GEOLOGICAL SURVEY CIRCULAR 331

RECONNAISSANCE FOR RADIOACTIVE DEPOSITS IN EASTERN INTERIOR ALASKA, 1946

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UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

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By Helmuth Wedow, Jr., P. L. Killeen, and others

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By Helmuth Wedow, Jr., P. L. Killeen, and others

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By Helmuth Wedow, Jr., and J. J. Matzko

ABSTRACT

A reconnaissance conducted in 1946 in areas adjacent to highways in the Tanana and upper Copper River valleys was the first time that field radioactivity tests were made in eastern interior Alaska. Before 1946 the scanning of the Alaskan placer-concentrate collection of the Geological Survey for radioactivity had indicated that radioactive minerals occurred in a few localities in the Fairbanks and Livengood areas. The objectives of the 1946 reconnaissance were to determine whether significantly radioactive lodes occurred in the vicinity of the placers from which the radioactive concentrates had been obtained and to conduct a routine survey for radioactive deposits in accessible areas adjacent to highways in eastern interior Alaska. The techniques used in the survey consisted of the direct testing of outcrops for radioactivity with a portable survey meter and the collection of rock samples and placer concentrates for equivalent uranium analysis in the laboratory.

Although the 1946 reconnaissance did not yield any further information on the source of the few concentrates of higher radioactivity that had been obtained previously, a few new sites of radioactivity were found. Data for all sites, regardless of favorable or unfavorable results, are presented in order that future investigators may evaluate how thoroughly negative areas have been determined. Lode deposits, consisting primarily of quartz veins containing gold and metallic sulphides, contain only as much as 0.005 percent equivalent uranium. Graphitic schists and black shales contain a maximum of 0.004 percent equivalent uranium; other types of schist contain only as much as 0.003 percent equivalent uranium. Tests of granitic and mafic igneous rocks indicate maximums of 0.006 and 0.005 percent equivalent uranium respectively. Concentrates from placer deposits, locally contain as much as 0.066 percent equivalent uranium.

The slight radioactivity of the igneous rocks appears to be due to traces of uranium and thorium in such accessory minerals as zircon and allanite. The slightly higher radioactivity of the placer samples at some localities is probably due to the natural concentration of the radioactive zircon and allanite. At a few localities, monazite has been found in the placers and probably also contributes to the radioactivity of the concentrates. Its bedrock occurrence is doubtless also as an accessory mineral in the granitic rocks.

INTRODUCTION

The Tanana and upper Copper River valleys in eastern interior Alaska (fig. 1) are on opposite sides of the Alaska Range. The Tanana River, on the north side of the range, flows northwest into the Yukon River, and the Copper River, on the south side, flows south into the Gulf of Alaska. The principal highways in Alaska either follow these two valleys or cross the intervening uplands. These highways and subsidiary roads are shown on figure 1.

The initial scanning of an Alaskan placer-sample collection for radioactivity in the winter of 1944-45 indicated a few sites in the Fairbanks and Livengood areas where radioactive materials were present in stream deposits. Subsequent field sampling by R. R. Coats in 1945, during a reconnaissance of the Yukon-Tanana placer region (Fortymile, Circle, Fairbanks, and Livengood districts), increased the number of samples available from these areas, but did not reveal any additional sites of significantly radioactive material. Information on those samples which were available before the 1946 reconnaissance in the Tanana and upper Copper River valleys is summarized in an informal file report by P. L. Killeen on trace elements investigations in Alaska and is reproduced below.

Radioactivity of samples collected before 1946 in the Tanana and upper Copper River valleys, Alaska

District	Total number of samples	Number of samples in each of three ranges of percent equivalent uranium			Not tested
		>0.02	0.02-0.01	<0.01	
Tolovana--	53	2	0	34	17
Fairbanks-	148	4	3	89	52

In 1946, a reconnaissance for radioactive deposits in areas accessible from the highways in the Tanana and upper Copper River valleys was undertaken because the accessibility permitted

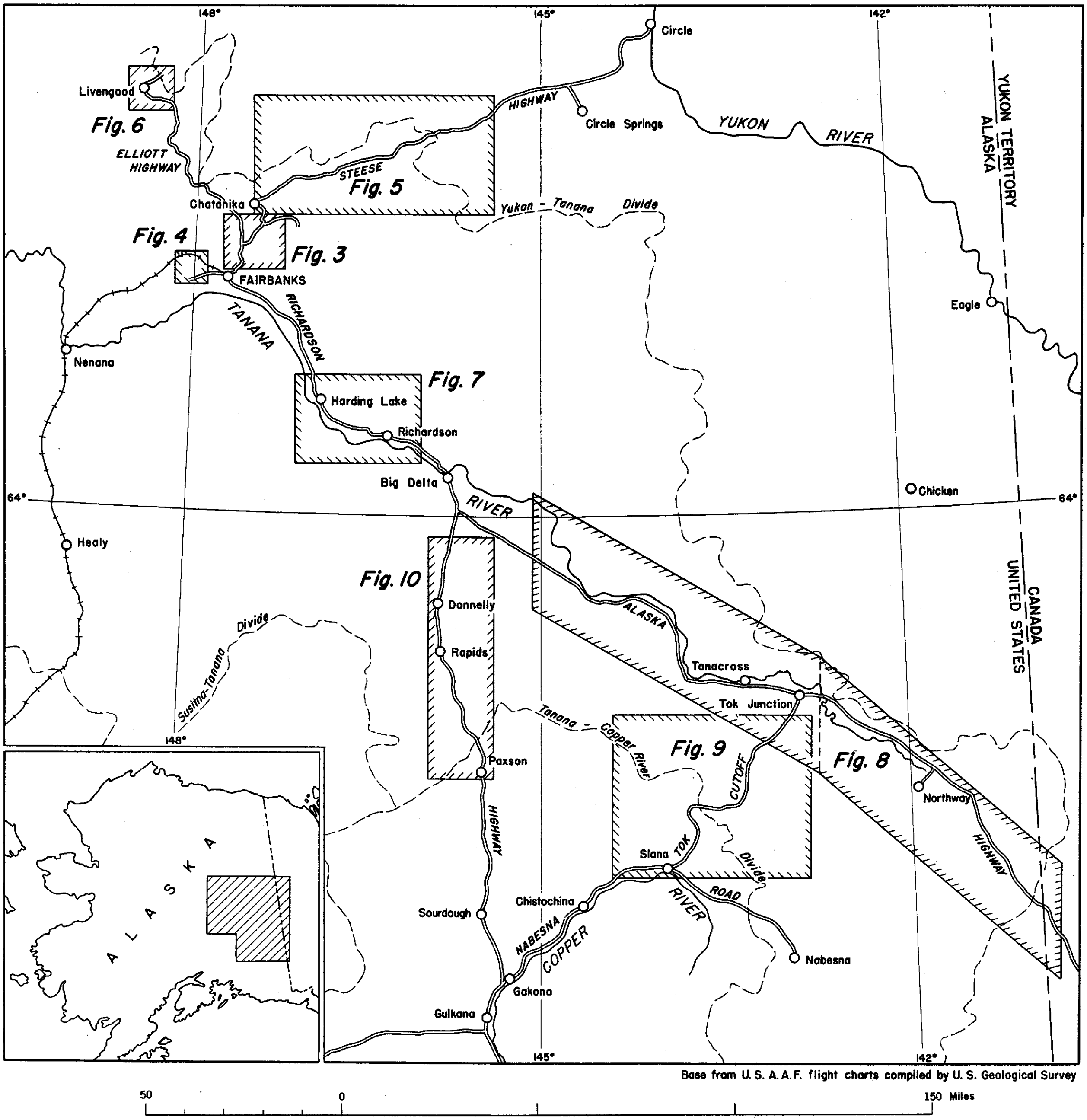


Figure 1. —Index map to areas investigated along the highways in the Tanana and upper Copper River valleys, Alaska.

covering a large area in the course of the field season and because previous information on radioactivity in areas adjacent to highways in the Tanana and upper Copper River valleys was either sparse or absent. The reconnaissance party consisting of Helmuth Wedow, Jr., and John J. Matzko, geologists, and Fred Freitag, camphand, was in the field from June through September 1946.

MEASUREMENT OF RADIOACTIVITY

The radioactivity of outcrops of bedrock and gravel, and of unconcentrated samples of crushed bedrock was measured in the field with a portable survey meter designed by the Geological Survey for the measurement of gamma-ray intensity. Tests on samples were made at base camps where readings were not influenced by any radiation from large areas of outcrop of the material sampled. Most of the rock samples were later crushed to minus 4-mesh in a jaw crusher at the Fairbanks laboratory of the Geological Survey. Subsequently, heavy-mineral separates of crushed rock samples, of panned concentrates of crushed rock samples, and of panned concentrates of gravels and weathered disintegrated rock materials were prepared and tested for radioactivity by beta count on a laboratory scaler in Washington. Table 1, at the end of this report, gives the location and description of each test station, the radioactivity determinations made at the stations or on samples obtained therefrom, and the concentration ratio of the ultimate concentrate for which the radioactivity was measured. The radioactivity throughout is expressed in terms of percent equivalent uranium.

Outcrop tests

Outcrops of bedrock and gravel were tested for radioactivity by placing the probe on the surface of the material and measuring the gamma count for 5-minute intervals. Background readings, with the probe several feet above the surface of the ground, were taken several times a day as a check. The results of the gamma count at each outcrop, as shown in table 1, is expressed in terms of percent equivalent uranium by interpolating from the diagram shown in figure 2.

In the construction of such a diagram (fig. 2) the average background counting rate of the instrument that was used was determined by averaging the averages of groups of four consecutive backgrounds. The final average background was then plotted on the diagram as ≤ 0.001 percent equivalent uranium. The equivalent-uranium values of a number of crushed samples were then plotted against the gamma counts obtained at the outcrops from which the samples were taken. The diagonal line, showing the probable relationship between the equivalent-uranium value and the outcrop gamma count, was then drawn by inspection from the point where the average background was assumed to represent <0.001 percent equivalent uranium. Deviation of points from the diagonal is attributed either to sampling errors or to the random nature of gamma radiation over short periods of time.

Unconcentrated crushed samples

To determine the equivalent-uranium content of the crushed rock samples, 5-minute readings of background, sample, a radioactive standard, sample, and background were made in that sequence.

Concentrated samples

To increase the proportion of heavy minerals to be tested for radioactivity at any one station, concentrates were made by panning unconsolidated materials such as stream gravel and slope wash, and disintegrated rock from mine dumps and weathered outcrops. Later, to obtain a standard type of concentration, separations of minus 20-mesh material were made with heavy liquids (bromoform, sp gr 2.8; methylene iodide, sp gr 3.3). The unconcentrated crushed samples were crushed further to minus 20-mesh and also separated with heavy liquids. The percent equivalent uranium in the resultant heavy fractions was then determined by beta-gamma count with laboratory instruments.

AREAS INVESTIGATED

Fairbanks district

The Fairbanks district, herein divided into the Pedro Dome area (figs. 1 and 3) and the Ester Dome area (figs. 1 and 4), includes about 300 square miles of territory adjacent to the city of Fairbanks.

The Pedro Dome area, from 5 to 25 miles northeast from Fairbanks, roughly includes the watersheds of the streams draining the area surrounding Pedro Dome and Gilmore Dome. The main streams are: Cleary, Little Eldorado, Dome, and Vault Creeks, north-flowing tributaries of the Chatanika River; Goldstream Creek and its west-flowing tributary, Big Eldorado Creek; and Fairbanks, Fish, and Smallwood Creeks, tributaries of the Little Chena River. In 1946 mining camps were located in most of the major valleys, and many of the smaller streams had been mined previously. The Steese Highway, crossing the area in a general northeasterly direction, has its origin at Fairbanks and leaves the area shown in figure 3 via the valley of Cleary Creek. The Elliott Highway, or Livengood road, diverges from the Steese Highway at Fox. Many secondary roads and trails lead from the main highways to sites of past and present mining operations.

The Ester Dome area, 10 to 15 miles west from Fairbanks, is drained by tributaries of Goldstream Creek on the northwest and by tributaries of Cripple Creek on the southeast. In 1946 the area was accessible by a graded gravel road from Fairbanks, and by many secondary roads and trails that branch out to lode and placer mining operations. A small settlement, Berry, P. O., located on Ester Creek, is the center of the dredging operations of the Fairbanks Exploration Department, U. S. Smelting, Refining, and Mining Co., in the Ester Dome area.

Geology

The general geology of the Fairbanks district is relatively well known as a result of studies of its gold-bearing placers and lodes (Prindle, 1905, 1908, 1910a, 1913; Ellsworth, 1910; Hill, 1933; Mertie, 1937; and Capps, 1940).

The Birch Creek schist of pre-Cambrian age is the bedrock underlying the larger part of the district. The schist is predominantly of sedimentary origin and has a considerable range of composition. The chief types, however, are quartz-mica and quartzite schist. Minor amounts of augen gneiss and crystalline limestone are

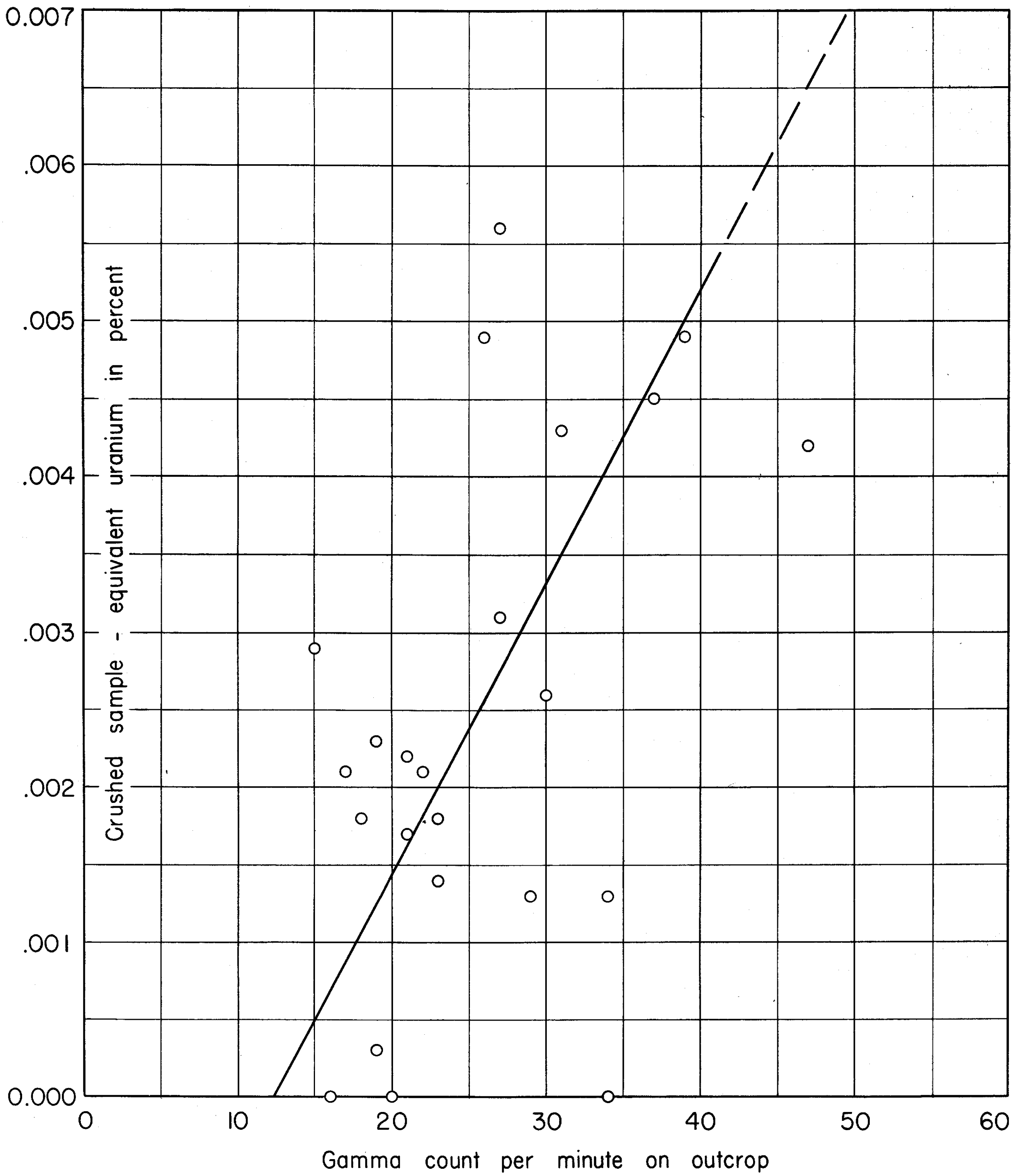
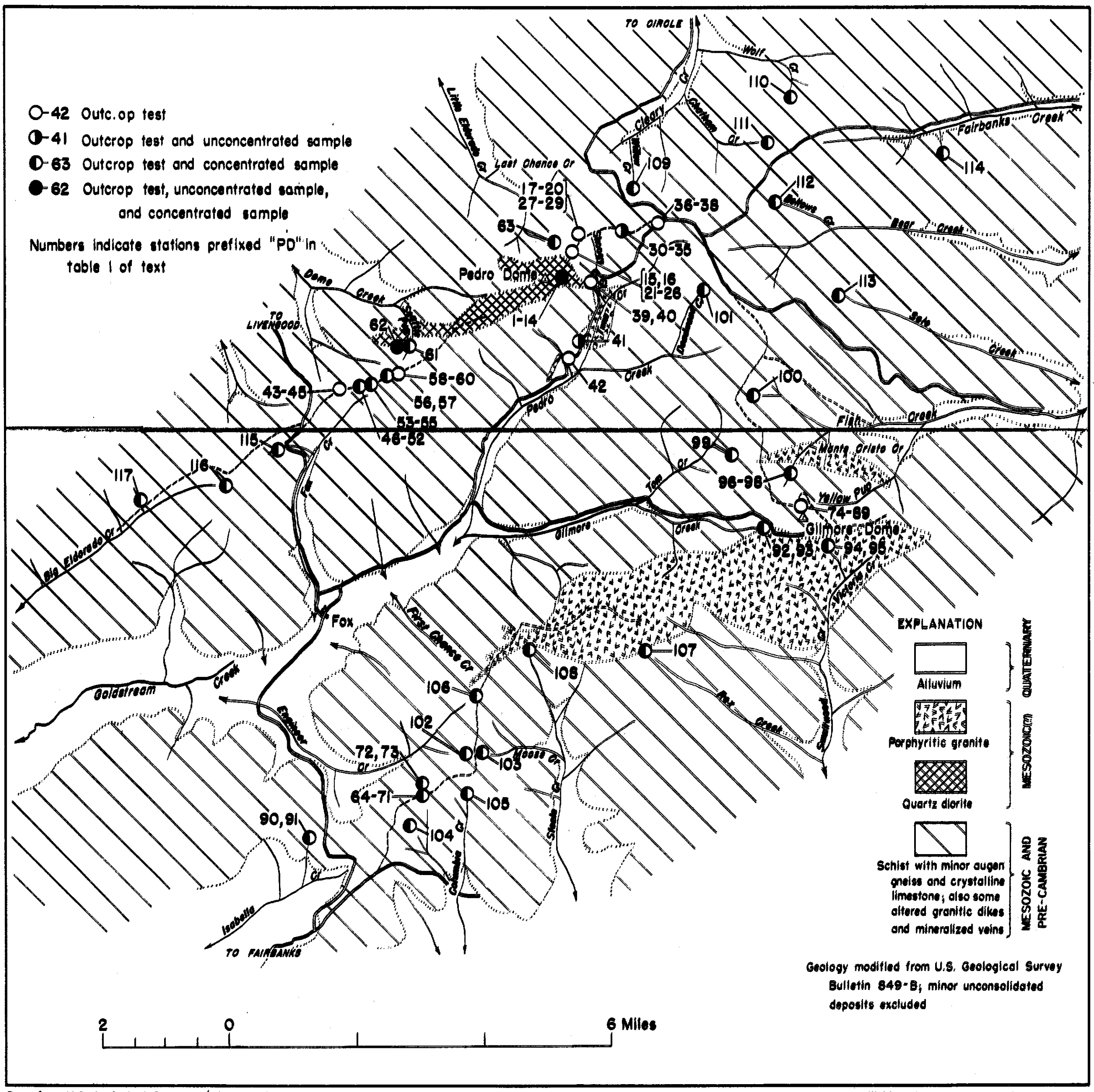


