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GEOLOGIC REPORT NO. 22

Geology and Geochemistry of the Nixon Fork Area, Medfra Quadrangle, Alaska

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by Gordon Herreid

SUMMARY

The Nixon Fork area lies 35 miles northeast of McGrath. It contains gold-copper deposits which have produced about 1.3 million dollars in gold from the oxidized portions of contact metamorphic deposits clustered about the margin of a quartz monzonite-quartz latite stock. The deposits occur in lower Paleozoic limestone which has been thrust over Upper Cretaceous graywacke and slate. A zone of northeast trending faults and small bodies of quartz latite porphyry occurs in the northern part of the map area. The map area lies on the projection of the Iditarod fault zone, and the faulting and thrusting are probably related to this major structure.

Stream sediment geochemical samples were taken throughout the area and soil samples were taken below known ore deposits. Irregular moderate to low stream sediment anomalies were found up to 0.6 miles below the Whalen Mine, one of the largest producers in the area. Moderate to low soil anomalies are present for a few hundred feet below known deposits. The low stream sediment and soil anomalies are thought to be due to percolation of surface waters through the soils into the porous limestone bedrock, carrying the metals from the surface down into the bedrock rather than downslope and into the streams.

Cold extractable heavy metal field tests were in good agreement with the copper, lead, and zinc contents of highly anomalous samples, but in only fair or poor agreement with moderately anomalous samples.

Two stream sediment samples moderately anomalous in zinc were taken near the north end of the stock and may be indications of undiscovered ore deposits in the area.

Three moderate stream sediment anomalies in the northern part of the map area suggest a mineral potential related to the zone of faults and small intrusives there.

INTRODUCTION

The mines in the Nixon Fork district produced about 1.3 million dollars from the time of their discovery in 1918 to 1942, when they were closed by war time restrictions on nonessential mining. These contact metamorphic deposits have been described in a regional reconnaissance report (Brown, 1925) and in several brief descriptive reports on the mines made during the period of mining and exploration. The deposits are adjacent to one of the several intrusives along the major Iditarod fault zone in an area largely obscured by a thin cover of soil and vegetation. The occurrence of copper deposits along a belt of complex structure and poor exposure offers attractive possibilities for the presence of undiscovered deposits. The present investigation provides a geologic and stream sediment geochemical map of the Mystery Creek intrusive and surrounding sediments in the Nixon Fork district. Geologic sketch maps were made of some of the areas of mining and prospecting, and reconnaissance geochemical soil sampling was carried out near the deposits. The only area where mineralization was seen in place - the Whalen glory hole - was mapped in detail.

The Nixon Fork area lies about 35 miles northeast of McGrath and is accessible most readily by light aircraft landing on the airstrip on the ridge above Hidden Creek. The road from Medfra, 12 miles south on the Kuskokwim, is reportedly in poor condition where it crosses the flats. The buildings and facilities in the area are on the 32 unpatented claims held by the Mespelts and T.J. Almasy. Thanks are due to Mrs. Margaret Mespelt and Mr. T.J. Almasy for use of the facilities at the Mespelt camp. Field work was done between August 17 and September 15, 1965. The author was ably assisted by Kent Smith, who took most of the geochemical samples.

GEOLOGY

The map area is almost devoid of exposures of bedrock in places. The geologic map (figure 1) is based on frost-heaved rubble, rock fragments embedded in the soil, and on photo interpretation, as shown by symbols on the map. In many places it was necessary to dig holes to a depth of one to two feet to find float to determine the underlying bedrock. The presence of only a few sharply differing types of sediments and intrusives which are readily differentiated in small fragments facilitated mapping. The geologic map is in broad agreement with that of J.S. Brown (1926).

Rock Types

Limestone

Limestone forms most of the higher hills of the map area. It is fine-grained, medium light gray to dark gray, often with white calcite veinlets. Bedding is fairly well shown on aerial photos, but was obscure in the few outcrops that were examined.

In the Whalen glory hole much of the limestone contains limonite films on the grains which gives it a pale yellowish orange color. The limonite is probably secondary, derived from oxidization of the nearby pyritic ore body.

The limestone on the dumps at the Garnet shaft, Recreation shaft, and shafts in the Mystery Creek drainage varies from light gray to tan and in places has been recrystallized to marble. Brown (1926) gives fossil ages that range from Ordovician and Silurian to possibly Devonian. He estimates that the limestone is at least 5,000 to 7,000 feet thick.

Graywacke, black argillite, and black slate

Black argillite and siltstone crop out discontinuously around the Mystery Creek intrusive and for about 7-1/2 miles to the northwest. Rocks similar in character but with more graywacke are present along the Nixon Fork River. The hills on both sides of lower Jones Creek are underlain by dark graywacke and lesser amounts of black cherty argillite and igneous rocks. The creek gravels there contain little or no limestone. A graywacke from the hill west of Sample 116 is made up of rounded grains averaging 0.3 mm in diameter composed of 25% carbonate, 25% quartz, 25% chert, and lesser amounts of quartz-muscovite schist, light colored quartz porphyry, light colored feldspar porphyry, black slate, fine-grained graywacke, feldspar (both fresh and sericitized), and micaceous quartzite.

No megascopically visible limestone or marble fragments were seen in these sediments.

Brown gives an Upper Cretaceous age for these rocks based on fossils in the area.

Quartz latite porphyry

North of Jumbo Peak the intrusives are composed of quartz latite porphyry (table 1). This rock has 5-10% quartz and feldspar phenocrysts in a fine-grained quartz-albite(?)-orthoclase matrix. Where alteration is present, the feldspar has been altered to sericite. The quartz content averages 30 to 60%. Similar rock makes up 1/3 to 1/2 of the larger Mystery Creek intrusive, which extends from Jumbo Peak south to Holmes Gulch. Evidence of minor pyrite was found only in the Submarine Creek body immediately north of Jumbo Peak.

Quartz monzonite

Quartz monzonite and its less siliceous variants monzonite and diorite (table 2) make up much of the float of the Mystery Creek intrusive and apparently form 1/2 to 2/3 of the underlying bedrock. In most areas the underlying bedrock is represented only by occasional large blocks which may or may not be of local origin. This rock is medium- to coarse-grained with granitic texture and shows little alteration. The average rock contains an estimated 10 to 15 percent quartz.

Because of poor exposures the structural relation of the quartz monzonite and quartz latite porphyry in the Mystery Creek intrusive are conjectural. The rock types have been plotted on figure 1. Large areas, in the interior of the intrusive as well as close to the contacts, appear to be underlain by porphyry as well as quartz monzonite. The conclusion of Brown (1926) that the porphyry represents a chill zone along the border of the intrusive and also occurs as dikes in the center of it is a reasonable explanation, but probably an over-simplification. The erratic distribution of the two rock types in the Mystery Creek intrusive, the similarity of the porphyry in that body with the porphyry of the intrusives further north, and the greater quartz content of the porphyry relative to the quartz monzonite suggest that the quartz monzonite and the porphyry are two separate intrusives emplaced at different times. It is likely that the two rocks are related in origin, with the quartz latite porphyry a later and more silicic differentiate from a magmatic source at depth. Probably the quartz monzonite cooled at a greater depth than the various porphyry bodies in the map area, which solidified at or near the earth's surface. Both types of igneous rock intrude Upper Cretaceous graywacke and slate and are of Tertiary age.

In a number of places large blocks of quartz monzonite up to 5-10 feet across rest on sediments or porphyry. Near the head of the eastern tributary to Holmes Gulch an isolated 4 foot by 6 foot quartz monzonite boulder lying on a 7° hill slope is underlain by black slate at a depth of about one foot. The boulder is at least 100 feet from quartz monzonite bedrock and must have been transported that far or more by frost heaving. In the placer cut on Birch Creek, boulders of hornfels and quartz monzonite occur in soil made up of porphyry fragments. These erratics derived from upslope make up an estimated 5% of the soil mantle. About 0.4 mile northwest of the Whalen Mine, a large area of the slope at the head of a tributary to Ruby Creek is underlain by large blocks of quartz monzonite which are probably underlain by black argillite bedrock. This tendency for quartz monzonite to occur as large mobile boulders adds to the difficulties of accurately delineating its contacts.

Quartzite (silicified siltstone?)

The rock at the south end of the airfield and extending down to the placer cut on Birch Creek is a fine-grained, light brown quartzite with scattered hematite specks. Microscopic examination shows it to be a silicified siltstone(?) composed of quartz grains .02 to .2 mm in diameter with finer-grained interstitial quartz, chlorite, and sericite. There are no feldspar or quartz phenocrysts. One thin section shows quartz overgrowths formed on the original quartz grains. Megascopically this rock looks like a porphyry but lacks quartz or feldspar phenocrysts. Areas of both porphyry and the similar appearing quartzite are present in the exposure at the placer cut on Birch Gulch. Because of the difficulty in distinguishing these two rocks and the lack of exposures, they are mapped together as silicified siltstone and porphyry ("Tig" in figure 1). The rock is considered to be an Upper Cretaceous siltstone which has been altered by the Mystery Creek intrusive.

Slickensides silicified black argillite float (blocks up to 10 feet long) is present just west of Jumbo Peak. The zone of silicification of the black argillite extends along the ridge northwest of the peak for nearly a mile, and is the only well-exposed area of bedrock present along an igneous contact. Tiny tourmaline grains make up about 1% of the rock in a pit 1/3 mile northwest of the peak. No strong iron-staining or abundant sulfides were seen anywhere along the zone.

