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E. H. Wells, President and Director

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GEOLOGY AND ORE DEPOSITS OF THE GROUND HOG MINE, CENTRAL DISTRICT, GRANT COUNTY, NEW MEXICO

By

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GEOLOGY AND ORE DEPOSITS OF THE GROUND HOG MINE, CENTRAL DISTRICT, GRANT COUNTY, NEW MEXICO

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INTRODUCTION

Scope of Report

Within the past two and a half years a large amount of ore has been developed at the Ground Hog mine near Vanadium, Grant County, New Mexico. This is the first important ore body of the vein type that has been developed in the igneous rocks of the southwestern part of the Central mining district. In recognition of the possibility of other similar deposits in this locality, the New Mexico Bureau of Mines and Mineral Resources in cooperation with the United States Geological Survey has instituted a survey and study of the ore deposits of this area. The present report precedes a detailed report on the district which will be prepared by the writer following a more exhaustive examination. The preliminary examination occupied three days in October, 1930.

Previous Work

The vicinity of the Ground Hog mine is included in the area covered by the Silver City folio of the United States Geological Survey by Paige[1]. It is also included in the area studied by A. C. Spencer, whose report on the Santa Rita district for the United States Geological Survey is in preparation. Due to the small amount of development work at the time of their investigations, Paige and Spencer did not make a thorough study of the Ground Hog area.

Acknowledgments

Thanks are due the officials of the Asarco Mining Company for permission to visit the Ground Hog mine and to publish this report, and for maps and other information. The assistance and suggestions offered by Mr. M. N. Hawkins of the staff of the Ground Hog mine, and also the geologic maps and sections prepared by him, have been of much value.

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[1]Paige, Sidney, U. S. Geol. Survey Geol. Atlas, Silver City folio, (No. 199), 1916.

Location and Topography

The Ground Hog mine is in sec. 5, T. 18 S., R. 12 W. about three fourths of a mile southeast of Vanadium post office and about 2 miles southwest of Santa Rita. The mine is situated in a saddle-like draw separating the western foothills of the Santa Rita Mountains and an outlying hill. The Lucky Bill mine adjoins the Ground Hog mine on the southwest and is in the same draw, which slopes both ways from the Ground Hog mine.

History and Production

The San Jose claim of the Ground Hog mine was located in 1875. Due to the fact that the outcrop on the Ground Hog claim, which adjoins the San Jose on the southwest, was mostly covered with rock debris and the exposed parts of the vein were barren quartz, this claim was not located until 1900.

The net smelter returns of shipments from the Ground Hog up to 1917 were about $50,000, representing about 2,000 tons, derived from lead-copper ores encountered about 100 feet below the surface at the south end of the claim. The mine was sold in 1917 and from then until February, 1920, when shipments ceased due to temporary closing of the smelters, the property produced 6,430 tons of lead-copper carbonate and sulphide ore. During this period, under the stimulus of high metal prices, the Main shaft was sunk to below the 300 level and the property equipped for air drilling.

The mine was idle from February, 1920 until the fall of 1924, when it was taken over by the Hayward-Richard Leasing Company. This company deepened the shaft to the 400 level and explored the vein on that level. Some small ore bodies were stoped south of the shaft and in the spring of 1928, after courageous drifting northward through a long barren zone, the present extensive ore shoot was discovered. In June, 1928 a controlling interest was sold to the Asarco Mining Company, a subsidiary of the American Smelting & Refining Company.

The total production of the mine to November 1, 1930 was approximately 123,260 tons of ere. Milling and smelting returns are not available, so the net value of this production is not known, but it is estimated at approximately $2,250,000. Production from January 1 to November I, 1930 was 39,512 tons of ore which contained 25 to 30 per cent of the valuable metals. This is indicative of the importance which the property has attained.