Figure 2. —Diagram showing relationship between the equivalent uranium content of unconcentrated crushed samples and outcrop gamma counts.



Base from U.S. Geological Survey Alaska Map 40

Field work by Helmuth Wedow, Jr., and J. J. Matzko, June-July 1946

Figure 3. —Geologic sketch map of the Pedro Dome area, Fairbanks district, Alaska.

also present. Igneous rocks of two main types intrude the Birch Creek schist. One is a quartz diorite, well exposed on Pedro Dome; the other is coarse-grained porphyritic granite underlying a large area south and southwest of Gilmore Dome (fig. 3). In the vicinity of Ester Dome only a few small bodies of porphyritic granitic rocks have been reported. Minor types of igneous rocks, represented primarily by altered granitic dikes, are numerous but scattered. All the igneous rocks are presumably Mesozoic in age. Known lode deposits in the Gilmore Dome watershed are mainly gold-quartz, bismuth, and tungsten veins and replacement bodies, all for the most part closely associated with the large intrusive mass of granite near Gilmore Dome. Extensive muck and gold-bearing gravel deposits cover most of the valley bottoms and lower hill slopes.

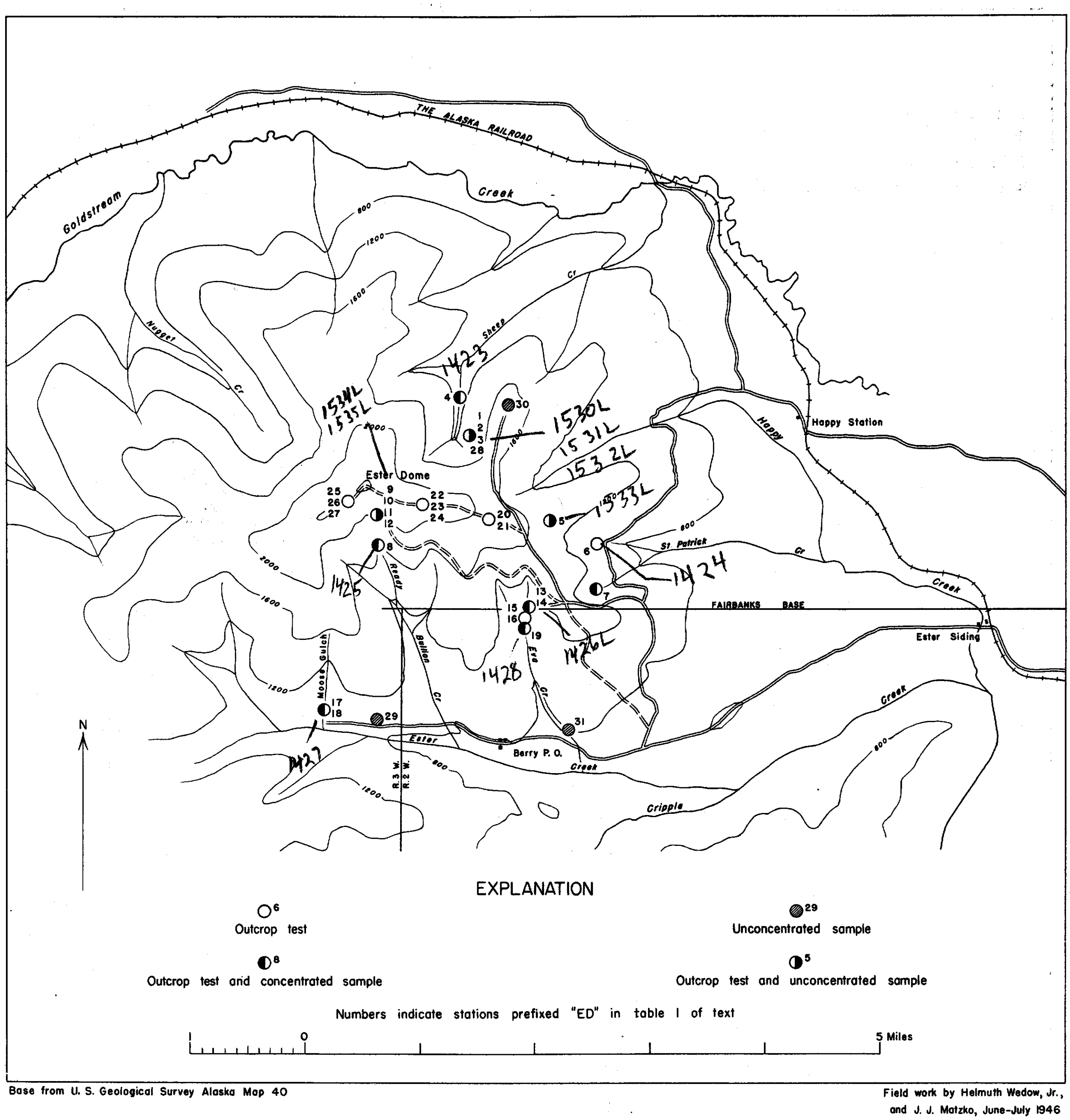


Figure 4.—Topographic sketch map of the Ester Dome area, Fairbanks district, Alaska.

Barren windrows of dredge tailings are now conspicuous as a result of placer mining in the valley bottoms of Goldstream, Gilmore, Pedro, Fish, Fairbanks, Cleary, and Ester Creeks. Slope wash and a heavy moss-cover make natural rock exposures on the hills a rarity, except locally at the crests, where weathering has sculptured the bedrock into odd castellated shapes.

Radioactivity studies in the Pedro Dome area

Previous equivalent uranium determinations on placer concentrates, obtained chiefly from gold-mining operations, showed that some radioactive material occurs in the Pedro Dome area. Seven of the concentrate samples had more than 0.01 percent equivalent uranium. The creeks from which these more radioactive concentrates were obtained, and the determinations of equivalent uranium in the concentrates, are given below.

Alaskan Concentrate file no.	Creek	Percent equivalent uranium	
		A[1]	B[2]
355	Fish Creek----------------	[3]0.100	0.016
628	Yellow Pup----------------	.028	.004
109	Gilmore Creek-------------	.013	.004
965	First Chance Creek--------	.029	---
648c	Seattle Pup---------------	[3].096	.024
163	Cleary Creek--------------	.013	.018
989	Specific locality unknown-	.014	---

[1]Determinations made about January 1945.
[2]Redetermined in April 1947.
[3]Indicates sample considered too small for accurate determination.

The first four streams in the above tabulation are parts of the watershed that surrounds Gilmore Dome. Cleary Creek and Seattle Pup are part of the watershed that surrounds Pedro Dome (fig. 3).

The recent testing in the Pedro Dome area indicated no appreciable amount of radioactivity except for two samples as follows:

(1) Sample 1398:
Location: Station PD 107, near head of Rex Creek.
Nature of sample: Heavier-than-bromoform fraction of panned concentrate from 50 pounds of gravel.
Equivalent uranium content: 0.066 percent.
Comparative data: Outcrop test, 0.001 percent equivalent uranium.

(2) Sample 1538L:
Location: Station PD 41, along west side of the Steese Highway in the valley of Twin Creek about 6 miles northeast of Fox.
Nature of sample: Heavier-than-bromoform fraction of crushed vein material on dump of abandoned scheelite mine.
Equivalent uranium content: 0.013 percent.
Comparative data: Outcrop test, 0.001 percent equivalent uranium; unconcentrated crushed sample, 0.002 percent equivalent uranium.

The radioactivity data of the remaining tests in the Pedro Dome area may be summarized as follows:

(1) Outcrop tests (115 stations):
Maximum equivalent-uranium content: 0.003 percent.
Average equivalent-uranium content: 0.001 percent.

(2) Unconcentrated crushed rock samples (4 samples):
Maximum equivalent-uranium content: 0.003 percent.
Average equivalent-uranium content: 0.002 percent.

(3) Concentrated samples (35 samples):
Maximum equivalent-uranium content: 0.006 percent.
Average equivalent-uranium content: 0.0025 percent.

Zircon, some of which is probably uranium- or thorium-bearing, is the only mineral as yet identified in the concentrates of the Pedro Dome area, to which radioactivity can be ascribed. Thus, in most samples, the presence of radioactive zircon could account for the small increases in equivalent-uranium content when the heavy minerals are concentrated. It appears likely, however, that some other radioactive mineral or minerals also occur in the samples containing more than 0.01 percent equivalent uranium.

The concentrate from Fish Creek (sample 355) consists of few small nuggets obtained from a placer operation about 2½ miles northeast of Gilmore Dome. Although the original radioactivity determination made in 1945 indicated 0.1 percent equivalent uranium, a second test in 1947 showed only 0.016 percent equivalent uranium. A qualitative spectrographic examination of one of the nuggets shows that the major elements are bismuth and silicon with the bismuth preponderant. The nuggets, therefore, are probably mostly native bismuth with some eulytite or argicolite possibly present. The gold, listed among the minor elements in the examination, occurs as fine flakes and wires. Uranium and thorium are listed among those elements looked for but not found. One bismuth lode occurs in the Fish Creek watershed above the location of this concentrate. The lode is in a biotite granite on the spur along the east side of Monte Cristo Creek. (Chapin, 1914, p. 330-331.) This lode was not investigated in the brief reconnaissance of the lodes in the Pedro Dome area, nor were concentrates taken downstream from it.

Radioactivity studies in the Ester Dome area

Five placer concentrates from the Ester Dome area that had been tested for radioactivity before the 1946 field season ranged from <0.001 to 0.002 percent equivalent uranium. Although such values are extremely low, the coverage represented by only five samples was so scant that it seemed desirable to test at least a few of the known lodes and collect a few additional placer concentrates from the area. The locations of the tests are shown on figure 4, and the results are included in table 1.

Structural conditions have limited the best metallic mineralization of the area to the southeast flank of Ester Dome, and, therefore, placer and lode mining activities have been restricted to this flank (Hill, 1933). Consequently, tests for radioactivity were similarly localized.

Many of the mines and prospects in the Ester Dome area have long since been abandoned, and adits have collapsed and are overgrown. Of necessity, therefore, the testing of lodes was restricted to ore materials scattered through the mine dumps. All the known lodes are of the gold-quartz variety, and carry, in addition to free gold, varying amounts of primary sulphides. Arsenopyrite and stibnite form the bulk of these sulphides, but minor amounts of boulangerite, jamesonite, and covellite have been reported (Hill, 1933, p. 120-152). Weathered parts of the veins examined are much stained with oxides of iron, manganese, antimony, and arsenic.

The radioactivity of materials tested in this area ranged from <0.001 to 0.007 percent equivalent uranium. The maximum value was obtained in the heavier-than-bromoform fraction of a concentrate panned from 50 pounds of gravel from St. Patrick Creek (station ED 7, sample 1424). As in the Pedro Dome area, the slightly higher equivalent-uranium values in the concentrates as compared to the outcrop test may be attributed to the proportional increase in radioactive zircon resultant from concentration.

Steese Highway belt in upper Chatanika valley

The portion of the Steese Highway midway between Fairbanks and Circle lies mainly in the upper or headwater part of the Chatanika valley, but extends north and east to the headwater portions of Beaver, Birch, and Preacher Creeks (figs. 1 and 5). As considered in this report and shown on figure 5 the belt adjacent to the highway is about 60 miles long and 15 miles wide, and has an area of about 800 square miles. The topography generally consists of long even-topped ridges with long, broad, lateral spurs separating wide, shallow valleys. The Steese Highway enters the valley of the Chatanika River at the mouth of Cleary Creek and follows the valley northeastward. At the head of McManus Creek the highway crosses the divide into the valley of Twelvemile Creek of the Birch Creek watershed. Short roads lead from the highway to the site of dredging operations on Nome Creek, and to other, smaller placer mines on Deep and Sourdough Creeks. Most of the short trails that start from the highway are for access to the U. S. Smelting, Refining, and Mining Co. ditch. The upper Chatanika valley has few inhabitants. Those who live there are employed mainly in prospecting and mining, or in maintaining the U. S. Smelting, Refining, and Mining Co. ditch or the Steese Highway.

Geology

The geology of the eastern or upper part of the Chatanika valley is similar to that of the Fairbanks district. The Birch Creek schist (see previous discussion under Fairbanks district) is again the major bedrock of the area. A large mass of intrusive granitic rock of Mesozoic(?) age crops out in the north-central part of the area in the headwater portions of Nome Creek, and tributaries of Faith and Preacher Creeks. Similar bodies of related igneous rock are present at the head of Sourdough Creek and in the divide separating the Faith, Idaho, and Preacher Creek drainage areas. (Prindle, 1910, p. 203-209; 1913, pl. 8; 1913a, pl. 2.)

Radioactivity studies

Before the present examination of materials from the upper Chatanika valley area, only seven placer concentrates, three from Sourdough Creek and four from Nome Creek, had been tested for radioactivity. Of the seven only a concentrate from Nome Creek has more than 0.01 percent equivalent uranium, and in this the equivalent-uranium content is 0.026 percent.

The investigations in 1946 were restricted to tests of bedrock cropping out in road cuts and to tests of concentrates of gravels from streams in the immediate vicinity of the highway and secondary roads. The locations of the sites tested are shown on figure 5, and the results are included in table 1.

Several varieties of schist and granitic rocks were tested. The data of these tests are summarized below.

