STATE OF ALASKA

Walter J. Hickel - Governor

DEPARTMENT OF NATURAL RESOURCES

Phil R. Holdsworth - Commissioner

DIVISION OF MINES AND MINERALS

James A. Williams - Director

GEOLOGIC REPORT NO. 28

Geology of the Upper Chistochina River Area, Mt. Hayes Quadrangle, Alaska

By

Arthur W. Rose

Juneau, Alaska
March 1967

TABLE OF CONTENTS (Continued)

	Page
GEOLOGIC HISTORY OF THE AREA	18
ECONOMIC GEOLOGY	19
Localities 1 to 32	19-23
Slate Creek and Miller Gulch placer deposits	23
Origin of gold	23
Buried former channel	25
Big Four placer deposit	25
Glacier claims	26
Other placer deposits	26
GEOCHEMISTRY OF STREAM SEDIMENTS	26
Discussion of anomalies	32
Arsenic	34
Silver	35
Panning concentrates	35
SUGGESTIONS FOR PROSPECTING	37
REFERENCES	38

ILLUSTRATIONS

Table 1 - Summary of stratigraphy	3
Table 2 - Units in the Chisna formation	5
Table 3 - Composition of mafic-ultramafic rocks	9
Table 4 - Composition of granitic rocks	11
Table 5 - Assays of samples	27
Table 6 - Analyses of stream sediment samples	28
Table 7 - Analyses of black phyllite samples	33
Table 8 - Mineralogy of panned stream sediments	36

TABLE OF CONTENTS

	Page
ABSTRACT	1
INTRODUCTION	1
REGIONAL GEOLOGY	2
ROCK UNITS	2
Phyllite, metagraywacke, and other rocks	2
Chisna formation (Pennsylvanian-Permian?)	4
Mankomen formation (Permian)	6
Basalt-diabase unit	6
Argillite unit	6
Limestone	7
Amphibolite, schist, and gneiss	7
Greenstone breccia	
Mafic-ultramafic complex	8
Gakona diorite	10
West Fork granodiorite	12
Boulder Creek quartz monzonite	12
Slate Creek granodiorite porphyry	12
Miscellaneous granitic rocks	12
Tertiary (?) volcanic rocks	13
Gakona formation (Eocene)	14
Conglomerate unit	14
Shale and sandstone unit	14
"Round wash"	15
Pleistocene deposits	15
STRUCTURAL GEOLOGY	16
Area north of Denali fault	16
Spire Creek area	16
West Fork-Main Fork area	17
Magnetite Creek area	18

ILLUSTRATIONS (Continued)

	Page
Figure 1 - Geology of upper Chistochina map area	In Pocket
Figure 2 - Cross sections of upper Chistochina River area	In Pocket
Figure 3 - Frequency distribution of stream sediment data	40
Figure 4 - Frequency distribution of arsenic in stream sediments	41

GEOLOGY OF THE UPPER CHISTOCHINA RIVER AREA,

MT. HAYES QUADRANGLE, ALASKA

by Arthur W. Rose

ABSTRACT

The upper Chistochina River map area consists of 75 square miles on the south slope of the Alaska Range between the Gakona River and the Slate Creek placer camp. The Denali fault, a regional strike-slip fault, crosses the north side of the map area. Offset of recent glacial deposits along the fault indicates small amounts of right lateral movement combined with minor uplift of the north side. North of the fault, phyllites and graywackes of possible early Paleozoic age are intruded locally by granitic rocks. South of the fault, Pennsylvanian and Permian andesite-dacite, basalt, argillite, and other sediments are intruded by Mesozoic ultramafic, mafic, and granitic rocks, all overlain by Tertiary(?) volcanic rocks and nonmarine conglomerate, sandstone, and shale of the Eocene(?) Gakona formation.

The Slate Creek fault zone parallels the Denali fault and is inferred to be right lateral strike-slip in nature. A large thrust fault which has thrust Permian argillite south over Gakona Formation, near Gakona Glacier, also appears to have offset and deflected the Slate Creek fault zone.

The placer gold deposits at Slate Creek have produced over three million dollars in gold, and several possible extensions of the deposits are indicated. The gold may have been derived from north of the Denali fault and deposited in certain parts of the Gakona formation, followed by reconcentration in the present streams. Stream sediment geochemistry has detected several strong anomalies in copper, lead, and zinc along the Slate Creek fault zone, as well as numerous moderate anomalies in these metals and molybdenum. A variety of small mineral occurrences were found during the mapping.

INTRODUCTION

Placer gold deposits on Slate Creek and nearby localities in the upper Chistochina River drainage were discovered near the turn of the century and have been worked sporadically since then. Total production from the district has probably been about 3.5 million dollars. The district was visited and mapped in reconnaissance by the U.S. Geological Survey in 1902 (Mendenhall, 1905). Later visits and reconnaissance geologic mapping took place in 1917 and 1941, but no detailed geologic work has ever been published on the district and its surroundings. An area about 15 miles long west of the West Fork of the Chistochina has not been mapped even in reconnaissance. In addition to placer gold, the presence of platinum, native copper, and other minerals in the placer concentrates, and large iron-stained zones in rocks of the district suggested the possibility of other types of mineral deposits in the region. The present project, consisting of geologic mapping at a scale of 1 inch to 1/2 mile and stream sediment geochemical sampling, is intended to fill this gap in information and thereby assist evaluation of the mineral possibilities of the district.

The field work was done between July 14 and August 17, 1966 by the writer and assistant L.J. Kerin. Access to the area was by float plane to a lake just east of the Gakona glacier (elevation 3,732') and by wheel plane to the airstrip at Slate Creek. The writer is indebted to Lewis Elmer for permission to use the airstrip and for information and hospitality while in the area. In view of thefts and equipment damage by unauthorized pilots using this airstrip, it is worth noting that the airstrip is on private patented ground and should not be used without permission of the owners.

The 1966 field work covered the area from the Gakona Glacier to the Slate Creek district. The remainder of the district, as far east as Canyon Creek is planned for investigation in 1967. Some geologic problems encountered in the work to date should be solvable by mapping this additional area and by revisiting troublesome localities.

For convenience in this report the West Fork of the Chistochina River is abbreviated West Fork, and the Chistochina River (flowing by Slate Creek) is called the Main Fork. The large glaciers at the head of these two streams are termed the West Fork Glacier and the Main Fork Glacier. Spire Creek, Magnetite Creek, Mendenhall Creek, and Volcanic Creek are names adopted for this report, as shown on the map.

REGIONAL GEOLOGY

The map area lies in the southern foothills and slopes of the Alaska Range, on the northern margin of the Copper River basin. The Denali fault, a major strike-slip fault, crosses the northern margin of the map area. Phyllite and schist on the north side of the fault are part of a large region of metamorphic rocks of little known age and structure exposed throughout the Yukon-Tanana region and the north side of the Alaska Range. Granitic and mafic intrusives are locally present in the region. On the south side of the fault, late Paleozoic to Triassic sediments and volcanics are intruded by Mesozoic granitic, mafic, and ultramafic rocks, and are covered locally by Tertiary sediments. The Pleistocene and Recent have been characterized by piedmont and valley glaciation centered in the Alaska Range.

The generalized stratigraphy of the area is summarized in Table 1.

ROCK UNITS

Phyllite, metagraywacke, and other rocks north of Denali fault (mp)

The rocks on the north side of the Denali fault were visited on only two traverses, both between the West Fork and Main Fork glaciers, but additional information has been gained from distant views and examination of float on the glaciers.

Black slaty phyllite and dark schistose graywacke is the main rock type for a mile or more north of the Denali fault in the area traversed. Dark limestone and limy sediments form beds up to 20 feet thick in the phyllite but are subordinate in amount. White quartz veins and fine disseminated pyrite are typical of most black phyllite. The crest of the ridge north of the fault is made up of more resistant layered rock, which, on the basis of float and one outcrop observation, is judged to be

Table 1.

Summary of Stratigraphy

Age	Symbol	Thickness (feet)	Unit and description
Pleistocene	Qb		Moraine and glacial outwash Bench gravels
Eocene(?)	Tg		Gakona formation
	Tgs	500+	Shale and sandstone unit
	Tgc	1000+	Spire Creek conglomerate unit
	Tgw	100+	"Round wash"
Eocene(?) or Cretaceous(?)	Tv	1500+	Volcanic rocks Andesite, dacite, and quartz latite flows and agglomerates
Permian (and Triassic?)	Pm		Mankomen formation
	Pma	5000+	Argillite unit
	Pmb	2000+	Basalt-diabase unit
		5000+	Lower units (not exposed in map area)
Pennsylvanian and Permian(?)	Pc	9000+	Chisna formation Andesite and dacite flows, agglomerates, tuffs, and tuffaceous sediments (see table 2)
pre-Pennsylvanian(?) (north of Denali fault)	Mp	3000+	Phyllite, metagraywacke and other rocks

schistose meta-graywacke. Unfoliated greenstone and fine mafic diorite are also present locally as indicated by float. Homogeneous massive light-colored rock presumed to be diorite or granite forms considerable areas northwest of Mt. Kimball and near Mt. Gakona. The meta-sediments strike approximately east-west, at a slight angle to the Denali fault, and dip at low to moderate angles to the north.

The metamorphic grade of most phyllite and schist observed in outcrop appears low, probably greenschist facies, and the original character of the rock is fairly evident in most exposures, although slaty cleavage, schistosity, and effects of shearing are locally strongly developed. Well-foliated coarser-grained schist is evidently present farther north judging from float on the central part of the Main Fork glacier. The coarse-grained schist is inferred to result from metamorphism near the granitic intrusives.

The age of these meta-sedimentary rocks is uncertain. An early Paleozoic or Precambrian age has generally been assigned, but Rose (1966) suggested a Mesozoic age for very similar meta-sediments near the Maclaren River.

Chisna formation (Pennsylvanian-Permian?) (Pc)

The majority of exposures in the southern half of the map area are andesitic and dacitic volcanics, and were mapped by Mendenhall (1905) as the Chisna formation. Mendenhall considered conglomerate, quartzite, and tuff to be the main components of the formation, but in the area mapped to date, which includes about a third of the area shown as Chisna formation on Mendenhall's map, the dominant rock types are andesite and dacite flows, agglomerates, and tuffs or tuffaceous sediments. The characteristic features of the formation in the area mapped are its andesitic to dacitic composition, a low to moderate content of mafic minerals (apparently mainly hornblende), and extensive alteration to chlorite, epidote, pyrite and other minerals. Of a half dozen volcanic rocks examined by x-ray and thin section, one contains enough potash feldspar to be called quartz latite.

Along the ridge between the West Fork and the Main Fork, several units striking north-south have been mapped. Actual contacts between the units were generally difficult to find because of poor exposures and the variable nature of some units; however, some of the units are relatively distinctive and could be recognized at numerous places along strike. A brief description of these units is given in table 2. Based on an average dip of about 45° to the west, the section of rocks exposed on this ridge is about 9,000 feet thick, although the thick middle unit (Pcu) appears to thin markedly to the south.

South of Slate Creek, porphyritic andesite-dacite flows with plagioclase phenocrysts are in contact with agglomerates, tuffs and flows along a northwest-trending contact. West of the West Fork, most of the Chisna formation is flows, tuffs, and agglomerates of variable character, but porphyritic andesite similar to unit Pcp is exposed north of Sandstone Creek, and thin discontinuous limestone was found just south of Volcanic Creek.