Tertiary(?) gravel

Tilted and slightly indurated stream gravel with petrified logs is exposed on lower Jones Creek (figure 1). This outcrop is barren of vegetation and clearly visible from across the creek. It forms a nearly vertical bank 10 feet high on the west side of Jones Creek and then slopes back more gently to the wooded slope above. The gravel is composed of beds of conglomerate 2-3 feet thick which are separated by dark sandy or coaly layers, and dip 20° south. The clasts are rounded and average less than 2-3 inches in diameter, but a few widely scattered 2-foot boulders are present. Clasts are graywacke, black argillite, and quartz porphyry with minor diorite, andesite, and vein quartz. A stratigraphic thickness estimated at 75 feet is exposed, with no bottom or top visible.

The gravel has a steep scarp on the north side due to a northwest trending steep dipping(?) fault on which the movement has been north side up. The gravel probably represents a capping on a fault block which is mainly composed of Upper Cretaceous graywacke.

The gravel is clearly younger than the Upper Cretaceous graywacke but old enough to be tilted, somewhat indurated, and faulted. It is probably Tertiary in age.

Structure

The outcrop pattern of the limestone, graywacke, and igneous rocks constitutes the principal information regarding the structure of the map area. J.S. Brown (1926) concluded that the early Paleozoic limestone had been thrust northwest over the younger graywacke and slate. He based this mainly on the presence of limestone on the higher hills and the lack of of marble fragments in the graywacke near the contacts. The present mapping confirms this interpretation. The irregular northeast trending H-shaped area underlain by graywacke can easily represent a moderately undulating contact between graywacke overlain by limestone. If the sequence were limestone overlain by graywacke, complex normal faulting would be necessary to form this pattern, particularly in the connecting area on Jones Creek. Most likely the intrusion of the Mystery Creek, Submarine Creek, and upper Jones Creek igneous bodies was controlled by a northeast-trending domal anticline. The outline of this structure is thought to be marked by the area of graywacke and intrusive rock extending northeast from the Holmes Gulch area.

Traces of limestone beds are quite evident in the air photographs, but the attitudes of these beds are less certain. Many appear to be quite steep, and no simple anticlinal pattern on either side of the domal anticline mentioned above is evident.

A number of straight fault(?) traces are visible on air photographs of the lower Jones Creek-Boulder Creek area. The scattered porphyry intrusives in this area and northeast of the map area, on Whirlwind Ridge (Brown, 1926), are probably genetically related to this fault zone.

The inferred north-west trending block faulting with north side up that is responsible for the preservation of the Tertiary gravel on lower Jones Creek was not observed elsewhere in the area.

MINERAL DEPOSITS

Historical Sketch

Placer gold was first discovered in the Nixon Fork district on Hidden Creek in June 1917. Other placers were soon located on Ruby, Mystery, and Submarine Creeks. Gold was traced to the headwaters of the creeks and in 1918, the Crystal lode was discovered by Pierson and Strand. During the winter of 1919, several hundred tons of high-grade ore was mined and shipped from this lode. Other lode discoveries were soon made, principally by Whalen and Griffin at the head of Holmes Gulch and McGowan and Mespelt on Mystery Creek. In 1920, the Treadwell Yukon Company took over these properties, built a ten-stamp mill and began developmnnt work and mining. This company deepened the Garnet and Recreation shafts (figure 2), but their main source of ore was the Whalen Mine. In 1924, they relinquished their leases after having produced an estimated $235,000 in gold, reportedly at a loss (Jasper, 1961). E.M. Whalen, for a time after this, continued operations at the Whalen Mine. From 1926 until 1942, the Mespelt brothers mined in the High Grade-Garnet shaft area with a production reported to be about $1,000,000 (Jasper, 1961). The total production of the district is given by Jasper as "in the neighborhood of $1,315,000".

This ore was milled at the Treadwell mill which could only concentrate free gold. Sulfides and associated gold went out in the tailings pond which is reputed to contain 10,000 tons averaging $30.00 per ton in gold. In 1950, H.G. Wilcox and Associates had the property under lease, and from 1952-1964, Strandberg and Sons, Inc., held the lease. In 1965, the property reverted to the Mespelts who, in association with T.J. Almasy, hold claims on all the lode and placer ground in the district.

Geology of the Mineral Deposits

The following general account of the geology of the ore deposits has been taken largely from U.S. Geological Survey reports by Martin (1922), Brown (1926), and Mertie (1934). The ore deposits found to date occur in marble, usually within 100 feet of an igneous contact. Ore minerals are chalcopyrite, pyrite, and in a few places, bornite. Copper values range from 2 to 12% in the ore. Unoxidized ores have gold bound up in pyrite and chalcopyrite. Oxidized ore is composed of limonite, quartz, malachite, azurite, and free gold. The ore is generally associated with dikes, faults, and contact metamorphic minerals (diopside, garnet, plagioclase, epidote, and apatite), of the hornblende hornfels facies. However, ore is also associated (e.g. Whalen glory hole) with sericite which suggests that the ore deposits are at least in part hydrothermal, deposited at lower temperature after the contact metamorphic minerals formed. Near the deposits the dark gray limestone country rock has been recrystallized locally to a fine-grained white to light gray limestone.

Native bismuth is present in the deposits and occurs in the placers. Cinnabar and stibnite are lacking, in contrast to their common occurrence in other Kuskokwim mining districts.

A number of descriptions of the old workings are given in the U.S. Geological Survey reports written when the work was more or less in progress. It was not possible to find and identify all of these workings in the time available due to the abundance of alders and the lack of detailed maps in the U.S. Geological Survey reports. During this study geological sketch maps were made of the workings which were seen in the Garnet shaft area (figure 2), on the southwest slope of Mystery Creek (figure 4) and at the Whalen shaft (figure 3). These maps were used as a base for plotting geochemical samples taken near the deposits. A detailed geologic map was made of the Whalen glory hole (figure 5). The older U.S. Geological Survey reports have been drawn on heavily to supplement observations of the mine workings and to describe workings that were inaccessible or not found.

Garnet Shaft Area (Crystal Gulch)

The numerous pits, trenches, and shafts in this area provide a relatively good picture of the extent of limestone and igneous rock (figure 2). Bedrock or bedrock rubble is generally covered by two or three feet of fine-grained tan soil without identifiable rock fragments. Two lines of geochemical samples were collected across the area. The small dump of the northernmost prospect shaft on the map, east of Sample B, assays: gold - 0.26 ounces per ton, silver - 0.1 oz/ton, lead - trace, zinc - 0.15% copper- 0.92%, and bismuth - 0.04.

Crystal shaft (figure 1)

This shaft, 65 feet deep, is on the crest of the rounded ridge east of the Garnet shaft. It marks the initial lode discovery in the district. A few hundred tons of high-grade ore were mined from an ore zone six feet thick in 1919-20. The ore is little oxidized and chalcopyrite, pyrite, and bornite, are reported. According to Martin (1922), the shaft is in monzonite. However, a sample taken from the dump by T.J. Almasy is medium gray marble with crystalline white calcite, pyrite, and chalcopyrite (samples 3 and 15, table 5) carrying 0.1 ounce gold per ton.

Garnet shaft (figure 2)

In 1933, Mertie reported this shaft to be at a depth of 310 feet with the lower workings in quartz monzonite and the higher grade ore present at shallower depths in limestone. Jasper (1961) reports the lowest level to be 460 feet deep with 520 feet of drift, mainly in barren limestone but with ore occurring near a tongue of quartz monzonite. A winze extended another 35 feet below the level. The ore mined in 1961 consisted of large slabs that had fallen to the floor of a natural cavern and were cemented by limonite and secondary copper minerals. Quartz monzonite was present on one wall and two feet of limonite-limestone gangue on the other. The ore minerals in order of abundance in the ore shoot were chrysocolla, malachite, azurite, free gold, and minor pyrite, and chalcopyrite in a limestone and limonite gangue.

High Grade shaft (figure 2)

Much of the Mespelts early mining was done from this shaft (depth 150 feet). There were two tabular bodies striking N25E, which were up to 11 feet thick, composed of partly oxidized ore which reportedly bottomed against an altered dike below the 70 foot level. About 5,000 tons was produced from this shaft.

Recreation shaft (figure 2)

This shaft, which reached a depth of 100 feet, was started on an ore zone six feet wide which had been traced for 200 feet by surface trenches. The ore was oxidized and consisted of limonite, quartz, malachite, azurite, and apatite with some chalcopyrite and bornite in gray limestone wall rock. Three small shafts 150 to 300 feet south of the Recreation shaft were not found during the mapping. These were sunk in 1924, in "a loose capping of decomposed limestone containing very rich ore" assaying $85-170 per ton at the present price of gold. Approximately 100 tons was mined.

Mespelt inclined shaft (figure 2)

Sinking was in progress at this shaft in 1933 when Mertie visited the property. It is inclined at about 35° southeast and follows an erratic ore body in limestone along the hanging wall contact of a quartz monzonite dike. The higher grade ore had a green copper stain, but the lower grade ore ($17 per ton or lower) was iron-stained and presumably carried less copper. Garnet-bearing tactite is present in the open pit near the collar of the shaft.

Southwest Slope of Mystery Creek

Four lines of geochemical samples were taken across the contact (figure 4). The area is everywhere covered, generally with no more than two or three feet of soil over bedrock or bedrock rubble. None of the old workings described in the literature could be positively identified with those found in the field and shown on the map.

