DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-351
SHEET 1 OF 2

INTRODUCTION

A reconnaissance geologic map and analytical data for 70 stream-sediment samples and 34 rock samples from the Anchorage A-6, 1:63,360-scale quadrangle are presented in this report, together with a statistical treatment of the geochemical data. The bedrock was mapped and samples collected during the summers of 1969, 1970, and 1971 as part of a continuing U.S. Geological Survey project to map basement rocks in the western Chugach Mountains.

Most of the early work on the bedrock geology of the Anchorage A-6 quadrangle was done by Capps (1916 and 1940), who studied the geology of the Turnagain-Knik region, and by Park (1933), who studied the Girdwood gold mining district, most of which is in the Anchorage A-6 quadrangle. Recent studies of bedrock in the quadrangle and nearby areas are described in papers by Clark and Bartsch (1971a, b) and Clark (in press, a, b).

Grateful acknowledgement is given to several persons who made valuable contributions to this report. They include Henry R. Schmoll and Ernest Dobrovolny who mapped the contacts between bedrock and surficial deposits shown in figure 1, David L. Jones who did the paleontological studies, and Susan R. Bartsch and Pamela S. Morse who participated in the geologic mapping and geochemical sampling.

MAP UNITS

McHugh Complex (KJm)

The McHugh Complex (Clark, in press, a) consists of a metaclastic sequence and a metavolcanic sequence that are lithologically distinct but chemically juxtaposed. The metaclastic rocks, which make up the bulk of the complex, predominantly are weakly metamorphosed siltstone, graywacke, arkose, and conglomeratic sandstone. The metavolcanic sequence includes massive and pillow greenstones with basaltic compositions and textures, associated with very fine-grained metasediments and bedded metachert. The age of the McHugh Complex is presumably Late Jurassic and(or) Cretaceous (Clark, in press, a).

The McHugh Complex is exposed in the northwest part of the Anchorage A-6 quadrangle. The complex is incompletely known in this area because of the extremely rugged terrain in which this group of rocks is exposed. In areas where observations were made, only the metaclastic part of the complex is present, mainly metasandstone and metaconglomeratic sandstone being the most common rock types. Metamorphic minerals in the Anchorage A-6 quadrangle and in most of the complex exposed in other areas are indicative of prehnite-pumpellyite facies metamorphism. The apparent thickness of the unit is at least several thousand feet.

In most areas, bedding is not preserved in the complex; predominant structures are pervasive shear fractures. A melange-like style of deformation is characteristic of much of the unit. However, in the Anchorage A-6 quadrangle, layers that appear to be thick, alternating metasiltstone and metasandstone sequences can be seen from a distance on steep sides of ridges near the fault contact with the Valdez(?) Group (fig. 1). These layers have not been examined closely but appear to be continuous for several thousand feet. If the layers are bedding, the apparent continuity suggests that the unit is not strongly deformed in these areas.

Valdez(?) Group (KJv)

A thick unit chiefly composed of metasandstone (mostly metagraywacke), metasiltstone, and argillite, that are locally calcareous, is questionably correlated (Clark, in press, b) with the type Valdez Group as described by Schrader (1900) in the vicinity of Port Valdez, Prince William Sound.

The Valdez(?) Group in the Anchorage A-6 quadrangle is most commonly composed of sequences of rhythmically alternating, thin-bedded (a few inches) metagraywacke and metasiltstone intercalated with massive metagraywacke from 10 to more than 100 feet thick. The metagraywacke beds lack large concentrations of detrital mica, chert, or lithicrate. In some areas, thin, rhythmically alternating beds predominate, thick metagraywacke layers are sparse, and metasiltstone and fine-grained metagraywacke are the most common rock types. The finer grained rhythmically bedded rocks are exposed most extensively around Crow Pass (fig. 1). In other areas, massive metasandstone is predominant, commonly as thick (several tens of feet) beds that locally form conspicuous outcrops. Subdivisions of the Valdez(?) Group based on the variations in bedding characteristics (fig. 1) are subjective because the group assignment may depend on the number and type of exposures seen in any particular area. The distribution of subdivisions can be used only to indicate general characteristics of bedding or in conjunction with other data to determine general structural and stratigraphic relations.

