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UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
JAMES BOYD, DIRECTOR

REPORT OF INVESTIGATIONS

INVESTIGATION OF MUIR INLET OR NUNATAK MOLYBDENUM DEPOSITS, GLACIER BAY, SOUTHEASTERN ALASKA

BY

R. S. SANFORD, G. A. APELL, AND F. A. RUTLEDGE

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By R. S. Sanford,[2] G. A. Apell,[3] and F. A. Rutledge[4]

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INTRODUCTION AND SUMMARY

The Muir Inlet or Nunatak molybdenum deposits are in the Glacier Bay district, Muir Inlet, Alaska, 78 miles northwest of Juneau.

The deposits were examined by Bureau of Mines engineers, and the area was mapped by a field party of the Federal Geological Survey during the summer of 1942.[5]

The following year the Bureau of Mines began developing the deposits. A total of 215 channel samples were taken, and 2 diamond drill holes totaling 286 feet were drilled. The samples were sent to the Bureau's laboratories at Rolla, Mo. for beneficiation.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 4421."
2/ Senior mining engineer, College Park, Md.
3/ Mining engineer, Minneapolis, Minn.
4/ Mining engineer, Juneau, Alaska.
5/ Smith, Philip S., Occurrences of Molybdenum Minerals in Alaska: U. S. Geol. Surv. Bull. 926-C, 1942, pp. 178-180.
Reed, J. C., Some Mineral Deposits of Glacier Bay and vicinity, Alaska: Econ. Geol. vol. 33, No. 1, Jan.-Feb. 1938, pp. 56, 57.

A discussion of the deposits, assay results, and drill logs are contained in this report.

ACKNOWLEDGMENTS

The authors acknowledge the assistance given by A. W. Tolonen and A. W. Erickson, former Bureau of Mines engineers, and special acknowledgment is made of the information and assistance given by W. S. Twenhofel of the Geological Survey.

LOCATION AND ACCESSIBILITY

The molybdenum deposits of the Muir Inlet or Nunatak Peak area are on Muir Inlet, in the Glacier Bay district of southeastern Alaska (figs. 1 and 2). The area is 78 airline miles N. 53° W. of Juneau, Alaska, at 58° 39' 30" north latitude and 136° 06' 30" west longitude. Water distance from Juneau is 129 nautical miles. Steamship lines pass the mouth of Glacier Bay at 37 nautical miles from the deposits, and, except for the hazard of icebergs, the route is navigable for ocean steamships.

During the summer, Muir Glacier is very active, and the icebergs constitute a transportation problem. Under normal conditions the ice would interfere with transportation to a certain extent but would not constitute a major hazard.

PHYSICAL FEATURES AND CLIMATE

The physical features are characteristic of a recently glaciated region. In 1926, the United States Navy made the first aerial photographs of Muir Inlet. At that time the mineralized area shown as No. 1 on figure 3 was partly covered to a depth of over 300 feet by ice of the Muir Glacier. Since that date this glacier has retreated 3-1/2 miles. The mineralized area is at present surrounded on three sides by active and stagnant glaciers. Stumps and broken tree trunks of an ancient, pre-glacial forest can be seen in places.

The large ice fields have a marked influence upon the climate. During the summer the temperature drops to almost freezing each night. There are more rain and lower temperatures in the Muir Inlet area than at Juneau, where the weather has been recorded for a number of years. The Juneau average annual precipitation is 80 inches and the mean temperature 42° F. The temperature at Juneau is very rarely lower than -7° F.

The region has almost no vegetation. Natural carriers must transport seeds for a considerable distance before vegetation can secure a foothold. Only an occasional small bush and some moss can be seen.

