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(19.46-19.9, 17.5-17.7) TERRITORY OF ALASKA
DEPARTMENT OF MINES

64°59'
147°20'

REPORT ON MAGNETIC AND NON-MAGNETIC GANGUE IN SCHEELITE ORE FROM CLEARY HILL MINES PROPERTY, GILMORE DOME, FAIRBANKS DISTRICT, ALASKA.

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Introduction

Scheelite ore from the Cleary Hill Mines property, on Gilmore Dome in the Fairbanks district of Alaska, contains a considerable proportion of magnetic gangue minerals. Tests were made to determine the identities and amounts of magnetic and non-magnetic gangue minerals in representative ore.

Gangue Minerals

Gangue minerals in scheelite ore from the Cleary Hill Mines property are, in the approximate order of their abundance: quartz, calcite, pyroxene (chiefly diopside and hedenbergite), hornblende, garnet, titanite and apatite. Of these the first four comprise the bulk of the gangue, although garnet is occasionally found in signifigant amounts. Titanite and apatite are relatively scarce. Pyrite, pyrrhotite and molybdenite are present, but are so rare that only a few grains were found in hundreds of specimens of ore. Vesuvianite and epidote were found in scheelite ore from the same area, but have not been identified in ore from the Cleary Hill Mines property.

Of the dominant gangue minerals, pyroxene, hornblende and garnet are sufficiently magnetic to be attracted by a small electromagnet, or by a small Alnico magnet fitted with pole pieces. The remaining non-magnetic gangue minerals are essentially quartz and calcite.

MAGNETIC AND NON-MAGNETIC GANGUE IN SCHEELITE ORE

Following is a tabulation of the approximate specific gravities and magnetic properties of the important gangue minerals and of scheelite.

Table I

Mineral	Specific gravity	Magnetic properties
Quartz	2.65	Non-magnetic
Calcite	2.7	" "
Diopside	3.4	Mod. magnetic
Hedenbergite	3.4	" "
Hornblende	3.4	" "
Garnet	3.75	" "
Scheelite	6.0	Non-magnetic

Because of their higher specific gravities, the magnetic gangue minerals would be somewhat more difficult to separate from the scheelite by tabling than the non-magnetic gangue.

Grinding and Screening

A representative sample, weighing 7.5 kg. (16.5 pounds) and containing an estimated 4.5% WO_3, was selected from ore taken from the shaft and from prospect pits on the Cleary Hill Mines property. The sample was crushed to minus ¼" in a jaw crusher and split to 470 grams in a Jones ore sampler. After removing the minus 20 mesh material, the coarse part of the 470 gram portion was ground to successively smaller sizes in a Braun pulverizer - this was done by setting the plates slightly closer for each new grinding - until all of the material passed a 20 mesh screen. In order to avoid excessive sliming the minus 20 mesh material was removed after each grinding.

MAGNETIC AND NON-MAGNETIC GANGUE IN SCHEELITE ORE

Practically all of the scheelite was liberated from the gangue in the 20-35 mesh (0.833 to 0.417 mm.) grain sizes, but in order to identify the gangue minerals and to facilitate magnetic separation with equipment available, this fraction was further crushed in an iron mortar until it passed a 35 mesh screen. In order to further facilitate the tests, the 470 gram portion was separated by screening into a 35-80 mesh (0.417 to 0.175 mm.) fraction and a minus 80 mesh fraction.

The weight of the 35-80 mesh fraction was 196 grams, while that of the minus 80 mesh fraction was 246 grams, making a total of 442 grams. 28 grams was therefore lost during crushing and sizing. A tenth part of each fraction, that is 19.6 grams and 24.6 grams, was used in determining the amounts of magnetic and non-magnetic gangue, as described in the following sections.

Separation of Light Gangue Minerals

Separation of quattz and calcite from the heavier gangue minerals was effected by the use of bromoform (sp. gr. 2.89). When placed in bromoform quartz and calcite float on top of the liquid, while scheelite and the remaining gangue minerals, which have specific gravities greater than 2.89, sink to the bottom. The amounts of quartz and calcite in the 35-80 mesh and in the minus 80 mesh fractions are shown in Table II.

Separation of Magnetic Gangue Minerals

Following the separation of quartz and calcite, the magnetic gangue minerals were removed by a small electromagnet fitted with pole pieces. From the 35-80 mesh fraction a nearly pure scheelite concentrate was obtained; thus practically all of the heavier gangue minerals are magnetic. From the minus 80 mesh fraction a high-grade concentrate could not be readily obtained with equipment available, because considerable scheelite was mechanically included with the magnetic minerals during the separation. By making several fractional separations under water, however, a concentrate containing about 40% scheelite (32% WO_3) was obtained. Results of the magnetic separation are shown in Table II.