Tactite ore on the dump of the southernmost shaft in figure 4 contains granular diopside, garnet, calcite, and minor quartz. Slightly recrystallized medium gray limestone is also present. The "waste dump" (figure 4) contains mainly tan marble with malachite and azurite films. It assays: gold - 0.04 oz/ton, silver - 0.3 oz/ton, lead trace, zinc - trace, copper - 0.51%, bismuth - 0.01%. The "ore pile" (figure 4) assays: gold - 0.54 oz/ton, silver - 4.5 oz/ton, zinc - trace, lead - trace, copper - 3.50%, bismuth - 0.10%.

Garnet trench

The limestone-quartz monzonite contact is exposed here. "The ore in this trench was notable because it consisted largely of garnet, with which were intergrown films and small masses of malachite, and azurite" along with augite, sericitized plagioclase, apatite, epidote, and chlorite (Mertie, 1934).

Twin shafts

These shafts were 50 to 20 feet deep and exposed highly oxidized ore along the contact of a fine-grained porphyry dike. Assays of $90 and $20 per ton are reported (Mertie, 1934).

Main shaft

In 1933 this 26° inclined shaft was 250 feet long (vertical depth 110 feet) with several drifts (Mertie, 1934). The ore body was a 2-5 foot thick replacement in limestone, in or near the footwall of a body of intrusive rock. Its strike was N70E with a dip of 0-60° south. "One section of the ore shows 2-3 feet of coarsely crystalline calcite along the footwall, followed upward by about six inches of cupriferous ore, in turn followed by two feet of less cupriferous (and therefore brownish rather than greenish) ore, which extends to the hanging wall" (Mertie, 1934). The copper-poor ore is richest in gold. Faulting is evident in the lower workings and the ore pinches to a few inches thick. The ore is highly oxidized.

Marble Roof Pendant at the Head of the Northern Tributary of Holmes Gulch

Whalen Mine (figures 5 and 6)

Brown (1926) describes the shaft as being in limestone with the drifts on the 100-foot level for 50 feet to northeast and southwest in much jointed, slickensided, and brecciated limestone. In the northeast drift 50 feet from the shaft beyond a steep fault, "monzonite" is present. Most of the limestone is white to gray and has been recrystallized, but locally there are irregular streaks of contact metamorphic minerals (zoisite, pyroxene, garnet, and fine-grained quartz). The ore is strongly oxidized and consists of limonite, malachite, black copper oxide, and free gold with a little of the original sulfide (pyrite and chalcopyrite) remaining. The ore shoots are irregular and are not confined to any vein or structure. The copper content probably does not exceed 1 or 2% for any "considerable tonnage" of ore (Brown, 1926). The Whalen glory hole (figure 5) lies just west of the shaft described above. It occurs in a roof pendant of marble in the Mystery Creek intrusive and is about 70 feet west of the quartz monzonite contact. The exposures show dike rocks, many steep faults of various orientations with both steep and nearly horizontal slickensides, and much alteration including limonitization, serpentinization, and sericitization. Copper minerals are present in altered marble along north-northeast trending shears at the south end of the pit and in altered quartz monzonite on the northeast side. The close association of ore with dikes, alteration, and faulting as seen in the glory hole is characteristic of the deposits in the district. Evidently, emplacement of the ore was controlled by both the presence of igneous bodies and post-intrusion faulting.

Whalen shaft (figure 3)

Along the old Medfra road, approximately 450 feet north-northeast of the Whalen glory hole, a shaft, ore pile, and tailings pile are present (figure 3). Bedrock is a tongue of limestone about 135 feet wide (along the road). There are no bedrock exposures. A sample from the ore pile is tactite containting about 25% biotite, 25% pyroxene (variety salite), 10% tremolite, 10% carbonate, plus malachite and hematite. A grab sample of this ore assays: gold - 1.24 oz/ton, silver - 2.9 oz/ton, lead-trace, zinc - trace, copper - 1.11%, and bismuth - 0.05%. Much of the material on the ore pile is brown marble. The sketch map (figure 3) shows the location of seven geochemical samples taken down the hill slope southeast of the shaft.

Birch Creek Drainage

A timbered shaft, estimated to have been 20 feet deep is located near a ruined cabin about 150 feet north of geochemical sample 24 (figure 1). The country rock is a fine-grained, dark gray brecciated limestone containing 1-3% calcite veins, but has little limonite and no sulfides. Mr. T.J. Almasy reports that minor copper showings are present in prospect pits further up the hill about 200 feet southeast of the airstrip (sample 1, table 5).

Mystery Creek Intrusive

The only mineral deposits in the Mystery Creek intrusive mentioned by the U.S. Geological Survey are the Crystal shaft, near the limestone contact, and the Keen shaft, well away from the contact. Both of these were little oxidized. In addition, several adits and shafts are present in the vicinity of the Mespelt camp at the end of the Medfra road. T.J. Almasy reports that the "old time" prospectors thought that ore in the intrusive would be unoxidized, and therefore lacking in free gold and not amenable to concentration in the old Treadwell mill. It would seem reasonable, then, that the intrusive has been prospected less diligently than the contact zone. Certainly, the almost complete cover and lack of igneous float would effectively mask any mineralization in most areas of the intrusive. However, the present geological and geochemical investigation found no definite clues suggesting that there is ore in the intrusive, but the possibility remains that hidden ore deposits may be present. Mr. Almasy has sent in a number of samples taken at various points in the intrusive body and elsewhere. These are listed on table 5.

Keen shaft (figure 1)

This shaft is in the quartz monzonite, 1000 feet east of the limestone contact. "It is said to have revealed a vein 4 feet wide, and material from this vein on the dump shows quartz with much yellow stain containing numerous small flakes of a grayish mineral with metallic luster (probably arsenopyrite) and a few small cubes of pyrite". (Martin, 1922). A sample taken by Mr. T.J. Almasy from the Keen shaft dump was yellowish buff porphyry and ran 0.02 ounce per ton gold, 0.18 ounce per ton silver, less than 0.05% copper, 0.10% lead, and a trace of zinc.

GEOCHEMISTRY

Introduction

Geochemical samples were taken of stream sediments throughout the area to determine the reflection of known deposits in the metal contents of stream sediments and in hopes of detecting undiscovered deposits. In addition, soil samples were taken below known deposits to test the effectiveness of soil sampling in detecting mineralization in the area. Samples were tested in the field using the cold extractable heavy metals method described by Hawkes (1963), modified by using the ammonium citrate extractant full strength instead of diluted 4:1. Samples were later analyzed for total copper, lead, zinc, and molybdenum in the -80 mesh fraction by Rocky Mountain Geochemical Laboratories in Salt Lake City. These values are reported on the various tables and maps.

Geochemical samples shown on figure 1

The strongest and most extensive stream sediment anomaly in the map area is on Ruby Creek. This anomaly extends up the creek to the old Treadwell mill and is undoubtedly the result of contamination by the mill tailings. The next largest group of anomalous samples is located below the Whalen Mine (glory hole), and is discussed below. As a result of a field test of 10 ml for stream sediment sample 79, numerous samples were taken on upper Submarine Creek. Sample 79 was later found to have only background total metal contents and the line of soil samples showed nothing, but two other stream sediment samples to the northwest are moderately anomalous. More geochemical sampling in the upper Submarine Creek area seems warranted. Mineral showings have reportedly been found in the area, but were not seen during this investigation.

Low anomalies of zinc and copper in the northern part of the map are a hopeful sign for the mineral potential of the belt of faults and small intrusives located in the northeastern part of the map. However, samples 108 and 120, taken on good sized creeks, showed anomalies that were not reflected in samples taken further up stream. Sample 109 was taken in a small short drainage in which a moderate sized deposit would be expected to make a strong anomaly.

Garnet shaft area

Two sample lines about 400 feet apart were run across the mineralized zone in the Garnet shaft area (figure 2). They indicate an anomaly in the area immediately below the Recreation and High Grade shafts but for the most part, only background metal content in the soil 400 feet further downhill. These samples indicate that soil sampling is effective in locating covered ore deposits but that anomalies do not extend for great distances, even directly downhill.

A sample grid should have line spacing considerably less than 400 feet. The cold extractable field test for heavy metals gave satisfactory results in this area and could be used for a sampling program.

The presence of anomalies at H, J, Q, and P (figure 2), underlain by porphyry is interesting, but the significance is unknown. It seems unlikely that undiscovered ore deposits with only a thin soil cover are present adjacent to the sample locations in this portion of the report area.

Mystery Creek area

Four lines of samples were taken across the limestone-intrusive contact zone (figure 4). Anomalous samples were mainly present along the contacts rather than in the limestone near the deposits. The soil sampling done did not effectively detect deposits in limestone in this area. Samples were taken at a depth of about one foot. More detailed work should be done in areas underlain by limestone to determine the behavior of copper, lead, and zinc during soil formation. Possibly, deeper sampling would be more effective. It is possible that undiscovered deposits are present in the quartz monzonite. Samples taken above sample site M by T.J. Almasy (table 5)show a small copper content. Because of the relative immobility of lead in soils the high lead content of sample M indicates a nearby bedrock source. The low metal contents of soil and stream sediment samples in Mystery Creek and along its banks indicates a low probability that any large base metal deposit is present nearby. However, the lack of anomalous samples at F, G, and H, near the shafts on Mystery Creek, illustrates the dangers of negative conclusions. Another sample line near the "stripped area" (figure 4) extending some distance into the intrusive woulddetermine if a soil anomaly is present below the shafts and would prospect the area above sample M.

