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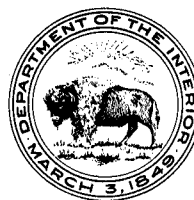
INVESTIGATION OF THE TEM PIUTE TUNGSTEN DEPOSIT
LINCOLN COUNTY, NEV.

BY E. O. BINYON, G. H. HOLMES, JR., AND A. C. JOHNSON

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UNITED STATES DEPARTMENT OF THE INTERIOR

Oscar L. Chapman, Secretary

BUREAU OF MINES

James Boyd, Director

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INVESTIGATION OF THE TEM PIUTE TUNGSTEN DEPOSIT,
LINCOLN COUNTY, NEV.

by

E. O. Binyon,^{1/} G. H. Holmes, Jr.,^{1/} and A. C. Johnson^{2/}

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^{1/} Mining engineer, Reno Branch, Mining Division, Bureau of
Mines, U. S. Department of the Interior.

^{2/} Chief, Reno Branch, Mining Division, Bureau of Mines, U. S.
Department of the Interior.

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INTRODUCTION AND SUMMARY

The tungsten properties of Lincoln Mines, Inc., and North Tem Piute Mining and Development Co. were first explored by the Bureau of Mines in 1942. Work on the project comprised trenching, sampling, a small amount of road and trail construction, and a small amount of core drilling. From April 13 to December 10, 1944, additional diamond drilling was done by the Bureau of Mines to test the lateral and downward extensions of the various tactite zones along the contact south of the Lincoln mine, including the property of the North Tem Piute Mining & Development Co.

Claims leased by the Lincoln Mines, Inc., are in secs. 25 and 36, T. 3 S., R. 56 E.; secs. 30 and 31, T. 3 S., R. 57 E.; and sec. 1, T. 4 S., R. 56 E., M. D. B. & M., in the Tem Piute Mining District, near the north end of the Timpahute Range in west central Lincoln County, Nev. D. B. Fegles is president of Lincoln Mines, Inc. and general offices are in the Wesley Temple Building, Minneapolis, Minn.

In June 1945, the Atolia Mining Co. leased the property and purchased the mill and mining equipment from Lincoln Mines, Inc. P. R. Bradley is president of the Atolia Mining Co., whose offices are in the Crocker Building, San Francisco, Calif. This company surrendered the lease on the property on September 30, 1948. The property owners are continuing operations and are now engaged in building a 20-ton mill.

The claims of the North Tem Piute Mining & Development Co. are in sec. 1, T. 4 S., R. 56 E., M. D. B. & M. Merle F. Schofield is president of the company and maintains an office at Hiko, Nev. These claims were leased by H. P. Laslett, of the Utah-Nevada Mining Co., in 1945 and by the Atolia Mining Co. in 1946. The owners are now doing some exploratory work.

Caliente, Nev., 90 miles east of the district and on the main line of the Union Pacific Railroad and U. S. Highway 93, is the nearest supply center (fig. 1). The postoffice for the Tem Piute district is Hiko, and the nearest telephone service is at Alamo, Nev., both small farming communities in the Pahrangat Valley, 50 and 65 miles, respectively, to the southeast. A good dirt road, which leaves U. S. Highway 93 about 40 miles west of Caliente, extends to the properties. The section of this desert road that continues west to Tonopah, through an area used for an army air force bombing range, has been closed by the Government.

Project work comprised trenching, core drilling, and sampling. Fourteen diamond-drill holes having a total length of 4,347 feet were drilled.

ACKNOWLEDGMENTS

Acknowledgment is made to Glen L. Allen, former district engineer, Reno, Nev., and to Dwight M. Lemmon and Donald G. Wyant, of the U. S. Geological Survey, for their assistance in the project work.

Acknowledgment is also made to A. C. Rice and staff of the Rare and Precious Metals experiment station, Reno, Nev., for analyses of samples from the project, and to R. S. Dean, C. H. Schack, H. G. Poole, R. E. Head, W. C. Tondell, and Lamar Evans, of the Metallurgical Division, Salt Lake City, for metallurgical test work on the ore.

OWNERSHIP

The property, which was operated by Lincoln Mines, Inc., and the Atolia Mining Co. under lease, comprises 28 claims owned equally by George Thiriot, Dean Thiriot, Eva Koyen, and Wesley Koyen, except a one-eighth interest in the Scheelite claim, which is owned by Winifred Green.

Adjoining the Lincoln Mines on the south are the 40 claims owned by North Tem Piute Mining & Development Co., a Nevada corporation. M. R., W. W., D. K., E. V., and T. T. Schofield are the principal stockholders. This property was under lease to H. P. Laslett, Utah-Nevada Tungsten Co. in 1945 and to the Atolia Mining Co. in 1946.

HISTORY

Between 1868 and the 1870's,^{3/} and again in the 1920's silver ore was mined in the old Tem Piute District, which is on the west side of the Timpahute Range. The Millick brothers first discovered scheelite in the district in 1916, but did not explore the deposits extensively. In 1936 Wesley Koyen located two claims, which he worked intermittently until 1937, at which time, with G. W. Thiriot, D. F. Thiriot, and Winifred Green, he located 16 additional claims to cover the contact zone. A small milling plant, comprising a ball mill and a Wilfley table and powered by a gasoline motor, was built at Black Rock, 15 miles west of the mine. About 250 tons of ore was treated in this mill. The ore was mined from short adits driven along the Grubstake and Moody ore zones and produced a concentrate that was sold for \$3,200.

Early in 1938 the property was leased to C. L. Baker and A. K. McFarlane. This lease was assigned to J. G. Barry, of El Paso, Tex., who, in turn, transferred it to D. B. Fegles of the Fegles Construction Co., Minneapolis, Minn. Construction of a 40-ton mill was started in 1939, and mill operations commenced in February 1940 by Lincoln Mines, Inc. Capacity of the mill was increased to 75 tons in 1941.

The Atolia Mining Co., San Francisco, Calif., acquired the lease in June 1945 and operated the property until September 30, 1948. During 1946 the mining and milling plants were rehabilitated. The property owners are continuing operations and are now engaged in building a 20-ton mill.

^{3/} F. C. Lincoln, "Mining Districts and Mineral Resources of Nevada", 1923.

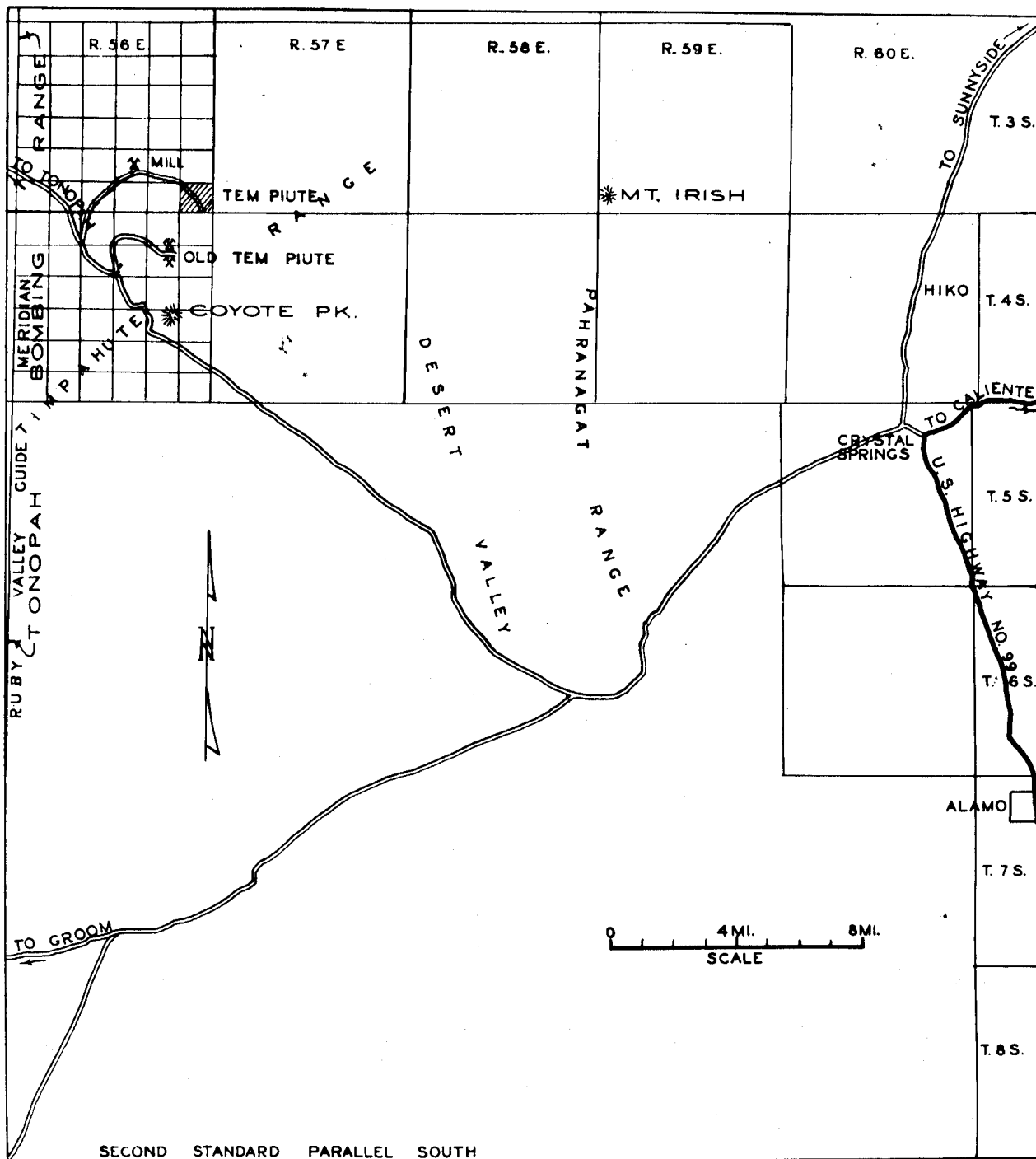


Figure 1. - Location map, Tem Piute tungsten deposits, Lincoln County, Nev.

This property has been the largest producer in the district. Total production to date has come from the main mine workings, which are situated at the north end of the contact zone. Development along the contact zone southward from the mine workings consists of short adits and a few small open cuts and trenches.

The Schofield brothers located their first claims in 1920 and in June 1937 incorporated the North Tem Piute Mining & Development Co. Little systematic development has been done, and the contact zone has been explored only by shallow trenches, open cuts, several short adits, and two drifts. The property is not being operated at present.

About one-fourth mile southwest of the Atolia Mining Co.'s mill, the North Tem Piute Co. built a small concentrator, comprising a jaw crusher, ball mill, and concentrating table, all powered by a gasoline motor. No records are available of the small tonnage treated in this plant, but the equipment proved inadequate.

The property was leased to F. A. Kennedy and associates in 1941; a short adit was driven across the contact zone, and an open cut was excavated. In 1942 the property was optioned to A. L. Merritt of San Francisco, and a lease was given in November 1944 by the North Tem Piute Co. to H. P. Laslett, of the Utah-Nevada Tungsten Co. Little work was done by these lessees. The Atolia Mining Co. leased the property in 1946 and drove two short drifts along the contact zone.

PHYSICAL FEATURES

The mine and camp of the Atolia Mining Co. are on the east slope of the Timpahute mountains near the north end of the range. This mountain range is approximately 5 miles long and has a northerly trend. The relief of this area is fairly rugged, extending from 5,000 feet at the base of the range to 7,100 feet at the crest. Altitude at the Lincoln mine is 6,350 feet, and southward on the North Tem Piute property the altitude increases to 6,750 feet. The Atolia mill is 5 miles west of the mine near the edge of a dry lake at an altitude of about 4,000 feet.

No surface water is found along the contact zone or near the Lincoln mine, but approximately 2,000 gallons are pumped daily from the mine's 4th level. This water formerly flowed to waste, but it is now being impounded for use at the mine. Flow from the 203-foot cased well in the Lincoln mill is 110 to 125 gallons per minute, which is adequate for milling requirements and camp needs. Two cased wells, 78 and 125 feet deep, adjacent to the North Tem Piute Mining & Development Co. mill, are reported to flow 15 to 50 gallons per minute, respectively.

The climate varies from hot, dry summers to moderately cold winters. Heavy snow during winter months has forced curtailment of production in the past few years. Scrub pine, juniper, and cedar grow in the district but are not suitable for mine use.

Freight and express shipments are handled through Caliente, Nev., a division point on the main line of the Union Pacific Railroad. Mail is delivered daily to Hiko, a postoffice 50 miles southeast of the Lincoln mine, and telephone service is available at Alamo, a small farming center about 15 miles south of Hiko. A graded dirt road connects the Lincoln mill with Hiko, and U. S. Highway 93 extends easterly from Hiko to Caliente. All supplies must be trucked from Caliente or Alamo to the mine. The nearest electric transmission lines are at Alamo, 65 miles distant.

LABOR AND LIVING CONDITIONS

The camp, established by the Atolia Mining Co., comprises 12 one-room cabins, each of which can accommodate one or two men; 19 large cabins for men with families; a boarding house; and a school. Electricity at the camp was supplied by a 16-kw. Diesel generator. The company supplied fuel for heating and water for domestic use. The boarding house was company-operated and furnished a good board at \$2.50 per day.

The school is for children of elementary grades and is under the supervision of an accredited teacher. Children of high-school age attend the school at Alamo.

Prior to 1942, adequate labor was available from the small surrounding farm communities, but at present this source supplies only a few men. It is necessary to obtain men from Ely, Las Vegas, or Tonopah. The labor turnover is high, and it is difficult to maintain an adequate crew.

Prevailing wage rate was \$1.25 hourly for miners, with time and one-half paid for all work over 40 hours weekly.

GEOLOGIC SUMMARY^{4/}

The north end of the Tem Piute Range consists of folded and faulted Paleozoic limestone, hornfels, and quartzite invaded by two small granite stocks and by several narrow, short, basalt dikes.

The south granite stock is about a mile in diameter, the north stock about 4,000 feet. Although the two are separated at the surface by a belt of limestone and hornfels 600 feet wide, they probably join at shallow depth. The stocks are partly concordant with the invaded sedimentary rocks, especially on the west side; they form the core of a faulted dome in the sedimentary rocks. The beds dip away from the intrusives at angles of 45° to 85°, except at the north end, where they appear in places to dip into the intrusive at small angles. Hornfels is in contact with both stocks for more than half their perimeters. On the west side of the south stock, the basal hornfels has been cut away by granite, which is there in direct contact

^{4/} Excerpts from unpublished report, "Tungsten Deposits of the Tem Piute Range, Lincoln County, Nevada", by D. G. Wyant, U. S. Geol. Survey, January 1944.

with limestone. However, both stocks may be entirely surrounded by the basal hornfels at some point in depth.

On the west side of the south stock, the limestone adjoining the granite and that adjoining the second or platy hornfels have been partly altered by contact metamorphism to thick bodies of tactite in bands parallel to the bedding. The remaining limestone up to the upper hornfels has been bleached irregularly and locally recrystallized. Around the north stock, only a few narrow lenses of tactite have been found, principally on the northeast side, although the limestone is directly in contact with granite along other parts of the stock.