Table II

	Weight grams	% of total sample	Quartz-Calcite gangue		Magnetic gangue		WO_3 content *	
			Weight	% of total sample	Weight	% total sample	Before conc.	After conc.
Coarse Fract. (35-80 mesh)	19.6	44.3	11.4	25.8	7.0	15.8	5	72
Fine Fract. (less than 80 mesh)	24.6	55.7	14.3	32.4	8.3	18.8	4	32
Total Sample	44.2	100.0	25.7	58.2	15.3	34.6	4.4	60

* WO_3 content estimated under fluorescent light

Variations in the Ore

As in most replacement deposits, there is a wide variation in tenor in the Cleary Hill Mines scheelite ore. Samples from the shaft and from surface pits contained anywhere from 0.5 to 30% WO_3, although the average WO_3 content of all the ore taken from the shaft is slightly less than 5%.

There is likewise considerable variation in the proportions and amounts of gangue. While the gangue minerals, especially quartz, pyroxene and hornblende, are invariably associated with the scheelite, there is no apparent quantitative relationship. This is illustrated in Table III, which shows percentages of magnetic gangue and of WO_3 in picked specimens of ore.

Table III

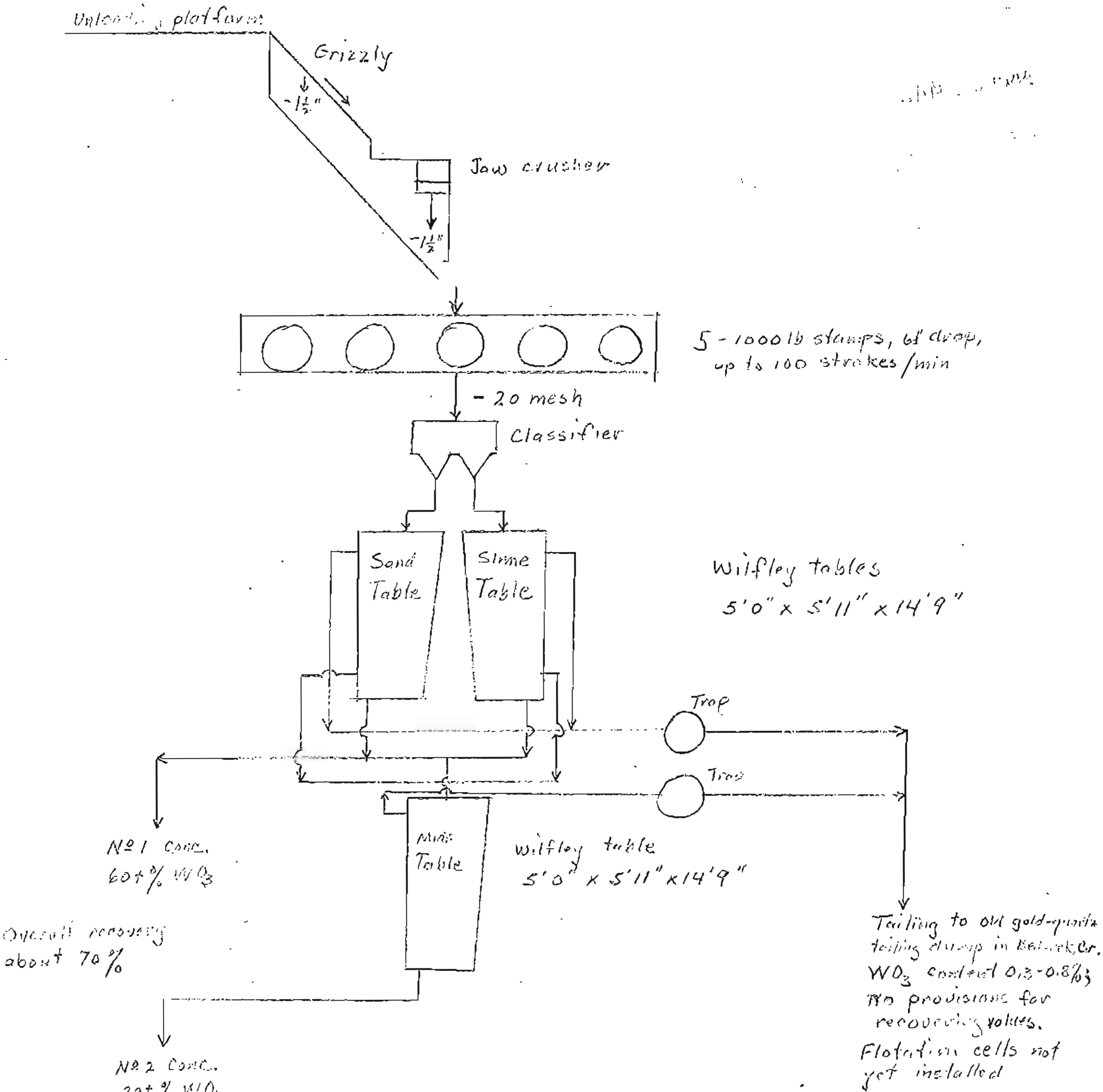
Sample No.	% Magnetic Gangue	% WO_3 (estimated)	Ratio Mag.Gangue/WO_3
A 1	0.5	2	0.25
A 2	90	3	30
A 3	12	3	4
A 4	75	5	15
A 5	9	6	1.5
A 6	24	16	1.5
Unweighted Mean	35.1	5.8	6.0

