Bureau of Mines
Report of Investigations 5493

TIN PLACER AND LODE INVESTIGATIONS EAR MOUNTAIN AREA, SEWARD PENINSULA, ALASKA

By John J. Mulligan

United States Department of the Interior — 1959

TIN PLACER AND LODE INVESTIGATIONS EAR MOUNTAIN AREA, SEWARD PENINSULA, ALASKA

BY JOHN J. MULLIGAN

* * * * * * * * * Report of Investigations 5493

UNITED STATES DEPARTMENT OF THE INTERIOR
Fred A. Seaton, Secretary
BUREAU OF MINES
Marling J. Ankeny, Director

1959

The Library of Congress has cataloged this publication as follows:

Mulligan, John J

Tin placer and lode investigations, Ear Mountain area, Seward Peninsula, Alaska. [Washington] U. S. Dept. of the Interior, Bureau of Mines, 1959.

iii, 53 p. illus., maps, tables. 27 cm. (U. S. Bureau of Mines. Report of investigations, 5493)

Bibliography: p. 53.

1. Tin mines and mining—Alaska—Seward Peninsula. 2. Tin ores—Alaska—Seward Peninsula. I. Title. (Series)

[TN23.U43 no. 5493] Int 59-116

U. S. Dept. of the Interior. Library
for Library of Congress

CONTENTS

ILLUSTRATIONS

TABLES

TABLES (Con.)

TIN PLACER AND LODE INVESTIGATIONS, EAR MOUNTAIN AREA, SEWARD PENINSULA, ALASKA[1]

by

John J. Mulligan[2]

SUMMARY

Ear Mountain is an isolated mountain mass that rises abruptly from the coastal plain on the northwest shore of the Seward Peninsula. Geologically it resembles the more accessible Brooks Mountain and Cape Mountain areas to the southwest, being composed of a granitic core surrounded and partly capped by metamorphosed sediments. The occurrence of lode- and placer-tin deposits in this area has been known since the early 1900's, when the Seward Peninsula region was prospected extensively for both gold and tin.

The Federal Bureau of Mines investigated the tin deposits in the Ear Mountain area during the 1953 and 1954 field seasons. The objectives were to delimit the areas in which tin minerals occur, as a guide to future prospecting, and to determine the amount of tin in the known prospects. Work by the Bureau of Mines included both placer and lode sampling.

The Bureau placer-sampling program was essentially a reconnaissance to determine the distribution and relative abundance of placer tin as a means of delimiting areas favorable to the discovery of the lode sources of the tin minerals. A churn drill was used, and normal placer sampling and evaluation procedures were followed to determine the quantity and type of heavy minerals in the stream gravels. The data so obtained are roughly indicative of the quantity and type of heavy minerals in the rocks from which the gravels were derived. This indirect method of determining the extent of lode tin was used because throughout the area outcrops are buried under a frozen mantle of detritus, peat, and tundra vegetation, varying in depth from a few inches to 40 feet or more.

Bureau placer sampling showed minor to trace amounts of placer tin in most streams that drain the granite and the granite-limestone contact zone on Ear Mountain. Cassiterite was identified in the gravels of Tuttle Creek, a nameless creek east of Tuttle Creek, and in the Eldorado (all three forks), Crosby,

---

1/ Work on manuscript completed December 1958.
2/ Mine examination and exploration engineer, Bureau of Mines, Region I, Juneau, Alaska.

Pinnacle, Step-Gulch, and Deer Creeks in amounts of less than 0.05 to 0.2 pound of tin per cubic yard in mining sections up to 10 feet thick. Radioactive minerals and valuable metals other than tin were not found in greater than trace amounts.

Sections of Tuttle, Eldorado, and Kreuger Creeks that were considered to be favorable for placer mining were drilled by the Alaska Tin Corp. under the provisions of a Defense Minerals Exploration Administration (DMEA) contract. On Tuttle Creek the "pay" gravels were found to average about 0.2 pound of tin per cubic yard in the mining section; in the best hole 8 feet of mining section contained 1.3 pounds of tin per cubic yard. On Kreuger and Eldorado Creeks the pay gravels averaged about 0.3 pound of tin per cubic yard in the mining section; in the best hole 10 feet of mining section contained 0.8 pound of tin per cubic yard. No significant quantities of other valuable minerals were found in the drill holes.

The Bureau lode-sampling program was confined to the areas drained by Tuttle and Eldorado Creeks, because the gravels of these streams contain substantially more tin than the gravels of the streams sampled, and most of the lode prospects are in this area. Both Tuttle and Eldorado Creeks head on the northeast slope of Ear Mountain. Float found in this area indicated that some cassiterite occurs as crystals and tiny veinlets in granite; however, it is associated more commonly with altered limestone adjacent to the granite-limestone contact. The few random crystals and scattered tiny veinlets of cassiterite that were found in granitic debris could not be traced to a source area. The cassiterite in altered limestone was found in an irregular zone extending along the granite contact from the east side of North Hill to the west side of Tuttle Creek, a distance of about 7,000 feet. The most mineralized float along this contact zone was from the vicinity of the Winfield shaft on North Hill, which was reopened. Bulldozer trenches were excavated along the contact east and west of the shaft, and additional samples were obtained from float and other old prospects.

The exposures in the Winfield shaft, and in trenches east and west of it, indicated that for about 1,000 feet and an average width of 65 feet the mineralized limestone adjacent to the granite contact contains 0.2 percent tin and 0.3 percent copper, with minor to trace amounts of gold, silver, lead, and zinc. Small zones within this area contain as high as 2 percent tin, and others as high as 3 percent copper; the higher grade zones apparently are due to local conditions that favoered deposition; however, the investigation did not eliminate the possibility that larger zones of similar grade may exist. In the areas sampled, much of the tin occurs either as fine-grained cassiterite that would be difficult to recover or as a component of minerals (such as paigeite) from which it would not be recoverable by the usual extraction processes. Analyses of selected specimens of float from the contact zone east and west of the above area indicated that the mineralization is similar but may be somewhat lower in grade.

Exposures during this investigation were not adequate to establish the dip of the contact zone or the limits of mineralization. The granite-limestone contact apparently dips toward the north but is highly irregular. Mineralization probably extends beyond the limits of sampling both along the contact zone and outward into the limestone.

Radioactivity, varying from trace amounts to 0.01 percent equivalent uranium, was noted in a few samples from the Winfield shaft. The amount was too small to permit identification of the radioactive mineral or to determine the mode of occurrence.

INTRODUCTION

Since 1942 the Bureau of Mines has been conducting intermittent investigations of tin deposits in the western part of the Seward Peninsula, Alaska (figs. 1 and 2). The ultimate objective is to evaluate the potential tin resources of the entire area. Previous work was concentrated in the Cape Mountain, Potato Mountain, and Brooks Mountain (Lost River) areas. As part of this long-range program, lode- and placer-tin deposits of the Ear Mountain area were investigated by the Bureau of Mines during the 1953 and 1954 field seasons.

At the same time the Alaska Tin Corp. conducted a churn-drilling project on three streams in the area: Tuttle, Eldorado, and Kreuger Creeks. Previous reconnaissance by this corporation had indicated the possibility of discovering minable deposits of placer tin. The Alaska Tin Corp. churn-drilling project was financed by the DMEA and was under the technical guidance of the writer, acting as the DMEA field team representative for the project.

This report presents the factual data resulting from both the Bureau and the DMEA projects in the Ear Mountain area.

ACKNOWLEDGMENTS

The Ear Mountain investigation was made possible through the use of equipment owned by the Alaska Tin Corp. This corporation also authorized the publication of all sample data obtained during the DMEA-financed churn-drilling program. The cooperation of Ralph Lomen and Harry Gabrielson, officers of the corporation, is gratefully acknowledged.

The base maps of the area were adapted from maps distributed by the Federal Geological Survey; information contained in Geological Survey publications (see bibliography) was used when preparing this report. P. L. Killeen, geologist, Alaska Geology Branch, Geological Survey, assisted in locating the old workings and lode-tin outcrops.

All samples, including those taken by the Alaska Tin Corp., were analyzed by the Bureau of Mines Alaska Mining Experiment Station, Juneau, Alaska. Petrographic and spectrographic analyses were made at the Bureau of Mines Northwest Electrodevelopment Experiment Station, Albany, Oreg. The only exceptions were the petrographic analyses of Bureau churn-drill samples (table 7) made in the Alaska Mining Experiment Station at Juneau.

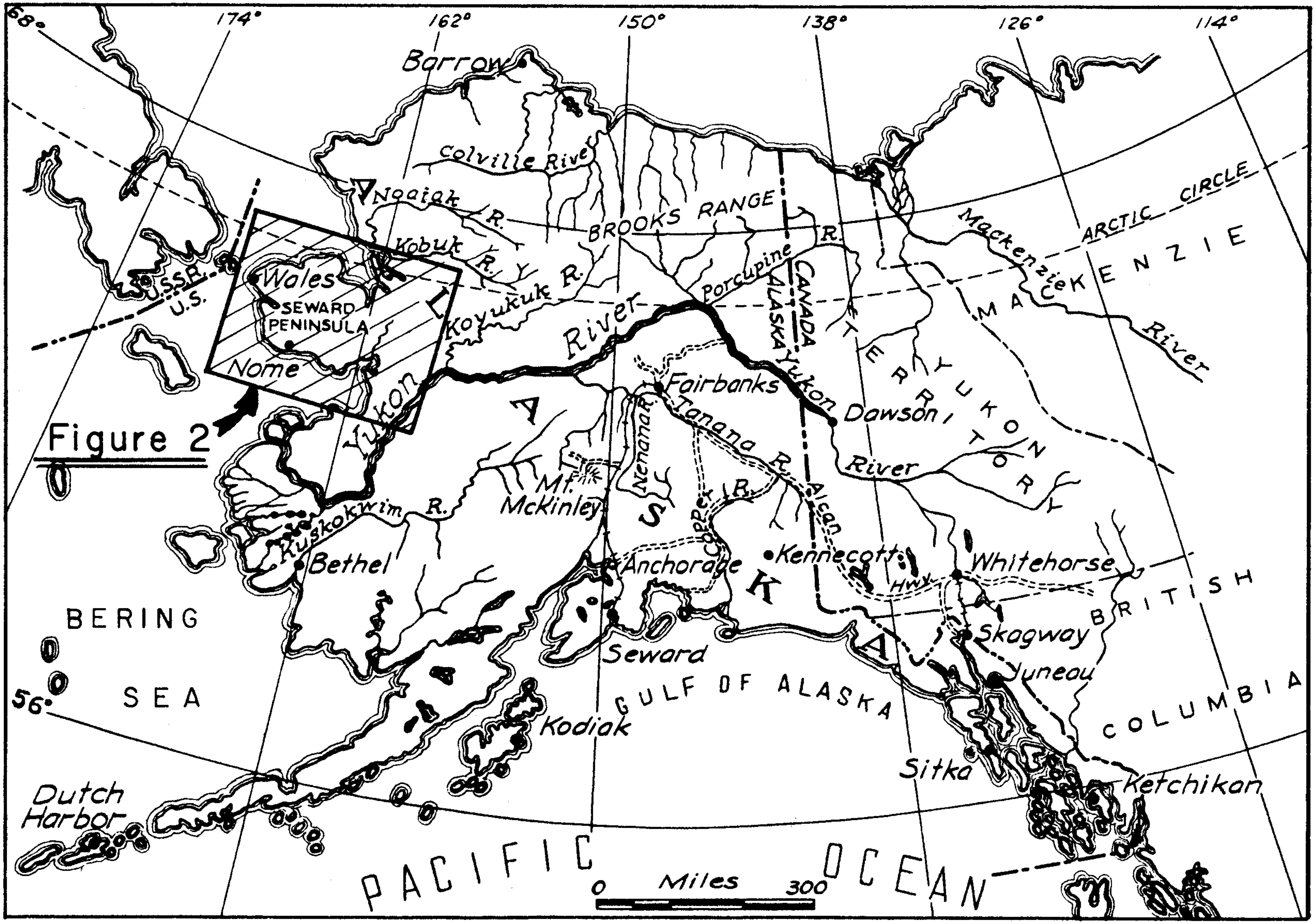

FIGURE 1. - Alaska.

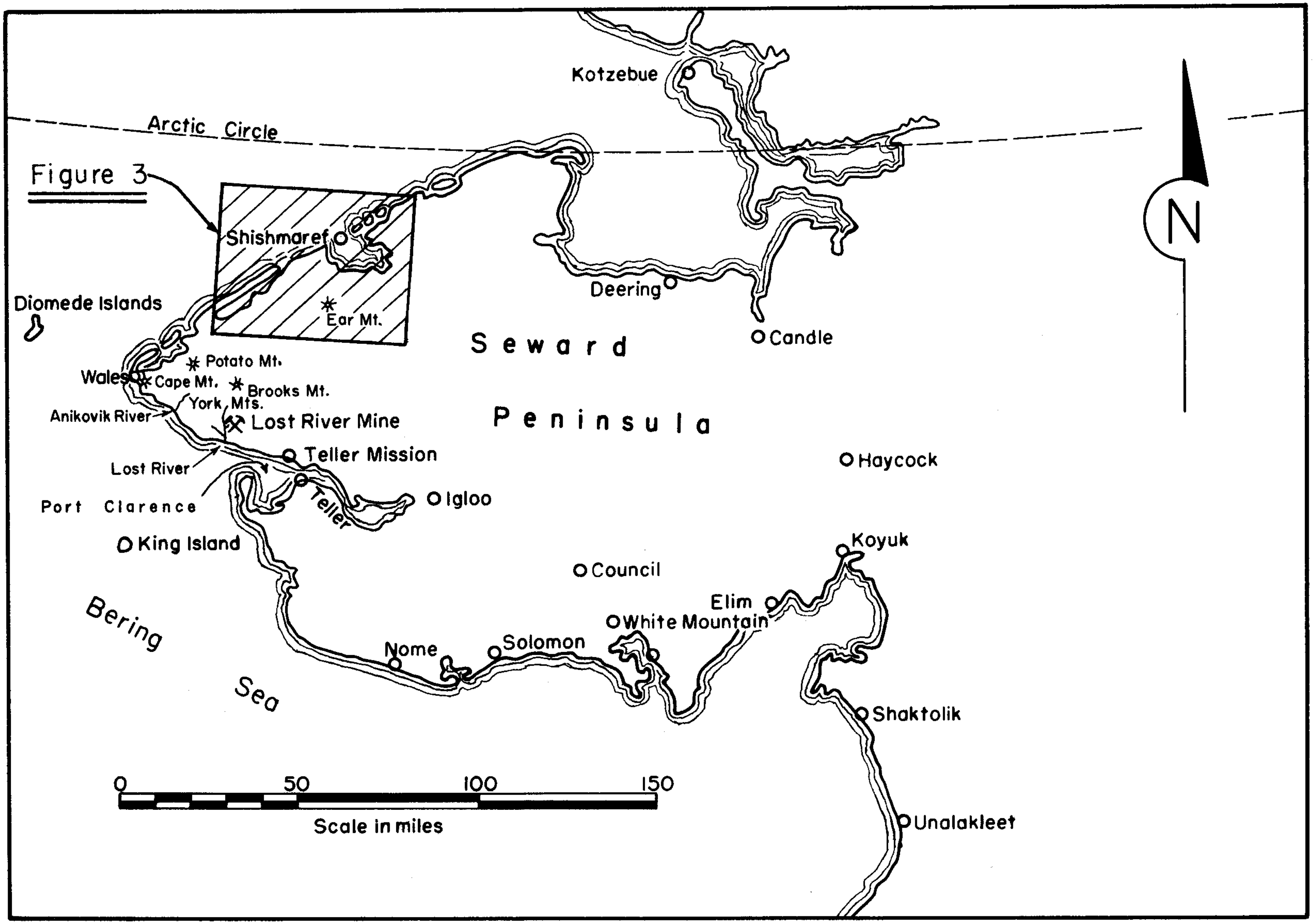

FIGURE 2. - Seward Peninsula.

LOCATION AND ACCESSIBILITY

Ear Mountain (fig. 3) is an isolated mountain mass that rises from the coastal lowlands in the northwestern part of the Seward Peninsula, Alaska. It is 105 miles N. 13° E. of Nome, 20 miles S. 10° W. of Shishmaref, and 45 miles N. 5° E. of Teller and Port Clarence. The area investigated includes Ear Mountain and the streams draining Ear Mountain.

The Ear Mountain area is uninhabited and relatively inaccessible. The nearest permanent settlement is Shishmaref, an Eskimo village with a population of 194 (1950 census). A winter dogsled trail from Teller to Shishmaref crossed the eastern foothills of Ear Mountain, but it is seldom used now, and the shelter cabins and markers have fallen into disrepair. The usual means of access now is by airplane. Bush planes land passengers and light freight on a natural airfield, about 900 feet long, on the northeast flank of Ear Mountain at an elevation of about 800 feet. The largest planes that have used this field carry a maximum payload of about 1 ton. There are no roads or trails suitable for wheeled vehicles in the area. Freight too heavy or too bulky for air transport is shipped by sea to either Shishmaref Inlet or Port Clarence and then hauled overland by tractor-drawn sleds. Preferably, tractor freighting is done when the ground is frozen and snow-covered, but with lighter loads it can be done during the summer. In late summer and early fall tractor travel becomes difficult, and in some places impossible, because of the swampy conditions created when upper portions of the frozen tundra thaw.

Shishmarel Inlet, the nearest harbor, is navigable by small barges and tugs drawing 3 or 4 feet of water. The entrance is shallow; frequently it is impossible to enter owing to storms. There are no docks, and the shores are soft and muddy. It is usually free of ice during July, August, and September.

Port Clarence, the harbor at Teller, is navigable by ocean-going freighters. Freight must be lightered ashore in barges; there are no docks, but the beach is composed of firm gravel. It is usually ice-free from late June to late October.

Nome is the principal port of call for ships serving the Seward Peninsula. Three steamships a year bring cargo to Nome and the Bering Sea ports. The first normally arrives in late June. The last departs in late October. There are no ports on the Seward Peninsula where ships can discharge directly. The ships anchor offshore and discharge into lighters. Barges of 50 to 150 tons of burden, towed by small tugs, commonly are used both for lightering and for coastwise shipping. The lighters used at Nome also are used to land freight at other points in the Seward Peninsula. Oil shipments are handled by dealers in Nome and distributed either in bulk or by the barrel.

Nome is the center of air traffic for the Seward Peninsula. Three airlines provide daily scheduled connections with Anchorage, Fairbanks, and Seattle. A mail plane, based in Nome, furnishes Shishmaref with scheduled twice-weekly mail service. Bush planes are available for charter services.