Material tested	Percent equivalent uranium		
	A[1]	B[2]	C[3]
Granitic rocks:			
Station UC 12, sample 1539L	0.005	0.004	0.017
19	.001	---	---
Graphitic schist:			
Station UC 31, sample 1540L	.003	.001	.003
32	.003	---	---
33	.003	---	---
42, sample 1542L	.003	.003	<.001
44	.001	---	---
Schist (other varieties):			
Station UC 13	.001	---	---
34	.002	---	---
35, sample 1541L	.002	.002	---
43	<.001	---	---

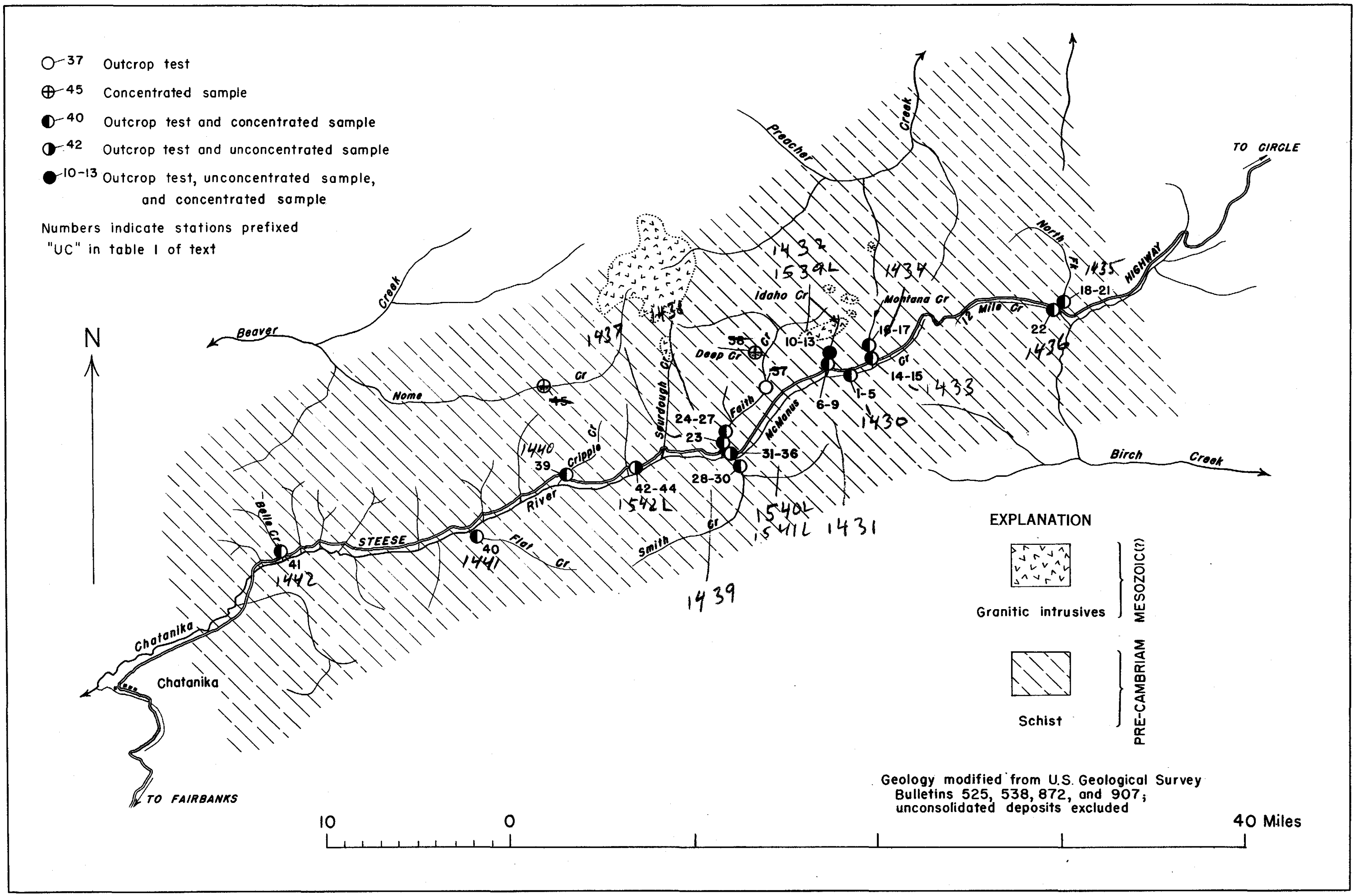
[1] A. Outcrop tests.
[2] B. Tests of unconcentrated crushed rock samples.
[3] C. Tests of bromoform concentrates from crushed rock samples.

The relatively higher values of equivalent uranium in the granitic rocks (station UC 12, sample 1539L) is probably due to radioactive elements in zircon, which was identified in the concentrate.

A placer concentrate obtained from a dredge on Nome Creek was the only appreciably radioactive placer material from the Chatanika area tested in 1946. Further concentration of the heavy minerals by separation in methylene iodide increased the radioactivity only to 0.012 percent equivalent uranium. Minerals of interest in this concentrate are relatively abundant topaz and cassiterite, and sparse tourmaline and monazite. This association suggests that tin-bearing veins may occur in the vicinity of the granite at the head of Nome Creek.

Livengood area

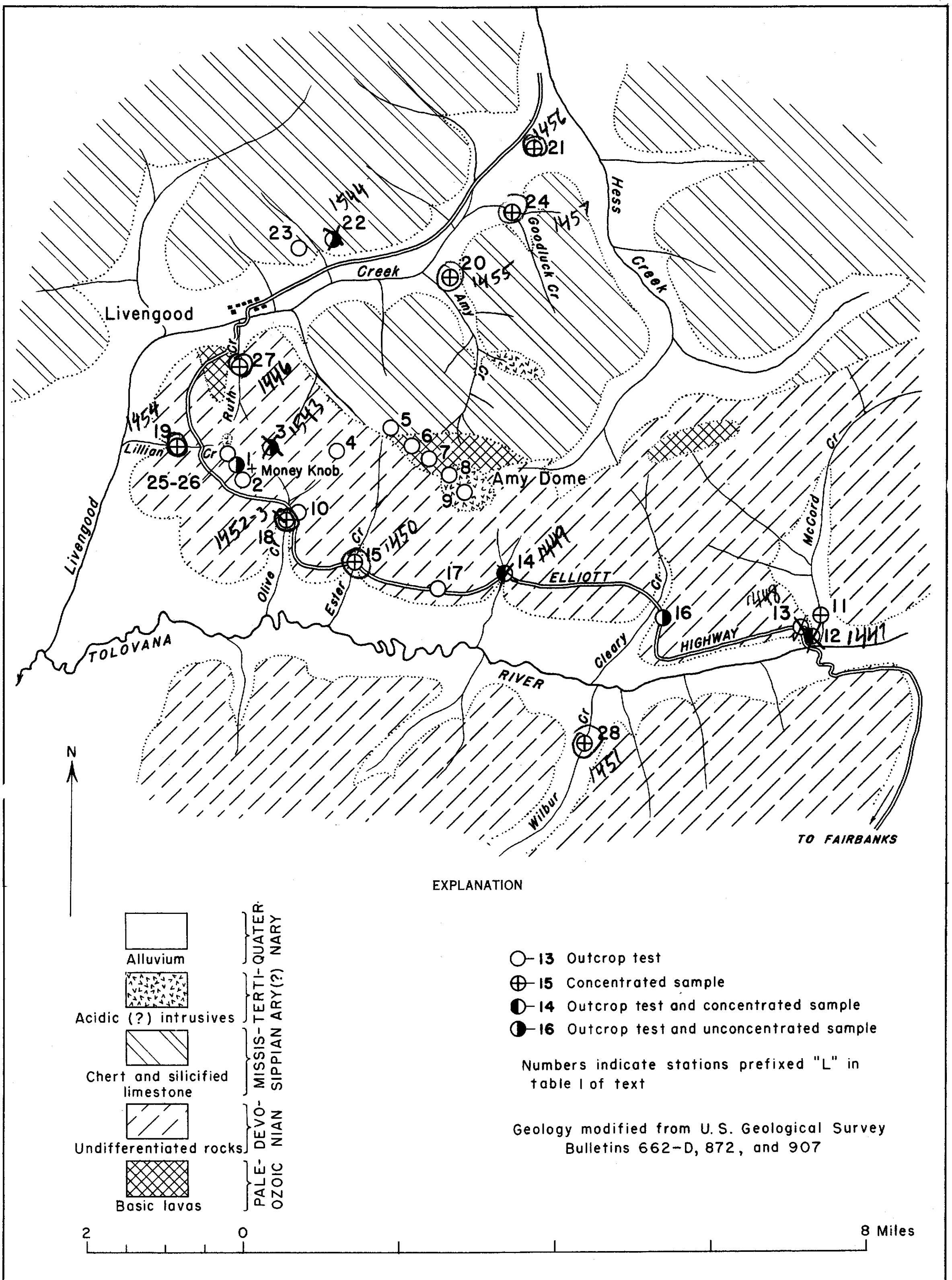
The Livengood area (figs. 1 and 6), as considered in this report, consists of an area about 100 square miles. The town of Livengood, the only settlement in the area and the northern terminus of the Elliott Highway, is 71 miles from Fox on the Steese Highway and 82 miles from Fairbanks. The Livengood area is part of the Yukon-Tanana upland and is characterized by broad, even-topped ridges from which long, gently sloping spurs descend to the valley floors. The area is drained by Livengood Creek and the



Base modified from U. S. Geological Survey
Alaska Maps 27, 38, and 39

Field work by Helmuth Wedow, Jr., and J. J. Matzko, July 1946

Figure 5. —Geologic sketch map of the Steese Highway belt in the upper Chatanika valley, Alaska.



Base from U. S. Geological Survey Alaska Map 27

Field work by Helmuth Wedow, Jr., and J. J. Matzko, August 1946

Figure 6.—Geologic sketch map of the Livengood area, Alaska.

Tolovana River of the Tanana drainage basin, and by tributaries of the South Fork of Hess Creek, which in turn is tributary to the Yukon River. Dredging operations of Livengood Placers, Inc., on Livengood Creek and several large scale opencut, hydraulic-placer operations on tributaries of Livengood Creek and the Tolvana River are the principal mining activities in the area.

Geology

The geology of the Livengood area has been discussed in some detail elsewhere. (See Brooks, 1916; Mertie, 1917; 1937; Overbeck, 1920; and Capps, 1940.) In general, the sedimentary rocks of the area have been mapped as two units: one, an undifferentiated, chiefly noncalcareous Devonian sequence, which lies to the south of Amy Dome; the other, a younger chert and silicified limestone sequence of Mississippian age, which lies to the north of the dome (fig. 6). Mafic rocks of Paleozoic age, thought to be extrusive and intrusive, are closely associated with both age groups of the consolidated sediments. Tertiary(?) granitoid rocks, predominantly felsic, intrude the older rocks in the vicinity of Amy Dome. Metamorphic effects and mineralization attributed to these later intrusives are clearly seen along the divide between Livengood Creek and the Tolovana River, and on the flanks of Amy Dome.

Radioactivity studies

Previous tests of 30 placer concentrates from the Livengood area indicated amounts of radioactivity of less than 0.01 percent equivalent uranium, except in a concentrate from Goodluck Creek which contains from 0.031 to 0.048 percent equivalent uranium. Although a cursory examination of this concentrate before the beginning of the field season of 1946 failed to reveal any mineral to which the radioactivity could be ascribed, more detailed study later indicated that the radioactivity is due to a black, pitchy-appearing, highly radioactive mineral with a conchoidal fracture.

Despite the apparently unpromising initial information, some field work appeared warranted to complete coverage of the placers of the area in an attempt to obtain other radioactive concentrates, and for testing a few of the sedimentary and igneous rocks and the attendant lode deposits. The location of these concentrates and outcrop tests are shown on figure 6, and the results are included in table 1.

A concentrate donated by a placer operator on Ruth Creek (station L 27) was the only placer concentrate obtained in 1946 that contains as much as 0.01 percent equivalent uranium. Sedimentary and igneous rocks, for the most part, contain less than 0.001 percent equivalent uranium and weathered granite 0.003 percent equivalent uranium. Results of various radioactivity tests made in 1946 on the most radioactive materials found in the Livengood area are summarized below.

Material tested	Percent equivalent uranium		
	A[1]	B[2]	C[3]
Sluice concentrate: Station L 27, sample 1446	---	---	0.010 [4] .009
Panned concentrate: Station L 19, sample 1454	---	---	.004
Black shale: Station L 16a, sample 1553L	0.002	0.002	.006
Weathered granite: Station L 3b, sample 1543L	.003	.005	.003

[1]A. Outcrop tests.
[2]B. Tests of unconcentrated crushed rock samples.
[3]C. Tests of bromoform concentrates.
[4]Test of methylene iodide concentrate.

Mineralogical examination of the sluice concentrate listed above indicates that the radioactivity is due to uranium- or thorium-bearing zircon, although a few grains of monazite also are present.

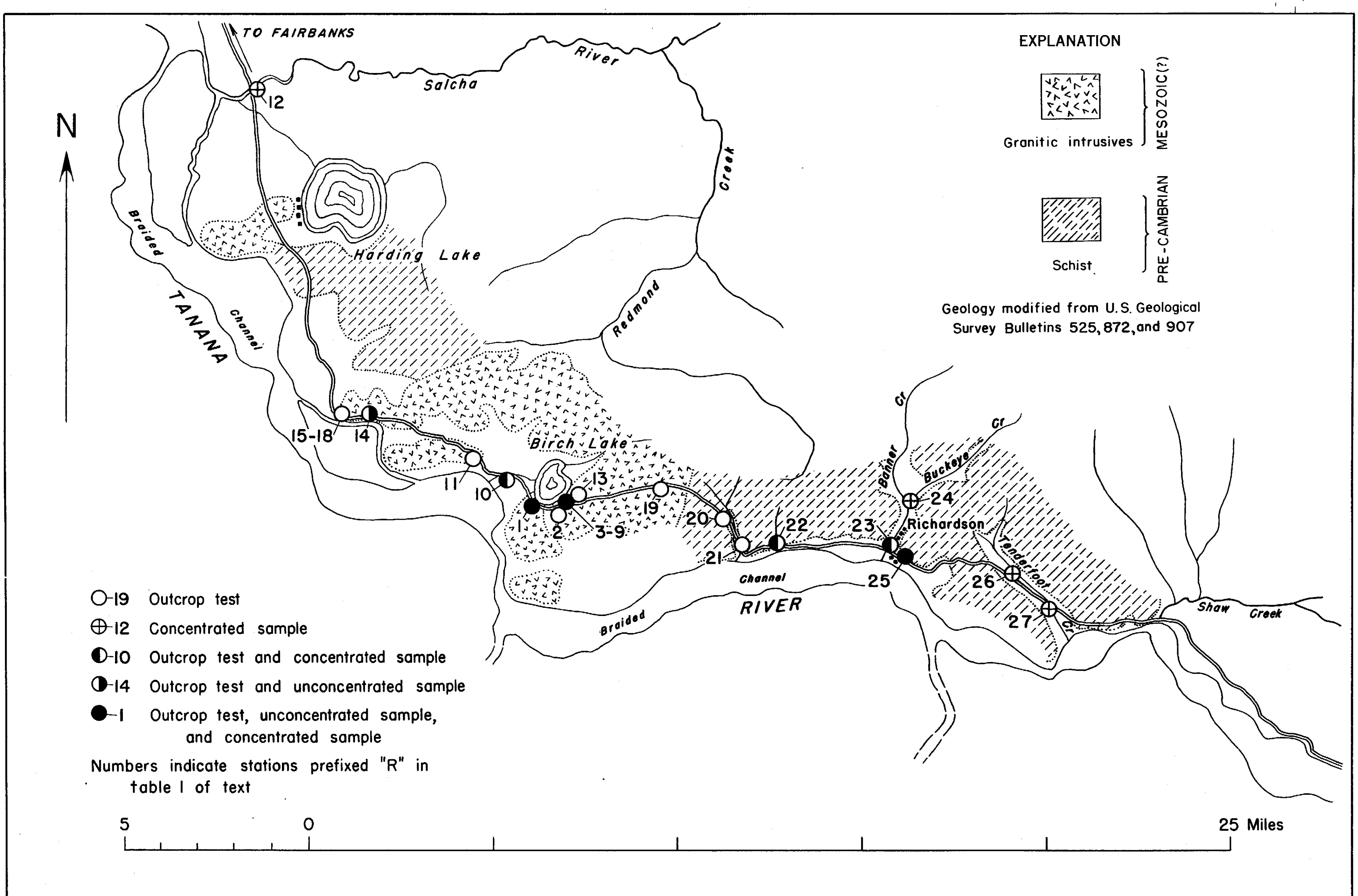
The Livengood area appears to hold little promise for significant uraniferous deposits, except, possibly, for the source of the highly radioactive mineral in the sample from Goodluck Creek.

Harding Lake-Richardson area

The Harding Lake-Richardson area (figs. 1 and 7), about 50 miles southeast from Fairbanks, is on the northeast side of the Tanana River between the lower courses of the Salcha River and Shaw Creek. The Richardson Highway crosses the area roughly parallel to the course of the Tanana River. Small settlements are located at Richardson, and at Birch and Harding Lakes. The area shown in figure 7 is about 400 square miles, but only a small fraction of this is easily accessible from the highway. Placer gold was first mined in this area in the early 1900's, chiefly in the valleys of Tenderfoot, Buckeye, and Banner Creeks, and in the headwater tributaries of Redmond Creek. Only one placer mine, located on claim 13 Below, on Tenderfoot Creek, was being worked in 1946.