Near the intrusives, within the major block containing the tactite bodies, there are numerous minor faults that strike in different directions and have offsets not greater than a few feet. These minor faults cut across the sedimentary rocks and some tactite and are in places mineralized with seams of scheelite, fluorite, and sphalerite. The faults appear to have been important controls for mineralization.

DESCRIPTION OF THE DEPOSIT ^{5/}

Most of the tactite in the area is scheelite-bearing ***.

The principal ore deposits occur in the bands and isolated pods of tactite adjacent to the granite on the west side of the south stock. The tactite bodies exposed around the north stock are narrow and discontinuous, although one series of lenses on the northeast side has a total length of 400 feet and averages 1 to 2 feet in width. However, these tactite zones contain too little scheelite to be economically significant.

The minerals observed in the tactite are listed in the approximate order of their abundance: garnet (andradite to grossularite, almandine), quartz, limonite, actinolite, calcite, fluorite, pyrite, pyrrhotite, diopside, sphalerite, scheelite, chlorite, hematite, clinozoisite, epidote, molybdenite, powellite, jarosite (?), and bismuthinite (?). The scheelite is buff to white; it fluoresces pale yellow to white in ultraviolet light, indicating that it contains a small amount of molybdenum.

Small lenses of both glassy and crystalline quartz occur in the tactite and in the limestone. Brecciated quartz is present at many places along the contact between the tactite and the granite, and quartz veins are common in the granite. Most of these veins contain limonite casts after pyrite. One quartz lens in the limestone contains a small amount of molybdenite and powellite.

^{5/} Excerpts from work cited in footnote 4.

The tactite bodies of the south stock are grouped into the following zones on the basis of their relative proximity to the granite: No. 1 or Moody zone, No. 2, No. 3, and No. 4 or Grubstake zone. The Moody zone, 6,200 feet long, with an average width of 40 feet, and the Grubstake zone, nearly 2,000 feet long, with an average width of 30 feet, are the only ones that had been explored or developed by the end of 1943.

The maximum relief of the ore zones is 500 feet. Tungsten mineralization appears to be relatively uniform and the attitude of the beds constant throughout this vertical distance. It seems probable that the tactite ore zones extend downward along the contact with the granite for a considerable depth. These zones have been only slightly explored, and further work is needed to determine the vertical extent of the ore bodies.

MINE WORKINGS AND PLANT, LINCOLN MINES

Scheelite ore has been mined underground from both the Grubstake and Moody ore zones. Mine workings comprise a 300-foot inclined shaft with four main levels, several sublevels, and stopes with connecting raises and winzes. These workings total about 5,800 feet of drifts and crosscuts and 1,900 feet of winzes and raises.

Stoping operations on the Grubstake zone have been limited to areas above the No. 1 or adit level. Two crosscuts from the Moody workings have cut the Grubstake zone on the second level. The Moody zone has been opened by the inclined shaft, which extends 35 feet below the fourth level and from which the second and third main levels were driven. The fourth level was opened from a winze sunk from the third level, and it was later connected with the Moody shaft. The 460 level was opened from the No. 3 winze sunk from the fourth level.

Plant buildings consist of wooden-frame structures covered with corrugated iron sheets that house the power plant, compressors, blacksmith shop, and mine hoist. One of two buildings of similar construction is used as a combination change house and storeroom, and the other as a mine office.

Compressed air was supplied by a 360-cubic foot stationary compressor and by two 210-cubic foot portable compressors. A 75-kw. Diesel generator supplied power for lights, the mine hoist, and the 60-lamp panel that charged the electric battery lamps used underground. Detachable rock drill bits were used. Repair work and drill steel shanking were done in the blacksmith shop, which was equipped with a coal forge, a small pneumatic sharpener, an acetylene welding outfit, and miscellaneous tools. Dulled detachable bits were sent to Salt Lake City for hot milling.

Hoisting was done by a 52-horsepower, electric, single-drum, geared hoist using 1-ton-capacity skips on skids. The main shaft is well-timbered and in good condition.

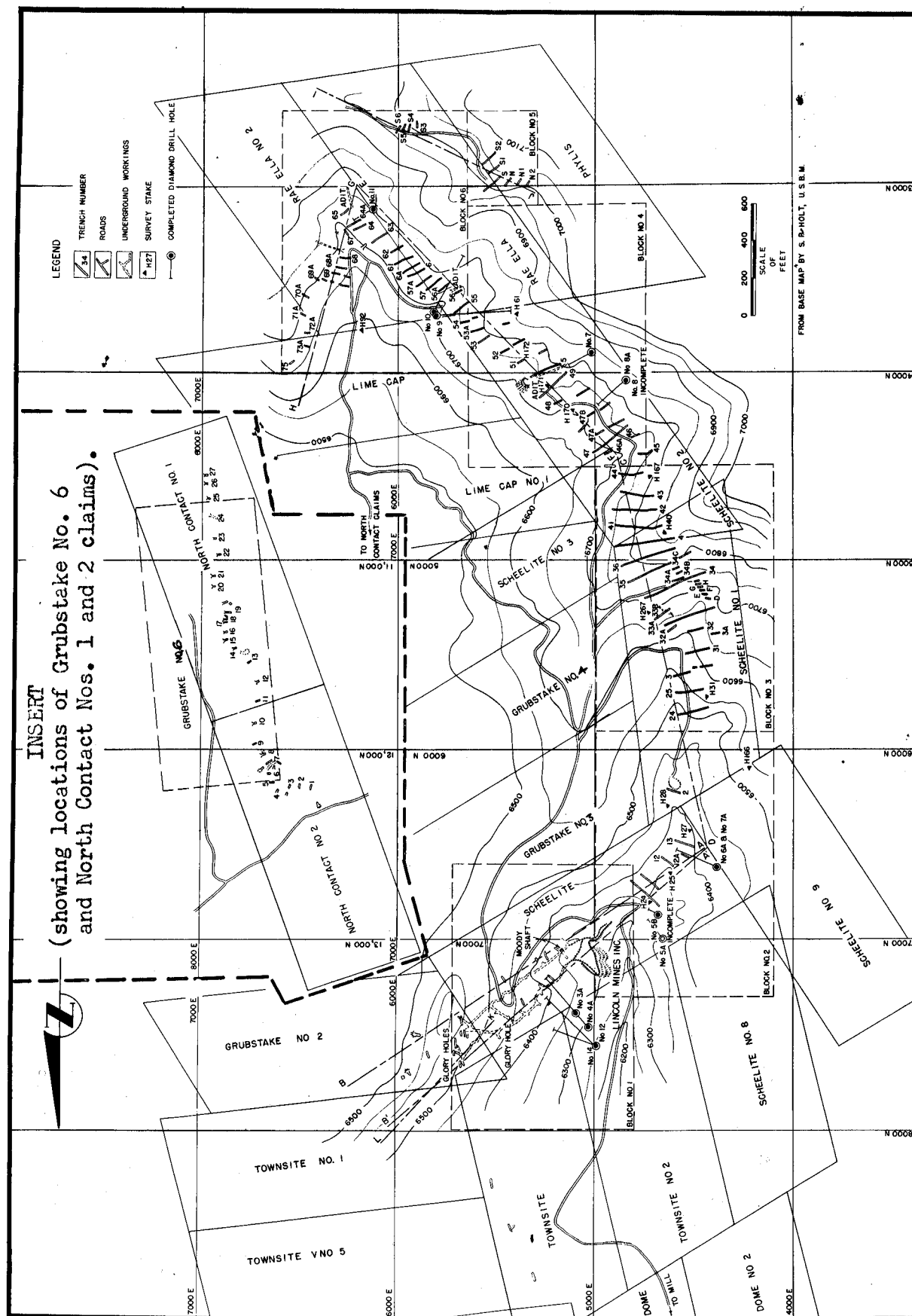


Figure 2. - Map showing topography and locations of mining claims, principal workings, trenches, and diamond-drill holes.

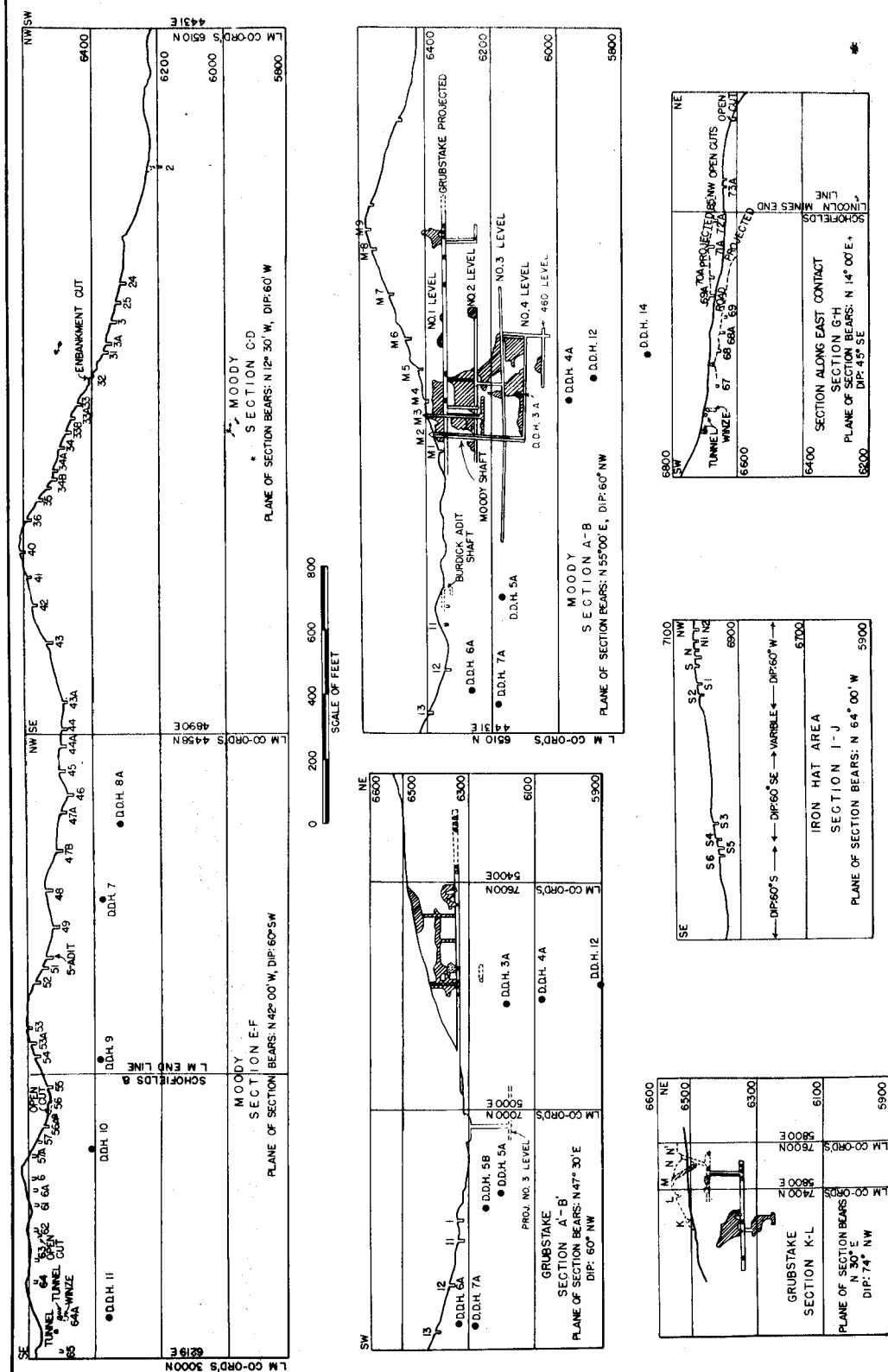


Figure 4. - Profiles and longitudinal sections, Tem Piute tungsten deposits.