Holmes Gulch-Birch Gulch

The Whalen Mine (glory hole) was found by tracing the placer gold up Hidden Creek to its source. The stream sediment geochemical samples taken on Hidden Creek, Holmes Gulch, and its northern tributary, allow a direct comparison between the two methods as they apply in the Nixon Fork area. As figure 1 shows, only detailed stream sediment sampling extended to the upper parts of the smaller creeks would have discovered anomalies in this area. Note that the soil samples taken near the glory hole (figure 6) are not anomalous. The Whalen deposit is not large nor is the grade of copper high, but it could be representative of (and possibly is) a larger deposit only partly unroofed. Evidently any anomalies should be followed up by closely spaced stream sediment and soil sampling. Low anomalies are present in Birch Gulch (24, 24A) and Hidden Creek (14), all draining more or less the same area. Intensive sampling as a result of these anomalies would have found the anomaly in upper Holmes Gulch and, eventually, the Whalen Mine.

A 3 foot sample pit dug at sample 36 (figure 1) showed 0-1 feet forest litter; 1-2½ feet: fine grayish brown clayey soil with very fine sand-size rock fragments; 2½-3 feet: mica flakes and 1 inch porphyry float in soil similar to that above only lighter yellowish-brown in color, with larger sand-size rock fragments, some of which are angular. The contact between the two soil layers is fairly sharp, but not horizontal. The upper soil layer relative to the lower one (36-1, 36-2, table 6) contains somewhat less copper and zinc, but equal lead. If the fine, float-free top layer of soil in this hole and elsewhere in the area, were loess (windblown silt) a sharper discontinuity in appearance and in metal values would be expected. Also thick local thickening and thinning would be expected rather than the fairly uniform layer of 1-2 feet which appears to be present throughout the map area.

Upper Hidden Creek

The deposits at the Whalen Mine (glory hole) and the Whalen shaft have no visible effect on the metal content on Hidden Creek, unless the 185 ppm copper in sample 14 is related to them. This moderately high copper anomaly could be related to deposits along the limestone-intrusive contact immediately to the northeast of it.

The soil samples taken below the Whalen shaft (figure 3) show moderate soil anomalies present at some distance below the ore deposit. The lack of any anomaly at sample Y may be due to the fact that a given particle of bedrock or ore must migrate a considerable distance downhill in the soil mantle, before it reaches the surface. The lack of anomalies 1/2 mile down the slope (figure 1) is consistent with the results on Mystery Creek.

Discussion of geochemical results

The metal contents of the soils and stream sediments are summarized on the metal abundance-frequency graphs (figure 7). These graphs show a remarkable similarity between the stream sediment and geochemical soil samples. Most of the soil samples were taken below known copper-bearing deposits whereas the stream sediments were taken over the entire area. Most of the soil sample holes were dug deep enough to find float - usually 1-2 feet. In other Alaskan areas, strong anomalies have been found at such depths.

On Mystery Creek (figure 4) most of the soil samples taken in limestone areas adjacent to the shafts are not anomalous, whereas several of those underlain by igneous rock are. The distribution of metal values suggests that anomalies are suppressed in the limestone areas. At sample site 36, the presence of 15 ppm copper at 1½ foot depth vs. 35 ppm copper at 3 feet is suggestive of surface leaching. This is borne out by a similar relationship for zinc. Lead, which is relatively insoluable, is equal in the two layers. In areas underlain by limestone the lack of surface drainage and presence of caverns at depth in the mines indicates that surface water tends to move downward through bedrock. This oxygen-bearing water is responsible for the strong oxidation of the ore deposits and a probable downward migration of metals. This surface water has evidently had the same effect on the soils, with metals released from ore deposits during formation of residual soil carried downward. Possibly more detailed work would indicate a concentration of metals at the base of the soil.

The several detailed maps which show the location of geochemical sediments and old workings give an idea of the extent and grade of metal anomalies relative to the deposits that have been found by traditional prospecting methods. It is evident that geochemical samples will detect buried deposits, if detailed sampling is done. However, the soil anomalies do not extend for great distances down hill slopes and only appear at the surface some distance downhill from the buried deposit.

In the field, geochemical samples were analyzed by a cold extractable heavy metals test described by Hawkes (1964) which uses ammonium citrate extractant and dithizone in a xylene solvent. This test was modified by using the extractant full strength instead of diluted 1:4 with water. There seems to be little or no advantage to this modification. The effectiveness of this field test relative to the total metal contents as indicated by the laboratory results are shown on the graphs in figure 8. Because the cold extraction test detects zinc about 2½ times better than it does lead and copper (Herreid and Rose, 1966), the laboratory results were recalculated as equivalent zinc by dividing the parts per million (ppm) copper and lead by 2.5 and adding the result to the ppm zinc. These equivalent zinc figures were plotted against the milliliters of dithizone for each sample. Samples that are anomalous in one or more metals in the laboratory tests are circled. If the field tests were 100 percent effective, all of the circles and no dots would lie above an ordinate of about 5 milliliters of dithizone, or whatever was the threshold of the field test. It is readily seen that any threshold high enough to exclude most dots (non-anomalous samples) also excludes many anomalies containing well over 130 ppm equivalent zinc. Despite the difficulties of the field test it does almost infalliby indicate highly anomalous samples. However, it only detects about 50 percent of the moderate anomalies. Note that a sample containing high but no anomalous amounts of copper, lead, and zinc may have a higher equivalent zinc than another sample anomalous in one metal and low in the two others - hence the intermingling of abcissa values of circles and dots on the graph.

CONCLUSIONS

Geology

Major thrusting of Paleozoic limestone over Cretaceous graywacke has taken place in the Mystery Creek area. This may be related in some way to the zone of northeast trending faults and intrusives along the Nixon Fork River. A domal anticline parallel to the Nixon Fork fault zone is the locus of the Mystery Creek intrusive. It seems likely the dome was the structural control of intrusion, or that doming was caused by intrusion.

Ore deposits are present in limestone around the contact at the west end of the Mystery Creek quartz monzonite and quartz latite intrusive. These are contact metamorphic deposits containing gold-bearing pyrite and chalcopyrite, plus minor bornite. They are closely associated with contact metamorphic minerals of the hornblende hornfels facies, and also lower temperature minerals, indicating that ore deposition continued as the temperature fell. There has been little alteration of the quartz monzonite, but considerable sericitization and very minor pyritization of the quartz latite. Sediments near the contact have been locally silicified. Oxidation of ore deposits has altered the copper minerals to malachite and azurite and released the gold from the sulfides.

Bedrock throughout the area is covered by one to three feet of fine-grained, light brown, clayey residual soil without bedrock fragments underlain by similar appearing soil with bedrock fragments.

Geochemistry

Geochemical stream sediment and soil anomalies in the Nixon Fork area are only low to moderate despite the presence of copper-bearing ore deposits. Below the mines on Crystal Gulch (Garnet shaft, etc.) soil anomalies extend for less than 400 feet and are not high, even near the deposits. On Holmes Gulch stream sediment anomalies extend for only 0.6 miles down a very small drainage. Evidently some mechanism exists for effectively reducing the metal content of the soil to background levels within a short distance. All of the known ore deposits are in limestone.

This suppression of anomalies is probably due to the lack of surface drainage in areas underlain by limestone. The surface water moves down through the soil into bedrock channels and carries metals leached from the soil with it. These metals are probably precipitated in the limestone so that they never reach the stream at the bottom of the hill. Thus, both soil and streams are impoverished in metals. Samples taken at depths of one to two feet were effective in detecting the higher grade deposits only to distances of a few hundred feet. Possibly, samples taken at the base of the soil mantle would be more consistent and show stronger anomalies.

Even low to moderate anomalies in areas underlain by limestone should be investigated.

Two moderately anomalous samples were taken on upper Submarine Creek from the area draining the igneous contact. Three moderately anomalous samples came from the zone of small porphyry bodies and regional faults that parallel the Nixon Fork River.

Suggestions for prospecting

The Mystery Creek intrusive has not been intensively prospected. It is covered with only a thin mantle of soil. Soil sampling on 200 foot centers would detect any significant copper deposits that may outcrop beneath the soil cover of the intrusive. Cold extractable field analyses would be satisfactory for this work.

The two moderate anomalies on upper Submarine Creek should be followed up by more detailed sampling.

The zone of faults and small porphyry intrusives along the Nixon Fork River should be prospected by a systematic stream sediment sampling program.

Soil and stream sediment samples should also be panned, principally for gold content.

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Table 1

Modes of Porphyritic Rocks

	5C747-D	5C770-D	5C787	5C736	5C726
Phenocrysts					
Quartz	5%c	2%c	5%c	4%c	2%c
Plagioclase	1%*			4%*	2% (oligoclase)
Orthoclase		5%d		2%*	5%*
Biotite					2%
Pyroxene		2%b			
Grain size	2mm	1 mm	2 mm	2 mm	1 mm
Groundmass					
Quartz	64%	35%	60%	25%	25%
Plagioclase		25%* (albite)		24%(?)*	20%*
Orthoclase	5%(?)	25%*		24%(?)*	35%*
Biotite				5%	2%
Chlorite		2%b			2% (alt of Bio)
Sericite	25%e		25%e	15%*e	5%
Sphene		1%a			
Carbonate		2%va			
Limonite			10%vp	2%av	
Grain size	.03 mm	.05 mm	.05 mm	0.02 mm	0.1 mm
Grain count	Visual estimate for all sections -------------------------				
Color	grayish orange	very light gray	pale yellowish brown	very pale orange	light greenish gray
Rock type	---------------quartz latite porphyry--------------------				

a - scattered small masses in ground mass and replacements of some phenocrysts
b - phenocrysts mostly altered to chlorite, carbonate, and sphene
c - corroded quartz
d - orthoclase partly altered to carbonate
e - fine-grained masses in groundmass
p - limonite pseudomorphs after pyrite cubes
v - veinlets
* - feldspar partly clouded with sericite

5C747-D Placer cut on lower Birch Creek. All feldspars have apparently been altered to sericite.

