R. I. 3945

SEPTEMBER 1946

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

BUREAU OF MINES
R. R. SAYERS, DIRECTOR

REPORT OF INVESTIGATIONS

EXPLORATION OF THE RILEY TUNGSTEN MINE
HUMBOLDT COUNTY, NEVADA

BY

GEORGE H. HOLMES, JR.

R. I. 3945,
September 1946.

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EXPLORATION OF THE RILEY TUNGSTEN MINE HUMBOLDT COUNTY, NEVADA[1]

By George H. Holmes, Jr.[2]

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INTRODUCTION

The Riley tungsten property of the Northern Nevada Mining Co. was examined by the Bureau of Mines in August 1943, and from February 22 to August 22, 1945, the property was explored by the Bureau.

Riley mine, which comprises 60 acres, is in sec. 9, T. 38 N., R. 42 E., Mount Diablo base and meridian, in the Potosi Mining District, on the east slope of the Osgood Range in eastern Humboldt County, Nevada. J. E. Riley is president of Northern Nevada Mining Co., the general offices of which are at 29 East First Street, Reno, Nev.

Winnemucca, Nev., 42 miles southwest of the mine and on the main line of the Southern Pacific and Western Pacific Railroads and U. S. Highway 40, is the nearest supply center. The post office for the Potosi district is 15 miles south at Red House, Nev., a station on the Southern Pacific and Western Pacific Railroads. A good dirt road, which leaves U. S. Highway 40 about 15 miles east of Winnemucca, extends northeast to the property.

Tungsten occurs as scheelite in a characteristic Nevada contact-metamorphic tactite deposit between limestone and granodiorite. Fifteen diamond-drill holes were completed for a total length of 2,630 feet.

1/ The Bureau of Mines will welcome reprinting of this report, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 3945."

2/ Mining engineer, Reno Division, Mining Branch, Bureau of Mines.

Between September 1944 and May 1945, a 250-ton mill was built at the Riley mine, and milling operations commenced late in May. About 8,500 tons of ore reported to average 0.70 percent WO_3 was said to have been treated in this mill up to July 31, 1945. Operation is being maintained at 250 tons daily.

PHYSICAL FEATURES AND COMMUNICATIONS

Riley mine and camp are on the east slope and near the center of the Osgood Mountains. This range is about 18 miles long, has a generally northerly trend, and is rugged in relief. Altitude ranges from about 5,300 feet at the base of the range to 8,400 feet at the crest, and at the Riley property ranges from 5,400 to 5,800 feet. The Riley mill is in the southeast corner of the property, and the camp has been built in a small canyon about one-fourth mile southwest of the mine.

Water is obtained from a series of springs near the camp and, except in the late summer, is sufficient for mine and mill requirements. This supply can be augmented from wells in the valley. Water transporting the mill tailings is impounded in ponds and pumped back into the mill circuit.

The climate varies from hot, dry summers to moderately cold winters. Occasional heavy snows occur in winter, but operations can proceed throughout the year. Vegetation is sparse, and there is no timber.

Freight and express shipments are handled through Red House, Nev., a station on the Southern Pacific and Western Pacific Railroads about 15 miles south of the mine. Mail is delivered daily to the post office at Red House, and there are telegraph facilities at this station. The Winnemucca-Getchell telephone line passes about 2 miles to the east, and connections have been made with it.

A graded dirt road extends from Riley mine to U. S. Highway 40, 27 miles southwest. Highway 40 continues westwardly 15 miles to Winnemucca, the county seat of Humboldt County and the nearest source of labor and supplies.

Power for mill operation is obtained from the Sierra Pacific Power Co.'s 66,000-volt transmission line, which passes about one-fourth mile east of the property. Air for mine use is supplied by Diesel-driven, portable compressors.

LABOR AND LIVING CONDITIONS

The camp at the Riley mine is on the property of Getchell Mine, Inc., and comprises twelve 1- and 2-room frame buildings for men with families. A bunkhouse and boarding house was formerly maintained by the company, but at present single men are rooming and boarding at the Getchell Mine, Inc., 2 miles to the north, where board and room are furnished at the daily rate of $1.70. Men are transported to and from work in company trucks.

An elementary school for children is maintained at the Getchell mine and is under the supervision of an accredited teacher. Children of high school age attend the school at Winnemucca.

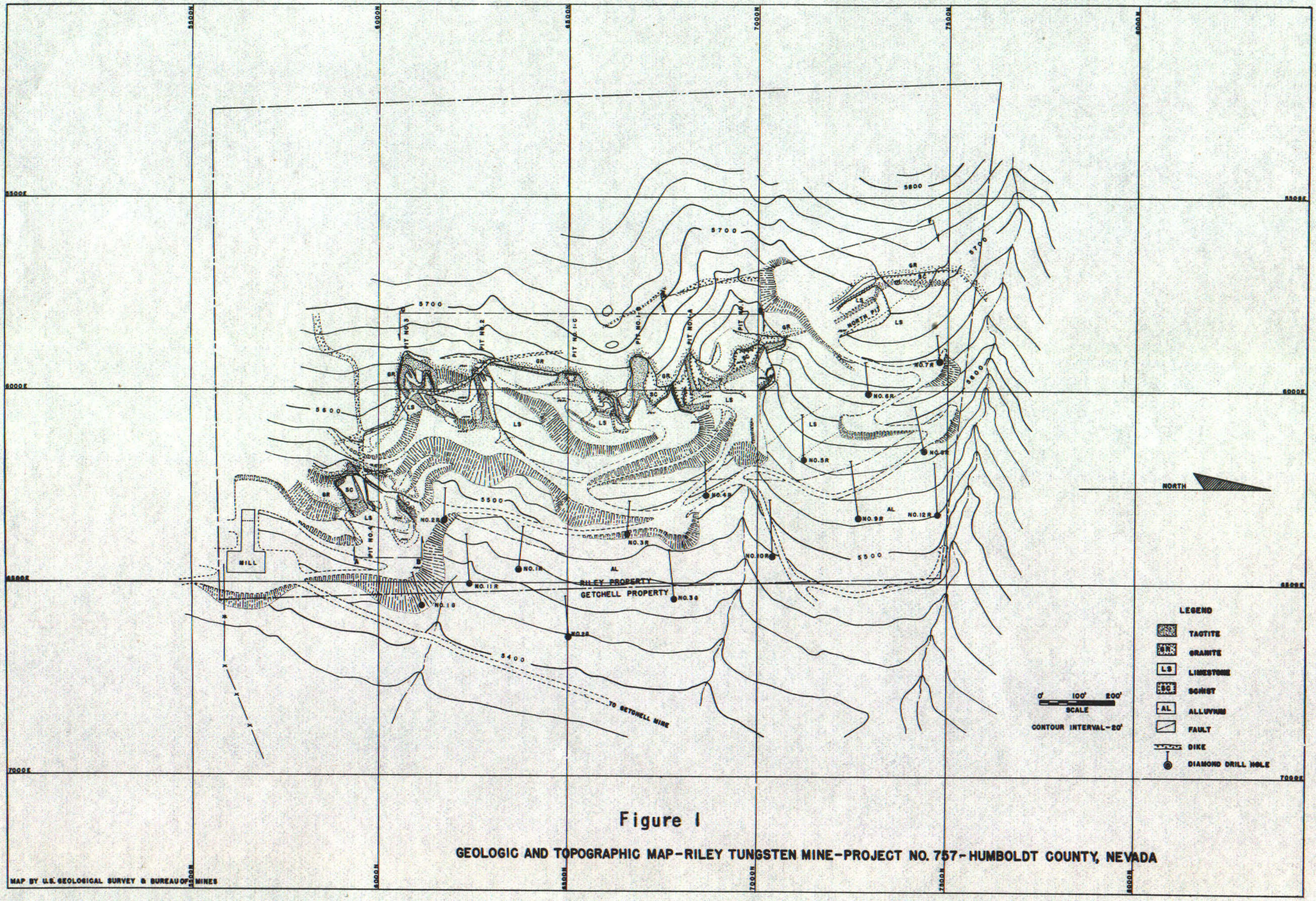


Figure I

GEOLOGIC AND TOPOGRAPHIC MAP-RILEY TUNGSTEN MINE-PROJECT NO. 757-HUMBOLDT COUNTY, NEVADA

MAP BY U.S. GEOLOGICAL SURVEY & BUREAU OF MINES

Common labor is scarce, and it is difficult to obtain skilled miners and mill operators. Prevailing wages range from $0.90 an hour for common labor to $1.65 an hour for skilled mechanics and shovel operators. Time and one-half is paid for all work over 40 hours weekly.

GEOLOGIC SUMMARY[3]

The Riley mine is situated on the eastern edge of a granodiorite stock at a place where limestones are in contact with the igneous rock. Tactite containing scheelite occurs along most of the limestone-granodiorite contact.

The granodiorite is a coarse-grained, light-colored, homogenous, igneous rock composed chiefly of feldspar, quartz, biotite, and hornblende. It shows very little change in character at the contact. The only other igneous rock in the area is andesite, which occurs as dikes cutting all of the other rocks and at places interrupts the continuity of the ore.

The limestones consist of interbedded series of thick-bedded, medium- to coarse-grained, pure, blue-gray limestone and thin-bedded, platy, fine-grained, impure limestone. Two series of each type have been differentiated in the vicinity of the mine. The generalized strike of the limestone is north, and the average dip is 40 degrees east. Locally, the limestone is contorted or bent slightly out of this general structure.

The tactite, formed by contact metamorphism of the limestone by the granodiorite, is composed largely of a red-brown garnet together with some epidote, diopside, and locally abundant quartz. Scheelite occurs in great or small amounts in most of the tactite. A layer of material, at places resembling a fine-grained schist and at other places resembling a hornfels or argillite, occurs almost universally between the granodiorite and the tactite or, where the tactite is absent, between the granodiorite and the limestone. This layer ranges in thickness from a few inches to 10 or more feet.

The contact of the granodiorite and the limestone strikes, on the average, a little west of north and dips about 40 degrees to the east. The surface of the ground slopes in the same direction, but somewhat less steeply, and diamond-drill holes indicate that the contact is several hundred feet below the surface at 500 to 600 feet down the dip from the outcrop.