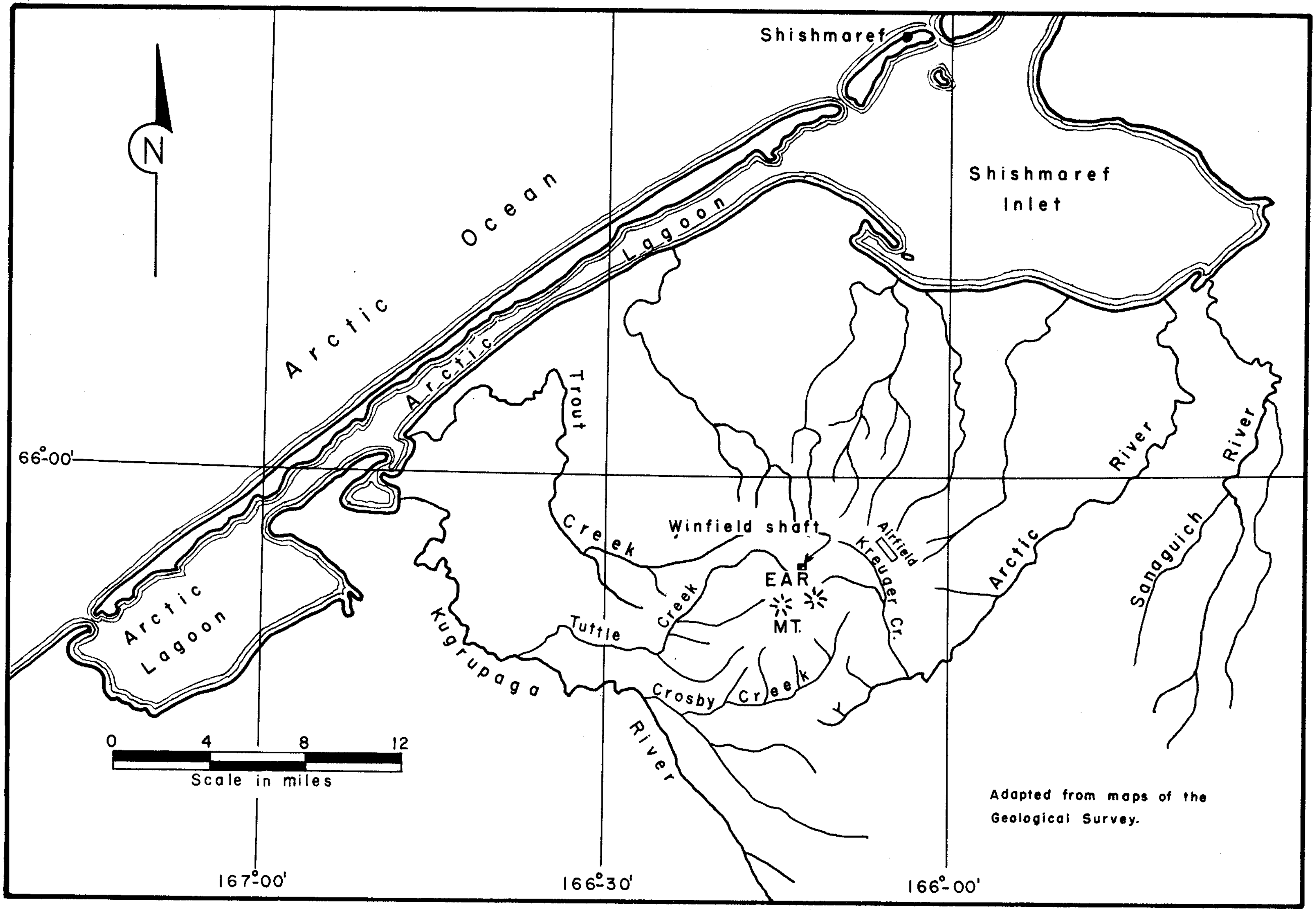

FIGURE 3. - Ear Mountain Area.

HISTORY AND PRODUCTION

Ear Mountain was first located and named "Ears" on a chart made by Captain Beechy (1)[3/] in 1826. It was visited by Arthur J. Collier (1) of the Geological Survey in 1901. The following is quoted from his report:

> During the summer of 1901 Tuttle Creek was the scene of a small excitement caused by reports brought out the year before. About 50 men visited the creek during the course of the summer . . . the creek was practically abandoned before the end of the season.

The earliest prospectors were interested in gold alone; later, others sought tin and other metals. Several parties of prospectors searching for tin ore visited the Ear Mountain area in 1903 and 1904 (3). Stream tin was reported from streams on the north and east sides of the mountain. The Winfield claims are said to have been staked in 1903; a shaft called "Eunson's shaft" is reported to have been sunk in these claims during the winter of 1905-6. The Vatney shaft and drift on the east slope of North Hill was sunk some time before 1907, when Adolph Knopf (6) of the Geological Survey visited Ear Mountain and described the deposits. The Winfield shaft (apparently an extension of the prospect pit previously called Eunson's shaft) was sunk, and the workings on it were driven during the winter of 1913-14. R. N. Dickman (7), a consulting engineer, visited Ear Mountain and reported on the Winfield shaft in November 1914. This apparently ended the early period of active prospecting.

Since 1914 the area has been visited by several members of the Geological Survey: Edward Steidtmann and S. H. Cathcart (8) in 1918, Rober R. Coats (9) in 1940 and 1941, and P. L. Killeen and R. J. Ordway (10) in 1945.

The Alaska Tin Corp. sampled the placer gravels of Tuttle Creek in 1940, using hand-dug pits and a drivepipe. This and the results of sampling other streams in the area, encouraged them to initiate and conduct a DMEA-financed churn-drilling program on Tuttle, Eldorado, and Kreuger Creeks in 1953.

The results of this exploration and the Bureau of Mines work during the 1953 and 1954 field seasons are described in this report.

There is no record of any production of tin or other minerals from the Ear Mountain area, and there are no signs of any mining activity other than prospecting.

PHYSICAL FEATURES, CLIMATE AND WATER SUPPLY

Ear Mountain stands in prominent isolation, surrounded by coastal flats and stream valleys ranging from 100 to 400 feet in elevation. The slopes rise gradually to about 1,000 feet. They then steepen abruptly, except on the northeast flank where the incline is more moderage, and culminate in three peaks - 2,000, 2,292, and 2,329 feet in elevation.

3/ Underlined numbers in parentheses refer to items in the bibliography at the end of this report. Page references refer to pages in the item and not in this report.

The drainage from Ear Mountain flows into the Arctic Ocean. The northwest, west, and south sides of the mountain are drained by the headwater tributaries of the Kugrupaga River, which flows into Arctic Lagoon. The east and northeast sides of the mountain are drained by the headwater tributaries of the Arctic River, which flows into Shishmaref Inlet. The northern foothills of the mountain are drained by the headwaters of several small streams, which meander across the coastal flats and flow into Shishmaref Inlet and Arctic Lagoon.

Bedrock is exposed at only a few places in the area. Typical tundra vegetation blankets the area from sea level to between 1,000 and 1,500 feet altitude. There are no trees, but scattered thickets of small willow bushes are found in the valleys. Underlying the tundra vegetation is a detritus and peat cover varying from a few inches to 40 feet or more in depth. The detrital cover extends to the mountain tops. Except for the top few feet, which thaws during the summer, the detritus, tundra, and underlying bedrock remain permanently frozen. Thawed zones of varying extent are found within the permafrost and are believed to result from the action of surface water. The thawed zones probably make up only a very small proportion of the permafrost area.

No weather records have been kept at Ear Mountain. The climate is similar to that of Shishmaref, except that rain and dense fog are more prevalent on the mountain. The following weather statistics for Shishmaref, Alaska, were furnished by the U.S. Department of Commerce, Weather Bureau, Anchorage, Alaska.

TABLE 1. - Shishmaref weather statistics

Average annual temperature...°F	20.2
Time that average temperature is above 32° F...	4 months
Average annual precipitation...inches	8.02
Average annual snowfall... do.	32.6
Prevailing wind...	North
Highest recorded temperature...°F	78
Lowest recorded temperature...°F	-48
Average breakup:	
Arctic Ocean...	June 18
Shishmaref Inlet...	June 20
Port Clarence...	June 12
Average freezeup:	
Arctic Ocean...	November 6
Shishmaref Inlet...	November 9
Port Clarence...	November 7

The water supply at Ear Mountain, while not large, is greater than the low annual rainfall at Shishmaref would indicate. During the investigation Tuttle and Kreuger Creeks did not dry up at any time. The amount of water in both creeks usually was adequate for small-scale placer mining if carefully used. Several small springs near the Winfield shaft had enough water for camp use and would have furnished enough water for a diamond drill. Streamflow was not observed during the winter. Native dogsled drivers reported that during the winter water can be obtained from a spring on the west bank of Kreuger Creek a short distance above the mouth of Eldorado Creek.

LABOR

Unskilled, most semiskilled, and some skilled labor can be drawn from the native Eskimo and resident white population of the Seward Peninsula. Supervisory personnel and labor skilled in specialized mining and milling operations must be brought in from other parts of Alaska or from the United States.

The native Eskimos often have little education and commonly lack training in the mechanical trades, but many have a high degree of mechanical aptitude and learn readily. Most Eskimos find it necessary to return to their village homes at frequent and irregular intervals, but to offset this they reside permanently in the area. The Eskimos and the resident white workmen are inured to primitive conditions in a difficult climate and will work well under circumstances that would be considered intolerable in more developed areas.

The population of the nearer settlements in the western part of the Seward Peninsula is listed below as recorded in the 1950 census. These settlements would be a primary source of labor, and a continuous operation would attract men from all parts of Alaska.

Population of the western part of the Seward Peninsula

Diomede	103
Igloo	64
Nome	1,930
Shishmaref	194
Teller	140
Teller Mission	109
Wales	141
	2,681

PROPERTY AND OWNERSHIP

Table 2 lists all known claims in the Ear Mountain area at the time of this investigation. Descriptions of the claims are on file in the office of the U.S. Commissioner at Nome, Alaska. Claim locations are shown in figures 4 and 5.

MINE WORKINGS

There are more than 50 old prospect holes on Ear Mountain. Except for a few sample pits dug by the Geological Survey in 1945, all workings appear to be contemporaneous with shafts put down before World War I. The three principal workings are the Winfield and Vatney shafts and an unnamed prospect at the head of Quartz Creek.

TABLE 2. - Lode and placer mining claims, Ear Mountain area

Claim	Owner	Recorded Volume and page	
(Patented lode mining claims - vicinity Winfield shaft)			
Surprise, Chloride Fraction, Granite	Winfield estate, Cora M. Hirschberg, Trustee, 7011 Roosevelt Way, Seattle, Wash.	U.S. Patent 953511, dated Feb. 17, 1925.	
(Unpatented lode mining claims - vicinity Winfield shaft)			
January	Alaska Tin Corp. 380 Colman Building Seattle, Wash.	228	239
March			211
April			211
May			211
June			210
July			210
August			209
September			209
October			238
November			238
December			239
(Unpatented placer mining claims - Tuttle Creek)			
Discovery	Alaska Tin Corp.	228	208
No. 1 below Discovery			208
No. 2 below Discovery			208
No. 3 below Discovery			207
No. 4 below Discovery			207
No. 5 below Discovery			207
No. 6 below Discovery			206
No. 7 below Discovery			206
No. 8 below Discovery			235
No. 9 below Discovery			236
No. 10 below Discovery			236
No. 11 below Discovery			236
(Unpatented placer mining claims - Kreuger Creek)			
Discovery	Alaska Tin Corp.	228	206
No. 1 below Discovery			205
No. 2 below Discovery			205
No. 3 below Discovery			204
No. 4 below Discovery			237
No. 5 below Discovery			237
No. 6 below Discovery			237
No. 7 below Discovery			238
(Unpatented placer mining claims - Eldorado Creek)			
Discovery (Association claim); No. 1 above Discovery (Association claim)	Alaska Tin Corp.	228	297

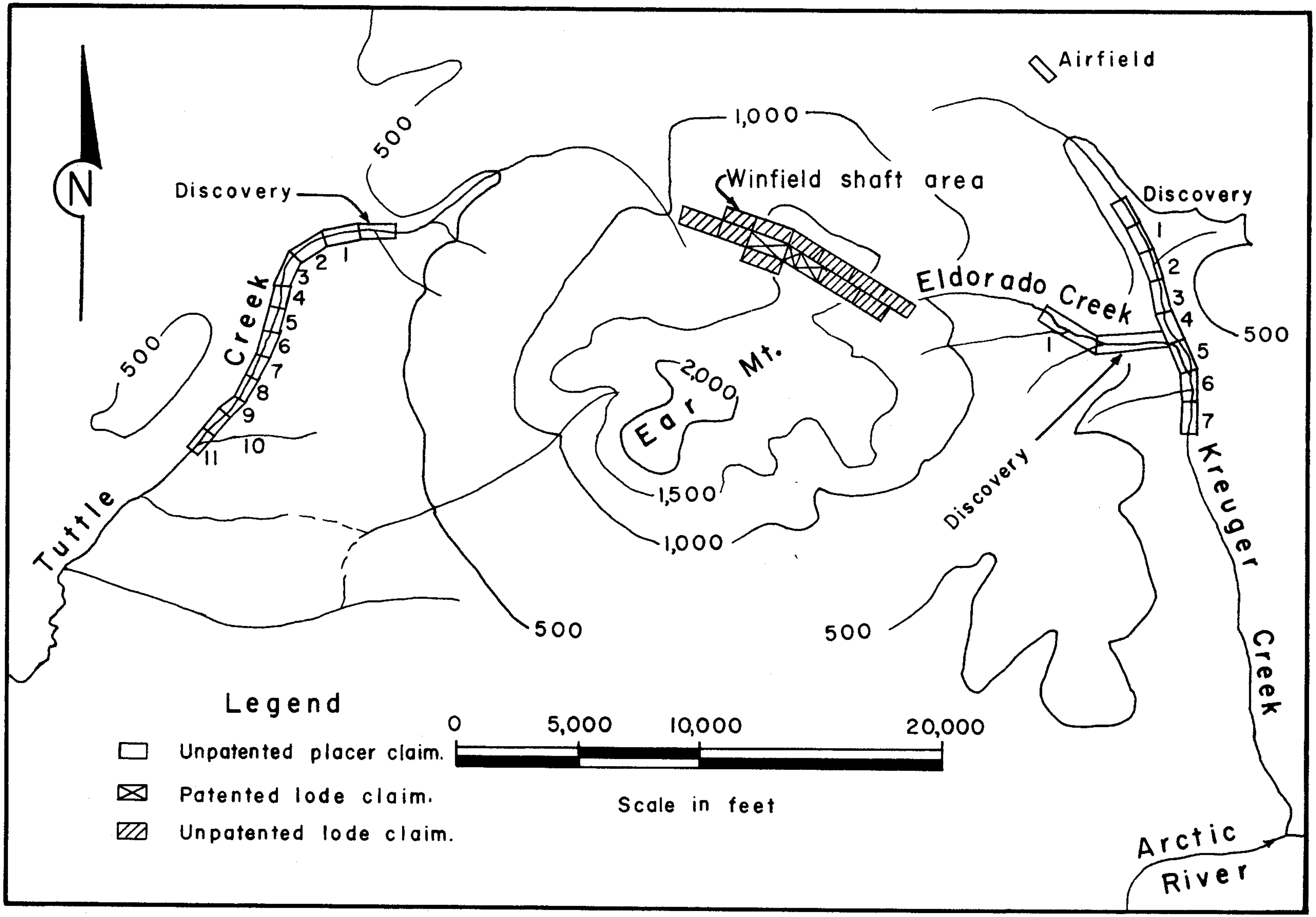

FIGURE 4. - Lode and Placer Claims in the Ear Mountain Area.

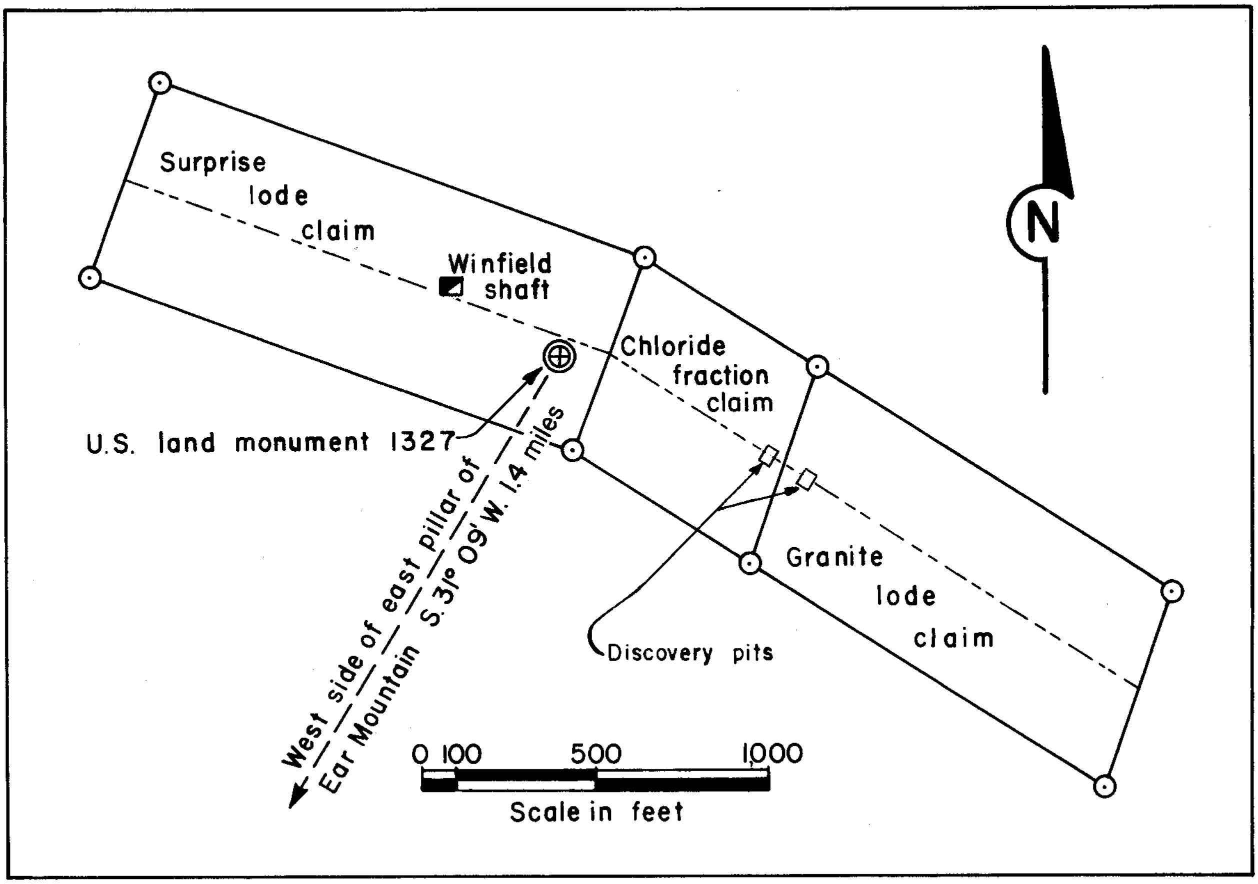

FIGURE 5. - Patented Lode Claims in the Ear Mountain Area.

Winfield Shaft

The Winfield shaft (figures 6, 7, and 8) on North Hill is the most prominent and extensive of the numerous old prospect pits in the granite-limestone contact zone. It was reopened and sampled during the investigation. As used in this report, the term "Winfield shaft" refers to the shaft itself and to the workings at the shaft bottom. The shaft is a timbered, vertical opening 29 feet deep and 4 by 5 feet in cross section. About 7 feet north of the shaft bottom a winze slopes downward 35 feet in a northerly direction at an angle of minus 34°. The other workings are on the 29-foot level, except for a sump about 4 feet deep at the end of the opening from which samples 124 and 125 were taken. At the point where the basic dike emerges from the granite the workings have broken into the bottom of an irregular hole, thought to be Eunson's shaft (described by Adolph Knopf of the Geological Survey in 1907). This hole is not open to the surface; the upper parts are choked with ice and rubble. Except for this irregular opening, all the workings are in good condition and will remain open indefinitely.

