

GEOLOGY OF THE GROOM DISTRICT,
LINCOLN COUNTY, NEVADA

A THESIS

SUBMITTED TO THE FACULTY

OF THE UNIVERSITY OF NEVADA

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF ENGINEER OF MINES

BY

FRED L. HUMPHREY

1948

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Submitted by

FRED L. HUMPHREY

Candidate for degree

Approved by

Jay A. Carpenter

Director, Mackay School of Mines

Accepted by

F. W. Franer

Chairman, Graduate Committee

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Geology of the Groom District,
Lincoln County, Nevada

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Geologist, Nevada State Bureau of Mines

PRICE TWENTY-FIVE CENTS



PUBLICATION OF THE NEVADA STATE BUREAU OF MINES

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PREFACE

Since 1936 the Nevada State Bureau of Mines has been making a study of Cambrian stratigraphy in Nevada. It has been aided by the work of the Hunt Foundation summer geology field course at the Mackay School of Mines.

The geologist in charge has been Dr. Harry E. Wheeler, Associate Professor of Geology, University of Nevada.

The bulletins issued are:

"Cambrian Formations of the Eureka and Pioche Districts, Nevada,"

"Revisions in the Cambrian Stratigraphy of the Pioche District, Nevada,"

"Lower and Middle Cambrian Stratigraphy in the Great Basin of Nevada,"

Dr. Wheeler has so aptly stated in the first of these bulletins, "Knowledge of Cambrian stratigraphy is of great importance in understanding the geological relationships of numerous ore deposits in Nevada, especially in the areas of the widespread lead-zinc mineralization of the eastern, central, and southern portions of the State. The need of such knowledge is manifest in any rational attempt to discover new deposits, or to locate unexplored continuations of previously known ore bodies, which are most invariably faulted into segments."

This bulletin extends the study to cover the Groom district in the southwestern part of Lincoln County.

Dr. Wheeler is on leave in the service of the U. S. Navy, and the work was carried out by Fred L. Humphrey, who was already familiar with Cambrian stratigraphy through study under Dr. Wheeler.

Paul Gemmill of the Prince Mine at Pioche, Nevada, served in an advisory capacity. His acquaintance with Cambrian stratigraphy covers the years since he was graduated from the Mackay School of Mines in 1930.

JAY A. CARPENTER,
Director.

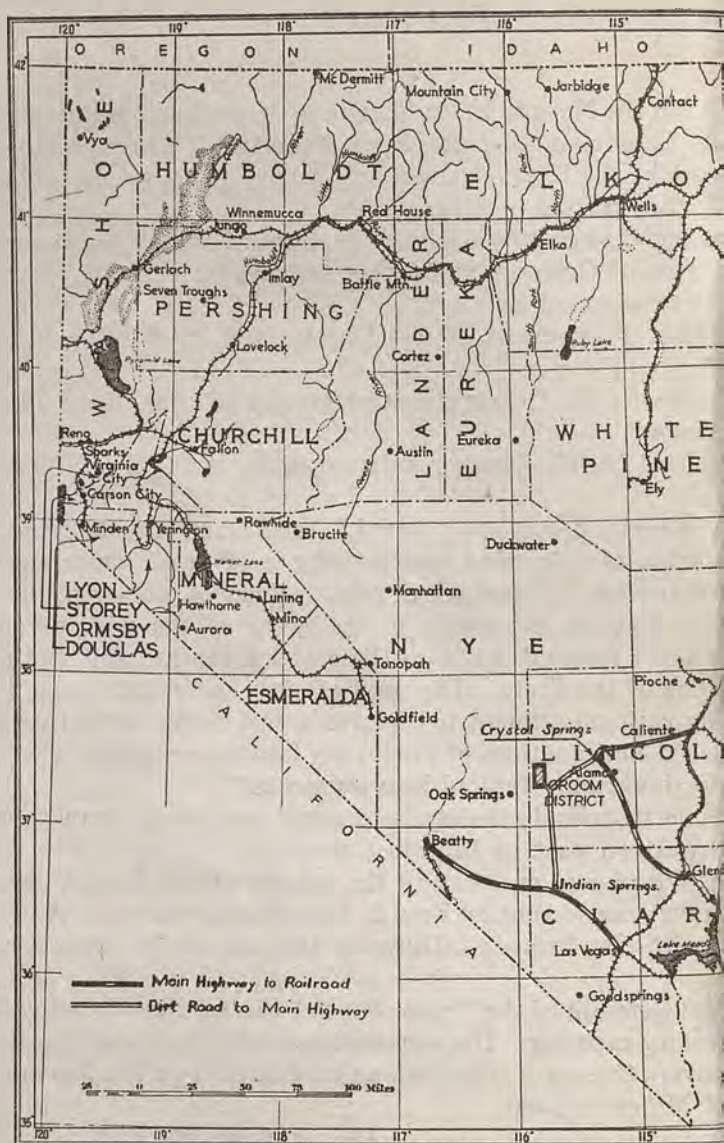


FIGURE 1--Map of Nevada showing location of Groom district

GEOLOGY OF THE GROOM DISTRICT, LINCOLN COUNTY, NEVADA

By FRED L. HUMPHREY

ABSTRACT

Old work in the Groom district has shown a distinct lithologic continuity in the Lower and Middle Cambrian stratigraphy with that of the Pioche district. An exceptionally thick section of Precambrian Mountain quartzite forms the west side of the Groom Range, measuring over 7,000 feet in thickness, with the base, as yet not disclosed. There is no distinct evidence of fault repetition in this section. No diagnostic fossils were found in the Precambrian Mountain quartzite, but it is the writer's opinion that this formation extends into the Pre-Cambrian. The east side of the Groom Range displays excellent exposures of the Pioche, Lyndon, Tonolowich, Peasley, Burrows, and Highland Peak formations, with characteristic fossil horizons. Volcanics, dominantly andesite, cover the central portion of the range.

The structure, in the southern portion of the Groom Range, is comparatively simple, with the exception of a fault block, or graben, within the quartzite, which is very complexly faulted. The graben area is a downfaulted block of Pioche shale and limestone, probably antedating the period of Basin and Range faulting. It contains the only known mineralization of economic importance, which is dominantly a replacement of limestone by argentiferous galena.

INTRODUCTION

LOCATION

The Groom mining district is situated in southwestern Lincoln County, Nevada, about 75 miles west-southwest of Caliente. The district lies in an unsurveyed area of the State, but is probably in Township 7 south, Range 55 east, M. D. B. & M. It is reached by a 45-mile dirt road from Crystal Springs which is 42 miles from Caliente on the Caliente-Las Vegas highway (U S 93). There is a 60-mile dirt road into the district from Indian Springs to the south, on the Las Vegas-Tonopah highway (U S 95). This road cannot be used at the present time as it crosses the Army Groom Range.