The Chisna formation is very similar to portions of the Rainbow Mountain sequence of Hanson (1964) and to the "Mississippian or Pennsylvanian" dacite, andesite, and

Table 2

Units in the Chisna formation

A. Between the West Fork and the Main Fork

Unit	Description
Pca	Fine-grained andesite or dacite, dark purplish to greenish gray, and agglomerate and massive tuff of similar material; bedded andesite tuff or graywacke present at west margin of outcrops.
Pcp	Porphyritic andesite with prominent plagioclase phenocrysts, purplish-gray to greenish gray.
Pcu	Andesitic to dacitic agglomerates with some tuffs and flows, quite variable in character but generally light-colored and lacking obvious phenocrysts. Some agglomerates contain a variety of fragments.
Pct	Andesitic tuff and fine agglomerate, mostly massive.
Pcd	Porphyritic dacite, dark green, with possibly some agglomerate of similar material.
Pcq	Dacite porphyry or fine quartz diorite, light-colored, abundant small quartz and feldspar grains; may be intrusive.

B. South of Slate Creek

Pcad	Porphyritic andesite and dacite with obvious plagioclase phenocrysts.
Pcu	Agglomerates, tuffs, and flows of andesitic to dacitic composition and variable character.

C. West of the West Fork

Pcl	Limestone up to 10 feet thick, discontinuous, mostly clastic, light gray to reddish-brown.
Pcu	As above, but includes porphyritic andesite like Pcp north of Mendenhall Creek along the West Fork.

graywacke of Rose (1966, p. 8). More recent paleontological studies indicate that the rocks described by Hanson and Rose are Pennsylvanian and/or Permian in age and that Mississippian is not present. (R. Petrocz personal communication). Several brachiopods and corals were collected from the limestone just south of Volcanic Creek and appear to be of upper Paleozoic age but have not yet been identified in detail. A Pennsylvanian-Permian(?) age is assigned from the above information.

Mankomen formation (Permian) (Pm)

The name Mankomen formation was applied by Mendenhall (1905) to more than 7,000 feet of Permian sedimentary and volcanic rocks exposed north of Mankomen Lake. In their reconnaissance mapping, Mendenhall (1905) and Moffit (1954) included the argillite and basalt north of Slate Creek and Boulder Creek in the present map area in the Mankomen formation, indicating that it was similar to shales in the upper part of the type area. A re-examination of the type area is needed for proper use of the name Mankomen, as it seems to include several units of widely different lithology, and the top is not well-defined. For this report, Mankomen is used as a formation name to include argillite, basalt, and associated rocks as informal map units.

Basalt-diabase unit (Pmb)

A belt about a mile wide just south of the Denali fault is composed largely of basalt and diabase. Where relatively unmetamorphosed, the major rock types are very fine-grained dark gray to dark green basalt in which small feldspar phenocrysts can generally be recognized, and moderate-size to large bodies of relatively fine-grained diabase containing plagioclase tablets about one mm in length in a mafic matrix. The diabase bodies are inferred to be thick flows or sills in the basalt. In a few outcrops between the West Fork and the Main Fork, and north of the head of Slate Creek, rounded masses of relatively coarse-grained basalt or diabase a foot or two in diameter are separate from each other by thin zones of fine-grained material, and may be pillow basalt. No vesicles were noted in the basalt unit. Thinly banded to massive greenish to gray sediments or tuffs are present locally near the south contact.

The age relation of the basalt and diabase to the argillite is not clear. On the east side of the West Fork glacier, the contact of the basalt and argillite can be located within a few feet and dips southward parallel to bedding in the argillite, suggesting that the two units are conformable. Similar relations were observed about two miles east. However, it is not clear which unit is older. Based on the greater degree of metamorphism of the basalt, and the attitude of the contact, it is tentatively concluded that the basalt is older. However, this does not fit into the stratigraphic section and relations described by Mendenhall (1905) and Moffit (1954) north of Mankomen Lake, and it is possible that the units are overturned. If this is true, the greater degree of metamorphism in the basalt may be due to proximity to the Denali fault. In either case, a probable age of Permian can be assigned from correlation of the argillite with the upper part of the type section north of Mankomen Lake.

Argillite unit (Pma)

An approximately east-west belt between the basalt-diabase and the Chisna formation is composed of dark argillite and siltstone, locally metamorphosed to hornfels, slate, and phyllite. Some argillite, especially in the western part of the district, is massive and aphanitic and may be of volcanic origin. However, the larger part of the unit, including some exposures in the western part of the map area, shows obscure to distinct banding or bedding. Individual bands or beds are generally less than an inch thick. The subordinate lighter colored bands are apparently composed of limy or more siliceous material than the prevailing dark gray to black argillite. Abundant graphite is visible in one thin section, and in combination with fine mafic material, is probably the major cause of the dark color. Plagioclase is the most abundant detrital constituent recognizable in thin section. Some argillite has been metamorphosed to hornfels and contains 5-10% biotite, indicating a moderate potash content in the original sediment. Other argillite has apparently been metamorphosed to amphibolite, indicating a more mafic composition.

In the Slate Creek area, the southernmost exposures are distinctly bedded argillite or shale. This obviously sedimentary material grades northward to good argillite, then to slaty argillite and phyllite, to well-foliated fine-grained schist at the head of Slate Creek. A similar transition appears to occur between the West Fork and the Main Fork. Approximately 5,000 feet of argillite is apparently present on the west side of the West Fork glacier, and 2,000 to 4,000 feet can be inferred elsewhere. The top of the argillite is not exposed.

These "shales" were correlated by Mendenhall (1905, p. 41) with the upper beds of the section north of Mankomen Lake. Permian fossils were found in limestone near the top of that section, and the argillites of the map area are therefore presumed to be Permian. However, they are also similar to argillites of possible Triassic age exposed along the Slana River (D.H. Richter, personal communication) and the location of the Permian-Triassic boundary therefore requires further study.

Limestone (Pml)

A thin-bedded fossiliferous cherty limestone can be traced for about a mile between Magnetite Creek and Mendenhall Creek. The fossils consist of abundant bryozoa preserved as molds in the chert. The limestone is identical in lithology and fossils to rocks of unit "Bl" in the Rainy Creek area about 30 miles to the west. (Rose, 1965).

A largely recrystallized limestone bed can be traced across the ridge on the northwest side of the Spire Creek glacier. This limestone or marble is white and relatively pure. It is separated from relatively massive argillite on the west by several hundred feet of "greenstone" which is presumed to be altered basalt.

An additional marble bed is discussed below under amphibolite.

Amphibolite, schist, and gneiss (Pmm, Pms)

At the head of the valleys of Magnetite Creek, Mendenhall Creek, and Volcanic Creek, exposures are predominantly amphibolite (Pmm). The amphibolite is fine- to medium-grained and composed largely of hornblende and plagioclase. One specimen examined in thin section contained considerable augite in addition to hornblende. Small to moderate amounts of pyrite, pyrrhotite, and magnetite are common. The amphibolite is interpreted as the product of metamorphism and possibly metasomatism of basalt and other rocks by the mafic and ultramafic intrusives of the vicinity. Associated with some amphibolite is magnetite-bearing hornblendite which is discussed with the ultramafic rocks.

Smaller areas of banded schist and gneissic amphibolite (Pms) are interpreted as metamorphosed equivalents of the banded argillite. Such rocks are found at the terminus of the Magnetite Creek glacier and as pendants within the gabbro and pyroxenite between Magnetite Creek and Spire Creek.

Impure marble, banded siliceous schist, and gneissic amphibolite are also found adjacent to diorite in Section 6 northwest of Magnetite Creek. These metamorphic rocks are also regarded as contact metamorphosed portions of the Mankomen section, though they could be considerably older.

Greenstone breccia (Pmg)

Just north of Boulder Creek, a layer of brecciated greenstone cuts through the argillite. The greenstone appears to have been a diabase or mafic diorite before alteration. As far as could be determined, the rock is completely fragmented into subangular pieces ranging from an inch to more than a foot in diameter. The rock is tenatively interpreted as a large dike of diabase that intruded the argillite and was later brecciated, possibly because of its massive nature compared to the enclosing incompetent argillite.

Very similar altered diabase is an abundant constituent of conglomerate in the Tertiary Gakona formation along Boulder Creek and locally along Slate Creek. An alternative is an origin as a "monolithologic breccia" which now occupies a narrow graben in the argillite; i.e., it is a part of the Gakona formation.

Mafic-ultramafic complex (Mesozoic)

A complex of mafic and ultramafic rocks is exposed discontinuously along an east-west belt from the Spire Creek glacier to just north of Slate Creek. These ultramafic rocks are part of a larger belt of ultramafics along the south side of the Denali fault. The belt is now recognizable from the Maclaren River through the Eureka Creek, Rainy Creek, and Rainbow Mountain areas to Slate Creek (Rose, 1966, Hanson, 1964), a distance of 50 miles. A further extension to the east is indicated by the recent discovery of dunite near Gillett Pass, 15 miles east of Slate Creek (D.H. Richter, personal communication).

Within the map area, coarse-grained pyroxenite is the most abundant rock type, in contrast to the Eureka-Rainy Creek area where dunite is the most abundant type. The pyroxenite typically contains small to moderate amounts of biotite, hornblende, magnetite, and apatite (table 3). In some specimens the magnetite content approaches that of low grade iron ore perhaps similar to the occurrences in southeastern Alaska (U.S. Geological Survey, 1964, p. 108) and the Alaska Peninsula (Reed and Detterman, 1965). The pyroxene is augite, typically a pale green slightly pleochroic variety. No orthopyroxene was noted. Minor amounts of peridotite and dunite were found between the West Fork and the Main Fork.

Mafic gabbro is common north of Slate Creek and elsewhere along the margins of the ultramafic bodies. The mafic gabbro typically contains 10-20% plagioclase in combination with hornblende, pyroxene, and smaller amounts of biotite, magnetite, and apatite.

Mafic diorite typified by samples 448 and 447 (table 3) forms the southern portion of the complex adjacent to the Magnetite Creek glacier. A small amount of interstital microcline is present, and the plagioclase is sodic andesine. Some diorite has distinct

Table 3

Composition of mafic-ultramafic rocks

	450	525	449A	461	416	635	448	447
Plagioclase						26	56	63
%An						75	36(?)	32(?)
K-feldspar							4	5
Saussurite			1					p
Epidote					3			tr.
Olivine	?	10						
Augite	98	78	72	68		30	21	11
Hornblende	1	tr.	6	24	78	39		10
Biotite	tr.	tr.	2				15	7
Chlorite	1				7			tr.
Serpentine		10						
Magnetite	tr.	2	15	8	10	5	2	2
Apatite			4			1	1	tr.
Pyrite					1			
Chalcopyrite			tr.		tr.			
Carbonate					1			
Sphene							tr.	tr.

----

450 Pyroxenite, near center section 32, T19S, R14E.
525 Olivine pyroxenite, SW1/4 section 6, T20S, R15E.
449A Magnetite-rich pyroxenite, near center of north boundary, section 5, T20S, R14E.
461 Hornblende pyroxenite, near center, section 4, T20S, R14E.
416 Magnetite-rich hornblendite, in float on Spire Creek.
635 Mafic gabbro, near center of west boundary, section 14, T20S, R14E.
448 Augite-biotite diorite, just south of center of north boundary, section 5, T20S, R14E.
447 Diorite, NW 1/4, section 5, T20S, R14E.

P Present

primary foliation and contains numerous inclusions of hornfels and amphibolite. Assimilation of argillite may be partly responsible for the composition of the diorite.

Along the north margin of the Magnetite Creek ultramafic body, zones of magnetite-bearing hornblendite and hornblende gabbro pagmatite have developed. Much of the hornblende is coarse-grained to pegmatitic in grain size. Similar hornblendite also occurs locally within the pyroxenite. Amphibolite of variable texture is a common associate of the hornblendite. The hornblendite is interpreted as a metasomatic reaction product between the ultramafic intrusive and the basalt-diabase unit. A similar origin has been proposed for magnetite-bearing hornblende-rich rocks adjacent to pyroxenite in southeastern Alaska (Irvine, 1963).