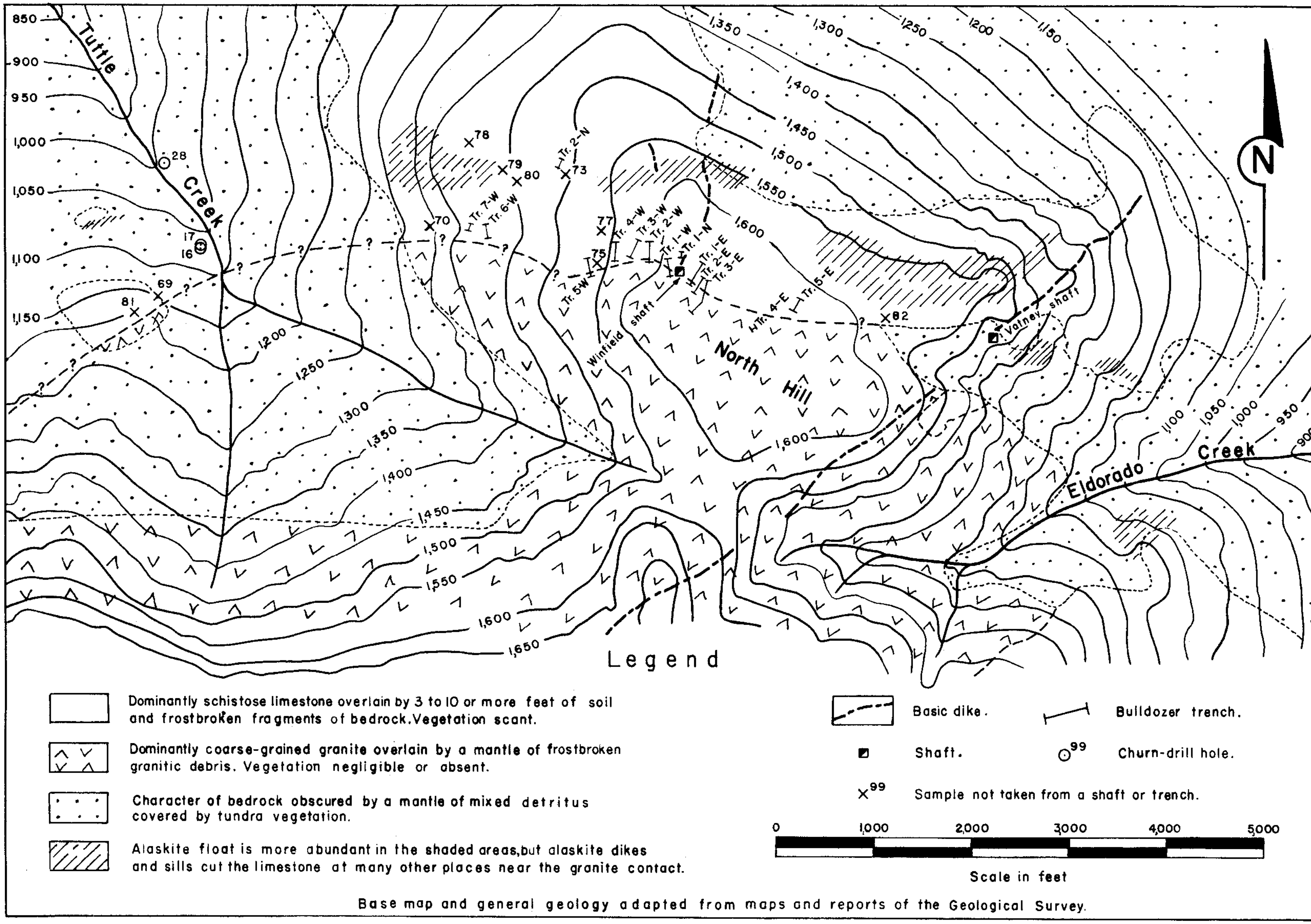

FIGURE 6. - Granite-Limestone Contact Zone, North Hill, Ear Mountain.

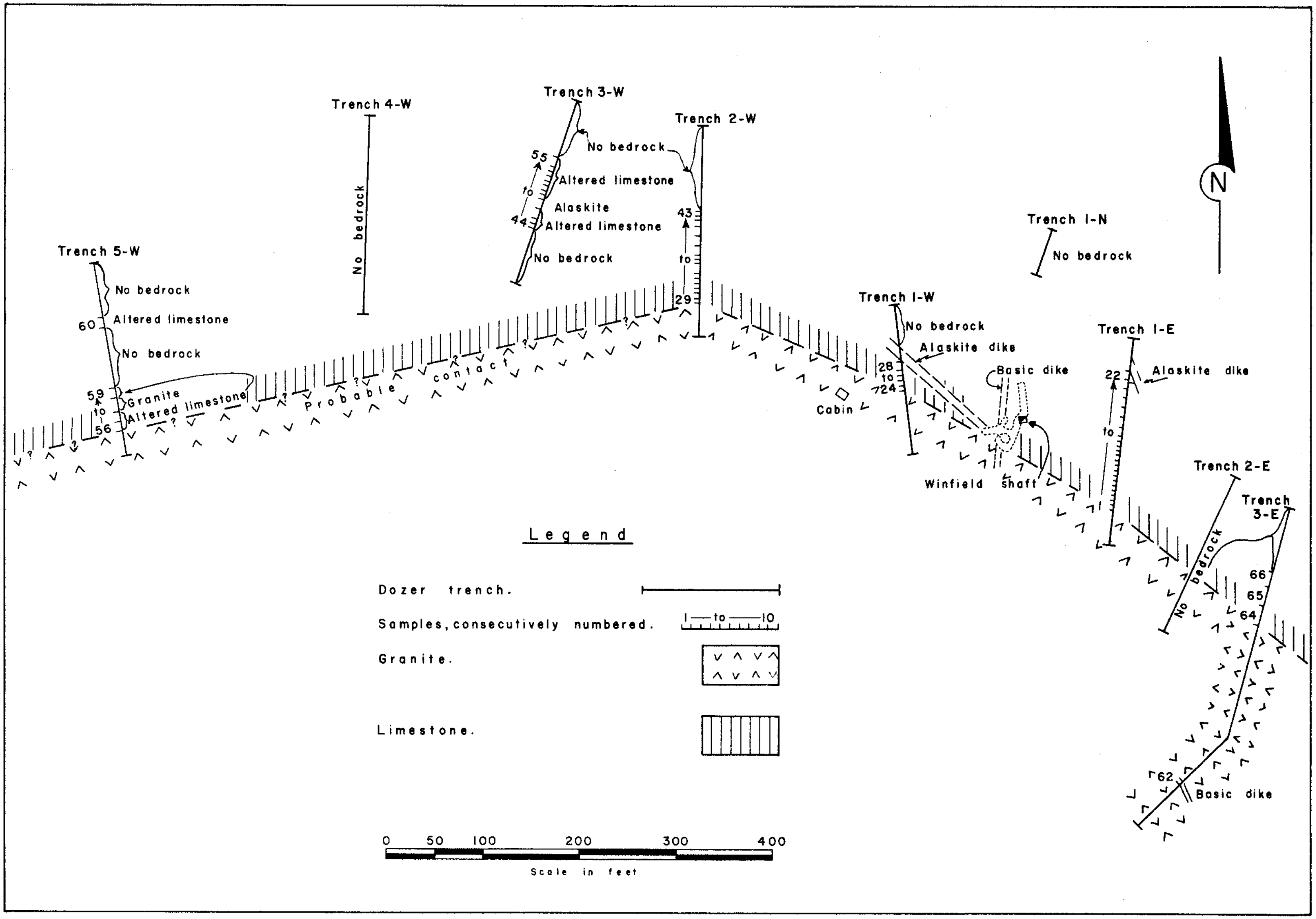

FIGURE 7. - Contact Zone, Winfield Shaft, Ear Mountain.

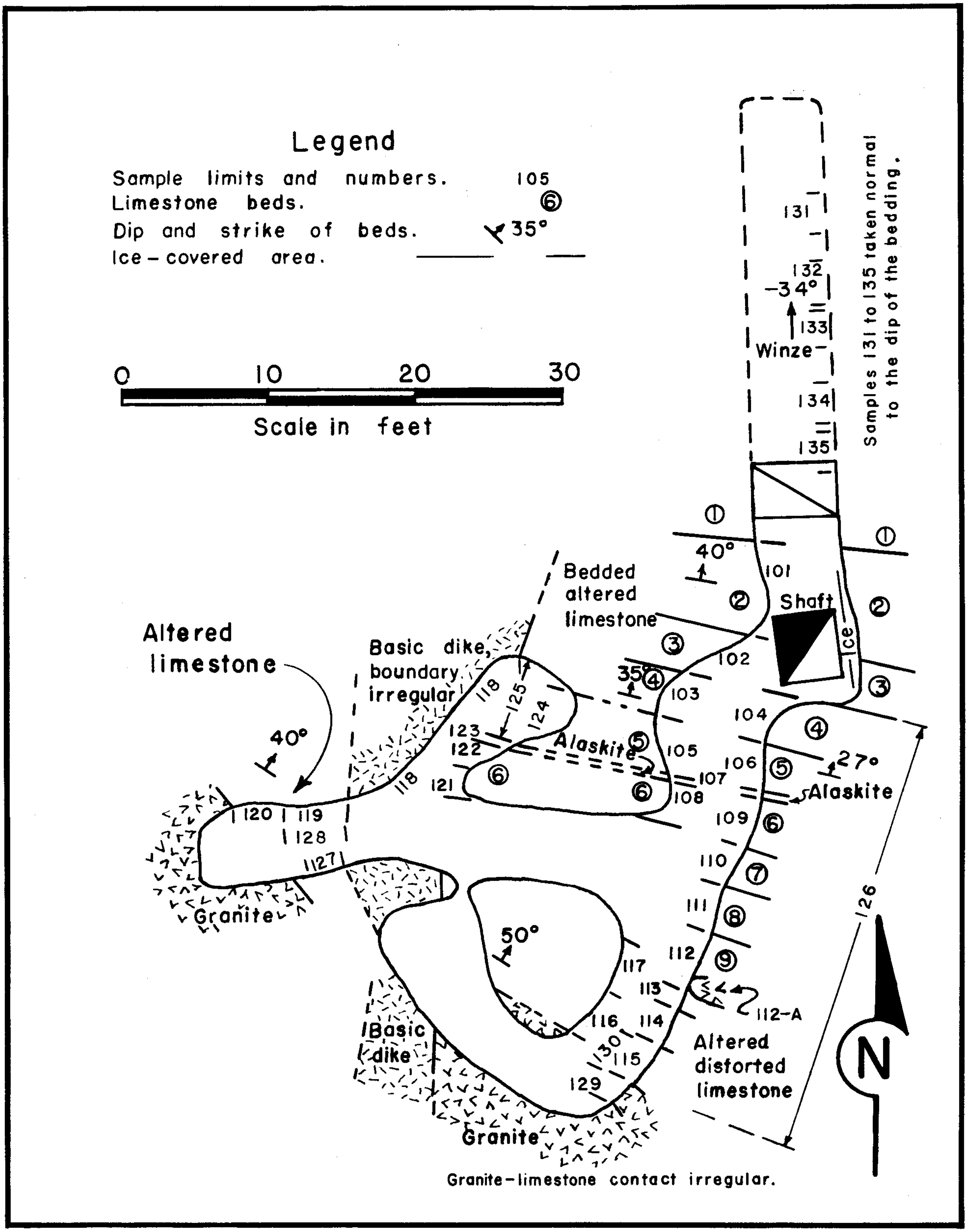

FIGURE 8. - Winfield Shaft, North Hill, Ear Mountain.

Vatney Shaft

The Vatney shaft is on the east slope of North Hill (fig. 6). The relatively extensive dump on this prospect did not contain visible cassiterite or other valuable minerals. The following is quoted from observations made in 1907 by Knopf (6), of the Geological Survey:

> On the northeast side of Ear Mountain an augite-quartz porphyry dike has been opened by a shaft and explored by a drift 112 feet long. Nothing but hard barren rock was encountered. Work was suspended and at the time of the visit the shaft was flooded with water. Further southwest on an extension of the same dike a number of open cuts had been made on account of the prevalence of numerous large augite crystals embedded in the dike rock. Chemical analysis of 'ore' samples, made in the laboratory of the survey, shows the presence of only traces of tin, amounting to a few hundredths of one percent.

The Vatney shaft was not reopened, and no samples were taken.

Miscellaneous Prospects

The prospect at the head of Quartz Creek also shows evidence of considerable work, but the openings have been buried by slides. No visible cassiterite was found in the dump, and no cassiterite was identified in placer concentrates from Quartz Creek. Consequently the exposure did not warrant the considerable expenditure needed to reopen the old workings or expose bedrock by trenching. No samples were taken from this prospect.

The remainder of the old workings are small, hand-dug pits, which either did not reach bedrock or have since caved so that no bedrock is visible. Except along the granite-limestone contact zone on the north side of Ear Mountain, the dumps do not contain enough metallic minerals to warrant resampling and reopening the workings. Samples from the old workings along the contact zone are included with the other lode samples.

GENERAL GEOLOGY

Ear Mountain (fig. 9) is in the York tin region in the western part of the Seward Peninsula, Alaska. The tin generally has been found in and around stocklike granitic intrusives, which have penetrated an overlying series of metasediments. Because they are more resistant to erosion than the metasediments, these intrusives and their fringe of dikes and veins tend to form mountains - a prominent and characteristic feature of the region.

Ear Mountain is a typical mountain of this type - a roughly circular granitic core surrounded by metasediments. The granitic core, about 2 miles in diameter, has been exposed by erosion, except for a small remnant capping of schist. The irregular border of the granite cuts across the metasedimentary beds, which show strong evidence of thermal metamorphism near the contact.

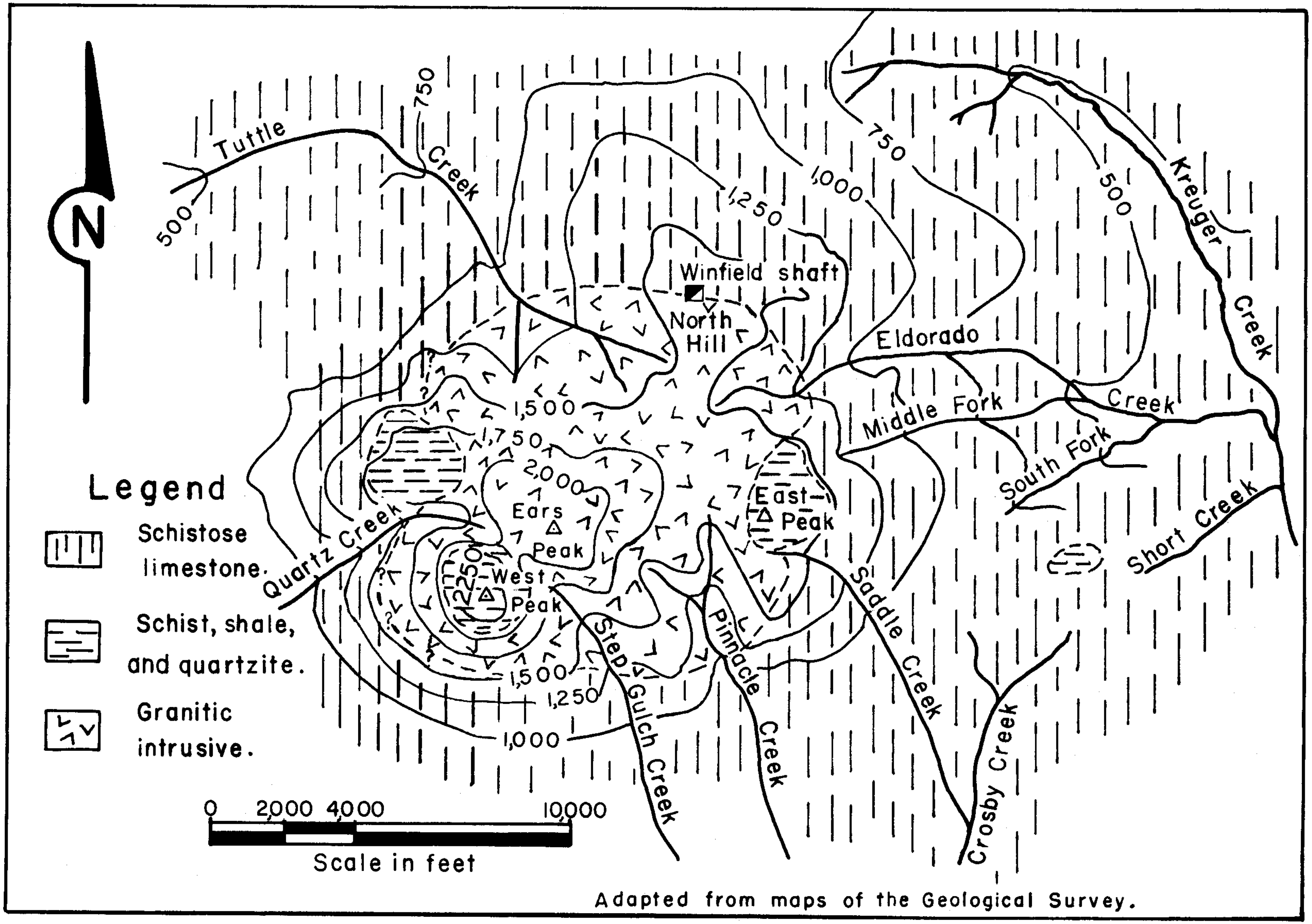

FIGURE 9. - Geology of Ear Mountain.

The metasedimentary series, dominantly shaley and schistose limestone with some shale, generally dips northward from 10° to 50°. Numerous alaskite dikes and sills thrust outward from the periphery of the granitic core. Two prominent dark-gray basic dikes (called quartz-augite porphyry (6) or augite-dacites (8) cut the granite, the contact zone, and the alaskite dikes and are probably the most recent intrusives. A fine-grained gray-to-black intrusive has been found in the remnant schist capping over the granite, but its relationship to the other intrusives is not apparent.

DESCRIPTION OF DEPOSITS

Placer-Tin Deposits

The erosive forces acting in the Ear Mountain area are typical of the Arctic region. Erosion is primarily a result of frostbreaking. The schistose metasediments of the area break down into small chips, flakes, and claylike soil, but the granitic rocks tend to break into fragments ranging in size from single crystals to angular boulders 5 to 10 feet or more in diameter (fig. 10). Except for a few outcrops, this frostbroken detritus mantles the entire area to depths ranging from a few inches to 40 or more feet. Much of this cover remains permanently frozen and slowly moves downhill in a manner resembling glacial flow. Ultimately the detritus is discharged into the streams. As a result the headwaters of those streams that drain the central part of Ear Mountain are choked with angular granitic boulders. Downstream from the base of the steep mountain slopes the average size of the gravels decreases rapidly because the streams are not capable of carrying the coarse material. This is due partly to the low rainfall and partly to the fact that the spring runoff occurs while the streams are protected by a solid cover of ice over which the snowwater flows with little or no erosive, carrying, or sorting action.

Lode-Tin Deposits

The principal lithologic units of the Ear Mountain area are exposed in typical relationship in the Winfield shaft. The oldest rock is a schistose limestone. It was invaded by a granite stock and by alaskite dikes and sills. The time relationship between the alaskite and the granite is not clear; they may have been simultaneous. A basic dike later cut through the limestone, the granite, and the alaskite and appears to have been the most recent intrusive.

The limestone along the contact, originally schistose, has been altered by contact with the granitic intrusive and later invaded by mineralizing solutions. Where it is not distorted by close contact with the granite, the original bedding can be distinguished. In figure 8 these beds are identified by numbers within circles (numbered from the top down). The contact with the granite is highly irregular. In the Winfield shaft the limestone in direct contact with the granite contains a smaller amount of metallic minerals than is found in the limestone many feet from the contact. Physically, the altered limestone is a hard, tough rock. The degree of hardness of the sedimentary beds varies considerably, but there is no apparent connection between the degree of hardness and the amount of metallic minerals.