Conclusions

Magnetic gangue minerals constitute about 34% of the Cleary Hill Mines scheelite ore; the remaining gangue is essentially quartz and calcite. The magnetic minerals are attracted by a low-powered electromagnet and are readily removed from ore ground to 35-80 mesh. Magnetic separation of finer grain sizes was more difficult with equipment available, but a partial separation was effected under water.

Because of the large proportion of relatively heavy magnetic minerals in the ore, further investigation is recommended to determine if magnetic separation can be advantageously used as an adjunct to gravity separation.

Henry R. Joesting
Assoc, Mining Engineer
Feb. 6, 1943



Flowsheet

Cleary Hill Mines, Inc.
Mill at Bedrock Creek
Fairbanks District, Alaska
for
Gravity concentration of Scheelite ore

Terr. Dept. Mines
Dec., 1943 H.R.J.

METAL MINING AND PROSPECT REPORT

A. General Features

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1. Mine *Gilmore Dome Tungsten* Mining District *Fairbanks*
2. Investigator *Henry R. Joesting* Date *Nov., 1943*
3. Location *26 mi. NE Fairbanks by graded road to mine; 25 mi NE Fairbanks by graded road to mill; 9 mi. by graded road mine to mill*
4. Owners *Cleary Hill Mines, Inc* Address *Fairbanks*
5. Supt. or Manager *Ralph E. Wyer* " *Fairbanks*
6. Chief Ores Mined *Scheelite*
7. Associated Minerals *Very small amounts pyrite, molybdenite, chalcopyrite*
8. Gangue Minerals *Quartz, calcite, hornblende, pyroxenes, clinozoisite, garnet, apatite, titanite, feldspars,*
9. Rock Formations *Crystalline limestone and calcareous schist horizon in qtz mica schist*
10. Nature of Deposit (Fissure vein, fissured zones, disseminated, etc.) ~~Hypothe~~ *Ore in replaced calcareous horizon in schist.*
11. Thickness of vein or deposit *0-4½' ; 1½' approx. average*
12. Strike of vein or deposit *N60°-70° E*
13. Dip of vein or deposit *20°-50° N*
14. Ore in (shoots, chimneys, etc.) *Irregular high-grade shoots plus lower grade disseminated ore*
15. Character and pitch of ore shoots *Controlled by changes in dip of ore zone and by crosscutting quartz veins at various attitudes*
16. Depth of barren zone *None* Depth of enrichment *None*
17. Genesis of ore *Replacement by hydrothermal tungsten bearing solutions of calcite and deposition of scheelite, qtz, calcite and Ca-Fe silicates. Solutions from underlying* ~~*intrusion of porphyritic granite*~~
18. Nature of associated dikes or veins *Ore zone cut* ~~at~~ *various angles by numerous qtz stringers & occasional larger veins. In gen'l the stringers & veins silicified & enriched the ore zone.*
19. Entrance to mine *Inclined shaft; tunnel now being driven to connect with 150' level* El. *Shaft 2380'; Floor of portal 2287'*
20. Amount of Drifts *220'* Raises *60'* X-cuts *80' (Nov. 1, 1943)*
21. Size of shafts *6' x 8'* No. of Levels *2 — 50' and 150'*
22. Mine Machinery *Drifters, stopers, cars, skip, S.D. hoist powered by Chev. gas engine. I-R 2-stage compressor powered by Cat. diesel for drilling and for blowers.*
23. Mill Machinery *See attached flowsheet. Mill powered by 1-120 HP Washington-Estep diesel & 1-100 HP. W-E diesel, each direct-connected to 440 V., 3 P. generators*
24. Men employed *16* Dates of operation *Continuous*
25. Available timber and water power *Mine timber within ½ mi. of mine*
26. Transportation *9 mi. by graded road from mine to mill; 25 mi. by graded road from mill to Fairbanks*
27. Reported assays *0.5± to 30± % WO_3. Av. tenor of ore mined 4-6%*
28. Amount of ore milled or shipped *About 1½ t. plus 60% WO_3 concentrates per month to date. Mill capacity about 600 lb. conc. per 8 hr. shift.*
29. Returns

References: *Terr. Dept. Mines Pamphlet No 1, 1942, p 40.*
" " " " 2, 1943, pp 20-25
Ann. Rep. Mine Insp. to Gov. of Alaska, 1922, pp. 111-112
U.S. G.S. Bull. 662, 1916, pp 419-424