Geology

Pre-Cambrian Birch Creek schist and granite rocks of Mesozoic(?)-age form the bedrock of the Harding Lake-Richardson area. The Birch Creek schist in this area consists chiefly of micaceous and quartzitic schists, and intergradations between these two types. Minor rock types in the Birch Creek are graphitic schist, crystalline limestone, and gneiss. Except for the gneiss, the Birch Creek is considered to be derived from sedimentary rocks. The gneiss is probably the metamorphic equivalent of pre-Cambrian intrusives. Quartz veins, in part gold-bearing, are associated with the schist. (Prindle, 1913, p. 35, 36, 52, 53, 140-142, pl. 8; Mertie, 1937, p. 47-59, 210-215, pl. 1; Capps, 1940, p. 134, 135, 145, 146, pl. 3.)



Base modified from U. S. Geological Survey Alaska Maps 27, 39, and 49

Field work by Helmuth Wedow, Jr., and J. J. Matzko, August 1946

Figure 7.—Geologic sketch map of the Harding Lake-Richardson area, Richardson Highway, Alaska.

Radioactivity studies

Granitic rocks of Mesozoic(?) age and attendant mineralization at outcrops of bedrock and in concentrates obtained from stream gravels eroded from the intrusive masses and surrounding rocks were tested for radioactivity in the Harding Lake-Richardson area. In addition concentrates were acquired from some of the streams formerly important as producers of gold, as this area was not previously represented in the Alaskan placer-concentrate file of the Geological Survey.

The location of the outcrop tests and sites of samples are shown on figure 7, and the data obtained are included in table 1. A summary of the data on the most radioactive materials found in the Harding Lake-Richardson area is tabulated below.

Material tested	Percent equivalent uranium			
	A[1]	B[2]	C[3]	D[4]
Granitic rock, weathered:				
Station R 1a, sample 1459L	0.006	0.004	---	0.009
Granitic(?) dike, light-colored, fine-grained, weathered:				
Station R 4a, sample 1460L	.005	.002	0.060	.110
Station R 13b, no sample	.005	---	---	---
Granitic dike, coarse-grained:				
Station R 14a, sample 1556L	.005	.004	.005	---
Graphitic schists:				
Station R 25b, sample 1557L	.002	.001	.005	---
Stream and bench gravels:				
Station R 23, sample 1464	.001	---	----	.008
Station R 24, sample 1465	---	---	---	[5].020
Station R 25a, sample 1466	<.001	---	---	.009

[1]A. Tests at the outcrop.
[2]B. Tests of unconcentrated crushed rock samples.
[3]C. Tests of bromoform concentrates from crushed rock samples.
[4]D. Tests of panned concentrates from 100-pound samples of unconsolidated material subsequently reconcentrated with bromoform.
[5]Methylene iodide used for final concentration instead of bromoform.

The radioactivity of the granite may be due to the presence of zircon and allanite(?) which were identified in a preliminary study of the concentrates. Scheelite is also present. Minerals of interest in the radioactive concentrate from Buckeye Creek (station R 24, sample no. 1465) are sheelite, tourmaline, rutile, zircon(?), titanite(?), cassiterite(?), and galena. This association of minerals, particularly that of tourmaline, cassiterite(?), and galena, suggests the possibility for vein deposits in the drainage area upstream from the site of the concentrate.

Alaska Highway belt

The Alaska Highway belt consists of a long narrow area along the highway from Big Delta to the international boundary. It is entirely within the drainage basin of the Tanana River. The highway is southwest of the river from Big Delta to a point a few miles east of Tok Junction; there it crosses the Tanana River and follows successively the northeast banks of the Chisana River and Scottie Creek to the boundary. The major settlements on the highway are Big Delta, Tanacross, and Tok Junction; and Northway is just south of the highway near the mouth of the Nebesna River (figs. 1 and 8). Also, a few small native villages are scattered along the river banks.

Geology

The geology of the area crossed by the Alaska Highway (fig. 8) was partly described and mapped by Mertie (1937), Moffit (1942), and Van Alstine and Black.[1] Some of this previous work, however, was revised and extended in 1946 during the reconnaissance for radioactive deposits.

Granitic intrusives of Mesozoic(?) age constitute the bulk of the bedrock exposed in the highway belt. These intrusives apparently cut pre-Cambrian or early Paleozoic schists and gneisses which are similar to, and in part probably the equivalent of, the pre-Cambrian Birch Creek schist of the Yukon-Tanana upland.

Radioactivity studies

The reconnaissance investigation of radioactivity in the Alaska Highway belt in 1946 was devoted chiefly to the granitic rocks of Mesozoic(?) age. For convenience in discussion the area is divided into two parts:

1. Localities northwest of Tok Junction (stations AH 1-AH 15, fig. 8 and table 1).

2. Localities southeast of Tok Junction (stations AH 1-AH 41, fig. 8 and table 1).

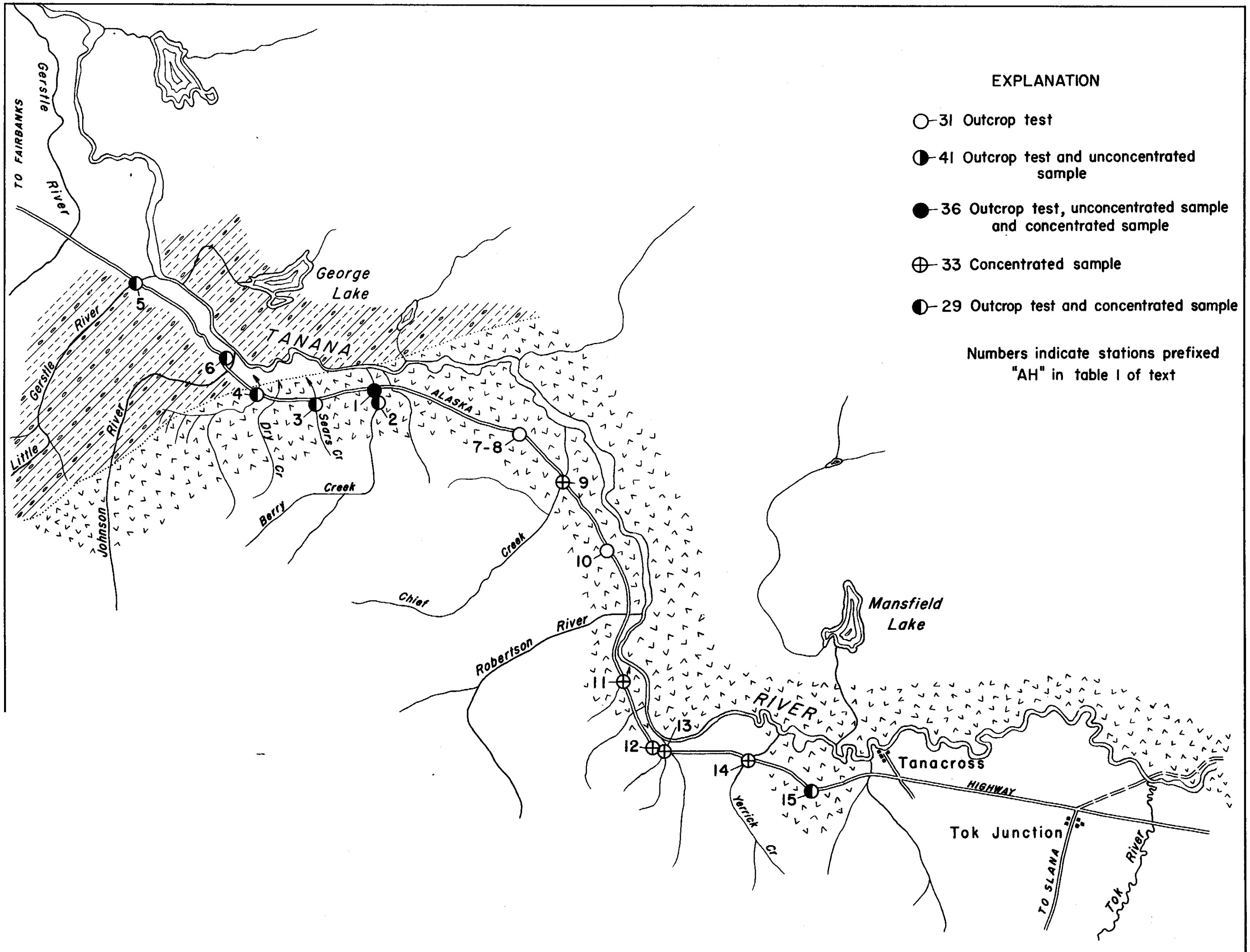
Localities northwest of Tok Junction.—Data on the most radioactive materials from localities northwest of Tok Junction are summarized below.

Material tested	Percent equivalent uranium	
	A[1]	B[2]
Granite, coarse-grained, weathered:		
Station AH 15b, sample 1480L	0.004	[3]0.008
Stream and bench gravels:		
Station AH 1a, sample 1469	.002	[3].014
Station AH 2, sample 1470	.002	[4].011
Station AH 4, sample 1472	.002	[4].008

[1]A. Tests at the outcrop.
[2]B. Tests of concentrates panned from 100-pound samples of gravel.
[3]Final concentration made with methylene iodide.
[4]Final concentration made with bromoform.

Preliminary study of the concentrates indicates the presence of minor amounts of zircon, a mineral which may be radioactive because it can contain uranium and thorium. All the gravels listed in the above tabulation are from streams draining areas underlain by granitic rocks.

[1]Van Alstine, R. E., and Black, R. F., 1944, Geology of the Alaska military highway from the international boundary to Big Delta, Alaska. [Unpublished rept., 1944. Manuscript and maps in the files of the U. S. Geol. Survey Alaskan Geology Branch.]


EXPLANATION
31 Outcrop test
41 Outcrop test and unconcentrated sample
36 Outcrop test, unconcentrated sample and concentrated sample
33 Concentrated sample
29 Outcrop test and concentrated sample
Numbers indicate stations prefixed "AH" in table I of text
TO FAIRBANKS
Gerstle River
George Lake
TANANA
RIVER
ALASKA
HIGHWAY
Little Gerstle River
Johnson River
Dry Cr
Sears Cr
Berry Creek
Chief Creek
Robertson River
Mansfield Lake
Tanacross
Yerrick Cr
Tok Junction
TO SLANA
Tok River
1
2
3
4
5
6
7-8
9
10
11
12
13
14
15

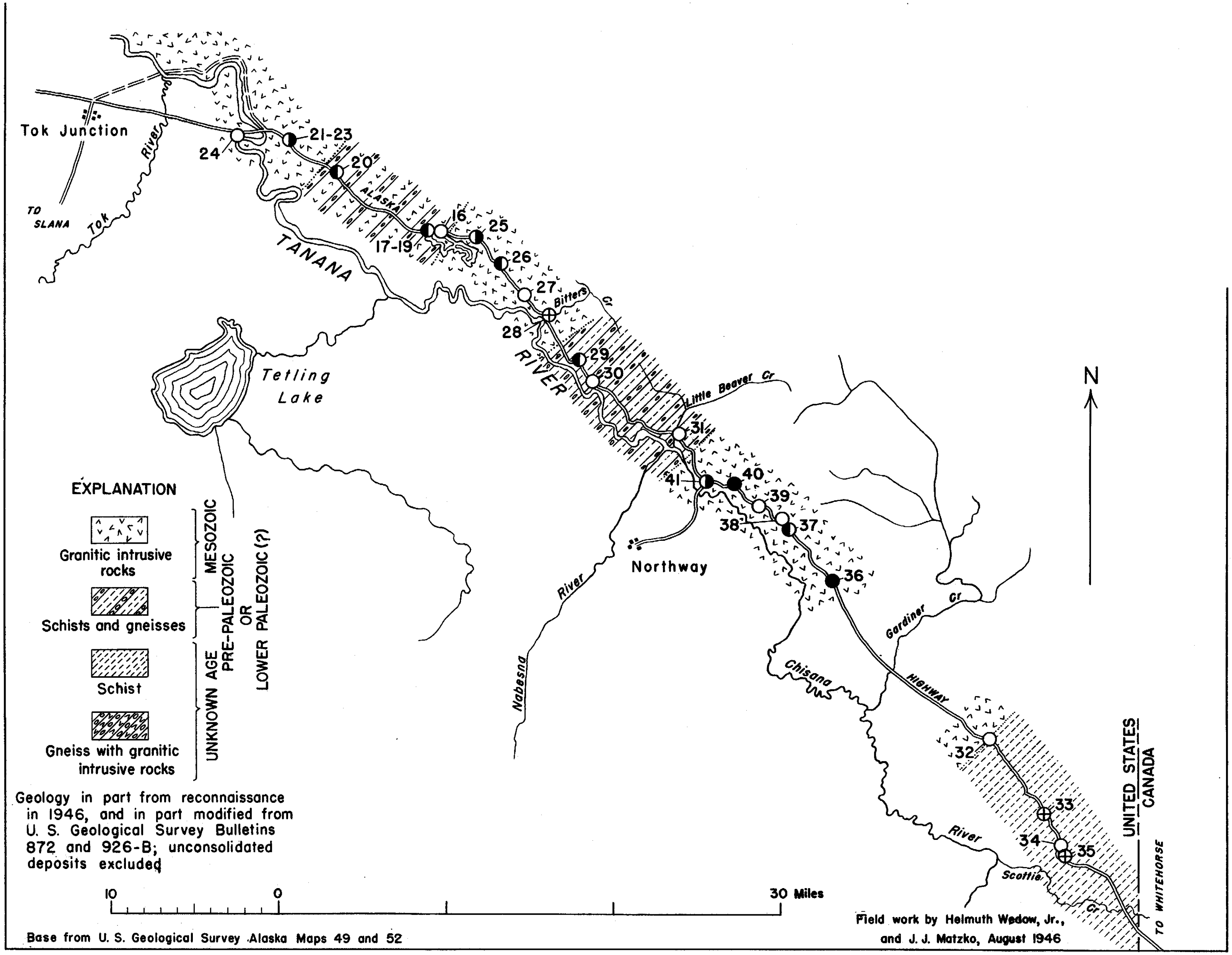


Figure 8.—Geologic sketch map of the Alaska Highway belt, upper Tanana valley, Alaska.

Localities southeast of Tok Junction. —Data on the most radioactive materials from localities southeast of Tok Junction are summarized below.

Material tested	Percent equivalent uranium			
	A[1]	B[2]	C[3]	D[4]
Granite, coarse-grained, weathered:				
Station AH 40, sample 1490L and sample 1547L.	0.004	0.001	0.013	0.074
Station AH 17a, sample 1481L	.005	---	---	.064
Station AH 37, sample 1489L	.004	---	---	[5].027
Station AH 26, sample 1483L	.003	---	---	.025
Station AH 36b, samples 1488L and 1546L.	.004	.001	.023	.010
Felsitic(?) dike, weathered:				
Station AH 31b, sample 1662L	.003	.003	.010	---

[1]A. Tests at the outcrop.
[2]B. Tests of unconcentrated crushed rock samples.
[3]C. Tests of bromoform concentrates from crushed rock samples.
[4]D. Tests of panned concentrates from 100-pound samples of unconsolidated material subsequently reconcentrated with methylene iodide.
[5]Bromoform used for final concentration instead of methylene iodide

Subsequently, samples 1481L and 1490L in the above tabulation were concentrated further by removing a magnetic fraction with a hand magnet. The equivalent-uranium content in the resultant nonmagnetic fractions of these two samples was then determined to be 0.65 and 0.89 percent, respectively.

Preliminary mineralogical studies of the concentrates from the granitic rocks show the presence of zircon in all samples from the five localities, usually in large amounts. Although it is presumed that the concentration of the zircon is to a large extent responsible for the increased radioactivity of the concentrates, other Alaskan studies (Moxham and West, 1953, p. 7; White and Killeen, 1953, p. 3) have shown that the radioactivity of pure zircon fractions of concentrates from granitic rocks was found to range, only from 0.1 to 0.15 percent equivalent uranium. Hence, zircon alone probably cannot account for the total radioactivity in samples 1481L and 1490L mentioned above. Allanite, another mineral which may contain uranium and thorium, has been identified also in these two concentrates (samples 1481L and 1490L) as well as in a third (sample 1483L). Although it is likely that the zircon and allanite account for the bulk of the radioactivity in the samples, traces of other, as yet unidentified, highly radioactive minerals may also be present. Other heavy minerals of interest identified in the concentrates from the granitic rocks are epidote, tourmaline, and axinite(?).

The refractory nature of the chief radioactive minerals in granitic rocks in the Alaska Highway belt indicates that these rocks should not be considered as a possible commercial source of uranium or thorium. If additional mineralogic study of the samples indicates the presence of radioactive oxide minerals, the problem then arises as to whether such radioactive oxide minerals occur as disseminated accessory minerals in the granitic rocks or are limited to a particular facies of the granite, or occur in vein systems cutting the granitic rocks.

Highway area between Slana and Tok Junction

The highway area between Slana and Tok Junction (figs. 1 and 9) lies across the divide between the Copper River and Tanana River basins. This new road, about 70 miles long and known informally as the "Tok cutoff," connects the Alaska Highway with the old Nabesna road by way of Mentasta Pass (altitude about 2,300 feet). It was originally constructed by the Army Engineers of the Alaska Department, and more recently, has been improved and maintained by the Alaska Road Commission. This road has opened up much country formerly accessible only by pack train. The area is drained chiefly by the Tok River, a north-flowing tributary of the Tanana River, and by the Slana River, a south-flowing tributary of the Copper River.