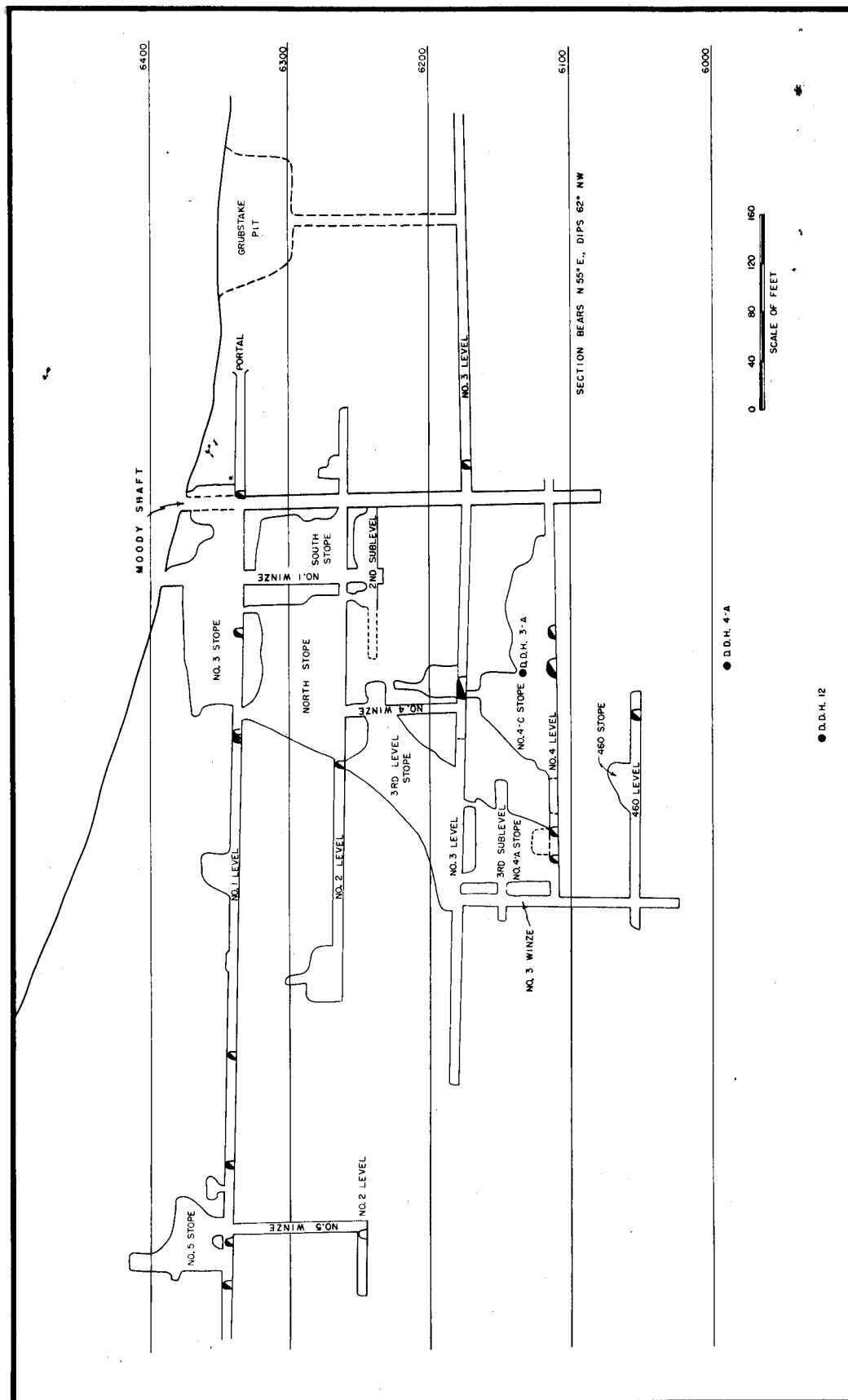
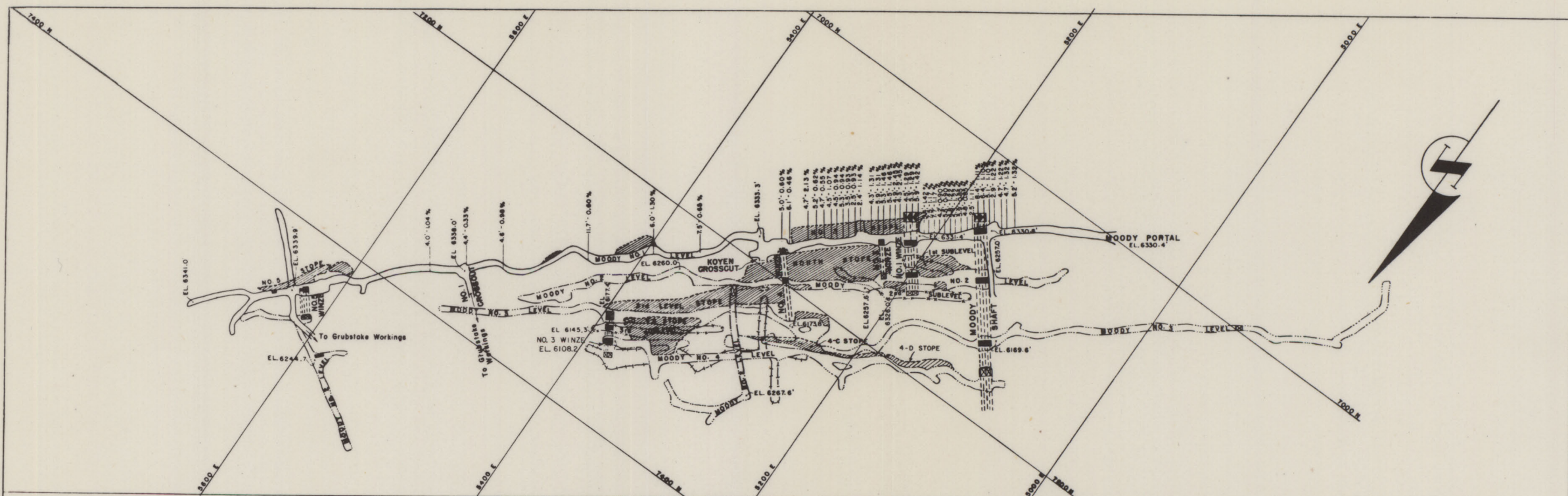
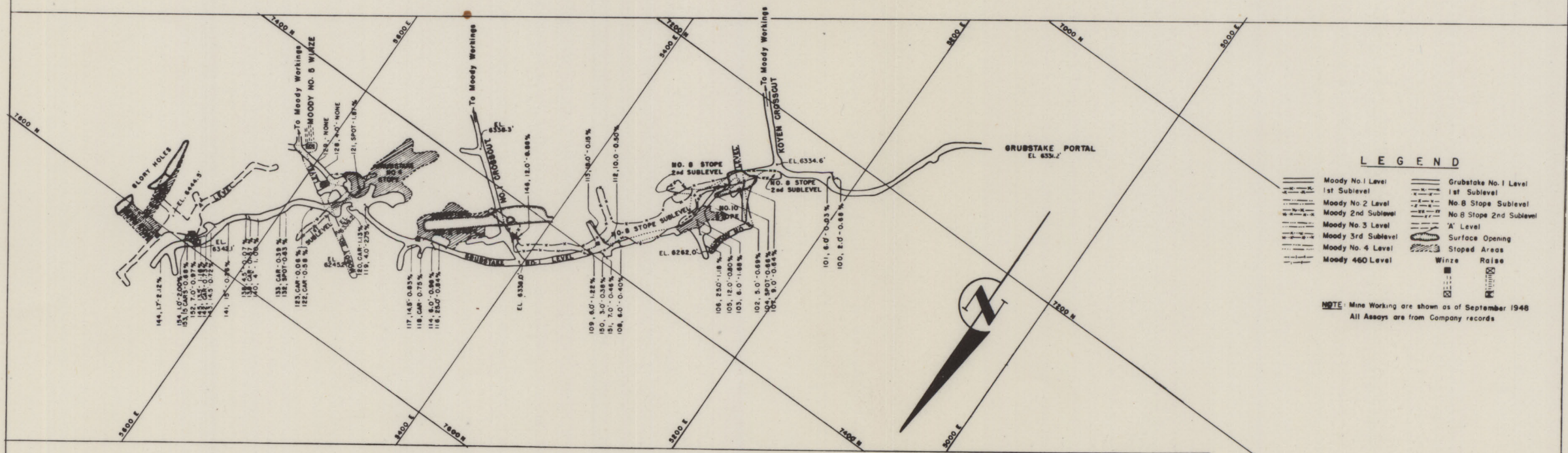


Figure 5. - Longitudinal section and plane of vein, Moody ore zone, Lincoln mine.



PLAN OF THE MOODY WORKINGS



PLAN OF THE GRUBSTAKE WORKINGS

Figure 3- Moody and Grubstake workings, Tem Piute tungsten deposits

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

The owners, Koyen and Thiriot, have purchased the mine hoist, compressor, and some of the rock drills and miscellaneous mining equipment from the Atolia Mining Co. Power will be supplied by a 75-kw. Diesel generator. Present plans are to continue production from the lower levels of the Moody ore zone.

No mining equipment of consequence was noted on the property of the North Tem Piute Mining & Development Co.

MINING METHODS

Two adits, about 100 feet apart, driven on the Grubstake and Moody ore zones, are roughly parallel and comprise the No. 1 Lincoln mine level (figs. 2 and 3).

Workings below the No. 1 level are reached through the Moody shaft, which has been sunk to a point 35 feet below the No. 4 level (figs. 4 and 5). The No. 4 level was worked from No. 3 winze, which was sunk from a point on No. 3 level about 325 feet north of the Moody shaft. This level was later connected with the Moody shaft. Prior to this connection, ore from the 4th level stopes was trammed to the No. 3 winze and dumped into a skip pocket, from which it was hoisted by skip and dumped into an ore pocket above the No. 3 level. It was then hand-trammed to the Moody shaft and hoisted by skip to an ore pocket above No. 1 level; thence, it was hand trammed from this pocket to the 3-compartment 100-ton surface ore bin and loaded into dump trucks for haulage to the mill.

The 460-level also was worked from the No. 3 winze. Ore from this level was handled in the same manner as ore from the No. 4 level.

The type of scheelite ore that has been mined by the company in the Moody ore zone occurs in lenses or shoots along the hanging wall of the ore zone. Remnants of residual marbleized limestone lie along the hanging wall of the ore zone between the tactite and overlying hornfels. The best grade of ore is found in lenses between the limestone and tactite. An ore shoot of this type, which was mined by the Lincoln Mines, Inc., ranged from 120 feet in length on the No. 1 level to 110 feet on the No. 3 level and 50 feet on the No. 4 level. It dipped 62 degrees to the northwest, raked about 55 degrees to the northeast, and ranged in width from 10 to 20 feet. Similar ore bodies were mined on the 4th and 460 levels. Lenses of hard, garnetized tactite and bands of scheelite-bearing sulfide underlie this ore, but as the mill is not equipped to handle high-sulfide and garnet ores, no attempt has been made to explore or mine them.

Principal mine development was north of the Moody shaft, although a drift was driven south for 360 feet along the contact on the No. 3 level, and a raise was driven to surface. The mine has been developed by drifts and crosscuts driven on and in the ore zone on the Nos. 1, 2, 3, and 4 levels. Subsequent development has been through winzes and sublevels.

Virtually no timber is required in drifting or crosscutting, as the ground stands well. Ore chutes are placed approximately on 10-foot centers, and stoping is by the shrinkage method.

No timber other than that used for raises is needed in the stopes. The ore shoots are crossed by minor pre-mineral faults and fractures, but little slabbing occurs, and no unusual difficulties have been encountered in shrinkage stoping. Stope 4-C on the 4th level averaged 65 feet in length and about 10 feet in width, although shrinkage stopes up to 120 feet in length and 20 feet in width have been worked successfully. Large horses of limestone were encountered in this stope. Stope 4-D averaged 100 feet in length and 20 feet in width.

Excessive handling of the ore was necessary between the 4th and 460 level stopes and the surface. This was due to the method of development, which was to follow the ore shoot at depth by winzes and drifts rather than by sinking the main shaft and developing the ore bodies by drifts driven from the shaft.

The fact that the best grade of ore occurs in shoots along the hanging wall of the tactite zone under the remnants of marbleized limestone justifies the development by drifts along the contact. In some instances, however, drifts have been driven closer to the footwall and even out in the hornfels hanging wall. Past mining operations show that the shrinkage method of stoping will be satisfactory in future stoping operations, although the cut and fill method should prove adaptable to stopes in which an appreciable amount of waste occurs.

Water in the mine causes little trouble. The mine makes about 2,000 gallons of water daily, which flows to a sump below the No. 3 winze. It is then pumped to the No. 3 level by a sump pump, flows by gravity through a pipe line to the Moody shaft, thence is raised up the Moody shaft to the surface by a second sump pump.

THE ORE

The two predominant ore zones in the mine area are known as the Grubstake, or hanging wall zone, and the Moody, or footwall zone. The Grubstake zone, overlain by silicified limestone and underlain by platy hornfels, is not continuous at depth and apparently bottoms a short distance below the Grubstake No. 1 or adit level. The Moody zone, separated from the Grubstake by an approximately 90-foot bed of platy hornfels, averages about 45 feet in thickness and is underlain by granite. This ore zone comprises the principal producing bed.

Three general types of scheelite-bearing tactite occur in the Moody zone, whereas in the Grubstake zone but one of these types occurs. Ore in this latter zone consists of hard tactite, principally garnet and quartz, and will average about 0.75 percent tungsten. Ore shoots in this zone, however, are sporadic in occurrence.

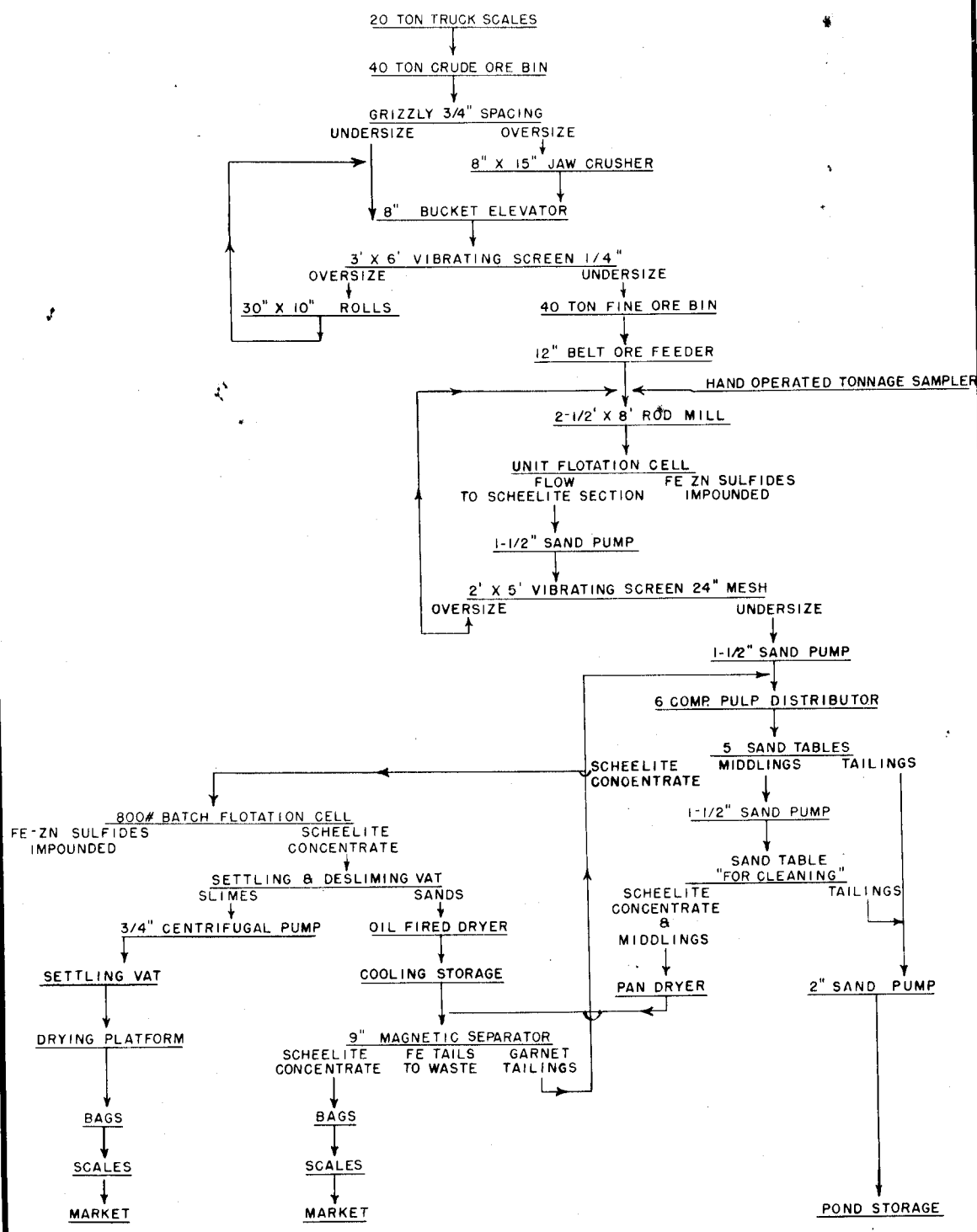


Figure 6. - Flow sheet for 75 ton concentrator, Lincoln Mines, Inc., December 1944.

The three classes of scheelite-bearing tactite that occur in the Moody zone are known as the iron-sulfide, garnet, and calcite-fluorite-chlorite types. The iron-sulfide type is a hard, dense ore in which the iron sulfides pyrrhotite and pyrite predominate. Garnet and quartz are present in smaller amounts. This ore occurs along the footwall of the zone for a thickness of 20 to 25 feet. The grade is usually low, 0.1 to 0.4 percent tungsten, although higher-grade bands 0.5 to 5.0 feet in thickness and 0.56 to 1.33 percent tungsten in grade, have been intersected by diamond-drill holes. The scheelite occurs as finely disseminated pin-point crystals.