Small-scale sedimentary features are well preserved in many outcrops. Graded bedding and small-scale cross bedding is common in the fine-grained, rhythmically bedded sequences. Convolute laminations and sole markings are present locally. Argillite clasts incorporated in metagraywacke beds are a common feature of the thicker, coarser grained beds. The sedimentary features of the unit are indicative of rapid deposition of unsorted material, probably by turbidity currents.

Fossils are sparse in the Valdez(?) Group but have been found in several places in the Anchorage A-6 quadrangle. Park (1933, p. 395-396) found crushed specimens of Inoceramus at six localities in the Girdwood district; however, the species could not be determined. T. W. Stanton (in Martin and others, 1915) reported that Inoceramus fossils from the head of Crow and Raven Creeks were possibly identical with the fossil described by Ulrich (1900) as Inoceramus concentricus. During the present study, fossils were collected at three localities (fossil localities 2 to 4, fig. 1) and were identified by David L. Jones of the U.S. Geological Survey as Inoceramus cf. Inoceramus (Haenlenia) ex gr. Inoceramus hobetsuensis Nagao and Matsumoto. The Inoceramus are associated with fossil worm trails and a probable worm tube, Terebellina Palachei Ulrich; a Paleodictyon fossil was collected near Crow Pass (fossil locality 1) (fossil identifications by David L. Jones, oral commun., 1971).

Deformation of the Valdez(?) Group is characterized by tight, similar, locally overturned folds to open folds. The folds have well-developed slaty cleavage that is approximately parallel to axial planes or converges upward toward anticlinal crests. Small-scale features, such as small sandstone dikes injected along cleavage, indicate that folding was initiated and cleavage formed before the sediments were completely lithified.

Folds generally plunge to the north-northeast; axial planes dip steeply to either north-northwest or south-southeast. Numerous small folds resulting in reversals in dip, together with the absence of marker beds, make recognition of major structures difficult. Some fold axes and faults are known with enough certainty to be shown on the map (fig. 1), but these probably represent only a small part of the structures that exist in the area. The anticline in the Crow Pass area, which area appears to be a large fold with numerous smaller folds on its limbs, is an example. In outcrops north of Eagle River, the fold axis is shown as a fault because of the absence of bedding on the steep, heavily forested slopes of the glacier area. This inference is strengthened by observation of horizontal slickensides with apparent right-lateral slip near Eagle River. Evidence of similar offsets and trends has also been seen in nearby areas of the Western Chugach Mountains (Clark and Bartsch, 1971b; H. R. Clark, unpub. data). Numerous small faults with other orientations and types of movement (strike slip, dip slip, and thrust) were seen in the quadrangle, but extent and significance of individual faults were not determined. Small offsets along axial surfaces of folds are common in tightly folded parts of the terrane.

In most of the Valdez(?) Group, a cleavage or schistosity is weakly developed and defined by orientation of micaceous minerals. In some areas, especially the east and southeast part of the quadrangle, the fine-grained rocks are phyllitic, and sedimentary features are almost completely obliterated. A distinct lepidoblastic fabric can be seen in metagraywackes associated with the phyllites. Mineral assemblages include chlorite, white mica, albite, and sparse epidote and suggest probable lower greenschist, facies metamorphism. These minerals would also be stable in the prehnite-pumpellyite facies. The same minerals occur in the rocks with slaty cleavage, but recrystallization is less complete.

Felsic to intermediate hypabyssal rocks

Swarms of Tertiary(?) dikes, sills, and plugs cut the Valdez Group rocks in the area around Crow Pass. Similar hypabyssal intrusive bodies are present but not numerous in other parts of the quadrangle. These intrusions cut both the Valdez(?) Group and McHugh Complex. The dikes and sills are generally a few tens of feet wide and a few thousand feet long, and the plugs have dimensions of a few thousand feet. The large intrusive bodies are visible at a distance and on aerial photos as white, light-gray, or orange areas in the predominantly dark-gray country rock. Most of the intrusive rocks shown on figure 1 were located and sampled on the ground; others were seen only from the air or on aerial photos. Park (1933) shows small intrusive bodies in several localities that were not examined in this study. These bodies are indicated by a letter "P" on the map (fig. 1).

Most of the hypabyssal rocks are light-colored, fine-grained, equigranular, altered rocks composed predominantly of plagioclase, quartz, chlorite, white mica, and sometimes calcite. Mafic minerals are most commonly absent or completely replaced. The dike rocks were probably originally quartz diorite, dacite, and quartz-plagioclase felsite with grenular to aplitic textures.