Table 1 (Continued)

5C770-D	Whalen glory hole, west wall. All feldspars have been altered to sericite.
5C787	Submarine Creek porphyry intrusive. 1510 foot elevation, southeast of summit of 1574-foot hill. Locally the porphyry is a breccia with angular 5-10 mm fragments cemented with limonite. Similar to 5C747-D.
5C736	Upper Jones Creek, southeast 1/4 of section 18.
5C726	Lower Jones Creek drainage, northwest 1/4 of section 9.

Table 2
Modes of Coarse-grained Igneous Rocks

	5C706	5C769	5C774-D
Quartz	6%	18%	6%
Plagioclase	46%	41%	35%
%An	An_{38} (andesine)	An_{38} (andesine)	An_{48} (andesine)
Orthoclase	26% (Perthite)	27%	4%
Biotite	10%	12%	25%
Hornblende	11%		14% (hornblende & tremolite)
Pyroxene			12% (augite)
Chlorite		trace	
Sericite	trace (in feld.)	1% (in feld.)	trace (in feld.)
Apatite	trace	trace	2%
Speene		trace	
Zircon	+	trace	
Opaque	trace	trace	2% (Magnetite?)
Points counted	512	319	504
Color Index	21	13	53
Orthoclase: total feldspar	0.37	0.4	0.1
Texture	granitic	granitic	granitic
Maximum grain size	5 mm	5 mm	4 mm
Rock type	monzonite	quartz monzonite	diorite

5C706 0.1 mile north of Medfra road near west edge of section 17
5C769 Medfra road southeast 1/4 of section 13
5C774-D 1000 feet north-northeast of Whalen glory hole on old road to Medfra

Table 3
Rock types at the Whalen Mine[1]

Map	Description
A	Altered quartz monzonite (?) - limonitized calcite with scattered quartz grains, large patches of oligoclase feldspar, sericite, and a few large biotite grains. (5C770A)
B	Quartz latite porphyry - quartz and orthoclase phenocrysts in a fine-grained quartz-orthoclase-ablite matrix. (5C770D)
C	Yellow brown marble - marble with limonite films at grain boundaries. Probably a result of supergene movement of iron from the adjacent ore deposit. (5C770E)
D	Monzonite - a medium-grained greenish rock with about 25% orthoclase, 20% plagioclase, 50% fresh diopside(?), and scattered calcite veinlets. (5C770H)
E	Altered marble with copper - carbonate, muscovite, quartz, malachite, and black copper pitch. Occurs along a fault zone. (5C770I)

X-ray analysis: Rock — Cu 1%, Pb 0.08%, Zn 0.08%

copper pitch — Cu 1.5%, Pb 0.05%, Zn 0.15%, Fe 8%, Mn 0.05%

Table 4
Soil samples taken west of Whalen Mine[2]

Map	Field No.	Cu	Zn	Pb	Ml Dz*	Depth	Float
		Concentrations (parts per million)					
A	5L640	20	95	15	6	2 ft.	none
B	5L641	25	85	15	3	2 ft.	marble, some porphyry
C	5L642	35	115	40	4	8 in.	marble
D	5L643	30	80	20	9	1-1/2 ft.	marble
E	5L644	20	75	20	3	1 ft.	porphyry
F	5L645	15	45	25	2	8 in.	quartzite with limonite stain
G	5L646	25	60	15	4	1 ft.	quartzite with limonite stain

* Milliliters of dithizone, cold extraction heavy metal field test

(1) Locations shown on figure 5

(2) Sample locations shown on figure 6

Table 5
Assays of samples from the Nixon Fork area(1)

Sample No.	Gold oz/ton	Silver oz/ton	Copper %	Lead %	Zinc %	Location
1	0.04	trace	0.17			pit 200 ft. SE of airstrip
2	0.06	1.38	0.57			pit about 650 ft. S of glory hole
3	0.70	1.32	1.01			Crystal shaft dump-1000 ft. E. of Garnet shaft
4	0.46	0.68	0.89			stripped "5 acre" area (Jasper 1961) 500 ft. E of Crystal shaft
5	0.04	trace	0.55			Mystery Creek S of sample M (fig 4)
6	trace	trace	trace			150 ft. downhill from sample #5
7	nil	trace	0.01			trench 275 ft. downhill from sample #5
8	trace	nil	trace			Garnet trench-150 ft. NE of #5
9	0.02	0.38	0.39			pit in SW $\frac{1}{4}$ Sec. 7 on N side of Mystery Creek
10	0.42	1.58	2.30			pit 100 ft. N of "5 acre" stripped area (Jasper 1961)
11	0.02	trace	N.D.(2)	N.D.	N.D.	700 ft. SW of Mesplet camp (quartz monzonite)
12	0.02	trace	N.D.	N.D.	N.D.	500 ft. W of messhouse, Mespelt camp (quartz monzonite)
13	0.02	0.36	0.15	0.18	trace	100 ft E of Mespelt camp messhouse, 50 ft. shaft (marble)
14	0.02	0.18	N.D.	0.10	trace	Kenn shaft dump - (porphyry)
15	0.10	0.20	0.34	N.D.	N.D.	Crystal shaft (marble)
16	2.60	1.30	0.65	N.D.	trace	Mystery Creek, S of sample M (altered porphyry)

(1) Samples provided by T.J. Almasy

(2) N.D. - sought but not detected using x-ray fluorescence

Table 6

Laboratory and field analyses of geochemical samples shown on figure 1

Map No.	Field No.	Copper	Concentration (ppm) Zinc	Lead	Molybdenum	Field test ml. dz.	Soil sample	Depth	Stream sediment sample	Limestone	Graywacke-slate	Porphyry	Quartz monzonite	Fine sediment only	Moss
1	5L559	30	100	15	2	5			X					X	
2	5L558	25	90	10	2	5			X	X				X	
3	5L557	15	65	10	1	1			X					X	
4	5L555	25	75	15	2	4			X					X	X
5	5L556	15	90	15	2	4			X					X	X
6	5L554	15	90	15	2	4			X						
7	5L552	30	90	20	2	5			X						
8	5L553	40	105	20	2	5			X					X	X
9	5L551	35	85	15	2	2			X					X	
10	5L550	30	80	15	2	1			X					X	
11	5L566	20	60	10	2	2			X					X	
12	5C763	40	90	20	3	1	X								
13	5L567	25	80	15	2	2			X					X	X
14	5L568	185	75	15	1	2			X					X	
15	5L571	35	70	15	2	1			X				X		
16	5L572	20	60	70	2	1	X								
17	5L570	25	65	15	3	2			X			10%	90%		
18	5L569	45	80	15	2	1			X				X		
19	5L573	15	60	15	2	1	X						X		
20	5L574										X				
21	5L575	15	40	10	2	1	X				X				
22	5L576	30	55	10	2	1	X				X				
23	5L577	20	40	15	2	1	X				X				
24	5C765	20	185	40	5	1			X					X	
25	5C766	30	60	60	3	1			X			X			
26	5L564	25	90	20	2	1	X							X	
27	5L563	25	75	15	2	1	X							X	
28	5L562	15	60	15	3	1	X							X	
29	5L565	25	80	15	2	4			X					X	
30	5L591	20	75	15	1	6			X					X	
31	5L592	20	50	15	1	1	X	6 in.						X	
32	5L593	90	150	30	1	3	X	10in.						X	
33	5L594	50	90	20	2	1	X	3 in.						X	
34	5L595	20	85	10	1	1	X	5 in.						X	
35	5L596	240	115	40	1	+20	X	4 in.						X	
36	(5C772-1	15	75	20	2	3	X	1-½ ft.						X	
	(5C772-2	35	100	20	3	5	X	3 ft.				X			

Map No.	Field	Concentration (ppm) Copper	Zinc	Lead	Molybdenum	Field test ml. dz.	Soil sample	Depth	Stream sediment sample	Limestone	Graywacke slate	Porphyry	Quartz monzonite	Fine sediment only	Moss	
37	5C771	45	75	15	3	2	X	6 in.					X			
38	5C790	25	90	10	2	4	X					X		X	X	dry creek
39	5C789	35	145	10	2	3	X	2 ft.		X						
40	5C742	15	65	10	2	2			X		40%	60%				
41	5L540	25	105	15	2	9			X					X		(1 run for ag)
42	5L539	+ 1000	340	270	3	+ 20			X					X		
43	5L541	10	90	15	3	6			X						X	
44	5L542	150	80	20	3	16			X					X		
45	5L543	20	75	15	2	4			X					X		
46	5L544	25	70	10	2	6			X					X		
47	5L545	80	75	15	2	10			X					X		
48	5L546	25	65	10	2	8			X					X		
49	5L547	+ 1000	115	50	2	+ 20			X					X		
50	5L548	+ 1000	115	45	2	+ 20			X					X		
51	5L561	20	100	10	2	5			X						X	
52	5L560	20	70	10	2	2			X						X	
53	5L508					1			X					X		
54	5L507	25	70	10	21	1			X					X		
55	5L506	20	65	10	2	1			X					X		
56	5L502	25	75	20	2	3			X				X	X		bornite
57	5L582	25	100	15	3	2			X					X		
58	5L501	35	80	30	2	2			X					X		
59	5L578	20	95	35	3	4			X			90%	10%			
60	5L579	25	45	39	3	3			X			X				
61	5L580	30	55	25	2	3			X			X	X			
62	5L581	25	55	20	2	2			X			X				
63	5L503	30	85	10	2	3			X						X	
64	5L505	30	65	15	2	1			X				X	X		
65	5L504	40	75	15	2	2			X				X	X		
66	5C781	45	80	10	3				X		75%	25%				
67	5L688	25	160	25	2	2			X						X	
68	5L670	20	100	20	3	6			X					X		
69	5L671	20	120	20	2	8			X						X	
70	5L673	15	95	15	2	15			X					X		
71	5L672	25	75	15	2	4			X					X		
72	5L687	15	90	10	2	2	X	6 in.		X						
73	5L686	20	100	15	3	1	X	6 in.		X						
74	5L685	15	75	15	2	1	X	6 in.		X						