The garnet-type ore lies above the iron-sulfide zone, between it and the hornfels hanging wall, and comprises the principal type of ore in the district. This ore is a dense, hard, crystalline tactite consisting principally of garnet, with smaller amounts of quartz, calcite, fluorite, and pyrite. Scheelite occurs in crystals from pin-point size to 1/4 inch in diameter, unevenly distributed throughout the ore shoots, which vary in grade from 0.3 to 1.0 percent tungsten. A general average, however, is about 0.5 percent tungsten. The tactite between the ore shoots probably will run between 0.1 and 0.2 percent tungsten. Zinc occurs as marmatite in the garnet ore in local enrichments, which contain 0.1 to 6.4 percent zinc. Including these local enrichments, the zinc content will not average over 0.5 to 1.0 percent. Tactite zones, which parallel the Moody zone and extend southward along the contact, are composed chiefly of this type of ore.

The calcite-fluorite-chlorite type of ore occurs along the hanging wall of the Moody ore zone in places where remnants of marbleized limestone are found. Marbleized limestone forms the hanging wall and garnet ore the footwall of these ore shoots. This ore is comparatively soft and is composed chiefly of calcite, fluorite, and chlorite, with minor amounts of quartz, garnet, and pyrite. Scheelite occurs in fairly large crystals and varies in grade from 0.5 to 2.5 percent tungsten. Shoots of this type of ore are 4 to 20 feet in width, although the average mining width has been about 10 feet. Zinc occurs as marmatite in ore of this character and varies in grade from 0.2 to 4.2 percent. The average of the mine-run calcite-fluorite-chlorite ore has been about 1.25 percent zinc, and principal mine production has been from this type material.

The good grade and large size of the ore shoots found in the garnet and sulfide types may warrant future development, as these two types predominate in the district and contain large tonnages of ore containing more than 0.5 percent tungsten.

ORE DRESSING

Equipment and milling practices shown in detail on the flow sheet (fig. 6) were those in use by Lincoln Mines, Inc., at the time of the Bureau of Mines projects at this property.

Ore from the mine was hauled in dump trucks to the mill and passed through an 8-inch grizzly into a 40-ton ore bin. A jaw crusher and rolls crushed the ore to 1/4 inch, and it was then ground to 24-mesh in a wet rod mill in closed circuit with a vibrating screen.

The screen undersize passed through a unit flotation cell and produced an iron-zinc sulfide float, which was impounded for future treatment. The non-float from the unit cell was distributed to 5 rougher concentrating tables, the concentrate from these tables going to an 800-pound batch flotation cell and the table tailings going to waste. Table middlings were retreated, producing a combined scheelite-garnet-sulfide concentrate and middlings that were dried and passed through a magnetic separator. The tailings from the middling retreatment table passed to waste.

The batch flotation cell, which treated the rougher table concentrate, produced an iron-zinc sulfide float that also was stored for future treatment. The nonfloat, comprised mainly of scheelite but containing some garnet and sulfides, was settled into slime and sands. The slimes, containing about 20 percent tungsten, were dried and stored. The sands were dried and passed through a magnetic separator, which made a sulfide product going to waste, a garnet tailing that was retreated on a concentrating table, and a finished scheelite concentrate, averaging 60 percent tungsten, which was sacked for shipment to Los Angeles dealers.

Mill feed averaged about 1.0 percent tungsten. Nominal daily capacity of the mill was 75 tons, but the actual daily rate during 1944 was about 25 tons. Over-all recovery was about 70 percent of the tungsten.

Power units for the mill comprised the following:

- 1 - 80-h.p. Diesel electric engine in poor condition.
- 1 - 60-h.p. Diesel electric engine in fair condition.
- 1 - 40-h.p. Diesel electric engine in fair condition.
- 1 - 40-h.p. Diesel electric engine in poor condition.
- 1 - 40-h.p. Gasoline engine in fair condition.

The Atolia Mining Co., which succeeded the Lincoln Mines, Inc., in 1945, rehabilitated the mill during 1946. A battery of 4-flotation cells replaced the unit flotation cell after the rod mill and served to scalp the ore of iron-zinc sulfides. These sulfides, plus iron-zinc sulfides from the batch flotation cell, were further ground in a ball mill in closed circuit with a rake classifier and passed to a battery of 2 flotation cells. This unit made a zinc concentrate averaging 46 percent zinc. The flotation tails passed to waste.

The scheelite concentrate from the magnetic separator was further refined by passing it over a 35-mesh screen. The screen undersize was bagged for market, whereas the oversize was ground in an 18-inch by 18-inch ball mill and passed to a unit flotation cell. The nonfloat scheelite concentrate was dried and bagged, and the sulfide float was impounded with the iron-zinc float from the batch flotation cell.

During 1947-1948, mill feed averaged about 0.67 percent WO_3 and 1.26 percent zinc. Daily tonnage was 70 tons. Over-all recovery was about 55 percent of the tungsten and 51 percent of the zinc.

The following is a summary of the report of the Bureau of Mines Salt Lake City laboratories on tests conducted on various types of Lincoln mine ore:

Chemical head analyses and identification of samples

Sample	Identification	Assay, percent					
		WO ₃	Zn	Fe	S	Insol.	CaO
Ne-27.1	Tem-1 north stope ore	0.98	4.1	6.65	4.0	29.6	26.6
Ne-27.2	Tem-2 garnet ore	.20	.65	11.7	.9	35.6	30.8
Ne-27.3	Tem-3 iron sulfides	.01	.1	39.2	29.3	16.0	2.4
Ne-27.4	Tem-4 table tailings	.16	1.5	3.45	1.0	31.0	33.36
Ne-27.5	Tem-5 flotation tails	.53	18.5	30.5	42.8	1.7	.9

Test work was confined to samples Ne-27.1, 27.4, and 27.5, and was carried out with the object of recovering both zinc and tungsten.

Ne-27.1. North Stope Ore

Mineralogically, sample Ne-27.1 from the north stope 4-C consists of pyrite, sphalerite, scheelite, and a very small amount of chalcopyrite scattered uniformly through altered limestone or tactite. The grain size of the scheelite and sphalerite ranges from 10-mesh to about 200-mesh, and optimum liberation required grinding to approximately 65-mesh. An appreciable quantity of secondary calcite can be differentiated from the tactite proper. Nearly all of the small copper content occurs as minus 200-mesh chalcopyrite inclusions in the sphalerite.

A sample of ore ground to 28-mesh in a rod mill was tabled, and the table concentrates and middlings were re-treated separately. Each product was reground to 35-mesh with lime and cyanide, and rougher zinc concentrates were floated and cleaned twice. The tailing from the zinc flotation was then conditioned with sulfuric acid, and iron concentrates were floated. Tailings from the iron flotation operation were dried, roasted, and treated by magnetic separation to recover a high-grade tungsten product in the nonmagnetic fraction. Total recovery of tungsten in the combined tungsten product was 80.2 percent with an analysis of 68.2 percent tungsten, 0.34 percent zinc, and 0.92 percent bismuth; the bismuth content probably exceeds penalty limit but could be cleaned out by modifying flotation procedure. The combined zinc concentrates represented a recovery of 67.4 percent of the total zinc and virtually none of the tungsten and assayed 59.4 percent zinc, 3.01 percent iron, 0.74 percent bismuth, 0.49 percent lead, 0.50 percent cadmium, 0.7 percent insoluble, and less than 0.01 percent tungsten. The bismuth, probably associated with galena as bismuthinite concentrated with the tungsten in the tabling operation. Hence, zinc concentrate 1 assayed 2.0 percent lead and 3.36 percent bismuth, whereas zinc concentrate 2 assayed only 0.1 percent lead and 0.06 percent bismuth. The latter product, obtained from retreatment of table middlings, contained the major portion of recovered sphalerite.

The table tailing from the above test contained 18 percent of the total zinc with an assay of 1.35 percent zinc. In order to recover additional amounts of this zinc, which would otherwise be lost in the table tailings, the use of a unit flotation cell in the grinding circuit is suggested for present operation. An additional advantage of the unit cell would be removal from this regular mill circuit of excessive amounts of sulfides resulting from mining and high sulfide portions of the ore body; thus, this type of ore could be treated without disturbing the usual mill treatment. A test on a bulk sulfide concentrate, described under sample Ne-27.5, indicated that zinc could be floated selectively, and that the tailing from this operation could be retreated for the recovery of additional tungsten.

Ne-27.4. Table Tailings

The sample of table tailings from present plant operation contained 6 percent by weight of plus 28-, 71 percent plus 100-, and 14 percent minus 200-mesh material; the same minerals were present as in the head sample Ne-27.1, but the zinc and tungsten content had been reduced by the regular concentrator tabling treatment. Screen analysis showed that the zinc was quite uniformly distributed through the various sizes but that 46.8 percent of the tungsten was in the minus 200-mesh size, largely as free particles of scheelite. This suggests the use of closer hydraulic sizing and more efficient tabling of the minus 200-mesh fraction to increase tungsten recovery.

Fatty acid flotation of the tailings to recover additional tungsten was not attractive, owing to the high lime content of the ore.

Sphalerite was floated selectively from a sample stage-ground through 48-mesh. The resulting zinc concentrate assayed 54.8 percent zinc, 4.8 percent iron, 2.2 percent insoluble, and less than 0.01 percent tungsten, representing a recovery of 79.5 percent of the zinc content.

Ne-27.5 Bulk Sulfide Concentrate

A screen analysis of bulk sulfide concentrate from the Lincoln mines concentrator, sample Ne-27.5, showed uniform distribution of the zinc through the different size ranges; however, nearly all of the tungsten was in the minus 200-mesh fraction. This would indicate that further cleaning of the sulfide concentrate would drop most of the scheelite. Microscopic examination indicated that the minor amount of scheelite occurring as inclusions ranged in size from 200- to 400-mesh, whereas virtually all the pyrite and sphalerite could be freed by grinding to minus 65-mesh. Less than 1 percent of the weight of the sample as received was plus 28-mesh, 48.1 percent was plus 65-mesh, and 6.6 percent minus 200-mesh.

By regrinding the bulk sulfide concentrates with bleaching powder, lime and cyanide, and selectively floating the sphalerite, 89 percent of the zinc was recovered in a cleaned concentrate assaying 54 percent zinc, 4.5 percent iron, 0.6 percent insoluble, and 0.02 percent tungsten. The tailing from zinc flotation was conditioned with sulfuric acid, and an iron concentrate was floated. The nonfloat or tailing from iron flotation was dried,

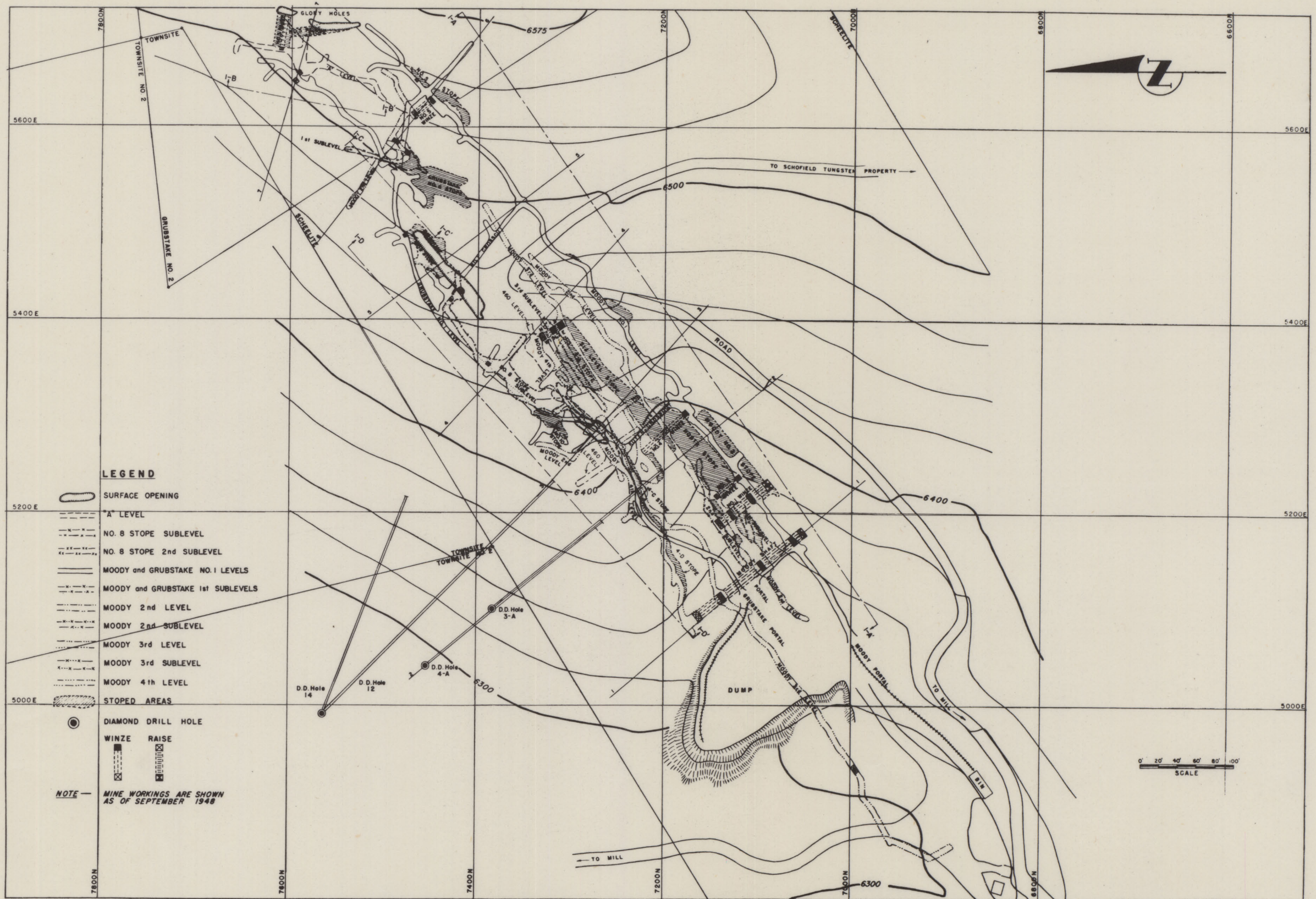


Figure 7- Block I, Tem Piute tungsten deposits.

