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MISCELLANEOUS FIELD STUDIES
MAP MF -351
SHEET 1 OF 2

1:63,360 SERIES (TOPOGRAPHIC)

5' (ANCHORAGE B-6)

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

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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 acknowledgment 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 chaotically 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, massive 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 can be followed laterally for several miles, usually pinch out or bifurcate. In some areas, thin, rhythmically alternating sequences predominate; thick metagraywacke layers are sparse, and metasiltstone and fine-grained metasandstone beds are more abundant than coarser grained rocks. The finer grained rhythmically bedded rock are best exposed 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. Subdivision of the Valdez(?) Group based on the variations in bedding characteristics (fig. 1) are subjective because the group assigned 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 scle sastrkiga 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. 393-394) 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 (1910) as Inoceramus concentricus. During the present study, fossils were collected that are Inoceramus cf. I. undulatoplicatus (fossil locality 2 to 4, fig. 1) and were identified by David L. Jones of the U.S. Geological Survey as Inoceramus barabini Morton (fossil locality 1) of Late Cretaceous (Senonian) age. The Inoceramus are associated with Pinna, worm trails, and a probable worm tube, Terebellites Palachei Ulrich; a Paleodictyon (fossil locality 3, Jones, oral commun., 1971). fossil was collected near Crow Pass (fossil locality 1) (fossil identification 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 Raven Creek area appears to be a large fold with numerous smaller folds on its limbs. In outcrops north of Eagle River, the fold axis appears to be offset to the east, suggesting right-lateral offset of several miles in the Eagle 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; S. H. B. 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 larger 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 granular 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 1909. The lode deposits were worked sporadically until about 1941 (Berg and Cobb, 1967). Some ore was mined 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 stained 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, "INST-HG(ferum)" 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 were reported to + or - 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 R. 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, B = no data. The terms N = 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	50.00000	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[1/]	Hg PPM[1/]		
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, 0.85, 0.56, 0.38, 0.26, 0.18, 0.12, 0.85. 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

[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.

The histograms and the statistics given below them are derived only from data values within the ranges of analytical determination ("analytical values"). The histograms are, therefore, incomplete, and the statistics are biased if data values qualified with N, L, G, T, or K codes are present. Statistical estimates that are unbiased in this regard are given at the end of tables 2 and 3. The geometric mean is the antilogarithm of the arithmetic mean of the logs of the analyses. It is an estimate of "central tendency" or of a characteristic value of a frequency distribution that is approximately symmetrical on a log scale. The geometric mean is not an estimate of geochemical abundance. The geometric deviation is the antilogarithm of the standard deviation of the logs of the analyses. See USGS Professional Paper 574-B (Miesch, 1967) for further discussion and USGS Bulletin 1152B (Miesch, 1963, p. 20-23) for further discussion and explanation of geometric deviation.

In the computations performed to produce the statistical summary at the end of tables 2 and 3, all elements are ignored where one or more of the unqualified data values is less than the analytical limit of detection specified on input or where any data values are qualified with the G (greater than) code. Data values qualified with B or N are not used in the computations. Where none of the data values for an element are qualified the mean and deviation should be the same as those given in the preceding section. Where data are qualified with the codes B, L, or T, the estimates of geometric mean and deviation are based on a method by A. J. Cohen for treating censored distributions. The application of this method of geochemical problems is described in USGS Professional Paper 574-B (Miesch, 1967). The estimates are unbiased in a strict sense only when the data are derived from a lognormal parent population, but experiments have shown that large departures from this requirement may not greatly invalidate the results. Acceptance and use of the estimates, however, is the responsibility of the individual.

ANOMALOUS SAMPLES

Normal background contents for rocks and stream-sediment samples were determined by inspection of the histograms and tabulated data in tables 2 and 3, supplemented by inspection of histograms and tabulated data for samples from the Anchorage B-6 and B-7 quadrangles (Clark and Bartsch, 1971a, b). The sampling revealed a few weak anomalies outside of the areas of known metallic mineral occurrence, but no strongly anomalous areas.

Mercury concentrations ranging from 0.7 to 1.4 ppm were found in both original and replicate analyses (table 2) of several samples from Camp Creek (samples 27, 29, and 34) and an unnamed creek almost on trend with Camp Creek northeast of Eagle River (samples 21, 22, and 28). The unnamed creek is in part almost coincident with the fault contact between the McHugh Complex and the Valdez(?) Group (fig. 1). Three metagraywacke samples (7r, 8r, and 9r) from the ridge southeast of the unnamed creek (fig. 2) contained between 0.7 and 1.0 ppm mercury (table 3). The significance of the mercury content in the stream-sediment and rock samples is not known.

Copper and lead concentrations of 150 ppm and 70 ppm, respectively, were found in two stream-sediment samples (samples 55 and 56) from near the head of Bird Creek (fig. 2), and a copper content of 150 ppm was found in sediments from a nearby stream near the head of California Creek (sample 61). A few other samples collected outside areas of known deposits are slightly anomalous. No attempt was made to locate the source of these anomalies.

Gold (0.1 ppm) was found by atomic absorption analyses in one stream-sediment sample (sample 7) collected downstream from the approximate location of the Peters Creek prospect and in two samples collected from Peters Creek in the Anchorage B-7 quadrangle (Clark and Bartsch, 1971b). Gold (0.9 ppm) was also found in one stream-sediment sample downstream from the lode deposits of the Crow Pass area.

Some of the rock samples collected in the areas of the known metallic mineral occurrences (fig. 2) contained anomalous amounts of molybdenum, copper, silver, arsenic, tungsten, or gold (table 3). These anomalous concentrations are probably related to the mineralization previously known in these areas.

EXPLANATION

ROCK UNITS

Qs — Surficial deposits

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

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.

KJm — McHugh Complex
Includes marine metaclastic and metavolcanic rocks. Predominantly metasandstone to metaconglomeratic sandstone.

TERTIARY — QUATERNARY
JURASSIC(?) and CRETACEOUS
JURASSIC and/or CRETACEOUS

SYMBOLS

- Contact, approximately located
- Thrust fault, approximately located, teeth 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 antiformal 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

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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	Calcareous 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 quartz, 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 metagraywacke, visible pyrite
30r	Metagraywacke
31r	Pink felsic aphanite, visible pyrite
32r	Calcareous felsic aphanite dike rock
33r	Metagraywacke, visible pyrite
34r	Quartz from lens in graywacke