MINE WORKINGS

The principal mine opening is a three-compartment vertical shaft which is herein referred to as the Ground Hog shaft, This is a new shaft 400 feet deep and is used as the mine entrance and for hoisting ore. The Main shaft - called also the No. 1 shaft - is about 800 feet southwest and the San Jose shaft about 500 feet northeast of the Ground Hog shaft. To date five main levels have been driven from the Ground Hog shaft and two sub-levels have been opened. The accompanying cross section (page 16) shows the workings from the Ground Hog shaft. In deepening the workings the ore is followed by a winze to each succeeding level. A footwall crosscut then is driven in the proper location and a raise put up on the line of the shaft. After the connection is made, the raise is enlarged to shaft size. The vein is drifted on as desired, and occasional crosscuts are driven to investigate the foot and hanging walls.

The San Jose shaft is 260 feet deep. Its bottom level connects by a winze with the north end of the Ground Hog fourth level.

The Main shaft, which was the working shaft prior to sinking the Ground Hog shaft, is 380 feet deep and bottoms on the fourth level, which is continuous from the Ground Hog workings. The third level likewise is continuous with the Ground Hog third level. This level connects with the Lucky Bill mine to the southwest.

It is roughly estimated that there are approximately a mile and a half of workings.

GENERAL GEOLOGY

Summary

In the Central district an irregular and discontinuous band of quartz diorite extends from sec 35, T. 17 S., R. 13 W. to sec. 31, T. 17 S., R. 11 W. Its length is about 8 miles and its average width about one mile. Fort Bayard and the town of Central are in this area near its western end, and the Kneeling Nun, which is about one and a half miles west of its eastern extremity, is underlain with this rock. The quartz diorite is intruded by a stock and dikes of granodiorite at Santa Rita, and it is cut by dikes of granodiorite in the vicinity of the Ground Hog mine and. elsewhere. Cretaceous and Paleozoic sedimentary rocks occur north of the quartz diorite area and Tertiary lavas and tuffs south of it.

The quartz diorite is an immense sill-like intrusion into the Colorado (Cretaceous) shale-sandstone series. Later, erosion re-moved the overlying sedimentary rocks, and a series of Tertiary sediments was laid down upon the eroded surface of the intrusive rocks. These in turn were covered by lava flows.

The district is traversed by a number of faults, the principal ones of which constitute a northeast system. A prominent fault zone of this system extends from a point south of Bayard Station northeastward nearly to Santa Rita. The Ground Hog mine lies along this fault zone at a place where the Tertiary lavas on the south are dropped down against the quartz diorite.

The Rocks

Quartz Diorite

The quartz diorite is a mottled, greenish-gray, rather fine grained porphyritic rock which weathers to a dull pink. It is made up of about 80 per cent of salic minerals enclosed in a mesh of chlorite. The salic minerals consist chiefly of white, partly altered feldspar. Small quartz phenocrysts can be readily observed, though this mineral does not seem to be abundant.

A narrow zone in the quartz diorite at the mine contains numerous spherical nodules which range in size from about half an inch to 4 or 5 inches in diameter. It is reported that similar nodules have been noted at a depth of 500 feet underground so that presumably they are not the result of weathering.

When the nodules are broken across it is noted that they contain a core of epidote, in places porous or miarolitic-looking, which grades into and is surrounded by a very fine grained, highly siliceous zone, and this in turn is surrounded by one or more shell-like, crusts which, except for an occasional speck of epidote and somewhat more quartz, seem similar in character to the surrounding quartz-diorite. Certain joints in the same zone exhibit similar phenomena, i.e., epidotic walls grading into a fine-grained siliceous band and ultimately into normal-appearing quartz diorite.
Granodiorite Porphyry

Granodiorite Porphyry

Granodiorite occurs in the vicinity of the Ground Hog mine as a northeastward-trending system of dikes in the quartz diorite. This rock contains phenocrysts up to 5 mm. in diameter in a fine-grained to medium-grained greenish-gray groundmass. The phenocrysts consist of quartz, feldspar, and biotite. The large, perfect phenocrysts of biotite, which are made up of pseudo-hexagonal basal plates in books up to a quarter of an inch in length, constitute a distinctive feature of this rock and one which seems to be a reliable criterion in distinguishing it from the quartz diorite, even where highly weathered or otherwise altered. The biotite is commonly partly or wholly altered to chlorite but without loss of crystal outline. Twinning in some of the feldspars is megascopically apparent.