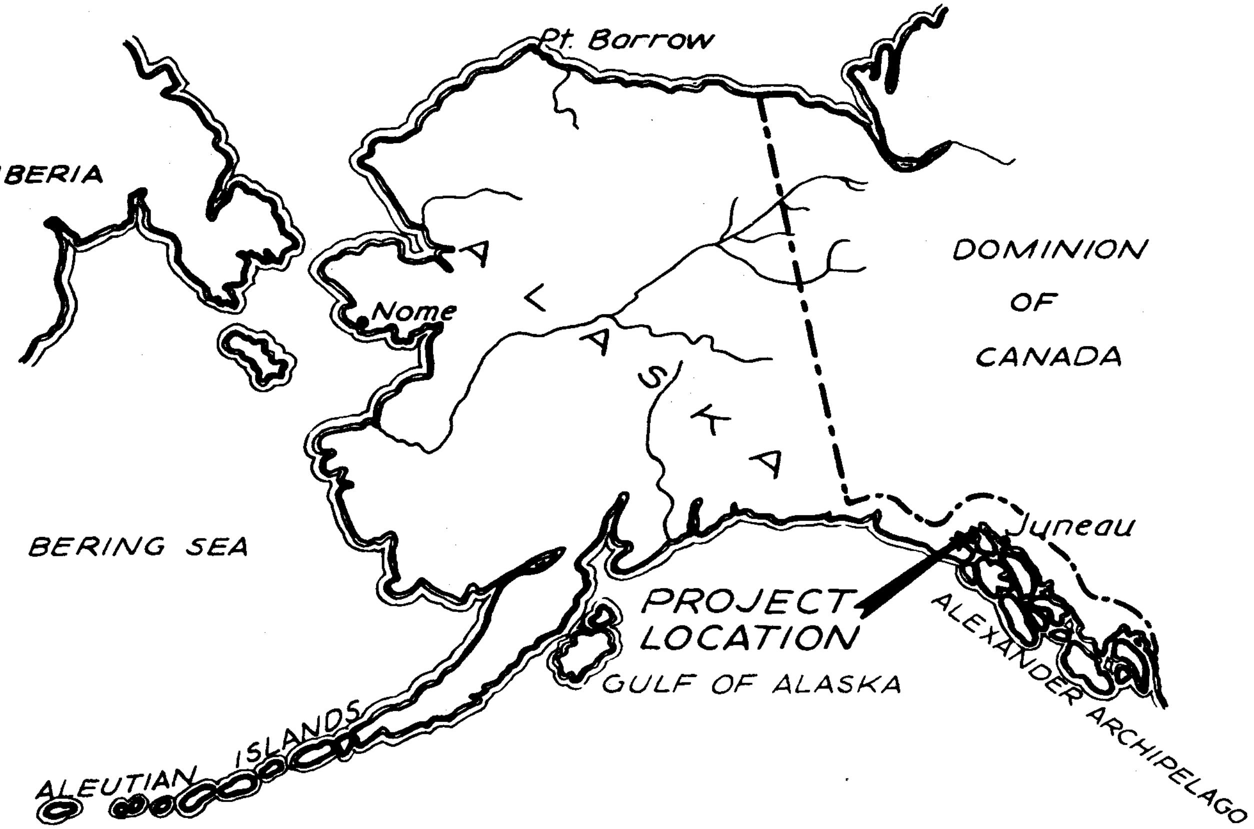


Figure I. - Territory of Alaska index map.

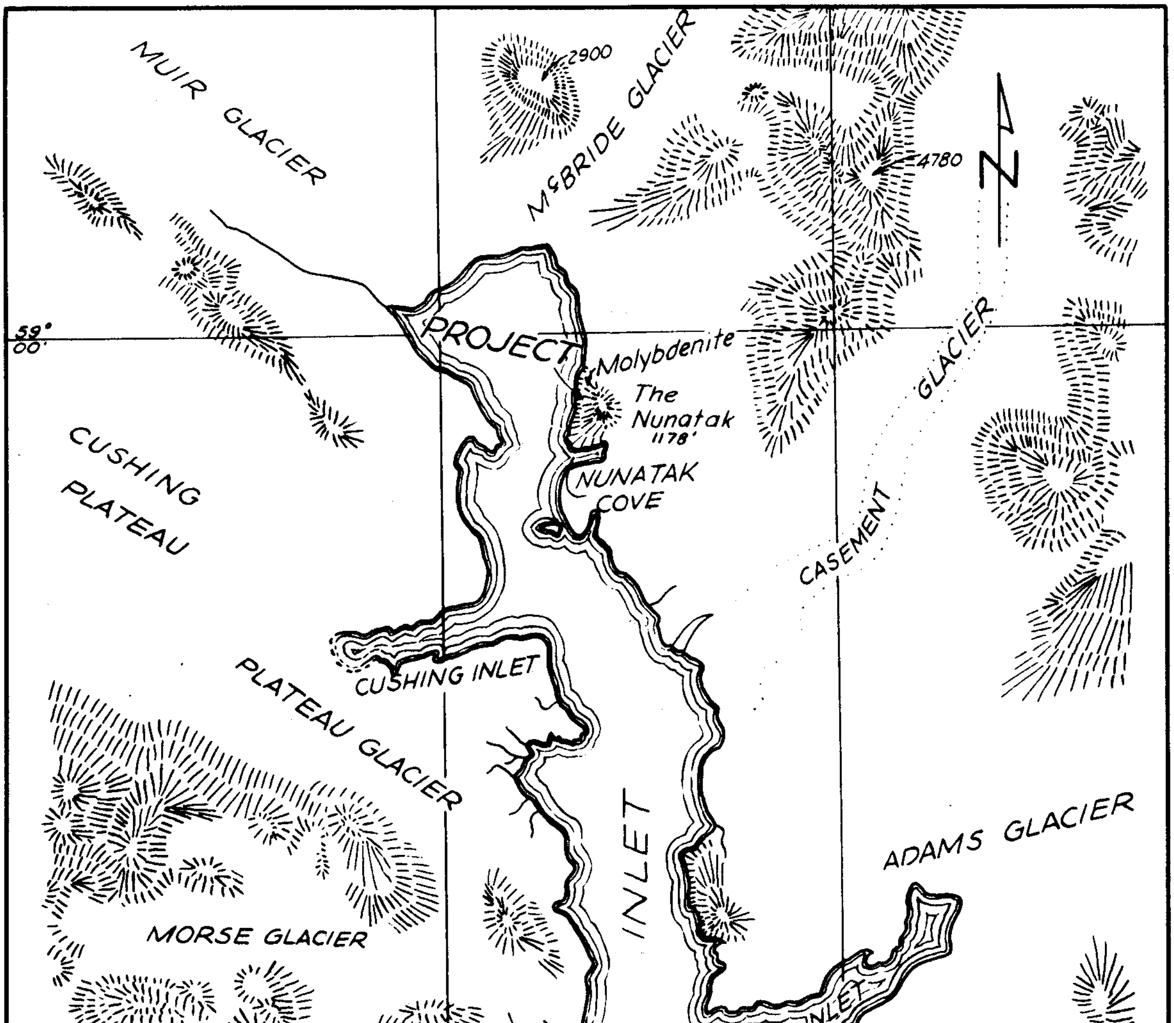


Figure 2. - Location map, showing molybdenite deposits.