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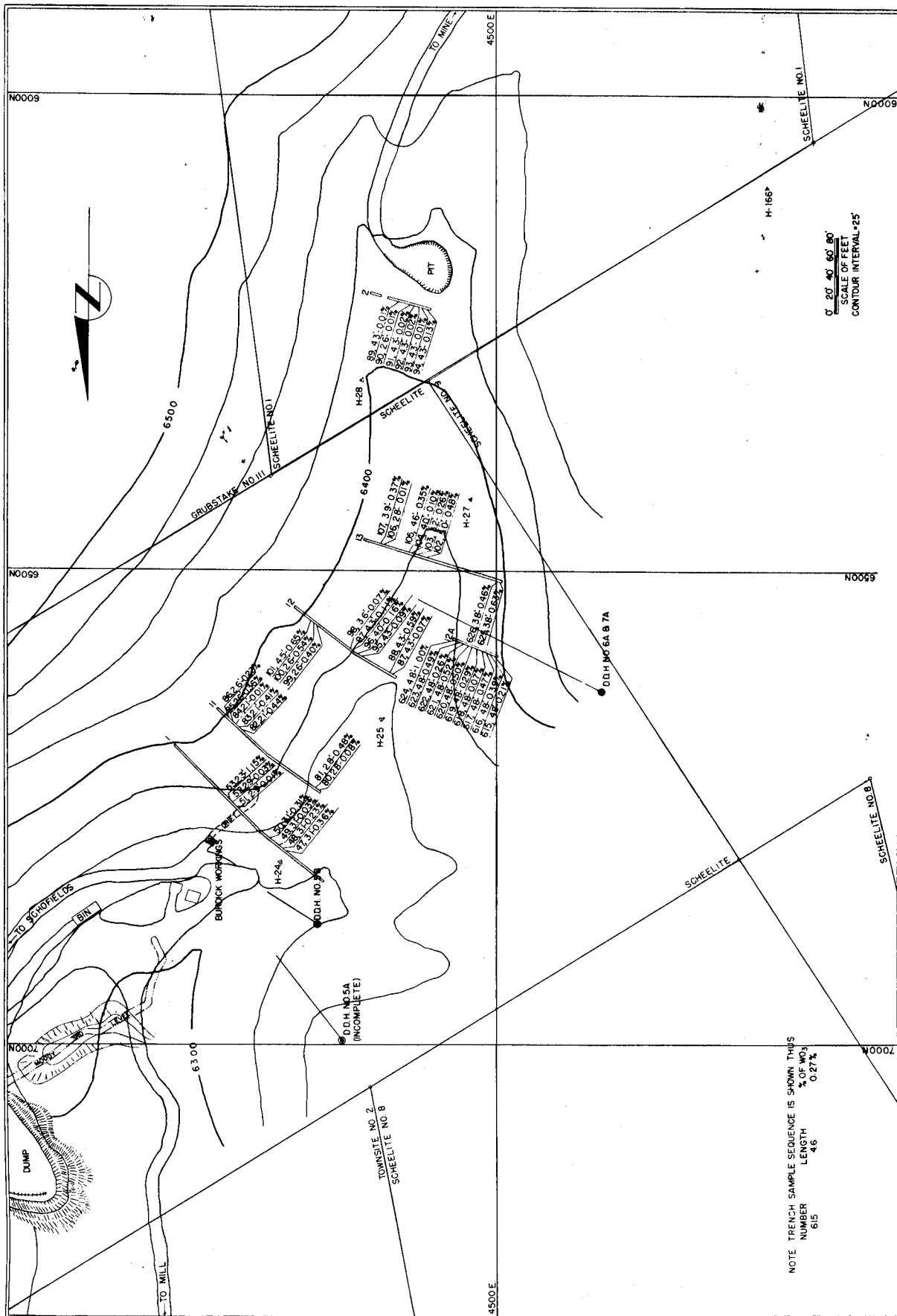


Figure 8. - Block 2, Tem Piute tungsten deposits.

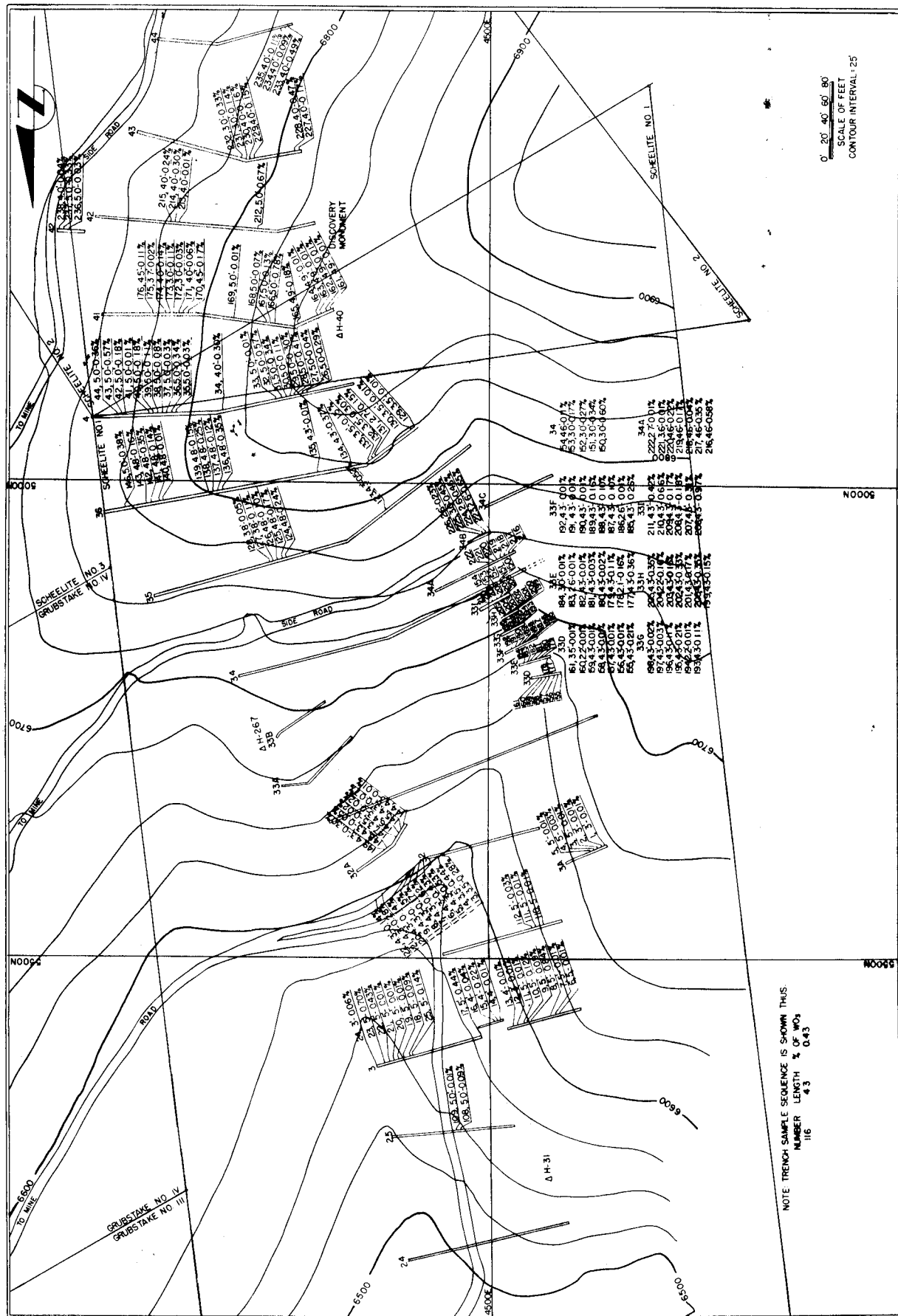


Figure 9. - Block 3, Tem Piute tungsten deposits.

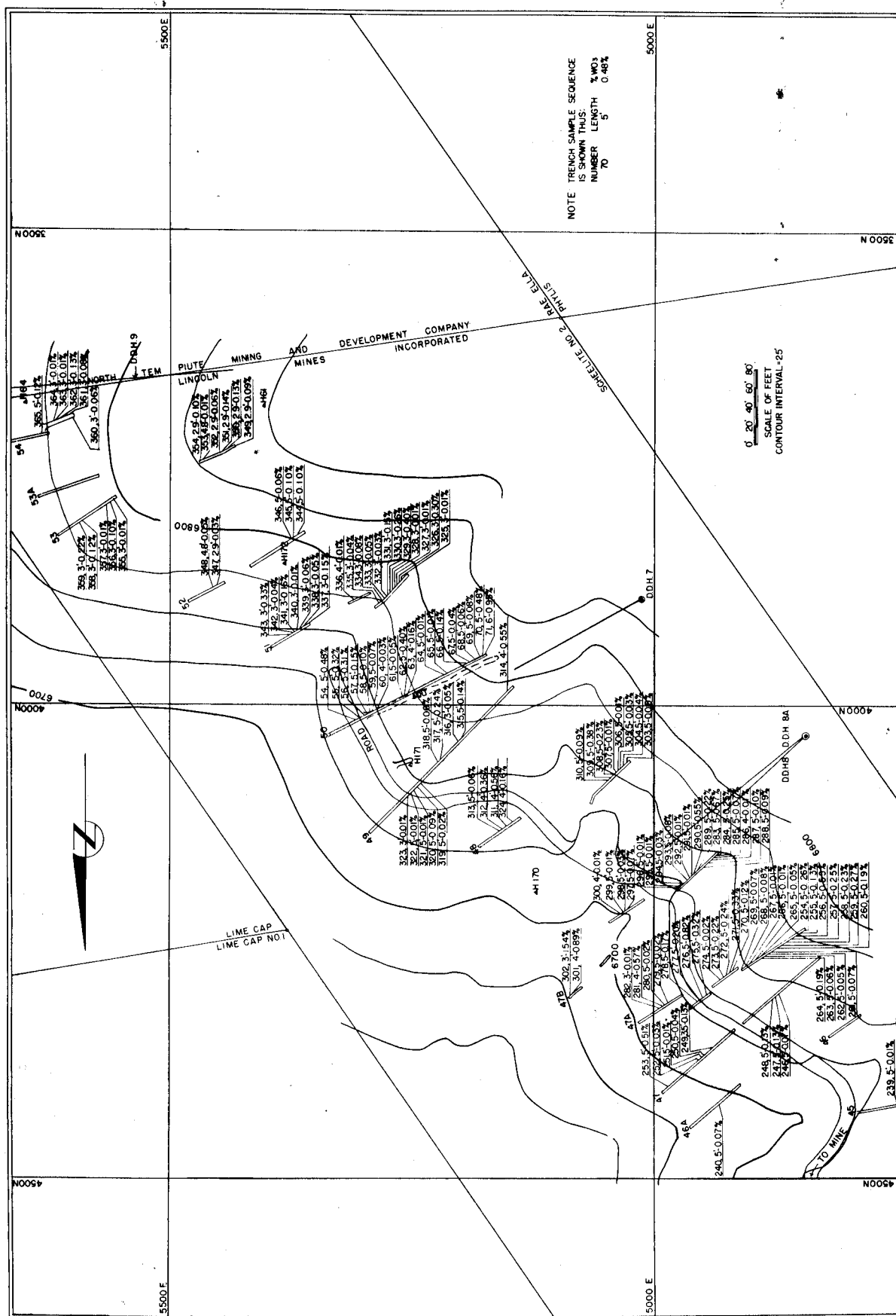


Figure 10. - Block 4, Tem Piute tungsten deposits.

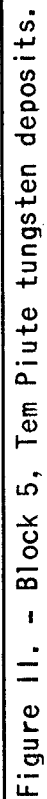
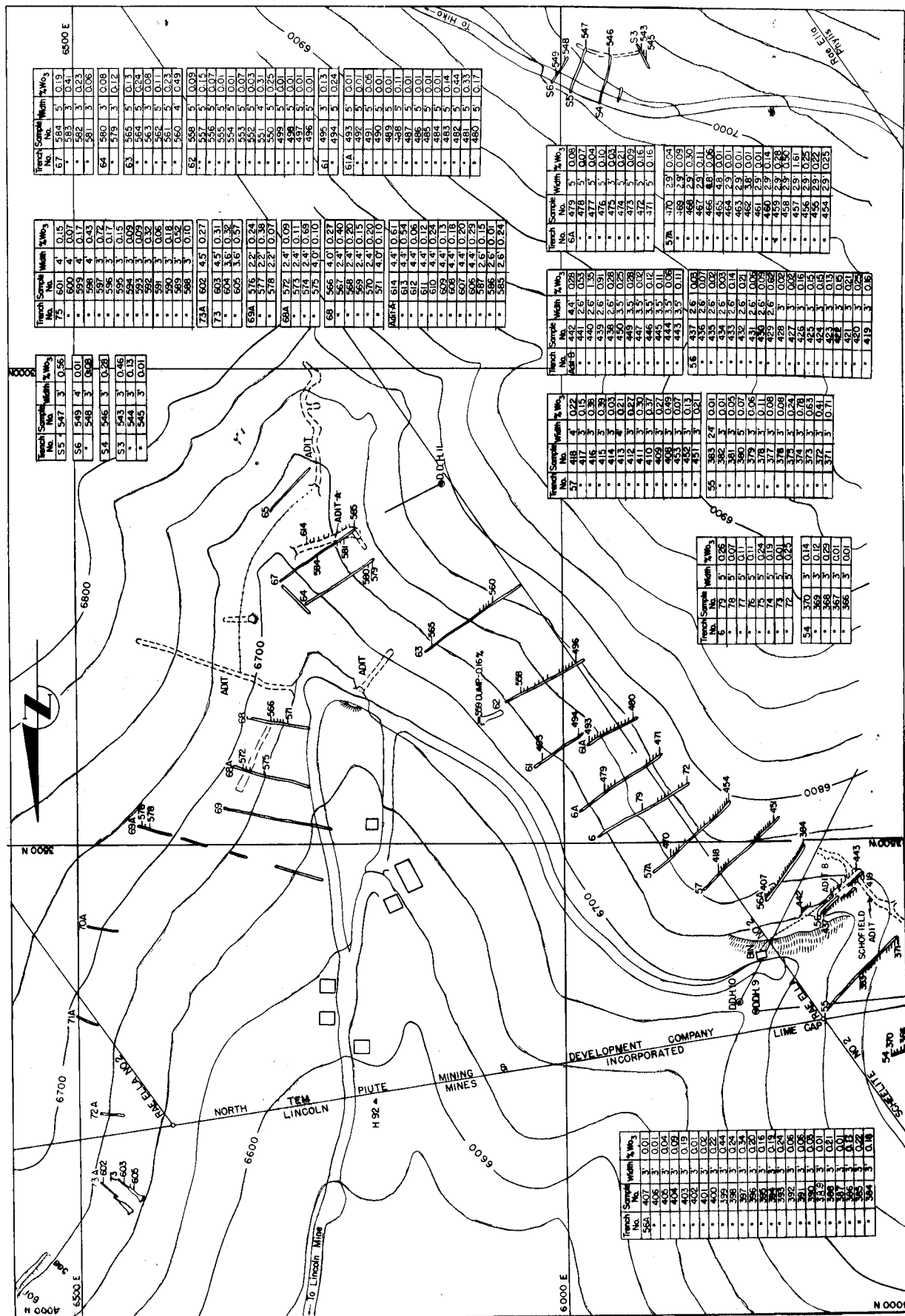


Figure 11. - Block 5, Tem Piute tungsten deposits.