The ultramafic body north of the Boulder Creek granodiorite grades from peridotite and pyroxenite in the center to "mafic diorite" on the contacts. The diorite is composed of hornblende and small to moderate amounts of quartz and potash feldspar. It is believed to result from reaction between the ultramafic rock and the granitic rock.

Age relations of rock types within the mafic-ultramafic complex are not clear. Dike-like bodies of pyroxenite occur within the mafic diorite adjacent to the Magnetite Creek glacier, but thin veins of feldspathic material cut the pyroxenite.

An unaltered gabbro dike cuts pyritized Chisna formation in section 21, T20S, R14E. The ultramafic rocks appear to be older than at least some of the granitic rocks of the area. In the southwest corner of section 6, T20S, R15E, a dike of granodiorite with large potash feldspar phenocrysts cuts through mafic hornblende gabbro gradational to pyroxenite, indicating that the Boulder Creek granodiorite is probably younger than the pyroxenite. In the northcentral part of section 3, T20S, R14E, leucocratic quartz diorite or granodiorite forms the matrix of a breccia composed of pyroxenite and gabbro fragments. Coarse-grained vuggy quartz-calcite-orthoclase-epidote rock also occurs locally between fragments in the breccia. Pyroxenite has reacted with both types of leucocratic material to form hornblende-orthoclase "gabbro" as a rim up to an inch wide around the fragments. The age relations of the ultramafic rocks thus contrast with the Maclaren River area, where ultramafic dikes cut through granitic rocks.

Gakona diorite

Hornblende diorite and related rocks are exposed just east of the Gakona River between Spire and Mendenhall Creeks. Sample 6E417, table 4, is a typical specimen of the outcrops west of Magnetite Creek, and contains minor amounts of biotite, quartz, and orthoclase in addition to hornblende and labradorite-andesine. The texture is granitic to seriate-porphyritic, with a tendency toward clustering of mafic minerals. The coarsest grains are 4-5 mm in length. Local gabbroic phases are present.

On the east side of Magnetite Creek, most of the diorite is medium-grained and equigranular, and it is possible that this is a separate intrusive, but local phases are very similar to the slightly coarser-grained diorite described above.

The diorite intrudes argillite of the Mankomen formation, and metamorphosed rock of the contact zone is overlain by a small patch of Tertiary Gakona formation in section 6 (not shown on map). Dikes possibly related to the diorite cut the mafic diorite and pyroxenite.

Table 4

Composition of granitic rocks

	417*	545*	601*	518*	622*	648	657	536A*	551*
Quartz	6	25	31	9	7	10	15	10	20
K-feldspar	2	17	23	27	26				10
Plagioclase	67	51	39	44	57	79	78	70	51
%An	52-40	10-15	40	45	28-15	43-10	40	45	20-5
Biotite	4		4	11					4
Hornblende	18	1	2	9	7	10		15	
Chlorite		5					4	5	15
Sericite									5
Epidote			tr.				3		
Carbonate						tr.	tr.	1	5
Sphene	tr.	tr.						1	
Apatite	tr.	tr.		tr.	1				tr.
Magnetite	3	1	tr.	tr.		1			tr.
Pyrite	tr.					tr.			

*Composition by point count of 400-500 points in thin section, other samples by microscopic estimate only.

6E-417 Gakona diorite, center section 6, T20S, R14E.
6E-545 West Fork granodiorite, head of Boulder Creek NE 1/4, section 18, T20S, R15E.
6E-601 West Fork granodiorite, just NW of center, section 36, T20S, R14E.
6E-518 Boulder Creek granodiorite, west center section 8, T20S, R15E.
6E-622 Slate Creek granodiorite porphyry, south center, section 13, T20S, R15E.
6E-648 Hornblende quartz diorite dike, SW 1/4 section 27, T20S, R15E.
6E-657 Porphyritic quartz diorite, just east of center, section 22, T20S, R15E.
6E-536A Fine-grained quartz diorite, NW 1/4,section 4, T20S, R15E.
6E-551 Fine-grained granodiorite, NW 1/4, section 4, T20S, R14E.

Relatively mafic diorite or gabbro of similar texture is exposed in a fault block on lower Volcanic Creek.

West Fork granodiorite

Leucocratic pink granodiorite and quartz monzonite intrudes the Chisna formation in several localities between the West Fork and the Main Fork. Samples 6E545 and 601 (table 4) are typical of this rock type. The texture is medium-grained granitic, and sample 601 contains notable amounts of myrmekite. Weak alteration of mafics to chlorite and limonite, and feldspar to clay, is typical.

The best-exposed body is a north-trending dike or sill with offshoots. The remaining exposures probably represent two or three stocks largely covered by glacial deposits and ice in the West Fork and Main Fork valleys. Outcrops near the mouth of the West Fork were not visited because of difficult access but appear to be similar rock.

Boulder Creek quartz monzonite

Rugged peaks north of Boulder Creek are made up of gray medium- to coarse-grained hornblende-biotite quartz monzonite, in part with large potash feldspar phenocrysts (sample 518, table 4). The granodiorite occurs as a pluton a little over a mile in diameter, with a "stem" extending off to the east. It intrudes argillite on the south side, and is interpreted to intrude pyroxenite on the north, as discussed previously. Most of the quartz monzonite is quite fresh and unaltered.

Slate Creek granodiorite porphyry

Specimens of a dioritic rock from the east side of upper Slate Creek in the south-central part of section 13 proved in thin section to be granodiorite porphyry (sample 622, table 3). Subhedral plagioclase and hornblende phenocrysts up to five mm in length are separated by a groundmass of anhedral quartz, plagioclase, and orthoclase with a grain size of about 0.5 mm. The texture is similar to that of granitic intrusives associated with porphyry copper and other base metal deposits in western United States. The porphyry appears to occur as discontinuous lenses and dikes in an east-west trending brecciated zone in argillite, but mapping is still incomplete. It is possible that this intrusive is related to the gold placers, as gold is found only downstream from the intrusive. The granodiorite was not noted west of Slate Creek, but the brecciated zone and an andesite porphyry dike were seen on strike.

Miscellaneous granitic rocks

A thick dike of hornblende quartz diorite cuts the Chisna formation about a mile south of Slate Creek (sample 648, table 4).

An elongate pod of porphyritic quartz diorite with prominent quartz phenocrysts was mapped in the Chisna formation just south of Slate Creek townsite (sample 657, table 4).

Fine-grained diorite and quartz diorite occurs as small dikes and plugs in the north half of section 4, T20S, R15E, (sample 536A, table 4).

Fine-grained granodiorite (sample 451, table 4) and granodiorite prophyry intrudes hornblendite and pyroxenite at the terminus of the Magnetite Creek glacier. Similar fine-grained granitic rock intrudes pyroxenite breccia at the head of the Mendenhall Creek glacier (and elsewhere, judging from float). Some of the granodiorite has undergone argillitic alteration. The fine grain size, the alteration, and the location in a zone of fine-grained dikes suggests that the granodiorite may be a hypabyssal representative of the Tertiary volcanic rocks.

Tertiary(?) volcanic rocks (Tv, Ti)

Volcanic rocks and shallow intrusives of intermediate composition are exposed in two main areas, one on Spire Creek and the other on Volcanic Creek. On the west side of Spire Creek the volcanic rocks occur as a layered sequence at least 1,500 feet thick, dipping northward at a low to moderate angle. The lowest unit is a dacite tuff-breccia several hundred feet thick composed of fragments of black aphanitic volcanic rock up to three inches in diameter in a light gray matrix containing quartz and plagioclase phenocrysts. This is overlain by greenish-gray dacite agglomerate with obscure rounded fragments, followed by a persistent sill or flow of pinkish quartz latite porphyry. Above the quartz latite is several hundred more feet of dacite tuff and agglomerate, overlain by 600-800 feet of brownish-gray, fine-grained, andesite breccia and andesite. The Tertiary conglomerate overlies the andesite disconformably or with slight angular unconformity. The Tertiary(?) volcanic rocks differ from the Chisna formation in a relative lack of propylitic alteration and a less mafic composition. Where present, alteration has produced a bleached chalky appearance.

The above units could not be identified on the south side of Spire Creek. Instead, a variety of massive argillized andesite, dacite, and latite flows and agglomerates are exposed.

The second area of volcanic rocks is on Volcanic Creek and vicinity. The central part of this valley is underlain by bedded tuffaceous sediments and volcanics of dacite to quartz latite composition. The volcanics are bordered on the south by a narrow band of poorly consolidated conglomerate and mudstone, and on the north by massive dacite porphyry, grading eastward to abundant dikes in the argillite. The relations of these three rock types are not clear, but presumably can be accounted for by a combination of faulting, erosion, tilting, and intrusion.

Additional exposures of argillized volcanic(?) rock and poorly-consolidated sediments are found in the Mendenhall Creek drainage west of the above outcrops. The more northerly exposure is interpreted as a shallow intrusive that has altered the adjacent diabase so that the contact is no longer readily locatable, but it is possible that the altered rock is entirely diabase.

A swarm of fine-grained and porphyritic dikes of intermediate composition is found in the area between the volcanic outcrops on Spire Creek and the West Fork glacier. Argillitic alteration is typical of many of these dikes. The dikes are presumed to be related to the Tertiary volcanics, although some could be related to the earlier intrusive periods.

A Tertiary(?) age is assigned on the basis of the near conformity of the volcanics with the overlying conglomerate. A correlation with the Chisna formation is precluded by the dike swarm cutting the argillite and mafic ultramafic complex, assuming that the dikes and the volcanics are related. A late Cretaceous(?) age has been suggested for possibly correlative dacite tuff in the Gulkana glacier area (Bond, 1965).

Gakona formation (Tg) (Eocene)

The name "Gakona formation" was given by Mendenhall (1905) to a sequence of shales, sandstones, and conglomerates exposed between the Gakona glacier and the West Fork. As described by Mendenhall, the formation consisted of a well-indurated basal conglomerate member overlain by moderately to poorly-consolidated coal-bearing shale, sands, and clays. An Eocene age was assigned on the basis of plant fossils.

Conglomerate unit (Tgc)

About 1,000 feet of cobble and boulder conglomerate beds are exposed on the north side of Spire Creek above the Tertiary volcanics and below a thrust fault. The conglomerate extends across to the south side of Spire Creek, and similar rock is present near the mouth of Volcanic Creek. Cobbles of andesitic volcanic rock are the most abundant type of clast, but well-rounded white quartz cobbles and boulders are a more distinctive feature. Clasts of metamorphic and granitic rocks are sparse and were noted only at the top of the unit.

Conglomerate is common in other exposures of the Gakona formation and is discussed below, but it is not clear whether they represent the same basal unit.

The conglomerate unit is grouped with the fossiliferous shale and sandstone unit on the basis of degree of consolidation and the close association of quartz cobble conglomerate with sandstone and shale on Volcanic Creek and elsewhere. However, in the lack of an exposed section of the upper contact of the conglomerate a distinctly older age is not precluded.

Shale and sandstone unit (Tgs)

The shale and sandstone unit is best exposed on the south side of Mendenhall Creek and on the north slopes of hill "Ona" about a mile to the west. The formation probably underlies a west-northwest belt about one and one half miles wide between the West Fork and Magnetite Creek. A few small exposures are also found between Magnetite and Spire Creeks, apparently deposited unconformably on a very uneven surface. Another group of exposures is between Spire Creek and Magnetite Creek, in a small fault block. A third set of occurrences is in the narrow graben extending from Volcanic Creek through Slate Creek. In most of these areas, the typical features of poor consolidation and the presence of coaly matter can be found.