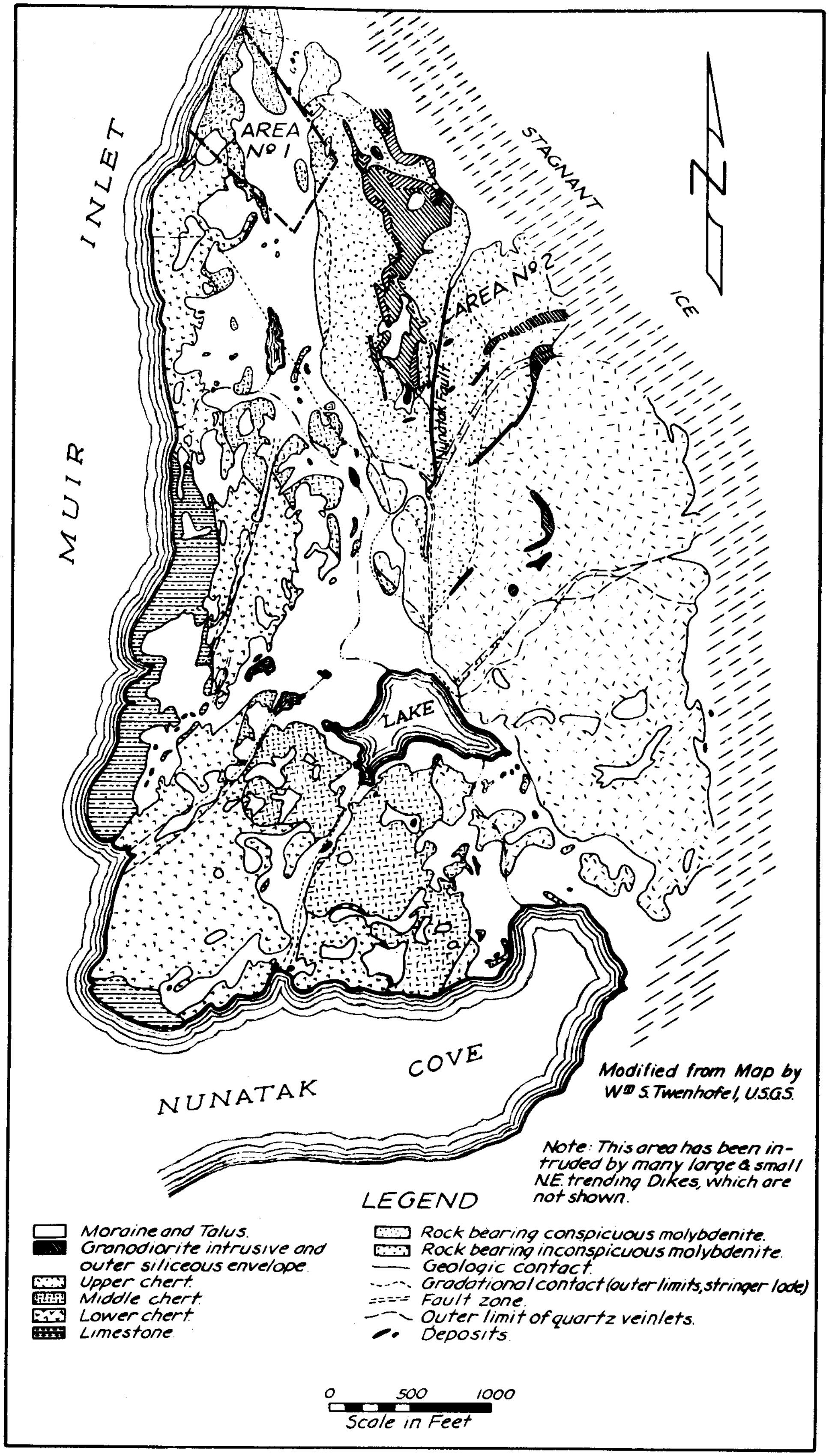


Figure 3. - Generalized geologic map, Nunatak area.

PROPERTY AND OWNERSHIP

Lode claims covering the mineralized areas were staked in 1941 and 1942 by three groups. The original discoverers, John Johnson, Hoonah, Alaska, and Tom Smith, Juneau, Alaska, located four claims. Later, S. H. P. Vevelstad and George Comstock, of Juneau, Alaska, located two claims.

The largest number of claims, 18, was located by Carl Vevelstad, Petersburg, Alaska. A list of unsurveyed claims with ownership follows: John Johnson and Tom Smith, O. K. Nos. 1, 2, 3, and 4; S. H. P. Vevelstad and George Comstock, Triton and Triton No. 1; Carl Vevelstad, Triton Nos. 2 to 20.