Rhoylite Porphyry

The lavas which overlie the Tertiary sediments consist in the vicinity of the Ground Hog mine of a massive extrusive rock which extends to the tops of the local hills. Flow bedding is prominent locally. The rock is porphyritic and contains a high proportion of phenocrysts in a pinkish-brown aphanitic groundmass. The phenocrysts consist of quartz, feldspar, and biotite. The feldspar phenocrysts are either clear, glassy and somewhat opalescent, or white. The rock resembles very much the quartz-latite of the Magdalena district. Paige[1] classifies similar rock from the vicinity as "rhyolite, though it approaches quartz latite in composition."

Colorado shale

The only surface exposure of the Colorado formation at the Ground Hog mine is a strip of bleached shale 20 to 100 feet wide in the fault zone. Underground workings expose similar thin, presumably faulted-in slices, and in addition expose a comparatively thick and extensive series of interbedded sandstone and shale.

The shale and sandstone, though commonly bleached, are recognizable as such in most places, but here and there the shale has been converted into a dense hornfels-like rock.

Gravel, Sand, and Tuff

The Tertiary sedimentary series consists of gravel, sand, and tuff which in the vicinity of the Ground Hog mine are probably between 300 and 400 feet thick.

The base of this series consists of sandy gravels which contain abundant small angular and subangular fragments of quartz diorite and granodiorite. The slopes above the outcrops of the basal gravel are covered with rock debris from the overlying rhyolite (quartz latite) flows, so that the thickness of the gravels is not known. At a few places where the debris was dug into, the underlying material seemed to be tuffaceous.

A coarse, brown, roughly sorted sandstone outcrops near the top of the debris covered slope. This rock seems to contain a fair amount of magnetite and grains of jaspery quartz similar to that which forms part of the veins.

Overlying the sandstone is a white, loosely-coherent, tuffaceous-appearing material which seems to grade upward into a similarly appearing but more solid rock which contains abundant,

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[1]Op. cit., p. 9

partly embayed quartz crystals and euhedrons of biotite in well-formed hexagonal plates. Nearly perfect euhedrons of sanidine 1 mm, or so across also occur. Some of the quartz phenocrysts, 2 to 3 mm, in length, which were gouged out of the rock are apparently nearly perfect double pyramids The rock has a slightly streaky appearance similar to some streaky rhyolites, caused by dashes of pinkish-brown aphanitic material. The ground-mass is slightly porous and kaolinized. This rock is locally called tuff and is shown on the sketch map as the top of the sedimentary series. The nature and character of the phenocrysts, which are characteristic of rhyolites, and likewise the streaky appearance, suggest, however, that this rock is a rhyolite and not a tuff, in which case it would represent the basal flow at this place.

Unexposed Sedimentary rocks

An undetermined thickness of Colorado formation underlies the quartz diorite, which was intruded into it. The Beartooth (Cretaceous) quartzite occurs below the Colorado formation, and it is probably in turn underlain by a nearly complete sequence of Paleozoic rocks,

STRUCTURAL FEATURES

Colorado Formation and Quartz Diorite

The quartz diorite is described by previous workers as a like intrusion into the Colorado formation. If this is borne in mind it tends to simplify the apparent anomolous position of beds of the Colorado formation exposed in underground workings

At the surface only a thin strip of bleached shale is exposed adjacent to the hanging wall fault on the footwall side (see sketch map, page 15). Although the nature of the other contact of the shale strip is not obvious at the surface, underground workings disclose that it also is a fault contact. Presumably, therefore, this strip is a slice between two faults.

Other slices, some relatively thick and others thin, which do not outcrop, are exposed by the mine workings. The contacts of these slices with adjacent rock are fault surfaces in all cases where examined, and they appear to be fault slices or lenses in a broad fault zone.