The contact of the granodiorite with the limestone tends to follow the general strike of the bedding in the limestone. However, notable exceptions to this occur in at least four places, where the granodiorite contact turns sharply and crosscuts the limestone for short distances before resuming a course more nearly parallel to the bedding. These sharp bends of the contact are always in the same direction - shifting the main granodiorite contact to the east in a series of jogs as it extends southward. Between the sharp jogs in the contact, the granodiorite at places follows the bedding closely and at other places diverges slightly from the bedding both along the strike and down the dip, causing different layers of the limestone to adjoin the granodiorite at different places.

3/ Geological summary prepared by S. Warren Hobbs, U. S. Geological Survey, August 23, 1945.

A large fault, which is probably an extension of the big fault zone exposed at the Getchell gold mine a mile and a half to the north, occurs along the eastern side of the Riley property. This fault strikes north and dips east at an angle somewhat steeper than the ore zone along the limestone-granodiorite contact. Consequently, the fault may be expected to cut out the ore at moderate depth. Partly as a result of the successive jogging of the contact to the east as it extends southward and partly because of a slight convergence of the general strike of the contact and the fault, the ore zone is terminated at the south end against this fault.

The ore mineral scheelite occurs in the tactite that has been formed by contact metamorphism of the limestone by the granodiorite along most but not all of the contact. At least three and perhaps four separate and distinct ore shoots have been formed, which seem to be localized by two principal controls. One of these is the character of the limestone at the contact. Wherever the rather massive, granular, fairly pure limestone adjoins the granodiorite, good tactite is formed. Wherever the platy, thin-bedded, impure limestone adjoins the contact, only very thin tactite or none at all is formed. The lighologic control of mineralization is especially noticeable in the areas where the contact closely parallels the bedding and gives rise to irregular, tabular ore bodies that play out down the dip or along the strike, depending on the character of the limestones at the contact. The other main factor is the occurrence of the right-angle bends in the contact. These bends, together with the general dip of the contact to the east, form troughlike features in the contact, which plunge slightly north of east at an angle of about 40 degrees. Limestone within these troughs has been more completely and extensively metamorphosed and mineralized then elsewhere. The ore bodies controlled by the troughs in the contact tend to be relatively small and limited in surface outcrop but extend down the dip as elongate shoots.

MINE WORKINGS AND PLANT

Scheelite ore has been mined along the contact zone from a series of eight pits varying in length from 60 to 125 feet and in depth from 25 to 85 feet. There are no underground workings, all ore having been produced by open-pit mining.

Plant buildings on the property comprise the mill, assay office, mine office, machine shop, and warehouse.

Broken ore and waste are loaded into 3-ton dump trucks by two Diesel-driven shovels; compressed air for drilling is supplied by portable compressors; stripping is done by two bulldozers; a well-equipped machine shop services the automotive equipment; and a mounted, motor-driven, electric welding outfit is used for making minor repairs to equipment in the field.

Rock drills, hose, steel, and other miscellaneous mining equipment are in good condition and adequate for present requirements.

Limestone is stripped by drilling a double row of 16-foot vertical holes on 4-foot centers parallel to the strike of the ore shoot. The waste is blasted by using free-running powder, detonated electrically, and moved by power shovel and truck. Successive rows of holes are drilled and blasted until the tactite is exposed, so that it can be mined and trucked to the mill. Drilling is done by wagon drills. This method of mining produces large boulders, which, in turn, are drilled with jackhammers and blasted with 45 percent dynamite.

The depth to which the tactite can be mined economically by this method has not yet been determined. It is evident that with increasing thickness of overburden and limestone and the increasing proximity of the Getchell fault, it will become necessary to resort to underground mining.

PLAN OF PROJECT

Bureau of Mines exploration in the Potosi Mining District included the diamond-drilling of holes to test the lateral and downward extensions of the tactite zones at various points along the contact on the Riley property of the Northern Nevada Mining Co. Essential surveys and mine plans were prepared, and mine and mill products were sampled.

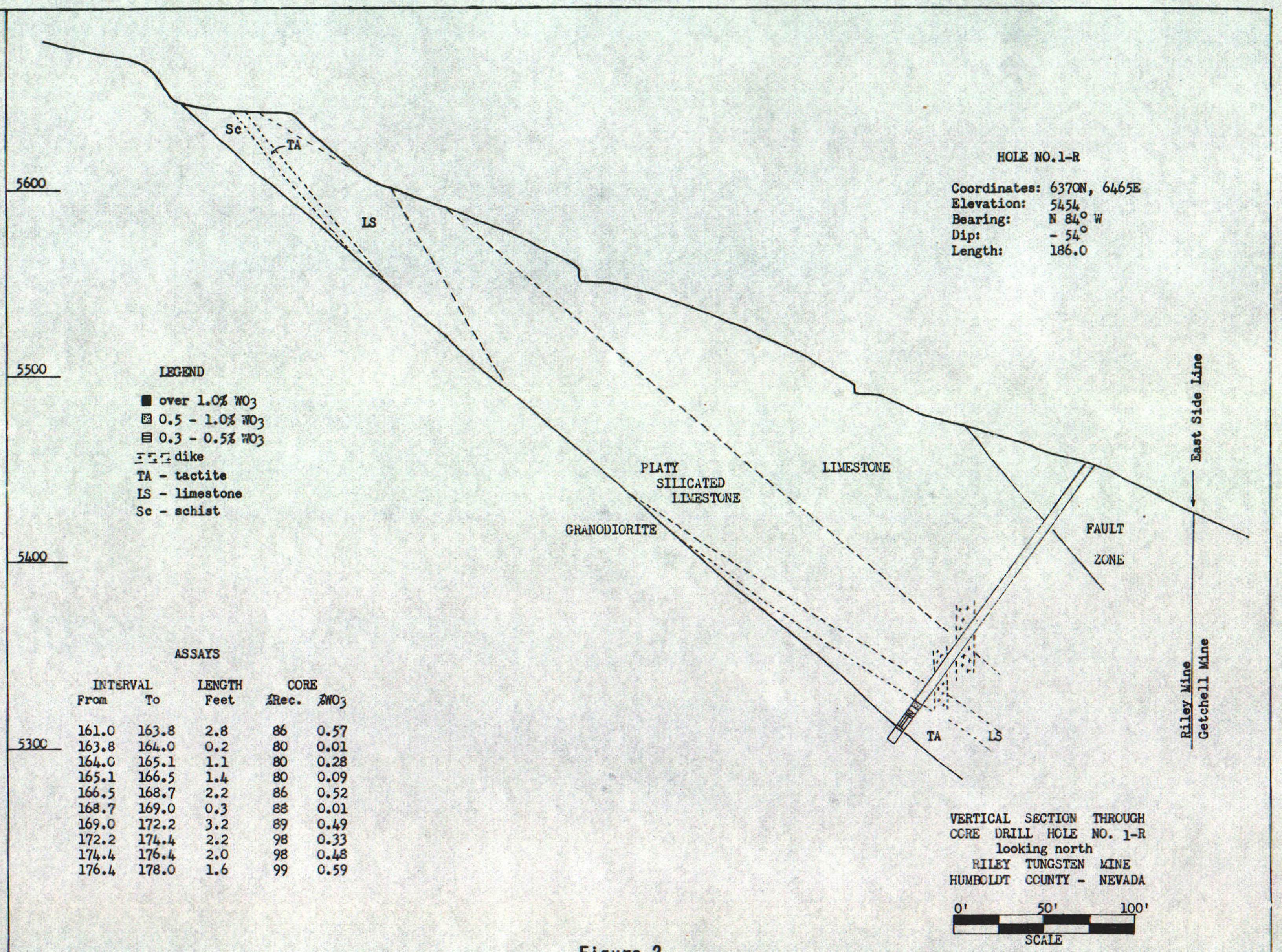
Drill holes were designed to intersect known ore shoots at depths up to 700 feet down dip and to explore intervening areas for possible lateral continuity of these ore bodies. Twelve holes, designated by the letter "R", were collared on the Riley property, and three holes, indicated by "G", were collared on the property of the Getchell Mine, Inc.

RESULT OF PROJECT WORK

Fifteen diamond-drill holes with an aggregate length of 2,630 feet were completed. Ten holes intersected tactite; the remaining five holes, although drilled to the granodiorite, penetrated barren zones. Holes drilled were:

Hole No.	Coordinates	Elevation, ft.	Bearing	Dip	Length, ft.
1-R	6370 N., 6465 E.	5,454	N. 84° W.	-54°	186
2-R	6172 N., 6338 E.	5,463	N. 88° W.	-50°	130
3-R	6658 N., 6374 E.	5,494	N. 85° W.	-50°	133
4-R	6865 N., 6272 E.	5,510	S. 88° W.	-50°	129
5-R	7120 N., 6180 E.	5,566	S. 84° W.	-45°	164
6-R	7292 N., 6008 E.	5,632	S. 82° W.	-50°	127
7-R	7478 N., 5926 E.	5,645	S. 80° W.	-50°	107
8-R	7438 N., 6154 E.	5,573	S. 78° W.	-50°	184
9-R	7266 N., 6330 E.	5,525	S. 82° W.	-50°	231
10-R	7039 N., 6430 E.	5,478	S. 87° W.	-50°	245
11-R	6240 N., 6504 E.	5,432	S. 86° W.	-50°	199
12-R	7475 N., 6320 E.	5,520	S. 86° W.	-52°	206
1-G	6114 N., 6559 E.	5,414	S. 73° W.	-50°	136
2-G	6502 N., 6640 E.	5,418	S. 85° W.	-65°	253
3-G	6781 N., 6540 E.	5,449	S. 85° W.	-50°	200