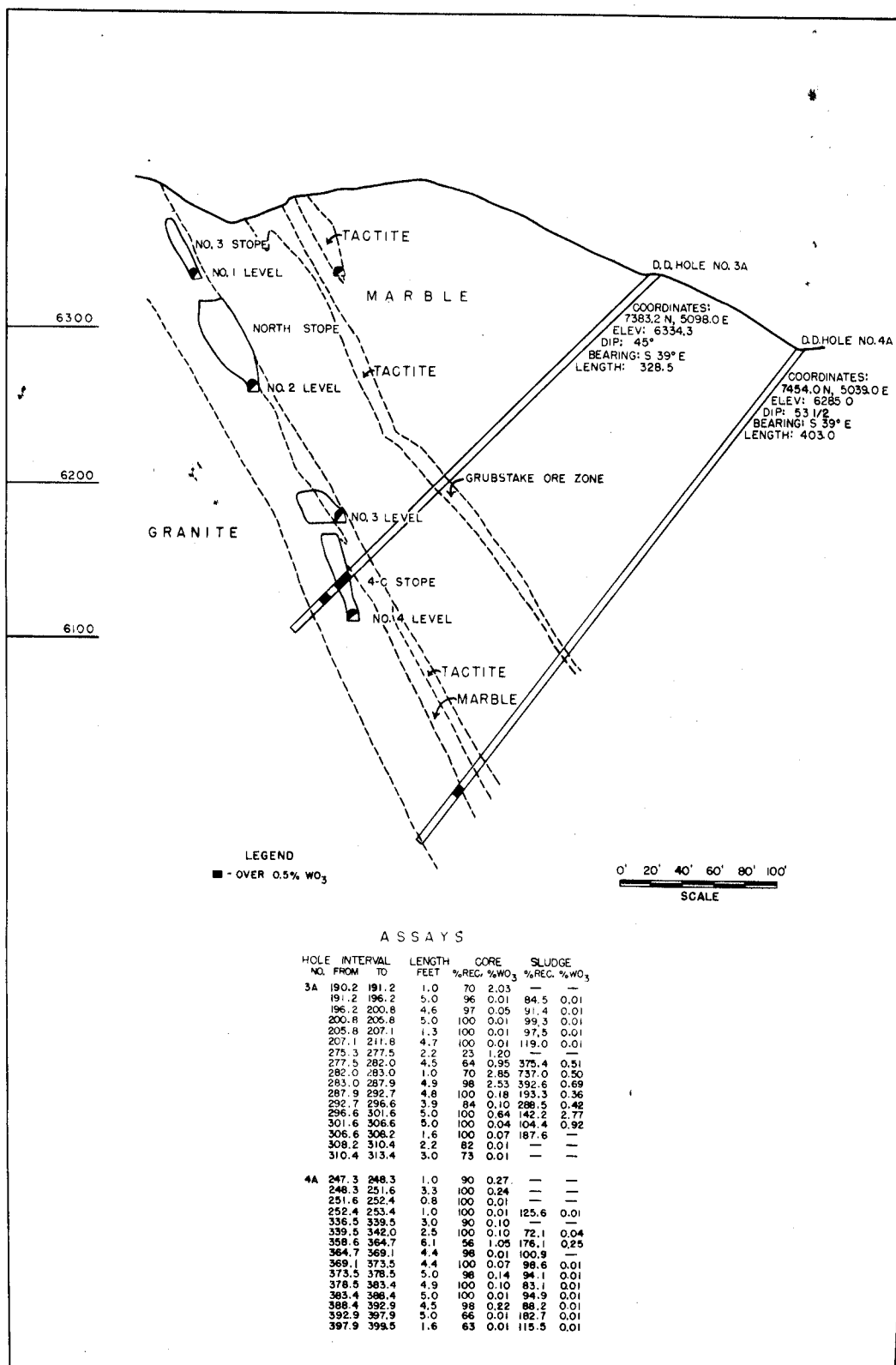


Figure 13. - Vertical section through core drill hole 3-A and 4-A looking southwest, Tem Piute tungsten deposits.

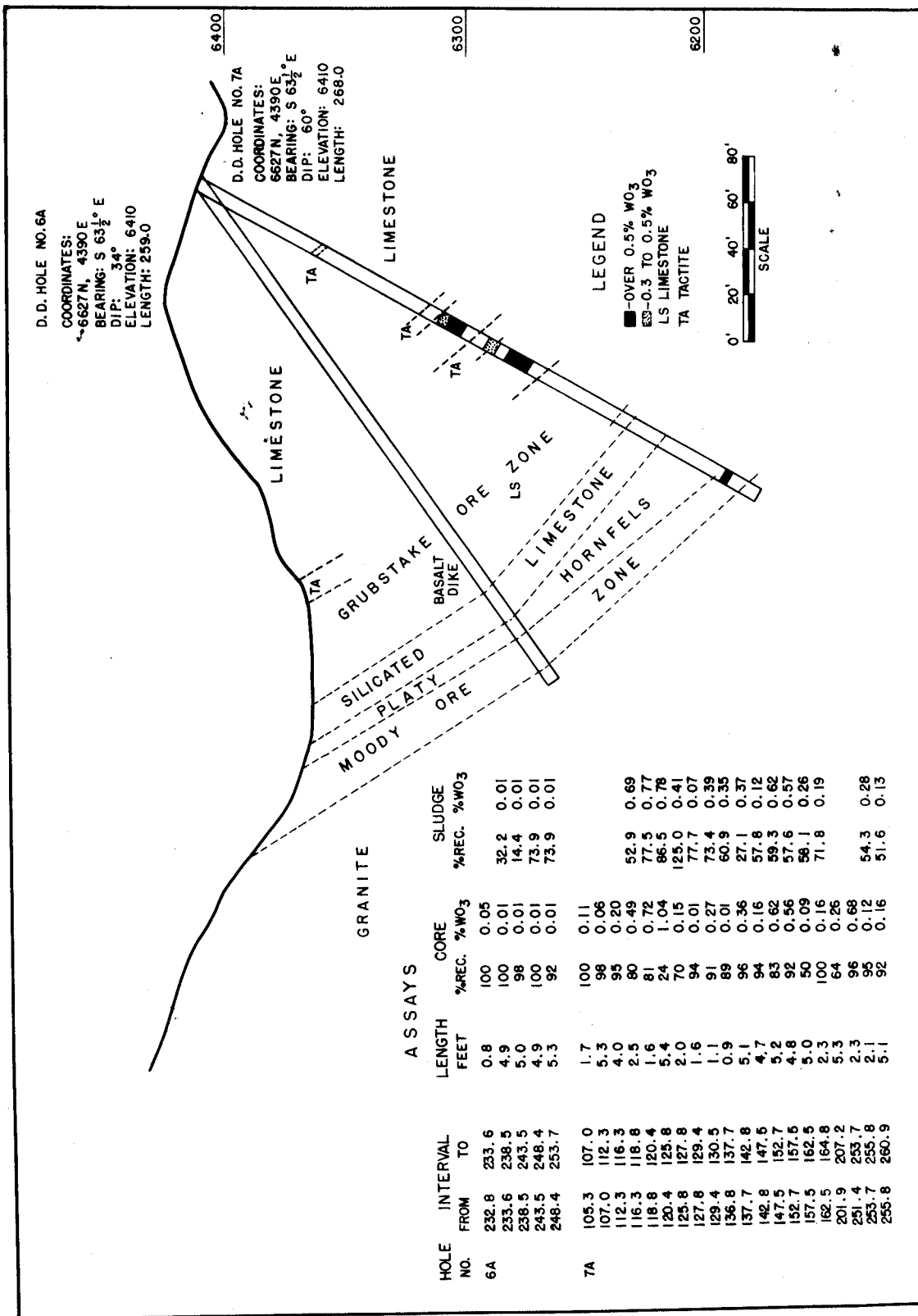


Figure 14: Vertical section through core drill hole 6-A and 7-A looking southwest, Tem Piute tungsten deposits.

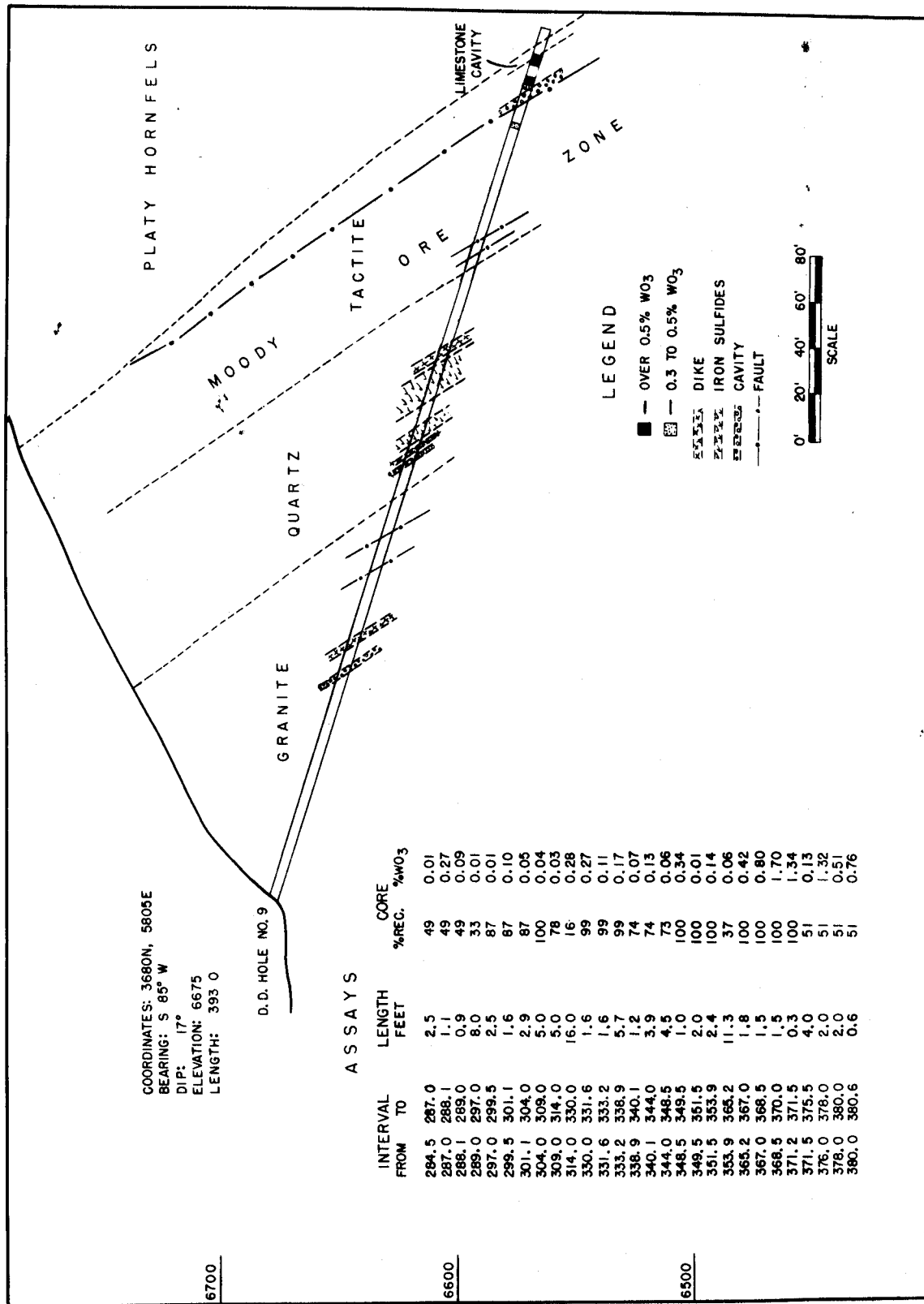


Figure 15.- Vertical section through core drill hole 9 looking south, Tem Plute tungsten deposits

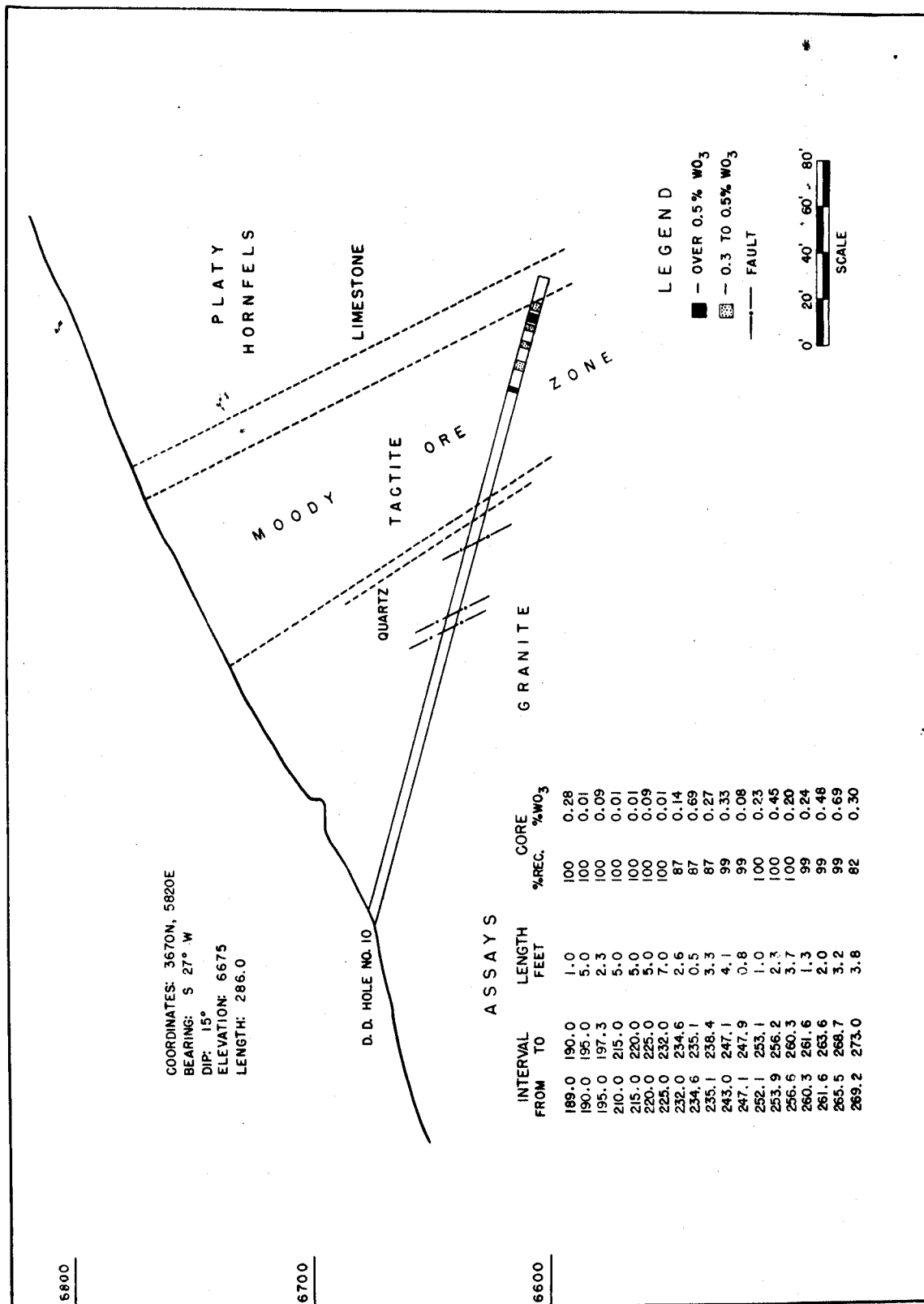


Figure 16.- Vertical section through core drill hole 10 looking south, Tem Piute tungsten deposits.