Along Boulder Creek, the higher and more easterly outcrops are predominantly conglomerate composed largely of greenstone-diabase clasts plus minor dunite. On the West Fork side of the divide, considerable contorted shale with coal beds up to two feet thick is present. There is a complete lack of clasts of the adjacent granodiorite, argillite, and Chisna formation, indicating that the Gakona formation has been faulted down into its present position rather than being deposited in a narrow valley.

Cobble conglomerate composed of greenstone-diabase clasts makes up most of the Gakona exposures along Slate Creek valley. The conglomerate is typically stained red from oxidation by meteoric waters. Coal-bearing shale or mudstone is present in association with the conglomerate on a small hill opposite Miller Gulch.

Along Mendenhall Creek, the shale and sandstone unit appears to lie unconformably on the Chisna formation, indicating that a basal conglomerate is not present everywhere.

"Round wash" (Trw)

The term "round wash" or "wash" has been applied by miners of the area to a conglomerate deposit at the headwaters of Miller Gulch (Chapin, 1919). The name is derived from the presence of rounded residual boulders of granitic and other rocks over most of the outcrop area. The exposures at the head of Miller Gulch consist of weakly consolidated sandstone and conglomerate, distinctly bedded and dipping about 20° north. Diorite and gabbro are the most abundant clasts, with lesser amounts of granodiorite, graywacke, slate, white quartz, and peridotite. Fine particles of schist and slate are the major constituents of the sandstone and the matrix of the conglomerate. A noticeable amount of fine white quartz is also present. The schist, slate, and graywacke are clearly derived from north of the Denali fault, and the granitic rocks and white quartz have no obvious local source. Little if any argillite could be recognized in the conglomerate, although the deposit unconformably overlies argillite. Based on its location and the presence of small amounts of gold in the conglomerate, it has been suggested as a source of the gold in the district by miners (Chapin, 1919).

The general similarity between the "round wash" and the conglomerate unit of the Gakona formation indicates that the two may be correlative in a general way, although granitic boulders were not noted elsewhere in the Gakona formation. An origin as piedmont alluvial accumulations at the foot of the uplifted ancestral Alaska Range is suggested by the nature of the deposits. Erosion or nondeposition of the Tertiary volcanics is indicated by their absence below the conglomerate.

Pleistocene deposits

No attempt was made to systematically map these deposits, but some observations are recorded below.

1. Thick deposits of outwash gravel were formed adjacent to the Gakona glacier, as on hill "Ona". These deposits appear correlative with similar material near Paxson.

2. At least two relatively recent sets of lateral and terminal moraines are evident in the Main Fork and West Fork valleys. On the Main Fork, the older of these crosses the valley about a mile above the West Fork. The ice of this stage extended about a third of a mile up the Slate Creek valley, with consequences discussed under placer deposits.

3. More than a hundred feet of gravels (Qb) derived from the higher slopes form a prominant bench on the north side of Slate Creek. These gravels are reportedly gold-bearing and may have developed while Slate Creek was blocked by the Main Fork glacier, as noted above.

4. When Mendenhall visited the district in 1902, the Main Fork glacier extended down to within a few hundred feet of the mouth of Slate Creek. It has retreated over a mile in the intervening 50 years, and has melted back about a half mile since 1954 when available air photos were taken. The West Fork glacier has retreated about a third of a mile since 1954.

STRUCTURAL GEOLOGY

The structural features of the area are discussed in four subareas, as follows:

1. Area north of Denali fault
2. Spire Creek area
3. Magnetite Creek area
4. West Fork-Main Fork area

Area north of Denali fault

On the basis of limited observation north of the fault, the black phyllite and graywacke dip northward at low to moderate angles. This rock sequence and structural pattern appears to persist from the head of the Gakona glacier eastward to the Chistochina glacier. Many minor complexities are evident where the rocks are examined in detail, especially in the phyllite, and doubtless there has been considerable bedding, plane shearing and crumpling.

Near the Denali fault, the phyllites are highly contorted and broken, and some fault movement has apparently been taken up in the incompetent phyllites. The zone of highly disturbed rocks extends at least a third of a mile north of the fault. More competent diabase and amphibolite south of the fault do not appear to have been deformed in this manner, although they are considerably fractured.

For most of its length through the area, the Denali fault trace is covered either by glaciers or by very recent glacial deposits (probably not older than 50 years, considering the retreat of the Chistochina glacier in this period). However, in section 32, T19S, R15E, a poorly-developed scarp suggests that the north side has moved 20-50 feet up. In section 2, T20S, R15E, the fault trace is evident as a line of anomalous topography and vegetation. Several small streams appear to have undergone 50-100 feet of right lateral offset. No vertical movement is evident here. Right lateral offset and uplift of the north side is consistent with observations of Stout (1965) along the Delta River and St. Amand (1957) for the fault as a whole.

Spire Creek area

This area extends from the Gakona glacier eastward to the ridge separating the Magnetite and Spire Creek drainages. The major structure of this area is interpreted as a north-dipping thrust fault (fault B) along which argillite, greenstone, and marble of the Mankomen formation and the mafic-ultramafic complex have been thrust over the Tertiary volcanics and conglomerate, as shown on cross-section A-A' of figure 2.

Two steeply dipping faults, A and C, displace units in the footwall block of the thrust. If movement has been dip slip, fault A must have a displacement of several thousand feet in order to cut out the volcanics and conglomerate in the east end of section 6. Fault C, in combination with fault A, forms a graben occupied by the Tertiary sandstone and shale, and thus bears similarities to the Slate Creek fault zone described below.

The great extent of the mafic-ultramafic complex on the east side of the Spire Creek glacier and its absence on the west side seems most simply explained as an abrupt termination of the mafic-ultramafic body. However, north-south cross-faulting in the upper plate of the thrust is also a possibility. Unfortunately, the critical evidence is hidden under the glacier and in inaccessible areas at the head of the glacier.

West Fork-Main Fork area

The eastern two-thirds of the map area, from Slate Creek to the west side of the West Fork, has fundamental structural features in common and is therefore discussed as a unit. This structural block apparently extends eastward to the Middle Fork, judging from the reconnaissance maps (Moffit, 1954) and thus has a length of about 15 miles. The western limit is fault F.

The major structural feature of this block is a large fault zone extending from Slate Creek through Boulder Creek to Volcanic Creek, and separating the Chisna formation from the Mankomen formation. This fault is here termed the Slate Creek fault zone. A narrow graben-like sliver of Tertiary sediments occurs within the zone (sections B-B' and C-C', figure 2). As noted previously, conglomerates in the Tertiary rocks contain few, if any, clasts of the adjacent rock types, indicating that the Tertiary rocks were faulted in from a higher level rather than accumulating in an older valley along the fault. Bedding is not well developed in the Tertiary sediments of the fault zone, but where evident, is highly contorted and faulted.

Two types of fault movement might be considered to explain the character of the Slate Creek fault zone.

1. The south fault of the zone is a normal fault, possibly flattening with depth. The graben of Tertiary rocks has been down-dropped by antithetic normal faults dipping into the main fault.

2. The movement along the zone has been strike-slip, and thin slices of Tertiary sediments have been dropped into the fault zone at locations of small bends in the fault.

According to Chapin (1919), the faults of the zone dip northward at 65-70°. However, at the only exposures of the fault seen by the writer, on Slate Creek just below Miller Gulch, the north fault has a nearly vertical dip. A very steep dip is also indicated by the trace of the fault in the headwaters of Boulder Creek.

The second hypothesis, of strike-slip movement, is more appealing in view of the parallelism with the Denali fault and the large vertical displacement of the slivers of Tertiary sediment (at least 1,000 feet along Boulder Creek and Slate Creek). Right lateral movement is inferred from fault offsets on Volcanic Creek, and by analogy with the Denali fault.

A north-south fault zone down the West Fork glacier is inferred to account for offset of the contact between basalt (Pmb) and argillite (Pma). This fault is inferred to be cut off by the Slate Creek fault zone. An alternate explanation is that it continues down the West Fork and is responsible for the "bend" in the Slate Creek fault zone across the West Fork.

Lithologic units in the Chisna formation south of the Slate Creek fault zone strike north-south to northwesterly and dip westward, forming the west limb of a large anticline. North of the fault zone, the Mankomen formation strikes more or less parallel to the zone and dips moderately to steeply in both directions. Assuming the argillite is younger than basalt, a considerable amount of overturning to the south has occurred, probably related in origin to the southward thrusting of the Spire Creek area. North of Slate Creek, the well-developed foliation in phyllite and schist of section 13 near the Denali fault also suggests compression normal to the Denali fault with accompanying southward thrust movements.

An east-west zone in argillite of the south half of section 13, T20S, R15E, is characterized by brecciation, intrusion, and alteration that has hardened the rock. The brecciated zone is on the strike of the ultramafic body and is intruded by dikes and pods of the Slate Creek granodiorite porphyry. The brecciation is evidently younger than development of foliation in rocks to the north, and some granodiorite appears brecciated.

In good exposures along lower Miller Gulch, numerous small folds and faults are present in the argillite, indicating that individual attitudes in this vicinity are of doubtful significance.. The attitudes of bedding recorded on the map suggest a large syncline passing through the upper part of Miller Gulch subparallel to the Slate Creek fault zone. An anticline may exist in the vicinity of the breccia zone. These structures need more detailed mapping for confirmation.

Magnetite Creek area

The structure of this area, extending from the Magnetite Creek glacier to fault F is not clear. The main problems are the inability to extend faults A and B of the Spire Creek area into this area, and the greater southward extent of the Mankomen formation, as compared to the West Fork-Main Fork area. The observed relations might be explained by two basically different types of structures:

1. A system of steep east-west and north-south faults.

2. A flat thrust, possibly related to fault B, locally cut by north-south faults, combined with movement on the Slate Creek fault zone.

The second alternative seems more in keeping with the structural features of the adjacent areas, but the details of fault interrelationships are not apparent. In the interpretation shown on the map, fault F is considered as a strike-slip fault, which offsets the Slate Creek fault zone, but has been offset itself by renewed strike-slip movement on the Slate Creek fault. The complex relations in section 10 could involve small gravity slides or large talus blocks.

GEOLOGIC HISTORY OF THE AREA

This history of the area is summarized as follows:

1. Deposition of graywacke and shale of area north of Denali fault	Early Paleozoic(?)

2. Possible low to moderate grade metamorphism (although this could be Mesozoic and Tertiary) — Paleozoic(?)

3. Accumulation of andesite and dacite flows, agglomerates, tuffs, and sediments of the Chisna formation — Pennsylvanian-Permian(?)

4. Deposition of argillite, basalt, limestone, and volcanics of the Mankomen formation — Permian

5. Folding and intrusion of ultramafic rocks — Mesozoic

6. Intrusion of granitic rocks (some granitic rocks could be older than ultramafics) — Mesozoic or early Tertiary

7. Erosion, and extrusion of Tertiary(?) volcanic rocks — Early Tertiary or Cretaceous

8. Erosion and deposition of Gakona formation — Eocene(?)

9. Probable north-south vertical faulting — Tertiary or older

10. Strike-slip and vertical movement of Slate Creek fault zone (and Denali fault; may have had earlier movement) — Tertiary

11. Thrusting, folding, and cross-faulting — Tertiary

12. Renewed strike-slip movement on the Slate Creek fault — Tertiary

14. Glaciation — Pleistocene

14. Continued uplift of the Alaska Range and movement on the Denali fault. — Pleistocene and Recent

ECONOMIC GEOLOGY

The locality numbers below refer to numbers shown on the geologic map. Most of the localities do not appear to be of economic interest in themselves, but are mentioned to indicate the location and type of mineralization encountered.

Locality 1

Iron-stained amphibolite, hornblendite, and hornblende-augite-plagioclase rock of this locality contain 5-10% disseminated pyrrhotite, pyrite, magnetite, and traces of chalcopyrite. The zone, as exposed on the ridge, is about 50 feet wide and a hundred or more feet long. A soecimen containing abundant sulfides and visible chalcopyrite assayed less than 0.05% copper (sample 6E429, table 5). This specimen was typical of the better material in the accessible outcrops, but a large part of the zone is inaccessible.

