chlorite, and chrome phengite. The vast majority of TKd unit believed to be mafic dikes (TKmd) now largely altered to silica-carbonate rock. A few mafic dikes contain central unaltered zones with fresh grains of olivine, clinopyroxene, plagioclase, and undifferentiated opaque minerals in a chloritized groundmass.

Metamorphic Rocks

TKhf HORNFELS---Brown to gray, massive to porphyroblastic, chlorite + biotite, locally tourmaline rich hornfels largely derived from Kuskokwim Group clastic rocks. Dark gray, massive, aphanitic variants sometimes difficult to distinguish from aphanitic volcanic rocks of TKvi and TKvm units. Unit is very resistant and forms striking hogbacks around Chicken Mountain pluton and two prominant hills north of Otter Creek. The overall distribution suggests that a much larger pluton than is exposed on Chicken Mountain and in Otter Creek underlies much of the Otter Creek drainage.

PzJc CHERT AND VOLCANIC ROCKS---Mixed unit of black, recrystallized radiolarian chert, tuffaceous sandstone, and clinopyroxene, basaltic-andesite flows and flow breccia. Volcanic rocks are metamorphosed to prehnite-pumpellyite facies. Unit is probably equivalent to Innoko Terrane. Assigned Paleozoic to Jurassic(?) age based on Mississippian through Triassic radiolarians found in Ophir Quadrangle (Chapman and others, 1982; Patton and others, 1980) and a possible Jurassic radiolarian from the Iditarod D-1 Quadrangle (Miller and Bundtzen, 1987).

bx- Undifferentiated bedrock; could include all lithologies previously described.