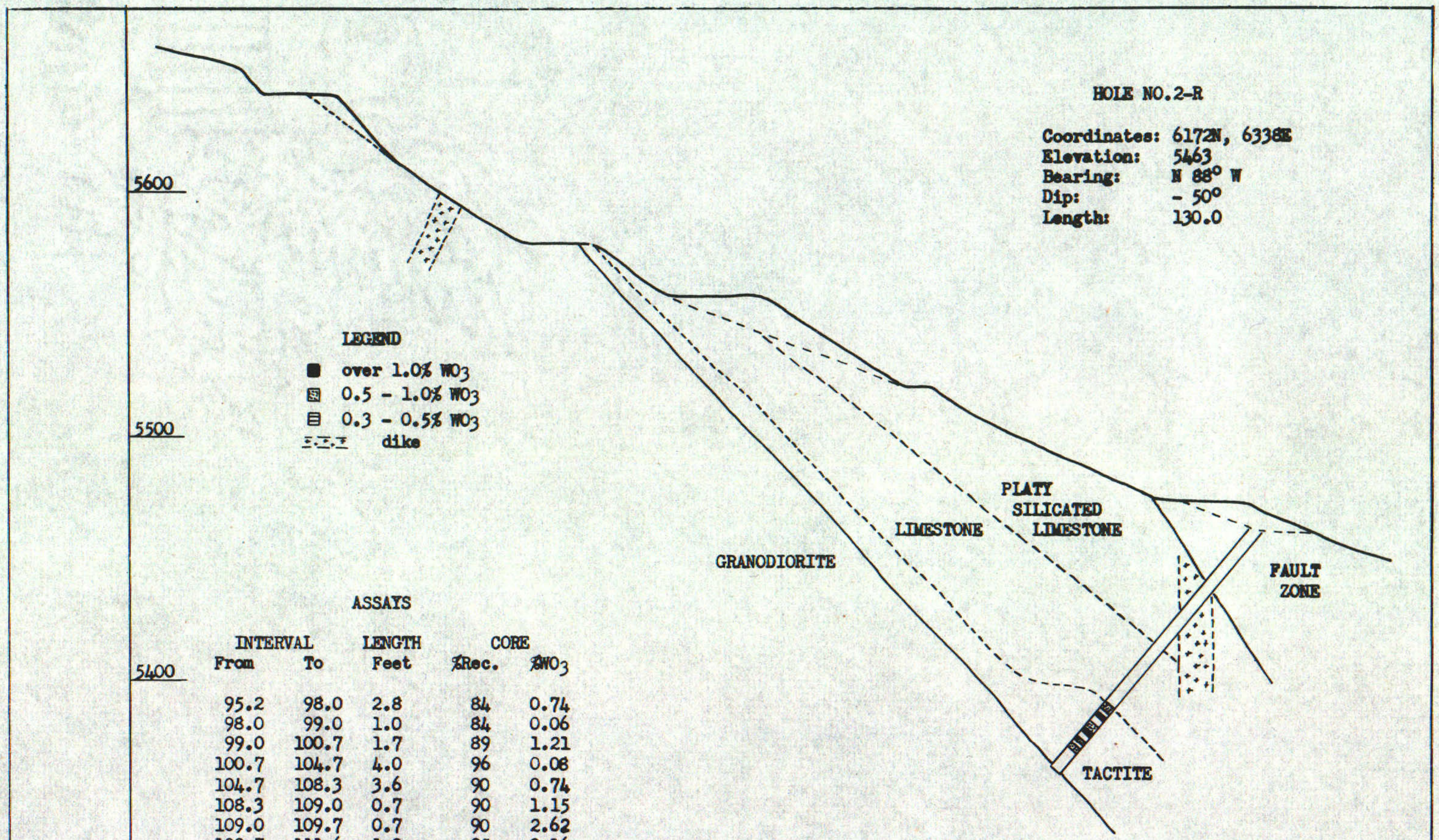
Core recovery in ore averaged 90 percent. Because of the clayey and gougy character of the formation, no recovery was made while penetrating the Getchell fault zone. Water recovery was poor owing to the numerous cavities encountered in the limestone. The high core recovery in the ore zones obviated the necessity for recovering sludges.



ASSAYS

INTERVAL From	To	LENGTH Feet	CORE %Rec.	%WO_3
161.0	163.8	2.8	86	0.57
163.8	164.0	0.2	80	0.01
164.0	165.1	1.1	80	0.28
165.1	166.5	1.4	80	0.09
166.5	168.7	2.2	86	0.52
168.7	169.0	0.3	88	0.01
169.0	172.2	3.2	89	0.49
172.2	174.4	2.2	98	0.33
174.4	176.4	2.0	98	0.48
176.4	178.0	1.6	99	0.59

Figure 2



ASSAYS

INTERVAL From	To	LENGTH Feet	CORE %Rec.	$\%WO_3$
95.2	98.0	2.8	84	0.74
98.0	99.0	1.0	84	0.06
99.0	100.7	1.7	89	1.21
100.7	104.7	4.0	96	0.08
104.7	108.3	3.6	90	0.74
108.3	109.0	0.7	90	1.15
109.0	109.7	0.7	90	2.62
109.7	111.6	1.9	95	0.16
111.6	113.3	1.7	96	0.51
113.3	114.1	0.8	96	0.17
114.1	115.4	1.3	97	0.06
115.4	116.5	1.1	100	0.01
116.5	119.2	2.7	100	0.95
119.2	123.5	4.3	99	0.03
123.5	127.0	3.5	97	0.04
127.0	129.4	2.4	97	0.05

VERTICAL SECTION THROUGH
CORE DRILL HOLE NO.2-R
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA

0' 50' 100'
SCALE

Figure 3

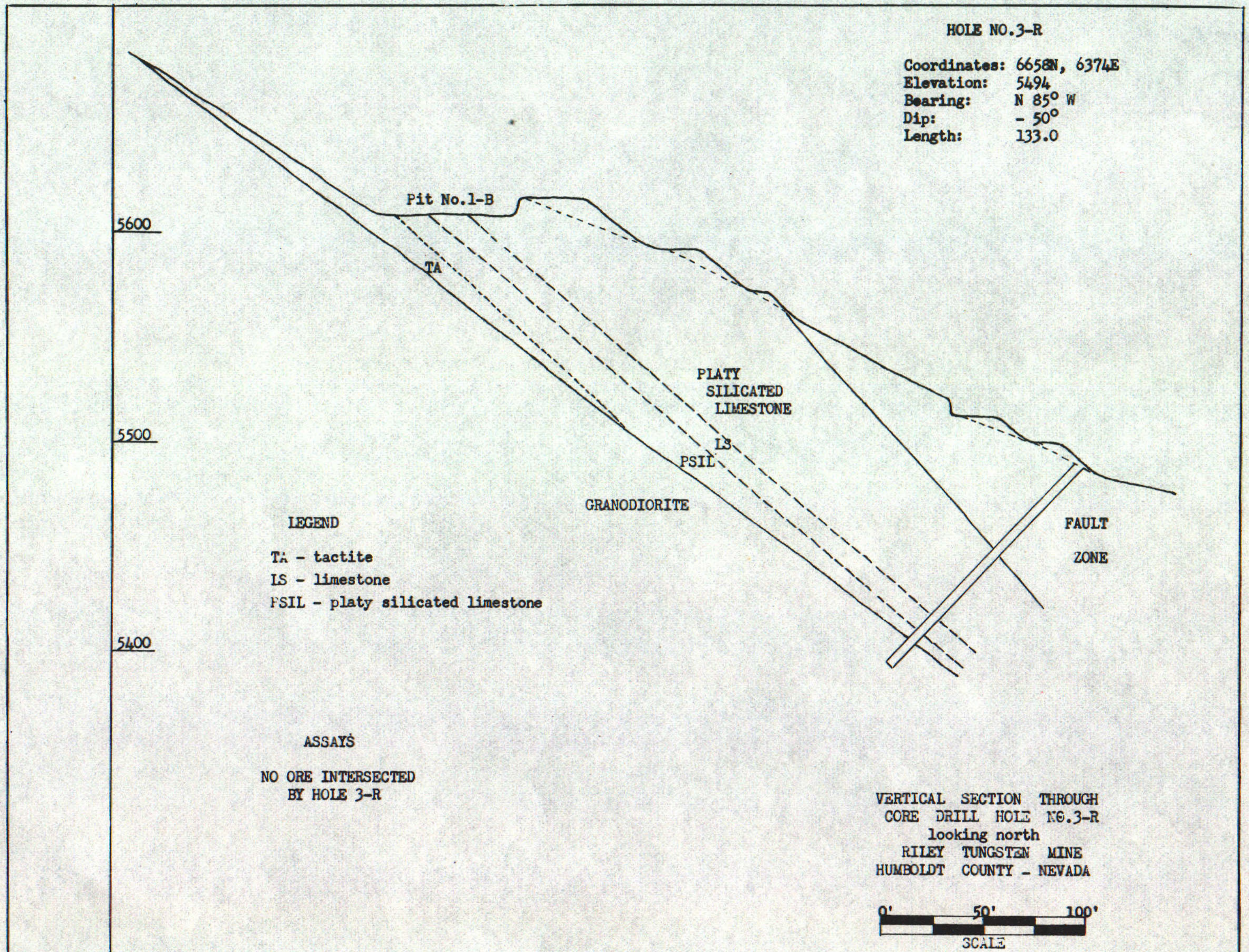
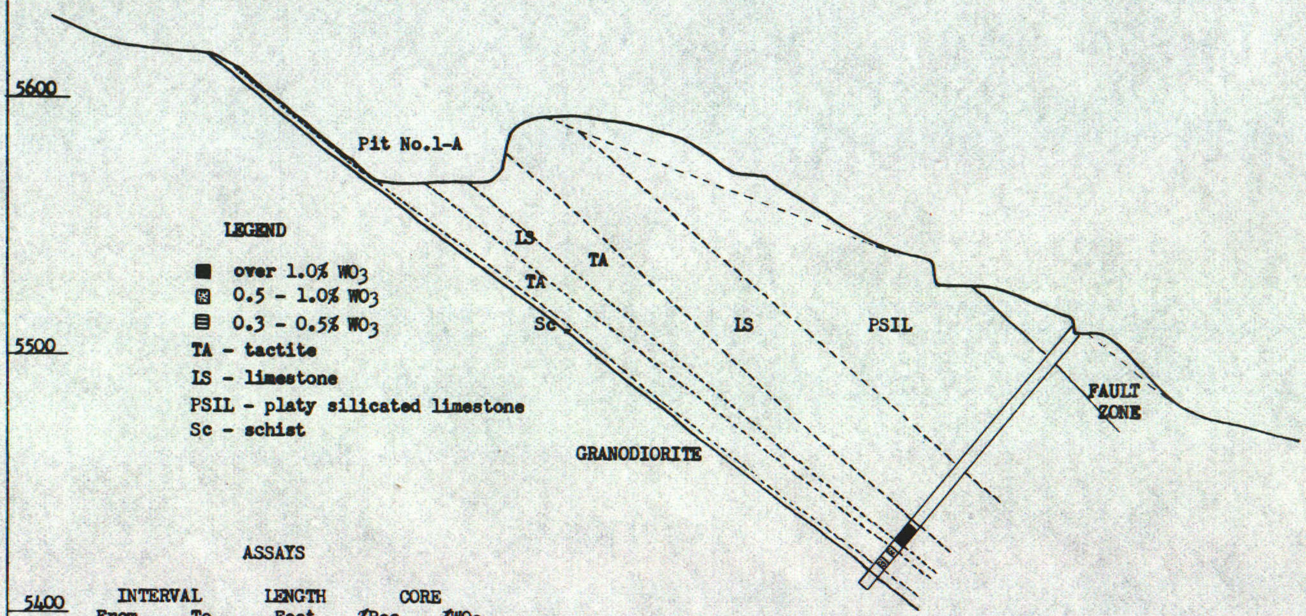