Map	Field	Concentration (ppm) Copper	Zinc	Lead	Molybdenum	Field test ml. dz.	Soil sample	Depth	Stream sediment sample	Limestone	Graywacke slate	Porphyry	Quartz monzonite	Fine sediment only	Moss	
75	5L684	20	95	20	3	2	X	6 in.		X						
76	5L683	15	60	5	3	2	X	8 in.								
77	5L682	15	80	15	2	1	X	8 in.								
78	5L674	25	75	15	1	4			X						X	
79	5C711	20	80	15	2	10			X					X	X	
80	5L675	20	50	15	2	3			X			X			X	
81	5L676	20	75	20	2	3			X						X	
82	5C712	15	75	10	1	4			X					X		
83	5C713	10	70	10	2	3			X					X		
84	5L538					3								X		
85	5L537	15	70	10	2	4			X					X		
86	5L536					3								X		
87	5L535	20	70	15	3	3			X		X					
88	5L681	25	95	15	2	6			X					X		
89	5L680	20	90	10	2	6			X					X	X	
90	5L679	15	60	10	2	4			X					X		
91	5L678	15	65	10	2	3			X					X		
92	5L677	20	70	10	1	3			X					X		
93	5L533	20	75	10	3	7			X					X		
94	5L534	20	90	15	2	3			X					X	X	
95	5C733									X						calc arenite
96	5C715	20	85	10	1	6			X		X					
97	5L511	20	65	5	2	4			X		X					
98	5L532	25	85	10	3	6			X					X		
99	5L510	30	110	15	2	3			X					X		
100	5L509					3			X					X		
101	5L512	25	85	15	2	2			X							
102	5L531	15	70	10	2	3			X	15%	70%	10%				andesite or basalt 5%
103	5L513					4			X		95%	5%				
104	5C731	15	70	5	3	5			X		X					
105	5L514	15	60	10	1	2			X					X		
106	5C727	10	80	10	2	2			X		90%	10%				
107	5C726	20	65	10	1	2			X		30%	70%				
108	5L515	50	170	10	2	3			X		90%	3%				andesite 7%
109	5C729	45	140	15	3	5			X		X					
110	5L516	15	70	10	2	1			X		X	X				
111	5L525	20	75	10	2	2			X					X		

		Concentration (ppm)														
Map	Field	Copper	Zinc	Lead	Molybdenum	Field test ml. dz.	Soil sample	Depth	Stream sediment sample	Limestone	Graywacke slate	Porphyry	Quartz monzonite	Fine sediment only	Moss	
112	5L526	25	70	10	2	7			X					X		
113	5L528	25	95	15	2	3			X					X		
114	5C724	20	95	10	2	1			X		90%	10%				
115	5L517	30	85	10	2	5			X					X		
116	5L524	25	110	10	2	3			X		80%		20%			
117	5L518	30	100	15	2	6			X		X					
118	5C721	20	85	5	1	1			X		95%	5%				
119	5C722	15	75	10	2	-			X					X		
120	5L519	25	125	15	2	2			X					X		
121	5L520	25	90	10	2	2			X					X		
122	5L521	20	70	10	2	3			X					X		
123	5L522	20	80	10	2	2			X				40%			andesite 10%
124	5C723	20	95	10	1	3			X		90%	10%				
125	5L692	30	100	10	2	3			X	X	X					
126	5L694	20	95	15	3	2			X						X	
127	5L690	25	100	20	2	2			X					X		

Table 7

Laboratory and field analyses of geochemical samples from the Garnet(1) and Whalen(2) shafts

Map No.	Field No.	Concentration (ppm) Copper	Zinc	Lead	Molybdenum	Field test ml dz*	Soil Sample	Stream Sediment Sample	Depth	Base of Moss	
Garnet shaft area											
A	5L630	95	90	20	2	8	X		2 ft.		Marble float nearby
B	5L629	105	85	20	2	5	X		2/3 ft.		Marble
C	5L628	40	100	30	1	6	X		1 ft.		no float - marble in adjacent pits
D	5L627	65	110	60	1	10	X				side of pit; 95% marble, 5% porphyry
E	5L623	125	140	80	3	17	X		2/3 ft.		quartz monzonite
F	5L624	380	210	85	1	18	X		2/3 ft.		quartz monzonite
G	5L625	45	130	95	2	9	X		3-1/2 ft.		no float
H	5L626	85	150	45	1	20	X		2 ft.		porphyry
I	5L631	30	100	45	2	8	X		1-1/2 ft.		porphyry
J	5L632	35	145	300	2	2	X		2/3 ft.		porphyry
K	5L585	25	95	40	3	1	X			X	marble
L	5L584	15	50	20	3	1	X			X	at marble porphyry coated
M	5L583	30	85	30	3	1	X			X	marble
N	5L586	40	120	40	2	1	X			X	porphyry
O	5L587	20	185	85	3	3	X			X	porphyry
P	5L588	80	325	120	3	10		X		X	creek less than 2 feet wide - porphyry
Q	5L589	35	70	35	2	2		X		X	porphyry
R	5L590	25	80	35	2	1		X		X	porphyry
Whalen shaft area											
S	5L651	30	55	25	2	1	X		1-1/2 ft.		no float
T	5L650	95	55	30	1	6	X		1 ft.		porphyry
U	5L649	70	60	20	1	9	X		1 ft.		porphyry
V	5L652	45	45	20	1	8	X		1 ft.		quartz monzonite
W	5L653	40	45	30	2	4	X		1 ft.		porphyry
X	5L648	70	55	20	1	9	X		1-1/2 ft.		porphyry
Y	5L647	40	40	15	2	7	X		1-1/2 ft.		porphyry

(1) Sample locations shown on figure 2
(2) Sample locations shown on figure 3
* Milliliters of dithizone

Table 8
Laboratory and field analyses of geochemical samples from the Mystery Creek area (1)

Map No.	Field No.	Copper	Concentration (ppm) Zinc	Lead	Molybdenum	Field test ml dz*	Soil Sample	Stream Sediment Sample	Depth
A	5L597	20	90	15	2	6	X		
B	5L598	20	100	30	1	6	X		
C	5L599	35	370	225	1	16	X		
D	5L600	55	60	15	2	7	X		
E	5L601	30	125	40	2	6	X		
F	5L619	25	80	35	3	2	X		8 feet
FF	5L500	+1000	75	35	2	+20	X		8 feet
G	5L620	35	75	25	1	3	X		1 foot
H	5L621	35	105	25	2	2	X		1 foot
I	5L622	55	70	25	1	8	X		
J	5L605					3	X		
K	5L602	20	80	15	2	7	X		
L	5L603	60	140	50	2	11		X	
M	5L604	120	130	650	2	6	X		
N	5L618	20	70	30	2	3		X	
O	5L617	25	85	35	2	3	X		
P	5L616	55	75	20	2	4	X		
Q	5L612	25	70	30	3	4		X	
R	5L611	25	75	15	3	3	X		
S	5L609	25	70	25	3	2	X		
T	5L608	25	75	20	1	3		X	
U	5L610	25	65	25	2	1		X	
V	5L606	30	85	20	2	2			
W	5L607	25	75	25	2	2		X	
X	5L613	25	95	15	2	6	X		
Y	5L614	40	120	35	1	4	X		
X	5L615	25	60	25	2	4		X	