Wherein restricted, the Groom mining district is in the southern portion of a small isolated north-south mountain range, about 10 miles south of Tem Piute. For want of any apparent name, the range will be called the "Groom Range." It is separated from

the Timpahute Range on the west and north by the nor-
extremities of Emigrant Valley, and from the Silver Cad
Mountains on the east by Desert Valley.

FIELD WORK

The Nevada State Bureau of Mines has long been ac-
studying and mapping the Cambrian sedimentary sequ-
eastern and southern Nevada. This work has been carri-
as an aid to the exploration and development of the r-
resources of the State.

Mr. Paul Gemmill visited the Groom area in 1943 at the
of Director Carpenter, and recognized the formations as b-
very similar lithologic character, and having the same
graphic sequence as the Cambrian formations at and
Pioche, Nevada.

Field work for this publication occupied the period from
ber 8 to December 6, 1944. The writer was assisted by D
Launer until November 8, then by Mrs. Glenna Humph-
the remainder of the period.

Temporary triangulation points were set up for control
system of coordinates established. Surface mapping was
transit and stadia, and the main underground workings w-
veyed by transit and tape. All intermediate levels and
were mapped by Brunton compass and tape.

Elevations are all based on an aneroid reading of 5,2
above sea level at the portal of the 200-foot level at the
mine.

Observations on Polaris established a true north poir
coordinate point 20,000 north-20,000 east. The magnetic
tion was found to be approximately 16° 40' east.

ACKNOWLEDGMENTS

The writer and the Bureau express their sincere thanks
Dan Sheahan, manager for the "International Mining Co
and Dan Sheahan," a joint venture, at the Groom Mine,
complete cooperation and assistance in the work.

Paul Gemmill of the Prince Mine, Pioche, Nevada, h-
most cooperative and helpful, aiding in many ways with h-
rienced knowledge of the Cambrian sequence in eastern N

Dr. G. Arthur Cooper, of the Smithsonian Institution,
made generic identifications of some diagnostic trilobite
from the area.

The writer desires to acknowledge his indebtedness

ry E. Wheeler of the Bureau, the recognized authority on Cambrian stratigraphy, for the knowledge of the Cambrian sequence gained under his tutelage in the Pioche district. The writer is indebted to Vincent P. Gianella, Professor of Geology, University of Nevada, and to Jay A. Carpenter, Director of the Nevada State Bureau of Mines, for the critical reading of this manuscript.

For detailed published information on the geology of the Groom District is known to the writer. The references coming to the writer's attention are cited below:

Albert, G. K., Geog. Surv. west of the one hundredth meridian: Vol. 3, pp. 41, 42, 169, 170, 181, 1875.¹

Angwell, C. R., Structural studies in southern Nevada and western Arizona: Soc. America Bull., Vol. 37, p. 556, 1926.

Curry, J. E., Descriptive geology of Nevada south of the fortieth parallel, adjacent portions of California: U. S. Geol. Surv. Bull. 208, pp. 159, 160.

Inasmuch as any study of this district would necessitate some knowledge of Nevada Cambrian stratigraphy the reader is referred to the following publications:

Bestgate, L. G., and Knopf, Adolph, Geol. and ore deposits of the Pioche District, Nevada: U. S. Geol. Survey Prof. Paper, 171, 1932.

Wellaghan, Eugene, Geol. of the Delamar district, Lincoln County, Nevada: Nevada Univ. Bull. Vol. 31, No. 5, 1937.

Wheeler, H. E., and Lemmon, D. M., Cambrian formations of the Eureka and Pioche districts, Nevada: Nevada Univ. Bull., Vol. 33, No. 3, Geol. and Mining Series, No. 31, 1939.

The Wheeler's terminology for formation names² in the Pioche District is followed by the writer. The fossil evidence, and the similarity of lithologic character of the formations to those in the Pioche District are felt to be sufficient to warrant this.

SURFACE FEATURES

The Groom Range is approximately 30 miles long and 10 miles wide. The elevation varies from about 4,500 feet in Emigrant Valley immediately south of the area mapped, to nearly 10,000 feet 10 miles north, at the summit of a bald volcanic peak near the center of the range.

The quartzites and lavas usually form steep rounding slopes in contrast to the more rugged and cliff-forming massive limestones.

¹The "Groom Range" was taken to be a part of the Timpahute Range.

²also called the Tequima Range by early settlers.

Wheeler, H. E., Revisions in the Cambrian stratigraphy of the Pioche District, Nevada: Nevada Univ. Bull., Vol. 34, No. 8, Geol. and Mining Series, No. 31, 1940.



FIGURE 3—Central portion of the south end of the Groom Range. A view northward from one mile south of Groom mine, showing a cross-section of the area mapped. The mine buildings can be seen at the left. The depression is the shale and limestone fault-block in the quartzite.

dolomites. The easily eroded shales and thin-bedded limestones are commonly occupied by drainage areas. This is particularly true of the Pioche shale formation which is much covered by alluvium.

The vegetation in the lower hills is scattered sagebrush and quail trees. Above the 5,500-foot elevation juniper trees appear, and become more numerous above 6,000 feet where there are also scattered fir trees. The top of the high volcanic peak near the center of the range is bare, which has given it the local name "Mount Baldy."

Precipitation in the district averages about six inches per year. Runoffs are scarce and flow only a small amount of water, most of which is utilized by cattlemen. Two springs in the volcanics on the west side of Mount Baldy might be opened and the flow considerably increased. At the time of the writer's visit they yielded an estimated 10 to 15 gallons per minute, but much water escapes as seepage into the alluvium.

Only one spring, Cane Springs, 6,000 feet southwest of the main shaft, was found in the limestone. It is on a fault in the upper limestone near the top of the underlying Pioche shale.

The hydrostatic pressure in the impervious shale undoubtedly forces the water to the surface along the fault. This shale-limestone contact might be a favorable horizon for deep well development.

The Groom mine obtains a small flow of about 12 gallons per minute in the 200-foot level, from water impounded in the fractured quartzite in the footwall of the Main fault.

The Nigrant Valley offers much the same favorable structural conditions for water development as do many other similar valleys in the area. Deep wells sunk in the valley along the western edge of the Groom Range would undoubtedly develop a substantial amount of water; however, it probably would contain a large amount of dissolved salts.

GEOLOGY

REGIONAL FEATURES

Sedimentary rocks are exceptionally well exposed in the Groom District and comprise an apparently complete sequence of Cambrian formations from the basal Prospect Mountain quartzite to the Highland Peak formation.