Geology

The geology of the area between Slana and Tok Junction has been described by Moffit (1938) in conjunction with surveys in the Copper River basin. The bedrock of the Slana-Tok district is a part of the core of the Alaska Range which here has a northwesterly trend. Moffit (1938, p. 1) states:

"The rocks of the district are prevailingly sedimentary but include tuff beds and lava flows and many masses of intruded granitic rocks, most of which are diorite and related types rather than granite. Some of these rocks are highly metamorphic. Others are greatly folded yet not notably altered. The structure is complex and not clearly understood. The rocks range in age from pre-Cambrian or early Paleozoic to late Mesozoic. In places they are concealed by Recent unconsolidated waterlaid and glacial deposits."

The distribution and age of the different rock types are shown on the geologic sketch map of the area (fig. 9).

Radioactivity studies

Tests for radioactivity in the area along the Slana-Tok highway were made principally on concentrates from gravels in tributaries of the Slana and Tok Rivers. The locations at which the concentrates were taken, as well as the few other tests on a lode deposit, are shown on figure 9. The data are included in table 1.

The equivalent-uranium values for 20 concentrates from gravels in the Slana-Tok Junction highway area range from <0.001 to 0.003 percent, and average 0.001 percent. A silver prospect (Moffit, 1938, p. 46,47) on Silver Creek, a small tributary of Ahtell Creek near Slana, was also tested for radioactivity. The mineralization consists of silver-bearing quartz veins in a fault zone. The country rock is chiefly medium-grained gray diorite and a dark basaltic-appearing rock that is probably igneous. The metallic minerals reported in the lode are sphalerite, pyrite, galena, and tetrahedrite. The silver is probably associated chiefly with the tetrahedrite and galena. Tests on materials from the Silver Creek lode indicate that the radioactivity is less than 0.001 percent equivalent uranium. An unconcentrated crushed sample of the country rock

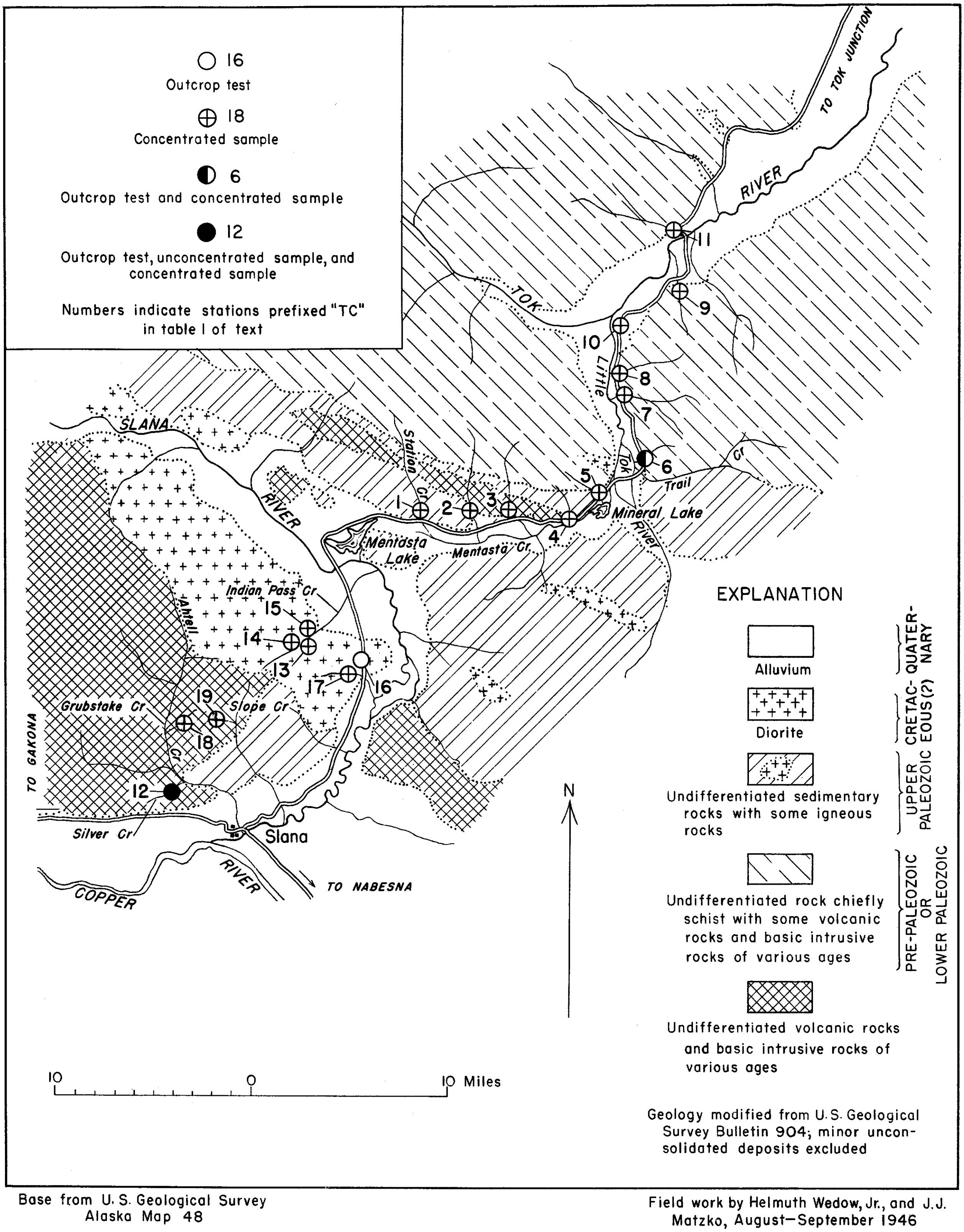


Figure 9. —Geologic sketch map of the highway area between Slana and Tok Junction, Alaska.

near the lode (station TC 12c), however, shows 0.005 percent equivalent uranium, but the bromoform concentrate from this sample has only 0.001 percent equivalent uranium.

Donnelly Dome-Paxson area

The Donnelly Dome-Paxson area, as considered in this report, is a narrow strip along the Richardson Highway about 70 miles in length between Donnelly Dome on the north and Paxson on the south (figs. 1 and 10). It is drained by the Delta River and its tributaries except at the most southerly end where it lies in the watershed of the Gulkana River, a tributary of the Copper River. In 1946, roadhouses were located at Rapids and Paxson.

Geology

The geology of the Donnelly Dome-Paxson area has been described in reports of broader regional scope (Moffit, 1912, 1942). The northern part of the area is underlain by schists and gneisses of pre-Paleozoic or early Paleozoic age, which in part may be equivalent to the pre-Cambrian Birch Creek schist of the Yukon-Tanana region to the north. The southern part of the area, although covered to a considerable degree by unconsolidated glacial and glacio-fluviatile deposits, is underlain by Carboniferous sedimentary rocks and lavas. Granitic rocks, considered to be pre-Tertiary in age, intrude the schists in the north-east corner of the area. Jurassic(?) intrusives of dioritic affinities are associated with the Carboniferous rocks in the southern part of the area. In the vicinity of Donnelly Dome and Jarvis Creek, Tertiary coal-bearing sediments unconformably overlie portions of the metamorphic basement, and are covered with a thin veneer of glacial debris.

Prospecting for placer gold in the Donnelly Dome-Paxson area has been carried on intermittently since about 1900. The most promising streams are Jarvis, Ober, and Macomber Creeks, although gravels of several other streams also contain placer gold. Mining activity in 1946 was limited to prospecting of claims on Ober Creek by Charles DeWitt, and to operations by the Yukon Corporation on the east bank of the Delta River about a quarter of a mile downstream from the mouth of Phelon Creek (fig. 10).

Radioactivity studies

As only a few days remained toward the close of the 1946 field season for the investigation of the Donnelly Dome-Paxson area, the work in that area consisted only of panning concentrates from various stream gravels. No concentrates had been available for study before the 1946 field season. The stations at which the concentrates were obtained are plotted on figure 10, and the data are included in table 1.

The equivalent-uranium content of 12 bromoform concentrates (stations RH 1-12) from stream gravels south of Donnelly (fig. 10) ranges from <0.001 to 0.004 percent and averages about 0.002 percent. The equivalent-uranium content of four concentrates (stations RH 13-15) obtained from prospecting operations on Ober Creek ranges from 0.003 to 0.011 percent and averages about 0.006 percent. The radioactivity is apparently due to the presence of small quantities of monazite in the concentrates. Tourmaline, zircon, fluorite, and epidote also occur in the Ober Creek concentrates.

CONCLUSION

Some granitic rocks and placer concentrates tested in areas adjacent to highways in the Tanana and upper Copper River valleys are moderately radioactive and thus may be of significance in the search for commercial deposits of radioactive elements in these areas Black shale, carbonaceous or graphitic schist, and mineralized vein deposits tested in this reconnaissance exhibited only traces of radioactive material.

The most significant results for the material tested are summarized below.

Type of material and area	Range of percent equivalent uranium	
	Outcrop tests and unconcentrated samples	Concentrated samples
Granitic rocks:		
Fairbanks district-----	<0.001-0.003	0.002-0.004
Upper Chatanika valley area-----------------	.001- .005	.017
Livengood area---------	<.001- .005	.003
Harding Lake-Richardson area-----------------	.002- .006	.005- .11
Alaska Highway belt----	.001- .005	.004- .074
Highway area between Slana and Tok Junction-------------	.001	---
Donnelly Dome-Paxson area-----------------	---	---
Mafic rocks:		
Fairbanks district-----	<.001- .001	---
Upper Chatanika valley area-----------------	---	---
Livengood area---------	<.001	---
Harding Lake-Richardson area------	.002- .003	---
Alaska Highway belt----	.001- .003	.004
Highway area between Slana and Tok Junction-------------	<.001- .005	<.001
Donnelly Dome-Paxson area-----------------	---	---
Mineralized veins and vein materials:		
Fairbanks district-----	<.001- .005	<.001- .013
Upper Chatanika valley area-----------------	---	---
Livengood area---------	<.001	<.001
Harding Lake-Richardson area------	.003	---
Alaska Highway belt----	---	---
Highway area between Slana and Tok Junction-------------	<.001- .001	<.001
Donnelly Dome-Paxson area-----------------	---	---
Schist, quartzitic and micaceous varieties:		
Fairbanks district-----	<.001- .002	---
Upper Chatanika valley area-----------------	<.001- .003	.003
Livengood area---------	---	---
Harding Lake-Richardson area------	.001- .002	---
Alaska Highway belt----	<.001- .002	---

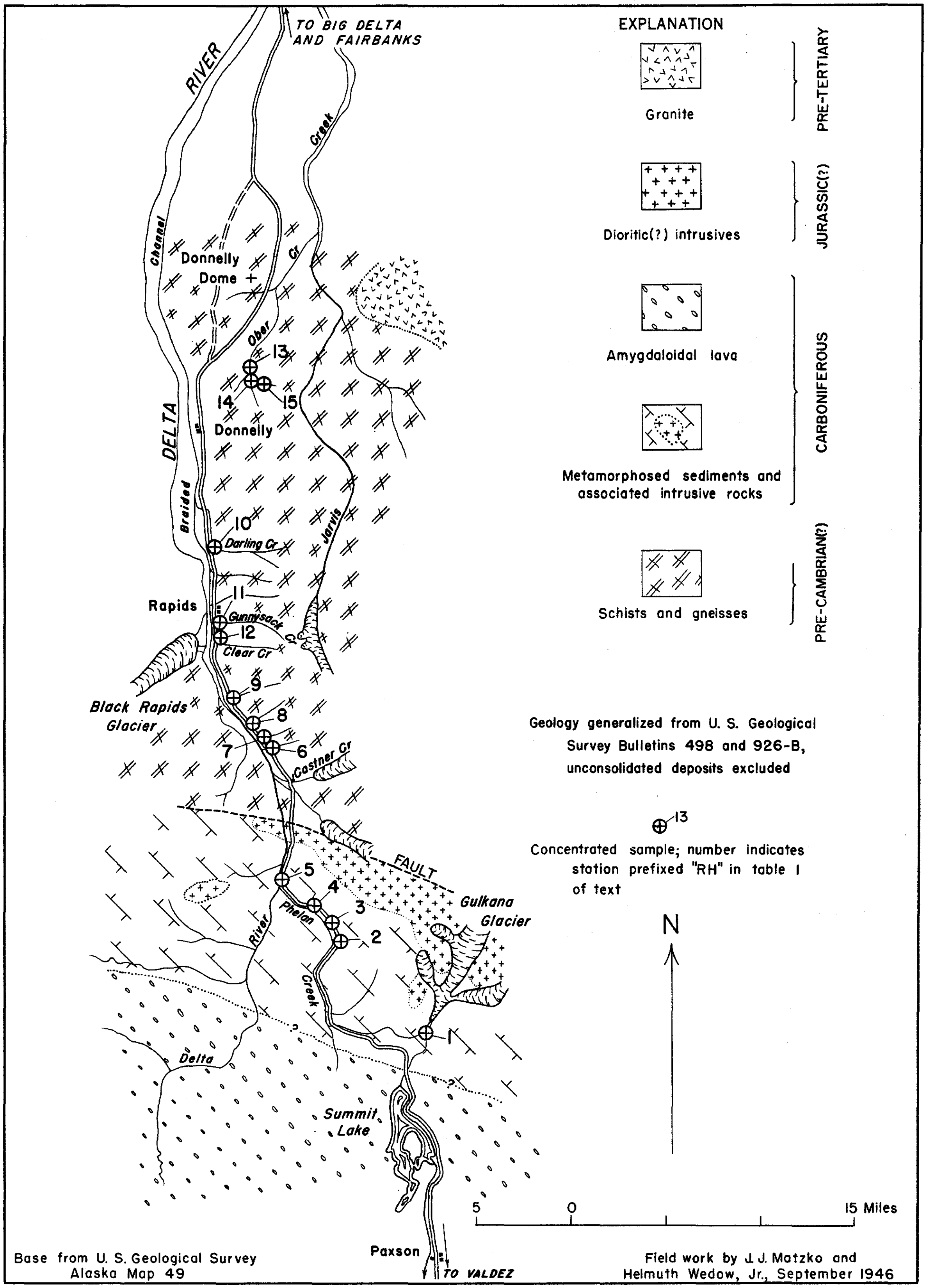


Figure 10.—Geologic sketch map of the Donnelly Dome-Paxson area, Richardson Highway, Alaska.

Type of material and area	Range of percent equivalent uranium	
	Outcrop tests and unconcentrated samples	Concentrated samples
Schist, quartzitic and micaceous varieties Continued:		
Highway area between Slana and Tok Junction	---	---
Donnelly Dome-Paxson area	---	---
Schist, graphitic:		
Fairbanks district	0.002	0.004
Upper Chatanika valley area	0.001- .004	.000
Livengood area	---	---
Harding Lake-Richardson area	.001- .002	.005
Alaska Highway belt	---	---
Highway area between Slana and Tok Junction	---	---
Donnelly Dome-Paxson area	---	---
Black shale:		
Fairbanks district	---	---
Upper Chatanika valley area	---	---
Livengood area	<.001- .002	.006
Harding Lake-Richardson area	---	---
Alaska Highway belt	---	---
Highway area between Slana and Tok Junction	<.001	<0.001- .003
Donnelly Dome-Paxson area	---	.001- .011
Stream and bench gravels, and slope wash:		
Fairbanks district	<.001- .003	<.001- .066
Upper Chatanika valley area	<.001- .001	<.001- .012
Livengood area	<.001- .001	<.001- .01
Harding Lake-Richardson area	<.001- .001	.001- .02
Alaska Highway belt	.001- .002	<.001- .014
Highway area between Slana and Tok Junction	<.001	<.001- .003
Donnelly Dome-Paxson area	---	<.001- .011

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Table 1.—Data on radioactivity tests in areas adjacent to highways in the Tanana and upper Copper River valleys, Alaska

[Abbreviations in subheadings under "Percent equivalent uranium" indicate the following: OT, outcrop test; UCS, unconcentrated crushed sample; BC-CS, bromoform concentrate from crushed sample; BC-PC, panned concentrate from 50- to 100-pound samples of gravel or disintegrated rock material subsequently reconcentrated with bromoform; also includes sluice concentrates obtained from placer-mine operators.]