(1) Sample locations shown on figure 4
* Milliliters of dithizone

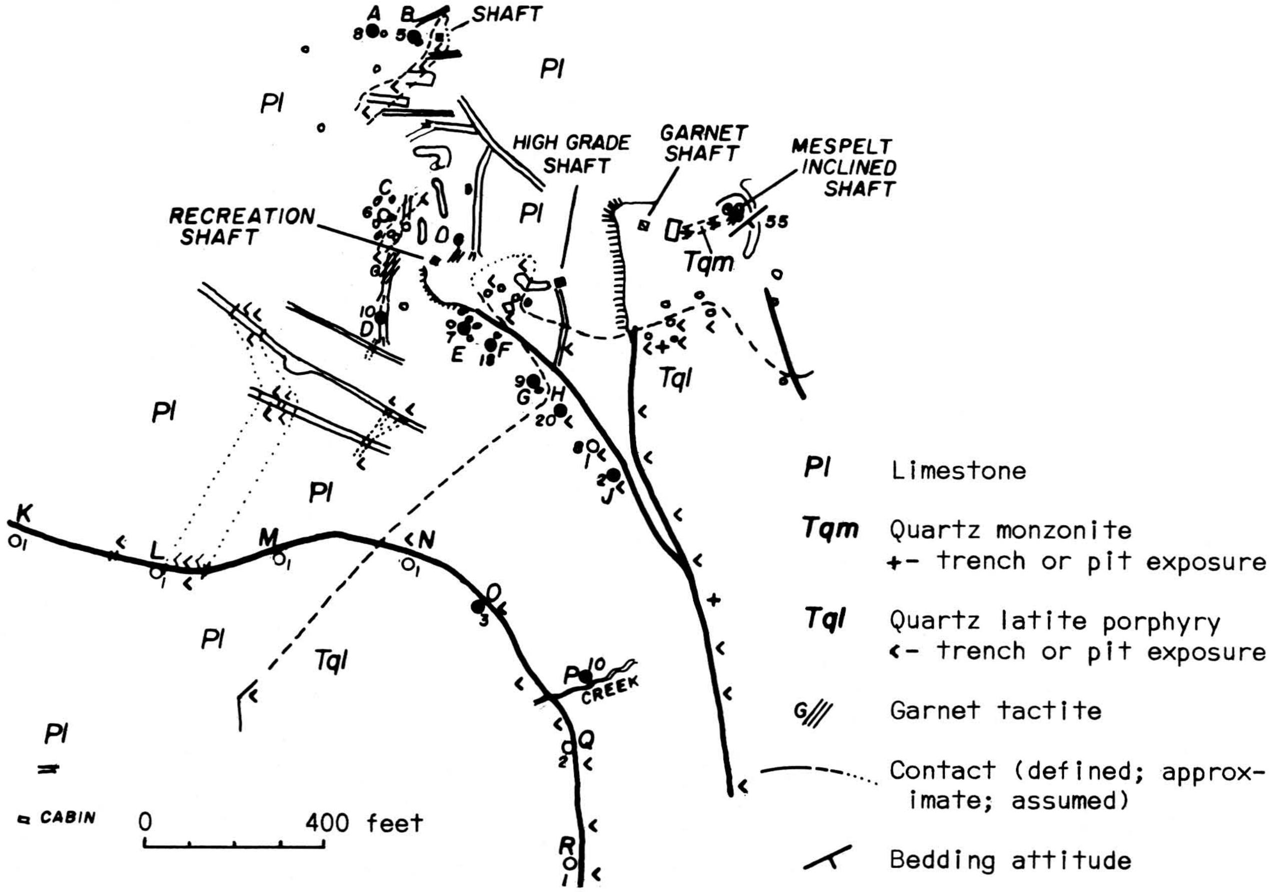

Figure 2. Geological-geochemical sketch map of Garnet Shaft area. Survey by compass and pace.

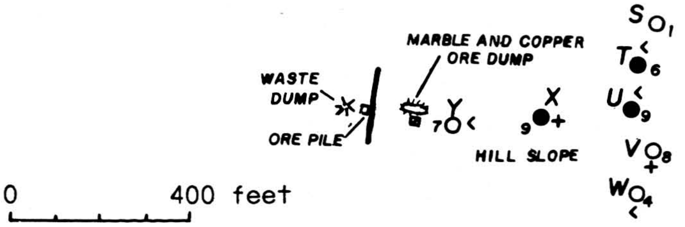

Figure 3. Geochemical sketch map of Whalen Shaft, 450 feet north-northeast of Whalen glory hole on old Medfra road. Survey by compass and pace.

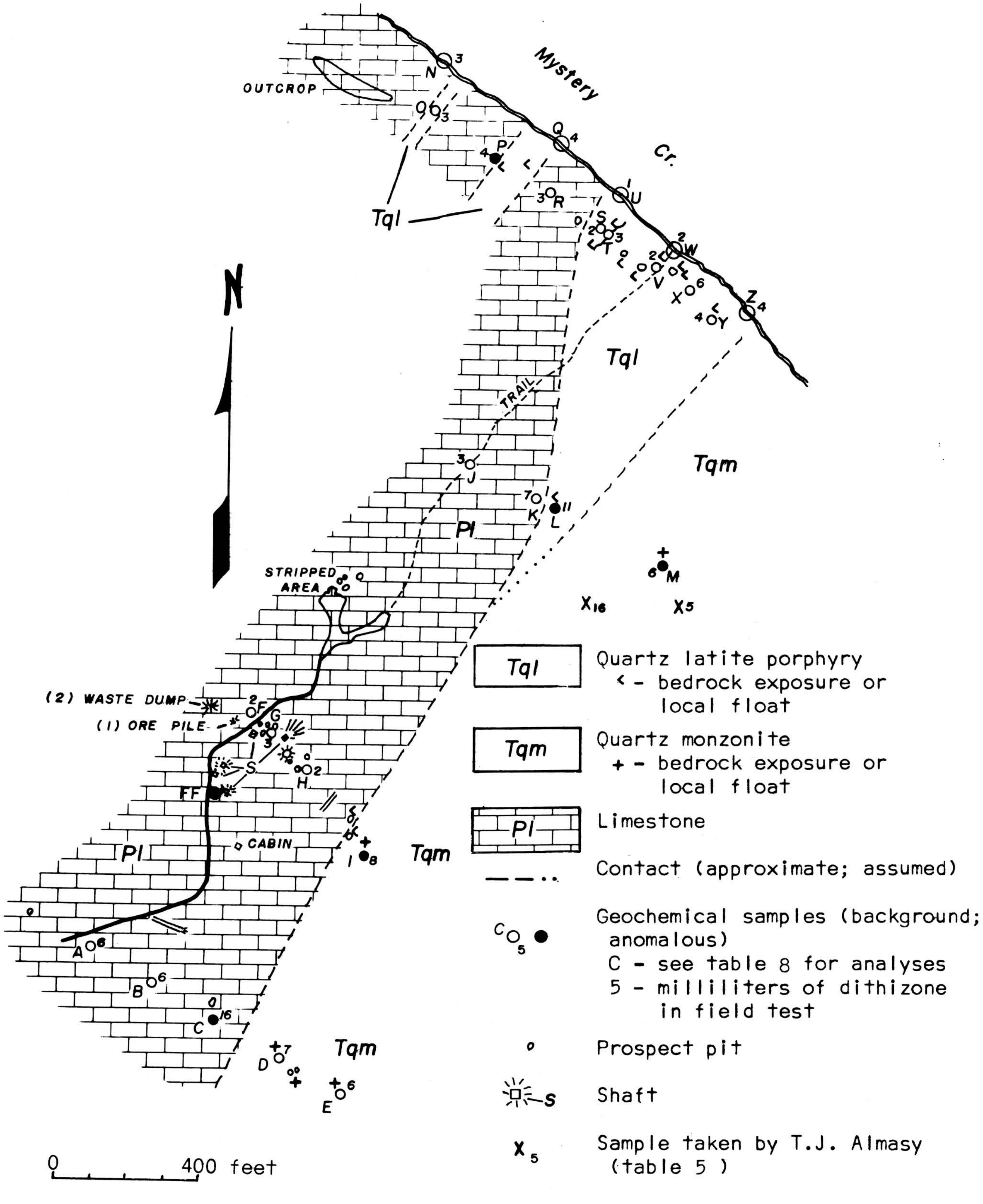

Figure 4. Geological-geochemical sketch map of the southwest slope of Mystery Creek. Survey by compass and pace.

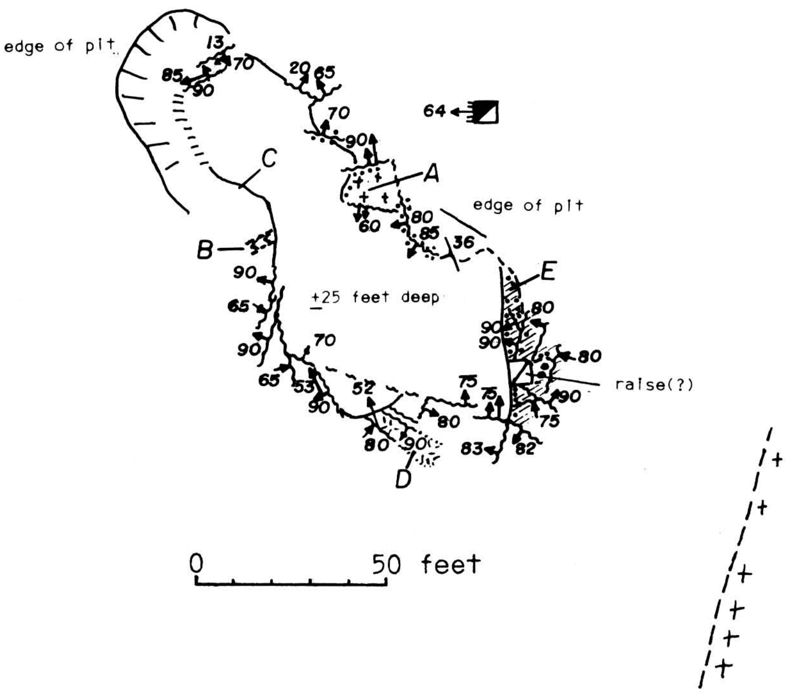

Figure 5. Geologic map of the Whalen Mine (glory hole). Letters refer to notes in table 3. Survey by compass and tape