In addition to these slices the mine workings disclose a comparatively thick and extensive series of shales and sandstones which, though broken by faults, does not as a unit seem to be a local fault lens. This mass was cut in the shaft near the second

level. The shaft is lagged and the relationship at this point unobservable, but it is reported that the shale series is in fault contact with quartz diorite. The shaft passes out of the shale series and into quartz diorite a short distance below the fourth level, thus exposing a continuous vertical section about 230 feet thick. The lower contact is also reported as a fault contact, as illustrated in the accompanying section, page 16.
The shaft at the time of the writer's visit could not be examined at this place.

The third level has penetrated the shale series for about 150 feet laterally. Part of the fourth level vertically below, how-ever, is in quartz diorite with seemingly no evidence to indicate that this is wholly the result of faulting. That it is partly the result of faulting is obvious since the shaft itself is in shale at this level and faults are actually exposed. Therefore, between the third and fourth levels there must be a contact between shale above and granodiorite below which is so flat that it does not intersect either level. A fault parallel to the third and fourth level cross-cuts might explain the structure, but no such fault appears to exist. Another and seemingly reasonable explanation is that the contact is the top of the intrusive.

The northwestern face of the third level crosscut, 150 feet of which is in shale, is still in this rock, though it is directly beneath quartz diorite at the surface. The relationship seems to be that the quartz diorite exposed in the draw is underlain by Colorado formation which in turn is underlain by more quartz diorite. So far as observed, there are no faults in the quartz diorite at this place. The shale-sandstone block may therefore represent an included lens within the quartz diorite or perhaps the intervening sedimentary rocks between an upper and a lower sill. Such a relationship is borne out by an occurrence abut a mile and a half east of Santa Rita described by E. H. Wells[1] of a thin lens of shale with concordant stratification enclosed in the quartz diorite sill.

Quartz Diorite and Granodiorite

A number of dikes of granodiorite cut the quartz diorite in a northeast direction. In some cases veins follow the walls of these dikes.

Granodiorite is also exposed along the main vein on the surface and in the mine workings; in places in the footwall, elsewhere in the hanging wall; in places in direct contact with ore and cut by stringers of ore, elsewhere at some distance from the vein. Bodies of

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[1]Oral communication

granodiorite locally pinch out and overlap in a lenslike manner. At no place, however, does it seem that the contact is intrusive in character. It appears that the granodiorite along the vein represents a rather wide dike which has been faulted in a complicated fashion.

Some of the contacts may represent igneous contacts along which there has been later faulting, and if so, the pinching and overlapping bodies of granodiorite may in part be due to offsetting during intrusion, a feature which in places is very common.

Faults

Faulting has been operative in a zone 200 to 300 feet wide over a considerable interval of time. The first fracturing seems to have occurred long prior to the pre-volcanic erosion period which laid bare the quartz diorite at this place and even may have occurred in the interval between quartz diorite and granodiorite intrusions. The last displacement is represented by the hanging wall fault which is post-volcanic. A number of intermediate movements are recorded.

Three fault systems may be observed upon the surface: (1) The flat system represented by the hanging wall fault and the vein; (2) the system represented by the practically vertical zone on the southeast slope of the saddle which drops rhyolite against tuff; and (3) a transverse fault just north of the San Jose shaft which displaces the vein about 40 feet but stops against or is faulted by the hanging wall fault. A few faults of this last system are exposed underground, but they seem discontinuous and perhaps represent only local adjustments in the fault zone.

Although surface observations suggest simple structural conditions, underground workings expose a complex sequence of faulting and adjustment. Faults or fault systems of at least three ages occur, and possibly as many as six ages may be deciphered with additional study. In the following paragraphs these faults are discussed in their apparent sequence.

Main Vein

The main vein strikes about N. 45°E. and in the central part of the mine has an average dip of about 50° SE. The vein flattens considerably to the southwest and the dip is as low as 30° in places. The vein is not a simple fissure but is made up of a number of connecting fissures, some of which dip locally as low as 20°.