HOLE NO.3-R
Coordinates: 6658N, 6374E
Elevation: 5494
Bearing: N 85° W
Dip: - 50°
Length: 133.0
Pit No.1-B
5600
5500
5400
TA
PLATY SILICATED LIMESTONE
LS
PSIL
GRANODIORITE
FAULT ZONE
LEGEND
TA - tactite
LS - limestone
PSIL - platy silicated limestone
ASSAYS
NO ORE INTERSECTED BY HOLE 3-R
VERTICAL SECTION THROUGH CORE DRILL HOLE NO.3-R
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA
0'
50'
100'
SCALE

Figure 4

HOLE NO.4-R

Coordinates: 6865N, 6272E
Elevation: 5510
Bearing: S 88° W
Dip: - 50°
Length: 129.0



ASSAYS

INTERVAL From	To	LENGTH Feet	CORE %Rec.	CORE %WO_3
98.2	99.7	1.5	100	0.24
99.7	104.7	5.0	100	1.22
104.7	106.5	1.8	100	1.41
109.7	110.5	0.8	100	0.86
110.5	112.5	2.0	100	0.77
112.5	116.0	3.5	65	0.04
116.0	119.0	3.0	98	0.78
119.0	121.0	2.0	98	0.02
121.0	123.0	2.0	98	0.01

VERTICAL SECTION THROUGH
CORE DRILL HOLE NO.4-R
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA

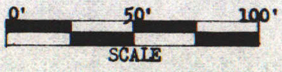
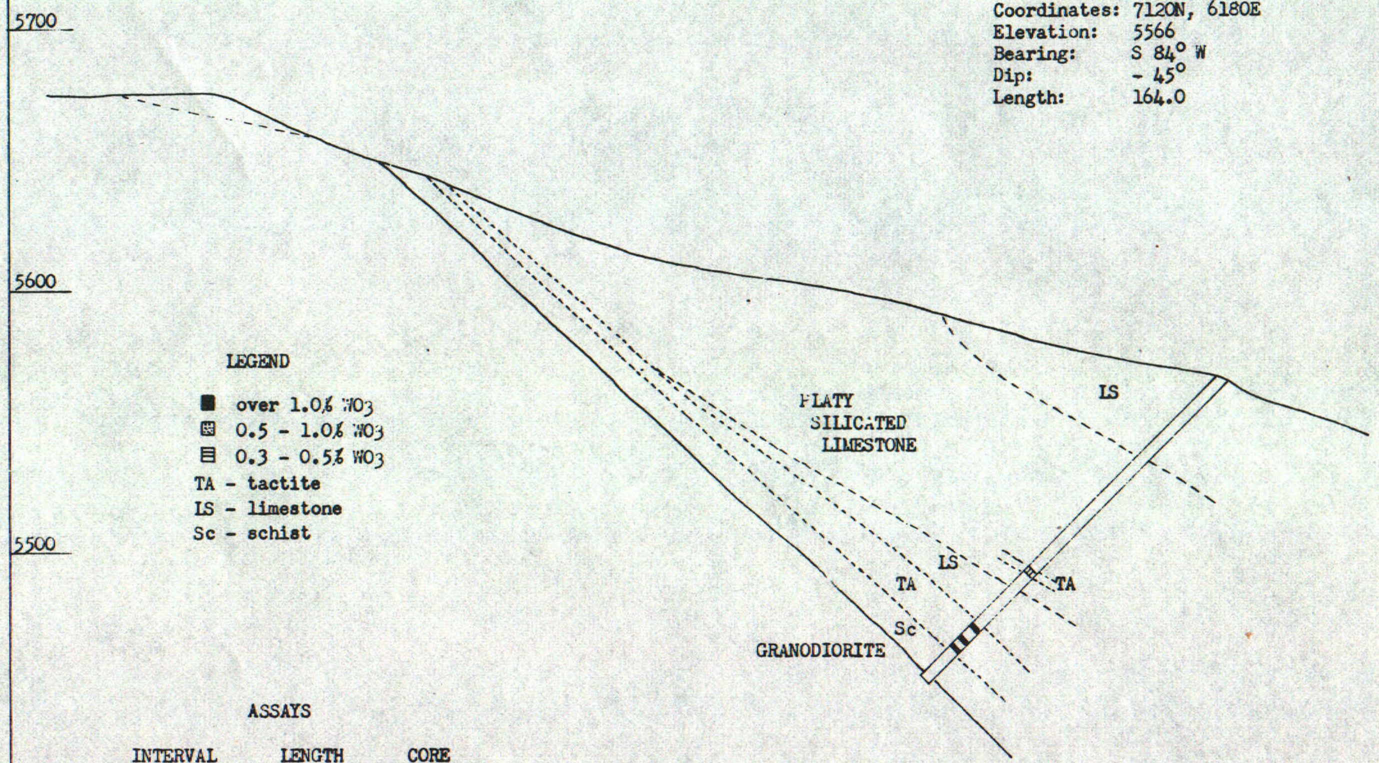


Figure 5

HOLE NO.5-R

Coordinates: 7120N, 6180E
Elevation: 5566
Bearing: S 84° W
Dip: - 45°
Length: 164.0



ASSAYS

INTERVAL		LENGTH	CORE	
From	To	Feet	%Rec.	%WO_3
104.8	106.6	1.8	94	0.36
134.2	135.4	1.2	96	0.16
135.4	136.0	0.6	96	1.50
136.0	138.1	2.1	88	0.21
138.1	141.0	2.9	88	0.01
141.0	143.0	2.0	96	1.12
143.0	145.3	2.3	96	0.04
145.3	146.6	1.3	67	1.42
146.6	148.0	1.4	34	0.01

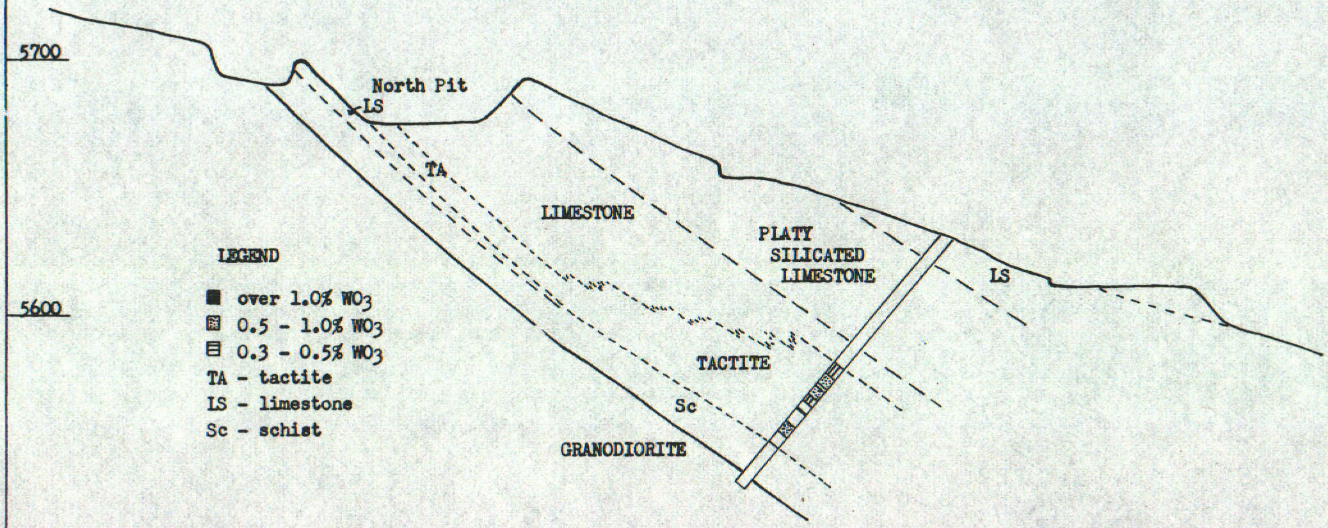
VERTICAL SECTION THROUGH
CORE DRILL HOLE NO.5-R
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA

0' 50' 100'
SCALE

Figure 6

HOLE NO.6-R

Coordinates: 7292N, 6008E
Elevation: 5632
Bearing: S 82° W
Dip: - 50°
Length: 127.0