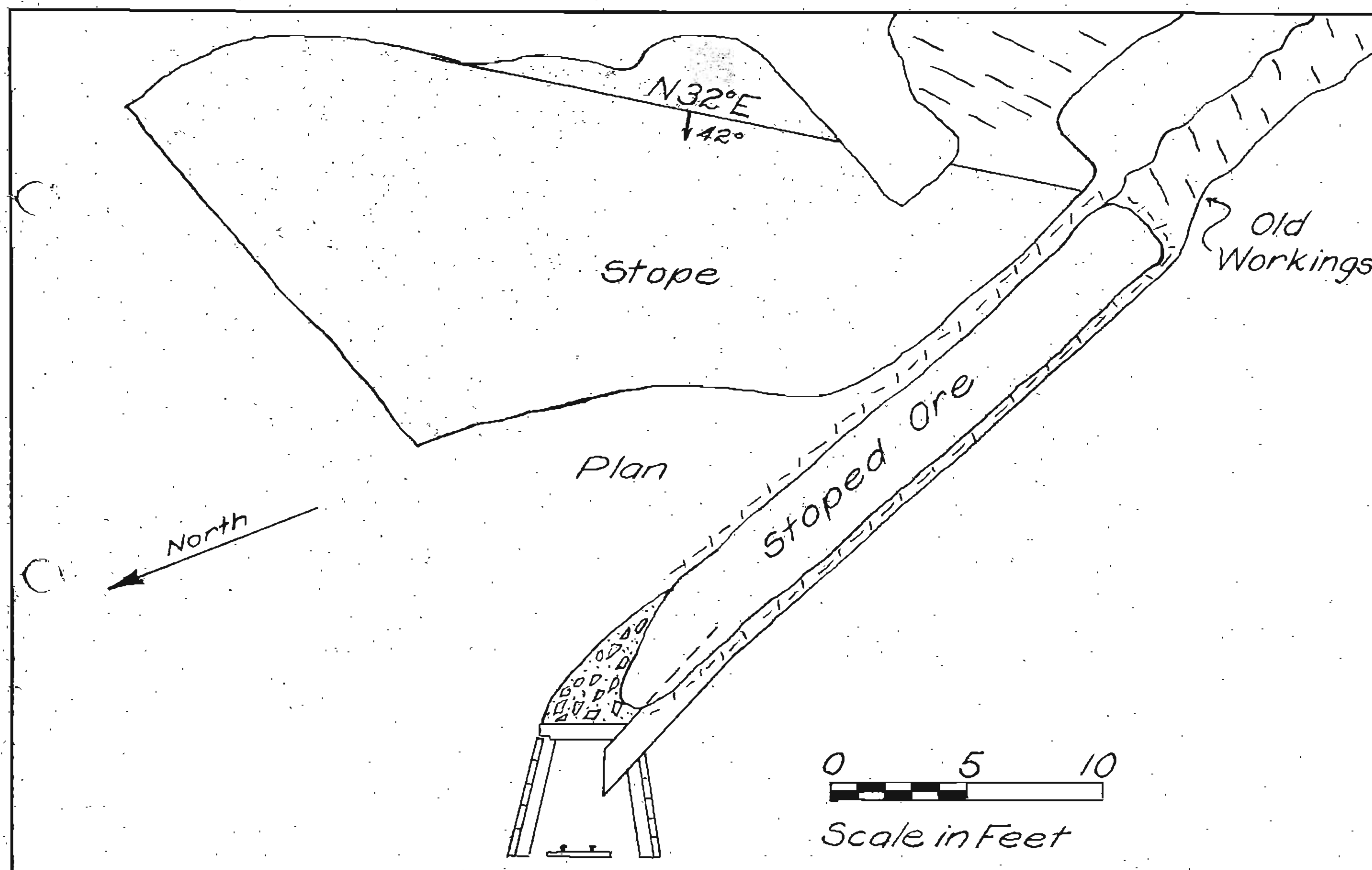

FIG. SECTION $A_1 \sim A_2$

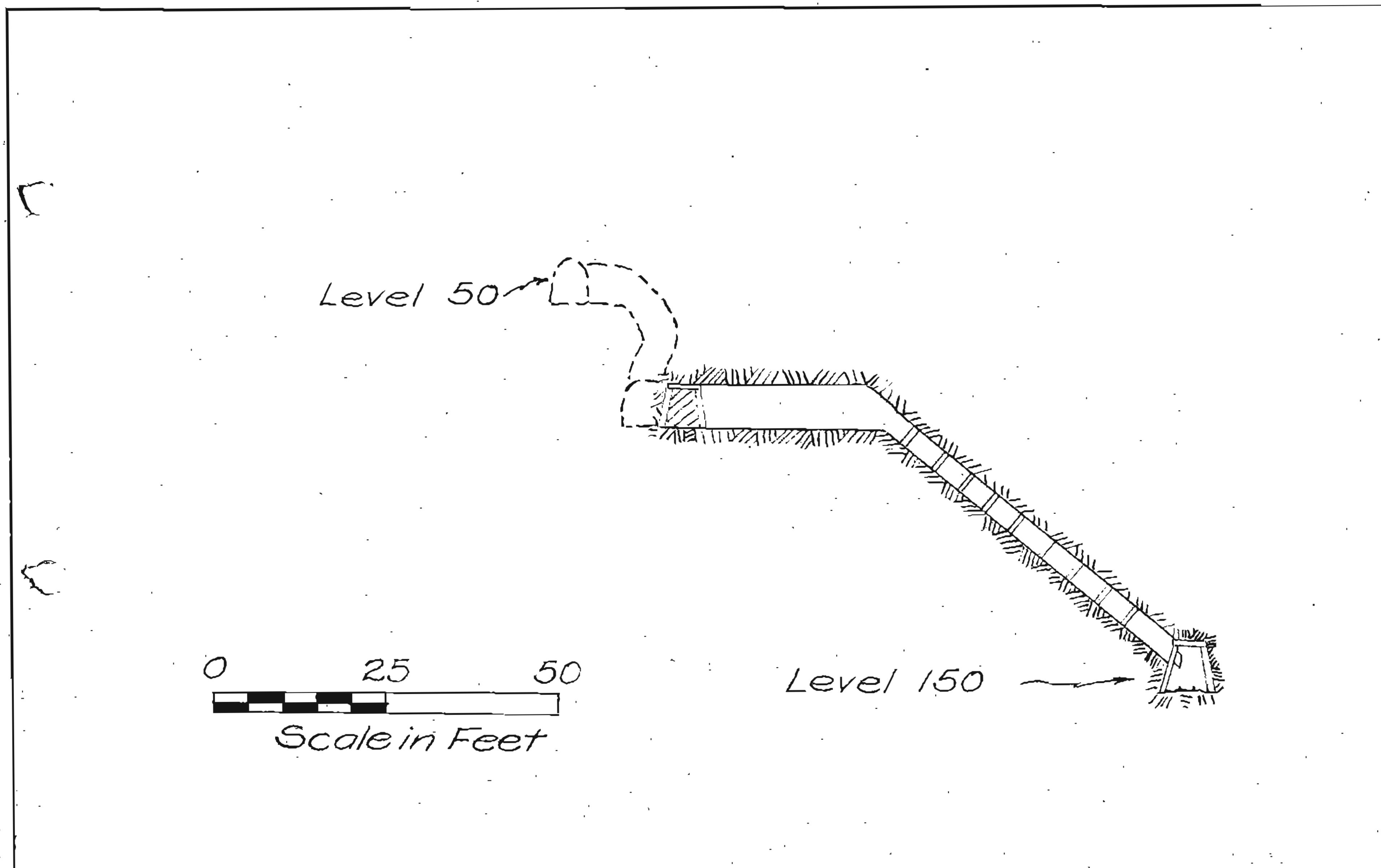

FIG. SECTION B_1~B_2

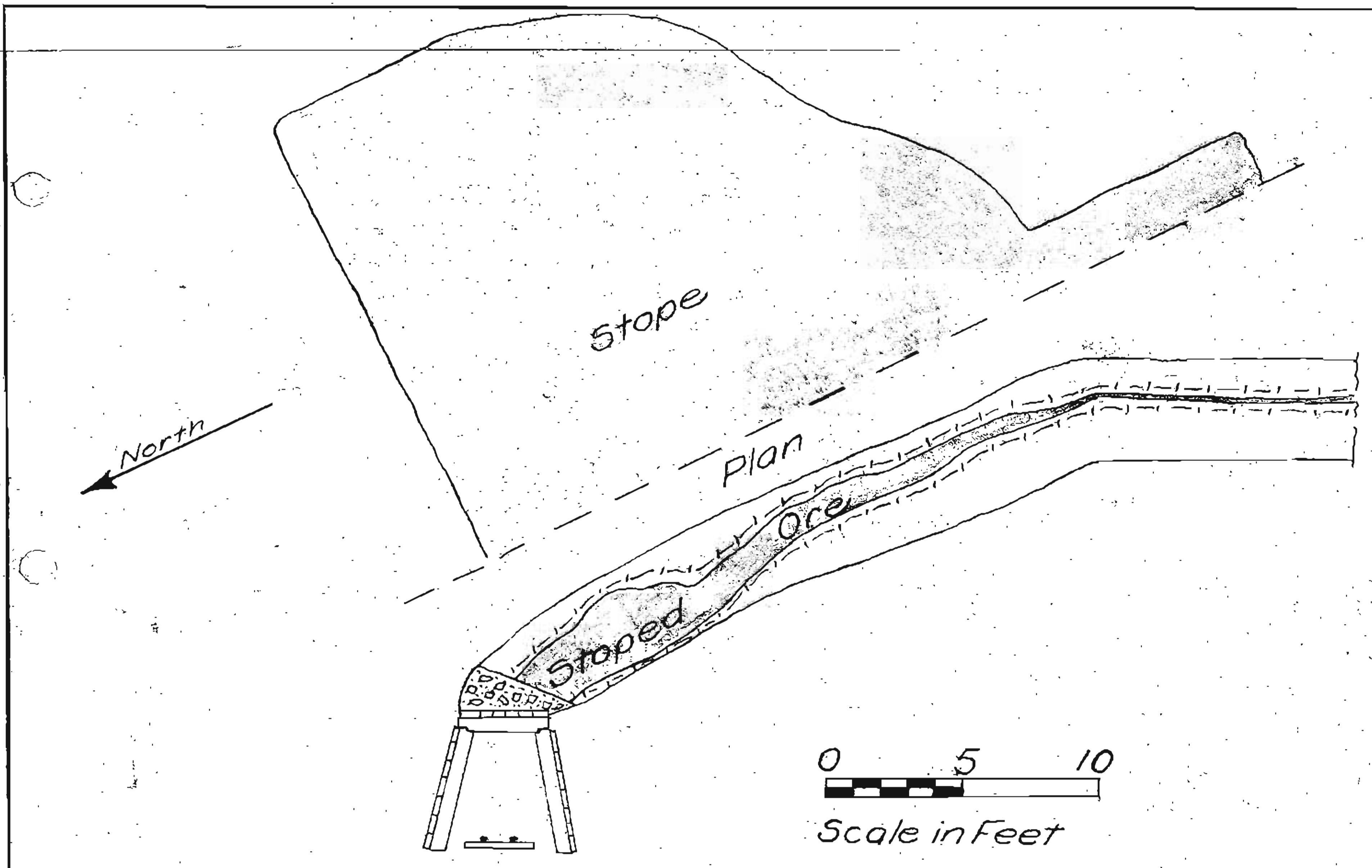