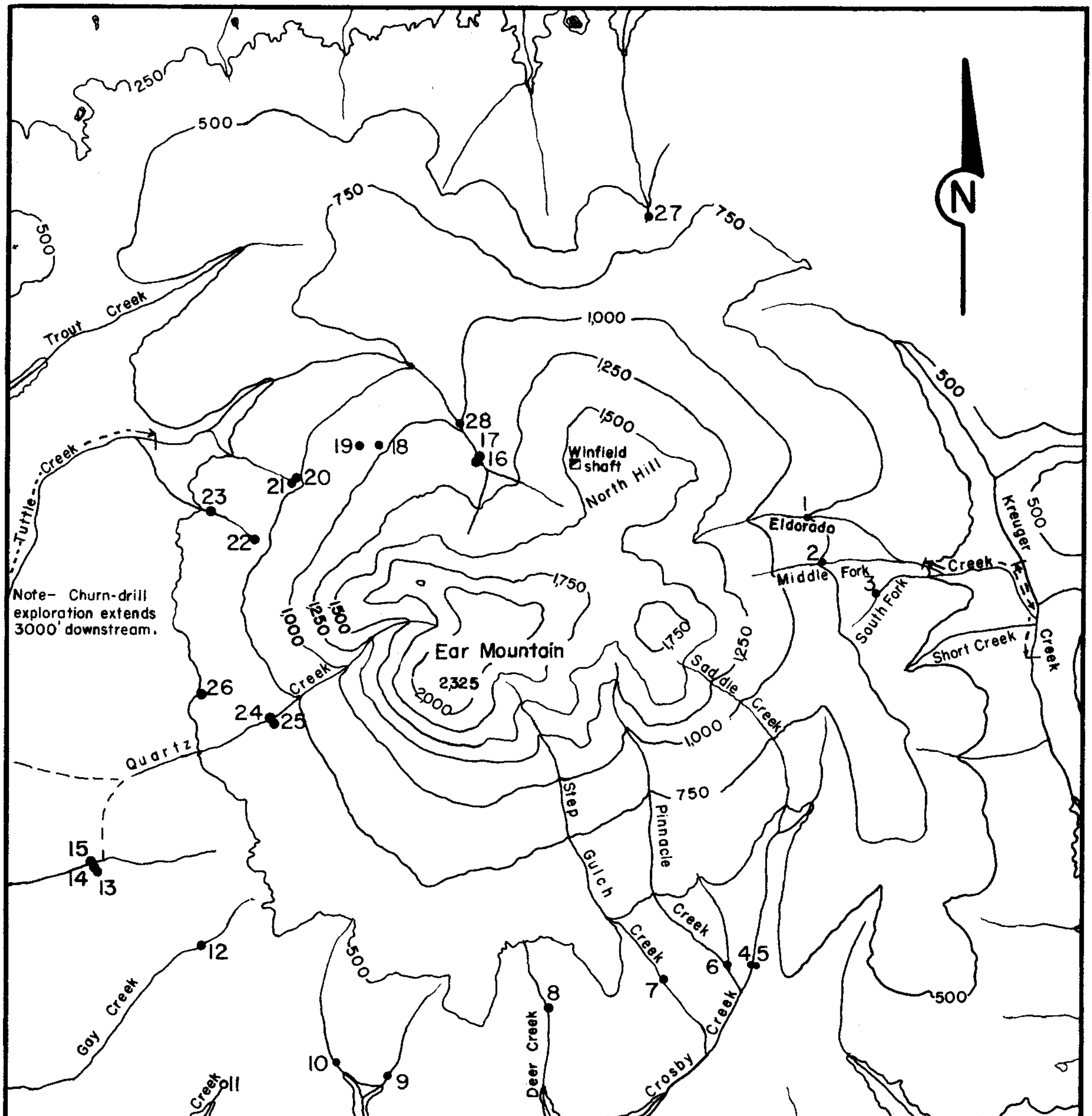

FIGURE 10. - Placer Samples, Ear Mountain Area.

The granitic stock that forms the core of Ear Mountain, as exposed in the Winfield shaft, is a light gray biotite granite, somewhat finer grained than the granite exposed higher on the mountain (probably a result of more rapid cooling near the borders). It contains no visible tin or sulfide minerals, and its irregular borders show no evidence of having formed a channel for mineralizing solutions.

Numerous alaskite dikes and sills cut the limestone near the granite contact. An alaskite sill (samples 123 and 127), alined with the limestone bedding planes, is the only typical alaskite occurrence in the Winfield shaft. A small light-color, irregular igneous mass (sample 112-A) exposed in the east wall of the workings may be either an alaskite intrusive or a contact phase of the granite. The alaskite is lighter in color and generally finer grained than the main mass of the granite. The alaskite dikes and sills contain only minor or trace amounts of tin minerals, although in places their borders appear to have served as channels for mineralizing solutions.

The basic dike exposed in the Winfield shaft is part of a large prominent dike having a north-south treand and a near-vertical dip. Its trend is roughly perpendicular to the granite contact, and it cuts limestone, granite, and alaskite. It has highly irregular borders and contains "drowned" fragments of the surrounding rocks. The dike is composed of a dark-gray aphanitic rock containing occasional phenocrysts of smoky quartz, feldspars, augite, and biotite; although no cassiterite was visible in hand specimens, analyses indicated a content of 0.20 percent tin and very small amounts of zinc, gold, and silver. It is interesting to note that a trace of cinnabar was identified in a sample from this dike; this is the only known occurrence of this mineral in the Ear Mountain area. There is no evidence to indicate that the basic dike or its borders served as a channel for mineralizing solutions or otherwise affected the mineralization of the adjoining altered limestone.

COMPANY OPERATIONS

General

The Winfield Estate and the Alaska Tin Corp. were the only groups known to hold claims in the Ear Mountain area at the time of this investigation. The Winfield Estate held three patented lode claims in the vicinity of the Winfield shaft but had not been active for many years. The Alaska Tin Corp. held both lode and placer claims and had been exploring the Ear Mountain area intermittently for several years.

DMEA Contract

In 1953 the Alaska Tin Corp. applied for and was awarded a DMEA grant (docket 2942, contract Idm-E-564) to sample the placer deposits on Tuttle, Eldorado, and Kreuger Creeks. In conformance with the terms of the loan the Alaska Tin Corp. drilled 642.5 feet of churn-drill holes on its claims on Tuttle Creek and 508.8 feet on its claims on Kreuger and Eldorado Creeks. An additional 279.0 feet of churn-drill holes drilled in areas adjacent to the claims on Tuttle Creek exceeded the requirements of the DMEA contract; the Government did not participate in the costs. This report includes the results of both DMEA-financed drilling and company-financed drilling.

The writer, acting as the representative of the DMEA field team, assisted the company officials in planning their exploration program and checked the drilling and sampling procedures at frequent intervals. Independent surveys of the claims and drill holes were made as the work progressed; the Bureau of Mines Alaska Mining Experiment Station at Juneau performed check analyses of all samples that contained heavy mineral concentrates; these survey and analytical data have been used in this report.

Nature and Extent of Work

In July 1953 the Alaska Tin Corp. assembled a drilling crew in Nome, Alaska, and collected equipment and supplies. The crew consisted four men - one foreman driller, one panner, one tractor operator-mechanic, and one laborer. The equipment included one churn drill, one medium-size crawler-type diesel tractor with bulldozer blade, one small crawler-type gasoline tractor with winch, freighting sleds, and skid-mounted camp facilities for the four men. Tools, spare parts, supplies, and food completed the outfit.

The crew, with all equipment and supplies, departed from Nome July 31, 1953, and traveled by tug and barge to Shishmaref Inlet, where the outfit was unloaded on the beach and pulled overland by tractor; the first load arrived at Ear Mountain August 9. Drilling started on Tuttle Creek August 15 and was completed September 22. The crew then moved the outfit to the Eldorado Creek-Kreuger Creek Valley, where drilling started September 25 and was completed October 18. This completed the planned work, but it was too late in the season for the tug to return to Shishmaref Lagoon, so the equipment and remaining supplies were stored at Ear Mountain, and the crew returned to Nome by plane. Later, the tractors and drill were driven overland to the Bering Sea for shipment to Nome.

The Alaska Tin Corp. sampled with the same equipment used by the Bureau of Mines for placer sampling, and also used the same sampling procedures and methods of evaluation. A description of the equipment used, the sampling procedure, and the methods of evaluation is included with the description of the Bureau placer sampling in this report.

Drilling data, sample-analyses data, and computations of grade are summarized in tables 3 and 4; drill-hole locations are shown in figures 11 and 12.

TABLE 3. - Summary of DMEA churn-drilling and sampling results, Tuttle Creek 1/

Drill-hole data							Pay horizon				Concentrate		Mining section		
Number		Collar elevation (feet)	Depths (feet)				Interval (feet)		Depth (feet)	Volume (cubic feet)	Weight (pounds)	Tin (per-cent)	Depth (feet)	Concentrate (pounds per cubic yard)	Tin (pounds per cubic yard)
Line	Hole		Total	OB	Gravel	Cased	From	To							
BL 6	7	364	27.5	19.5	6.5	5.0	19.5	27.0	7.5	2/1.06	1.33	1.40	7.5	33.85	0.47
BL 6	9	354	27.0	19.0	6.0	1.5	19.0	26.0	7.0	.99	1.35	.60	7.0	36.88	.22
BL 5	5	396	22.5	15.0	4.5	5.0	15.0	20.5	5.5	2/ .76	1.08	.65	5.5	38.12	.25
BL 5	8	385	27.5	18.0	8.0	5.0	18.0	27.0	9.0	2/1.20	2.11	.54	9.0	47.64	.26
BL 4	3	406	20.0	15.0	3.0	5.0	15.0	19.0	4.0	2/ .52	.07	10.80	4.0	3.40	.37
BL 4	5	399	20.0	14.0	4.0	5.0	14.0	19.0	5.0	2/ .69	1.63	.54	5.0	63.57	.34
BL 4	7	392	23.0	16.0	5.0	5.0	16.0	22.0	6.0	2/ .79	1.62	.54	6.0	55.82	.30
BL 4	9	382	20.5	13.0	4.0	4.0	13.0	18.0	5.0	.66	.97	.70	5.0	39.90	.28
BL 3	1	424	19.5	15.0	2.0	5.0	15.0	19.0	4.0	.60	.70	Trace	4.0	31.74	Trace
BL 3	2	424	13.5	10.0	2.0	5.0	10.0	13.0	3.0	.45	.52	Trace	3.0	31.57	Trace
BL 3	3	404	12.0	10.0	-	5.0	-	-	-	-	-	-	-	-	-
3 AB	1	427	10.0	5.5	1.5	3.5	5.5	8.0	2.5	.42	.67	Trace	2.5	43.72	Trace
3 AB	2	457	8.0	-	6.0	8.0	.0	7.0	7.0	1.61	1.02	.08	7.0	17.04	.01
2 AB	1	392	10.0	5.0	3.0	5.0	5.0	9.0	4.0	.66	.51	Trace	4.0	20.61	Trace
2 AB	2	387	8.0	4.0	2.5	8.0	4.0	7.5	3.5	.81	.71	.31	3.5	23.82	.07
1 AB	3	388	23.0	10.0	10.0	7.0	10.0	21.0	11.0	2/1.43	1.26	.10	11.0	23.80	.02
1 AB	6	379	16.0	5.0	9.5	5.0	5.0	15.5	10.5	1.36	1.18	1.70	10.5	23.38	.40
1	3	370	10.0	2.5	6.0	4.0	2.5	9.5	7.0	.91	.53	.05	7.0	15.75	.01
1	5	368	19.5	2.5	15.5	3.0	2.5	19.0	16.5	2/2.14	1.14	1.30	16.5	14.40	.19
1	7	362	14.0	1.5	11.0	2.5	1.5	13.5	12.0	2/1.56	1.78	1.55	12.0	30.79	.48
1	8	355	10.0	1.5	6.5	10.0	1.5	9.0	7.5	1.73	.68	.54	7.5	10.54	.06
2	5	365	19.0	10.0	7.0	7.0	10.0	18.0	8.0	1.04	.85	.30	8.0	21.98	.07
2	7	359	16.0	7.0	7.0	7.0	7.0	15.0	8.0	2/1.04	1.70	2.90	8.0	44.23	1.28
2	11	347	9.5	4.0	3.0	4.5	4.0	8.0	4.0	2/ .52	1.21	1.30	4.0	62.82	.82
3	5	346	12.0	5.0	4.0	5.0	6.0	10.0	4.0	2/ .52	.92	.60	5.0	38.29	.23
3	11	335	7.0	2.5	3.5	7.0	2.5	7.0	4.5	1.04	1.13	.20	4.5	29.39	.06
3	13	333	12.0	-	8.0	11.0	.0	9.0	9.0	2.07	.99	.10	9.0	12.88	.01
3	15	334	9.0	-	7.5	9.0	.0	8.5	8.5	1.96	1.06	.70	8.5	14.55	.10
7	5	314	10.0	4.5	4.5	9.0	4.5	10.0	5.5	1.27	.24	.70	5.5	5.02	.04
7	7	314	11.5	3.0	7.0	3.0	6.0	11.0	5.0	2/1.02	.52	2.60	8.0	13.77	.36
7	9	311	10.0	3.0	6.0	3.0	3.0	10.0	7.0	1.43	.57	2.60	7.0	10.84	.28
7	11	310	12.0	2.5	7.5	3.0	2.5	11.0	8.5	1.73	2.43	.80	8.5	37.94	.30
7	13	309	9.0	1.5	6.0	4.5	4.0	8.5	4.5	2/ .76	1.65	.40	7.0	37.56	.15
7	17	308	6.0	-	5.0	6.0	.0	6.0	6.0	1.38	.42	.40	6.0	8.21	.03
7	19	307	6.0	-	5.0	6.0	.0	6.0	6.0	1.38	.41	.80	6.0	7.96	.06
9	1	335	23.5	17.0	4.5	4.0	17.0	22.5	5.5	.91	.98	.31	5.5	29.01	.09
9	5	314	16.0	8.0	6.5	5.0	8.0	15.5	7.5	2/1.11	.58	.50	7.5	14.07	.07
9	9	306	13.5	5.0	7.0	1.5	5.0	13.0	8.0	2/1.09	.60	1.90	8.0	14.92	.28
9	11	302	12.0	3.5	7.5	3.0	3.5	11.5	8.0	2/1.14	.55	1.20	8.5	12.24	.15
9	13	300	10.0	3.5	5.5	3.0	4.0	10.0	6.0	1.00	.56	.20	6.5	13.85	.03
9	15	298	9.0	4.5	3.0	9.0	4.5	8.5	4.0	.92	.40	2.00	4.0	11.56	.23
9	17	297	8.0	1.0	5.0	7.0	1.0	7.0	6.0	1.38	.27	.20	6.0	5.29	.01
11	1	313	10.0	7.0	1.0	3.0	7.0	9.0	2.0	.26	.61	.05	2.0	63.65	.03
11	9	300	12.0	5.0	5.5	4.0	5.0	11.5	6.5	1.50	.56	1.10	6.5	10.05	.11
11	11	297	12.5	7.0	4.0	3.0	7.0	12.0	5.0	.74	.56	.50	5.0	20.25	.10
11	13	296	11.5	3.0	7.0	3.5	5.0	11.0	6.0	.94	1.91	.90	8.0	41.45	.37
11	15	293	11.5	4.0	6.0	3.5	5.0	11.0	6.0	2/1.00	2.16	1.60	7.0	50.15	.80
11	17	290	9.5	2.0	6.5	9.5	4.0	8.0	4.0	.92	1.75	2.00	7.5	27.30	.55
11	19	288	7.0	2.0	3.5	6.0	2.0	6.5	4.5	1.04	.98	.20	4.5	25.43	.05
11	21	287	6.5	-	5.5	6.0	.0	6.5	6.5	1.50	.76	.10	6.5	13.78	.01
13	1	299	12.0	7.0	3.0	3.0	7.0	11.0	4.0	.52	.55	.30	4.0	28.50	.09
13	5	286	9.5	5.0	3.5	9.5	5.0	9.5	4.5	1.04	1.05	1.20	4.5	27.31	.33
13	9	282	10.0	5.5	3.0	5.0	6.0	10.0	4.0	2/ .69	.94	.90	4.0	36.71	.33
13	11	281	9.0	3.0	4.5	3.0	3.0	8.5	5.5	.95	.76	.40	5.5	21.67	.09
13	13	279	9.0	3.0	4.5	3.0	3.0	8.5	5.5	.95	1.06	.20	5.5	30.07	.06
13	15	278	8.5	3.0	4.0	4.0	4.0	8.0	4.0	2/ .71	.93	.30	5.0	28.17	.08
13	17	276	7.0	-	5.5	6.5	.0	6.5	6.5	1.50	.53	.20	6.5	9.57	.02
13	19	276	7.5	-	5.5	6.5	.0	6.5	6.5	1.50	.37	.30	6.5	6.66	.02
15	5	280	11.0	2.0	8.0	4.5	4.0	11.0	7.0	1.15	.65	1.50	9.0	11.88	.18
15	7	274	10.0	3.0	7.0	3.0	3.0	10.0	7.0	1.15	.46	.10	7.0	10.71	.01
15	9	267	10.5	1.0	3.0	7.0	1.0	5.0	4.0	.92	.43	.20	4.0	12.53	.03
15	11	267	13.5	-	9.0	9.0	.0	10.0	10.0	2.30	1.01	2.30	10.0	11.85	.27
15	13	270	22.0	2.0	10.0	14.0	2.0	13.0	11.0	2.54	1.02	.20	11.0	10.84	.02
17	5	268	13.0	5.5	6.0	4.0	5.5	12.5	7.0	1.15	1.05	.20	7.0	24.65	.05
17	7	259	7.0	2.0	3.0	7.0	2.0	6.0	4.0	.92	.45	.40	4.0	13.17	.05
17	9	258	7.0	-	5.5	7.0	.0	6.5	6.5	1.50	.45	.20	6.5	8.14	.02
17	11	258	7.0	-	5.5	7.0	.0	6.5	6.5	1.50	1.19	.60	6.5	21.44	.13
19	5	246	10.0	7.0	1.0	10.0	7.0	9.0	2.0	.46	.75	.10	2.0	43.75	.04
19	9	250	13.0	5.0	6.5	5.0	5.0	12.5	7.5	1.18	1.24	.10	7.5	28.35	.03
19	13	242	7.5	2.0	4.5	7.5	2.0	7.5	5.5	1.27	1.08	.90	5.5	22.99	.21
19	15	240	9.5	-	8.0	8.5	.0	9.0	9.0	2.07	1.27	.60	9.0	16.50	.10
20	7	235	14.0	2.5	7.5	3.5	5.0	11.0	6.0	2/ .96	1.33	.80	8.5	26.62	.21
20	9	235	11.0	2.0	6.5	3.0	2.0	9.5	7.5	1.18	.70	.20	7.5	16.11	.03

1/ Drilled by Alaska Tin Corp.
2/ Determined by water measurement.

NOTE: Data were not complete enough to compute total volume of tin-bearing gravel or total amount of tin present. Because of the low grade encountered drill-hole lines were not put in at intervals close enough to justify the assumption that deposition was continuous from line to line.