ASSAYS

INTERVAL From	To	LENGTH Feet	CORE %Rec.	%WO3
65.8	71.7	5.9	90	0.34
71.7	76.0	4.3	90	0.88
76.0	77.2	1.2	100	0.27
77.2	82.0	4.8	100	0.70
82.0	85.0	3.0	100	0.44
85.0	88.3	3.3	100	0.12
88.3	88.7	0.4	100	5.03
88.7	92.0	3.3	100	0.03
92.0	96.0	4.0	100	0.06
96.0	101.0	5.0	66	0.78
101.0	107.2	6.2	66	0.10

VERTICAL SECTION THROUGH
CORE DRILL HOLE NO.6-R
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA

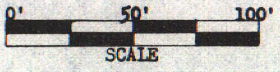
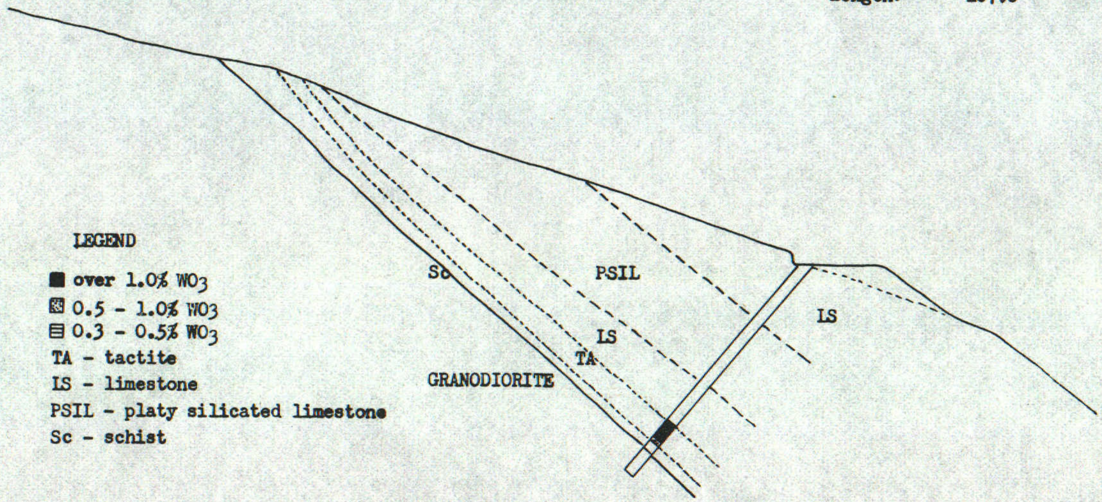


Figure 7



HOLE NO.7-R

Coordinates: 7478N, 5926E
Elevation: 5645
Bearing: S 80° W
Dip: - 50°
Length: 107.0

LEGEND

- ■ over 1.0% WO_3
- 0.5 - 1.0% WO_3
- 0.3 - 0.5% WO_3
- TA - tactite
- LS - limestone
- PSIL - platy silicated limestone
- Sc - schist

ASSAYS

INTERVAL		LENGTH	CORE	
From	To	Feet	%Rec.	%WO_3
80.1	82.9	2.8	83	1.15
82.9	84.3	1.4	83	1.75
84.3	85.3	1.0	53	1.40
85.3	90.0	4.7	53	1.56
90.0	91.0	1.0	53	0.69

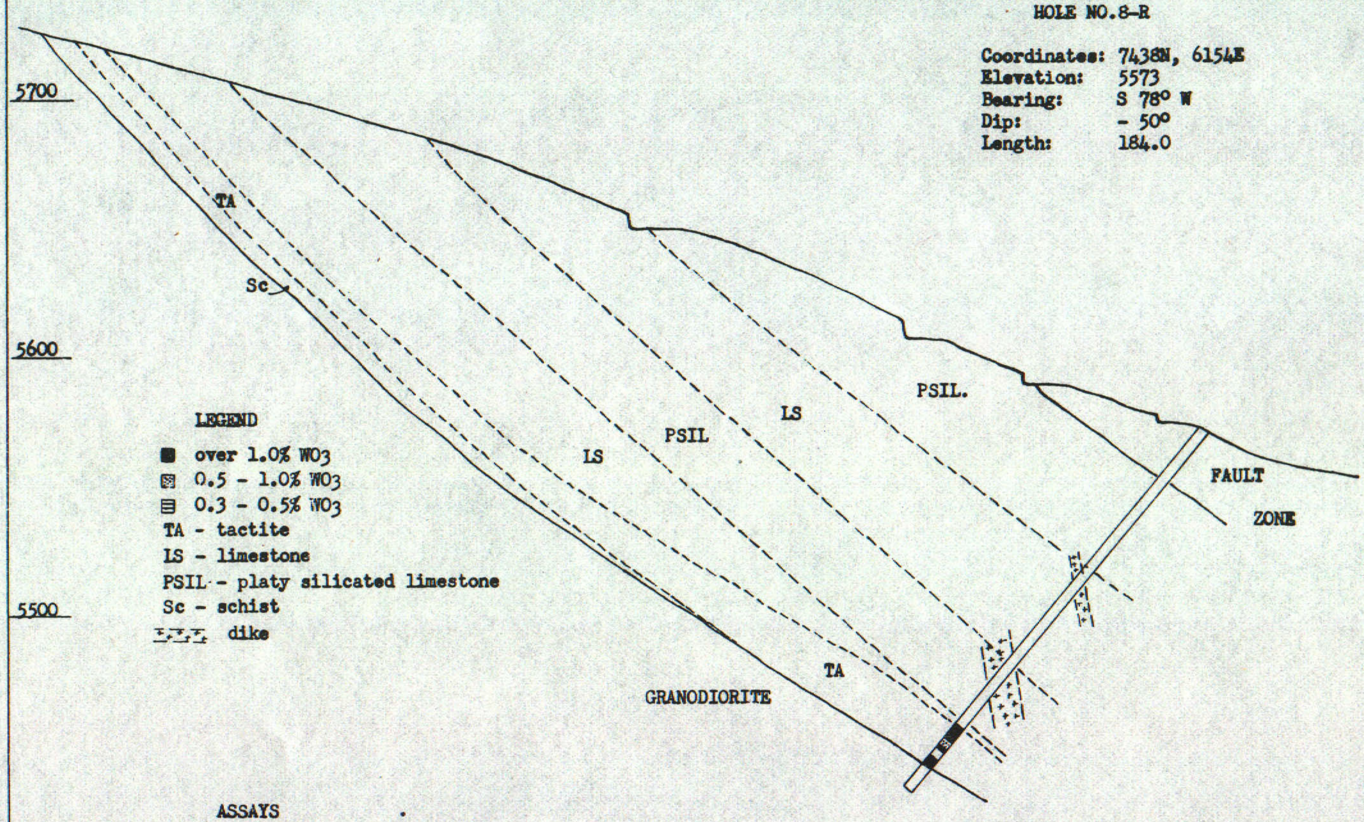
VERTICAL SECTION THROUGH
CORE DRILL HOLE NO.7-R
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA

0' 50' 100'
SCALE

Figure 8

HOLE NO. 8-R

Coordinates: 7438N, 6154E
Elevation: 5573
Bearing: S 78° W
Dip: - 50°
Length: 184.0



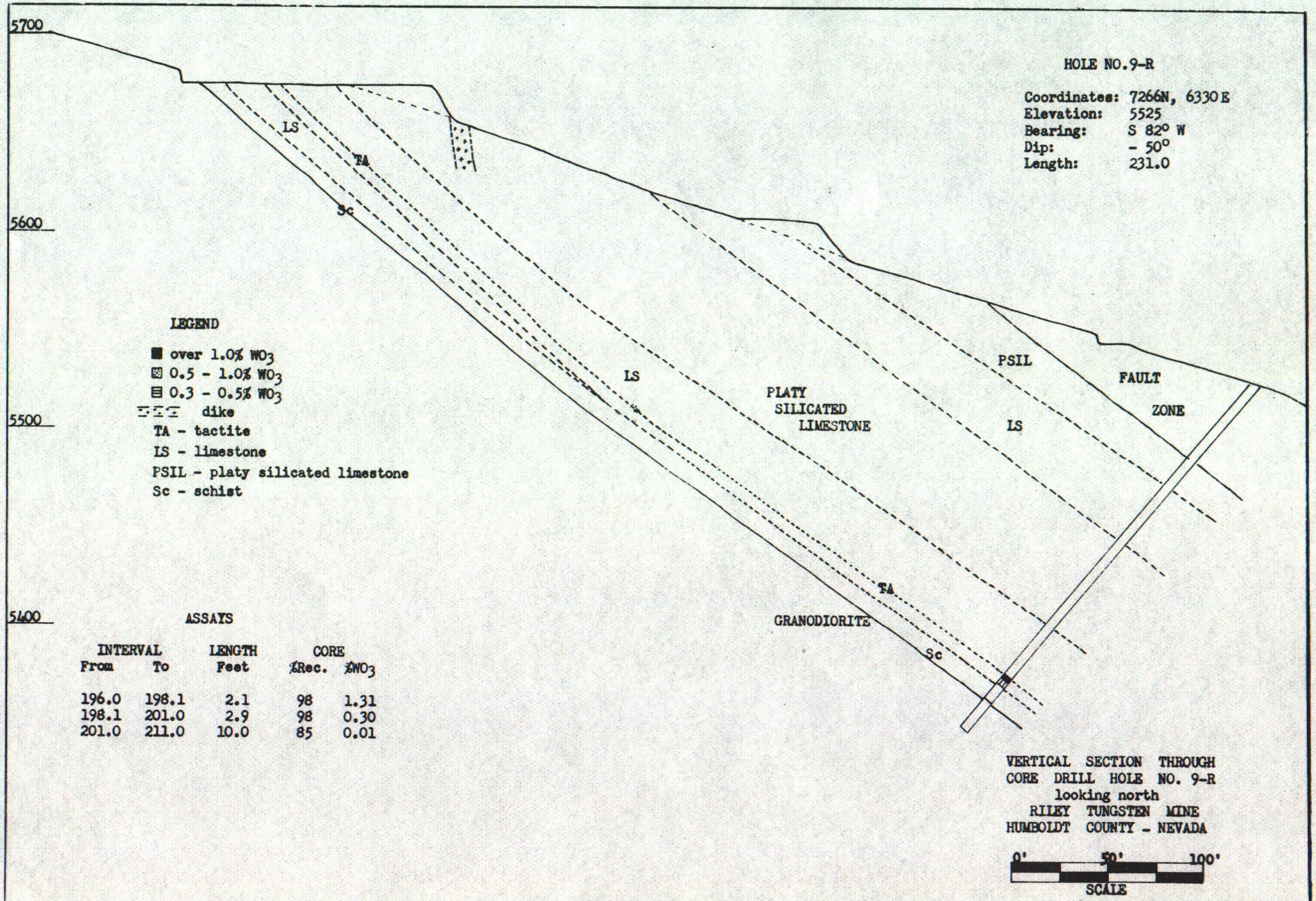
ASSAYS

INTERVAL From	To	LENGTH Feet	CORE %Rec.	%WO3
151.6	153.6	2.0	98	1.32
153.6	155.4	1.8	97	1.00
155.4	156.5	1.1	97	0.96
156.5	157.3	0.8	97	2.29
157.3	161.2	3.9	97	0.59
161.2	161.9	0.7	97	2.25
161.9	167.3	5.4	100	0.05
167.3	169.8	2.5	100	2.23
169.8	171.6	1.8	100	0.01