FIG. SECTION C_1~C_2

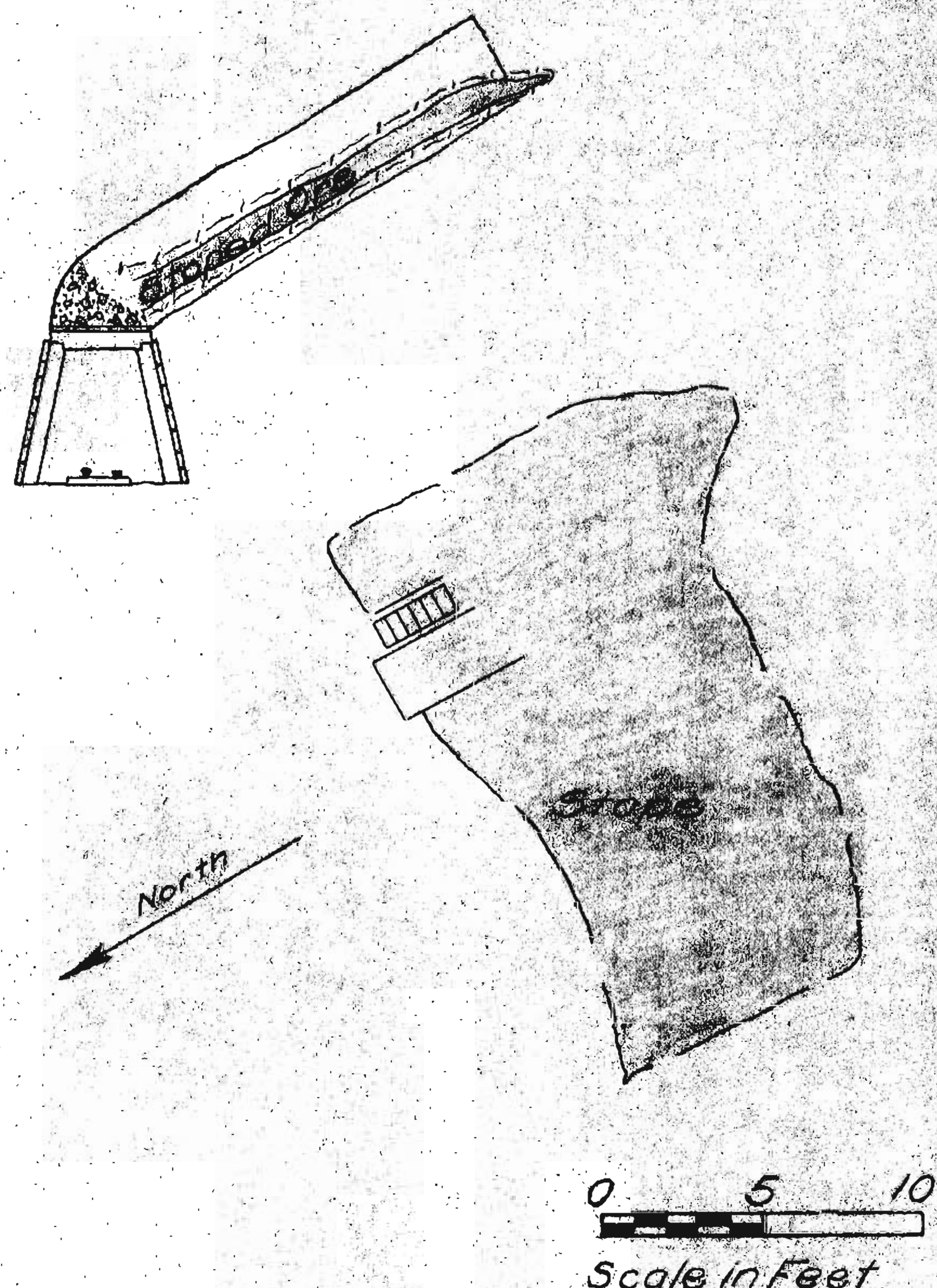

FIG. SECTION D_1~D_2

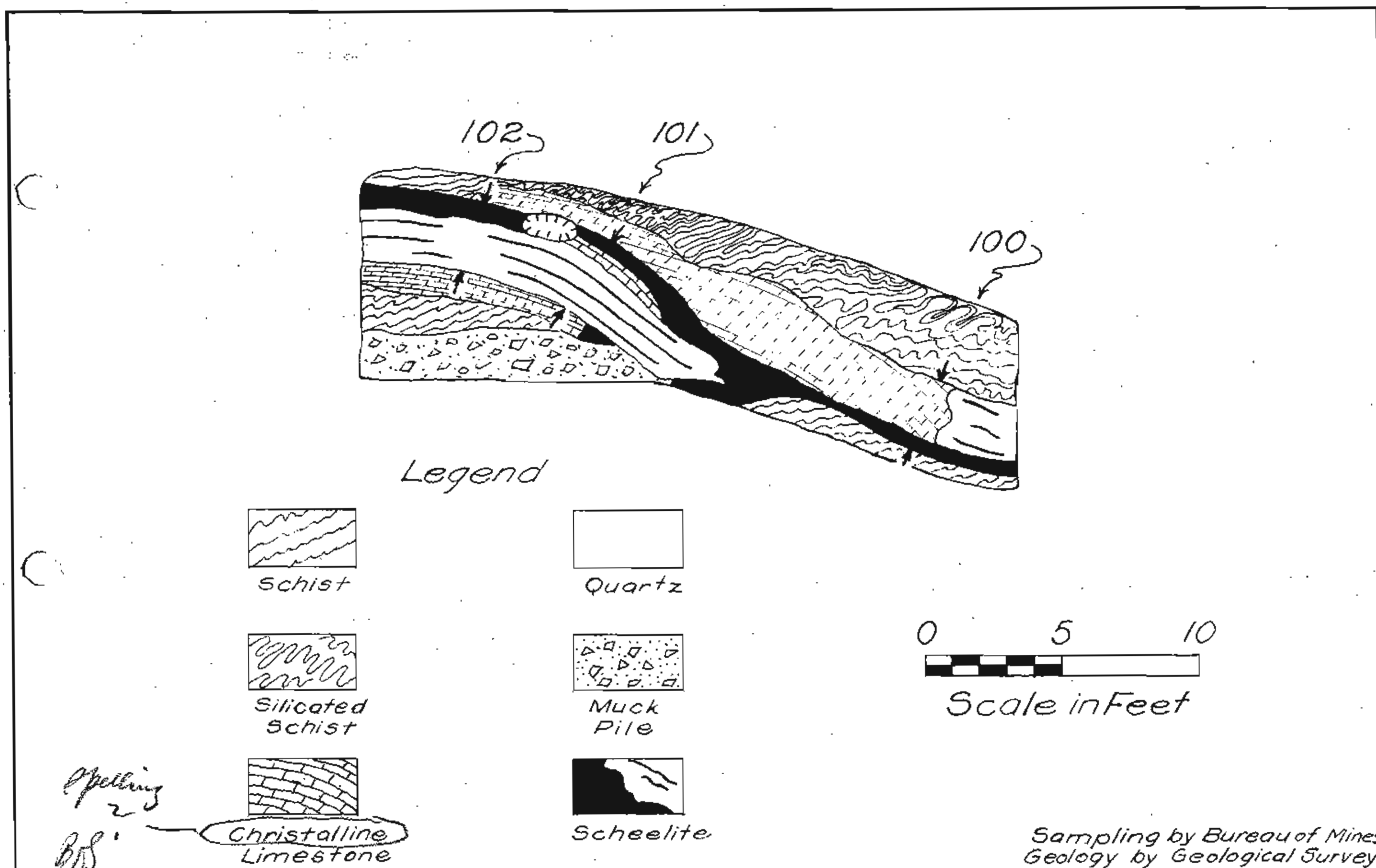

FIG. SECTION E_1~E_2

Juneau, Alaska
February 18, 1943

Memorandum to Mr. C. Travis Anderson
Rolla, Missouri

Enclosed is a more detailed report, on the magnetic and nonmagnetic gangue mineral in the scheelite ore from the Cleary Hill Mines property, by Dr. Henry R. Joesting. I am sure you will find this of assistance in the metallurgical tests being conducted on this ore.