Surficial deposits (Qs)

Surficial deposits include a variety of glacial, alluvial, colluvial, and lacustrine materials of Quaternary age. They are being mapped and described as part of a study of the Anchorage Borough by Ernest Dobrovolny and H. R. Schmoll of the U.S. Geological Survey and will not be considered here.

EAGLE RIVER THRUST FAULT

Rocks of the McHugh Complex generally overlie the Valdez(?) Group with slight to sharp discordancy. Along most of the contact, the two units are thought to be separated by a low- to moderate-angle thrust fault, the Eagle River thrust fault (Clark, in press, b). The dip of the thrust fault is generally north to northwest in the Anchorage A-6 quadrangle. In several areas, the contact is a high-angle structure that can be interpreted either as variation in the attitude of the Eagle River thrust fault or as a younger high-angle fault.

The style of deformation in the unit below the fault differs from that in the unit above the fault. Structures of the Valdez(?) Group (discussed above) are predominantly folds and numerous faults generally with unknown amounts of displacement. Bedding is preserved in much of the unit. The style of deformation contrasts sharply with the pervasive shear fractures and absence of recognizable bedding that characterize the McHugh Complex (described above). In the vicinity of the Eagle River thrust fault, rocks of the Valdez(?) Group are generally strongly deformed. Bedding is obscured, and remnants of graywacke beds commonly occur as lenses as much as a few inches thick in a strongly sheared metasiltstone matrix. Outcrops of rocks characteristic of the Valdez(?) Group alternate with outcrops of rocks characteristic of the McHugh Complex in the vicinity of the fault. The alternation suggests that the fault is a complex zone of imbrication.

METALLIC MINERAL DEPOSITS

Most of the Girdwood gold mining district, which was described by Park (1933), is in the Anchorage A-6 quadrangle. Lode deposits are known from near the head of Crow Creek, Eagle River, and Peters Creek (fig. 2). Placers have been worked on Crow Creek (fig. 2). The only production from the Girdwood district is gold, most of which was taken from placer mines. The amount of production is not known but probably was fairly small (Berg and Cobb, 1967).

Placer gold was discovered on Crow Creek about 1896, and lode gold deposits were discovered in the upper part of the creek near Crow Pass in 1900. The lode deposits were worked sporadically until about 1941 (Berg and Cobb, 1967). Some ore was produced from the veins, but the amount was probably small. The lode deposits consist of small, irregular gold-quartz veins (Park, 1933) in metagraywacke and metasiltstone country rock. The deposits are grouped around small Tertiary(?) hypabyssal intrusive bodies that are numerous in the Crow Pass area. In addition to gold, Park (1933) reported arsenopyrite, chalcopyrite, argentiferous galena, sphalerite, pyrrhotite, molybdenite, pyrite, and magnetite.

A prospect on the south bank of Eagle River, just below the terminus of Eagle Glacier, contained mineralized quartz stringers in metagraywacke country rock (Park, 1933). The stringers contained galena, pyrite, sphalerite, arsenopyrite(?), chalcopyrite, and possibly malachite, according to Park (1933), but little work was done on the property because the gold content was low.

At a prospect near the head of Peters Creek, described by Capps (1916), gold-quartz veins occur in country rock that is probably the metaclastic rocks of the McHugh Complex. The veins are as much as a foot thick but generally 2 inches or less and contain sparse pyrite, galena, and chalcopyrite. Several adits were driven, but there is no record of production.

DATA ON STREAM-SEDIMENT AND ROCK SAMPLES

Standard procedures were followed in the collection and preparation of samples.

Rock samples are grab samples from typical and atypical outcrops. They were chosen for analysis to provide data on background or because they were altered with limonite or contained visible sulfides, generally mostly pyrite. Descriptions of analyzed hand specimens are given in table 1.

Stream-sediment samples were generally collected from an active stream channel; where this was not possible, samples were collected from bank or terrace deposits adjacent to the channel.

Rock samples were crushed and split, and one split was pulverized. Stream-sediment samples were dried and sieved. The pulverized splits of the rock samples and the minus-80-mesh fractions of the stream-sediment samples were analyzed for 30 elements by the six-step semiquantitative spectrographic method and for gold and mercury by the atomic absorption method[1/] (tables 2 and 3). Several samples from one group of stream-sediment samples collected in the Anchorage A-6 quadrangle showed higher than background concentrations of mercury. All samples of the group were reanalyzed for mercury. Results of the replicate analyses are given in the column headed, "DUST-80(reanal)" in table 2.