ORE DEPOSITS

Field studies of the Nunatak, Muir Inlet area, were made by the United States Geological Survey during the summer of 1942. The following description of the deposits is quoted in part from Twenhofel's report,[6]

> The bedrocks of the Nunatak area include a metamorphosed sedimentary sequence of tightly folded Paleozoic (possibly Devonian) hornfels with some shale and limestone. ***. The earliest intrusions into the stratified rocks are a group of dark altered dikes and sills ***. The hornfels was intruded by a small body of quartz monzonite porphyry, probably early in Cretaceous time after the folding of the bedded rocks.
>
> Around the intrusive, and developed by it, is a contact aureole characterized by abundant diopside in the hornfels. The diopside imparts a dark color to the normally light-colored hornfels. The contact sureole and the three recognized hornfels units *** are cut by myriad quartz veinlets. The quartz veinlets are increasingly abundant toward the intrusive mass. Near its periphery they coalesce and leave only faint remnants of the original rock. In places the outer part of the intrusive is almost completely silicified.
>
> The general trend of the bedded rocks is about N. 5° W., but at most places, because of minor plications, the rocks strike about N. 30° E. Near the stock the bedding has been obscured. Steeply dipping, closely spaced joints cross all the bedrocks. The majority of these strike about N. 65° W. The numerous quartz veinlets for the most part are in these joints. Many faults strike northeastward and dip steeply southeastward. A few of the faults are zones as much as 75 feet wide. The most recent dikes are approximately vertical and trend northeastward. Fault movements both preceded and followed the formation of the quartz veinlets and the intrusion of the dikes.

6/ Twenhofel, W. S., Molybdenite Deposits of the Nunatak Area, Muir Inlet, Glacier Bay, Alaska: U. S. Geol. Surv. Bull. 947-B, 1946, pp. 12-16.

The molybdenite deposits of the Nunatak area are of two types - a stockwork type and a fault type.

The stockwork is by far the largest deposit. It embraces all the diopside-rich contact aureole described *** and extends outward beyond its limits but not inward into the intrusive core or its silicified outer parts. The stockwork as herein defined is that part of the zone of quartz veinlets already mentioned in which molybdenite is prevalent.

Where the zone of quartz veinlets projects conspicuously northwestward to Muir Inlet it contains most of the richer parts of the stockwork. In this part of the zone the bedrock has been folded into a well-defined anticline.

Several faults within the zone of quartz veinlets contain conspicuously more molybdenite than their wall rocks. The fault deposits are similar to the stockwork, in that molybdenite is present generally along the margins of the quartz veinlets, but they differ from it principally in containing many open fractures, in containing molybdenite in thicker masses, and in being locally almost completely epidotized. The deposit along the Nunatak fault is particularly large and well-mineralized.

The Nunatak fault deposit crops out for a length of 2,000 feet. It disappears to the north beneath talus and moraine and to the south beneath moraine and a small lake. The known vertical range of the deposit is from about 380 feet to about 910 feet above sea level. Its width ranges from about 5 feet to as much as 20 feet and averages about 9 feet. The fault strikes about N. 5° E., and its dip steepens from 60° E. in its southern part to 75° E. at its northernmost exposure.

The quartz veinlets that cross the fault zones are similar in most respects to the quartz veinlets elsewhere. The veinlets are better mineralized in the fault zones and seem to indicate that earlier fault movements formed places particularly favorable for molybdenite deposition.

Molybdenite is the most conspicuous metallic mineral in the deposits, because much of it occurs as films and thin plates along the margin of the quartz veinlets. This mode of occurrence makes a visual grading of the ore difficult and is probably the reason the importance of the deposits has been overestimated in the past.