The southern portion of the Groom Range is divided longitudinally into approximately two equal parts. The west portion is composed largely of Prospect Mountain quartzite, while the

east portion is made up of the overlying shales and limestone. The quartzite portion is divided by a down-faulted block of quartzite and limestone which averages about 2,000 feet in width (see figure 4). The important economic feature of the district is the mineralized "fault block" in the quartzite about one-half mile west of the conformable quartzite and shale contact.

Because of limited time only the formations from the quartzite through the base of the Highland Peak were mapped along the down-faulted block. In order to understand the contact of the faulted inlier, a detailed study was made of corresponding geologic units to the east, which are comparatively unfaulted. The inlier consists primarily of Pioche shale and Lyndon limestone with a little Chisholm shale and Peaslee limestone.

No Highland Peak rocks were found in the "fault block" with the possible exception of an isolated butte (see figure 16) on the edge of the valley south of the Groom mine. The northern part of this butte was studied hurriedly and found to be Peaslee limestone, Burrows dolomite, and Highland Peak formation.



FIGURE 4—Cross-section of the south end of the Groom Range. Valley is to the left; q is Prospect Mountain quartzite; plc is Pioche shale, Lyndon limestone, and Chisholm shale; pbh is Peaslee limestone, Burrows dolomite, and Highland Peak formation.

stone and Burrows dolomite. The length of the butte and the attitude of the beds would indicate the probability of the amount of Highland Peak formation exposed on the south side. Without further study, which would probably necessitate drilling through the surrounding alluvium, and a search for faults striking normal to the bedding, this butte should be included as a southern extension of the "fault block."

The Highland Peak formation extends for several thousand feet east of the area mapped. It is probable that further study in the eastern part of the range would reveal Peaslee rocks younger than the Highland Peak formation.

To the west of the area mapped the Prospect Mountain quartzite extends for a horizontal distance of over $2\frac{1}{2}$ miles north of the strike of the bedding, to the edge of Emigrant Valley. A large north-south fault forms the west side of the range. To the north in the range the exposed quartzite outcrops for a greater width, as the average bedding strike is about N 8° E. The fault bounding the range trends approximately north-south.

At the base of the quartzite formation may be exposed some place along the edge of the valley, but a hurried reconnaissance for a distance of six or eight miles failed to reveal it. In a few places the very flat-dipping, thin-bedded, red and white banded sandstone is found exposed in gulches west of the north-south fault.

It is doubtful that this rock is a part of the Prospect Mountain quartzite formation, and is presumed to be much younger; very probably it is an erosional product of the quartzite. The massive quartzite immediately east of the fault is somewhat conglomeratic. This might indicate possible proximity of the base of the formation, although similar "conglomerates" were noted at higher altitudes.

PROSPECT MOUNTAIN QUARTZITE

The Prospect Mountain quartzite is the basal Cambrian formation in the district. A vertical thickness of 7,855 feet was measured to the west of the "fault block" with no appreciable, fault repetition. The base is not exposed. Further structural study is needed to verify this great thickness. The formation consists of alternating beds of massive white to pink quartzite, and thin-bedded brown or red quartzite with interbedded shale. Two shale beds, with thin quartzite ribs of two to three inches in width, measure over 200 feet in thickness. The shale is fine-grained, micaceous, dull-buff rock with some greenish shaly layers probably containing glauconite. No fossils were found, but worm borings are common in the shaly quartzite beds, some measuring one-half inch in diameter. Due to the lack of any diagnostic fossils there is only the exceptional thickness of the formation to substantiate the writer's opinion that the formation may be found to extend into the Pre-Cambrian, without any demonstrable break between the Cambrian and Pre-Cambrian. The massive quartzite commonly weathers brown or red with very distinctive beds weathering black. Some of the massive quartzite is conglomeratic with quartzite pebbles one-eighth to one-half inch in diameter in a fine-grained white quartzite matrix. The bedding is pronounced in massive quartzite near the middle of the exposed portion of the formation immediately below a thick shale bed.

North-south gulleys consistently develop along the shaly "horizontals" which depressions were apparently mistaken by Gilbert to have been the manifestations of major faults.³

The section of the quartzite measured extends from the top of

³ Gilbert, G. K., Op. cit., p. 38.

the formation, which is in fault contact with the west side of the "fault block." Approximately the upper 1,500 feet is a repetition of the quartzite to the east of the "fault block."

PIOCHE SHALE

The Pioche shale is 961 feet thick which coincides closely with the thickness recorded at Pioche⁴ and at Delamar.⁵ The formation is generally a thin-bedded, micaceous, green, buff, or gray shale with several intercalated limestone members.

The basal limestone bed, "a" bed on the maps, 110 feet thick, at the base of the formation is a thin-bedded, dark-gray, fine-grained, dense limestone with an 8-foot green shale bed near the top. This limestone undoubtedly represents about the same horizon as the "Combined Metals bed" at Pioche. Above this limestone is a thin-bedded limestone and interbedded carbonaceous shale separated by 30 feet of green, thin-bedded shale, is 250 feet thick. The limestones mapped as "b" bed. This "b" bed has been divided for purposes of large-scale mapping, into a lower "b" and an upper "b" or "b²". Trilobite fragments are present in both "a" and "b" limestone beds. Near the top of "b" is an eight-foot bed of very dense, shale-parted limestone with large well-preserved head shields of *Olenellus* sp. Three feet below the top of the Pioche shale is a 15-foot bed of gray limestone. This limestone is resistant to erosion and commonly forms a small ridge. It overlies about 100 feet of thin-bedded, carbonaceous shale which usually weathers purple. The upper 48 feet of the formation is shale, with seven interbedded limestone members from one to three feet in thickness. The upper limestone beds, where encountered in the Groom District, are very favorable to mineralization. Medium- to dark-gray limestone is characteristic of these limestones. One thin limestone bed shows very pronounced stylolites. Minor strike faulting and local slippage is very common through this horizon, making it difficult to accurately measure the thickness of the section.

The boundary between the Lower and Middle Cambrian is probably near the "c" limestone bed in the Pioche shale. Fossiliferous material from this horizon was identified by Dr. Cooper as *Elrathia* (?). It is the writer's impression that *Elrathia* is restricted to the middle and upper part of Middle Cambrian.

⁴Wheeler, H. E., and Lemmon, D. M., Op. cit., p. 54, 1939.

⁵Callaghan, Eugene, Geology of the Delamar district, Lincoln County, Nevada Univ. Bull. Vol. 31, No. 5, p. 17, 1937.

⁶Cooper, G. A., Curator, Invertebrate Paleontology and Paleobotany, Smithsonian Institution, United States National Museum, Washington, D. C.

ever, if not *Elrathia* these fossils may be an *Ehmania* or *Dawsonella* of similar appearance.