Excluding bench and limit holes, the following unweighted averages indicate the grade of the deposit:

Tuttle Creek (45 holes averaged):

Average value..pound of tin per cubic yard 0.2
Average depth of mining section.. feet 7.0
Best hole (value)....................................pound of tin per cubic yard 1.28
Best hole (depth of mining section).. 8.0

TABLE 4. - Summary of DMEA churn-drilling and sampling results, Eldorado Creek-Kreuger Creek 1/

Drill-hole data							Pay horizon				Concentrate		Mining section		
Number		Collar elevation	Depths (feet)				Interval (feet)		Depth	Volume (cubic	Weight	Tin	Depth	Concentrate (pounds per	Tin (pounds per
Line	Hole	(feet)	Total	OB	Gravel	Cased	From	To	(feet)	feet)	(pounds)	(percent)	(feet)	cubic yard)	cubic yard)
36	15	513	19.5	3.0	14.0	5.0	12.5	18.0	5.5	2/1.06	1.28	Trace	15.0	11.97	Trace
24	1	463	5.0	-	3.0	8.0	.0	4.0	4.0	.92	.14	Trace	4.0	4.07	Trace
24	3	461	9.5	2.0	6.0	8.5	2.0	9.0	7.0	1.61	.83	0.51	7.0	13.86	0.07
24	5	462	10.0	1.5	7.0	10.0	1.5	9.5	8.0	1.84	1.56	3.50	8.0	22.91	.80
24	7	461	10.0	1.5	7.0	10.0	1.5	9.5	8.0	1.84	.80	.77	8.0	11.65	.09
24	9	463	10.0	2.0	6.5	10.0	2.0	9.5	7.5	1.73	1.04	1.20	7.5	16.17	.19
24	11	465	13.5	4.0	8.0	13.5	4.0	13.0	9.0	2.08	1.09	.88	9.0	14.19	.12
24	13	467	17.0	7.0	8.0	5.0	8.5	15.5	7.0	2/1.30	.85	1.80	9.0	13.73	.25
24	15	469	20.0	5.0	11.5	5.0	9.5	17.5	8.0	2/1.21	1.70	2.00	12.5	24.24	.48
24	17	470	19.5	11.5	4.5	5.0	13.5	17.0	3.5	2/ .62	1.30	1.10	5.5	36.11	.40
24	19	472	19.5	10.0	7.5	5.0	13.0	18.5	5.5	2/ .95	1.00	1.10	8.5	18.50	.20
12	5	422	13.5	-	10.5	12.0	.0	11.5	11.5	2.65	.93	.92	11.5	9.47	.09
12	7	425	15.0	2.0	10.5	4.0	7.0	13.5	6.5	2/1.28	2.43	1.20	11.5	28.95	.35
12	9	428	16.0	4.0	9.5	3.0	8.0	14.5	6.5	2/1.27	2.20	1.40	10.5	29.00	.41
12	11	429	19.5	6.0	11.5	4.0	10.0	18.5	8.5	2/1.89	2.66	1.50	12.5	25.82	.39
12	13	430	21.0	8.0	9.0	5.0	9.0	17.0	8.0	2/ .94	1.62	.57	10.0	37.49	.21
12	15	430	20.0	7.0	11.0	4.0	11.0	19.0	8.0	2/1.17	1.11	1.00	12.0	17.07	.17
12	17	430	19.0	8.5	8.5	4.0	11.0	18.0	7.0	2/ .93	1.19	1.10	9.5	25.29	.28
12	19	430	15.0	8.5	4.5	5.0	8.5	14.0	5.5	.80	1.55	.41	5.5	52.38	.21
12	23	430	15.0	11.0	1.0	5.0	11.0	13.0	2.0	.29	.47	Trace	2.0	43.97	Trace
16	6	388	20.0	2.0	15.0	18.5	2.0	18.0	16.0	3.69	1.64	.54	16.0	12.02	.06
16	8	393	23.5	5.0	15.5	5.0	8.0	21.5	13.5	2/2.14	2.68	1.90	16.5	27.61	.52
16	12	399	26.0	4.0	19.0	4.0	9.0	24.0	15.0	2/2.46	2.00	4.30	20.0	16.48	.71
16	14	400	25.5	1.5	22.5	2.5	9.0	25.0	16.0	2/2.85	2.61	3.70	23.5	16.85	.62
28	10	369	13.0	2.0	9.0	11.0	2.0	12.0	10.0	2.30	1.54	.21	10.0	18.07	.04
28	12	372	16.0	2.0	12.0	3.0	2.0	12.0	13.0	2.20	1.75	.62	13.0	21.42	.13
28	14	374	18.0	4.0	11.5	4.0	11.0	16.5	5.5	2/ .94	2.06	.46	12.5	25.99	.12
28	16	375	19.0	4.0	12.0	4.0	12.0	17.0	5.0	2/ .78	1.63	1.00	13.0	21.82	.22
40	12	351	11.5	1.0	8.5	11.5	1.0	10.5	9.5	2.19	1.22	1.40	9.5	15.09	.21
40	14	352	12.5	2.0	8.5	4.0	5.0	11.5	6.5	2/ .90	1.56	.72	9.5	31.92	.23
40	26	357	16.0	8.0	6.0	6.0	8.0	15.0	7.0	.97	.99	Trace	7.0	27.50	Trace

1/ Drilled by Alaska Tin Corp.
2/ Determined by water measurement.

NOTE: Data were not complete enough to compute total volume of gravel or total amount of tin present. Because of the low grade encountered drill-hole lines were not put in at intervals close enough to justify the assumption that deposition was continuous from line to line. For the same reason drill-hole lines, in general, do not delimit the margins of deposition.

Excluding bench and limit holes, the following unweighted averages indicate the grade of the deposit:
Kreuger Creek-Eldorado Creek (26 holes averaged):
Average value...pound of tin per cubic yard 0.3
Average depth of mining section..feet 10.0
Best hole (value).....................................pound of tin per cubic yard .8
Best hole (depth of mining section)..feet 10.0

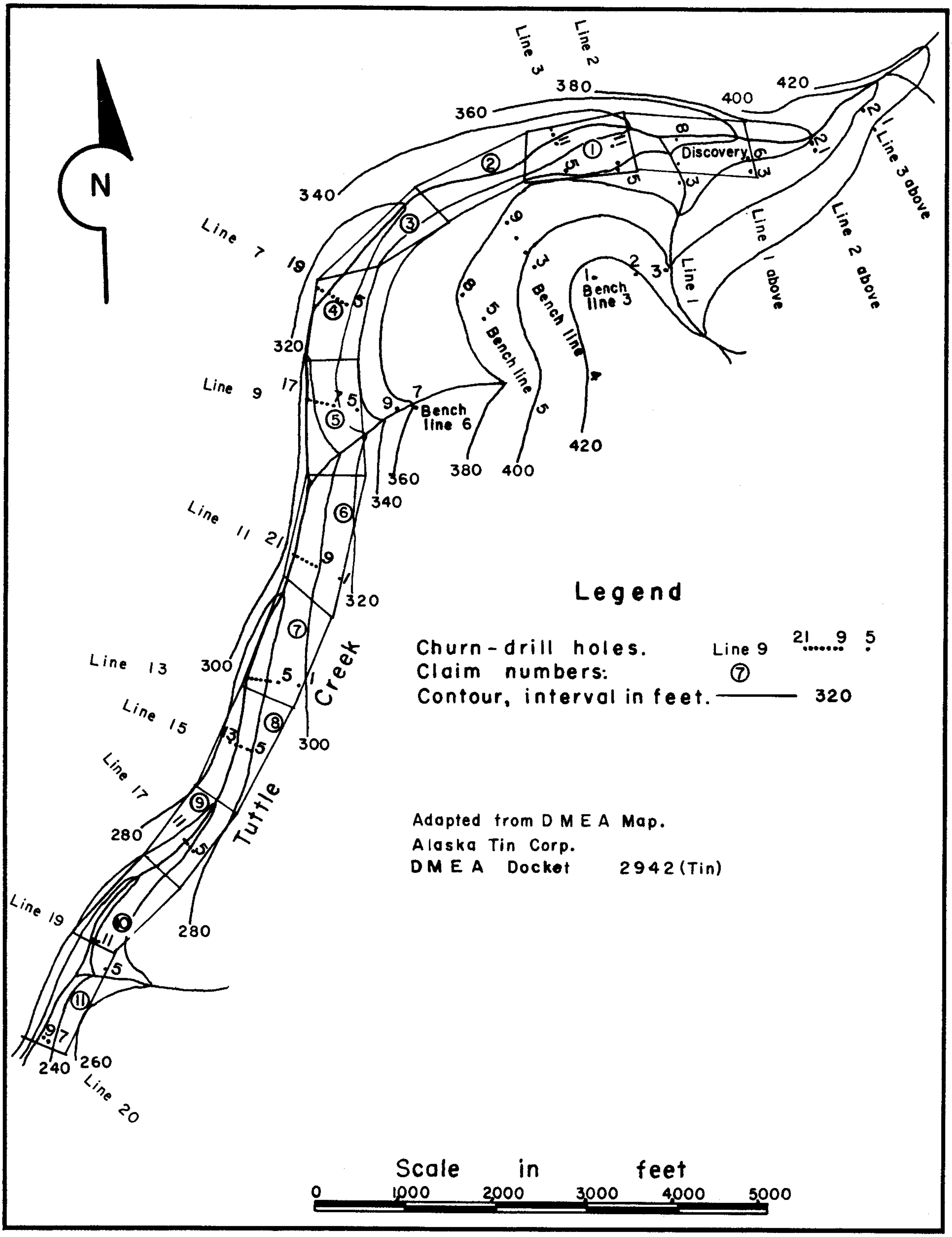

FIGURE 11. - Churn-Drill Holes, Tuttle Creek.

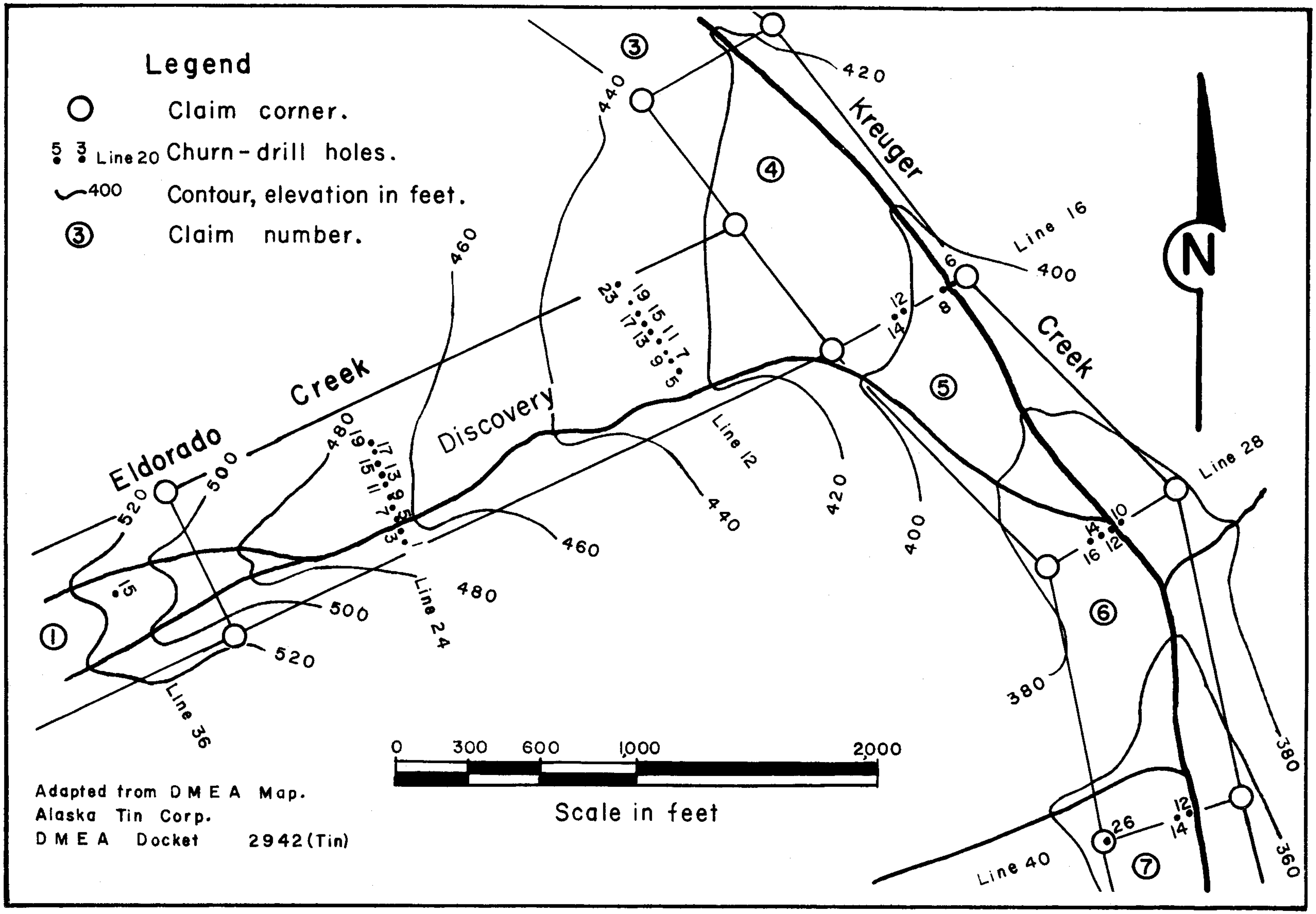

FIGURE 12. - Churn-Drill Holes, Kreuger Creek.

BUREAU OF MINES WORK

Placer Reconnaissance

The churn-drill sampling of stream-gravel deposits in the vicinity of Ear Mountain was conducted by the Bureau of Mines essentially as reconnaissance to determine the distribution and relative abundance of placer tin as a means of delimiting areas favorable to the discovery of the lode sources of the tin minerals. The indication of areas favorable for more detailed placer exploration was incidental to the lode investigation. The program was based upon the assumption that the heavy minerals in the stream gravels would be roughly proportional in type and amount to the heavy minerals in the rocks from which the gravels had been derived. This indirect method was used to outline the distribution of tin and other heavy minerals because bedrock throughout the area is buried under a permanently frozen mantle of detritus, peat, and tundra vegetation, which varies in depth from a few inches to 40 feet or more. The sampling data resulting from the investigation are given in detail as a guide to future lode and placer prospecting in the Ear Mountain area.

Sampling Procedure and Method of Evaluation

Representative concentrates of heavy minerals were obtained from one or more churn-drill holes drilled in each of the streams draining the granite and the granite-limestone contact zone on Ear Mountain.

The concentrate samples were taken from stream gravels near the base of the steeper slopes of the mountain. The sites selected were considered favorable for concentration of heavy minerals; one to three samples were taken in each valley. All the sample sites were in sections of the streams underlain by metasediments. The smaller headwater tributaries, underlain by granite, were steep, choked with boulders, relatively inaccessible, and therefore almost impossible to sample with available equipment. Sampling the small tributaries underlain by granite was limited to random panning during investigation of lode outcrops. The samples of placer concentrates obtained by the Bureau are roughly indicative of the grade of the placer deposits; however, the placer-sampling program was essentially a reconnaissance, and the few samples taken from each stream were not enough evidence for estimating the placer reserves in that stream.

The Bureau placer samples were obtained by conventional placer-sampling methods, similar in all respects to those used by the Alaska Tin Corp. In both instances a skid-mounted, Fairbanks-type churn drill, utilizing a tool string designed for use with 5-inch casing, was used. The casing had a nominal inside diameter of 5 inches, and the casing shoe had an outside diameter of 6-1/2 inches. In thawed ground samples were obtained from cased holes; in frozen ground, from uncased holes. Drilling and sampling data were recorded on special drill-hole-log forms developed for use in permafrost areas. Samples from the drill holes were panned to a rough concentrate, and the valuable mineral content was estimated. The samples were then dried, weighed, sacked, and shipped to the Bureau of Mines Alaska Mining Experiment Station in Juneau, where they were assayed for tin. In addition, the Bureau samples were checked with a Geiger counter and submitted for spectrographic and petrographic analyses.

The results of both the Bureau and the Alaska Tin Corp. churn-drilling program was calculated and summarized in accordance with normal placer-evaluation procedures as adapted to permafrost areas. The following definitions and methods-of-evaluation have been used throughout this report:

The overburden (O.B.) is a mixture of varying proportions of organic material, rock-decomposition products, and ice, which is called "muck" by Alaska placer miners. Usually a dense mat of moss and tundra vegetation, varying in thickness from 1 to 3 feet, covers the overburden and serves as an insulator, which prevents thawing during the summer months.

The pay horizon (P.H.) is that section of the hole from which a heavy mineral concentrate was obtained. In cased holes the volume of the pay horizon is the area encompassed by the cutting edge of the casing shoe multiplied by the depth of the pay horizon. In uncased holes (in frozen ground) the sample volume was determined by measuring the volume of water required to refill the pay horizon. To save time, in low-grade deposits many of the uncased holes were not measured. In this instance the volume of the pay horizon is an estimate based upon the measured volume of the pay horizon in nearby uncased holes.

The mining section (M.S.) is the total depth of the gravel and bedrock that would be handled during mining. In most of the calculations 1 foot of bedrock was included in the mining section. The following equation was used to determine the amount of concentrate in the mining section:

$$(27)\quad \frac{\text{Concentrate weight, pounds}}{\text{Volume of P.H., cubic feet}} \times \frac{\text{Depth of P.H., feet}}{\text{Depth of M.S., feet}} = \text{Concentrate in M.S.,}$$

pounds per cubic yard.

To obtain the quantity of tin in the mining section the above result was multiplied by the analyses data:

Concentrate in M.S., pounds per cubic yard X Concentrate assay in percent tin = tin M.S., pounds per cubic yard.

The Bureau drill holes are shown in figure 10. Petrographic and spectrographic analyses are included in tables 5 and 6. Drill-hole and analyses data, calculations, and results are summarized in table 7. Checking with a Geiger counter revealed only barely perceptible traces of radioactivity in the concentrates; therefore these data have not been tabulated.

TABLE 5. - Petrographic analyses of churn-drill placer samples, Ear Mountain area[1]

Sample No.	Analysis
BM 1......	Sample composed of quartz, calcite, tourmaline, diopside, and grossularite garnet, with some albire and orthoclase. Traces of zircon, epidote, hornblende, limonite, and crossite. Tin detected spectrographically. Cassiterite identified.
BM 2......	Sample composed of quartz and calcite, with grossularite garnet, albite, diopside, and limonite (pseudomorph after pyrite). Traces of tourmaline, hornblende, chlorite, chondrodite, vesuvianite, epidote, and magnetite. Tin detected spectrographically. Cassiterite identified.
BM 3......	Sample composed of quartz and calcite, with some albite, grossularite garnet, vesuvianite, chondrodite, diopside, and limonite (pseudomorph after pyrite). Tin detected spectrographically. Cassiterite identified.
BM 4 and BM 5....	Samples composed of quartz, calcite, grossularite garnet, albite, and limonite (pseudomorph after pyrite). Traces of blue tourmaline, brown tourmaline, epidote, and vesuvianite. Tin detected spectrographically in sample BM 4. Cassiterite identified.
BM 6......	Sample composed of quartz, calcite, orthoclase, plagioclase, grossularite garnet, vesuvianite, pyrite, and traces of blue tourmaline, brown tourmaline, and epidote. Tin detectected spectrographically. Cassiterite identified.
BM 7......	Sample composed of quartz, orthoclase, albite, oligoclase, and tourmaline, with smaller amounts of grossularite garnet, vesuvianite, diopside, ankerite, pyrite, zoisite, epidote, chlorite, and limonite (pseudomorph after pyrite). Tin detected spectrographically. Cassiterite identified in very small amounts.
BM 8......	Sample composed of quartz, orthoclase, oligoclase, pyrite, limonite (pseudomorph after pyrite), and small amounts of grossularite garnet, tourmaline, vesuvianite, chondrodite, epidote, and actinolite. Tin detected spectrographically. Cassiterite identified.
BM 9......	Sample composed of quartz, orthoclase, oligoclase, and limonite (pseudomorph after pyrite), with small amounts of grossularite garnet, tourmaline, vesuvianite, actinolite, and pyrite. Tin not detected.
BM 10.....	Sample composed of quartz, garnet, and lesser amounts of albite, calcite, limonite (pseudomorph after pyrite), epidote, diopside, and tourmaline. Very small amounts of pyrite, vesuvianite, chondrodite, actinolite, and chlorite. Tin not detected.
BM 11.....	Sample composed of quartz, calcite, and lesser amounts of olivine, limonite, and oligoclase. Traces of tourmaline, vesuvianite, epidote, and pyrite. Tin not detected.
BM 12.....	Sample composed of quartz, oligoclase, orthoclase, and garnet. Traces of actinolite, tourmaline, hypersthene, pyrite, vesuvianite, chondrodite, and epidote. Tin not detected.

See footnote at end of table.

TABLE 5. - Petrographic analyses of churn-drill placer samples, Ear Mountain area[1] (Con.)