Test station	Sample file no.	Percent equivalent uranium				Concentration ratio	Description and location
		OT	UCS	BC-CS	BC-PC		
							Pedro Dome area (fig. 3)
PD 1	----	0.001	---	---	---	---	Weathered quartz diorite; on road to summit of Pedro Dome.
2	----	<.001	---	---	---	---	Weathered quartz diorite; 200 feet south of PD 1.
3	----	.001	---	---	---	---	Weathered quartz diorite; 300 feet south of PD 1.
4	----	<.001	---	---	---	---	Weathered quartz diorite; 500 feet south of PD 1.
5	----	.001	---	---	---	---	Weathered quartz diorite; 700 feet south of PD 1.
6	----	.001	---	---	---	---	Weathered quartz diorite; 800 feet south of PD 1.
7	1401L	.001	---	---	0.002	570:1	Weathered quartz diorite; 900 feet south of PD 1.
8	----	.001	---	---	---	---	Weathered quartz diorite; 1,000 feet south of PD 1.
9	----	<.001	---	---	---	---	Weathered quartz diorite; 1,100 feet south of PD 1.
10	----	.002	---	---	---	---	Weathered quartz diorite; 1,200 feet south of PD 1.
11	----	.001	---	---	---	---	Weathered quartz diorite; 1,300 feet south of PD 1.
12	----	.001	---	---	---	---	Quartz diorite talus; on road to summit of Pedro Dome, 1,400 feet south of PD 1.
13	1527L	.003	0.003	0.004	---	4:1	Do.
14	----	.002	---	---	---	---	Do.
15	----	.001	---	---	---	---	Quartzitic schist; in stripped area about 0.6 mile northeast of Pedro Dome.
16	----	.001	---	---	---	---	Do.
17	----	.001	---	---	---	---	Weathered quartz vein; in series of old prospect pits about 1 mile northeast of Pedro Dome.
18	----	.001	---	---	---	---	Do.
19	----	.000	---	---	---	---	Weathered schist; same locality as PD 17.
20	----	.001	---	---	---	---	Weathered quartz vein; same locality as PD 17.
21	----	.001	---	---	---	---	Weathered quartzitic schist; same locality as PD 15.
22	----	.001	---	---	---	---	Do.
23	----	<.001	---	---	---	---	Weathered micaceous schist; same locality as PD 15.
24	----	.001	---	---	---	---	Weathered phyllite; same locality as PD 15.
25	----	.001	---	---	---	---	Weathered schist, same locality as PD 15.
26	----	.001	---	---	---	---	Do.
27	----	.001	---	---	---	---	Weathered schist, same locality as PD 17.
28	----	.001	---	---	---	---	Do.
29	----	.001	---	---	---	---	Do.
30	----	.001	---	---	---	---	Weathered quartz vein and schist; in old prospect pits west of road about 1.5 miles northeast of Pedro Dome.
31	----	.001	---	---	---	---	Do.
32	1537L	.002	.002	[1] .004	---	4:1	Thin bed of graphitic schist; in stripped area along east side of road about 1.5 miles northeast of Pedro Dome.
33	----	.001	---	---	---	---	Do.
34	----	.001	---	---	---	---	Fractured quartz vein; same locality as PD 32.

See footnotes at the end of the table.

Table 1.—Data on radioactivity tests in areas adjacent to highways in the Tanana and upper Copper River valleys, Alaska—Continued

Test station	Sample file no.	Percent equivalent uranium				Concentration ratio	Description and location
		OT	UCS	BC-CS	BC-PC		
							Pedro Dome area—Continued
PD 35	----	0.002	---	---	---	---	Graphitic schist; same locality as PD 32.
36	----	<.001	---	---	---	---	Iron-stained quartz vein; Boyle's prospect near junction of Fairbanks Creek road and Steese Highway.
37	----	<.001	---	---	---	---	Do.
38	----	.001	---	---	---	---	Disintegrated rock on mine dump; same locality as PD 36.
39	----	<.001	---	---	---	---	Weathered schist; in road cut on Steese Highway in Skoogy Gulch.
40	----	<.001	---	---	---	---	Do.
41	1538L	.001	0.002	0.013	---	336:1	Vein material on mine dump; Eagan scheelite mine on Twin Creek.
42	----	.001	---	---	---	---	Iron-stained schist; in old prospect pit along Steese Highway near mouth of Twin Creek.
43	----	.001	---	---	---	---	Weathered quartz and schist on mine dump; at old prospect shaft on ridge between Fox Creek and Seattle Pup about 0.85 mile east of road.
44	----	<.001	---	---	---	---	Do.
45	----	<.001	---	---	---	---	Do.
46	----	.001	---	---	---	---	Do.
47	1408	.001	---	---	.003	1,150:1	Slope wash(?); in bull-dozer trench 0.6 mile east of station PD 43.
48	----	.001	---	---	---	---	Do.
49	----	<.001	---	---	---	---	Weathered quartz vein and schist on mine dump; at old prospect shaft near station PD 46.
50	----	.001	---	---	---	---	Do.
51	----	.001	---	---	---	---	Slope wash; in trench about 300 feet east of station PD 46.
52	----	.001	---	---	---	---	Do.
53	----	<.001	---	---	---	---	Weathered quartz vein and schist on mine dump; at old prospect shafts 0.7 mile east of station PD 43.
54	1409L	.001	---	---	.002	1,200:1	Do.
55	----	.001	---	---	---	---	Do.
56	----	.001	---	---	---	---	Same as PD 53, but 0.3 mile farther east.
57	1410L	.001	---	---	.003	1,530:1	Do.
58	----	.001	---	---	---	---	Same as PD 53, but 0.45 mile farther east.
59	----	.001	---	---	---	---	Do.
60	----	.001	---	---	---	---	Do.
61	1411	.001	---	---	.001	770:1	Angular gravel from test pit; Seattle Pup.
62	1412L	.001	---	---	.002	270:1	Weathered rock on mine dump; at prospect shaft on divide between Seattle Pup and Moose Creek.
	1536AL	---	.001	.001	---	10:1	Sulphide-enriched limestone; at station PD 62.
	1536BL	---	.003	[1] .001	---	2:1	Do.
63	1413	.001	---	---	.003	700:1	Angular gravel from test pit; on south tributary of Last Chance Creek.
64	----	.001	---	---	---	---	Disintegrated rock on mine dump; on ridge between Engineer and Steele Creeks.
65	----	<.001	---	---	---	---	Do.

66	----	.001	---	---	---	---	Do.
67	----	.001	---	---	---	---	Do.
68	----	<.001	---	---	---	---	Do.
69	----	.001	---	---	---	---	Disintegrated rock on mine dump; on ridge between Engineer and Steele Creeks.
70	----	.001	---	---	---	---	Do.
71	1397L	.002	---	---	.006	1,410:1	Do.
72	1396	.001	---	---	<.001	15,620:1	Slope wash from test pit; on ridge between Engineer and Steele Creeks.
73	----	<.001	---	---	---	---	Do.
74	----	<.001	---	---	---	---	Tungsten vein in drift; Gilmore Dome.
75	----	.001	---	---	---	---	Bedrock in same drift; Gilmore Dome.
76	----	<.001	---	---	---	---	Tungsten vein in second drift; Gilmore Dome.
77	----	.001	---	---	---	---	Tungsten vein 500 feet from mouth of third drift; Gilmore Dome.
78	----	.001	---	---	---	---	Rock on dump of third drift; Gilmore Dome.
79	----	<.001	---	---	---	---	Mafic rock in dump of shaft at summit; Gilmore Dome.
80	----	.001	---	---	---	---	Tungsten vein in opencut near summit; Gilmore Dome.
81	----	<.001	---	---	---	---	Do.
82	----	.001	---	---	---	---	Do.
83	----	.001	---	---	---	---	Mafic rock in dump of shaft at summit; Gilmore Dome.
84	----	<.001	---	---	---	---	Do.
85	----	.001	---	---	---	---	Tungsten vein in first drift; Gilmore Dome.
86	----	<.001	---	---	---	---	Bedrock in first drift; Gilmore Dome.
87	----	<.001	---	---	---	---	Tungsten vein in second drift; Gilmore Dome.
88	----	<.001	---	---	---	---	Bedrock in second drift; Gilmore Dome.
89	----	.001	---	---	---	---	Mafic rock in dump of shaft at summit; Gilmore Dome.
90	1400	.002	---	---	.003	2,940:1	Angular gravel from test pit; north tributary of Isabella Creek.
91	----	.002	---	---	---	---	Do.
92	1402	.002	---	---	.003	550:1	Stream gravel from test pits; Gilmore Creek.
93	----	.001	---	---	---	---	Do.
94	1403	.001	---	---	.004	1,030:1	Angular gravel from test pit; north tributary of Victoria Creek.
95	----	.001	---	---	---	---	Do.
96	----	.001	---	---	---	---	Do.
97	1404	<.001	---	---	<.001	17,450:1	Stream gravel (slope wash?) from several closely spaced gullies; Monte Cristo Creek.
98	----	.001	---	---	---	---	Do.
99	1405	.002	---	---	.005	3,340:1	Stream gravel from test pit; east fork of Tom Creek.
100	1406	.001	---	---	.004	1,860:1	Stream gravel from test pit; west fork of Fish Creek.
101	1407	.001	---	---	.001	460:1	Stream gravel from test pit; Deadwood Creek.
102	1391	<.001	---	---	.003	5,790:1	Angular gravel from test pit; east headwater tributary of Engineer Creek.
103	1392	<.001	---	---	.003	1,740:1	Angular gravel from test pit; west headwater tributary of Moose Creek.
104	1393	.001	---	---	.004	4,580:1	Angular gravel from test pit; middle fork of northwest tributary of Columbia Creek.
105	1394	.003	---	---	.005	240:1	Angular gravel from test pit; Columbia Creek.
106	1395	<.001	---	---	.002	1,470:1	Angular gravel from test pit; Engineer Creek.
107	1398	.001	---	---	.066	5,030:1	Stream gravel from test pit; Rex Creek.
108	1399	.002	---	---	.003	2,600:1	Angular gravel from test pit; middle fork of Steele Creek.
109	1414	<.001	---	---	<.001	470:1	Stream gravel; Willow Creek.
110	1415	.001	---	---	.004	1,240:1	Angular gravel in placer cut; Wolf Creek.
111	1416	.001	---	---	.003	1,470:1	Stream gravel; Chatham Creek.

See footnotes at the end of the table.

Table 1.—Data on radioactivity tests in areas adjacent to highways in the Tanana and upper Copper River valleys, Alaska—Continued

Test station	Sample file no.	Percent equivalent uranium: OT	Percent equivalent uranium: UCS	Percent equivalent uranium: BC-CS	Percent equivalent uranium: BC-PC	Concentration ratio	Description and location
Pedro Dome area—Continued							
PD 112	1417	<0.001	---	---	<0.001	120:1	Angular gravel; Bellows Creek.
113	1418	.001	---	---	.001	330:1	Angular gravel; Solo Creek.
114	1419	.001	---	---	.001	540:1	Angular gravel; south tributary of Fairbanks Creek.
115	1420	<.001	---	---	<.001	1,770:1	Angular gravel from cut in stream bank; west tributary of Fox Creek.
116	1421	.001	---	---	.005	1,510:1	Angular gravel from test pit; Big Eldorado Creek.
117	1422	<.001	---	---	<.001	830:1	Angular gravel from test pit; northwest tributary of Big Eldorado Creek.
Ester Dome area (fig. 4)							
ED 1	1530L	0.001	<0.001	<0.001	---	19:1	Massive quartz vein in drift; Michley mine on Sheep Creek.
2	1531L	.002	.002	---	---	---	Shear zone in schist; Michley mine on Sheep Creek.
3	1532L	.001	.002	.002	---	48:1	Mineralized part of quartz vein; Michley mine on Sheep Creek.
4	1423	.001	---	---	.004	390:1	Stream gravel; Sheep Creek below Michley mine.
5	1533L	.002	.002	.004	---	28:1	Rock material from mine dump; Bondholder mine.
6	----	.002	---	---	---	---	Rock material on mine dump; Mohawk(?) mine.
7	1424	.002	---	---	.007	400:1	Stream gravel; St. Patrick Creek.
8	1425	.001	---	---	.004	810:1	Stream gravel from test pit; Ready Bullion Creek.
9	----	.002	---	---	---	---	Rock material on mine dump; Farmer(?) mine at head of Ready Bullion Creek.
10	----	.001	---	---	---	---	Do.
11	1534L	.003	.003	.005	---	19:1	Do.
12	1535L	.001	<.001	<.001	---	24:1	Do.
13	1426L	.004	---	---	.005	1,080:1	Rock material on mine dump; Clipper mine on Eva Creek.
14	----	.004	---	---	---	---	Do.
15	----	.001	---	---	---	---	Rock material on mine dump; drift below Clipper mine on Eva Creek.
16	----	.004	---	---	---	---	Do.
17	1427	.001	---	---	.004	1,100:1	Stream gravel from test pit; Moose Gulch.
18	----	.001	---	---	---	---	Do.
19	1428	.002	---	---	.004	1,240:1	Stream gravel from test pit; Eva Creek below Clipper mine.
20	----	.002	---	---	---	---	Mine dump; at prospect shaft on trail to summit of Ester Dome.
21	----	.003	---	---	---	---	Do.
22	----	.002	---	---	---	---	Weathered schist; trench near station ED 20.
23	----	.003	---	---	---	---	Do.
24	----	.001	---	---	---	---	Weathered antimony ore; trench near station ED 20.
25	----	.002	---	---	---	---	Mine dump; at inclined shaft about 0.2 mile southwest of summit of Ester Dome.
26	----	.002	---	---	---	---	Do.
27	----	.001	---	---	---	---	Selected pieces of sulphide ore; same location as station ED 25.
28	1523L	---	.005	<.001	---	(?)	Vein material(?); Michley mine.
29	1524L	---	.001	.003	---	8:1	Vein material(?); Hudson mine.

30	1525L	---	.002	---	---	---	Vein material(?); Sanford prospects.
31	1529L	---	<.001	.001	---	7:1	Vein material(?); Little Eva mine.
				Steese Highway belt in upper Chatanita valley (fig. 5)			
UC 1	1429	0.001	---	---	<0.001	(?)	Stream gravel; McManus Creek about halfway between Montana and Idaho Creeks.
2	1430	.001	---	---	<.001	100:1	Do.
3	----	<.001	---	---	---	---	Do.
4	----	.001	---	---	---	---	Do.
5	----	.001	---	---	---	---	Do.
6	----	.001	---	---	---	---	Stream gravel from prospect pit; Idaho Creek about 250 feet above highway bridge.
7	----	.001	---	---	---	---	Do.
8	1431	.001	---	---	.001	90:1	Do.
9	----	.001	---	---	---	---	Do.
10	----	.001	---	---	---	---	Stream gravel from prospect pit; Idaho Creek about 3,000 feet above highway bridge.
11	1432	.001	---	---	<.001	130:1	Do.
12	1539L	.005	0.004	0.017	---	267:1	Porphyritic biotite granite boulders and pebbles; same location as station UC 10.
13	----	.001	---	---	---	---	Schist boulders; same location as station UC 10.
14	----	.001	---	---	---	---	Stream gravel; Montana Creek about 25 feet above highway bridge.
15	1433	.001	---	---	<.001	120:1	Do.
16	----	.001	---	---	---	---	Stream gravel; Montana Creek about 0.5 mile above highway bridge.
17	1434	.001	---	---	.002	160:1	Do.
18	----	.001	---	---	---	---	Stream gravel; North Fork of Twelvemile Creek (Circle district).
19	----	.001	---	---	---	---	Weathered igneous cobbles (granite?); North Fork of Twelvemile Creek (Circle district).
20	----	<.001	---	---	---	---	Stream gravel; same location as station UC 19.
21	1435	.001	---	---	<.001	45:1	Do.
22	1436	<.001	---	---	<.001	90:1	Stream gravel; Twelvemile Creek (Circle district) above mouth of North Fork.
23	1437	.001	---	---	.001	110:1	Bench gravel; Faith Creek, trench in northwest bank about 0.5 mile above mouth.
24	----	.001	---	---	---	---	Bench gravel; trench about 400 feet northeast of station UC 23.
25	1438	.001	---	---	.002	280:1	Bench gravel; trench about 100 feet east of station UC 24.
26	----	.001	---	---	---	---	Do.
27	----	.001	---	---	---	---	Bench gravel; trench about 200 feet northeast of station UC 25.
28	----	.001	---	---	---	---	Stream gravel; Smith Creek about 0.25 mile above mouth.
29	----	.001	---	---	.004	380:1	Do.
30	----	.001	---	---	---	---	Bench gravel; same location as station UC 28.
31	1540L	.003	.001	.003	---	133:1	Weathered gray-black micaceous schist (fault gouge?) Steese Highway, Mile 70.2.
32	----	.003	---	---	---	---	Do.
33	----	.003	---	---	---	---	Do.
34	----	.002	---	---	---	---	Weathered quartz mica schist; Steese Highway, Mile 70.2.
35	----	.002	---	---	---	---	Do.
36	1541L	.002	.002	---	---	---	Do.
37	----	<.001	---	---	---	---	Stream gravel; Faith Creek about 5 miles above mouth.

See footnotes at the end of the table.