Locality 2

A hornblendite boulder from glacial deposits at this locality contains about 10% magnetite and is similar to others noted in the glacial debris. Small amounts of chlorite, pyrite, chalcopyrite, and calcite accompany the hornblende and magnetite. A copper assay showed less than 0.05% (sample 6E416, table 5). The presence of magnetite in hornblendite associated with ultramafic rocks is similar to the magnetite occurrence at Duke Island in Southeastern Alaska (Irvine, 1963).

Locality 3

Coal fragments, thin coal beds, and coalified logs are common in the Gakona formation here but those examined have been altered to contain a high content of silica and do not burn well.

Locality 4

Magnetite is very abundant in the stream sediments here, and magnetite-bearing hornblendite boulders are scattered through the stream gravel and moraines.

Locality 5

Pyritization and traces of copper stain were noted in amphibolite and marble along the diorite contact.

Locality 6

A silver-bearing galena-quartz-carbonate vein has been reported in this vicinity since the field work was done.

Locality 7

A trace of copper stain was found in argillite at this location.

Locality 8

A quartz-pyrite-chalcopyrite vein striking N10W and dipping 80°NE is exposed here and has been prospected by a small pit. The sulfide-bearing part of the vein is about six inches wide, and is accompanied by a similar thickness of quartz. A sample across the six inch sulfide-bearing width contained 2.2% copper, and traces of gold, silver, and lead (sample 6E555, table 5). Several other quartz veins crop out in the immediate vicinity and pyritization and minor copper staining were found at several localities within 200 yards.

Locality 9

Several pods of pyrite-chalcopyrite-magnetite mineralization are exposed here along an abandoned stream channel close to the contact of the quartz monzonite. Quartz, epidote chlorite, and carbonate accompany the sulfides and magnetite. The pods have developed by replacement of andesite, and have a width of up to five feet. They are exposed for about 15 feet, and pass under cover at the top of the bank but are not exposed in outcrops about 25 feet up the hill.

A nearby boulder contains rhodochrosite, rhodonite, and abundant quartz, but may be glacially transported.

Locality 10

Traces of copper stain were found in andesite-dacite float near the granodiorite dike at this locality.

Locality 11

Pieces of coarse specular hematite and quartz with some magnetite are scattered through float along a zone trending about north-south for approximately 100 yards. At the only exposure, the hematite occurs as a banded zone about 15 feet thick with a shallow dip. The hematite appears to have replaced the volcanics. The zone seems worthy of a few pits and samples to determine whether other elements accompany the iron, and to obtain a better idea of its size.

Locality 12

Several magnetite-quartz boulders were found as float in this vicinity.

Locality 13

Coal beds at least two feet thick are poorly exposed in clays and shales of the Gakona formation of this vicinity. Megascopically the coal appears to be of moderate quality, but is highly folded and deformed.

Locality 14

Argillite along the contact with the basalt is highly iron-stained from oxidation of pyrite. A grab sample of pyritic argillite with traces of chalcopyrite contained traces of gold and silver (sample 6E531, table 5).

Locality 15

A grab sample of pyritic diabase-basalt with quartz veins from this area contained traces of gold, silver, and copper (sample 6E534, table 5).

Locality 16

Amphibolite containing pyrrhotite, pyrite, and quartz veins and a trace of chalcopyrite showed traces of gold, silver, and copper (sample 6E537, table 5).

Locality 17

A grab sample of highly stained and pyritized argillite from this locality contained traces of gold, silver, and zinc (sample 6E584, table 5).

Locality 18

A boulder of dunite from the glacial moraine bearing abundant pyrite contained 0.75% copper and traces of gold, silver, platinum, and nickel (sample 6E583, table 5).

Locality 19

Narrow sporadic veins of cross-fiber chrysotile asbestos occur in dunite in this vicinity, but no concentrations approaching economic grade were noted.

Up to 10% magnetite occurs in some hornblendite in a limited area on this spur.

Locality 20

A highly pyritized area about 50 feet in diameter occurs at the contact of peridotite and monzonite here. A grab sample contained traces of gold and silver, and 0.2% copper (sample 6E581, table 5).

Locality 21

A small copper occurrence is reported in this vicinity but was not encountered in mapping.

Locality 22

A sample of pyritic slaty argillite from this locality contained a trace of gold and silver (sample 6E615, table 5).

Locality 23

Minor chalcopyrite and copper stain were noted in an epidote-filled segregation or vein in the mafic gabbro.

Locality 24

A grab sample of highly pyritized andesine-dacite from this locality contained small amounts of gold, silver, and copper (sample 6E656, table 5).

Locality 25

A grab sample of pyritized and altered andesite cut by small quartz veinlets contained a trace of gold (sample 6E658, table 5).

Locality 26

Boulders of magnetite-hematite-pyrite-chlorite rock are present in talus of this area, but no outcrops were found. The mineralized body does not appear large, but may warrant further prospecting.

Locality 27

A number of boulders along the ridgeline at this point contain chalcopyrite and hematite with quartz, chlorite, and epidote. An assay of part of a chalcopyrite-bearing boulder showed 1.14% copper and a small amount of silver (sample 6E646, table 5). There is little real outcrop near this locality, but float indicates a probable width of 5-15 feet for the mineralized zone. Country rock is porphyritic andesite, possibly an agglomerate, and is epidotized near the mineralized zone. The occurrence definitely warrants further prospecting.

Localities 28 and 29

Hematite and hematite-pyrite boulders are present locally in talus at these localities.

Locality 30

Approximately 85 claims were staked in this area during 1966 by Norman Moore and others of Fairbanks. The eight Daisy claims lie along the outcrop on the south side of the West Fork. Judging from the maps with the location notices, the remaining claims are mainly to the east. The quartz monzonite of this area is weakly iron-stained, but no other evidence of mineralization was noted.

Locality 31

A copper occurrence in this general vicinity has been staked and prospected by C.W. Monroe for Northland Mines. The mapping was not extended to this area, but specimens indicate that the copper occurs as chalcopyrite replacing silicated limestone.

Locality 32

A sample of ferruginous breccia from this locality contained no detectable base metals.

Slate Creek and Miller Gulch placer deposits

The placer deposits of the Slate Creek area have been previously reported on by Mendenhall (1905), Moffit (1912), Chapin (1919), Moffit (1944), and Moffit (1954), plus a recent summary by Jasper (1957). No attempt will be made in this report to completely discuss this older information. The following material deals mainly with the origin of the gold, and a possible buried channel of Slate Creek.

The total gold production from the Chistochina district is estimated to be between 3 and 3.5 million dollars. Of this production, about 1.2 million was recovered between 1898 and 1907. Probably 90% or more of this production came from the Slate Creek and Miller Gulch workings. The richest ground was on Miller Gulch and at its intersection with Slate Creek. Production has been hampered by short seasons and costly transportation. Several hundred thousand dollars were recovered by Hobb Enterprises and Monte Cristo Mining Company between 1956 and about 1962, but since then only small shovel-in operations have been active. The patented claims on Slate Creek are understood to be owned by Lewis Elmer and others of the Elmer family since liquidation of the Slate Creek Mining Company a few years ago. The Elmer family also has part ownership of unpatented claims on upper Slate Creek on the Chisna divide area. Claims on Miller Gulch are reportedly held by a Mr. Howard Hayes of Juneau.

Origin of gold

This question has previously been discussed by Mendenhall (1905) and Chapin (1919). As discussed by Chapin (1919), gold occurs at Slate Creek in three ages of gravels: (1) the present stream gravels, (2) bench gravels on the north side of lower Slate Creek, and (3) Tertiary "round wash" conglomerate. Essentially all the production has been from the present-day stream gravels, but economically interesting values are reported locally in the bench gravels.

Three possible source terranes can be envisioned for the gold of the district. These are:

1. The metamorphics and intrusives north of the Denali fault, possibly in the vicinity of Mt. Kimball.

2. The Mankomen argillite and slate in the immediate vicinity of the deposit, with a possible relation to the Slate Creek granodiorite porphyry intrusive, or to eroded equivalents of the argillite and granodiorite.

3. Strongly pyritized and altered Chisna formation.

The best evidence against the third alternative is the large amount of gold in Miller Gulch combined with the lack of gold in streams draining solely the Chisna formation. In addition, the presence of gold in the bench gravels and the "round wash" is not explicable if the source is in the Chisna formation, as these formations contain few or no clasts of Chisna formation.

The first two alternatives have been ably discussed by Mendenhall (1905, p. 114-115), who favored the second alternative. In the writer's opinion, more evidence is needed to reach a firm conclusion, but the first alternative seems more likely.

If the source is north of the Denali fault, the gold might have been associated with the granitic intrusive interpreted to crop out a few miles west of Mt. Kimball near the head of the glacier feeding the East Fork of the Robertson River. This area might also be the source of the granite and quartz boulders in the "round wash". Alternatively if lateral movement on the Denali fault has been more than a few miles, the source may now be some distance to the east. The gold would have been eroded from the source area during the Tertiary and deposited in the Gakona formation at the foot of the scarp formed by uplift. The "round wash" is clearly a basal conglomerate, and might be expected to contain a concentrate of any gold eroded from the uplifted area. Under this theory, the gold has since been redistributed to the bench gravels and present streams by erosion of most of the "round wash". Other patches of "round wash" appear to exist in unmapped areas west of upper Slate Creek and elsewhere, and may thus have furnished a source of the gold on the Chisna River and the Middle Fork.

An additional line of evidence favoring origin of the gold from north of the Denali fault is the reported occurrence of gold in recent glacial gravels of the Main Fork about a half mile north of Slate Creek (see below). Although it is conceivable that this gold could be derived from the Mankomen formation along the south side of the glacier, it seems much more likely that the source is north of the fault.

Evidence favoring the origin of gold from the argillite and slate of the immediate vicinity is the coarse size and abundance of gold in Miller Gulch, the increased metamorphism in this area, and the presence of a granodiorite porphyry intrusive just north of the limits of productive placer deposits. However, metamorphism increases northward throughout the map area. One ounce nuggets were "not rare" in Miller Gulch, and a four ounce nugget was found, suggesting (but not proving) a local source. The lack of coarse gold on Big Four Creek was also cited by Mendenhall (1905) as evidence against origin in the "round wash". Although a few small quartz veins are present in the argillite and slate, they are not abundant, and no reports of gold in the bedrock have come to the writer's attention.

A much firmer conclusion on the origin might be reached by a program of sampling and panning, with special attention to the "round wash" and the argillite. If the source of the gold is in the Mankomen formation, the gold in the "round wash" should be highly concentrated as a residual deposit at the base of the conglomerate. Also, it should be possible to find at least a minor amount of gold in the presently-exposed argillite, even if the main source has been eroded away. If the gold was carried in from north of the fault, the gold would probably be present throughout the basal conglomerate. In addition, a helicopter traverse in the vicinity of Mt. Kimball might give confirmatory evidence of mineralization, possibly of economic value.

The gold placers carry platinum metals to an extent of about 1% of the gold, according to Chapin (1919). In seems most likely that the platinum is related to the peridotite and mafic gabbro, although no specific source can be pin-pointed. The only information in disagreement with this interpretation is the reported presence of platinum with the gold in the recent glacial gravels on the Main Fork above Slate Creek (see below). However, it is possible that additional ultramfic rocks are present north of the fault.