Sample No.	Analysis
BM 13, BM 14, and BM 15...	Samples composed of quartz, calcite, oligoclase, orthoclase, garnet, and diopside. Traces of pyrite, limonite, vesuvianite, tourmaline, epidote, chlorite, biotite, actinolite, and muscovite. Tin detected spectrographically in samples BM 14 and BM 15; the tin mineral could not be identified.
BM 16, BM 17, and BM 28...	Samples composed of grossularite garnet, epidote, diopside, quartz, and orthoclase. Traces of oligoclase, magnetite, biotite, tourmaline, vesuvianite, axinite, apatite, pyrite, and actinolite. Tin detected spectrographically. Cassiterite identified.
BM 18 and BM 19...	Samples composed of quartz, orthoclase, calcite, garnet, and some albite. Traces of diopside, tourmaline, vesuvianite, and chondrodite. Tin detected spectrographically; the tin mineral could not be identified.
BM 20 and BM 21...	Samples composed of quartz, orthoclase, calcite, and garnet. Traces of zoisite, vesuvianite, and tourmaline. Tin detected spectrographically in sample BM 20; the tin mineral could not be identified.
BM 22 and BM 23...	Samples composed of quartz, orthoclase, and calcite and traces of tourmaline, hypersthene, and limonite. Tin not detected.
BM 24 and BM 25...	Samples composed of quartz, chlorite, and less calcite, diopside, orthoclase, albite, and limonite. Traces of garnet, epidote, vesuvianite, and tourmaline. Tin not detected.
BM 26.....	Sample composed of chlorite, quartz, and lesser limonite, oligoclase, and orthoclase. Trace of hornblende. Tin not detected.
BM 27.....	Sample composed of calcite, with quartz, diopside, and grossularite garnet. Traces of actinolite, tourmaline, orthoclase, albite, and limonite (pseudomorph after pyrite). Tin detected spectrographically. Cassiterite identified.

1/ Minerals listed in approximate order of relative abundance.

Summary of Results

Tin in the form of cassiterite was identified in the gravels of Tuttle Creek, a nameless creek east of Tuttle Creek (BM 27), and in the Eldorado (all three forks), Crosby, Pinnacle, Step Gulch, and Deer Creeks. The strongest concentration was found in hole BM 28 on Tuttle Creek - 0.2 pound of tin per cubic yard in a mining section 10 feet deep. The next best holes, BM 17 on Tuttle Creek and BM 1 on Eldorado Creek, contained about 0.1 pound of tin per cubic yard. The remaining holes that contained identifiable cassiterite ranged in grade from 0.05 pound per cubic yard to trace amounts.

Traces of tin also were identified spectrographically in holes BM 13-BM 15 and BM 18-BM 21, but the tin-bearing mineral could not be recognized.

TABLE 6. - Spectrographic analyses of churn-drill placer samples, Ear Mountain area

Letters indicate estimates from qualitative analysis

A Over 10 percent. C 1 to 5 percent. E 0.01 to 0.1 percent. G Under 0.001 percent.
B 5 to 10 percent. D 0.1 to 1 percent. F 0.001 to 0.01 percent. - Not detected.

< = Less than.

Sample No.	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sb	Si	Sn	Sr	Ta	Ti	V	W	Zn	Zr
BM 1..	G	A	E	-	D	D	F	-	A	-	-	F	F	B	-	-	C	D	-	D	-	E	<D	E	-	A	E	E	-	D	E	-	-	E
BM 2..	G	A	E	-	D	D	G	-	B	-	-	F	F	B	-	-	C	D	F	D	-	E	<D	E	-	A	E	-	-	D	E	-	-	E
BM 3..	G	A	E	-	E	D	G	-	A	-	-	F	F	B	-	-	C	D	-	D	-	E	<D	-	-	A	E	E	-	D	E	-	-	E
BM 4..	G	A	E	-	E	D	G	-	A	-	-	F	F	B	-	-	C	D	-	C	-	E	<D	-	-	A	E	E	-	D	E	-	-	E
BM 5..	G	A	E	-	D	D	G	-	A	-	-	F	F	B	-	-	C	D	-	D	-	E	<D	-	-	A	-	E	-	D	E	-	-	E
BM 6..	G	A	E	-	D	D	F	-	B	-	F	-	F	B	-	-	C	D	-	D	-	E	<D	-	-	A	E	-	-	D	E	-	-	D
BM 7..	G	A	E	-	D	D	F	-	B	-	-	-	F	B	-	-	C	D	-	D	-	E	<D	-	-	A	E	-	-	D	E	-	-	E
BM 8..	G	A	E	-	D	-	F	-	C	-	F	F	F	A	-	-	C	D	F	D	-	E	<D	E	-	A	E	-	-	D	E	-	-	E
BM 9..	G	A	E	-	D	-	G	-	C	-	-	-	F	B	-	-	C	D	-	D	-	E	<D	-	-	A	-	-	-	D	E	-	-	E
BM 10.	G	A	E	-	E	-	G	-	B	-	-	-	F	B	-	-	C	D	-	D	-	E	<D	-	-	A	-	-	-	D	E	-	-	E
BM 11.	G	B	F	-	E	-	G	-	B	-	-	-	F	B	-	-	C	D	-	D	-	E	<D	-	-	A	-	E	-	D	<E	-	-	<E
BM 12.	G	A	E	-	D	D	G	-	A	-	-	F	F	B	-	-	C	D	-	D	-	F	<D	-	-	A	-	E	-	D	E	-	-	E
BM 13.	G	A	E	-	D	D	E	-	A	-	-	F	F	B	-	-	C	D	-	D	-	E	<D	-	-	A	-	E	-	D	E	-	-	E
BM 14.	G	A	E	-	D	D	F	-	A	-	-	F	F	B	-	-	C	D	F	-	-	E	<D	-	-	A	E	E	-	D	E	-	-	E
BM 15.	G	B	E	-	D	D	F	-	B	-	-	F	F	B	-	-	C	D	-	D	-	E	<D	-	-	A	E	-	-	D	E	-	-	E
BM 16.	-	A	D	-	D	E	F	-	A	-	-	-	F	B	-	-	C	D	-	D	-	E	-	F	-	A	D	<E		D	F	-	-	E
BM 17.		A		-	D	E	F	-	A	-	-	-	F	B	-	-	A	D	-	C	-	D	-	E	-	A	D	<E		D	F	-	-	E
BM 18.		A		-	D	-	F	-	A	-	-	-	F	B	-	-	C	D	-	C	-	E	-	-	-	A	D	<E		D	F	-	-	E
BM 19.		A		-	D	E	F	-	A	-	-	E	F	B	-	-	B	D	-	C	-	D	-	-	-	A	E	<E		D	F	-	-	E
BM 20.		A		-	D	E	F	-	A	-	-	-	F	B	-	-	A	D	-	C	-	D	-	F	-	A	E	<E		D	F	-	-	E
BM 21.		B		-	D	E	F	-	A	-	-	E	F	B	-	-	C	D	-	D	-	D	-	-	-	A	-	<E		D	F	-	-	E
BM 22A		B		-	D	E	F	-	D	-	-	F	F	B	-	-	C	D	-	D	F	D	-	-	-	A	-	<E		C	E	-	-	E
BM 22B		A		-	D	E	F	-	D	-	-	F	F	B	-	-	B	D	-	D	F	D	-	E	-	A	-	<E		D	E	-	-	E
BM 23.		A		-	D	-	F	E	D	-	-	E	F	B	-	-	C	E	-	D	F	D	-	-	-	A	-	<E		D	F	-	-	E
BM 24.		A		-	D	-	F	-	C	-	-	F	F	B	-	-	A	D	-	C	F	D	-	-	-	A	-	<E		C	F	-	-	E
BM 25.		A		-	D	-	F	-	D	-	-	F	F	B	-	-	B	D	-	C	F	D	-	-	-	A	-	<E		C	E	-	-	E
BM 26.		A		-	D	F	F	-	E	-	-	F	F	B	-	-	C	D	-	C	F	D	-	-	-	A	-	<E		C	E	-	-	E
BM 27.		A		-	D	F	F	F	A	-	-	-	F	B	-	-	C	D	-	D	-	D	-	-	-	A	E	<E		D	-	-	-	E
BM 28.		A		-	D	E	F	-	A	-	-	-	F	B	-	-	B	D	-	D	-	D	-	-	-	A	D	<E		D	-	-	-	E

TABLE 7. - Summary of churn-drilling and sampling results, Ear Mountain[1]

Drill-hole data[2]					Pay horizon				Concentrate		Mining section		
Sample No.	Depths (feet)				Interval (feet)		Depth (feet)	Volume (cubic feet)	Weight (pounds)	Tin (percent)	Depth (feet)	Concentrate (pounds per cubic yard)	Tin (pounds per cubic yard)
	Total	OB	Gravel	Cased	From	To							
BM 1......	15.5	0.0	9.0	9.5	0.0	9.0	9.0	2.07	1.47	0.50	10.0	17.19	0.09
BM 2......	24.0	3.0	9.0	20.0	3.0	12.0	9.0	2.07	1.42	.20	10.0	16.59	.03
BM 3......	10.0	3.0	3.0	7.0	3.0	6.0	3.0	.69	1.31	.05	4.0	38.21	.02
BM 4......	12.5	.0	6.0	8.5	.0	6.0	6.0	1.38	1.72	.05	7.0	28.74	.01
BM 5......	11.0	1.0	4.0	9.5	1.0	5.0	4.0	.92	1.00	-	5.0	23.54	-
BM 6......	16.5	1.0	9.0	12.5	1.0	10.0	9.0	2.07	1.05	.20	10.0	12.25	.02
BM 7......	18.0	2.0	10.0	14.0	2.0	12.0	10.0	2.30	1.22	.40	11.0	13.00	.05
BM 8......	14.0	2.0	6.0	3.0	2.0	8.0	6.0	.88	1.11	.05	7.0	29.39	.02
BM 9......	10.0	2.0	4.0	4.0	2.0	6.0	4.0	.72	1.21	-	5.0	36.30	-
BM 10.....	13.0	2.0	3.0	5.0	2.0	5.0	3.0	.69	1.09	-	4.0	31.80	-
BM 11.....	21.0	7.0	6.0	3.5	7.0	13.0	6.0	.78	1.40	-	7.0	41.59	-
BM 12.....	21.0	13.0	.0	2.0	-	-	.0	-	1.38	-	-	-	-
BM 13.....	17.0	5.0	3.0	2.0	5.0	8.0	3.0	.39	1.40	-	4.0	72.79	-
BM 14.....	14.0	4.0	5.0	8.5	4.0	9.0	5.0	1.15	1.50	Trace	6.0	29.25	Trace
BM 15.....	12.0	3.0	4.0	5.0	3.0	7.0	4.0	.72	1.28	Trace	5.0	38.40	Trace
BM 16[3]...	8.5	3.0	5.5	8.5	3.0	8.5	5.5	1.27	.90	.20	5.5	19.07	.04
BM 17.....	22.0	3.0	11.0	20.0	3.0	14.0	11.0	2.54	2.07	.50	12.0	20.18	.11
BM 18.....	7.0	2.0	2.5	5.0	2.0	4.5	2.5	.58	3.34	Trace	3.5	111.93	Trace
BM 19.....	7.5	3.0	1.0	6.0	3.0	4.0	1.0	.23	4.25	Trace	2.0	249.39	Trace
BM 20.....	8.5	4.0	1.0	4.0	4.0	5.0	1.0	.13	7.08	Trace	2.0	735.33	Trace
BM 21.....	13.5	3.0	3.0	4.0	3.0	6.0	3.0	.49	4.18	-	4.0	172.91	-
BM 22.....	52.0	6.0	43.0	4.0	6.0	49.0	43.0	5.59	10.47	-	44.0	49.41	-
BM 23.....	42.5	4.0	36.0	4.0	4.0	40.0	36.0	4.68	10.01	-	37.0	56.20	-
BM 24.....	9.5	.0	5.0	8.5	.0	5.0	5.0	1.15	6.89	-	6.0	134.37	-
BM 25.....	10.5	.0	6.5	7.5	.0	6.5	6.5	1.50	5.16	-	7.5	80.66	-
BM 26.....	9.0	3.0	1.0	3.0	3.0	4.0	1.0	.13	5.42	-	2.0	563.00	-
BM 27.....	13.0	3.0	3.0	12.5	3.0	7.0	4.0	.92	6.24	Trace	4.0	182.85	Trace
BM 28.....	14.5	3.0	13.5	13.5	3.0	12.5	9.5	2.19	6.64	.30	10.5	74.08	.22

1/ Drilled by U. S. Bureau of Mines.
2/ Collar elevation not measured.
3/ Hole abandoned when large boulder was encountered.

No churn-drill or measured pit samples were taken in the headwater tributaries underlain by granite, but random panning of the gravels indicated the presence of trace amounts of cassiterite.

As noted above, gravels of Tuttle and Eldorado Creeks were somewhat higher in grade than gravels of the other streams. The headwaters of both streams cross the granite-limestone contact zone on the northeast corner of Ear Mountain, where cassiterite has been identified in the contact zone. Although all the headwater tributaries tested contained traces of tin in the sections underlain by granite, it is probable that erosion of the contact zone resulted in the greater abundance of placer tin in drainages of the Tuttle, Eldorade, and Kreuger Creeks. The relatively wide distribution of placer tin in the Ear Mountain area would suggest that the placer deposits were derived from long-continued erosion of widespread lode deposits; the lack of substantially stronger local concentrations would suggest that these deposits are low grade or small.

Not enough gold, scheelite, or other valuable minerals were found in quantity either to be minable as placer deposits or to suggest the presence of significant lode outcrops.

Traces of radioactivity were noted in the placer gravels; the radioactive minerals were not identified. As an indication of the grade of possible lode deposits this has little significance, because many uranium minerals are water soluble and do not tend to form placer concentrations.

Churn-drill sampling proved to be a workable method of roughly outlining the distribution, type, and relative abundance of the more durable heavy minerals in an area covered by frozen overburden.

Lode Investigations

Nature and Extent

The churn-drill sampling indicated that the principal source of placer tin probably was a granite-limestone contact extending from Eldorado Creek westward across North Hill to Tuttle Creek (fig. 6). This contact zone was reported to be exposed in the Winfield shaft where tin ore minerals were known to exist; elsewhere, the contact zone was deeply covered, and its location was indicated only by float. Fine-grained cassiterite found in float widely distributed along the zone was evidence that the lode minerals were not confined to the immediate vicinity of the Winfield shaft.

Some crystals and veinlets of cassiterite were found in granitic material or panned from streams cutting the intrusive; efforts to locate definite deposits or enriched areas in the granite were unsuccessful. The lode investigations, therefore, were confined to the granite-limestone contact.

The investigation consisted principally of reopening and sampling the Winfield shaft and trenching and sampling along the indicated extensions of the contact zone. The lode sampling essentially was a reconnaissance of the most favorable and accessible areas. Results of the work are given in detail as a guide to such future exploration as may be undertaken in the Ear Mountain area.

Winfield Shaft

The Winfield shaft on North Hill was sampled first, because dump samples from the shaft and float samples from the surrounding area indicated that the shaft has been sunk in a section of the granite-limestone contact zone containing stronger than average concentrations of metallic minerals.

At the start of the examination the shaft was filled to the collar with ice, overlain by 1 or 2 feet of water. The water was bailed out and the ice chopped out by pick and shovel. At a depth of about 22 feet the picks broke through into air. Candles lowered through the hole would not burn, so fresh air was blown down through a canvas hose. When the air supported combustion, the workings were entered and found to be free of ice, except for 1 or 2 feet on the floor. A coating of ice crystals covered the walls and back.

The ice in the Winfield shaft was derived from surface water, which seeped in at the shaft collar during the summer. Only part of this water ran into the workings; the remainder froze on the shaft wall. Icicles formed and gradually enlarged until the shaft was plugged; the seepage water then filled the shaft to the collar and froze, and, except for 1 or 2 feet at the top, it remained frozen during the summer. The shaft was opened in the fall of 1953; by September 1954 over half of the total cross section of the shaft had refilled with ice.

Thirty-five chip and channel samples were taken in the Winfield shaft. Sample descriptions, analytical data, and average grades are presented in tables 24 through 27. The openings, geology, and sample locations are shown in figure 8. Petrographic and spectrographic analyses of both trench and shaft samples appear in tables 31 and 32. Metallurgical test data are given in table 30.

The Winfield shaft is shallow (29 feet deep); therefore the computations of average grade were designed to be directly comparable with the trench data. The total width of the mineralized zone in the Winfield shaft (as shown in table 27) is the horizontal width normal to the apparent strike of the granite-limestone contact. The average grade is an average of the grades of the individual metamorphosed-limestone beds (and the granite sill) weighted according to their horizontal widths measured normal to the strike of the granite-limestone contact. (The width of bed 1 is an estimate because its upper border was not exposed.) The grade of a limestone bed (or the granite sill) is a weighted average of all pertinent samples.

Trenches

During the 1954 field season 14 bulldozer trenches and several hand-dug pits were excavated along the granite-limestone contact zone east and west of the Winfield shaft. Some old prospect pits along the contact also were reopened. The objective was to determine if the grade and type of mineralization in the Winfield shaft is typical of the contact zone.

In most instances it was impossible to expose fresh, unbroken bedrock in the trenches. The overburden proved to be deeper and more difficult to penetrate than had been anticipated. It generally was frozen but contained porous zones both within the mass of overburden and along the bedrock. Inflows of water from these porous zones made it necessary to drain the trenches. Some trenches or sections of trenches had to be abandoned because drainage was not practical. The bedrock consisted of frostbroken zones interspersed with solid, unbroken ridges, which made it impossible to dig deeper with the bulldozer. Trenches were dug by pick and shovel in the bottom of the bulldozer trenches. These did not always penetrate below the zone of frostbreaking because freezing weather set in before the trenches were completed. Drifting snow filled the trenches and hampered the digging and sampling. Two types of samples were taken from the trenches and pits - channel and grab. The channel samples were taken where it seemed reasonably certain that the bedrock, although frostbroken, was essentially in place and had not been diluted or enriched. Some oxide minerals were observed, but it is believed that the effects of oxidation were not extensive enough to have made a significant difference in grade. The channel samples were taken in trenches hand dug in the bottom of bulldozer trenches and are believed to represent the sampled area approximately. The grab samples were taken from trenches and pits that did not reach bedrock and are specimens of mineralized float. They can be considered as indicative but not necessarily representative of the grade of the bedrock.

The trenches, pits, and geology of the contact zone are shown on figures 6 and 7. Sample descriptions and analytical data are included in tables 8 through 23. Petrographic and spectrographic analyses of both shaft and trench samples are in tables 31 and 32. Computed average grades of trench and shaft samples are summarized in tables 28 and 29.

TABLE 8. - Sample descriptions and radiometric analyses, trench 1-E

Sample No.	Analysis type[1/] P	S	C	Sample description	eU, percent	Sample No.	Analysis type[1/] P	S	C	Sample description	eU, percent
1			x	5 feet of altered limestone		14			x	5 feet of altered limestone	
2			x			15			x		
3			x			16			x	10 feet of altered limestone	-
4			x			17			x		
5			x			18			x		
6			x			19			x		
7			x			20			x		
8			x			21			x		
9			x		-	22			x		
10			x			23			x	10 feet of alaskite, composite of samples 2 to 12	-
11			x			67		x			
12			x								
13			x								

1/ P = Petrographic analysis; S = spectrographic analysis; C = Chemical analysis.