The spectrographic analyses were reported in percentage (pct) or parts per million (ppm) to the nearest number in the series 1.0, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1. The precision of a reported value is approximately plus 100 percent or minus 50 percent. Analyses for gold by the atomic absorption method are accurate to ± 100 percent. Minimum limits of determination for each element are given below. Semiquantitative spectrographic analyses were done by K. J. Curry, and atomic absorption analyses were done by R. L. Miller, A. L. Meier, D. G. Murray, and H. D. King.

Locations of the rock and stream-sediment samples are shown on figure 2.

The results of the analyses of the stream-sediment and rock analyses have been processed by means of a computer program known as GEOSUM and are presented in tables 2 and 3. The GEOSUM program is designed primarily to summarize and tabulate geochemical data--especially data from semiquantitative spectrographic analyses (commonly referred to as six-step spectrographic analyses) by the laboratories of the U.S. Geological Survey. The computer output consists of: (a) a tabulation of the data, (b) histograms and cumulative frequency distributions for all elements for which there is sufficient data, (c) a statistical summary that includes geometric means and geometric deviations.[2/]

EXPLANATION OF TABLES 2 AND 3

Analytical results from rock and stream-sediment samples are given in tables 2 and 3 as analytical values, such as 7.0000 ppm and 10.0000 percent, or as qualified values expressed as a letter. These letter codes are N = not detected, L = less than specified limit of detection, G = greater than value shown, R = no data, I = interference and T = trace do not occur in these data. Note that the zero digits on the extreme right for each analytical value may or may not be significant. The specified limits of detection are as follows:

Specified limits of detection

Fe PCT	Mg PCT	Ca PCT	Ti PCT	Mn PPM	Ag PPM	As PPM	Au PPM	B PPM	Ba PPM	Be PPM	
0.05000	0.02000	0.05000	0.00200	10.00000	0.5000	200.00	10.00000	10.00000	20.00000	1.00000	
Bi PPM	Cd PPM	Co PPM	Cr PPM	Cu PPM	La PPM	Mo PPM	Nb PPM	Ni PPM	Pb PPM	Sb PPM	
10.00000	20.00000	5.00000	10.00000	5.00000	20.00000	5.00000	10.00000	5.00000	10.00000	100.000	
Sc PPM	Sn PPM	Sr PPM	V PPM	W PPM	Y PPM	Zn PPM	Zr PPM	Au PPM[3/]	Hg PPM[3/]		
5.00000	10.00000	100.00000	10.00000	50.00000	10.00000	200.00000	10.00000	0.02000	0.01000		

Semiquantitative spectrographic analyses by the U.S. Geological Survey are reported as geometric midpoints (1.0, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1) of geometric brackets having the boundaries 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, 0.83. The frequency distributions and histograms are on logarithmic scales and are computed using these brackets as class intervals, for example:

Reported value (ppm)	Limits
1.0	.83 1.2
1.5	1.2 1.8
2.0	1.8 2.6
3.0	2.6 3.8
5.0	3.8 5.6
7.0	5.6 8.3
10.0	8.3 12.0

On the histograms decimal numbers are shown as powers of 10, for example:

7.0E-01 means	7.0×10^{-1} or 0.7
7.0E 00 means	7.0×10^{0} or 7.0
7.0E 01 means	7.0×10^{1} or 70.0
7.0E 02 means	7.0×10^{2} or 700.0
7.0E 03 means	7.0×10^{3} or 7,000.0

The histograms are constructed of X's, each of which represents 1 percent of the total number of samples.

[1/] Analyses for 26 elements by semiquantitative analysis and for gold and mercury by atomic absorption are given in tables 2 and 3. Semiquantitative analyses are omitted for gold, bismuth, and cadmium in tables 2 and 3 and for arsenic in table 2 because these elements were not detected by the spectrographic method.

[2/] The frequency tables and histograms for gold and mercury have been omitted because the classes used in calculating these tables are those used in the semiquantitative spectrographic method, and gold and mercury were analyzed by the quantitative atomic absorption method. The frequency tables and histograms that contain three or fewer valid data points and those for which the minimum and maximum are the same have also been omitted. The replicate mercury analyses given in the tabulation were not processed by the GEOSUM program.