Table 1.—Data on radioactivity tests in areas adjacent to highways in the Tanana and upper Copper River valleys, Alaska—Continued

Test station	Sample file no.	Percent equivalent uranium				Concentration ratio	Description and location
		OT	UCS	BC-CS	BC-PC		
Steese Highway belt in upper Chatanita valley—Continued							
UC 38	----	---	---	---	0.001	(?)	About ½ cubic foot sluice concentrates after removal of gold; Deep Creek; workings of Deep Creek Mining Co.
39	1440	0.001	---	---	.001	95:1	Stream gravel; Cripple Creek about 50 feet above highway bridge.
40	1441	.001	---	---	.002	350:1	Bench gravel; Flat Creek.
41	1442	.001	---	---	.002	190:1	Stream gravel; Belle Creek about 100 feet above highway bridge.
42	1542L	.003	0.004	<0.001	---	(?)	Weathered graphitic schist; Steese Highway, Mile 64.3.
43	----	<.001	---	---	---	---	Weathered gray schist; Steese Highway, Mile 64.3.
44	----	.001	---	---	---	---	Graphitic schist; Steese Highway, Mile 64.3.
45	1443	---	---	---	.012	(?)	Dredge concentrate; Deadwood Mining Co. mining operations on Nome Creek.
Livengood area (fig. 6)							
L 1a	1555L	0.001	---	<0.001	---	1.4:1	Mineralized zone in altered limestone; prospect shaft on Money Knob.
1b	----	<.001	---	---	---	---	Do.
2	----	<.001	---	---	---	---	Iron-stained chert; prospect shaft on Money Knob.
3a	----	.001	---	---	---	---	Altered shale; Livengood Ridge.
3b	1543L	.003	0.005	.003	---	187:1	Weathered granite float; Livengood Ridge.
4	----	.001	---	---	---	---	Black shale; Livengood Ridge.
5	----	<.001	---	---	---	---	Black siliceous rock; west spur of Amy Dome.
6	----	<.001	---	---	---	---	Shear zone in basic volcanic rocks; west spur of Amy Dome.
7	----	<.001	---	---	---	---	Basic volcanic rocks; west spur of Amy Dome.
8	----	<.001	---	---	---	---	Coarse-grained diorite; Amy Dome.
9a	----	<.001	---	---	---	---	Diorite; Amy Dome.
9b	----	<.001	---	---	---	---	Weathered diorite; Amy Dome.
10	----	.001	---	---	---	---	Black shale; Livengood road at Olive Creek.
11	1447	---	---	---	<.001	1,500:1	Stream gravel; McCord Creek near mouth.
12	1448	.001	---	---	<.001	1,300:1	Bench gravel on bedrock; low bench of Tolovana River downstream from mouth of McCord Creek.
13	----	.001	---	---	---	---	Fissile black shale containing thin beds of gray sandstone; Livengood road just north of Tolovana River.
14	1449	<.001	---	---	<.001	250:1	Stream gravel from test pit; small unnamed tributary of Tolovana River on south side of Amy Dome, 2.1 miles east of Ester Creek,
15	1450	---	---	---	<.001	570:1	Stream gravel; Ester Creek near bridge over Livengood road.
16a	1553L	.002	.002	.006	---	152:1	Black shale; Livengood road near Cleary Creek.
16b	----	.001	---	---	---	---	Do.
16c	----	.001	---	---	---	---	Conglomerate lens in black shale; Livengood road near Cleary Creek.
17a	----	.001	---	---	---	---	Black shale; Livengood road about 1.2 miles east of Ester Creek.
17b	----	.001	---	---	---	---	Do.
18a	1452	---	---	---	.003	(?)	Sluice concentrate; Parkers' claims on Olive Creek.
18b	1453	---	---	---	.001	(?)	Sluice concentrate after retorting; Parkers' claims on Olive Creek.
19	1454	---	---	---	.004	1,800:1	Stream gravel on bedrock; Jurich's claim on Lillian Creek.
20	1455	---	---	---	<.001	(?)	Sluice concentrate; Well's cut on Amy Creek.

	21	1456	---	---	---	<.001	8,790:1	Bench(?) gravel; from gravel pit on divide between Livengood and Hess Creeks.
	22	1544L	.001	<.001	.001	---	17:1	Weathered chert; south slope of Livengood Dome.
	23	----	<.001	---	---	---	---	Do.
	24a	1457A	---	---	---	.002	(?)	Gravel from drift dump pile; drift on Goodluck Creek.
	24b	1457B	---	---	---	.002	200:1	Tailings; drift on Goodluck Creek.
	25a	----	<.001	---	---	---	---	Mineralized vein in altered limestone; north slope of Money Knob.
	25b	----	<.001	---	---	---	---	Do.
	26	----	<.001	---	---	---	---	Rock material on mine dump; from drift on vein at same location as station L 25.
	27	1446A	---	---	---	.010	(?)	Coarse fraction of sluice concentrate; Radak's cut on Ruth Creek.
		1446B	---	---	---	[1] .009	(?)	Fine fraction of sluice concentrate; Radak's cut on Ruth Creek.
	28	1451	---	---	---	.003	(?)	Sluice concentrate; Benn Falls' workings on Wilbur Creek.
								Harding Lake—Richardson area (fig. 7)
R	1a	1459L	0.006	0.004	---	0.009	1,910:1	Weathered granite; south shore of Birch Lake on south side of Richardson Highway.
	1b	----	.004	---	---	---	---	Do.
	1c	----	.004	---	---	---	---	Fine-grained granitic dike; same location as station R 1a.
	2a	----	.004	---	---	---	---	Porphyritic granite; about 1 mile east of station R 1 on south side of Richardson Highway.
	2b	----	.002	---	---	---	---	Mafic inclusion in granite; same location as station R 2a.
	2c	----	.004	---	---	---	---	Pegmatitic phase of granite; same location as station R 2a.
	2d	----	.005	---	---	---	---	Fine-grained phase of granite; same location as station R 2a.
	3	----	.003	---	---	---	---	Weathered granite; about 500 feet east of station R 2 on north side of Richardson Highway.
	4a	1460AL	.005	.002	0.060	---	185:1	Fine-grained light-colored (granitic?) dike; same location as station R 3.
		1460BL	---	---	---	.110	(?)	Do.
	5a	----	.004	---	---	---	---	Same as station R 4a.
	7a	----	.003	---	---	---	---	Do.
	8a	----	.004	---	---	---	---	Do.
	9a	----	.004	---	---	---	---	Do.
	5b	----	.003	---	---	---	---	Weathered granite on northwest side of fine-grained dike; same location as station R 3.
	7b	----	.003	---	---	---	---	Do.
	8b	----	.002	---	---	---	---	Do.
	4c	----	.003	---	---	---	---	Weathered granite on southeast side of fine-grained dike; same location as station R 3.
	5c	----	.003	---	---	---	---	Do.
	8c	----	.002	---	---	---	---	Do.
	9c	----	.003	---	---	---	---	Do.
	6	----	.003	---	---	---	---	Mafic zone along side of dike; same location as station R 3.
	10a	1461	.001	---	---	.001	450:1	Bench(?) gravel of Tanana River; south side of Richardson Highway, Mile 309.4.
	10b	----	<.001	---	---	---	---	Do.
	11a	----	.003	---	---	---	---	Weathered porphyritic granite; south side of Richardson Highway, Mile 310.7.
	11b	----	.003	---	---	---	---	Do.
	11c	----	.002	---	---	---	---	Mafic inclusion in granite; same location as station 11a.

See footnotes at the end of the table.

Table 1.—Data on radioactivity tests in areas adjacent to highways in the Tanana and upper Copper River valleys, Alaska—Continued

Test station	Sample file no.	Percent equivalent uranium				Concentration ratio	Description and location
		OT	UCS	BC-CS	BC-PC		
				Harding Lake—Richardson area—Continued			
R 12	1462	---	---	---	0.004	430:1	Stream gravel; left bank of Salcha River about 300 feet above highway bridge.
13a	----	0.004	---	---	---	---	Weathered granite; east shore of Birch Lake on north side of Richardson Highway.
13d	----	.003	---	---	---	---	Do.
13b	----	.005	---	---	---	---	Fine-grained light-colored (granitic?) dike; same location as station R 13a.
13c	----	.004	---	---	---	---	Do.
14a	1556L	.005	0.004	0.005	---	65:1	Coarse-grained granitic dike; Richardson Highway, Mile 313.9.
14b	----	.004	---	---	---	---	Do.
14c	----	.002	---	---	---	---	Fine-grained border zone of granitic dike; same location as station R 14a.
14d	----	.002	---	---	---	---	Quartz mica schist adjacent to granitic dike; same location as station R 14a.
15	----	.003	---	---	---	---	Granitic dike; Richardson Highway, Mile 314.5.
16	----	.001	---	---	---	---	Yellow-stained zone in schist adjacent to fractured quartz vein; Richardson Highway, Mile 314.7.
17	----	.003	---	---	---	---	Weathered igneous (granitic?) dike in schist; Richardson Highway, Mile 314.8.
18	----	.002	---	---	---	---	Fine-grained mafic dike in schist; Richardson Highway, Mile 314.85.
19a	----	.004	---	---	---	---	Weathered granite; Richardson Highway, Mile 304.65.
19b	----	.003	---	---	---	---	Iron-stained quartz vein in granite; Richardson Highway, Mile 304.65.
19c	----	.003	---	---	---	---	Do.
20	----	.002	---	---	---	---	Altered limestone containing streaks of graphitic schist and a few thin quartz veins; Richardson Highway, Mile 302.65.
21	----	<.001	---	---	---	---	Dark-colored dune sand; Richardson Highway, Mile 301.75.
22	1463	.001	---	---	.004	950:1	Stream gravel; unnamed tributary of Tanana River at Mile 299.8, Richardson Highway.
23	1464	.001	---	---	.008	660:1	Bench gravel; Banner Creek about 100 feet above highway bridge.
24	1465	---	---	---	[1] .020	1,590:1	Gravel from old drift dump; near mouth of Buckeye Creek.
25a	1466	<.001	---	---	.009	1,180:1	Bench gravel on bedrock; Tanana River at Mile 296.9, Richardson Highway.
25b	1557L	.002	.001	.005	---	3:1	Graphitic schist; same location as station R 25a.
26	1467	---	---	---	.005	590:1	Gravel from old drift dumps; Tenderfoot Creek at Mile 293.7, Richardson Highway.
27	1468	---	---	---	.005	790:1	Gravel from bottom of 100 foot shaft; claim 13 at Mile 292.1, Richardson Highway.
				Alaska Highway belt (fig. 8)			
AH 1a	1469	0.002	---	---	[1] 0.014	1,830:1	Bench gravel; Berry Creek about 300 feet above highway bridge.
1b	1558L	.001	< 0.001	0.004	---	4:1	Coarse-grained granite in bank of creek; same location as station AH 1a.

AH 1c	----	.002	---	---	---	---	Stream gravel; same location as station AH 1a.
1d	----	.002	---	---	---	---	Bench gravel; same location as station AH 1a.
2	1470	.002	---	---	.001	790:1	Stream gravel; Berry Creek about 0.25 mile above highway bridge.
3	1471	.001	---	---	.006	1,630:1	Stream gravel; Sears Creek about 0.25 mile above highway bridge.
4	1472	.002	---	---	.008	1,010:1	Stream gravel; Dry Creek about 250 feet above highway bridge.
5	1473	.001	---	---	[1] .001	670:1	Stream gravel; Little Gerstle River about 300 feet above highway bridge.
6	1474	.001	---	---	.003	560:1	Glacial gravel; Alaska Highway, Mile 1,387, near mouth of Johnson River.
7	----	.002	---	---	---	---	Granite; Alaska Highway, Mile 1,368.9.
8	1559L	.003	.003	.005	---	8:1	Granite; Alaska Highway, Mile 1,368.7.
9	1475	---	---	---	.007	520:1	Stream gravel; Chief Creek about 75 feet above highway bridge.
10a	----	.001	---	---	---	---	Granite, unweathered; Alaska Highway, Mile 1,359.3.
10b	----	.002	---	---	---	---	Granite, weathered; Alaska Highway, Mile 1,359.3.
11	1476	---	---	---	.003	280:1	Stream gravel; unnamed tributary of Tanana River at Mile 1,350, Alaska Highway.
12	1477	---	---	---	.003	340:1	Stream gravel; flood channel of unnamed tributary of Tanana River at Mile 1,345, Alaska Highway.
13	1478	---	---	---	.003	400:1	Stream gravel; main channel of same creek as at station AH 12, crosses Alaska Highway at Mile 1,344.6.
14	1479	---	---	---	.003	260:1	Stream gravel; Yerrick Creek about 100 feet above highway bridge.
15a	----	.003	---	---	---	---	Granite (slope wash?); in road-metal quarry about 0.5 mile east of intersection of old road with Alaska Highway near Mile 1,335.
15b	1480	.004	---	---	[1] .008	180:1	Do.
16a	----	.002	---	---	---	---	Weathered gneiss; Alaska Highway, Mile 1,292.1.
16b	----	.001	---	---	---	---	Crushed zone (gouge?) in weathered gneiss; Alaska Highway, Mile 1,292.1.
17a	1481L	.005	---	---	[1] .064	2,200:1	Weathered granite; Alaska Highway, Mile 1,292.8.
17b	----	.003	---	---	---	---	Do.
17c	----	.004	---	---	---	---	Do.
18	----	.003	---	---	---	---	Mafic (basalt?) dike in weathered granite; Alaska Highway, Mile 1,292.9.
19a	----	.002	---	---	---	---	Weathered mafic (basalt?) rock along fracture in weathered granite; Alaska Highway, Mile 1,293.0.
19b	----	.003	---	---	---	---	Yellow-brown rock in fracture zone in weathered granite; 25 feet west of location of station AH 19a.
20	1482	.001	---	---	<.001	130:1	Dark-colored wind-blown silt(?), Alaska Highway, Mile 1,299.7.
21a	----	.002	---	---	---	---	Weathered granite; Alaska Highway, Mile 1,304.0.
21b	----	.002	---	---	---	---	Iron-stained fracture zone in weathered granite; Alaska Highway, Mile 1,304.0.
22	----	.002	---	---	---	---	Cemented breccia zone in weathered granite; Alaska Highway, Mile 1,304.2.
23	1660L	---	.003	.004	---	20:1	Mafic dike in weathered granite; Alaska Highway, Mile 1,304.4.
24	----	.003	---	---	---	---	Brown-black stained zone in weathered granite; Alaska Highway, Mile 1,308.5.
25a	----	.003	---	---	---	---	Weathered granite; Alaska Highway, Mile 1,290.0.
25b	1581L	.004	.005	.007	---	236:1	Light-colored felsitic dike; Alaska Highway, Mile 1,290.0.
25c	----	.001	---	---	---	---	Mafic dike; Alaska Highway, Mile 1,290.0.
25d	----	.004	---	---	---	---	Weathered granite; Alaska Highway, Mile 1,290.0.
26	1483L	.003	---	---	[1] .025	2,700:1	Weathered granite; Alaska Highway, Mile 1,286.9.
27a	----	.003	---	---	---	---	Weathered fine-grained granite (dike?); Alaska Highway, Mile 1,283.8.

See footnotes at the end of the table.

Table 1.—Data on radioactivity tests in areas adjacent to highways in the Tanana and upper Copper River valleys, Alaska—Continued

Test station	Sample file no.	Percent equivalent uranium				Concentration ratio	Description and location
		OT	UCS	BC-CS	BC-PC		
							Alaska Highway belt—Continued
AH 27b	----	0.003	---	---	---	---	Weathered coarse-grained granite; Alaska Highway, Mile 1,283.8.
28	1484	---	---	---	0.002	360:1	Stream gravel, but includes some reworked dark-colored wind-blown silt(?); Bitters Creek at Mile 1,282.2, Alaska Highway, about 300 feet above highway bridge.
29a	----	.004	---	---	---	---	Weathered granite gneiss; Alaska Highway, Mile 1,278.7.
29b	1485	.004	---	---	[1] .005	5,600:1	Slope wash from weathered granite gneiss; Alaska Highway, Mile 1,278.7.
30	1661L	.003	0.004	0.004	---	80:1	Rhyolite(?) dike; Alaska Highway, Mile 1,277.0.
31a	----	<.001	---	---	---	---	Hornblende(?) schist; Alaska Highway, Mile 1,269.8.
31b	1662L	.003	.003	.010	---	1,120:1	Weathered felsitic(?) dike; Alaska Highway, Mile 1,269.8.
32a	----	.002	---	---	---	---	Granite near contact with schist; Alaska Highway, Mile 1,238.9.
32b	----	.002	---	---	---	---	Quartzitic schist; Alaska Highway, Mile 1,238.9.
32c	----	.001	---	---	---	---	Schist near granite contact; Alaska Highway, Mile 1,238.9.
32d	----	.001	---	---	---	---	Granite; Alaska Highway, Mile 1,238.9.
33	1486	---	---	---	.006	930:1	Slope wash from schist; Alaska Highway, Mile 1,232.5.
34a	----	.001	---	---	---	---	Weathered iron-stained rock (igneous?) in schist; Alaska Highway, Mile 1,230.3.
34b	----	<.001	---	---	---	---	Schist; Alaska Highway, Mile 1,230.3.
35	1487	---	---	---	[1] .002	4,930:1	Slope wash from schist; Alaska Highway, Mile 1,229.4.
36a	----	.003	---	---	---	---	Hematite-stained granite; Alaska Highway, Mile 1,253.
36b	1546L	.004	<.001	.023	---	55:1	Weathered granite; Alaska Highway, Mile 1,253.2.
	1488L	.004	---	---	[1] .010	7,820:1	Do.
37	1489L	.004	---	---	.027	5,670:1	Weathered granite; Alaska Highway, Mile 1,257.4.
38	----	.004	---	---	---	---	Weathered granite; Alaska Highway, Mile 1,257.7.
39	----	.004	---	---	---	---	Weathered granite; Alaska Highway, Mile 1,261.0.
40	1547L	.004	.001	.013	---	12:1	Weathered granite; Alaska Highway, Mile 1,263.1.
	1490L	.004	---	---	[1] .074	1,680:1	Do.
41	1560L	.001	.003	.002	---	21:1	Sulphide-rich zone in granite; Alaska Highway, Mile 1,265.0 (Northway Junction).
							Highway area between Slana and Tok Junction (fig. 9)
TC 1	1491	---	---	---	0.001	680:1	Stream gravel; Station Creek about 0.5 mile above highway bridge.
2	1492	---	---	---	.001	680:1	Stream gravel; unnamed tributary of Mentasta Creek about 2.5 miles east of Station Creek, about 1 mile above highway bridge.
3	1493	---	---	---	.001	270:1	Bench(?) gravel; unnamed tributary of Mentasta Creek about 4.5 miles east of Station Creek, about 0.5 mile above highway bridge.
4	1494	---	---	---	.002	550:1	Pan gravel; unnamed tributary of Mentasta Creek about 6.6 miles east of Station Creek.
5	1495	---	---	---	.003	890:1	Pan gravel; unnamed tributary of Mentasta Creek about 9.2 miles east of Station Creek.