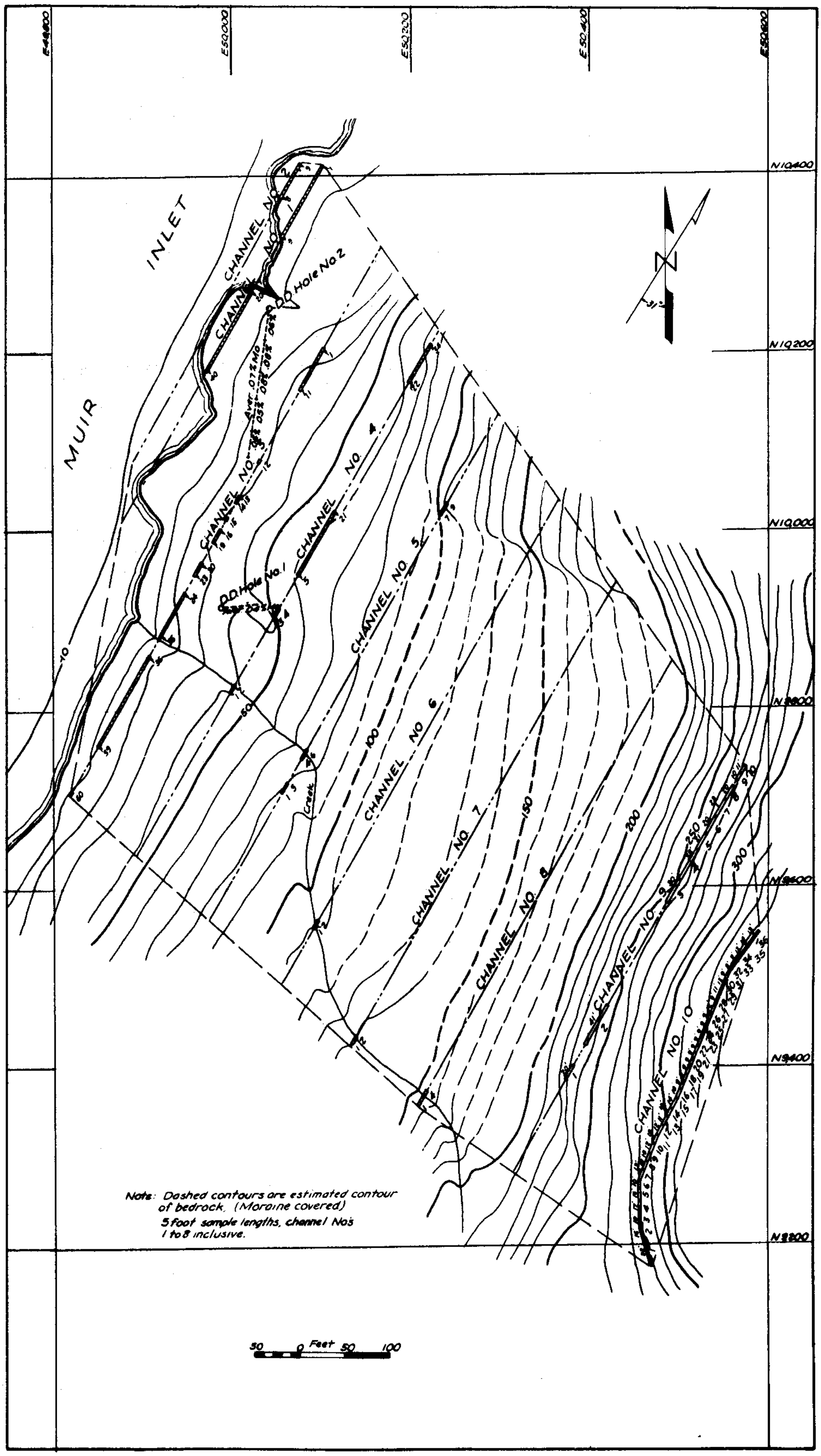


Figure 4. - Assay plan, area I.

CHANNEL #1	
Sample #	% Mo
1	0.09
2	.07
3	.09
4	.09
5	.04
6	.04
7	.08
8	.08
9	.09
10	.08
11	.10
12	.14
13	.08
14	.12
15	.04
16	.05
17	.07
18	.05
19	.05
20	.09
21	.07
22	.06
23	.06
24	.05
25	.05
26	.04
27	.05
28	.06
29	.09
30	.05
31	.07
32	.05
33	.09
34	.06
35	.07
36	.08
37	.10
38	.04
39	.05
40	06

CHANNEL #2	
Sample #	% Mo
1	.03
2	.05
3	.03
4	.07
5	.02
6	.04
7	0.05
8	.03
9	.06

CHANNEL #3	
Sample #	% Mo
1	.05
2	.07
3	.03
4	.04
5	.08
6	.06
7	.08
8	.09
9	.10
10	.10
11	.03
12	.08
13	.06
14	.06
15	.10
16	.05
17	.04
18	.02
19	.03
20	.04
21	.02
22	.03
23	.03
24	.03
25	.03
26	.02
27	.05
28	.03
29	.03
30	.02
31	.03
32	.04
33	.13
34	.03
35	.06
36	.07
37	.04
38	.08
39	.04
40	.04
41	.02
42	.07
43	.03
44	0.06
45	.08
46	.04
47	.04
48	.02
49	.06
50	.04
51	.06
52	.05
53	.05
54	.06
55	.04
56	.06
57	08
58	.05
59	.06
60	.07

CHANNEL #4	
Sample #	% Mo
1	.08
2	.08
3	.07
4	03
5	.06
6	.07
7	.09
8	.09
9	.12
10	.09
11	.06
12	.07
13	.14
14	15
15	.05
16	.13
17	.08
18	.09
19	.07
20	.07
21	.06
22	.10
23	.05
24	.08
25	.05
26	.06
27	.04
28	.05
29	.02
30	0.06
31	.06