TABLE 9. - Chemical analyses, trench 1-E

Sample No.	Length (feet)	Percent					Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Au	Ag
1................	5	0.3	-	0.35	-	0.10		-
2................	5	.3	-	.15	-	.10		-
3................	5	.2	-	.08	-	.20		-
4................	5	1.0	-	.08	-	.10		-
5................	5	1.1	-	-	-	.10	Trace	-
6................	5	.3	0.02	.15	-	.20		0.13
7................	5	.3	.04	1.20	-	.20		1.02
8................	5	.4	-	.51	-	.30		.57
9................	5	.4	-	.74	-	1.30	-	.35
10................	5	.2	-	1.10	-	1.90	-	1.24
11................	5	.4	-	1.50	-	2.80	0.05	2.35
12................	5	.2	-	.84	-	.10	.01	.60
13................	5	.1	-	.20	-	.20	-	.15
14................	5	.1	-	.10	-	1.00	.01	-
15................	5	.05	-	-	-	.70	.02	-
Total...........	75							
Average.........		.36	Trace	.47	-	.62	Trace	.42
4................	5	1.0	-	.08	-	.10	Trace	-
5................	5	1.1	-	-	-	.10	Trace	-
Total...........	10							
Average.........		1.05	-	.04	-	.10	Trace	-
16................	10	.05	-	-	-	-	-	.05
17................	10	-	-	.20	-	.10	Trace	-
18................	10	-	-	.08	-	-	Trace	-
19................	10	-	-	.30	-	-	.02	-
20................	10	.10	-	.35	-	.05	Trace	-
21................	10	.20	-	.15	-	-	.03	-
22................	10	.05	-	.68	-	.05	.01	.03
Total...........	70							
Average.........		.06	-	.25	-	.03	.01	.01
23................	10	.05	-	-	-	-	Trace	-
1-15..............	75	.36	Trace	.47	-	.62	Trace	.42
16-22.............	70	.06	-	.25	-	.03	.01	.01
Total...........	145							
Average.........		.22	Trace	.36	-	.34	Trace	.22

TABLE 10. - Sample descriptions and radiometric analyses, trench 1-W

Sample No.	Analysis type[1/] P	S	C	Sample description	eU, percent
24			x	5 feet of altered limestone	-
25			x		
26			x		
27			x		
28			x	10 feet of altered limestone	-

1/ P = Petrographic analysis; S = Spectrographic analysis; C = Chemical analysis.

TABLE 11. - Chemical analyses, trench 1-W

Sample No.	Length (feet)	Percent					Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Au	Ag
24	5	0.40	-	-	-	0.10	0.02	-
25	5	.20	-	-	-	.05	.01	-
26	5	.05	-	-	-	.10	.12	-
27	5	.05	-	-	-	.10	Trace	-
Total	20							
Average		.18	-	-	-	.09	.04	-
28	10	.50	-	0.20	-	-	-	-
24-27	20	.18	-	-	-	.09	.04	-
28	10	.50	-	.20	-	-	-	-
Total	30							
Average		.29	-	.07	-	.06	.03	-

TABLE 12. - Sample descriptions and radiometric analyses, trench 2-W

Sample No.	Analysis type[1/] P	S	C	Sample description	eU, percent
29			x	5 feet of altered limestone	-
30			x		
31			x		
32			x		
33			x		
34			x		
35			x	10 feet of altered limestone	-
36			x	3 feet of altered limestone	-
37			x	5 feet of altered limestone	-
38			x	10 feet of altered limestone	-
39			x		
40			x		
41			x	5 feet of altered limestone	-
42			x		
43			x		

1/ P = Petrographic analysis; S = Spectrographic analysis; C = Chemical analysis.

TABLE 13. - Chemical analyses, trench 2-W

Sample No.	Length (feet)	Percent					Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Au	Ag
29	5	0.10	-	0.08	-	0.10	-	0.01
30	5	.20	-	.10	-	.10	-	.11
31	5	.40	-	.08	-	.10	Trace	.02
32	5	.60	-	.15	-	.20	Trace	-
33	5	.30	-	.10	-	.10	Trace	-
34	5	.20	-	3.55	-	.10	Trace	-
Total	25							
Average		.34	-	.80	-	.12	Trace	.03
35	10	.10	-	.58	-	.10	Trace	.31
36	3	.10	-	.20	-	.10	0.01	.27
37	5	.10	-	.15	-	.10	Trace	.11
Total	18							
Average		.10	-	.40	-	.10	Trace	.25
38	10	.10	-	.10	-	.10	Trace	-
39	10	.10	-	.08	-	.20	.02	-
40	10	-	-	.08	-	.30	-	-
Total	30							
Average		.07	-	.09	-	.20	Trace	-
41	5	.10	-	.08	-	.20	Trace	.04
42	5	.10	-	.63	-	.40	Trace	1.26
43	5	.10	-	.38	-	.20	.03	.60
Total	15							
Average		.10	-	.36	-	.27	.01	.63
29	5	.10	-	.08	-	.10	-	.01
30-34	25	.34	-	.80	-	.12	Trace	.03
35-37	18	.10	-	.40	-	.10	Trace	.25
38-40	30	.07	-	.09	-	.20	Trace	-
41-43	15	.10	-	.36	-	.27	.01	.63
Total	93							
Average		.15	-	.38	-	.17	Trace	.16

TABLE 14. - Sample descriptions and radiometric analyses, trench 3-W

Sample No.	Analysis type1/			Sample description	eU, percent
	P	S	C		
44			x	3 feet of altered limestone	-
45			x	7 feet of altered limestone	-
46			x	10 feet of altered limestone	-
47 2/			x	10 feet of alaskite	-
48 2/			x	5 feet of altered limestone	-
49 2/			x	5 feet of altered limestone	-
50 2/			x	5 feet of altered limestone	-
51 2/			x	5 feet of altered limestone	-
52 2/			x	5 feet of altered limestone	-
53 2/			x	5 feet of altered limestone	-
54 2/			x	5 feet of altered limestone	-
55 2/			x	10 feet of altered limestone	-
68		x		Composite of samples 48 to 54	

1/ P = Petrographic analysis; S = Spectrographic analysis; C = Chemical analysis.

2/ Sample taken in frozen decomposed bedrock.

TABLE 15. - Chemical analyses, trench 3-W

Sample No.	Length (feet)	Percent					Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Au	Ag
44...............	3	-	-	-	-	0.10	Trace	-
45...............	7	-	-	-	-	.05	0.01	-
46...............	10	-	-	-	-	.10	Trace	0.02
Total..........	20							
Average........		-	-	-	-	.08	Trace	.01
47...............	10	0.05	-	-	-	.10	.01	.03
48...............	5	.60	0.02	0.10	-	.50	-	.26
49...............	5	.30	.04	.10	2.30	1.70	.03	.14
50...............	5	.20	-	.10	2.20	1.90	.02	.11
Total..........	15							
Average........		.37	.02	.10	1.50	1.37	.02	.17
51...............	5	.05	-	-	-	-	.04	-
52...............	5	.10	-	-	-	.10	-	-
53...............	5	.20	-	.08	-	.85	Trace	-
54...............	5	.10	-	-	-	.58	.02	.02
55...............	10	.05	-	.08	-	.05	-	.05
Total..........	30							
Average........		.09	-	.04	-	.27	.01	.02
48-50............	15	.37	.02	.10	1.50	1.37	.02	.17
51-55............	30	.09	-	.04	-	.27	.01	.02
Total..........	45							
Average........		.18	Trace	.06	.50	.64	.01	.07

TABLE 16. - Sample descriptions and radiometric analyses, trench 5-W

Sample No.	Analysis type1/			Sample description	eU, percent
	P	S	C		
56................			x	10 feet of altered limestone	-
57................			x	do.	-
58................			x	14 feet of granite	-
59................			x	10 feet of altered limestone	-
60................			x	11 feet of altered limestone	-

1/ P = Petrographic analysis; S = Spectrographic analysis; C = Chemical analysis.

TABLE 17. - Chemical analyses, trench 5-W

Sample No.	Length (feet)	Percent					Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Au	Ag
56...............	10	0.20	0.02	-	-	0.10	Trace	-
57...............	10	.30	.02	-	-	-	-	-
Total..........	20							
Average........		.25	.02	-	-	.05	Trace	-
58...............	14	.05	-	-	-	-	.02	-
59...............	10	.20	-	0.08	-	-	.04	-
60...............	11	.05	-	-	-	.05	.02	-
Total..........	21							
Average........		.12	-	.04	-	.03	.03	-

TABLE 18. - Sample descriptions and radiometric analyses, trench 5-E

Sample No.	Analysis type1/ P	S	C	Sample description	eU, percent
61.........			x	Trench 5-E did not encounter solid bedrock; float in trench bottom indicates that it is near an altered limestone bedrock. Sample 61 is a composite of float specimens from bottom of trench.	-

1/ P = Petrographic analysis; S = Spectrographic analysis; C = Chemical analysis.

TABLE 19. - Chemical analyses, trench 5-E

Sample No.	Length (feet)	Percent					Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Au	Ag
61...........	Specimens	0.05	0.05	0.08	-	-	0.02	-

TABLE 20. - Sample descriptions and radiometric analyses, trench 3-E

Sample No.	Analysis type1/ P	S	C	Sample description	eU, percent
62.........			x	Specimens of basic dike near south end of trench.	-
63.........			x	Typical specimen of altered limestone from the contact zone.	-
64.........			x	20 feet of altered limestone.	-
65.........			x	do.	-
66.........			x	15 feet of altered limestone.	-

1/ P = Petrographic analysis; S = Spectrographic analysis; C = Chemical analysis.

TABLE 21. - Chemical analyses, trench 3-E

Sample No.	Length (feet)	Percent					Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Au	Ag
62..........	Specimens	0.20	-	-	-	0.10	0.03	-
63..........	do.	.10	-	-	-	.05	.03	-
64..........	20	-	-	-	-	.05	.02	-
65..........	20	.10	-	0.08	-	.05	Trace	-
66..........	15	-	-	.08	-	.05	Trace	-
Total.....	55							
Average...		.04	-	.05	-	.05	Trace	-

TABLE 22. - Sample descriptions and radiometric analyses, miscellaneous samples

Sample No.	Analysis type[1/] P	S	C	Sample description	eU, percent
67		x		Composite of samples 2 to 12, trench 1-E.	-
68		x		Composite of samples 48 to 54, trench 3-W.	-
69	x	x	x	Selected specimens from prospect pit in contact zone west of the head of Tuttle Creek.	-
70			x	Selected specimens from prospect pit on iron-stained outcrop in contact zone between Tuttle Creek and Winfield shaft.	-
71			x	Selected specimens from same general area as sample 70.	-
72			x	Selected specimens from trench 2-N; no bedrock encountered in this trench.	-
73			x	Selected specimens from float lines near trench 2-N.	-
74			x	Selected specimens from float near trench 2-N.	-
75			x	Selected specimen from old prospect pit about 300 yards west of Winfield shaft and adjacent to trench 5-W. Prospect pit did not encounter solid bedrock.	-
76	x			Selected specimens from Winfield shaft area for paragenesis study.	-
76-A	x			Same as 76.	-
77	(2/)	(2/)	(2/)	Axinite-cassiterite float with some copper stain and visible pyrite.	-
78	(2/)	(2/)	(2/)	Copper-stained float with some pyrite but no visible cassiterite.	-
79	(2/)	(2/)	(2/)	Copper-stained axinite-cassiterite float with some pyrite.	-
80	(2/)	(2/)	(2/)	Same as sample 79.	-
81	(2/)	(2/)	(2/)	Axinite-cassiterite float with some pyrite.	-
82	(2/)	(2/)	(2/)	Very small amounts of copper-stained float with visible pyrite and traces of fluorite.	-
				End of surface loade samples.	

1/ P = Petrographic analysis; S = Spectrographic analysis; C = Chemical analysis.

2/ No analysis.

TABLE 23. - Chemical analyses, miscellaneous

Sample No.	Length	Percent						Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Fe	Au	Ag
67	Specimens	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
68		(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
69		0.80	-	0.30	-	0.50	9.20	(1/)	(1/)
70		.70	-	.10	-	.05	13.80	(1/)	(1/)
71		.05	-	.18	-	.05	17.20	(1/)	(1/)
72		.30	-	-	-	-	7.20	(1/)	(1/)
73		.20	-	-	-	-	6.20	(1/)	(1/)
74 2/		1.25	-	-	3.70	-	-	-	-
75		.10	-	.20	.10	.29	-	-	0.26
76		(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
77		(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
78		(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
79		(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
80		(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
81		(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
82		(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)

1/ No assay.
2/ Antimony: 1.70 percent.

TABLE 24. - Sample descriptions and radiometric analyses, Winfield shaft

Sample No.	Analysis type 1/			Sample description	eU, percent
	P	S	C		
101			x	Chip sample, mineralized limestone	-
102			x		
103			x		
104			x		
105			x		
106			x		
107			x	Chip sample, alaskite sill	-
108			x	Chip sample, mineralized limestone	-
109			x		
110			x		
111			x		
112			x		
112-A			x	Chip sample, small irregular granitic (alaskite?) intrusive	-
113			x	Chip sample, mineralized limestone	-
114			x		
115			x		
116			x		
117			x		
118			x	Chip sample, basic dike	-
119			x	Chip sample, mineralized limestone	-
120			x		
121			x		
122			x		

See footnote at end of table.

TABLE 24. - Sample descriptions and radiometric analyses, Winfield shaft (Con.)

Sample No.	Analysis type[1] P	S	C	Sample description	eU, percent
123			x	Chip sample, alaskite sill	-
124			x	Chip sample, mineralized limestone	-
125			x	Chip sample, check sample of mineralized limestone from the alaskite sill to the basic dike	-
126			x	Chip sample check sample of the mineralized limestone on east wall of workings between the shaft and the granite	0.01
127			x	Channel sample, 2.5 feet of altered limestone	.01
128			x	Channel sample, 4.2 feet of altered limestone	-
129			x	Channel sample, 1.8 feet of granite	-
130			x	Channel sample, 3.5 feet of altered limestone	.01
131[2]			x	Channel sample, 4.5 feet of altered limestone	-
132[2]			x	Channel sample, 5.2 feet of altered limestone	-
133[2]			x	Channel sample, 4.4 feet of altered limestone	-
134[2]			x	Channel sample, 5.0 feet of altered limestone	-
135[2]				Channel sample, 5.4 feet of altered limestone	0.01
136		x		Composite of samples 125 to 135	-
137	x			Composite of samples 107 and 123 (both in alaskite sill)	-
138	x			Selected specimens from basic dike (sample 118)	-
139	x			Composite of samples 122 and 124 (mineralized limestone adjacent to alaskite sill)	-
140	x			Composite of Winfield shaft samples 102-106, 109-111, 116, and 117	-
141	x	x	x	Selected specimens containing visible sulfides from dump at Winfield shaft	-

1/ P = Petrographic analysis; S = Spectrographic analysis; C = Chemical analysis.

2/ Measured normal to dip of winze.

TABLE 25. - Chemical analyses, Winfield shaft samples

Sample No.	Length (feet)[1]	Percent Sn	WO_3	Cu	Pb	Zn	Ounces per ton Au	Ag
101.............	6.7	0.20	-	1.40	-	0.80	Trace	0.36
102.............	3.5	.30	-	.35	-	.10	0.01	-
103.............	3.3	1.10	-	-	-	.10	Trace	-
104.............	3.7	.80	-	-	-	.20	Trace	-
105.............	4.0	1.30	-	-	-	.20	.01	-
106.............	3.5	.70	-	.08	-	.10	Trace	-
107.............	.5	.05	-	.51	-	.10	.02	-
108.............	2.8	.40	-	-	-	.10	.01	-

See footnote at end of table.

TABLE 25. - Chemical analyses, Winfield shaft samples (Con.)

Sample No.	Length (feet)1/	Percent					Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Au	Ag
109.............	3.5	0.80	-	0.56	-	0.10	Trace	-
110.............	3.0	1.00	-	.10	-	.10	-	-
111.............	3.3	.80	-	-	-	.10	-	-
112.............	4.4	.20	-	-	-	.05	-	Trace
112-A...........	Specimen	.20	(2/)	-	-	-	(2/)	(2/)
113.............	1.4	.40	-	-	-	.05	-	0.02
114.............	2.8	.30	-	-	-	.05	-	.01
115.............	3.1	.10	-	-	-	-	-	-
116.............	3.8	.50	-	-	-	-	-	Trace
117.............	3.8	1.20	-	-	-	.10	-	Trace
118.............	3/11.0	.20	-	-	-	.05	-	.01
119.............	4/4.5	.10	-	-	-	.05	-	Trace
120.............	4/3.5	.20	-	.08	-	-	.34	Trace
121.............	1.8	.20	-	.28	-	.10	-	.02
122.............	2.2	2.20	-	.20	-	.05	-	.03
123.............	5/1.0	.10	-	.15	-	.05	-	.03
124.............	4.5	2.20	-	.20	-	.20	-	Trace
125.............	6.0	1.20	0.02	.07	-	-	2.58	-
126.............	30.0	.50	-	.06	-	-	.26	-
127.............	2.5	-	(2/)	-	0.90	.10	Trace	Trace
128.............	4.2	.05	(2/)	-	.70	.20	.01	.09
129.............	1.8	-	(2/)	-	.40	.10	Trace	Trace
130.............	3.5	.10	(2/)	-	.40	.10	Trace	Trace
131.............	6/4.5	.10	(2/)	2.72	.20	1.90	-	2.73
132.............	6/5.2	.13	(2/)	3.00	.90	1.20	-	1.07
133.............	6/4.4	.10	(2/)	.94	.10	1.80	-	3.41
134.............	6/5.0	.10	(2/)	.72	.20	1.40	-	2.77
135.............	6/5.4	.10	(2/)	1.30	.90	1.30	-	1.44
136.............	(7/)	(7/)	(7/)	-	-	-	-	-
137.............	(7/)	(7/)	(7/)	-	-	-	-	-
138.............	(7/)	(7/)	(7/)	-	-	-	-	-
139.............	(7/)	(7/)	(7/)	-	-	-	-	-
140.............	(7/)	(7/)	(7/)	-	-	-	-	-
141.............	Dump specimens	.20	(2/)	3.30	.20	3.30	.01	7.06

1/ Measured normal to GR-LS contact unless otherwise noted.
2/ No assay.
3/ Measured normal to strike of basic dike.
4/ Measured along wall of drift.
5/ May include some altered wall rock.
6/ Samples 131 to 135 were taken in bed 1 normal to dip of winze (-34°).
7/ No chemical analyses.

TABLE 26. - Average grade of sedimentary beds and other lithological units in Winfield-shaft area

	Sample No.	Length (feet)	Percent					Ounces per ton	
			Sn	WO_3	Cu	Pb	Zn	Au	Ag
Sedimentary bed 1	131[1].....	4.5 x 6.0	0.10	([2])	2.72	0.20	1.90	-	2.73
	132.......	5.2 x 4.2	.13	([2])	3.00	.90	1.20	-	1.07
	133.......	4.4 x 4.8	.10	([2])	.94	.10	1.80	-	3.41
	134.......	5.0 x 5.0	.10	([2])	.72	.20	1.40	-	2.77
	135.......	5.4 x 4.3	.10	([2])	1.30	.90	1.30	-	1.44
	Totals	[3]24.3							
	Weighted average		.11	([2])	1.77	.46	1.52	-	2.27
Sedimentary bed 2	101.......	6.7	.20	-	1.40	-	.80	Trace	.36
Sedimentary bed 3	102.......	3.5	.30	-	.35	-	.10	0.01	-
Sedimentary bed 4	103.......	3.3	1.10	-	-	-	.10	Trace	-
	104.......	3.7	.80	-	-	-	.20	Trace	-
	Weighted average	3.5	.94	-	-	-	.15	Trace	-
Sedimentary bed 5	124.......	4.5	2.20	-	.20	-	.20	-	Trace
	105.......	4.0	1.30	-	-	-	.20	.01	-
	106.......	3.5	.70	-	.08	-	.10	Trace	-
	Weighted average	4.0	1.46	-	.10	-	.17	Trace	Trace
Alaskite sill	123.......	1.0	.10	-	.15	-	.05	-	.03
	107.......	.5	.05	-	.51	-	.10	0.02	-
	Weighted average	.8	.09	-	.27	-	.07	Trace	.02
	121.......	1.8	.20	-	.28	-	.10	-	-
	122.......	2.2	2.20	-	.20	-	.05	-	.03
	Total	4.0							
	Weighted average		1.30	-	.24	-	.07	-	.03
Sedimentary bed 6	121-22....	4.0	1.30	-	.24	-	.07	-	.03
	108.......	2.8	.40	-	-	-	.10	.01	-
	109.......	3.5	.80	-	.56	-	.10	Trace	-
	Weighted average	3.4	.88	-	.28	-	.09	Trace	.01
Sedimentary bed 7	110.......	3.0	1.0	-	.10	-	.10	-	-
Sedimentary bed 8	111.......	3.3	.80	-	-	-	.10	-	-
Sedimentary bed 9	112.......	4.4	.20	-	-	-	.05	-	Trace
	113.......	1.4	.40	-	-	-	.05	-	.02
	114.......	2.8	.30	-	-	-	.05	-	.01
	115.......	3.1	.10	-	-	-	-	-	-
	Total	11.7							
	Weighted average	-	.22	-	-	-	.04	-	Trace

See footnotes at end of table.