6	1496	<.001	---	---	.001	170:1	Pan gravel from test pit; unnamed tributary of Little Tok River about 1 mile below Trail Creek, about 100 feet above highway bridge.
7	1497	---	---	---	.002	590:1	Pan gravel in cut bank of stream; unnamed tributary of Little Tok River about 4 miles below Trail Creek, above highway bridge.
8	1498	---	---	---	.002	590:1	Pan gravel in cut bank of stream; unnamed tributary of Little Tok River about 5.5 miles below Trail Creek, above highway bridge.
9	1499	---	---	---	.003	350:1	Pan gravel in cut bank of stream; unnamed tributary of Tok River about 5.5 miles northeast of location of station TC 8.
10	1500	---	---	---	<.001	230:1	Glacio-fluvial gravel; in road cut, Tok River valley, at mouth of Little Tok River.
11	1501	---	---	---	.003	670:1	Stream gravel; unnamed tributary of Tok River about 5.5 miles below Little Tok River.
12a	----	.001	---	---	---	---	Weathered rock on mine dump; Silver Creek about 0.5 mile above tractor trail.
12b	1503	<.001	---	---	<.001	140:1	Angular gravel (slope wash?) on low bench; same location as station TC 12a.
12c	1562L	<.001	.005	.001	---	3:1	Weathered bedrock; same location as station TC 12a.
12d	1561L	.001	<.001	<.001	---	19:1	Sulphide-rich quartz vein; same location as station TC 12a.
12e	1502	---	---	---	<.001	135:1	Stream gravel; same location as station TC 12a.
13	1504	---	---	---	<.001	65:1	Pan gravel from cut bank; first right limit tributary of "Indian Pass" Creek.
14	1505	---	---	---	<.001	140:1	Pan gravel; third left limit tributary of "Indian Pass" Creek.
15	1506	---	---	---	[1] <.001	8,530:1	Pan gravel from test pit; first left limit tributary of "Indian Pass" Creek.
16	----	.001	---	---	---	---	Weathered diorite(?); Tok cutoff road near Mile 12.
17	1507	---	---	---	<.001	200:1	Bench gravel on bedrock; second right limit tributary of Slana River above Porcupine Creek.
18	1508	---	---	---	.001	(?)	Sluice concentrate; upper workings on Grubstake Creek.
19	1552A	---	---	---	<.001	(?)	Sluice concentrate; Bronniche's workings on Slope Creek.
	1552B	---	---	---	<.001	(?)	Coarse fraction of sluice concentrate; Bronniche's workings on Slope Creek.
Donnelly Dome—Paxson area (fig. 10)							
RH 1	1509	---	---	---	<0.001	120:1	Glacio-fluvial gravel; Gulkana River about 1 mile below toe of glacier.
2	1510	---	---	---	<.001	400:1	Pan gravel; right limit tributary of Phelan Creek about 4.5 miles above mouth of Phelan Creek.
3	1511	---	---	---	.001	250:1	Pan gravel; right limit tributary of Phelan Creek about 3.5 miles above mouth of Phelan Creek.
4	1512	---	---	---	<.001	350:1	Pan gravel; right limit tributary of Phelan Creek about 2 miles above mouth of Phelan Creek.
5	1513	---	---	---	<.001	300:1	Bench gravel; Delta River about 0.25 mile below mouth of Phelan Creek, Yukon Corp. workings.
6	1514	---	---	---	.003	480:1	Stream gravel; right limit tributary of Delta River about 2.25 miles below Castner Creek.
7	1515	---	---	---	.003	500:1	Stream gravel; right limit tributary of Delta River about 3.25 miles below Castner Creek.
8	1516	---	---	---	.002	310:1	Stream gravel; right limit tributary of Delta River about 4.25 miles below Castner Creek.

See footnotes at the end of the table.

Table 1.—Data on radioactivity tests in areas adjacent to highways in the Tanana and upper Copper River valleys, Alaska—Continued

Test station	Sample file no.	Percent equivalent uranium				Concentration ratio	Description and location
		OT	UCS	BC-CS	BC-PC		
Donnelly Dome—Paxson area—Continued							
RH 9	1517	---	---	---	0.002	360:1	Stream gravel; right limit tributary of Delta River about 6.25 miles below Castner Creek.
10	1518	---	---	---	.003	410:1	Stream gravel; Darling Creek about 0.25 mile above highway bridge.
11	1519	---	---	---	.004	480:1	Pan gravel in cut bank; Gunnysack Creek about 0.25 mile above highway bridge.
12	1520	---	---	---	.003	(?)	Stream gravel; Clear Creek below falls near highway.
13a	1521	---	---	---	.004	430:1	Stream gravel; Ober Creek valley of DeWitt's workings.
13b	1444	---	---	---	.007	(?)	Concentrates from drill-hole pannings; Ober Creek valley, DeWitt's workings.
14	1522	---	---	---	.003	(?)	Stream gravel on bedrock; Ober Creek valley, old Miller cut near mouth of Mineral Creek.
15	1522A	---	---	---	[2] .011	(?)	Panned concentrates obtained from operator; Ober Creek valley, old cut about 300 feet above location of station RH 14.

[1] Methylene iodide used instead of bromoform for concentration.
[2] Minus 60-mesh fraction tested instead of minus 20-mesh fraction.

CHAPTER B.—GRANT CREEK AREA

By P. L. Killeen and M. G. White

ABSTRACT

In August 1946 field search failed to locate a reported occurrence of float from pitchblende veins in the Grant Creek area north of the Yukon River about 30 miles west of Tanana in eastern interior Alaska. The late Walter Fisher, placer-gold miner on Grant Creek, reported the occurrence to the Geological Survey. It is believed that fragments of black hematite were mistaken for pitchblende.

INTRODUCTION

Purpose and scope of investigation

In the fall of 1945 the late Walter Fisher, Alaskan placer-gold miner, reported to R. M. Chapman of the Geological Survey at Fairbanks an occurrence of pitchblende veinlets in hillside float along a tractor trail near his placer-mining property on Grant Creek in the Yukon valley. During the winter of 1945-46 no correspondence was exchanged with Mr. Fisher on the subject of the pitchblende because of the security regulations in effect at that time.

In August 1946 a Geological Survey field party went to Grant Creek to investigate the reported pitchblende. The party consisted of P. L. Killeen and M. G. White, geologists, and R. D. Hamilton, camphand. When the party arrived at Grant Creek, it was learned of Mr. Fisher's death earlier in the summer. The Fisher mine was closed, and none of the residents in the area had any information about the reported deposits. Thus, no direct information was available as to the location of the pitchblende, and a search was made of the area to determine whether the report had any significance.

Location of area

Grant Creek enters the Yukon River from the north about 30 miles west from Tanana in central Alaska (fig. 11). The area is accessible from Tanana by boat. In addition to Grant Creek the following other areas were examined during this investigation: the headwaters of Tozimoran Creek, a tributary of the Tozitna River which enters the Yukon River about midway between Grant Creek and Tanana; and the headwaters of Melozimoran Creek, a tributary of the Melozitna River which enters the Yukon River in the vicinity of Ruby about 100 miles west of Tanana.

GEOLOGY

The geology of the Grant Creek area was discussed briefly by Maddren (1909, p. 234-237; 1910, p. 80-83) and Eakin (1913, 1916). Maddren's two reports contain short accounts of the geology of the area gathered during brief investigations of the placer-mining activities in the area. Eakin's two reports were based on geological reconnaissance investigations on a regional scale in which the Grant Creek area is included. No details, however, of the areal distribution, age, and structural relations of the individual rock types in the Grant Creek area are known.

The Grant Creek area is part of a broad zone of metamorphosed rocks that are well developed on the north side of the Yukon valley between the Koyukuk River and the Yukon Flats. The rocks are thought to be early Paleozoic in age. A complex of intensely folded and metamorphosed schist, limestone, quartzite, and greenstone occurs within the area.

Pebbles with quartz stringers occur in the placer cuts on Grant Creek. The quartz stringers in the bedrock are probably the source of some of the placer gold. Some pebbles of a medium-grained pegmatite are also present in the gravels.

A monzonite mass mapped by Eakin (1913, p. 16) at the head of Golden Creek (fig. 11) was not found. The rock at that locality consists of mica schist and greenstone. A granitic intrusion of unknown areal extent was found at the head of Melozimoran Creek.

RADIOACTIVITY

The principal objective of the investigation in the Grant Creek area was the examination of an area adjacent to a tractor trail along which the late Walter Fisher had reported finding float from a pitchblende-bearing vein. When the search along this trail failed to reveal any deposits of radioactive materials, the investigation was extended to other trails and intervening areas. All possible materials representative of the bedrock in the area (outcrops, talus, and fragments selected from the soil mantle) were tested, particularly at places where there were traces of mineralization. Only a few concentrates of the heavy minerals in the stream gravels were collected for testing (table 2). The radioactivity tests in the Grant Creek area were made with a portable survey meter designed by the Geological Survey. The background for this meter in this area averaged 8 to 10 counts per minute.

Locations of tests

The main tractor trail in the Grant Creek area extends from the Yukon River to Fisher's camp on upper Grant Creek, a distance of about 4 miles (fig. 11). The southern portion of this trail has been shifted

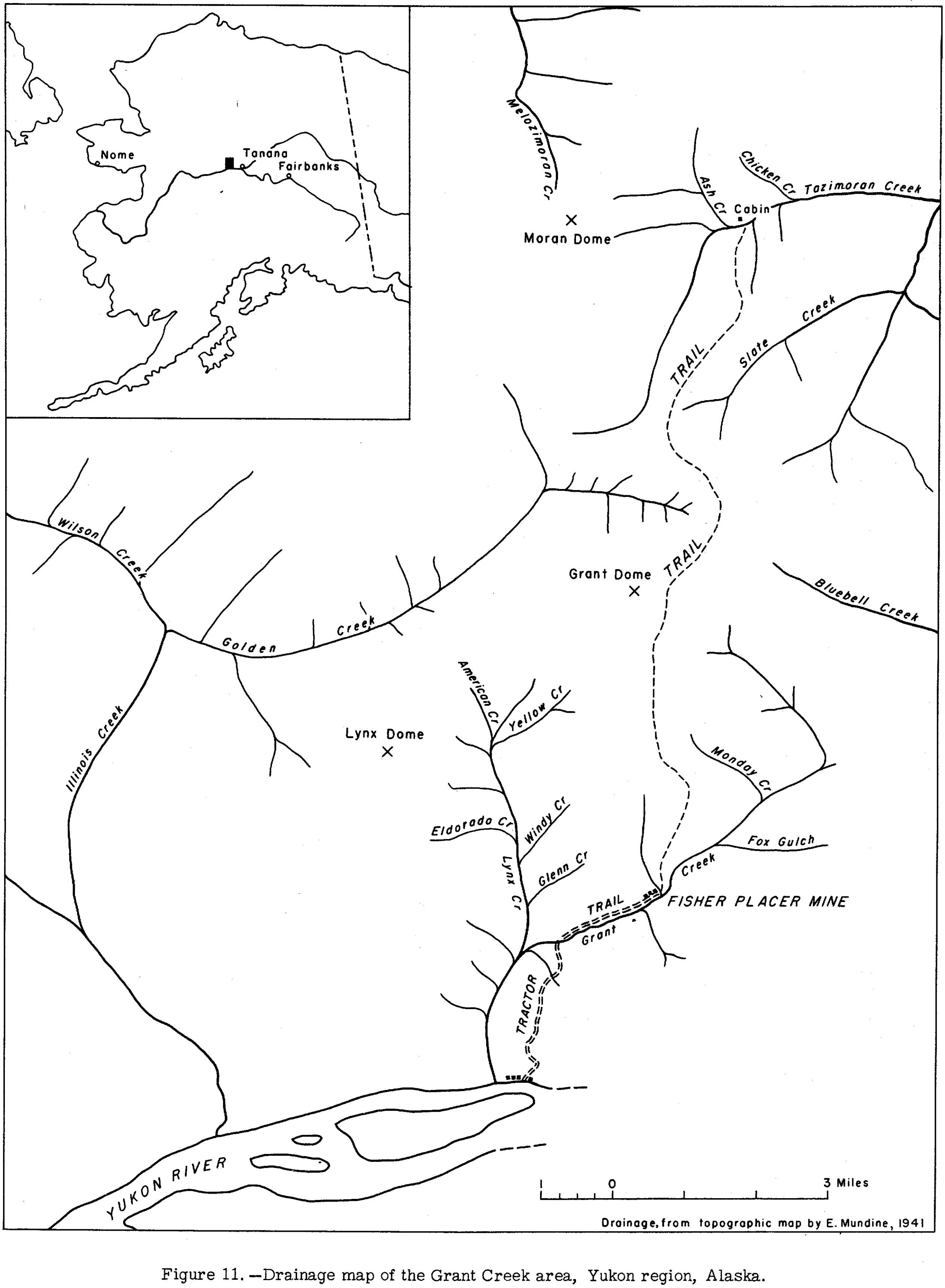

Figure 11.—Drainage map of the Grant Creek area, Yukon region, Alaska.

Table 2.—Data on placer concentrates from Grant and Tozimoran creeks, Alaska

Alaskan Concentrate file no.	Equivalent uranium content of concentrate (percent)	Concentration ratio	Location
			Grant Creek
733	0.005	(?)	Fisher's placer cut, 1942.
1360	.008	8,110:1	Fisher's placer cut, 1946.
1361	.008	5,125:1	Monday Creek, at footbridge about 60 feet above mouth, in Grant Creek valley.
1362	.005	1,790:1	Monday Creek, at tractor-trail crossing just above edge of Grant Creek valley.
1363	.007	11,350:1	Southern of two gulches on east side of Grant Creek, opposite Fisher's camp below Monday Creek.
445	---	(?)	Berton claim of the Tozi or Gold Hill district; probably from former prospects of Berton Anicish of Lynx Creek.
			Tozimoran Creek
528	0.001	(?)	Tozimoran Creek, between its tributaries, Chicken and Ash creeks.
721	---	(?)	Do.
722	.001	(?)	Do.
723	.001	(?)	Do.
724	.001	(?)	Do.
725	.001	(?)	Do.
729	.001	(?)	Do.
730	---	(?)	Do.
731	.001	(?)	Do.
739	.001	(?)	Do.

successively uphill as the lower route became boggy. Traces of the older, abandoned parts of the trail still remain. A less distinct tractor trail runs via Lynx Creek and Windy Creek to some prospect pits. A third and more prominent trail, cleared by ax and bulldozer for a railroad survey, follows the north bank of the Yukon River eastward from the mouth of Grant Creek. It was included in the investigation because many of Fisher's more recently staked claims were in that general area. A few short old tractor trails were found on the upper part of Grant Creek above Fisher's mine; some lead to wood lots, others to drilling sites as far upstream as the mouth of Fox Gulch. Other narrower lines have been brushed out along many of the boundaries of Fisher's claims. A prominent horse trail extends from Fisher's camp to the head of Tozimoran Creek via Grant Dome.

All occurrences of bedrock along the above trails and in much of the intervening area were examined. Pieces of float were also tested. A portable survey meter was operated continuously over many parts of the trails, and individual stations were selected arbitrarily for taking 5-minute readings. No radioactive material was indicated by these tests.

A short time was spent investigating the area in the vicinity of the headwaters of Tozimoran Creek. At this locality galena veins occur on the south side of the creek, and cassiterite is present in the gravels. The source of the cassiterite could not be located. No other evidence of important mineralization was found, and no appreciable radioactivity was detected anywhere in the area. In table 2 are listed the available data on samples from Tozimoran Creek.

An attempt was made to examine the granitic intrusion on Melozimoran Creek, but a heavy snowfall restricted the examination to a few tests with the portable survey meter. The radioactivity of the intrusion averaged 20 counts per minute as compared to an 8- to 10-count per minute average on the adjacent metamorphic rocks.

CONCLUSION

The investigations in the Grant Creek area disclosed no float rock corresponding to Fisher's reported description of his pitchblende-bearing vein float material. The only material that appeared to fit his description was schist containing a few narrow streaks of limonite, but this was found on the west side of Windy Creek near its headwaters and a considerable distance from any tractor trail. It is improbable that this occurrence of limonite is the float referred to by Fisher. Sufficient search was made of the hillsides to conclude that the pitchblende vein or veinlets as reported by Fisher probably do not exist.

Two fragments of a black platy mineral that were seen among the samples in Fisher's camp may have been collected from hillside float rather than from his placer workings. If this is true, Fisher's "pitchblende" is probably black hematite.

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