A fossil collected by Mr. Paul Gemmill, in 1943, was identified by Dr. Chas. E. Resser, who stated: "The one cranidium was certain, but may possibly be referred to *Ehmania* of the lower part of Middle Cambrian." While this fossil was found near the mine in an area that is highly faulted, and much obscured by alluvium, it came from a purple shale which is characteristic of the shale immediately underlying the "c" limestone bed. This evidence suggests that the base of the Middle Cambrian is at least, 320 feet below the top of the Pioche formation, and more than 170 feet stratigraphically above the uppermost *Olenellus* (Lower Cambrian) that were found in the Groom section. However, such fossil evidence as is cited is not conclusive. Dr. Charles Deiss⁸ writes: "A number of rather nondescript trilobites occur in the upper part of the Lower Cambrian and lower part of the Middle Cambrian that superficially resemble *Elrathia*, and some, to a less extent, resemble *Ehmania*. The anatomy and relationships of these forms have not been worked out but they probably bear little relationship to *Ehmania* or *Elrathia*. Until a relationship is established such doubtful forms must be considered as having little value as index fossils of formational value." *Olenellus* trilobites and an undetermined species of brachiopods (?) are numerous throughout the "a" and "b" limestone of the Pioche formation. The uppermost *Olenellus* specimens found were in the shale about 30 feet above the top of the "c" limestone.

LYNDON LIMESTONE

Underlying the Pioche shale is the Lyndon limestone, composed of 100 feet of thick-bedded, massive, dark-gray limestone, alternating with thin-bedded, shale-parted, easily eroded limestone. Part of the massive limestone has numerous irregularly distributed small lenses of buff-colored shale. These shale lenses average about two inches long and one-quarter of an inch thick. The matrix is usually dark gray in color, but near the center and the top, disseminated iron oxide gives the rock a pinkish tinge. Fossils or algae with characteristic shapes are abundant at certain horizons in this formation, and also in certain limestone beds at the top of the underlying Pioche shale. They have both concentric and radial structures, ranging from one-half to two

⁸Atwell, B. F., and Mason, J. F., Correlation of Middle Cambrian faunas of America: Journal of Paleontology, Vol. 12, No. 3, p. 296, 1938.
⁹Deiss, Charles, Professor of Geology, Montana State University. Personal communication.

inches in diameter. As no sponges or algae were found in the limestone formations, except for a very few at the top of the massive Peasley limestone, these may be used to advantage as marker beds.

Nondescript trilobite fragments were noted in shale about 50 feet above the base of the formation at Cane Springs. As no fossils are recorded to have been found in the Lyndon limestone, further search in this area for diagnostic fossils may be of particular interest.

The Lyndon limestone and the underlying top of the Peasley shale are of particular interest as they comprise the exposures of mineralization at the Groom mine.

CHISHOLM SHALE

The Chisholm shale measures 332 feet in thickness along B-B' of figure 2. One mile to the south a section partly covered by alluvium measured 295 feet. At this place strike-slip faulting occurs in the Lyndon limestone immediately below the shale, hence a section of the shale may have been faulted out.

The lower half of the Chisholm is largely a thin-bedded, buff limestone. The bottom 12 feet is a very thin-bedded limestone with numerous flat, smooth, oval pebbles, four to six inches in longitudinal diameter, of very dense, fine-grained (lithology) limestone lying parallel with the bedding. These do not resemble any limestone found in the underlying Lyndon formation and may be concretions. Trilobite fossils of *Kootenia* sp. and *Elrathia* sp. are very numerous in an eight-foot carbonaceous limestone bed, which is 40 feet above the base of the shale.

Dr. Harry E. Wheeler⁹ writes: "You will note that this is the first reported occurrence of *Kootenia* from the Chisholm shale, although * * * the genus ranges from upper Pioche to the top of the high in the Middle Cambrian * * *. This is the first occurrence of *Elrathia* in Chisholm shale of this general region, although it is found in Chisholm of the western Grand Canyon."

The upper half of the formation grades into a more arenaceous shale and becomes very arenaceous toward the top. The top 30 feet is a very resistant argillaceous sandstone which is dark brown to black, and is commonly cliff forming.

⁹Wheeler, H. E., Associate Professor of Geology, University of New Mexico, serving in the armed forces as a Lieutenant, U. S. N. R. Personal communication.

PEASLEY LIMESTONE

op the Pioche district, the differentiation of the Peasley and geows formations from the Highland Peak formation is primarily based, by Wheeler (op. cit.), on the occurrence of unconformable contacts between them. While no unconformities have definitely established, by the writer, in the Groom district, it is felt that the distinct difference in lithology, between the three formations of rock, warrants their being classed as different forma-

The Peasley formation along section B-B' measures 215 feet in thickness. The bottom 152 feet is essentially a dark-gray, fine-grained limestone with many shale nodules in the lower half. The rock resembles the more massive portions of the Lyndon limestone, commonly forming rugged, steep slopes. The top 62 feet is interbedded massive limestone, and very thinly laminated and sandy parted limestone. The thinly laminated shaly limestones are pink on a freshly broken surface and weather red-

The Peasley limestone is found to be susceptible to recrystallization. South of the strike fault near the middle of the map (figure 2) much recrystallization has taken place. This recrystallized rock is a medium-grained limestone, grading gradually from light gray to dark gray near the base. The prevalence of faults here may be the dominant controlling factor for the recrystallization. Similar recrystallized white Peasley limestone is found at the Groom mine (see figure 8). Metamorphism of the Peasley limestone differs from that in other formations in that dolomite was formed.

A recognizable unconformity was found at the top of the Peasley formation in the Groom district. However, the thin-bedded shale and sandy-parted limestone at the top of the formation indicate a period of shallow water deposition. It is probable that the unconformity present in the Pioche district does not extend this far west.

BURROWS DOLOMITE

The Burrows formation is a light gray to white, coarse-grained, recrystallized dolomite and limestone measuring 347 feet thick along section B-B'. While the formation is called a dolomite, and generally shows complete recrystallization, it is but partly dolomitic. As the top half of the formation, overlying a 20-foot bed of thin-laminated, cream-colored, more-impervious limestone, is



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more consistently dolomitized than the lower part, it indicates a supergene origin for the dolomitization. A distinctive, "frozen," knife-edge contact between the white dolomite and a dark-gray limestone of the overlying Highland Peak formation is noted in this area. This implies, if an unconformity, at least a period of no deposition, during which time the Burrows formation began to consolidate. No difference in the attitudes of the two formations could be observed, nor is there any appreciable difference in the thickness of the Burrows formation where measured.

HIGHLAND PEAK FORMATION

The total thickness of the Highland Peak formation was not measured, but it appears to exceed 4,000 feet. It is dominantly dark-gray, massive dolomite with several thin interbedded dark-gray dolomite and limestone beds (see figure 5). Some of the gray dolomites are lenticular while others are continuous.