TABLE 26. - Average grade of sedimentary beds and other lithological units on Winfield-shaft area (Con.)

	Sample No.	Length (feet)	Percent					Ounces per ton	
			Sn	WO_3	Cu	Pb	Zn	Au	Ag
Granite	58.......	14.0	0.05	-	-	-	-	0.02	-
	129.......	1.8	-	(2/)	-	0.40	0.10	Trace	Trace
	(4/)								
Alaskite	23.......	10.0	.05	-	-	-	-	Trace	-
	47.......	10.0	.05	-	-	-	.10	.01	.03
	107.......	.5	.05	-	0.51	-	.10	.02	-
	123.......	1.0	.10	-	.15	-	.05	-	.03
	112-A5/...	Specimen	.20	(2/)	-	-	-	(2/)	(2/)
	(4/)								
Basic dike	118.......	11.0	.20	-	-	-	.05	-	.01
	62.......	Specimens	.20	-	-	-	.10	.03	-
	(4/)								

1/ Samples 131 to 135 were taken in bed 1 normal to dip of winze (-34°). The first figure is width of sample measured normal to dip of winze. The second figure is length of influence of sample measured parallel to dip of winze. Average value of samples 131 to 135 is weighted according to area of influence of samples/

2/ No assay.

3/ Total length measured parallel to dip of winze. Horizontal width of sedimentary bed 1 is estimated to be 8 feet or more normal to the granite contact.

4/ Average grade not computed.

5/ Specimen 112-A may be an irregular protusion from granite rather than an alaskite intrusive.

TABLE 27. - Average grade of contact zone in Winfield shaft

Sedimentary bed or other unit	Sample distance (feet)1/	Percent					Ounces per ton	
		Sn	WO_3	Cu	Pb	Zn	Au	Ag
1..................	8+	0.11	(2/)	1.77	0.46	1.52	-	2.27
2..................	6.7	.20	-	1.40	-	.80	Trace	.36
3..................	3.5	.30	-	.35	-	.10	0.01	-
4..................	3.5	.94	-	-	-	.15	Trace	-
5..................	4.0	1.46	-	.10	-	.17	Trace	Trace
Alaskite sill.......	.8	.09	-	.27	-	.07	Trace	.02
6..................	3.4	.88	-	.28	-	.09	Trace	.01
7..................	3.0	1.00	-	.10	-	.10	-	-
8..................	3.3	.80	-	-	-	.10	-	-
9..................	11.7	.22	-	-	-	.04	-	Trace
Total............	47.9							
Weighted average..		.49	-	.56	.08	.43	Trace	.43

1/ Sample distance is average horizontal width of bed measured normal to strike of granite-limestone contact; this figure used to obtain grade and width directly comparable with trenching data.

2/ No assay.

TABLE 28. - Average grade of contact zone adjacent to Winfield shaft

Shaft or trench	Width (feet)1/	Distance (feet)2/	Area (square feet)	Percent					Ounces per ton	
				Sn	WO_3	Cu	Pb	Zn	Au	Ag
TR 1-W........	28	186	5,208	0.29	-	0.07	-	0.06	0.03	-
Winfield shaft	48	120	5,760	.49	-	.56	0.08	.43	Trace	0.43
TR 1-E3/......	70	113	7,910	.36	Trace	.47	-	.62	Trace	.42
Totals......		419	18,878							
Weighted average....	45			.38	Trace	.39	.02	.41	.01	.31

1/ Normal to granite contact.
2/ Influence of sample considered to extend halfway to adjacent trench or shaft.
3/ Weighted average of samples 1-15.

TABLE 29. - Average grade of contact zone from trenches 3-E to 3-W

Shaft or trench	Width (feet)1/	Distance (feet)2/	Area (square feet)	Percent					Ounces per ton	
				Sn	WO_3	Cu	Pb	Zn	Au	Ag
3-W...........	45	174	7,830	0.18	Trace	0.06	0.50	0.64	0.01	0.07
2-W...........	85	208	17,680	.15	-	.38	-	.17	Trace	.16
1-W...........	28	186	5,208	.29	-	.07	-	.06	.03	-
Winfield shaft	48	120	5,760	.49	-	.56	.08	.43	Trace	.43
1-E...........	133	164	21,812	.22	Trace	.36	-	.34	Trace	.22
3-E...........	51	220	11,220	.04	-	.05	-	.05	Trace	-
Totals......		1,072	69,510							
Weighted average....	65			.20	Trace	.28	.06	.27	Trace	.15

1/ Normal to GR-LS contact.
2/ Influence of a trench sample is considered to extend halfway to next trench; influence of end trenches considered to extend beyond trench a distance equal to half the distance to adjacent trench.

TABLE 30. - Petrographic analyses and paragenesis studies of samples from contact zone

Sample No.	Analysis
69....	Sample essentially contains amphibole (including hornblende and tremolite), axinite, some vesuvianite, calcite, small amounts of quartz, fluorite, biotite, phlogopite, limonite, chalcopyrite, malachite, cassiterite, and very small amounts of sphalerite, pyrrhotite, pyrite, and tourmaline. The bulk of the cassiterite is liberated in the minus-48, plus-65-mesh fraction; however, because of the extremely fine-grained nature of some cassiterite, and because of its intimate association with other minerals, complete liberation does not take place even in minus-200-mesh material.

TABLE 30. - Petrographic analyses and paragenesis studies of samples from contact zone (Con.)

Sample No.	Analysis
76....	Sample has been classified as a contact metasomatic rock. Altered zone along vein (black hornfelsic material) consists primarily of tourmaline, some quartz, and relatively small amounts of amphibole, axinite, feldspar, sphene, zoisite, sericite, and chlorite. Also present are very small to trace amounts of zircon, ilmenite, and calcite. Vein filling consists primarily of coarse crystals of axinite, some associated quartz, and small amounts of calcite and a finely fibrous mineral tentatively identified as actinolite. Presence and association of distinctive high-temperature, nonmetallic minerals such as axinite, tourmaline, zoisite, epidote, chlorite, and actinolite are an outstanding feature of contact metasomatic deposits. It is hypothesized that both recrystallization and recombination of constituents along the altered zone of tourmalinized hornfelsic rock have resulted in formation of the axinite vein filling.
76A...	Sample has been classified as contact metasomatic rock consisting essentially of axinite, fluorite, and feldspar, some quartz, clinozoisite, and tremolite, relatively small amounts of chalcopyrite, chlorite, scapolite, calcite, sericite, and chalcocite, and small amounts of tourmaline, sphalerite, malachite, biotite, pyrite, scheelite, and limonite. Also present are very small to trace amounts of magnetite, paigeite, siderite, cassiterite, arsenopyrite, garnet, and rutile. Sample is similar to 76 in that both are high-rank metamorphic rocks in which development of lime-borosilicate hornfels apparently has been produced through the alteration of limestone at the periphery of the Ear Mountain granite. Evidences indicate that during period of metamorphism the limestone was highly susceptible to alteration, which resulted in the loss of much of the contained calcium and carbon dioxide. It is hypothesized that this loss of material was compensated for by introduction of magmatic emanations of silica, iron, alumina, sodium, etc., and mineralizers such as sulfur, chlorine, fluorine, boron, and arsenic. These magmatic emanations (at least in part pneumatolytic) produced a series of metasomatic changes on the neighboring rocks. It therefore is suggested that two stages of metamorphism exist in the deposit: (1) Contact metamorphism at the time of intrusion, and (2) contact metasomatism after the consolidation of the granitic magma. The altered nature of this material precludes the possibility of a complete development of the mineral succession; however, on the basis of polished-surface and thin-section studies, the following paragenetic sequence is proposed: (1) Quartz, (2) silicates

TABLE 30. - Petrographic analyses and paragenesis studies of samples from contact zone (Con.)

Sample No.	Analysis
	(including complex borosilicates), (3) calcite, (4) fluorite, (5) quartz, (6) cassiterite, (7) pyrite, (8) sphalerite, and (9) chalcopyrite.
137...	Sample essentially contains feldspar and quartz, less fluorite, and small amounts of chlorite, pyrite, arsenopyrite, tourmaline, and cassiterite. Also present are very small amounts of zircon, stannite, siderite, biotite, apatite, sphene, amphibole, limonite, and pyrolusite.
	The cassiterite and stannite are essentially liberated in the minus-48, plus-65-mesh fraction.
138...	Sample essentially contains feldspar, less quartz, some sericite, and relatively small amounts of pyrrhotite, clinopyrozene, siderite, chlorite, tourmaline, amphibole, limonite, fluorite, and pyrite. Also very small to trace amounts of paigeite, garnet, magnetite, cassiterite, and cinnabar.
	The cassiterite and paigeite are essentially liberated in the minus-65, plus-100-mesh fraction.
139...	Sample essentially contains quartz, less fluorite, some feldspar and tourmaline, and relatively small amounts of clinopyroxene, amphibole, siderite, arsenopyrite, chlorite, limonite, epidote, sericite, pyrite, biotite, paigeite, pyrrhotite, and cassiterite. Very small amounts of rutile, garnet, magnetite, pyrolusite, and gold also observed.
	The cassiterite and paigeite are essentially liberated in the minus-65, plus-100-mesh fraction.
140...	Sample essentially contains feldspar with some associated amphibole, fluorite, quartz, clinopyroxene, tourmaline, and relatively small amounts of pyrite, pyrrhotite, siderite, limonite, scapolite, arsenopyrite, chlorite, paigeite, and sericite. Also very small to trace amounts of cassiterite, pyrolusite, rutile, and chalcopyrite.
	The cassiterite and paigeite are essentially liberated in the minus-65, plus-100-mesh fraction.
141...	Sample essentially contains quartz, fluorite, axinite, zinnwaldite, chalcopyrite, arsenopyrite, sphalerite, and relatively small amounts of pyrrhotite, tourmaline, tremolite, limonite, cerussite, talc, and pyrite. Also very small amounts of malachite, galena, hypersthene, calicte, cassiterite, and scheelite.

TABLE 30. - Petrographic analyses and paragenesis studies of samples from contact zone (Con.)

Sample No.	Analysis
	The sphalerite, chalcopyrite, and galena are essentially liberated in the minus-65, plus-100-mesh fraction, although there is only a relatively small amount of locking of these sulfides in the minus-48, plus-65 mesh. The fluorite and zinnwaldite also are liberated in the aforementioned sized fractions. Maximum liberation of the cassiterite occurs in the minus-48, plus-65 mesh. The very small amount of scheelite is liberated in the minus-65, plus-100-mesh fraction. Although most of the cerussite is liberated in the minus-65, plus-100-mesh material, some of the cerrusite and malachite remain locked in the finer sizes.

TABLE 31. - Spectrographic analyses of samples from contact zone

Legend:
- A More than 10 percent.
- B 5 to 10 percent.
- C 1 to 5 percent.
- D 0.1 to 1 percent.
- E 0.01 to 0.1 percent.
- F 0.001 to 0.01 percent.
- G Less than 0.001 percent.
- \- Not detected.

Sample No.	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Li	Mg
67.......	F	B	D	-	D	-	E	E	A	E	-	-	D	A	-	E	C
68.......	F	B	E	-	D	-	F	E	B	F	-	-	E	C	-	-	C
69.......	F	A	E	-	D	-	F	G	A	-	-	E	D	A	-	-	B
74.......	E	E	C+	-	C	-	F	-	-	-	-	-	E	A	-	E	G
136.......	F	A	D	-	C	-	E	E	A	-	-	-	D+	A	-	-	D
141.......	E	C+	C	-	D	-	E	E	A	-	-	-	D+	A	-	-	C

Sample No.	Mn	Mo	Na	Nb	Ni	P	Pb	Sb	Si	Sn	Sr	Ta	Ti	V	W	Zn	Zr
67.......	D	-	D	-	E	-	D	-	A	D	-	-	D	E	-	D	-
68.......	D	-	D	-	F	-	C	E	B	D	-	-	E	F	-	D	-
69.......	C-	-	D	-	E	-	D	-	A	C	-	-	D	D	-	D	-
74.......	E	F	-	-	E-	-	C	C-	A	D	-	-	F	F	-	D	-
136.......	D	-	-	-	E	-	E	-	A	D	-	-	E	F	-	C	-
141.......	E+	-	-	E	E	-	D	-	A	D	-	-	F+	F	-	C	-

Summary of Results

Tin was found on Ear Mountain as a constituent of the minerals cassiterite, paigeite, and stannite. Cassiterite (the tin oxide, SnO_2), was found in small veinlets in granite and as tiny crystals in the contact metamorphic zone. Paigeite (a complex borate with the approximate formula $30\ FeO.5\ Fe_2O_3.1\ SnO_2.6\ B_2O_3$) occurs widely distributed in the metamorphosed sediments of the contact zone. Stannite (a copper-iron-tin sulfide with the formula $Cu_2S.FeS.SnS_2$) was identified in some samples from the Winfield shaft.

The cassiterite veinlets found in granite are much too small (less than one-fourth inch wide) to warrant sampling as lode deposits, although the erosion of such veinlets undoubtedly has contributed to the formation of the placer deposits. Veins of cassiterite larger than those observed may occur in the granite; the alteration that accompanies tin deposition often tends to make tin veins softer than the surrounding rock; therefore the outcrops of such veins would be inconspicuous.

The principal lode tin deposit found on Ear Mountain is in the North Hill area, where cassiterite, paigeite, and stannite occur, associated with sulfide minerals in metamorphosed limestone along the granite-limestone contact. The cassiterite occurs as crystals too small to be recognized readily. In the specimens tested the bulk of the cassiterite was liberated by grinding to sizes between 48 and 65 mesh, but some of it is so extremely fine grained and so intimately associated with other minerals that complete liberation did not take place even when ground to minus-200 mesh. The percentage of tin occurring as a constituent of paigeite and stannite is not known.

In the Winfield shaft on North Hill small zones of this deposit contain up to 2 percent tin and others up to 3 percent copper. The average grade in the Winfield shaft, however, is much lower: For a width of 48 feet (measured horizontally and normal to the contact) the metamorphosed limestone contains 0.5 percent tin; 0.6 percent copper; minor amounts of lead, zinc, and silver; and traces of gold. The metallic minerals are irregularly distributed in the altered limestone. They are most abundant near, but not necessarily adjacent to, the granite-limestone contact, and there is a pronounced tendency toward irregular localization in certain beds or parts of beds. The spotty nature of the deposit is demonstrated by the wide range in metal content of samples taken from the comparatively small area exposed by the underground workings.

Minerals generally similar in occurrence to those found in the Winfield shaft were found along the contact zone from the Eldorado Creek drainage to the west side of Tuttle Creek, a distance of about 7,000 feet. Sampling indicated that a section of this contact zone about 1,000 feet long and 65 feet wide, including trenches 1-E through 3-W and the Winfield shaft, has an average grade of 0.2 percent tin and 0.3 percent copper, with minor to trace amounts of lead, zinc, gold, and silver. East of trench 1-E the few exposures indicated an abrupt drop in grade. West of trench 3-W the contact was obscured by heavy overburden. Such samples as could be obtained between trench 3-W and Tuttle Creek indicated that the grade may be lower and the deposit may not be continuous. No bedrock exposures were made in the section of the contact zone west of Tuttle Creek, but specimens of float were found that contained 0.8 percent tin and appeared to be similar in occurrence and associations to the samples from the Winfield shaft.

The most common copper mineral in the contact zone is chalcopyrite, but chalcocite and malachite also were identified, and some copper undoubtedly occurs as a constituent of stannite.

The small amount of lead and zinc in the contact zone occurs principally as galena and sphalerite, although some cerussite is present. Stibnite associated with galena was identified in one float sample (74) found near the Winfield shaft.

Gold and silver, usually in minor to trace amounts, were found in some samples from the Winfield-shaft area.

Radioactivity ranging from 0.01 percent eU downward to trace amounts was found in the Winfield shaft, but the radioactive mineral was not identified.

The altered limestone of the contact zone is a high-rank metamorphic rock showing evidence of contact-metamorphism coincident with the granitic intrusion and subsequent metasomatism. The metallic minerals, at least in part, appear to have been deposited from pneumatolytic solutions that penetrated the contact zone after the granitic intrusive had cooled. The exposures made during the investigation did not establish the dip of the contact zone or the limits of deposition. The contact zone appeared to dip towards the north, but the borders of the granite are highly irregular. The zone in which metallic minerals occur may extend farther than the sampling would indicate both along the contact zone and outward into the limestone.

BIBLIOGRAPHY

1. COLLIER, ARTHUR J. A Reconnaissance of the Northwestern Portion of the Seward Peninsula, Alaska. Geol. Survey Prof. Paper 2, 1902, pp. 9, 12, 13, 20, 25, 29, 30, 37, 51-55.

2. _____. The Tin Deposits of the York Region, Alaska. Geol. Survey Bull. 229, 1904, pp. 26-28.

3. BROOKS, ALFRED H., AND OTHERS. Report on Progress of Investigations of Mineral Resources of Alaska in 1904. Geol. Survey Bull. 259, 1905, pp. 120-127.

4. _____. Report on Progress of Investigations of Mineral Resources of Alaska in 1905. Geol. Survey Bull. 284, 1906, pp. 145-157.

5. _____. Mineral Resources of Alaska. Geol. Survey Bull. 345, 1908, pp. 252-256.

6. KNOPF, ADOLPH. Geology of the Seward Peninsula Tin Deposits. Geol. Survey Bull. 358, 1908, pp. 25-32, 64.

7. DICKMAN, R. N. Report on Property of the Ear Mountain Tin Mining Company. November 1914 (unpublished).

8. STEIDTMANN, EDWARD, AND CATHCART, S. H. Geology of the York Tin Deposits, Alaska. Geol. Survey Bull. 733, 1922, pp. 102-110.

9. COATS, ROBERT R. Preliminary Report on the Tin Deposits of the Ear Mountain Area, Seward Peninsula, Alaska. Geol. Survey unpublished report.

10. HEIDE, HAROLD E. Investigation of the Lost River Tin Deposit, Seward Peninsula, Alaska. Bureau of Mines Rept. of Investigations 3902, 1946, 57 pp.

11. HEIDE, HAROLD E., WRIGHT, WILFORD S., AND SANFORD, ROBERT S. Exploration of Cape Mountain Lode-Tin Deposits, Seward Peninsula, Alaska. Bureau of Mines Rept. of Investigations 3978, 1946, 16 pp.

12. HEIDE, HAROLD E., AND SANFORD, ROBERT S. Churn Drilling at Cape Mountain Tin Placer Deposits, Seward Peninsula, Alaska. Bureau of Mines Rept. of Investigations 4345, 1948, 14 pp.

13. HEIDE, HAROLD E., AND RUTLEDGE, F. A. Investigation of Potato Mountain Tin Placer Deposits, Seward Peninsula, Northwestern Alaska. Bureau of Mines Rept. of Investigations 4418, 1949, 21 pp.

14. KILLEEN, P. L., AND ORDWAY, R. J. Radioactivity Investigations at Ear Mountain, Seward Peninsula, Alaska, 1945. Geol. Survey Bull. 1024(c), 1955, 35 pp.