Buried former channel

As shown on the geologic map, the present channel of Slate Creek does not exactly follow the Slate Creek fault zone near the mouth of the creek. Chisna formation is exposed on the north wall of the valley for several hundred feet above the mouth. Examination of bench gravels at approximately the location of "S" in Slate Creek on the geologic map disclosed an interval of angular gravels or consolidated talus dipping northward toward the flat-lying bench gravels and clay a few feet away as shown on figure 2. This unit of northward-dipping gravels is composed mainly of Chisna formation clasts, and lies on top of red-stained diabase conglomerate of the Gakona formation. The bench gravels contain little or no Chisna formation. The northward-dipping gravels are interpreted as a deposit on the south bank of ancestral Slate Creek at a time when its channel lay several hundred feet north of its present location. It seems likely that this old channel followed the zone of soft Tertiary sediments in the fault zone. The north-dipping unit (and the channel) must be older than at least part of the bench gravels.

On the basis of this data, it is inferred that a former channel of Slate Creek is present under the bench gravels for a quarter to a third of a mile upstream from the mouth. The change in course is probably the result of glacial blockage of ancestral Slate Creek, followed by superposition of the present channel onto Chisna formation after erosion of bench gravels accumulated during the period of blockage. It seems likely that this possible buried channel contains as much gold as the present channel, and it could contain much more if it was in existence longer.

Big Four placer deposit

Gold-bearing gravels were discovered on Big Four Creek early in the history of the district, and have produced small amounts of gold at intervals over the succeeding 65 years. This short creek heads in the "round wash and flows mainly over gabbro before emptying into the side of the Chistochina glacier. Placer operations have worked the gravel of the present-day stream from about 4,300 feet elevation where the present camp is located up to about 4,600 feet. A cabin at 4,300 feet is accessible by a jeep trail from the Slate Creek airstrip. A large tractor, a small tractor, and a section of sluices fed through a grizzly were the main items of equipment at the site in 1966. Some gravel had evidently been run through the sluices in the past few years. Recent work has apparently been limited to the gravels within a few hundred feet above the cabin, but higher sections of the stream show evidence of older work, at least partly by hand methods. Water is supplied by Big Four Creek and several other small creeks which have been diverted into a small dam north of the cabin. At present the unpatented claims are held by a group headed by W.J. Beerman of Yakima, Washington.

Glacier claims

Approximately 12 claims have been staked on gravels of the Main Fork of the Chistochina River north of Slate Creek and a mile or so south of the Main Fork glacier by Lewis Elmer. He reports the recovery of interesting amounts of gold from gravels a few feet above the level of the present river. This area was apparently covered by the glacier in 1900, so the gold must be coming from very recent glacial material. Elmer reports that minor amounts of platinum occur with this gold.

These claims seems to be significant mainly in suggesting the possibility of dredge ground in the broad valley of the Main Fork.

Other placer deposits

Ruby Gulch and Quartz Creek - Ten patented claims from which there has been a small production.

Chisna River - An undetermined number of unpatented claims extending from Red Mountain Creek approximately to the Ruby Gulch patented claims. Very little production is indicated from these claims.

Hazelett claims, lower Chisna River - Two patented placer claims in the area of the original discovery in the district, just off the south sdge of the map. The production has apparently been small to moderate.

Middle Fork claims - An indefinite number of unpatented claims on Bedrock, Limestone, Kraemer, Ptarmigan, and Russian John Creeks adjacent to the Middle Fork of the Chistochina. Production has probably been a few thousand dollars, although considerable development was done in the late 40's.

GEOCHEMISTRY OF STREAM SEDIMENTS

A total of about 120 stream sediment samples were collected from the map area and are plotted on the geologic map. Analytical data are listed in table 6.

Sediments were collected from active stream channels and analyzed in the field by the heavy metal procedure described by Hawkes (1963). In the lab, samples were dried, screened to -80 mesh, and analyzed for total copper, zinc, lead, molybdenum, nickel, and arsenic by Rocky Mountain Geochemical Laboratories using atomic absorption and colorimetric methods.

Values used for the threshold of anomalies are 150 parts per million for copper, 220 ppm for zinc, 30 ppm for lead, and 6 ppm for molybdenum. No nickel anomalies are recognized. These values were selected on the basis of histograms for the various

Table 5

Assays of samples

	Au (oz/T)	Ag (oz/T)	Pt (oz/T)	Cu (%)	Pb (%)	Zn (%)	Ni (%)	As (%)	Locality
6E416				tr.					2
6E429				tr.					1
6E512				N.D.	N.D.	N.D.			32
6E531	0.04	tr.		N.D.	N.D.	N.D.			14
6E534	0.02	0.18		tr.	N.D.	N.D.			15
6E537	0.02	0.14		tr.	N.D.	N.D.	tr.		16
6E555	0.02	0.46		2.2	tr.	N.D.			8
6E581	0.02	0.18		0.2	N.D.	N.D.	tr.		20
6E583	tr.	0.12	tr.	0.75	N.D.	N.D.	0.2	N.D.	18
6E584	0.02	tr.		N.D.	N.D.	N.D.			17
6E615	tr.*	0.12*		N.D.	N.D.	N.D.			22
6E646	tr.*	0.52*		1.14*	N.D.	tr.			27
6E656	tr.*	0.12*		0.15	N.D.	N.D.			24
6E658	0.04	N.D.		N.D.	N.D.	N.D.			25

---

*Assayed by Coast Eldridge, Inc. All other assays by Division of Mines and Minerals.

N.D. - Not detected, generally less than 0.05%

tr. - Trace, present but less than 0.05% for Cu, Pb, Zn, and Ni

Table 6

Analyses of stream sediment samples

All Analyses by Rocky Mountain Geochemical Laboratories, Salt Lake City, Utah.

Map. No.	Sample No.	Concentration (ppm) Cu	Zn	Pb	Mo	Ni	As	Field Test (Ml. of dye)
1	6E-442	105	60	10	1	60	20	5
2	6N-145	150	105	15	3	95	460	3
3	6N-144	75	80	10	1	75	30	1
4	6N-130	90	75	10	2	55	15	8
5	6N-129	90	100	10	3	95	20	3
6	6E-409	60	85	10	1	120	35	0
7	6N-131	50	90	10	1	80	15	0
8	6N-132	65	95	10	4	115	20	3
9	6N-133	60	80	10	2	45	25	3
10	6N-143							
11	6N-137	55	100	10	2	50	25	1
12	6N-134	60	60	5	1	10	5	5
13	6N-135	75	65	10	3	50	10	12
14	6E-414	25	75	5	4	70	10	0
15	6N-149	170	80	10	3	30	10	3
16	6N-146	50	50	10	3	80	25	0
	6E-431	85	45	5	4	70	10	0
17	6N-148	90	40	5	2	70	10	1
18	6N-147	80	50	10	1	85	10	1
19	6N-153	40	35	10	2	75	5	3
20	6N-152	100	35	10	4	95	15	1
21	6N-154	60	40	5	1	95	10	0
22	6N-155	195	60	10	1	40	10	2
23	6N-152	85	60	10	2	60	30	4
24	6N-151	90	150	25	3	80	110	3
25	6N-150	70	135	10	2	95	20	6
26	6N-128	115	90	5	4	65	-5	3
27	6N-136	105	45	10	2	75	20	2
28	6N-159	80	80	15	3	75	25	0
29	6N-162	90	80	10	3	10	25	0
30	6N-161	50	100	10	1	40	55	0
31	6N-160	65	100	10	2	55	15	15
32	6N-157	70	80	10	2	60	20	0
33	6N-158	65	85	10	1	55	20	2
34	6N-163	45	85	10	5	80	25	1
35	6N-186	65	85	10	1	65	25	0

Table 6 (Continued)

Map No.	Sample No.	Concentration (ppm) Cu	Zn	Pb	Mo	Ni	As	Field Test (ml. of dye)
36	6N-164	95	60	20	2	80	50	1
37	6N-165	90	95	25	2	45	35	1
38	6N-169	40	70	10	3	15	15	1
39	6N-170	105	120	35	2	40	35	1
40	6N-185	95	85	15	2	40	45	1
41	6N-184	100	115	25	3	125	70	1
42	6N-172	90	100	15	4	50	40	1
43	6N-171	340	115	60	4	30	+1000	12
44	6N-173	100	105	15	1	40	55	1
45	6E-505	90	60	5	2	55	5	1
46	6N-208	100	245	10	5	155	55	5
47	6N-206	80	270	10	5	105	50	+20
48	6N-207	95	400	10	9	85	60	10
49	6N-209	75	155	15	4	75	45	4
50	6N-202	100	330	10	7	65	45	20
51	6N-203	100	360	10	9	90	55	14
52	6N-204	95	260	5	5	140	55	4
53	6N-201	90	60	5	2	25	55	8
54	6N-205	120	70	10	2	100	25	4
55	6N-200	100	100	10	4	55	25	4
56	6N-210	85	115	10	4	40	35	14
57	6N-211	85	205	10	4	75	50	10
58	6N-199	110	80	5	3	10	20	6
59	6N-213	90	105	15	3	95	35	0
60	6N-212	125	620	70	2	50	30	20
61	6N-198	90	630	105	2	55	35	10
62	6N-197	130	175	50	3	35	35	7
63	6N-196	110	150	135	3	45	40	7
64	6E-555	175	125	20	3	40	20	5
65	6N-195	145	115	50	2	45	30	12
66	6E-602	75	120	15	3	35	40	3
67	6N-230	45	85	5	3	60		9
68	6N-229	60	120	5	3	65		6
69	6N-194	85	170	40	4	45	25	8
70	6N-228	70	85	5	2	65		4
71	6N-227	50	145	10	4	65		19
72	6N-226	105	125	20	2	75		4
73	6E-604	80	105	5	2	90	10	0
74	6N-238	85	140	5	1	130		
75	6N-237	60	95	5	1	160		

Table 6 (Continued)

Map No.	Sample No.	Concentration (ppm) Cu	Zn	Pb	Mo	Ni	As	Field Test (ml. of dye)
76	6N-236	50	75	-5	1	145		
77	6N-214	115	115	10	1	70	30	4?
78	6N-215	105	115	10	2	75	45	3
79	6N-216	130	150	15	2	95	120	4
80	6N-217	145	160	10	3	80	75	4
81	6N-218	155	170	15	4	95	45	9
82	6N-219	190	105	10	4		10	6
83	6N-220	110	150	10	4	70	30	15
84	6E-584	170	260	10	4	50	35	15
85	6N-221	120	250	10	8	125		15
86	6N-222	140	460	5	10	140		20
87	6N-223	125	295	10	10	110		15
88	6N-224	110	280	10	8	105		7
89	6N-225	95	240	10	5	95		9
90	6N-245	115	65	5	2	130	15	3
91	6N-246	200	85	10	2	125	10	1
92	6N-247	60	115	10	3	180	15	2
93	6N-261	95	180	10	3	45	75	1
94	6N-260	110	180	10	3	55	15	10
95	6N-263	70	140	10	2	125	25	3
96	6N-259	2200	190	30	6	30	45	2
97	6N-258	120	140	15	1	85	20	5
98	6N-257	1300	155	10	7	15	10	5
99	6N-269							
100	6N-268	105	235	20	4	85	45	7
101	6N-270							
102	6N-267	200	85	10	5	10	10	0
103	6N-235	170	120	15	6	60		3
104	6N-234	70	270	80	3	65		6
105	6N-233	70	165	110	3	55		3
106	6N-232	70	180	10	3	95		20
107	6N-231	50	150	10	1	80		20
108	6N-244	85	120	10	4	100	15	2
109	6N-243	90?	130?	15?	4?			4
110	6N-242	95	115	10	2	105	10	8
111	6N-241	120	140	15	2	125	10	11
112	6N-239	180	460	90	3	70	50	20
113	6N-240	440	2300	130	4	15	85	20
114	6N-262	490	200	15	5	20	15	20
115	6N-266	70	150	15	2	30	25	0

Table 6 (Continued)

Map No.	Sample No.	Concentration (ppm) Cu	Zn	Pb	Mo	Ni	As	Field Test (ml. of dye)
116	6N-265	25	95	20	1	10	15	0
117	6N-249	60	95	15	2	50	10	3
118	6N-248	90	115	20	3	85	15	1
119	6N-250	120	150	20	2	30	25	1
120	6N-251	140	130	20	2	75	10	3
121	6N-252	115	150	15	2	45	25	3
122	6N-253	160	160	20	2	40	15	4
123	6N-254							3
124	6N-255							3
125	6N-256							1

elements, plus analyses of rocks from the literature and from the Rainy Creek area (Rose, 1965). Values above 400 parts per million copper, 500 ppm zinc, and 100 ppm lead are considered strongly anomalous.