[3/] Analyses by atomic absorption method.

Figure 1. Geologic Map

Bedrock geology by Sandra H. B. Clark, Martha E. Yount, Susan R. Bartsch and Pamela S. Morse, 1969-1971. Contacts of bedrock and surficial deposits by H. R. Schmoll and E. Dobrovolny, 1971.

EXPLANATION

ROCK UNITS

Qs — Surficial deposits — QUATERNARY

Felsic to intermediate hypabyssal rocks. Dikes, sills and other small intrusive bodies "P" shown bodies mapped by Park (1933) in areas not visited during present investigation — TERTIARY

KJv — Valdez(?) Group
Predominantly metagraywacke, siltite and argillite flysch deposits; locally calcareous.
-Small dot pattern shows areas of predominantly thin bedded siltite and graywacke.
-Large dot pattern shows areas of predominantly graywacke and areas where massive graywacke beds, 10 feet or more thick are predominant
-Open dot pattern shows areas characterized by thick (10 feet and more)graywacke beds alternating with thinly and rhythmically bedded graywacke-siltite deposits.
-Wavy line pattern shows phyllitic areas. — JURASSIC(?) and CRETACEOUS

KJm — McHugh Complex
Includes marine metaclastic and metavolcanic rocks. Predominantly metasandstone to metaconglomeratic sandstone. — LATE JURASSIC and/or CRETACEOUS

SYMBOLS

Contact, approximately located

Thrust fault, approximately located, sawteeth on upper plate, dotted where concealed

Inferred fault, approximately located; arrows show apparent relative horizontal movement

Air photo linear feature, thought to be a fault

Strike and dip of bedding

Strike and dip of overturned bedding

Strike of vertical bedding

Approximate strike and dip direction taken from distant observation or aerial photographs; number indicates estimated dip

Strike and dip of cleavage

Strike and dip of parallel bedding and cleavage

Strike and dip of foliation

Strike and dip of parallel foliation and bedding

Approximate strike and dip of foliation or cleavage taken from distant observation or aerial photographs

Strike and dip of axial plane of minor fold

Minor fold axis, showing plunge

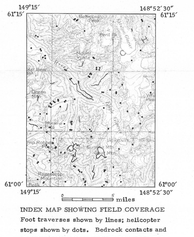
Lineation, showing plunge

Approximate current direction, rotated to horizontal around strike of enclosing bed; taken on small-scale cross-bedding and flute casts

Trace of anticlinal axial plane, approximately located

Trace of synclinal axial plane, approximately located

Fossil locality



INDEX MAP SHOWING FIELD COVERAGE
Foot traverses shown by lines; helicopter stops shown by dots. Bedrock contacts and structures have been extended between field stations by aerial reconnaissance.