The ore itself is in many places strongly fractured, but no actual brecciation of ore was observed. A highly distorted cleavage system suggestive of strain was noted in galena microscopically.

The ore is cut by veins of comb quartz and sericite, and similar quartz stringers with sulphide walls penetrate the adjacent rock. Microscopic examination of a few specimens shows veinlets of quartz earlier than some sulphides. The vein in general tells a story of continued shattering during mineralization but seemingly without actual displacement among it. The vein is, however, faulted by a different system. Continued fracturing and sealing of the openings by mineral matter probably accounts for the local great thicknesses of the ore body.

The exact age of the vein fracture is at present a debatable question. The ordinary surface work incident to building up a mining camp has somewhat obscured the outcrop near its junction with the Tertiary gravels at the crest of the saddle, but it appears that the vein passes below the gravels and does not cut them. Wall rock alteration (see page 13) suggests that the earliest opening along the line of the vein occurred even prior to intrusion of the granodiorite dikes.

An approximately parallel fault lies between the vein and the hanging wall fault. It is displaced at one place underground by a fault which seems to be of the same system that offsets the vein. The footwall is granodiorite; the hanging wall is shale. The shale probably represents material originally lying above the and, if this is true, the age of the fault is referred to a time when there was still some 200 feet of uneroded shale on top of the quartz diorite sill. It appears that this fault is contemporaneous with or later than the vein fault.

Footwall and Associated Faults

The vein and seemingly also the fault between it and the hanging wall fault have been cut and displaced by a series of vertical faults. These faults do not continue indefinitely downward but seen to bend into a rather strong fault zone roughly parallel to the weir and about 25 to 50 feet within its footwall. This is a compound fault composed of a series of slices or lenses, some of which have been elevated, others depressed. This fault occurred during the period of mineralization since locally it and also one of the vertical faults carry a slight amount of ore. Undoubtedly some of the late fracturing in the vein occurred in sympathy with this fault.

Inasmuch as the footwall fault zone is rather flat, movement along it would be under considerable frictional restraint. The set of vertical faults in the hanging wall may represent tension breaks developed in response to this restraint. That they occur only in the hanging wall may be significant, since they would develop in the block offering easiest relief, that is, toward the surface.

There are a number of subordinate faults in the footwall of the compound fault which dip to the northwest. They are not common and may represent subordinate development of one set of a conjugate system of which the compound fault represents the other set.

Hanging Wall Fault

The hanging wall fault, so called because it is the most prominent fault in the hanging wall of the vein, represents the latest faulting in this vicinity. It dips about 45° and is somewhat flatter than the vein. On the surface at the mine it is 25 to 100 feet from the vein, but the vein and fault gradually converge upward. This convergence brings them together at the top of a low ridge about 250 feet northeast of the San Jose shaft, and the fault seems to have cut off the upper part of the vein. There would seem to be little likelihood of finding the faulted extension, however, for judging from the throw, the fault seems to have intersected the vein quite close to the old erosion surface on which the gravels were laid down. Northeast of this, on the opposite slope of the ridge and out of the mapped area, are some workings on a vein in the footwall of the fault which may represent a continuation of the Ground Hog vein as the vein and fault again diverge down dip. It is reported that the vein and fault converge again at the Lucky Bill mine a short distance to the southwest and that the fault here contains boulders of ore. No ore other than this has yet been found along the hanging wall fault.

The hanging wall fault has been cut at numerous places underground, and its downward course may be plotted with a fair degree of accuracy. As plotted from these observations it appears that the hanging wall fault, which developed after the volcanic rocks had been laid down, opened up slightly in the hanging wall side of the earlier faulting. As the hanging wall fault passed through the volcanics and into the earlier, already faulted rocks, it was still in the hanging wall side and apparently opened a new shear in the hanging wall shale in preference to following the existing break between shale and igneous rocks. With greater depth, where both walls of the old fault were of the same character, the new fault swung into and followed the older break.