VERTICAL SECTION THROUGH
CORE DRILL HOLE NO. 8-R
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA

0' 50' 100'
SCALE

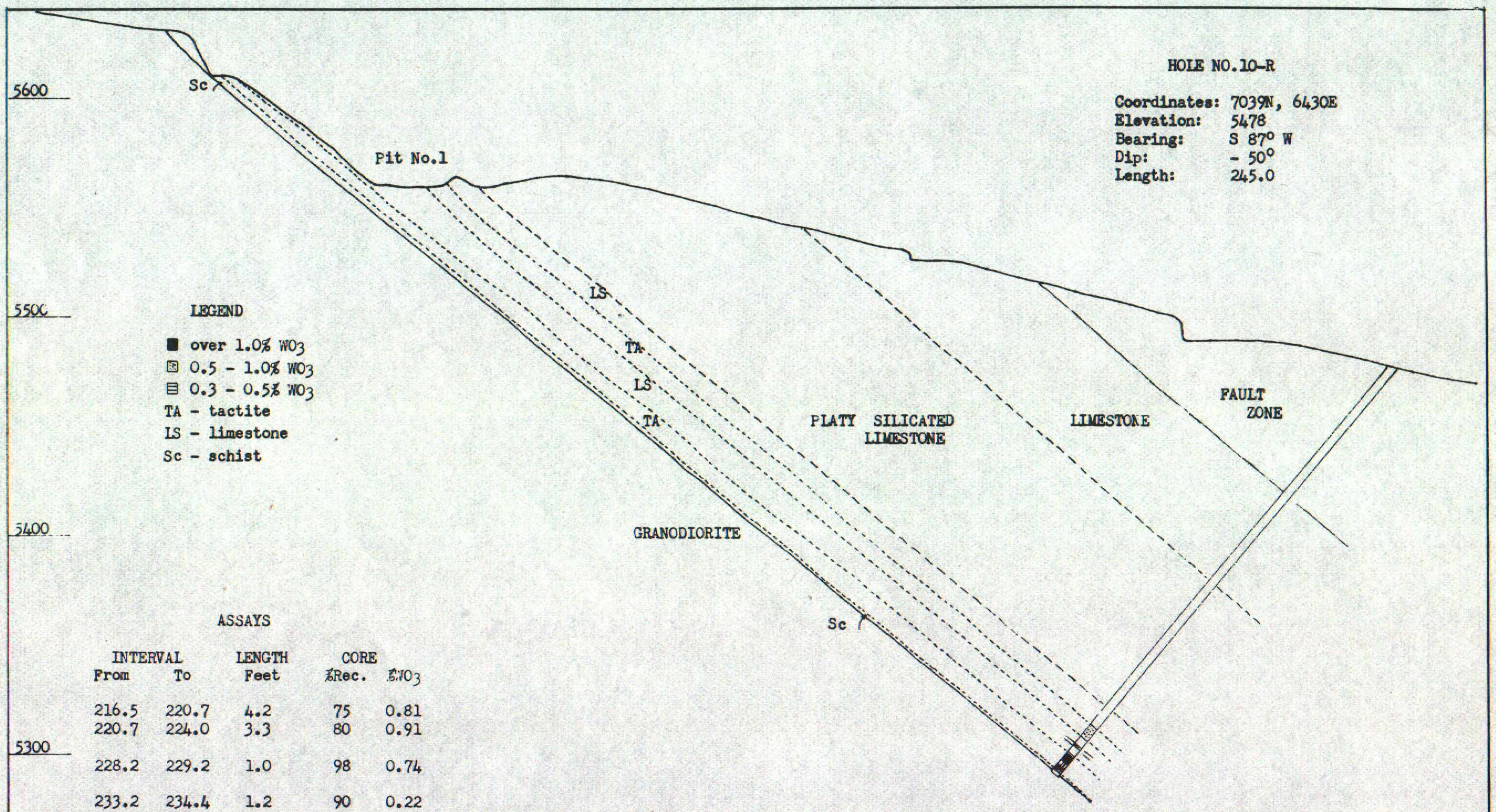
Figure 9



ASSAYS

INTERVAL From	INTERVAL To	LENGTH Feet	CORE %Rec.	CORE $\%WO_3$
196.0	198.1	2.1	98	1.31
198.1	201.0	2.9	98	0.30
201.0	211.0	10.0	85	0.01

Figure 10

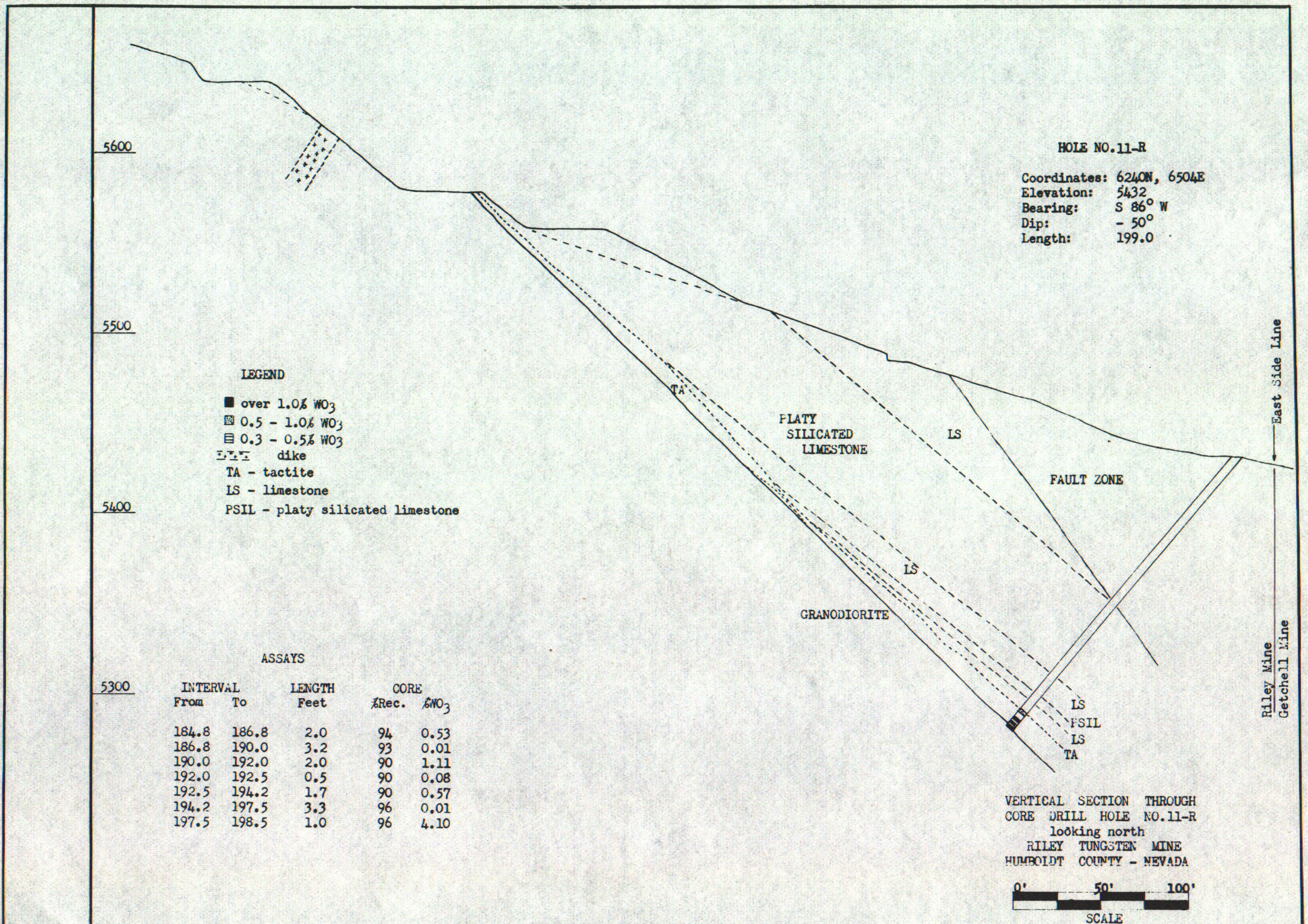


ASSAYS

INTERVAL From	To	LENGTH Feet	CORE %Rec.	%WO3
216.5	220.7	4.2	75	0.81
220.7	224.0	3.3	80	0.91
228.2	229.2	1.0	98	0.74
233.2	234.4	1.2	90	0.22
234.4	238.3	3.9	80	1.16
238.3	241.3	3.0	76	0.40
241.3	242.0	0.7	70	6.53
242.0	243.0	1.0	70	0.64

VERTICAL SECTION THROUGH
CORE DRILL HOLE NO.10-R
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA

Figure 11



INTERVAL From	INTERVAL To	LENGTH Feet	CORE %Rec.	CORE $\%WO_3$
184.8	186.8	2.0	94	0.53
186.8	190.0	3.2	93	0.01
190.0	192.0	2.0	90	1.11
192.0	192.5	0.5	90	0.08
192.5	194.2	1.7	90	0.57
194.2	197.5	3.3	96	0.01
197.5	198.5	1.0	96	4.10