Discussion of anomalies

Samples 2, 5, and 22

These are weak to questionable copper anomalies of unknown source. All are in streams draining argillite of the Mankomen formation.

Sample 39

A weak lead anomaly in the Chisna formation. The source is unknown, but many comments under samples 60-63 probably apply here also.

Sample 43

A weak to moderate anomaly in copper, lead, and silver, along with high arsenic. Traces of copper were noted in rocks just upstream from the sample, and a lead-silver showing is reported in the adjacent drainage of sample 42 (see localities 6 and 7 under Economic Geology). Amphibolite in the headwaters of the drainage is highly pyritized. Further prospecting of this area seems warranted.

Samples 46-48, 50-52, 85-89, and 100

All these samples show moderate anomalies in zinc, and most are anomalous in molybdenum and in the field test. All the anomalous streams drain black phyllite on the north side of the Denali fault.

In view of the high results on the field test, three samples of black phyllite were collected along the ridge between the drainages of samples 85 and 86. These samples consisted of about three pounds of black phyllite collected as chips across about 100 feet of section. The analyses are listed in table 7. All three rock samples are "anomalous" in molybdenum, and two are "anomalous" in zinc. From these results, it appears that zinc and molybdenum are widely distributed through the black phyllite, but their exact mode of occurrence (i.e. disseminated throughout, veinlets, metal-rich beds) remains unknown. Most likely the metal is syngenetic and was precipitated with iron sulfides during deposition in a reducing environment. However, local beds in the sequence might contain considerably greater amounts of zinc and molybdenum than the average, and could thus be of economic interest.

Very similar zinc and molybdenum anomalies were obtained from black slate and phyllite terranes in the Eureka Creek area (Rose, 1965) and north of the Slana River (D.H. Richter, personal communication), and the phenomenon thus appears widespread in the eastern and central Alaska Range. Further sampling to obtain a more accurate idea of the upper limits of zinc and molybdenum content seems worthwhile.

Samples 60-63, 65, and 69

These moderate to strong lead and zinc anomalies are from streams draining altered and locally pyritized Chisna formation intruded by quartz monzonite, and definitely seem worth further prospecting and sampling of rocks and stream sediments.

Table 7

Analyses of black phyllite samples

Sample	Copper	Zinc	Lead	Molybdenum	Arsenic
6E-627	130	440	10	8	10
6E-628	60	170	10	14	30
6E-629	90	370	10	24	70

6E-627 Limy black phyllite with some iron staining and quartz veins at crest of ridge. Section 27, T19S, R15E, at location A.

6E-628 Soft black phyllite, including some iron-stained chips and a few quartz veins. Section 27, T19S, R15E, at location B.

6E-629 Weakly to moderately iron-stained black phyllite with minor quartz veins. Section 34, T19S, R15E, at location C.

Analyses by Rocky Mountain Geochemical Laboratories in parts per million

Sample 64

A weak copper anomaly, probably related to the copper showings described under Locality 8.

Samples 81 and 82

Weak to questionable copper anomalies of unknown source.

Sample 84

A weak zinc anomaly derived from a strongly pyritized patch at the contact of argillite and basalt. A rock sample from this area contained only traces of base and precious metals (Locality 17).

Sample 91

A weak copper anomaly, possibly related to a reported copper show in this vicinity (Locality 21).

Samples 96, 98, 102, 112, 113, and 114

Strong to moderate anomalies in copper are characteristic of all these samples, along with anomalous amounts of zinc, lead, and molybdenum in most cases. All these streams drain the Chisna formation, and at least in the case of samples 96 and 98, the andesite-dacite is strongly pyritized. A rock sample (Locality 24) contained 0.15% copper. Further prospecting and sampling is definitely indicated. The presence of small chalcopyrite and hematite showings within a mile to the south is encouraging, as is the presence of a porphyritic quartz diorite near Locality 24. The alignment of these samples and samples 60 and 61 just south of the Slate Creek fault zone suggests a regional structural control, although the fault has clearly moved since the pyritization of the Chisna formation.

Samples 103, 104, and 105

These three samples are anomalous in lead, zinc, and molybdenum, and are treated separately because all three are soils rather than stream sediments. Exposures of Chisna formation uphill from these samples are moderately to strongly iron-stained, and in the lack of streams, soils developed from talus were collected. The anomalous values indicate that some further attention to this area may be justified.

Sample 123

A weak to questionable copper anomaly. Additional stream sediment sampling is needed in this part of the area.

Arsenic

Arsenic has been successfully used as a pathfinder for gold in epithermal deposits in western United States (Cavender, 1964; Erickson et al, 1964; Miesch and Nolan, 1958) and at Kantishna by Chapman (1958). In hopes of detecting possible sources of the placer gold, most of the stream sediment samples were analyzed for arsenic, with results listed in table 6.

Assignment of background and threshold values for the arsenic analyses is rather uncertain. According to the literature, background in igneous rocks is 1-3 ppm, in shales 5-10 ppm, and in other sediments much less. Arsenic values in the Chistochina stream sediments average at least 20 ppm, and it is possible that some analytical bias is present in the data. All samples draining the black phyllite north of the Denali fault contain 45-60 ppm. As indicated in table 7, the black phyllite contains unusually high amounts of arsenic along with the high zinc and molybdenum values. For the remaining samples, it is tentatively concluded that a threshold of 50 ppm can be used to distinguish anomalies. Samples 2 and 83 (460 and over 1000 ppm) are clearly strongly anomalous, and both are anomalous in other metals, suggesting introduced sulfides as the source. A similar conclusion seems justified for sample 113. The anomalies in samples 24, 30, 53, 79, 80, and 93 may result either from introduced sulfides or from an unusually high arsenic content of some argillite in the Mankomen formation.

Analyses of additional rocks from the area would be very useful in determining the background level to be expected. At the moment, no source for the placer gold is evident in the arsenic values.

Silver

In order to check on the possibility of silver accompanying the lead-zinc in the source of anomalous samples 60, 61, and 63, these samples and samples 38, 41, 42, 43, 51, and 57 were analyzed for silver by Rocky Mountain Geochemical Laboratories. Sample 43 contained 1 ppm silver; the others contained less than the detection limit of 1 ppm. These results indicate that large amounts of silver probably do not accompany the lead and zinc, but that the source of the copper, lead and arsenic in samples 43 may also contain some silver.

Panning Concentrates

Sediments from or near the surface of 32 selected streams were panned in the field and the concentrates examined in the lab with a binocular miscroscope. Results are listed in table 8. A 12-inch pan of sediment was panned to 1/4 to 1/2 cup, but in many cases the concentrate still consisted largely of quartz, feldspar, and rock fragments, particularly from streams draining the area north of the Denali fault. To obtain a better idea of the heavy minerals in certain samples, eight samples were processed through methylene iodide, as shown in the table.

Concentrates from streams draining the ultramafic complex contain large amounts of pyroxene accompanied by moderate amounts of magnetite and hornblende, and small amounts of epidote, pyrite, and other minerals. Streams draining the black phyllite north of the Denali fault contain pyrite as their dominant heavy mineral, but the concentrate is relatively small. Drainages from the Chisna formation contain considerable epidote. Garnet is present in Miller Gulch, the Chistochina River, and several other localities, and probably is derived from north of the Denali fault or from the Tertiary sediments.

Small amounts of scheelite were detected in six samples. The largest amounts are in the West Fork and the Main fork of the Chistochina. Although the content is not large enough to be of interest in itself, detection of scheelite in these large streams suggests the possibility of interesting amounts in bedrock in the drainages.

Table 8

Mineralogy of panned stream sediments

Map No.	Field No.	Magnetite (%)	Pyrite° (%)	Scheelite (grains)	Malachite (grains)	Others (M, major; m, minor)
10	6N143	10	0			M: px, hb; m: ol
19	6N153	20	2			M: px, hb; m: ep
20	6N152	10	0			M: px; m: hb, biot, ep
27	6N136	70	tr.			M: px
36	6N164	30	0			M: px, hb; m: ep, ap
37	6N165*	15	2			M: px; m: hb, ep, ap
41	6N184	30	10	6		M: px; m: hb
42	6N172*	15	5		3	M: hb, ep; m: px, gar, ap, zirc
43	6N171*	15	10	2	1	M: px; m: ep, hb
44	6N173	1	5	2		M: hb, qfa; m: ep, gar
46	6N208	0	3			M: phyl, qfa
48	6N207	tr.	3			M: phyl, qfa
50	6N202	0	3			M: phyl, qfa
51	6N203*	1	90	1		m: qfa, lim
52	6N204	1	3			M: phyl, qfa
53	6N201	2	1			M: px, qfa; m: hb
56	6N210	0	1			M: qfa, slate & schist
57	6N211	1	1			M: phyl, qfa: m: px
58	6N199	15	tr.			M: hb, px, ep; m: zirc, ap?
60	6N212*	30	10		2	M: ep, px; m: hb, zirc
83	6N220	2	2			M: qfa, ol; m: hb
85	6N221	0	3			M: phyl, qfa
86	6N222	0	3			M: phyl, qfa
87	6N223	0	5			M: phyl, qfa; m: lim
88	6N224	2	10			M: qfa, phyl
89	6N225	1	10			M: phyl, qfa
94	6N260	0	tr.			M: phyl, qfa
95	6N263	1	tr.			M: phyl, qfa; m: ep, lim
97	6N258*	30	5		2	M: il, ep; m: gar
100	6N258*	5	70	7		m: hb, ep, gar
107	6N231*	30	tr.	1		M: ep; m: rut, px, gar
112	6N239	10	tr.			M: qfa, chl; m: ep, hb, zirc

*Separated with methylene iodide in lab. Remaining samples may contain considerable light fraction.
°"Pyrite" may include pyrrhotite and chalcopyrite.

Abbreviations:

ap	apatite	il	ilmenite	phyl	phyllite
chl	chlorite	lim	limonite	px	pyroxene
ep	epidote	M	Major constituents, greater than 10%	qfa	quartz, feldspar, apatite or other colorless mineral
gar	garnet	m	minor constituent, less than 10%	rut	rutile
hb	hornblende	ol	olivine	zirc	zircon

Traces of malachite were noted in four concentrates. One of these streams (sample 43) gives a copper anomaly in the total sediment and another (samples 212) shows strong zinc and lead anomalies.

Gold was not detected in any of the samples, but its lack is not surprising in view of the fact that only the surface stream sediment was used, rather than gravel from bedrock.

SUGGESTIONS FOR PROSPECTING

The strong copper anomalies in stream sediments just south of the Slate Creek fault zone seem the most attractive indications for immediate follow-up in the map area. Although outcropping high-grade copper deposits probably would have been discovered long ago, there seems a distinct possibility of low-grade deposits of moderate to large size, either exposed or vertically zoned from low-grade cappings at the surface to better grades at depth. The presence of granodiorite porphyry intrusives and numerous small copper occurrences in the area furnishes additional favorable features.

The strong lead-zinc anomalies in stream sediment samples 60-63 also seem attractive targets for immediate follow-up.