Yours very truly

Robert S. Sanford

Robert S. Sanford
District Engineer

Enclosure

cc: B. D. Stewart

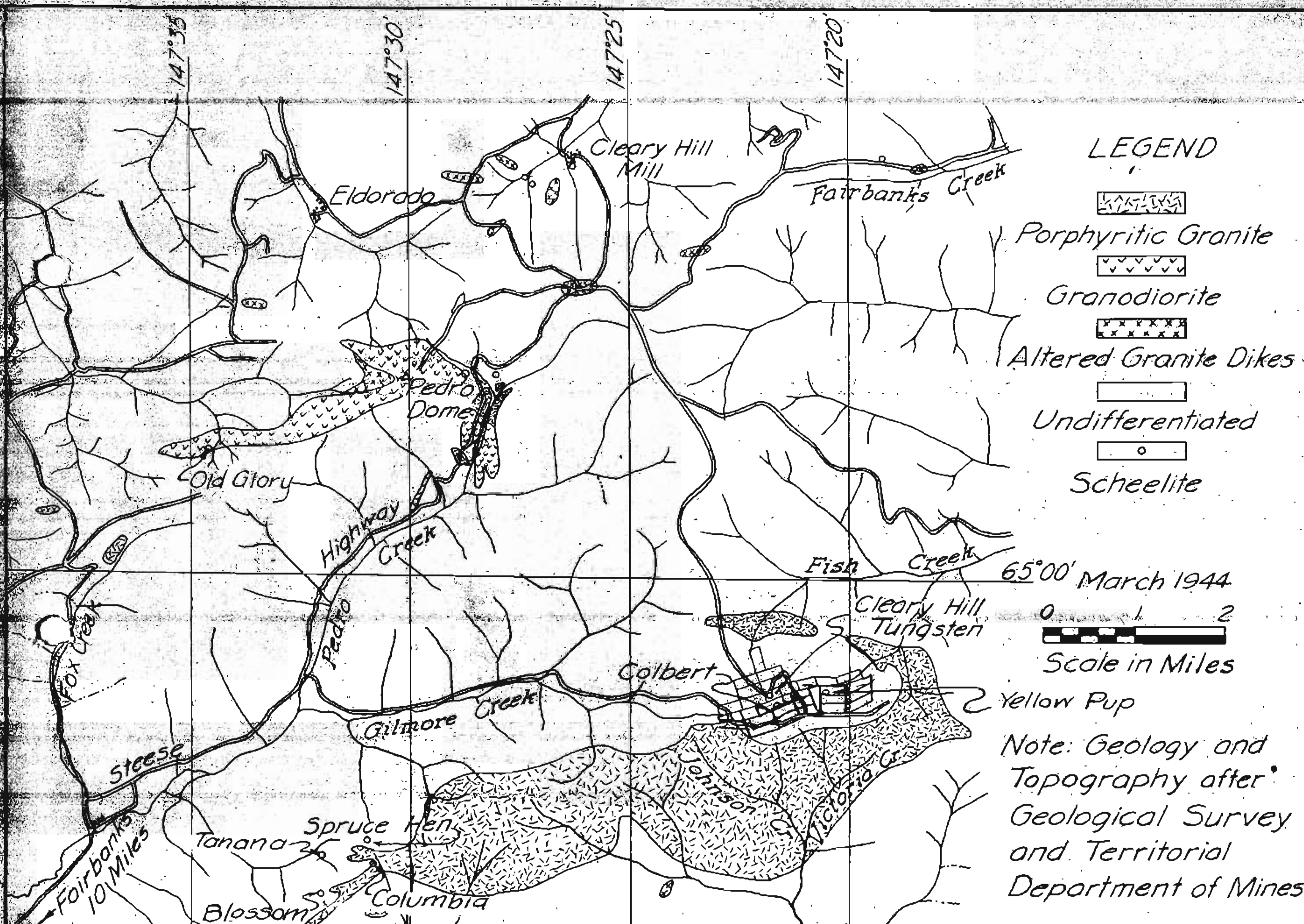

FIG. 2 - LOCATION AND GEOLOGY, FAIRBANKS TUNGSTEN AREA