Figure 12

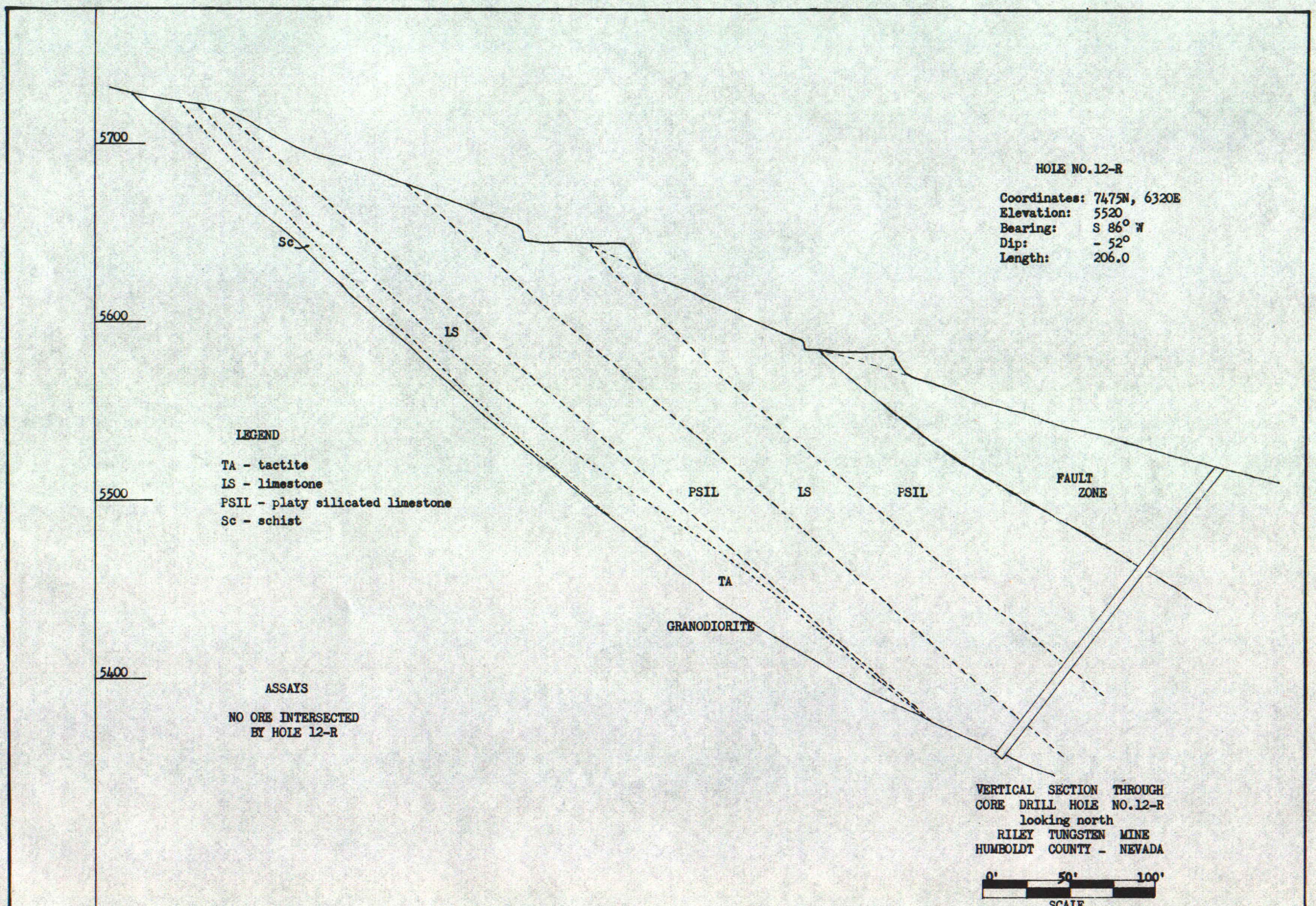

5700
5600
5500
5400
HOLE NO.12-R
Coordinates: 7475N, 6320E
Elevation: 5520
Bearing: S 86° W
Dip: - 52°
Length: 206.0
Sc
LS
PSIL
LS
PSIL
FAULT ZONE
TA
GRANODIORITE
LEGEND
TA - tactite
LS - limestone
PSIL - platy silicated limestone
Sc - schist
ASSAYS
NO ORE INTERSECTED BY HOLE 12-R
VERTICAL SECTION THROUGH CORE DRILL HOLE NO.12-R
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA
0'
50'
100'
SCALE

Figure 13

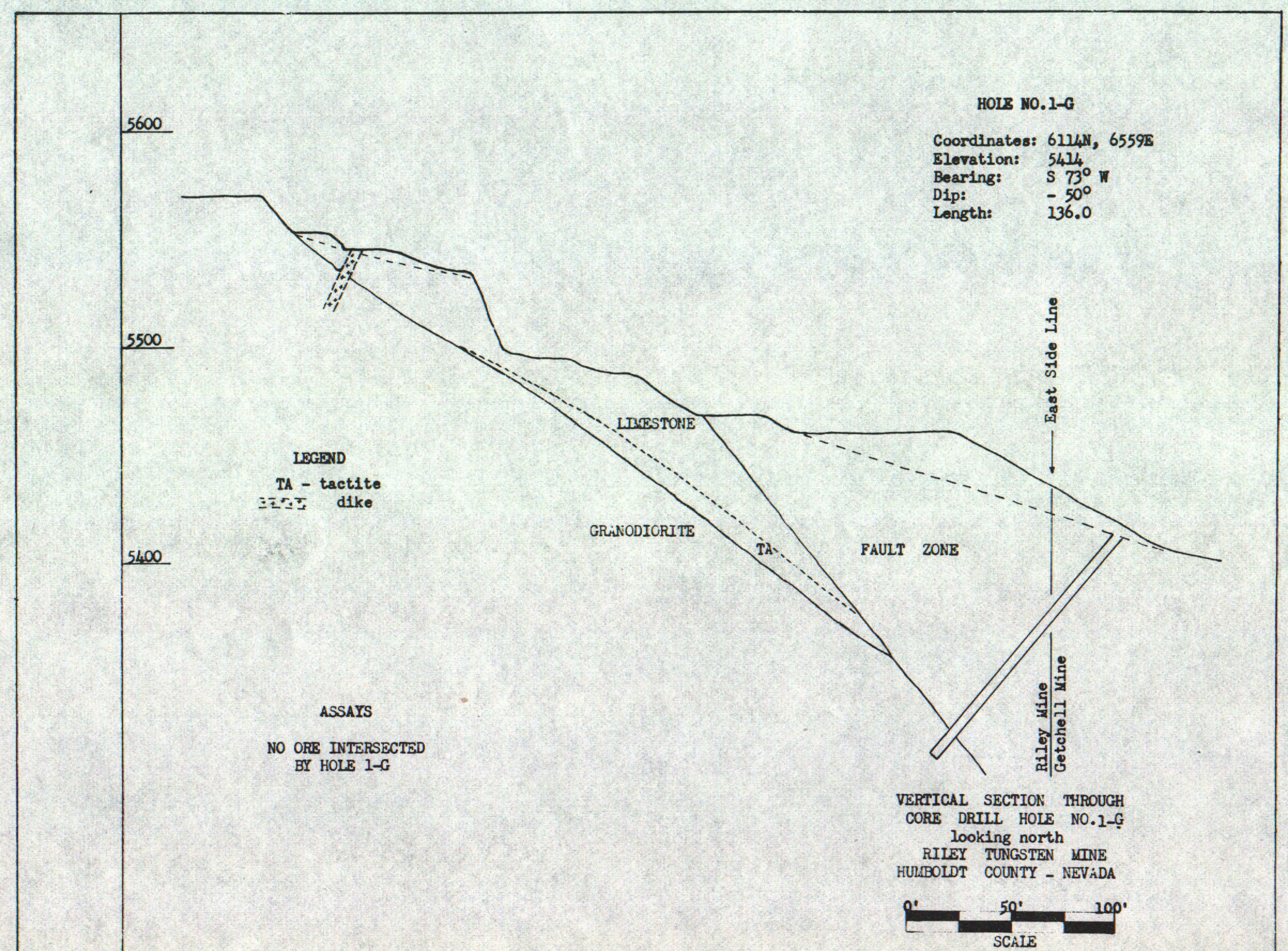

HOLE NO.1-G
Coordinates: 6114N, 6559E
Elevation: 5414
Bearing: S 73° W
Dip: - 50°
Length: 136.0
5600
5500
5400
LIMESTONE
GRANODIORITE
TA
FAULT ZONE
East Side Line
Riley Mine
Getchell Mine
LEGEND
TA - tactite
dike
ASSAYS
NO ORE INTERSECTED
BY HOLE 1-G
VERTICAL SECTION THROUGH
CORE DRILL HOLE NO.1-G
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA
0'
50'
100'
SCALE