The vertical faults in the rhyolite and tuff in the hanging wall of the hanging wall fault perhaps have the same origin as the other set of vertical faults already described, that is, they represent relief from tension due to resistance to movement along a flat surface.

The throw along the hanging wall fault is probably about 300 feet, as noted by the position of the base of the rhyolite porphyry (quartz latite) on either side. This checks the position of the gravel noted underground in the hanging wall of this fault.

ORE DEPOSITS

General Features

Some of the structural features of the vein have already been described. Briefly, the ore occurs along a flatly-dipping fault zone in the sill. Intermineralization fracturing has occurred.

The ore represents chiefly fissure filling. At some places, according to Mr. Hawkins, fault gouge several feet thick forms the hanging wall and footwall of the vein. Whether in all cases this is actually comminuted material or whether it is hydrothermally altered wall rock was not determined. Elsewhere the ore is in direct contact with the wall rock. Microscopic examination of this contact shows that there is some encroachment by replacement, but there seems to be no advance dissemination of ore. In places' the vein contains blocks of altered rock which look more like interfissure blocks than replacement residuals.

Four classes of ore have been mined: (1) Lead carbonate ore with a little copper and silver, (2) secondary copper ore, (3) argentiferous zinc-lead-copper sulphides, and (4) galena ore.

Main Ore Body

The main ore body occurs as a well-defined shoot within the vein. Early work south of the Main shaft encountered some small and irregular bodies of ore, but as much as 500 tons of ore was seldom in sight at one time until the main shoot was discovered. This shoot as thus far developed is about 1,000 feet long and 40 feet wide at the thickest part. It has been developed to a depth of 400 feet below the surface with splendid ore in sight at that depth. The top of the shoot is said to be near the third level in general, though a prong reached the surface and some high grade oxidized lead ore was mined from it there. It is stated that the southwest end of the shoot is about 200 feet or so northeast of the Main shaft. Where explored on the fourth level this interval is practically barren of sulphides. The northeast end of the shoot has not yet been encountered.

Where the shoot was first discovered, a 3-inch stringer of sulphide was followed for 65 feet before it began to open into a minable ore body.

Primary Ore

The primary ore consists of a massive argentiferous mixture of sphalerite, galena, pyrite, and chalcopyrite. Locally the ore has a suggestion of banding in zincy and leady streaks, some of which are sufficiently pure to be sent directly to the smelter.

The relationship, if there is any, of chalcopyrite to' this semi banding is not apparent.

The primary ore now being mined has the following average composition: Silver, 8 ounces per ton; lead, 8 per cent; copper, 4 per cent; and zinc, 16.5 per cent. The ore to which this analysis refers shows a very incipient secondary copper enrichment, but this is so slight that it can have no more than an insignificant effect on grade.

Pyrite occurs throughout the ore in more or less crystalline particles, some of which are well developed, and in fine-grained crystalline aggregates. Crystalline pyrite also occurs disseminated in some of the wall rock, particularly in the quartz diorite.

Sphalerite is in general the most abundant mineral, though as noted above, leady streaks occur in which sphalerite is unimportant. The sphalerite is black or deep brown marmetite. A preliminary microscopic examination shows that it contains chalcopyrite as rows of dots and threadlike veins which follow a pattern suggestive of grain boundaries. A narrow quartze-chalcopyrite vein was noted in one specimen of sphalerite. Chalcopyrite, in addition to the above described microscopic particles, occurs also as megascopic masses in the ore.

The galena is both coarse-grained and fine-grained and in all specimens examined was the last sulphide deposited.

Gangue is scarce in the ore shoot. It consists mainly of quartz and sericite and occurs chiefly in stringers cutting the ore. Quartz combs are common in these stringers. In that part of the vein where sulphides are less prominent or are absent the vein consists of massive quartz which at the outcrop is a reddish jaspery material.

In general, the mineral sequence is as follows: Pyrite, sphalerite, chalcopyrite and quartz, galena, quartz and sericite.