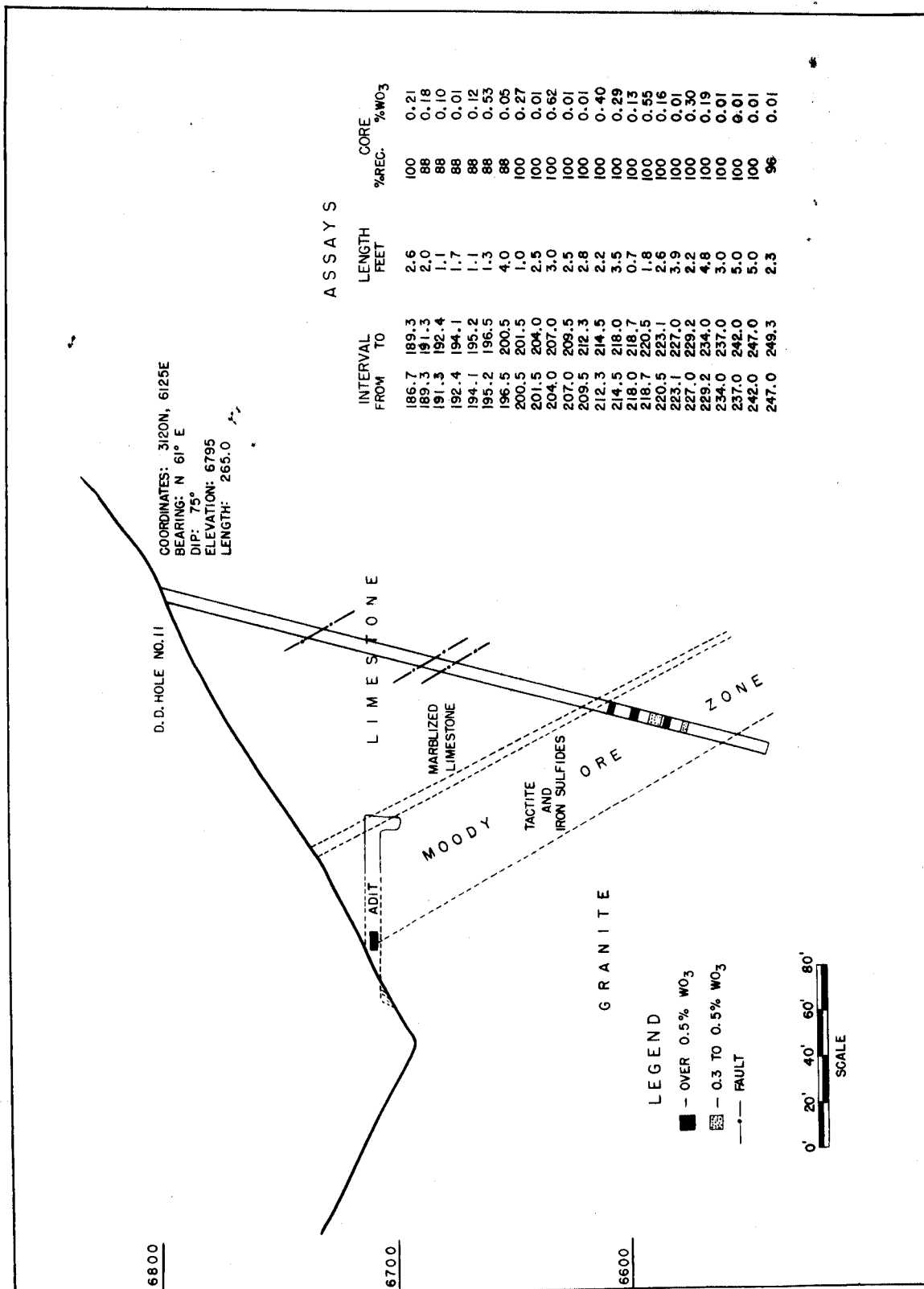


Figure 17:- Vertical section through core drill hole 11 looking southeast, Tem Piute tungsten deposits.

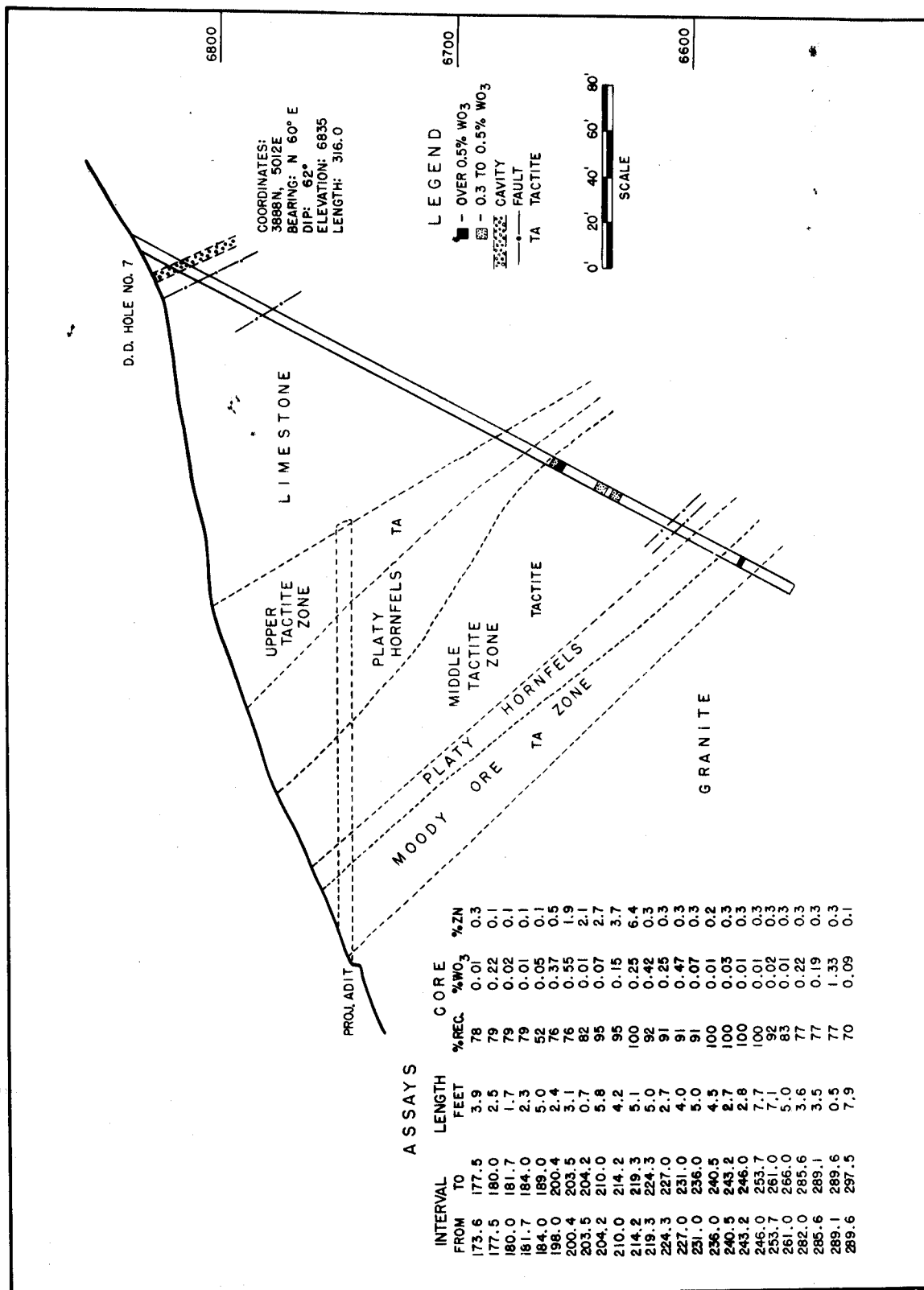


Figure 18.- Vertical section through core drill hole 7 looking southeast, Tem Piute tungsten deposits.

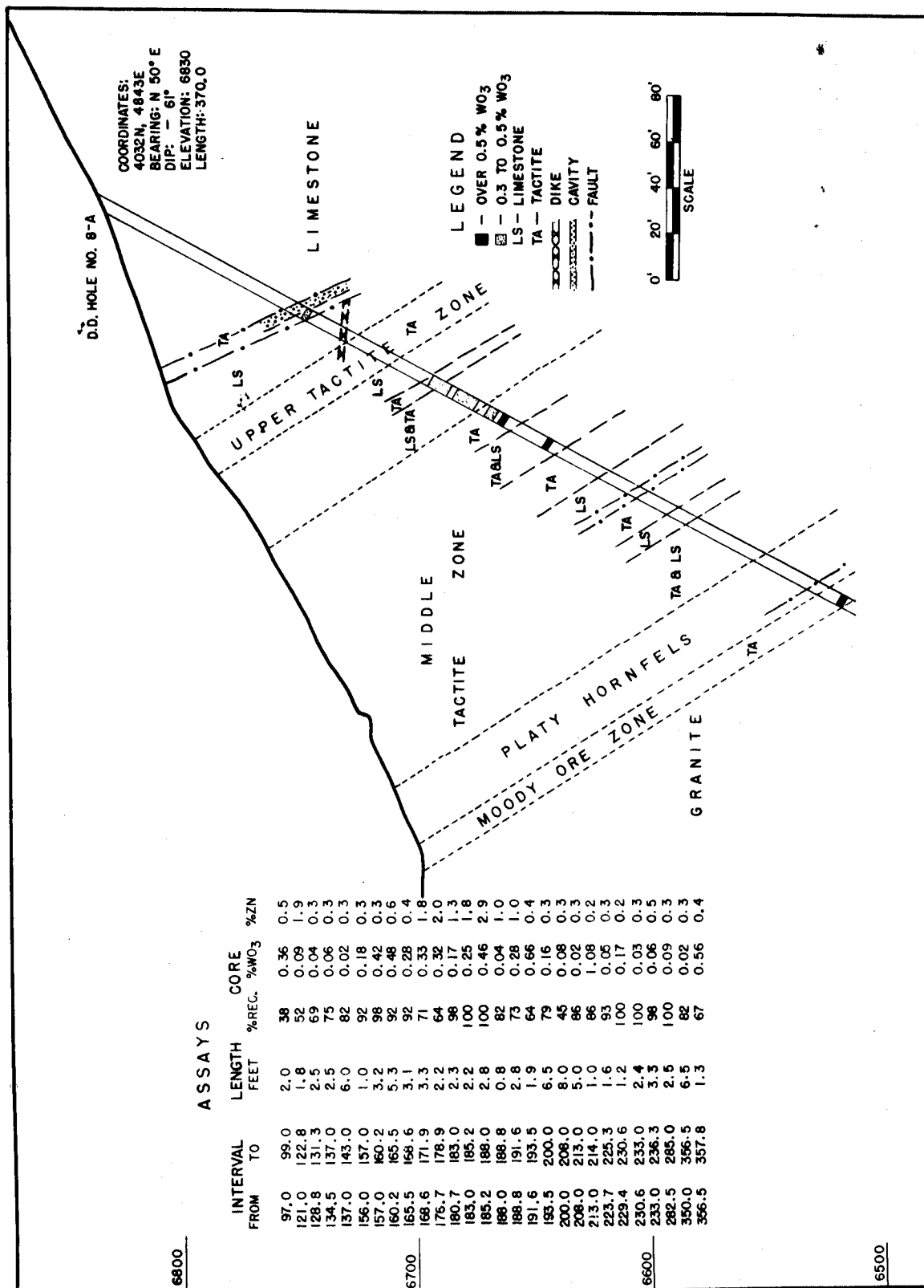


Figure 19.-Vertical section through core drill hole 8-A looking southeast, Tem Piute tungsten deposits.

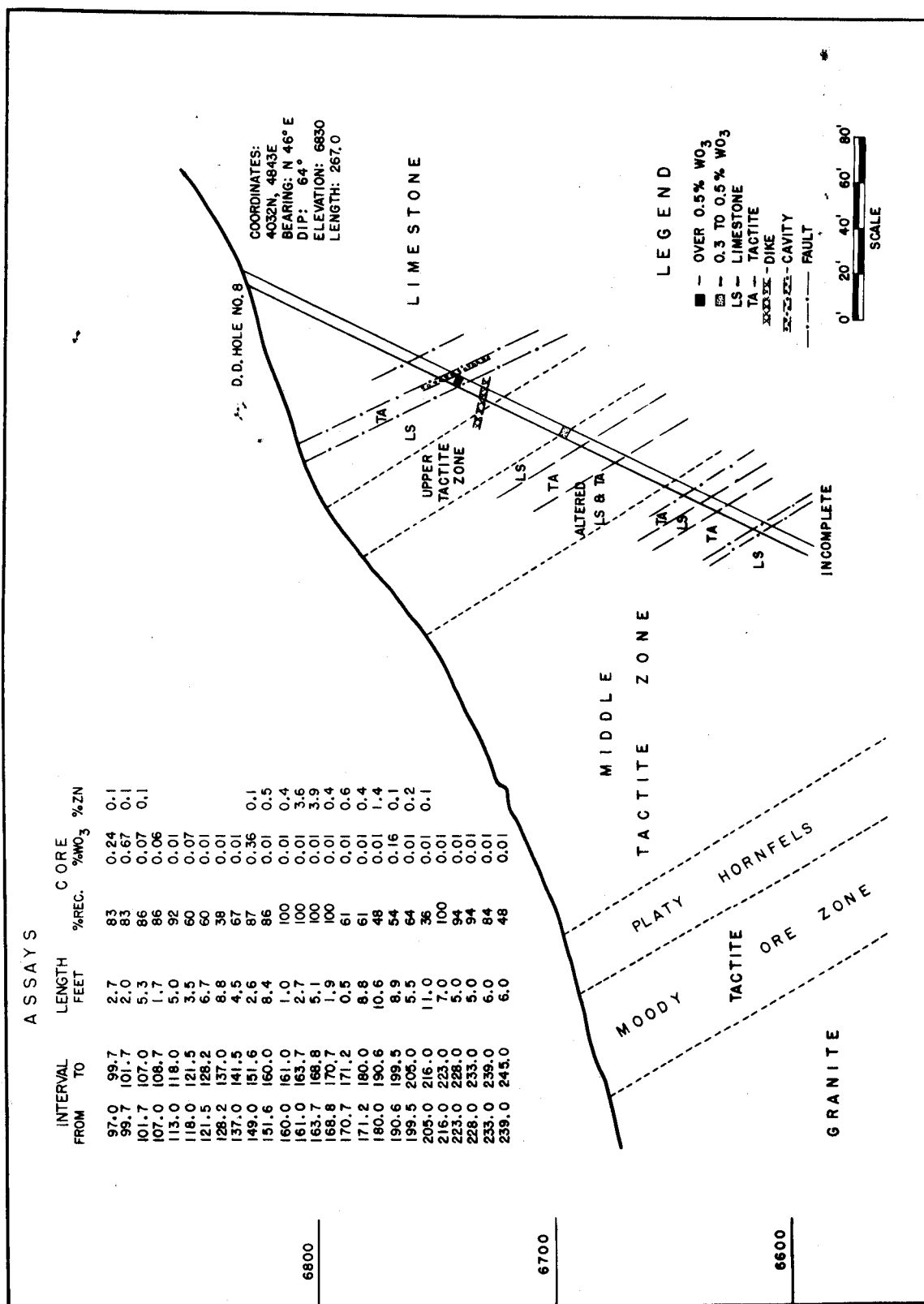


Figure 20- Vertical section through core drill hole 8 looking southeast, Tem Piute tungsten deposits.