The lenticular beds, especially, show a transition from gray carbonate rock to recrystallization and bleaching.

The basal 270 feet is a dark-gray to black, fine-grained limestone with many nodules of medium-gray recrystallized limestone. The top thirty feet of this bed is a black (sooty), dense, fine-bedded, thin-bedded limestone. The sooty limestone grades into a gray argillaceous, thin-bedded, shale-parted, medium-gray to black limestone 124 feet in thickness. Fossils found near the base of this shaly bed were identified as *Coelaspis* (?) sp. and are probably of the Middle Cambrian. This bed is undoubtedly about the same horizon as a 12-foot shaly member found 60 feet above the base of the Highland Peak formation in the Pioche area.¹⁰

Above the shaly member is about 2,000 feet of dominantly gray, recrystallized dolomite, with scattered interbedded beds of dark-gray, white-speckled dolomite. The dolomite is replaced by a very thin-laminated, dense, very fine-grained interbedded cream-colored limestone and dolomite, with some thin-bedded platy, distinctive brown-weathering, calcareous sandstone. Sandstone and dolomite occur in the cream-colored rock as thin-laminations. Disseminated iron oxide is present in the dolomite. This rock is thought by the writer to be a primary carbonate precipitated in shallow waters. The limestone laminations were due to precipitation during seasonal, or periodical freshenings by the sea when the waters were less stagnant. As

10. S. E. Hurler, H. E., Revisions in the Cambrian stratigraphy of the Pioche District, Nevada: Nevada Univ. Bull., Vol. 34, No. 8, Geology and Mining Series, p. 33, 1940.

evaporation proceeded and the waters became more stagnant. More soluble iron oxide would precipitate along with dolomite. The cycle was repeated by recurrent flooding.

This thin-laminated carbonate rock is very similar in lithology to a thin-laminated rock found near the middle of the Highland Peak formation in the Pioche area.

To the east a considerable thickness of light-gray dolomite was observed overlying the thin-laminated rock, but was not studied.

**PARTIAL CAMBRIAN SECTION OF THE GROOM DISTRICT
UPPER (?) AND MIDDLE CAMBRIAN
HIGHLAND PEAK FORMATION**

Dolomite and limestone (estimated thickness)	
Sandstone, calcareous, brown to buff	
Limestone and dolomite, dark-gray	
Dolomite, light-gray, massive	
Sandstone, calcareous, with thin-laminated, sandy, buff dolomite	
Dolomite, white, massive	
Sandstone, calcareous, brown, thin-bedded	
Dolomite, cherty, buff to pink	
Dolomite, medium-gray, mottled with dark-gray limestone	
Limestone, dark-gray, fine-grained, cherty, sandy	
Sandstone, brown, calcareous, platy	
Dolomite, cream, thin-laminated with alternate layers of cream limestone	
Dolomite, light-gray, coarse-grained, recrystallized, contains beds of dark-gray, recrystallized dolomite	
Limestone, thin-bedded, shale-parted, contains trilobite fossils of <i>Coelaspis</i> (?) sp.	
Limestone, black (sooty), fine-grained, thin-bedded	
Limestone, dark-gray to black, massive, with medium-gray limestone nodules	
Total thickness of the Highland Peak formation	

**MIDDLE CAMBRIAN
BURROWS DOLOMITE**

Dolomite, light-gray, recrystallized, with some limestone	
Limestone, cream, thin-laminated	
Dolomite, massive, coarse-grained, light-gray	

MIDDLE CAMBRIAN—Continued

	FEET
estone, cream, thin-laminated.....	17
estone, massive, light-gray, recrystallized, partially dolomitized.....	95
<hr/>	
al thickness of Burrows dolomite.....	247
PEASLEY LIMESTONE	
estone, sandy, cream to pink, thin-laminated.....	10
estone, dark-gray, fine-grained.....	10
estone, sandy, shaly, brown, thin-bedded.....	12
estone, medium-gray, medium-grained, massive.....	16
estone, fine-grained, dense, dark-gray, thin-bedded, sandy and shaly.....	15
estone, dark-gray, fine-grained, massive-bedded, few shale nodules (this section amenable to recrystalli- zation).....	64
estone, same as above but with many shale nodules....	80
estone, dark-gray, fine-grained, thin-bedded, shale- parted.....	8
<hr/>	
al thickness of Peasley limestone.....	215

CHISHOLM SHALE

estone, argillaceous, micaceous, resistant, weathers dark-brown to black.....	9
e, arenaceous, blocky, dark-brown.....	34
e, thin-bedded to blocky, brown to buff.....	80
e, buff, scattered 1/2- to 1-inch limestone units.....	34
estone, thin-bedded (1/2 to 2 inches), with thin, buff- colored shale partings.....	30
e, thin-bedded, buff and olive green.....	83
estone, carbonaceous, shaly, easily eroded, abundant fossils of <i>Kootenia</i> sp. and <i>Elrathia</i> sp.....	10
e, buff and brown, thin-bedded.....	41
e, brown to buff, thin-bedded, many oval, water- worn limestone pebbles.....	11
<hr/>	
al thickness of Chisholm shale.....	332

LYNDON LIMESTONE

e. stone, dark-gray, weathers medium-gray from dis- seminated iron oxide, top one foot characteristically cherty.....	8
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MIDDLE CAMBRIAN—Continued

Limestone, dark-gray, fine-grained, resistant, sponge beds	op
Limestone, thin-bedded, easily eroded.....	nest
Limestone, resistant, medium-gray and pink banding, disseminated iron oxide.....	nest
Limestone, thin-bedded, shale-parted, easily eroded.....	de
Limestone, dark-gray, fine-grained, resistant.....	of
Limestone, dark-gray, thin-bedded, easily eroded.....	le, '
Limestone, dark-gray, fine-grained, resistant, shale nodules, sponges.....	me
Limestone, thin-bedded, shale-parted, easily eroded.....	nest
Limestone, massive, resistant, dark-gray, shale nodules and partings, sponges.....	sha
Limestone, dark gray, thin-bedded, shale-parted.....	le, c
Total thickness of Lyndon limestone.....	bro