Secondary Ore

The depth to which oxidation has extended seems at present to bear no relationship to the existing surface. The highest point of the base of the oxidized zone lies about 225 feet below the surface and about midway between the Ground Hog and the Main shafts. The oxidized zone pitches rapidly in both directions along the vein from here, whereas in general the surface rises slightly in both directions.

The fifth level penetrates the oxidized zone about 275 feet northeast of the Ground Hog shaft and about 415 feet below the surface. Though the ore is not strongly oxidized at this place, it is sufficiently altered to give trouble in milling. Native copper occurs at the surface and is said to extend at least as deep as the bottom level of the San Jose shaft, 260 feet below the surface. Native silver is said to occur above the third level and south of the Main shaft at a depth of about 240 feet.

Goslarite and chalcanthite occur in some of the underground workings. The goslarite is both massive and capillary and some of it is red or green, perhaps representing Ferro-goslarite and cuprogoslarite. No oxidized zinc minerals other than goslarite were noted, though they probably occur. Copper carbonates and silicate are present.

The upper levels in the oxidized zone furnished some good ore in the earlier days of the mine. A bonanza body of cerusite was glory-holed at one place. Vanadinite and cuprodescloizite occur at and near the surface, and at the Lucky Bill mine the vein was worked for vanadium at one time .[1]

Veins and bands of porcelainous material resembling halloysite are common in places in the lower part of the oxidized zone.

The chalcocite zone between the primary and leached zones seems very irregular. Chalcocite is prominent on the 400 level toward the Main shaft. Massive sulphides from the 450 level and 100 feet or more below the top of the sulphide zone show incipient microscopic enrichment of chalcopyrite by bornite and covellite, and a few blades of covellite were noted replacing galena. No obvious chalcocite was noted here, even microscopically, but some of the sphalerite has a sooty-looking tarnish which probably represents incipient chalcocitization.

Primary Wall Rock Alteration

The quartz diorite adjacent to the vein is sericitized, silicified, and pyritized, and generally altered beyond recognition. The granodiorite, on the contrary, though older than the ore, is comparatively fresh and at least recognizable, even where in direct contact with massive sulphides. A polished specimen of granodiorite in direct contact with ore shows a few pyrite specks but no other sulphides. The feldspar phenocrysts of this rock are partly altered.