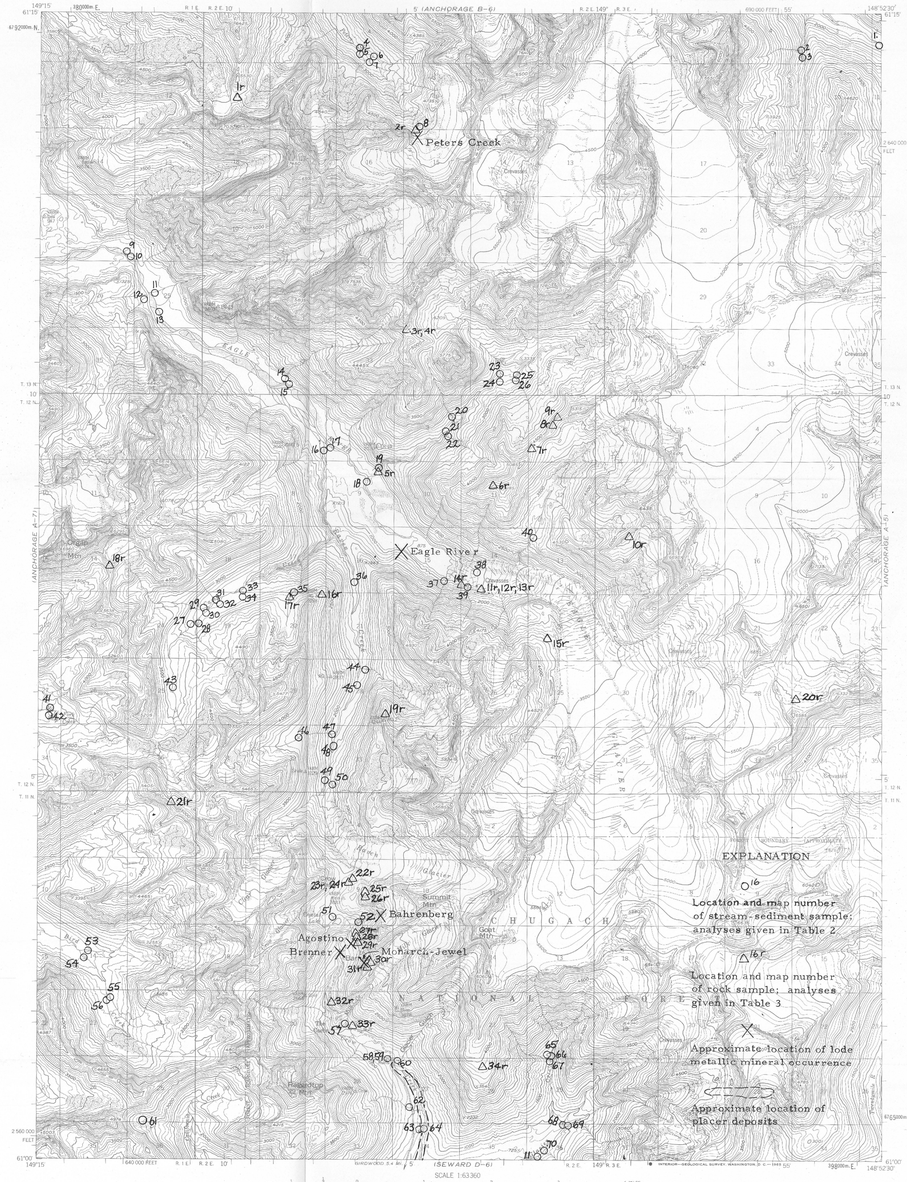


Figure 2. Location of stream-sediment and rock samples

EXPLANATION

Location and map number of stream-sediment sample; analyses given in Table 2

Location and map number of rock sample; analyses given in Table 3

Approximate location of lode metallic mineral occurrence

Approximate location of placer deposits

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Table 1.--Description of bedrock samples from the Anchorage A-6 quadrangle. Sample localities are shown by sample number plotted on figure 2.

Map Number	Sample Description
1r	Massive metasandstone
2r	Massive metasandstone
3r	Vein material, mostly quartz
4r	Metasandstone, contains visible pyrite
5r	Metagraywacke
6r	Metagraywacke
7r	Metagraywacke
8r	Metagraywacke
9r	Fine-grained metagraywacke
10r	Calcareous metagraywacke
11r	Quartz veinlets in metagraywacke, contains pyrite
12r	Limonite-stained metagraywacke
13r	Metagraywacke
14r	Limonite-stained, limonite-stained brecciated rock
15r	Metagraywacke
16r	Metagraywacke
17r	Metagraywacke with limonite-stained fractures
18r	Metagraywacke
19r	Quartz from veins as much as 1/2-inch wide
20r	Metagraywacke
21r	Calcareous metagraywacke
22r	Gray quartzs, contains visible pyrite
23r	Quartz diorite(?) from dike
24r	Silicified metagraywacke, about 6 feet from dike
25r	Silicified metasedimentary rock
26r	Hornfelsed metasedimentary rock, limonite-stained, visible pyrite
27r	Felsic aphanite dike rock
28r	Limonite-stained silicic rock, visible sulfides, mostly pyrite(?)
29r	Silicified metasedimentary, visible pyrite
30r	Slaty metasiltstone
31r	Pink felsic aphanite, visible pyrite
32r	Calcareous felsic aphanite dike rock
33r	Metagraywacke, visible pyrite
34r	Quartz from lens in graywacke

RECONNAISSANCE GEOLOGIC MAP AND GEOCHEMICAL ANALYSES OF STREAM-SEDIMENT AND ROCK SAMPLES OF THE ANCHORAGE A-6 QUADRANGLE, ALASKA

by Sandra H. B. Clark and Martha E. Yount

1972