MIDDLE AND LOWER CAMBRIAN

PIOCHE SHALE

Shale, brown, thin-bedded, sandy.....	le, g
Limestone, medium and dark-gray banding, sponges.....	wit
Shale, brown, sandy, thin-bedded.....	esto
Limestone, medium-gray, sponges.....	otto
Shale, brown	le, g
Limestone, medium and dark-gray banding, sponges.....	op '
Shale, brown, calcareous, thin-bedded.....	esto
Limestone, medium-gray	Ole
Shale, brown, includes one foot of resistant, blocky sandstone	esto
Limestone, medium-gray, stylolites.....	sha
Shale, brown, sandy.....	e, g
Limestone, medium and light-gray banding.....	esto
Shale, brown to buff, thin-bedded.....	fra
Limestone, medium and light-gray banding.....	otto
Shale, green and buff, mostly thin-bedded, more blocky and calcareous near top.....	e, g
"e" limestone bed—	e, b
Limestone, dark-gray, fine-grained, resistant, 3-inch to 1-foot bedding.....	l th
Shale, thin-bedded, green, buff and purple (carbonaceous shale weathers purple), one foot calcareous rib 80 feet below "e" limestone.....	stor
	tzit

MIDDLE AND LOWER CAMBRIAN—Continued

	FEET
Top "b" limestone bed—	
"b ² "	
limestone, nodular, shaly.....	15
limestone, thin-bedded with smooth buff bedding planes, dense, fine-grained, dark-gray, abundant head shields of <i>Olenellus</i> sp.	6
shale, "paper," carbonaceous, calcareous, trilobite frag- ments and brachiopods.....	6
limestone, thin-bedded, nodular, interbedded brown shale	70
shale, calcareous, thin-bedded, brachiopods, red-to- brown iron-stained in Groom mine area.....	30
"b ¹ "	
limestone, dark-gray, fine-grained, very thin-bedded, shale parted	35
limestone, dense, fine-grained, dark-gray (blue), thin- bedded but resistant.....	70
limestone, massive, bottom four feet usually red-brown iron-stained	8
shale, green to gray, poorly laminated, can be confused with shale at bottom of "a" limestone bed.....	4
limestone, thin-bedded, shale parted, dark-gray.....	6
Bottom "b" limestone bed—	
shale, green, thin-bedded, few thin calcareous units.....	30
Top "a" limestone bed—	
limestone, dark-gray, fine-grained, dense, abundant <i>Olenellus</i> trilobite fragments in particular beds.....	7
limestone, thin-bedded, dark-gray, fine-grained, dense, shale nodules	20
shale, green, thin-bedded.....	8
limestone, thin-bedded, shale-parted, abundant trilobite fragments	7
Bottom "a" limestone bed—	
shale, green to buff, thin-bedded, micaceous.....	42
shale, buff to brown, micaceous, interbedded sandstone....	68
Total thickness of Pioche shale.....	961

LOWER CAMBRIAN AND PRE-CAMBRIAN(?)

PROSPECT MOUNTAIN QUARTZITE

quartzite, quartzitic, red-platy, and brown-argillaceous....	38
quartzite, massive, white to pinkish.....	462

LOWER CAMBRIAN AND PRE-CAMBRIAN (?)—Continued

Quartzite, brown, thin-bedded, intercalated thin shale beds	
Shale, brown, thin-bedded, micaceous, intercalated thin quartzite ribs.....	
Quartzite, brown, micaceous, thin-bedded, few massive quartzite ribs	
Quartzite, massive, bedded white and red.....	
Quartzite, brown, thin-bedded, intercalated shale.....	
Shale, brown, micaceous, intercalated thin quartzite ribs..	
Quartzite, massive, white and pink, cross-bedding near top, conglomeratic with $\frac{1}{8}$ to $\frac{1}{2}$ inch quartz pebbles..	
Quartzite, brown and red, thin-bedded, intercalated shale, scattered massive ribs.....	
Quartzite, massive, white to red.....	
Quartzite, red, thin-bedded, platy, ribs of massive red quartzite	
Quartzite, massive, red-banded.....	
Quartzite, white and pink, massive, conglomeratic.....	
Total thickness of exposed Prospect Mountain quartzite..	
Total estimated thickness of exposed Cambrian strata in the Groom district. (To top of Highland Peak formation)	

IGNEOUS ROCKS

The sediments in the central portion of the range are composed by volcanics of considerable thickness. These were not studied in detail but appear to be dominantly andesite. Some rhyolite is exposed near the quartzite andesite contact, and it appears to underlie a large portion of the andesite. There is one small basalt cone in the same area which is younger than the other volcanics.

Two dikes of pyroxene andesite were found in the quartzite about two miles southwest of Mount Baldy. These were probably some of the feeders for the large mass of andesite covering the quartzite to the north. One dike is about four feet and the other about 20 feet wide. The larger dike shows a tendency toward horizontal columnar jointing. The rock is comparatively fine-grained with large feldspar phenocrysts of labradorite (Ab_4). These crystals, some of which are corroded on the edges, are usually zoned, and are mottled with glassy and microcrystalline inclusions. The felsitic ground mass is composed largely of myt-

aining 10 to 15 percent of very small plagioclase laths. The omagnesium minerals are dominantly pyroxenes. Augite, onite and faintly pleocroic enstatite (bronzite) were recog- ed. The pigeonite is very faintly pleocroic, and has a 2V of roximately 27 degrees, while that of the augite is about 60 rees. A few small, rounded crystals of brown biotite are pres- surrounded with an absorption aureole of brown opaque erial. The rock contains 59.5 percent silica.¹¹ The quartzite he vicinity of the dikes has much the appearance of a jas- id, either through the introduction of iron by igneous min- izing solutions, or due to the breaking down of biotite or onite in the quartzite.

STRUCTURE

aulting is common throughout the range, but generally on a or scale. Normal strike faults are prevalent while many rs cut diagonally northeast or northwest across the bedding. It drag, especially noticeable in the limestone formations, is pronounced along the diagonal faults (see figure 6). The ipal movement, on many of these, has been horizontal rather vertical. There is much local bending or folding of the ments along these faults due to horizontal pressures. In Lyndon limestone, immediately northeast of Cane Springs (figure 2), is a good example of compression and folding a consequent fault break.

ecause of the drag folding, a northeast striking fault in the and Peak formation, east of the area mapped, is so con- ous it can be easily distinguished from Emigrant Valley or six miles to the south. The relationship of distinctive on either side of the fault indicate approximately 500 feet orizontal displacement. Drag folding has deformed the sedi- ts for a distance of several hundred feet from the fault.

is often impossible, because of the horizontal movement, to rmine the direction of dip of such faults as the faults are gnized by the displacement of the sediments, and not by the ence of discernible fault scarps. The direction of the dip of ilt with vertical movement can be determined by the relation- of the faulted beds. However, if the horizontal movement fficient, it may reverse this relationship.

minor bedding faults occur in thin-bedded limestones, as well thin interbedded limestones and shales. Both strike, and lip movements were noted.

ly myth, W. I.; Analyst, Nevada State Analytical Laboratory.