CHANNEL #5	
Sample #	% Mo
1	.05
2	03
3	.08
4	.05
5	.04
6	.05
7	.52
8	.06
9	.11

CHANNEL #6	
Sample #	% Mo
1	.05
2	.04

CHANNEL #7	
Sample #	% Mo
1	.02
2	.04

CHANNEL #8	
Sample #	% Mo
1	.05
2	.04
3	.04
4	.07

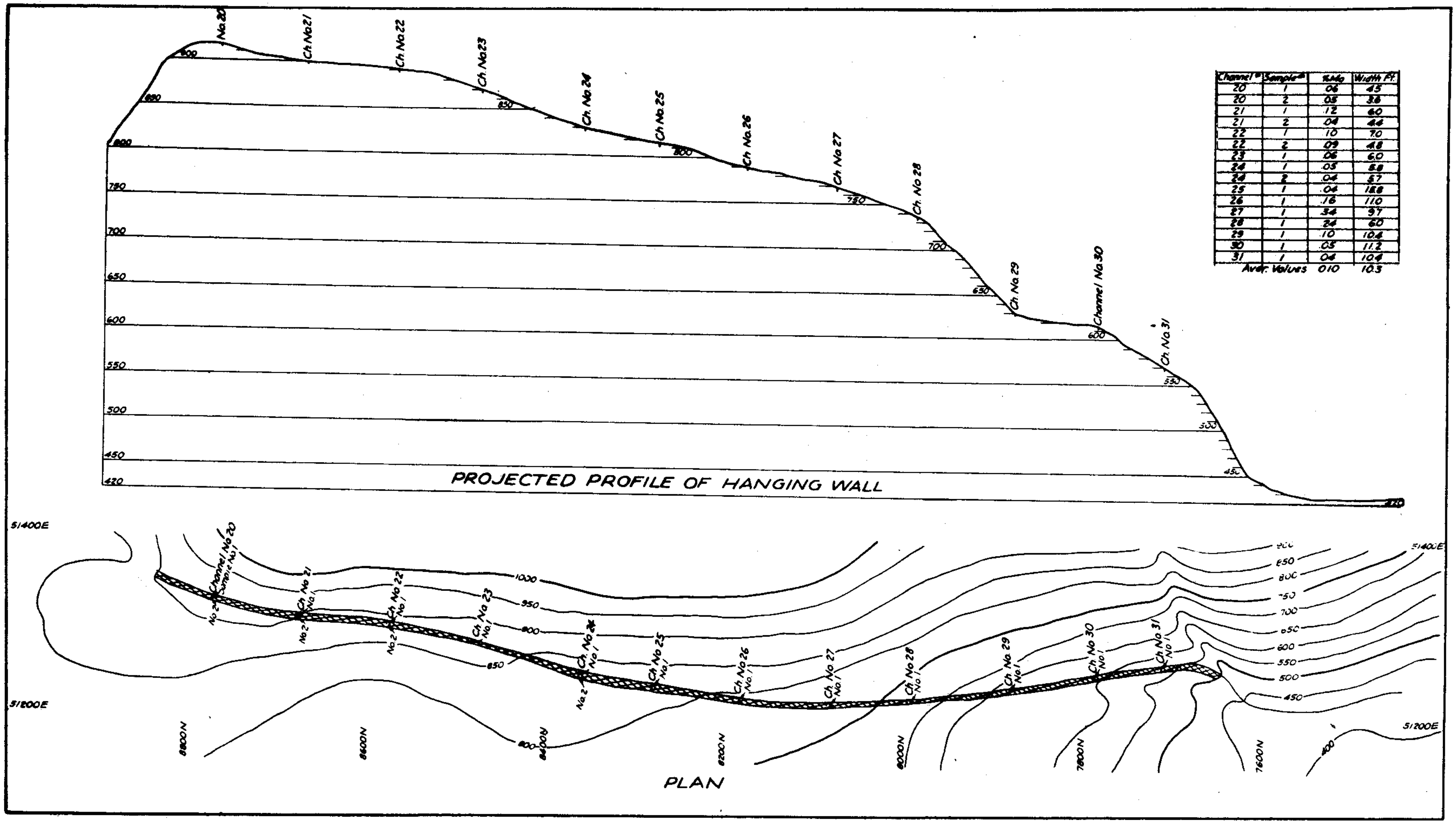
CHANNEL #9	
Sample #	% Mo
1	.05
2	.05
3	.06
4	.09
5	.08
6	.11
7	.08
8	.11
9	.08
10	.07

CHANNEL #10	
Sample #	% Mo
1	.06
2	.10
3	.05
4	.05
5	.07
6	.09
7	.06
8	0.04
9	.03
10	.04
11	.04
12	.06
13	.04
14	.C5
15	.04
16	.04
17	.07
18	.05
19	.07
20	.07
21	.05
22	.10
23	.08
24	.07
25	.11
26	.10
27	.09
28	.08
29	.13
30	.20
31	.09
32	.21
33	.09
34	.11
35	.10
36	.07

CHANNEL	% Mo
1	.07
2	.05
3	.05
4	.07
5	.11
† 6	.05
† 7	.03
‡ 8	.04
9	.07
10	.07
Aver. all Channels	.07

† - 2 samples not representative.
‡ - 4 " " "
5 foot sample lengths, channels 1-8 inclusive.

Figure 5. - Assay data, area I.



Channel #	Sample #	% Mg	Width Ft.
20	1	.06	4.5
20	2	.05	3.6
21	1	.12	6.0
21	2	.04	4.4
22	1	.10	7.0
22	2	.09	4.8
23	1	.06	6.0
24	1	.05	5.8
24	2	.04	5.7
25	1	.04	18.8
26	1	.16	11.0
27	1	.34	9.7
28	1	.24	6.0
29	1	.10	10.4
30	1	.05	11.2
31	1	.04	10.4
	Aver. Values	010	10.3

Figure 6. - Plan and profile, area 2.