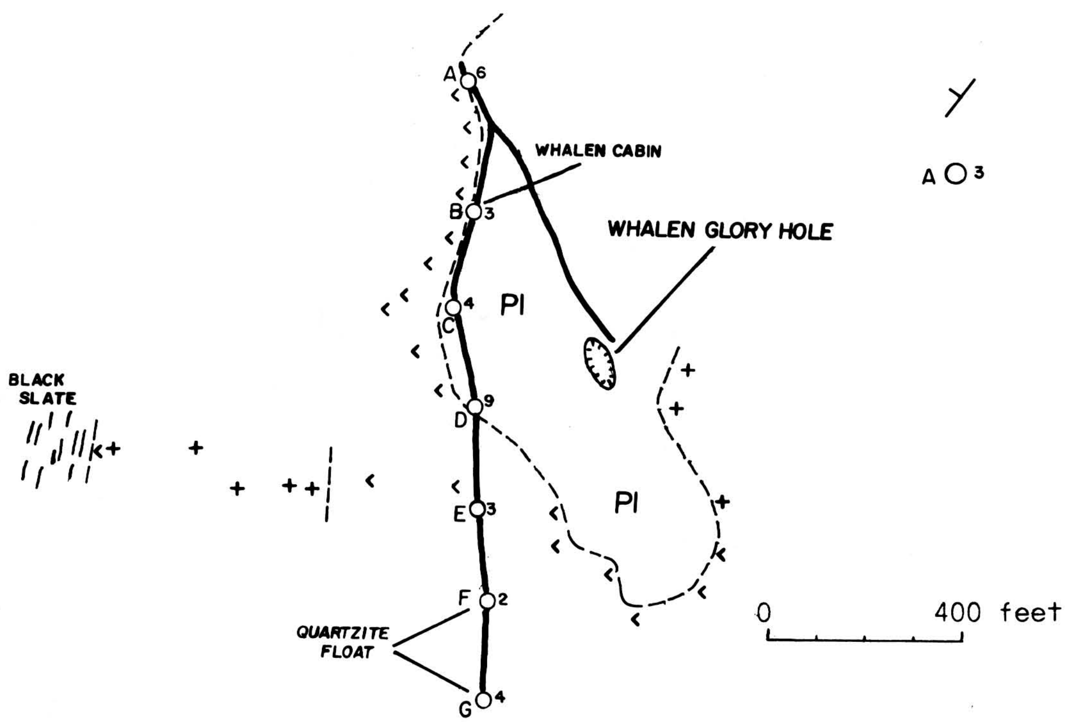

Figure 6. Geochemical soil sample traverse west of the Whalen Mine (glory hole). Survey by compass and pace.

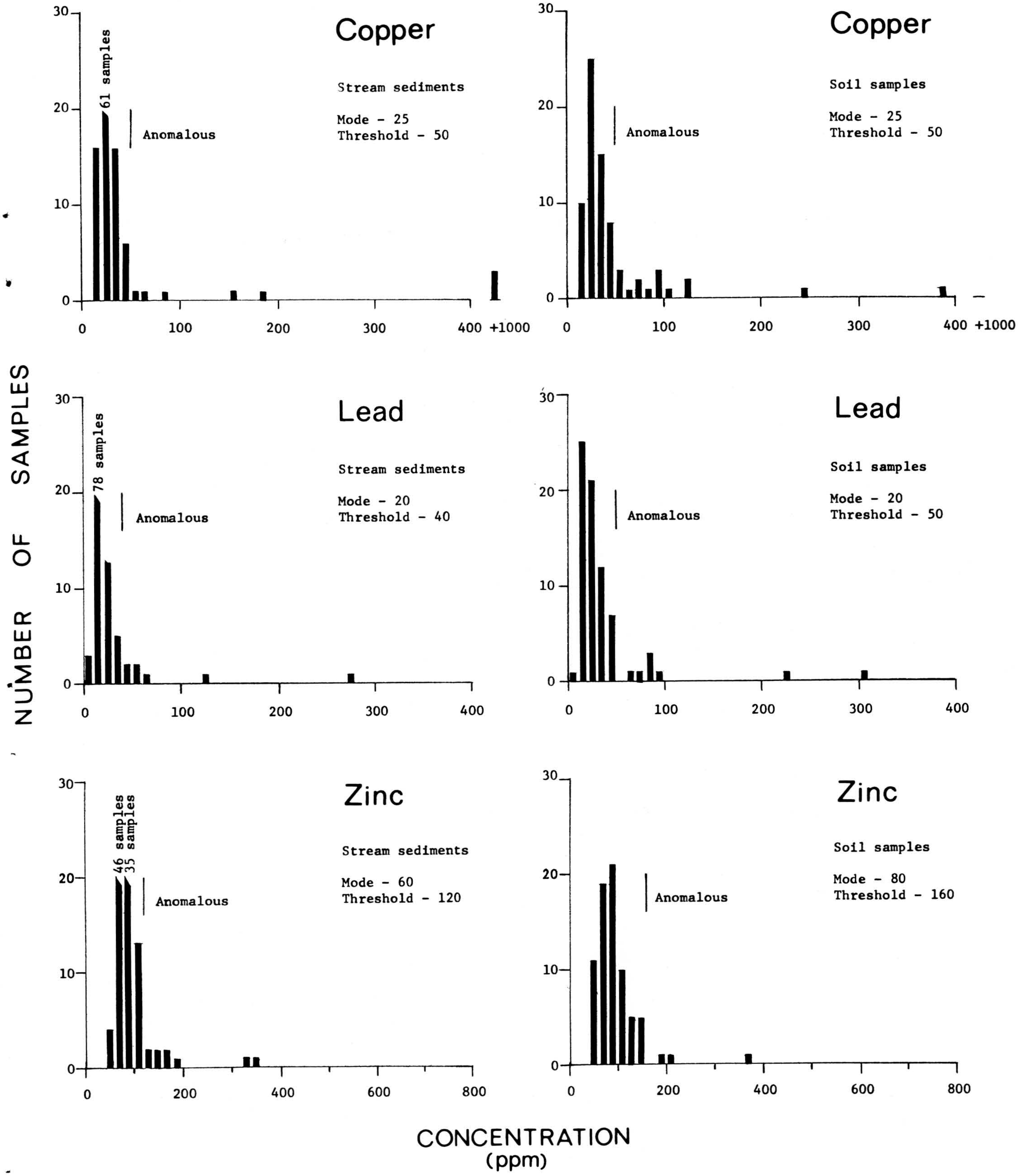

Figure 7. Concentration frequency graphs of geochemical samples, Nixon Fork area.

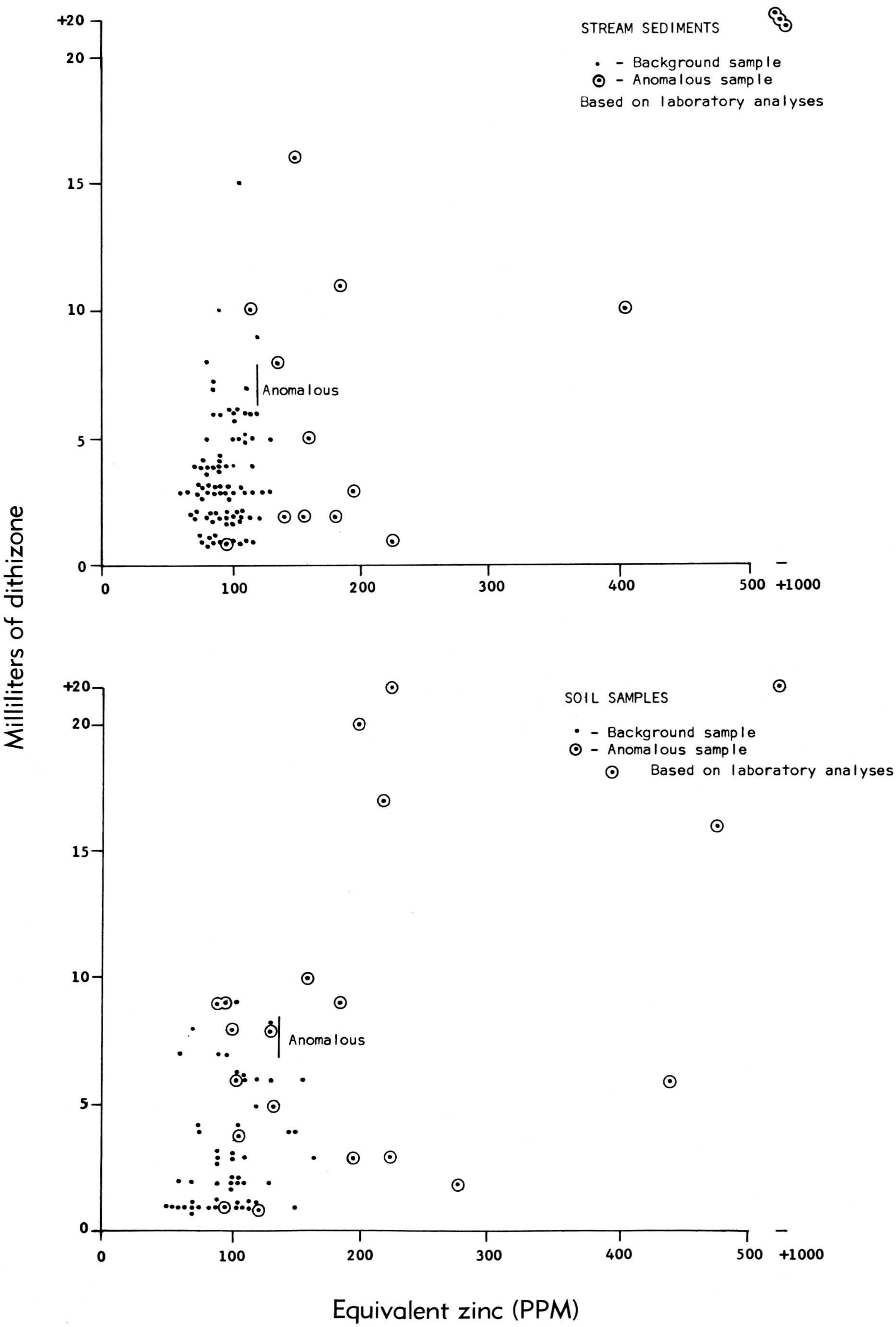

Figure 8. Equivalent zinc vs. geochemical field test, Nixon Fork area.