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Flat west-dipping fractures are commonly found in the quartzite with quartzite breccia ranging from one inch to one foot in thickness. None of these fractures have the appearance of "hanging wall" faults, as little apparent displacement was noticed. The displacement on the normal fault, bounding the west side of the range, must be considerable, but its magnitude is not known. The fault is of the basin and range type, dipping to the west, and has relatively depressed the hanging wall side. However, the quartzite in the footwall dips at a much steeper angle to the east than the average dip of the formation farther from the fault, indicating either recurrent movement on the fault or a further tilting of these beds from some unrelated force.

THE GRABEN AREA

The "fault block" in the quartzite is the only feature in the area showing extensive and intricate large-scale faulting. For simplicity of reference this "fault block" will be referred to as the graben area, defined as a depressed block caused by faults. The structure of the graben is very complex, with thrust faults, normal strike faults, and steep reverse faults. Its origin is primarily the result of relative downward movement in the hanging wall of the west-dipping Main fault which has dropped shale and sandstone into the underlying quartzite (see figure 7). This normal fault has a calculated vertical movement of over 3,000 feet. Another west-dipping normal fault forms the west side of the graben.

The thrust faults are older than most of the normal faults, and, as a result, are cut into many discontinuous planes within the graben. The westward dip extensions of the thrust faults are at least 1,000 feet below the surface, to the west of the graben, as a result of the displacement on the normal fault there (see figure 7). This discounts the possibility of the exposed quartzite to the west of the graben being repeated by these thrust faults.

The period of west-dipping normal faulting followed the thrust faulting and is responsible for the graben. It compares in magnitude with the recent Basin Range faulting, with displacements measuring in the thousands of feet.

It is evident from the amount of erosion that this period of faulting antedates the Basin Range faulting. A study of figure 7 indicates that there has been over 3,000 feet of erosion since the displacement on the Main fault. The accumulation of angular,

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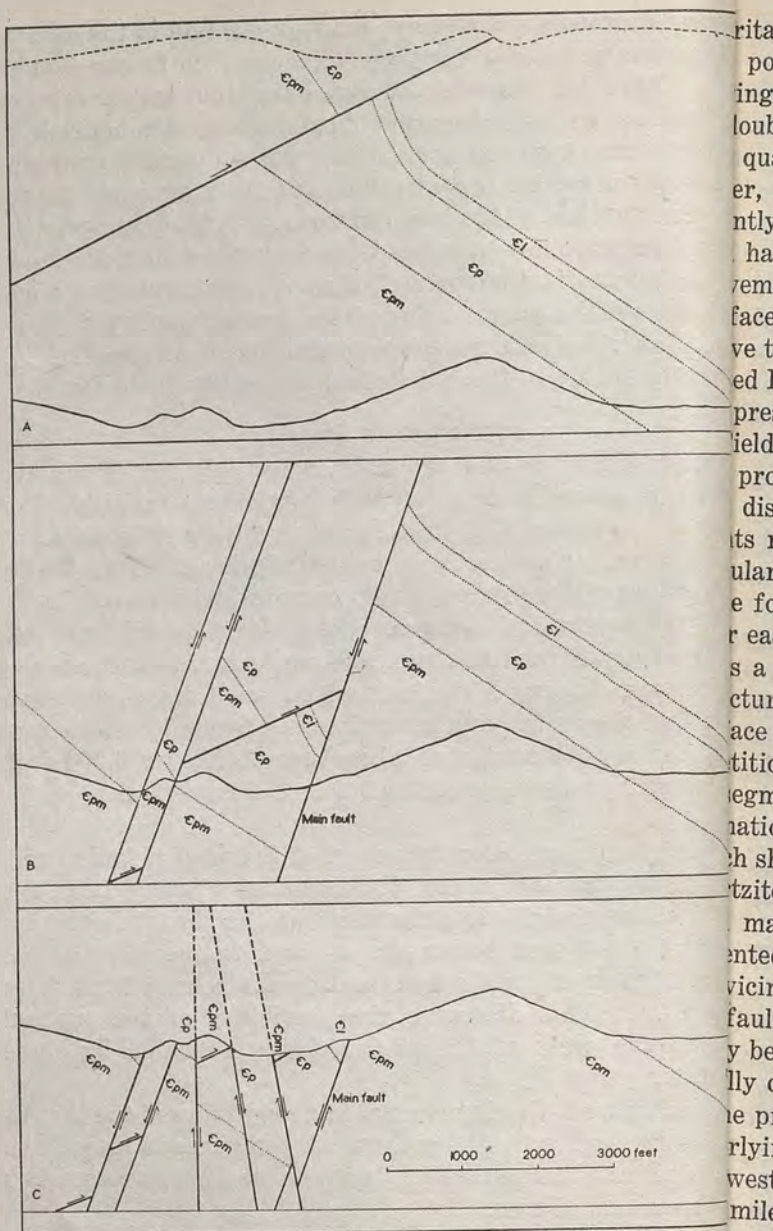


FIGURE 7—Generalized cross-sections showing, progressively, the structural features represented in the fault-block of shale and quartzite. The present topography is used as a reference. A shows thrust faulting, B shows west-dipping faulting, C shows east-dipping normal faulting.

detrital quartzite, which covers a large percentage of the south-portion of the graben, is in many places quite thick. Following the period of movement on the normal fault there was undoubtedly a pronounced scarp along the quartzite contact, and quartzite alluvium rapidly covered the shale and limestone, perhaps to a thickness of several hundred feet. Consequently, the shale and limestone have but recently been exposed, and have undergone comparatively little erosion since the fault movement. From this it can be inferred that the old erosional face, just prior to the normal faulting, was a short distance above the point at which the projected normal fault cuts the projected Lyndon limestone. This is approximately 3,000 feet above the present surface, at the graben and quartzite contact. Field evidence indicates that the east-dipping normal faults are probably the younger (see figure 11), and that they have less displacement than the west-dipping faults. The displacements range from only a few feet to possibly 500 or 600 feet. Large blocks of overthrust quartzite have been dropped into the formation where the thrust faults have been cut by these east-dipping faults.

As a result of the intensity and multiplicity of faulting, the structure and stratigraphy of the graben is very complex. The face exposures are dominantly Pioche shale with many fault segments, along with fault segments of quartzite. These quartzite segments, wherever exposed, are all the top of the quartzite formation. This fact can best be illustrated by a study of figure 7, which shows the east dipping normal faults cutting the top of the quartzite formation in the hanging wall of the thrust.

In many places the detrital quartzite in the graben area is cemented by a secondary carbonate precipitate. It is always in the vicinity of faults, and implies percolation of water through fault openings at an earlier period. This material might easily be mistaken to be a cemented fault breccia, especially as it usually directly overlies the faults.