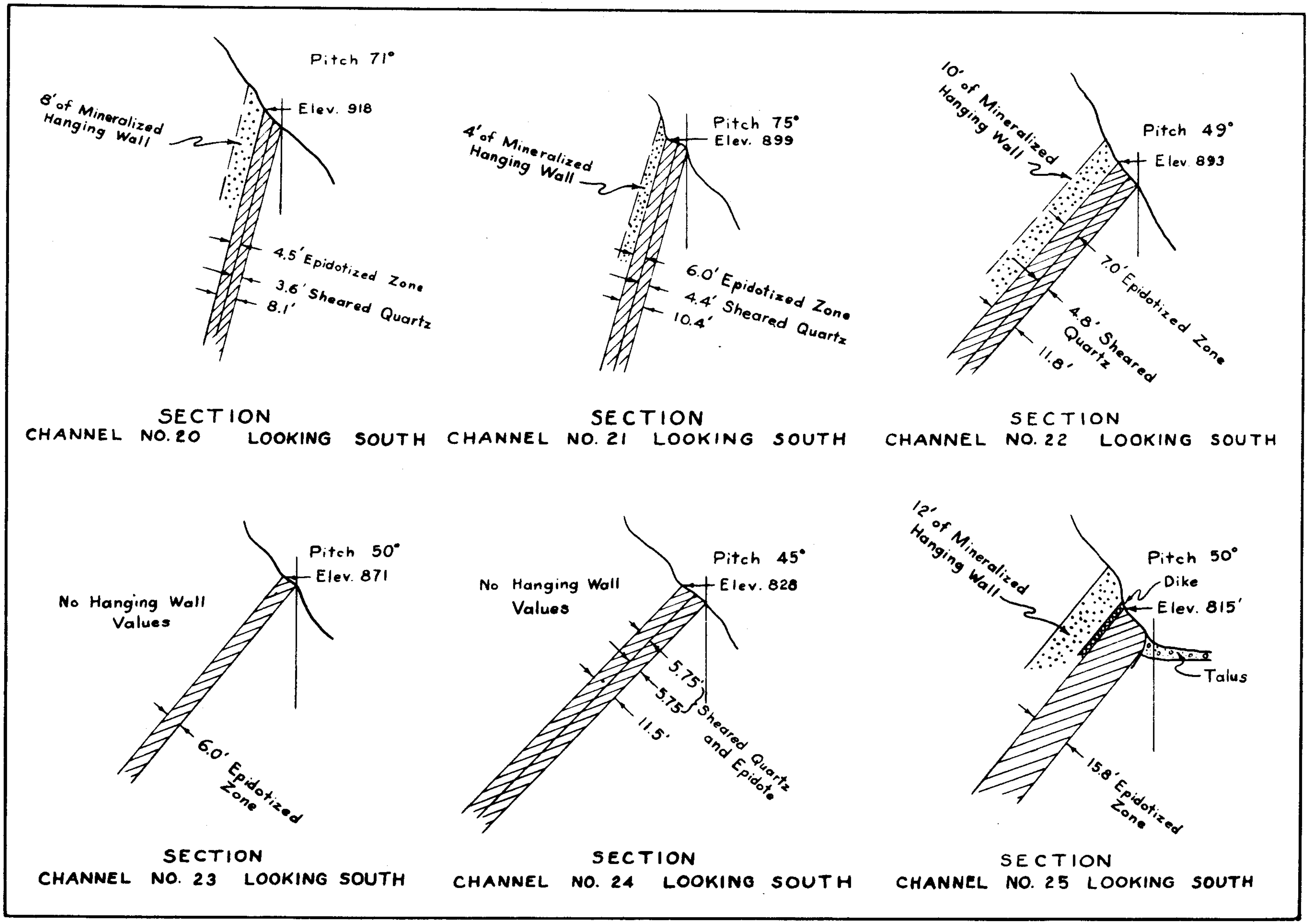


Figure 7. - Sections, area 2.