The mineralization described under localities 6, 8, 11, and 27 also seems worthy of some prospecting and sampling, although minable deposits in these areas seem likely to be of the small high-grade type.

Some gold undoubtedly remains to be recovered from the present channel of Slate Creek, especially at its upper and lower ends. The buried channel described in this report and probable buried former channels in the Slate Creek-Chisna divide area furnish likely extensions of the placer deposits, although in both areas a considerable amount of overburden is present. The possibility of placers amenable to dredging in the Chistochina valley seems worth investigation in view of the occurrence of gold in the recent glacial sediments. If the gold at Slate Creek is derived from north of the Denali fault, a more speculative possibility is that the Gakona conglomerate on Spire Creek and elsewhere might contain gold (analogous to that in the "round wash") which has never been recognized because the drainage of most streams in the area is glacial and has not formed easily-tested placer deposits.

The widespread occurrence of anomalous amounts of zinc and molybdenum in black slates and phyllites north of the Denali fault invites a follow-up study to determine if ore-grade concentrations exist anywhere in this terrane. A reconnaissance of the Mt. Kimball area for mineralization from which the Slate Creek placers might have been derived is also suggested.

The West Fork granodiorite crops out in a number of areas on the margins of both the West Fork and Main Fork valleys. It thus appears likely that granitic rocks, and consequently favorable areas for mineral deposits, may underlie large parts of the valley areas under a relatively thin cover of moraine and outwash.

REFERENCES

Bond, G.C., 1965, Bedrock geology of the Gulkana glacier area, Alaska Range: M.S. Thesis, University of Alaska, 45 pp.

Cavender, W.S., 1964, Arsenic in geochemical gold exploration: AIME preprint of talk given at New York, February 1964, 12 pp.

Chapin, T., 1919, Platinum-bearing auriferous gravels of Chistochina River: U.S. Geological Survey Bulletin 692, p. 137-141.

Chapman, R.M., 1958, Geochemical exploration in the Kantishna area, Alaska (abst.): Geol. Soc. Am. Bull., v. 69, p. 1751-1752.

Erickson, R.L., Marranzino, A.P., Oda, U., and Janes, W.W., 1964, Geochemical exploration near the Getchell mine, Humboldt County, Nevada: U.S. Geological Survey Bulletin 1198A, 26 pp.

Hanson, L.G., 1965, Bedrock geology of the Rainbow Mountain area, Alaska Range, Alaska: Alaska Division of Mines and Minerals, Geologic Report 2, 82 pp.

Hawkes, H.E., 1963, Dithizone field tests: Econ. Geol., v. 58, p. 579-586.

Irvine, T.N., 1963, Origin of the ultramafic complex at Duke Island, Southeastern Alaska: Mineralogical Society of America, Special Paper 1, p. 36-45.

Jasper, M.W., 1957, Hobb Enterprises: Alaska Division of Mines and Minerals, Open File Report.

Mendenhall, W.C., 1905, Geology of the central Copper River region, Alaska: U.S. Geological Survey Professional Paper 41, 133 pp.

Miesch, A.T., and Nolan, T.B., 1958, Geochemical prospecting studies in the Bull-whacker mine area, Eureka district, Nevada: U.S. Geological Survey Bulletin 1000-H, p. 337-408.

Moffit, F.H., 1912, Headwater regions of the Gulkana and Susitna Rivers, Alaska: U.S. Geological Survey Bulletin 498, 82 pp.

Moffit, F.H., 1944, Mining in the northern Copper River region, Alaska: U.S. Geological Survey Bulletin 943-B, p. 25-47.

Moffit, F.H., 1954, Geology of the eastern part of the Alaska Range and adjacent area: U.S. Geological Survey Bulletin, 989-D, 218 pp.

Reed, B.L., and Detterman, R.L., 1965, A preliminary report on some magnetite-bearing rocks near Frying Pan Lake, Iliamna D-7 quadrangle, Alaska; U.S. Geological Survey open file report.

Richter, D.H., 1966, Geology of the Slana district, Southcentral Alaska: Alaska Division of Mines and Minerals, Geologic Report 21, 51 pp.

Rose, A.W., 1965, Geology and mineral deposits of the Rainy Creek area, Mt. Hayes quadrangle, Alaska: Alaska Division of Mines and Minerals, Geologic Report 14, 51 pp.

Rose, A.W., 1966, Geological and Geochemical investigations in the Eureka Creek and Rainy Creek areas, Mt. Hayes quadrangle, Alaska: Alaska Division of Mines and Minerals, Geologic Report 20, 36 pp.

St. Amand, P., 1957, Geological and geophysical synthesis of the tectonics of portions of British Columbia, the Yukon Territory and Alaska: G.S.A. Bulletin v. 68, p. 1343-1370.

Stout, J.H. 1965, Bedrock geology between Rainy Creek and the Denali fault, eastern Alaska Range, Alaska: M.S. Thesis, University of Alaska, 75 pp.

U.S. Geological Survey, 1964, Mineral and water resources of Alaska: Committee Print, Committee on Interior and Insular Affairs, U.S. Senate, p. 108.

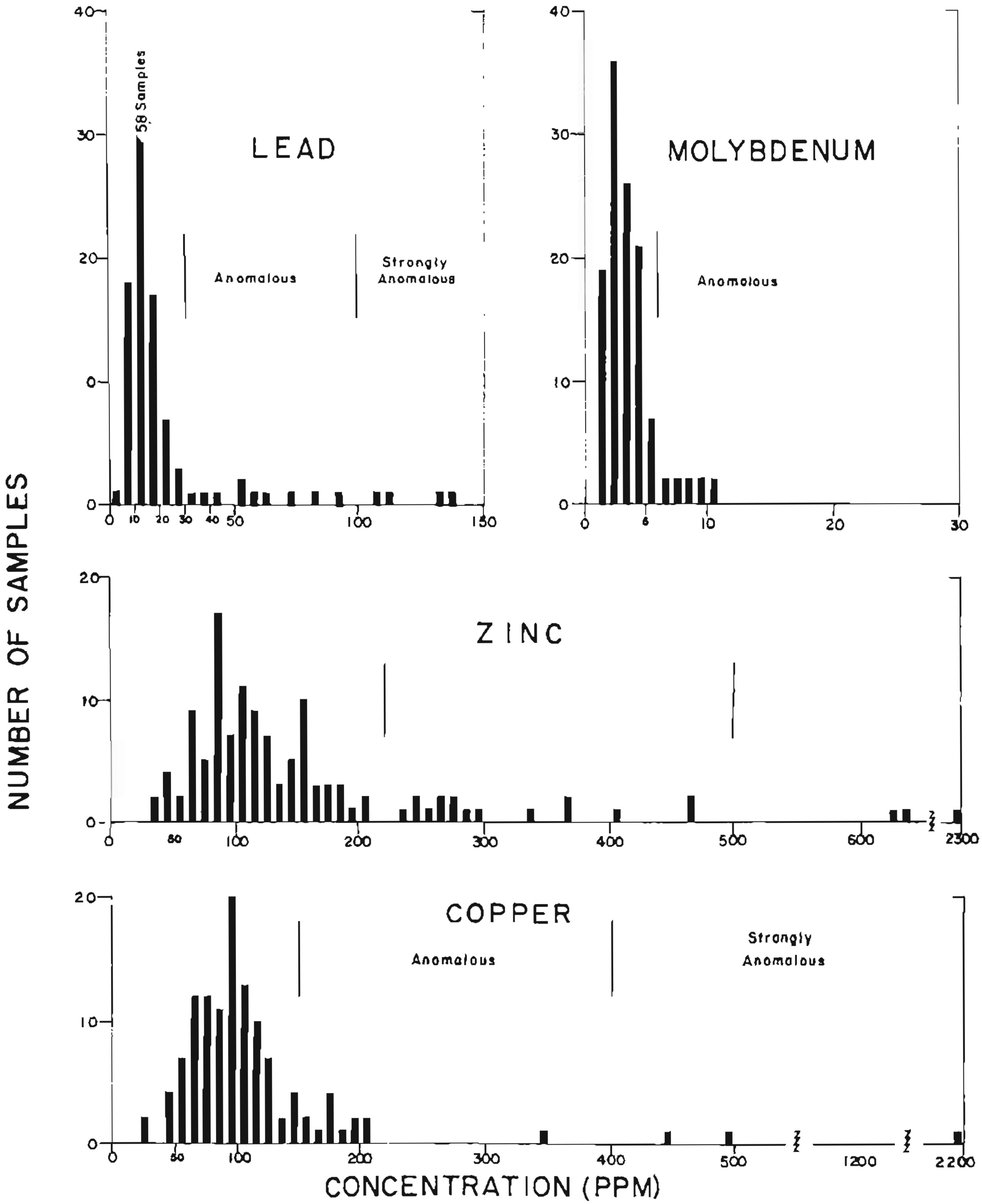

Figure 3. Frequency distribution of stream sediment data

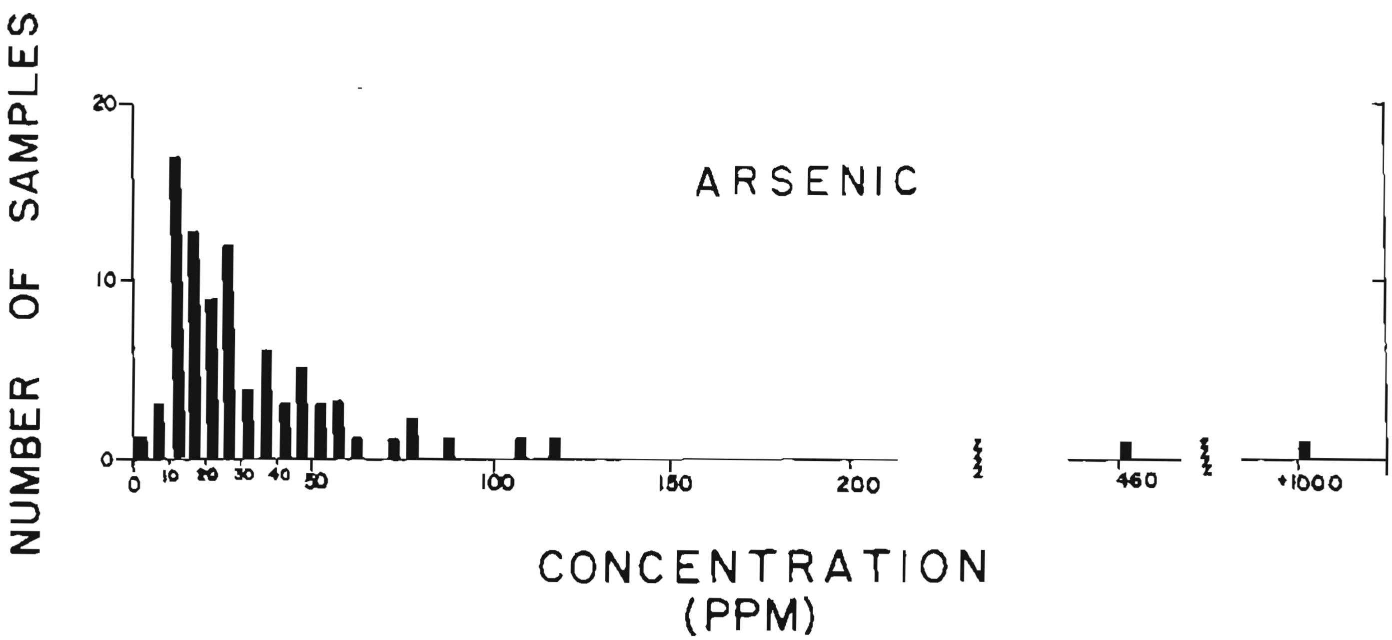

Figure 4. Frequency distribution of arsenic in stream sediments.