Figure 14

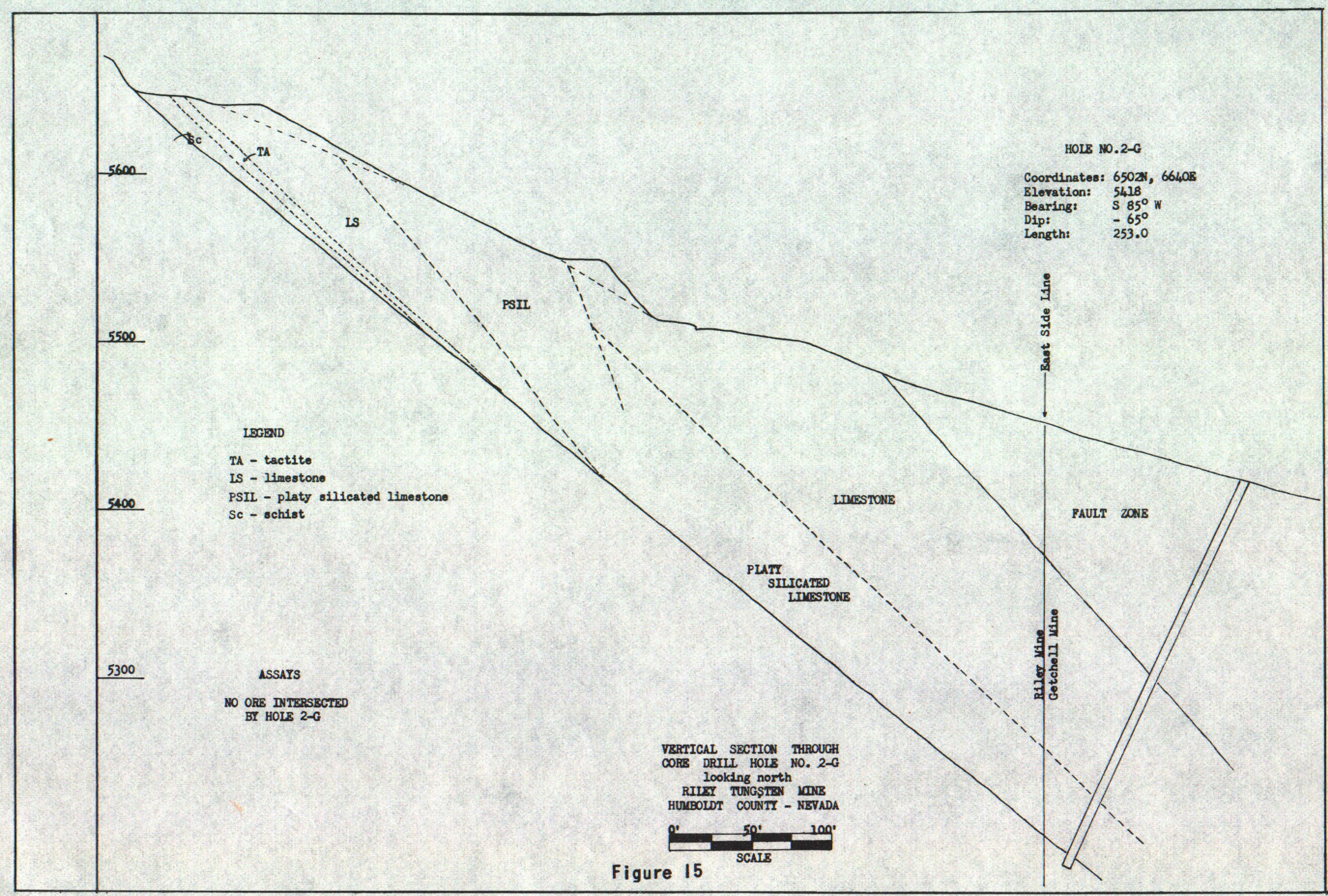

5600
5500
5400
5300
Sc
TA
LS
PSIL
HOLE NO.2-G
Coordinates: 6502N, 6640E
Elevation: 5418
Bearing: S 85° W
Dip: - 65°
Length: 253.0
East Side Line
LEGEND
TA - tactite
LS - limestone
PSIL - platy silicated limestone
Sc - schist
LIMESTONE
FAULT ZONE
PLATY
SILICATED
LIMESTONE
ASSAYS
NO ORE INTERSECTED
BY HOLE 2-G
Riley Mine
Getchell Mine
VERTICAL SECTION THROUGH
CORE DRILL HOLE NO. 2-G
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA
0'
50'
100'
SCALE

Figure 15

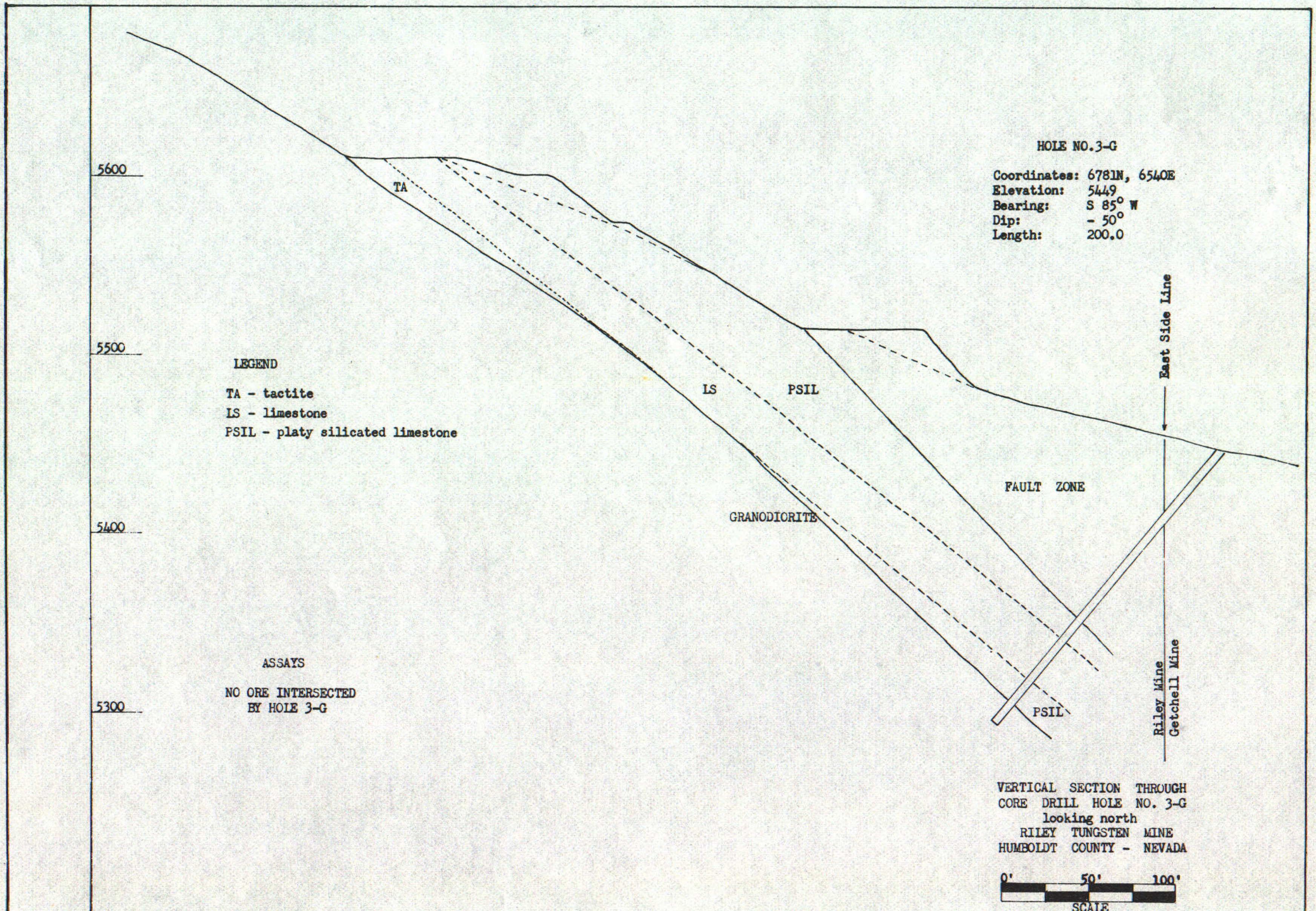

5600
5500
5400
5300
TA
LS
PSIL
HOLE NO.3-G
Coordinates: 6781N, 6540E
Elevation: 5449
Bearing: S 85° W
Dip: - 50°
Length: 200.0
East Side Line
LEGEND
TA - tactite
LS - limestone
PSIL - platy silicated limestone
FAULT ZONE
GRANODIORITE
ASSAYS
NO ORE INTERSECTED
BY HOLE 3-G
PSIL
Riley Mine
Getchell Mine
VERTICAL SECTION THROUGH
CORE DRILL HOLE NO. 3-G
looking north
RILEY TUNGSTEN MINE
HUMBOLDT COUNTY - NEVADA
0'
50'
100'
SCALE

Figure 16

Drill holes 1-R, 2-R, and 11-R explored the tactite zones below pits 2 and 3 to depths ranging from 290 to 500 feet down dip of the zone. These three holes intersected scheelite-bearing tactite.

Hole 1-G, drilled to cut the downward extension of the ore shoot exposed in pit 4, failed to intersect ore.

Holes 2-G, 3-G, and 3-R explored the area below pits 1-B and 1-G at depths ranging from 325 to 700 feet down dip of the mineralized zone. No ore was intersected by these three holes.

Hole 4-R, designed to explore for the downward extension of the ore shoot exposed in pit 1-A, intersected scheelite-bearing tactite at 240 feet down dip below the bottom of the pit.

Holes 5-R, 6-R, 7-R, 8-R, 9-R, 10-R, and 12-R explored the north area of the Riley property under pit 1 and the upper pit. Ore was intersected in all but hole 12-R at depths ranging from 200 to 490 feet down the dip of the zone. Hole 12-R, drilled to the granodiorite, failed to intersect ore.

Results of the project work proved the downward continuity of the ore shoots in the upper pit-No. 1 area, the No. 1-No. 1-A pit area, and the No. 2-No. 3 pit area. Drilling indicated the existence of a barren zone below pits 1-B and 1-C and extending laterally from pit 2 to pit 1-A. Bureau work also proved that the Getchell fault zone cuts off the ore below pit 4.

Abnormal drilling difficulties were experienced in the Getchell fault zone. The soft fault gouge would squeeze and close the hole, and methods had to be devised to keep the hole open. Cementing was done through the rods at short intervals but slowed drilling progress considerably. The fastest and most effective method of boring through the fault zone was to use an AX saw-tooth bit, penetrate the fault for about 5 feet, and then drive the AX casing down over the rods and bit. This was repeated until limestone was reached. Diamond cutting bits proved ineffectual in this ground, as excessive loss resulted when the rapidly rotating bit struck fragments of argillite enclosed in the softer fault material.

No abnormal difficulties were experienced when drilling through the limestone and tactite.