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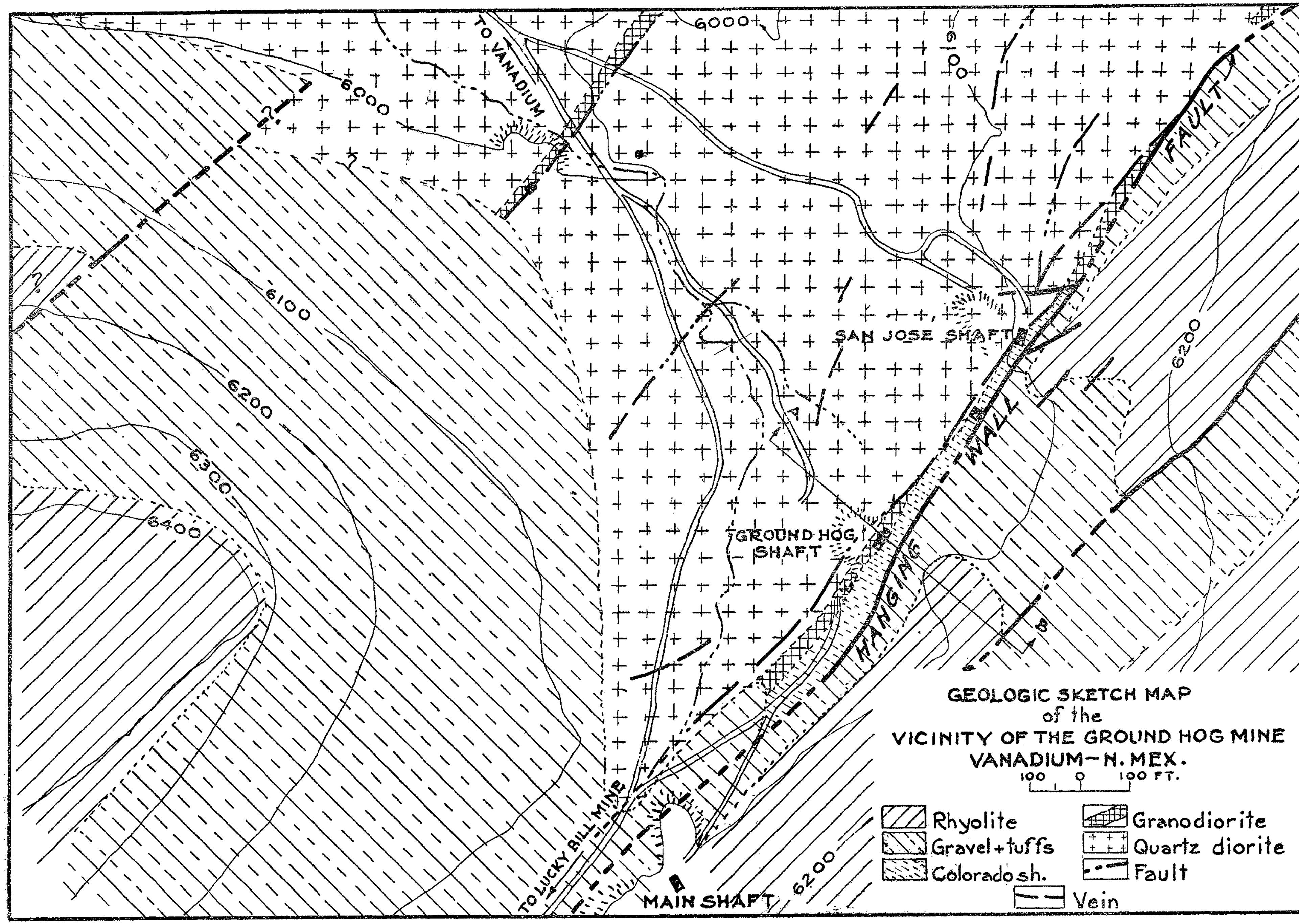
[1] Larsh, P. A., Lucky Bill Vanadium Mine: E. & M. J., PP- 1103-1104, Dec. 13, 1913.

The difference in degree of alteration between quartz diorite and granodiorite is surprisingly great. Either these rocks are inherently susceptible to alteration to a different degree or else they both were not bathed by the same solutions, Commonly primary alteration attacks different igneous rocks without great preference, and the resulting altered rocks generally look alike. The inference is that fracturing took place in the sill, and that the sill rock was altered prior to intrusion of the granodiorite.

Genesis of the Deposit

The wall rock alteration described above throws interesting light on the genesis of the deposit. Presumably the sill was fractured prior to intrusion of the granodiorite, and the rock along this fractured zone was altered by its own concomitant or related magmatic juices. These juices may have carried no metals, for the pyrite may have resulted from the femic minerals of the rock.

Later intrusions of granodiorite in the form of dikes followed the earlier fracturing, and these in turn were fissured and faulted. The granodiorite juices were heavily metal-laden though not so rich in those constituents which promote intense rock alteration. These solutions probably furnished the ore, which to a very great degree seems only to have filled the available openings. The few pyrite specks in the granodiorite probably resulted from alteration of the femic minerals and if so are different in origin from the pyrite of the ore.


GEOLOGIC SKETCH MAP
of the
VICINITY OF THE GROUND HOG MINE
VANADIUM – N. MEX.
100 0 100 FT.
Rhyolite
Gravel + tuffs
Colorado sh.
Granodiorite
Quartz diorite
Fault
Vein
TO VANADIUM
TO LUCKY BILL MINE
SAN JOSE SHAFT
GROUND HOG SHAFT
MAIN SHAFT
HANGING WALL
FAULT
6000
6100
6200
6300
6400
A
B