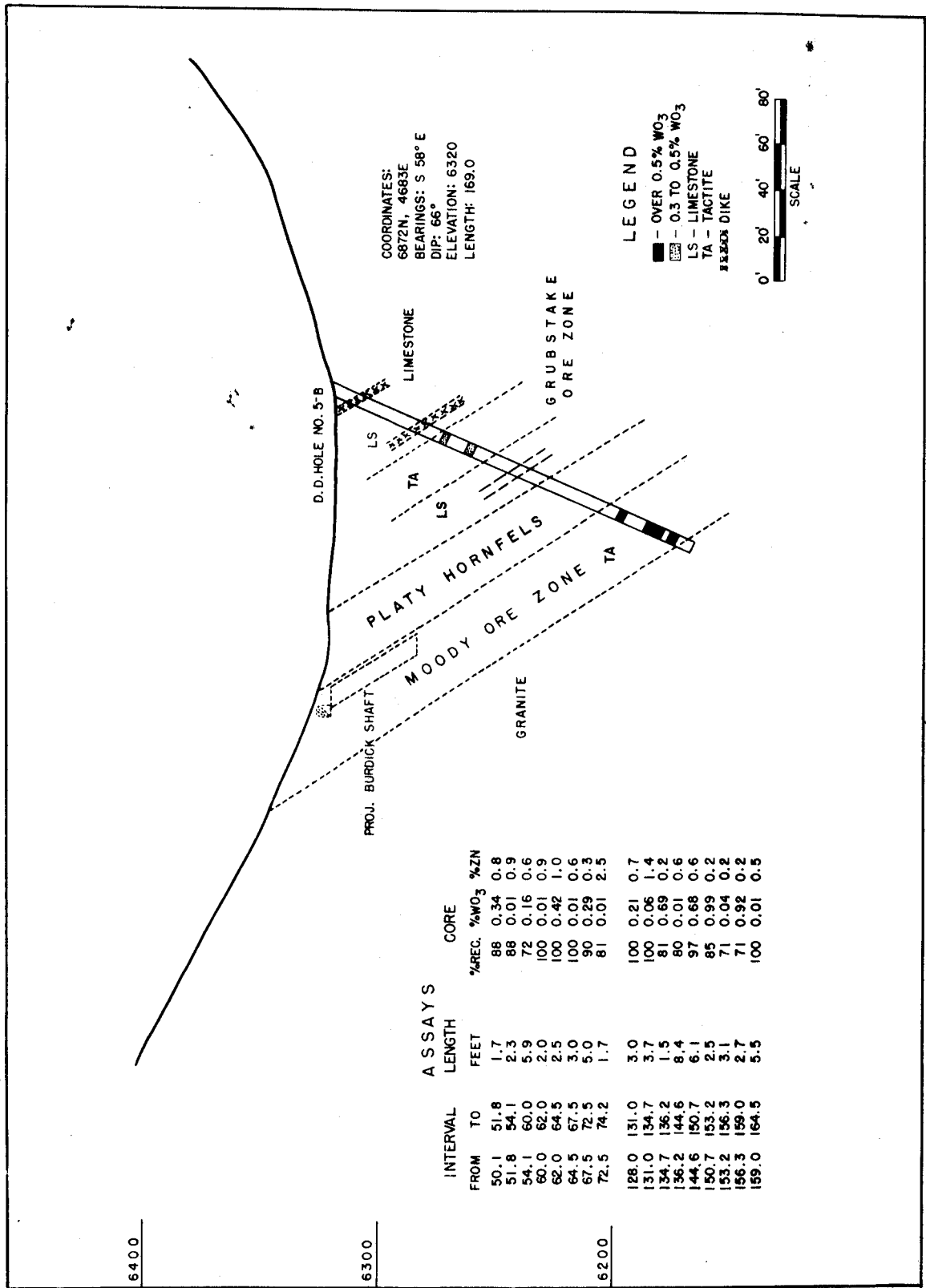


Figure 21:- Vertical section through core drill hole 5-B looking southwest, Tem Piute tungsten deposits.

roasted, and treated by magnetic separation to recover 36.5 percent of the tungsten content of the original bulk sulfide concentrate in the nonmagnetic product; this tungsten concentrate assayed 69 percent tungsten. The magnetic fraction still contained 26.5 percent of the tungsten and in regular operation should be reground and retreated for additional recovery.

PLAN OF THE PROJECT

The work planned included surface trenching and sampling of most promising outcrops, as indicated by the ultra-violet lamp, to diamond drill to test the lateral and downward extension of the tactite zones at various points along the contact south of the Lincoln mine, including the property of the North Tem Piute Mining and Development Co.

Drill holes also were planned to intersect the Moody ore zone in the Lincoln mine area at about the elevation of the projected 6th and 8th levels to determine the continuity of known ore bodies at these depths.

WORK PERFORMED BY THE BUREAU OF MINES

Work on the project comprised trenching, sampling, a small amount of road and trail construction, and core drilling. Trenching totaled 10,013 linear feet in 138 trenches, from which 2,039 cubic yards of material was excavated. A total of 659 samples were taken from the trenches and two short adits. ("See figures 7, 8, 9, 10, 11, and 12.) Approximately 4,935 feet of roads and trails were built for access to drill sites and working areas.

Fourteen holes with a total length of 4,347 feet were drilled.

Drill holes 3A, 4A, 6A, and 7A established the continuity of ore at depth, particularly under good surface outcroppings, and they disclosed the dip of the granite-tactite contact to conform to that of the surface exposures. Figure 13 shows holes 3A and 4A looking southwest. Figure 14 shows holes 6A and 7A looking southwest. Hole 5A penetrated the Grubstake ore zone but was abandoned because of caving conditions.

Drill holes 9, 10, and 11 on North Tem Piute Mining & Development Co. ground explored the downward extension of the Moody ore zone to depths ranging from 170 to 270 feet down-dip of the zone (figs. 15, 16, and 17).

Holes 7 and 8A explored the tactite zones near the south end of the Lincoln Mines, Inc., property. In these holes the Grubstake zone was cut at depths to 150 feet and the Moody zone at depths to 210 feet down the dip of the deposits. Hole 8, not completed, drilled to a depth of 267 feet, intersected the Grubstake ore zone and partly penetrated a middle ore zone (figs. 18, 19, and 20).

Hole 5B was drilled to explore the Moody ore zone under the Burdick workings (fig. 21).

Holes 12 and 14 explored the Moody ore zone below present workings on the 4th level of the Lincoln mine, intersecting this zone on the projected 6th and 7th levels (figs. 22 and 23).

The project work resulted in proving the continuity of scheelite-bearing tactite zones laterally and at depth and also established the downward extension of the ore bodies currently being worked in the Lincoln mine.

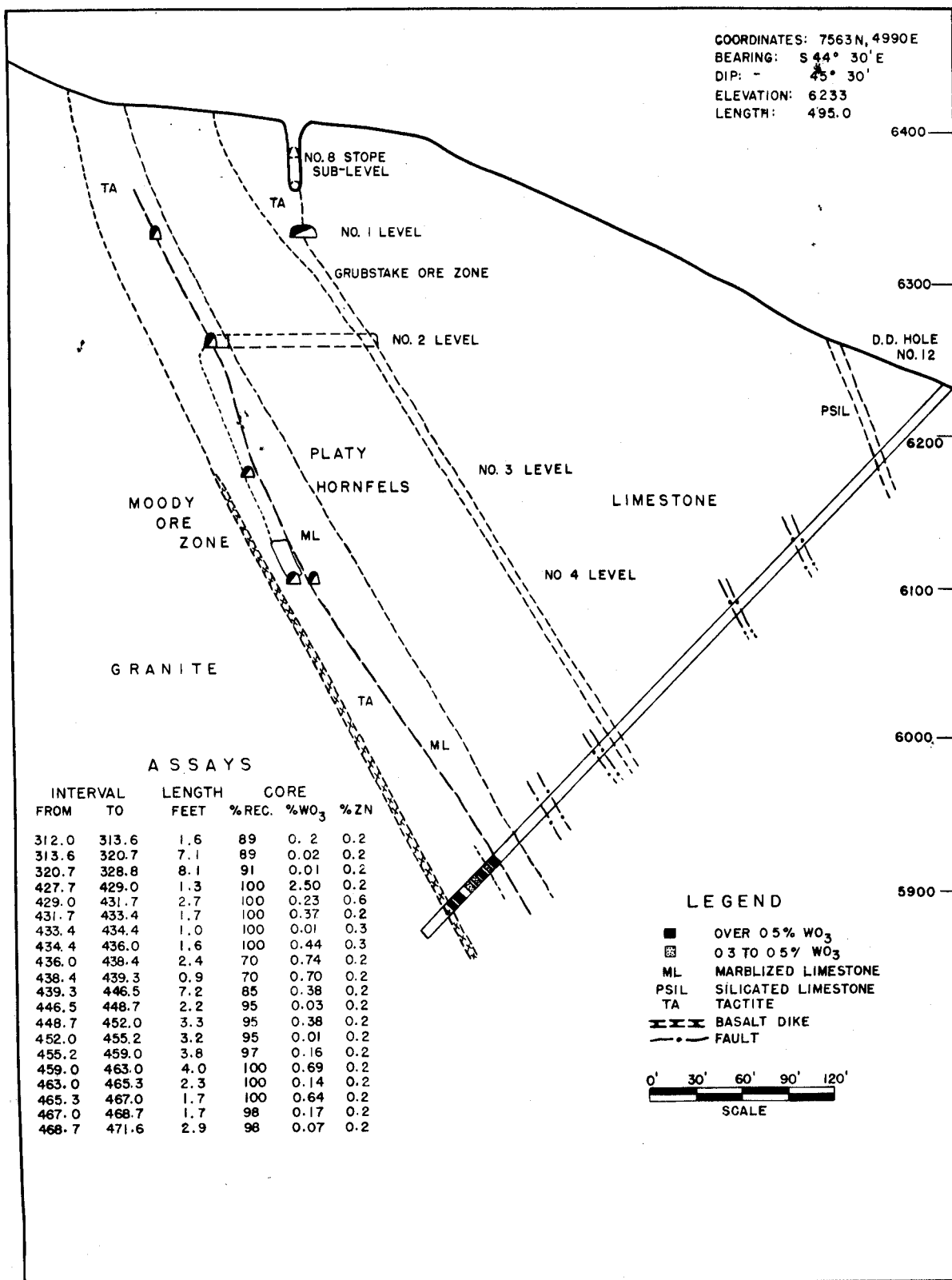


Figure 22.- Vertical section through core drill hole 12 looking southwest, Tem Piute tungsten deposits.

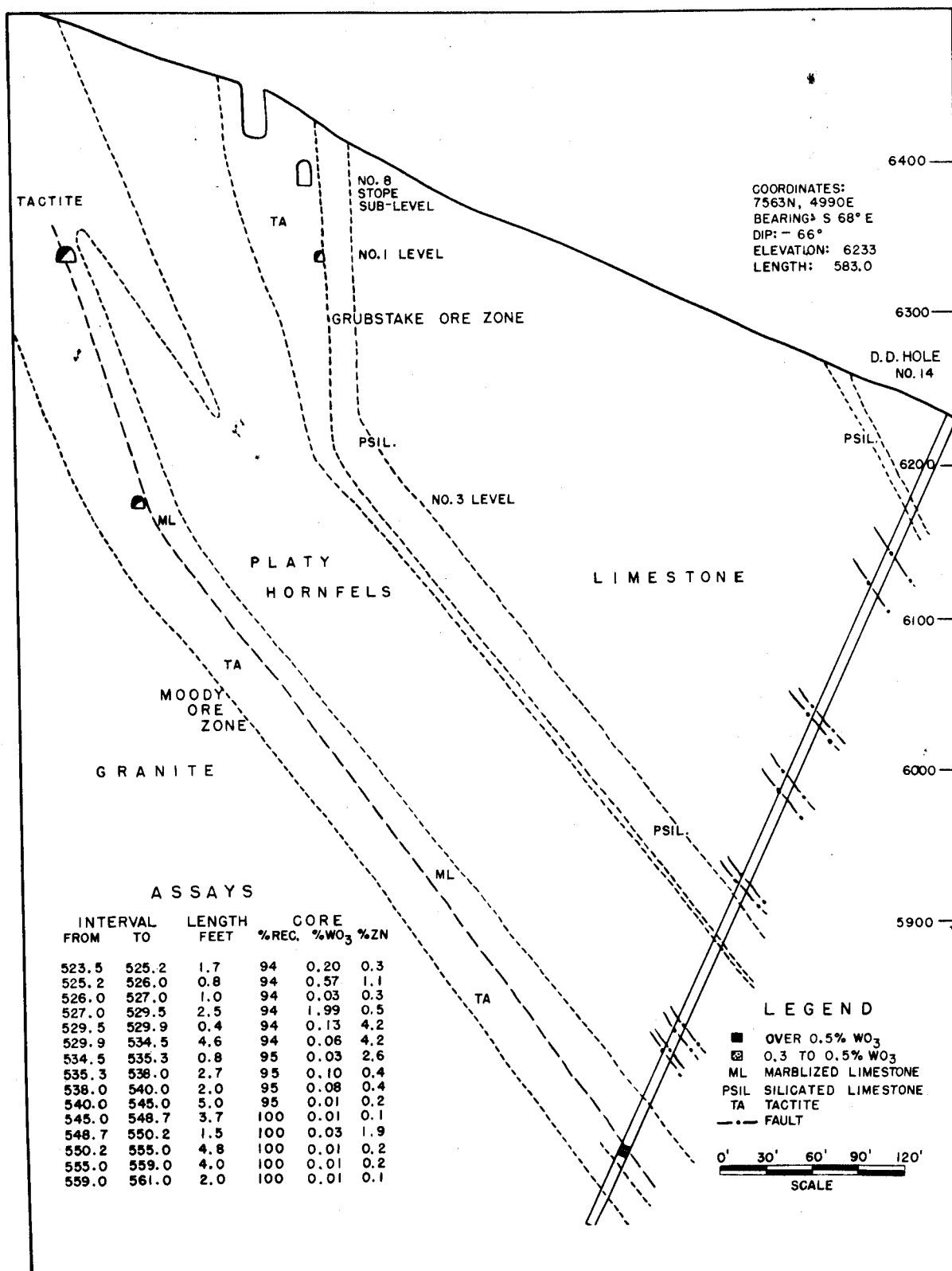


Figure 23.- Vertical section through core drill hole 14 looking southwest, Tem Piute tungsten deposits.