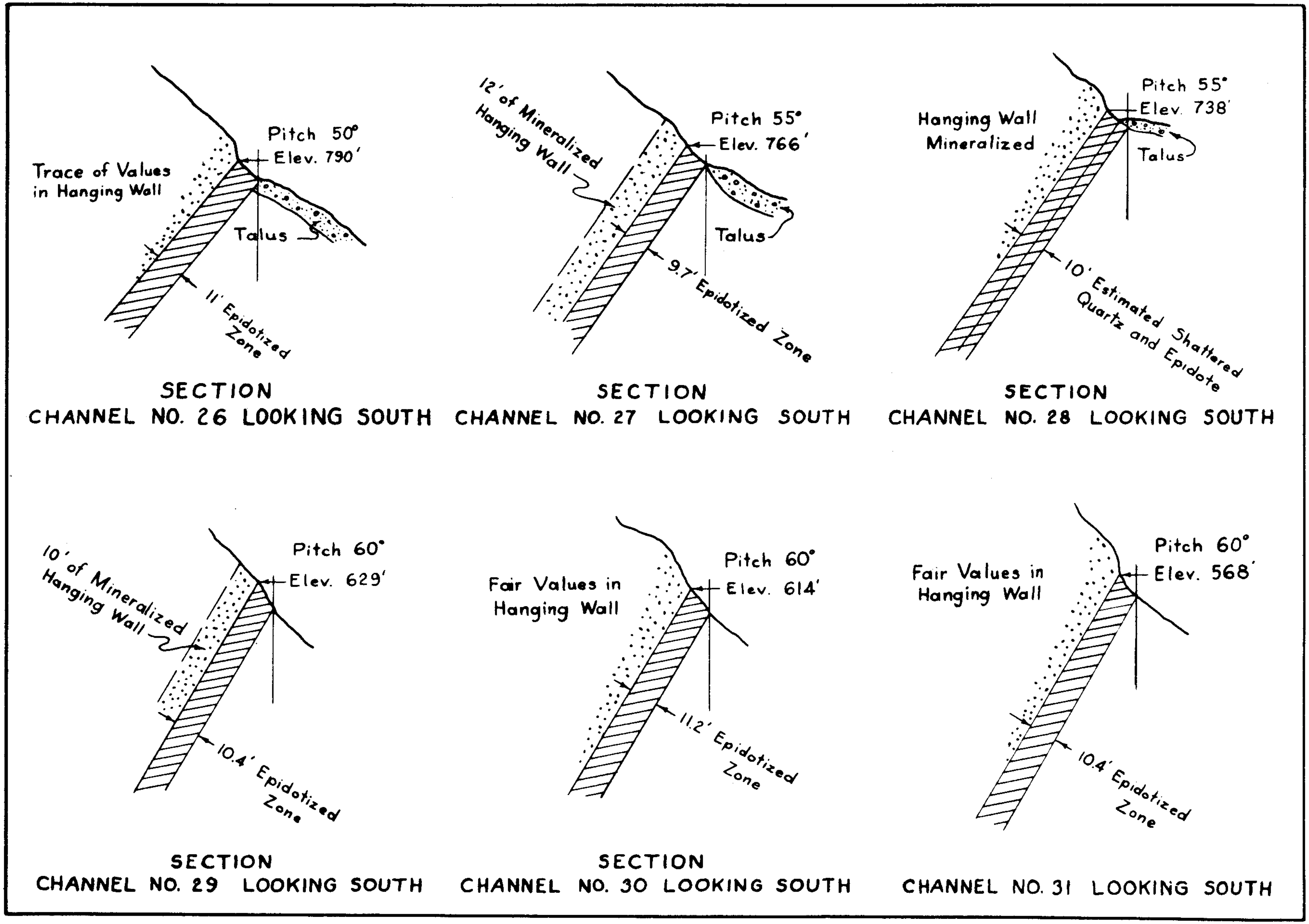


Figure 8. - Sections, area 2.

SAMPLING AND ANALYSIS

Stockwork deposits. - The stockwork molybdenite deposits outcrop over an area of about two million square feet and are partly covered by glacial moraine. The more noticeable mineralization is confined to an area of 550,000 square feet. This is designated as Area No. 1 and was selected for systematic exploration. (See fig. 3.)

A total of 203 channel samples were cut over a length of 1,440 feet. These samples averaged 0.07 percent molybdenum. The highest analysis from this group of samples was 0.52 percent molybdenum, and only four samples assayed 0.15 percent molybdenum or higher. The location of samples taken is shown on figure 4, and the analyses are shown on figure 5.

Two core drill holes were put down in this area. Hole 1 was drilled at an inclination of -30° and completed to a depth of 46.7 feet. Hole 2 was drilled at an inclination of -45° and completed to a depth of 238.1 feet. This hole reached a vertical depth of 169 feet below the surface or 158 feet below sea level. The location of the holes is shown on figure 4.

The grease ordinarily used to lubricate the drill rods could easily float the molybdenite when core drilling in this type of deposit. The possibility was anticipated, and provisions were made to recover all of the sludge for analysis.

The following tabulation gives the total weighted core and sludge analyses and the adjusted average analyses:

Hole	Percent molybdenum		
	Core	Sludge	Adjusted average
1	0.043	0.041	0.042
2	0.063	0.073	0.072

The same uniformly low-grade mineralization as found on the surface continued to the bottom of the holes. Only two samples obtained in the drilling contained more than 0.15 percent molybdenum.

Fault deposits. - There are four faults that contain more molybdenite than is found in the wall rock. The Nunatak fault, the largest, is well-mineralized. This deposit was selected for exploration and is designated Area 2. The samples were cut in 12 channels spaced over a length of 1,100 feet. These samples contained an average of 0.10 percent molybdenum. The average width of fault samples was 10.3 feet. Only three of the samples obtained from this deposit contained more than 0.15 percent molybdenum. The analysis of individual samples and a plan and profile of Area 2 are shown on figure 6. Sections through the fault at points sampled are shown on figures 7 and 8.

BENEFICIATION TESTS

Two representative samples were shipped to the Bureau of Mines Laboratory in Rolla, Mo., for metallurgical testing. One sample was taken near the first drill site in Area 1. The other sample was obtained from the shear zone in Area 2.

On the sample from Area 1, a concentrate containing 88.04 percent molybdenum sulfide was recovered, whereas on the one from Area 2 (shear zone) the recovered concentrate contained 94.49 percent molybdenum sulfide. As molybdenum concentrates are usually quoted on the basis of 90 percent minimum molybdenum sulfide content, the product made from the Area 1 sample was slightly below specification; the other concentrate, however, was considerably above the minimum.