The principal thrust fault is thought to be No. 1 thrust fault, underlying the quartzite rib shown within the graben about 600 feet west of the Groom shaft. It trends due north for about one mile then bears slightly to the east. It can be traced for about two miles to a point where it is cut by the Main fault. This fault plate has been removed by erosion for a distance of 2,500 feet south of the Groom shaft. Horizontal displacement, on this fault, is calculated roughly to be between 1,000 and 2,000 feet,

with the movement gradually increasing to the north where it may possibly exceed this amount (see figures 2 and 8).

Minor thrust faults were encountered in the underground workings of the Groom mine. Apparently they are complementary to the major thrust, and are the result of frictional drag in the limestone beds in the footwall. The displacement along these faults ranges from a few feet to possibly 200 feet. Later movement is indicated on at least one of the faults.

The resultant drag along the thrust faults is undoubtedly responsible for the steep and overturned west-dipping shaly limestone beds in the graben. The overturned beds to the east of No. 1 thrust fault are normal fault repetitions of the Pioche shale with another included fault segment of quartzite.

It becomes apparent that the surface exposures extend to shallow depth along their measured dip because of the drag on the thrust faults, and the displacements on the thrust faults.

The small west dipping fractures mentioned to be found in the quartzite are no doubt manifestations of the compression responsible for the thrust faulting.

The greater part of the regional tilting of the sedimentary rocks is assumed to be pre-thrust. Any appreciable post-thrust tilting comparable to the average 35 to 40 degree present dip of the formations, would either indicate very steep pre-tilting thrusting, or would have flattened the thrusts to a plane approaching the horizontal.

MINERALIZATION

LEAD, SILVER, AND ZINC DEPOSITS

Replacement deposits in limestone, within the graben, represent the only mineralization of any economic importance found in the district. Both irregular fissure replacement and bedded deposits occur. The thin limestone members in the upper part of the Pioche shale are good examples of bedded deposits at the Groom mine, while the mineralization in the overlying limestone is controlled by steep-dipping fissures.

Argentiferous galena and a subordinate amount of sphalerite are the primary ore minerals. The galena is very finely crystalline. A polished surface of massive galena showed no crystalline structure of sphalerite or argentite. However, on etching with hydrochloric acid fumes several microscopic, undetermined, silvery minerals appeared on the tarnished surface. Cerussite and anglesite are present in the oxidized zone, partially replacing residual galena. The mineralization of the sulfide ore, at the Groom mine, has not extended below the 50-foot level except immediately along open fissures.

Sphalerite is very sporadic in its occurrence, with little apparent relationship to the galena concentration. Assays¹² were found to vary from a trace to twenty-two percent zinc in ores, with no similar variations in lead values. The smelter returns on recent ore shipments from the Groom mine run from one to four percent zinc, with the lead usually over twenty percent. A smaller amount of ore shipped from the Lane shaft, one-half mile south of the Groom mine, was said¹³ to have run ten percent zinc and twenty percent lead. Here both rosinjack and blackjack can be shafted.

Silver consistently averages about one-third ounce per percent lead at the Groom mine, with the gold content practically nil. Arsenic, in the form of chalcopyrite, with possible tetrahedrite, averages about 0.35 percent. Pyrite, in minor amounts, is found in intimate association with the galena.

Quartzification of the limestone commonly occurs along mineralizing fissures, and there are often very thin quartz veinlets in the limestone and shale near the ore deposits.

Microcrystallized irregular calcite veinlets almost universally occur throughout the fractured limestones within the graben. Similar calcite stringers, close to faults, are found in many of the limestone formations to the east, but do not characterize any particular horizon.

MODE OF OCCURRENCE

The principal mineralizing fissures in the graben area are symmetric to the Main fault, and are from 20 to 100 feet distant in the hanging wall. While they usually dip steeply to the west, they are sometimes vertical and show effects of both normal and reverse movement.

The mineralization was found to occur in the Main fault. It is characterized by an impervious gouge which is over 30 feet thick. In the writer's opinion that this fault was the primary feeder for the hypogene mineralizing solutions. In the underlying limestone the fault breccia and gouge was undoubtedly open enough to allow passage of solutions, but on reaching the level of the shale and limestone the gouge was impervious. No solutions could ascend the fault above this level. Consequently they descended the wallrock by the aid of innumerable fractures until they reached horizons amenable to replacement.

There are commonly many east-west fractures and joints in the limestone.

¹²DeMyth, Wm. I., Analyst, Nevada State Analytical Laboratory.
¹³DeMyth, Wm. I., Analyst, Nevada State Analytical Laboratory.
¹⁴DeMyth, Wm. I., Analyst, Nevada State Analytical Laboratory.

the more highly mineralized zones. Some of these carry grade galena well away from the centers of mineralization; ever, such enrichments are usually only a few inches in thickness. Although the main mineralized fissures trend north-south, east-west fractures have undoubtedly aided materially in access to the ore solutions.¹⁴

Minor thrust faults, in two separate instances, were found to have locally controlled the mineralization.

The system of east-dipping faults in the graben are thought by the writer to be postmineral. Where encountered at the Groom mine they were not found to be mineralized and have any bearing on control of the mineral solutions.

The Lyndon limestone, along with the immediately underlying limestone beds of the upper Pioche shale, contain all the ore bodies. This area is of limited depth as a result of its upward dip into the Main fault, although it is exposed longitudinally for a distance of about two miles as a comparatively narrow strip along the east edge of the graben.

Some of the intercalated limestone beds in the upper part of the Pioche shale appear to be faulted out in the graben area. In a normal section there are seven thin limestone members in the upper 48 feet of the formation, while at the Groom mine there commonly are only two, and four was the maximum number in place. In some places the east dipping faults have completely cut out the upper Pioche shale and a portion of the lower Pioche limestone. The shale between these limestone beds is very irregular in thickness and generally shows signs of bedding modification. Drill cores from diamond drill hole No. 1, shown in figure 1, contain thin limestone units scattered in the shale to a depth of 150 feet. These are very probably faulted segments and indicate considerable small scale faulting. Mineralization was noted in the first 85 feet of this hole.

GOLD DEPOSITS

In the quartzite west of the fault inlier are several minor occurrences. They occur along fractures carrying from one to one foot of quartzite breccia. These fractures dip 30 to 40 degrees to the west.

¹⁴Paul Gemmill, of Pioche, Nevada, in a personal communication, has observed at the Prince mine similar structures have almost always accompanied the mineralization, and probably provided the openings for solution penetration.

MINES AND PROSPECTS

GROOM MINE

The Groom lead and silver mine was discovered in 1864, and its claims were located. These four claims were originally grouped in a group, two long and two wide, each claim being 250 feet in width. However, as local mining laws at that time limited claims to a maximum width of 200 feet, the mineral survey for the mine, made in 1874, shows these claims as being 200 feet in width, and separated by a 100-foot strip of "open" ground.

John Taylor and Co., an English concern, bonded the property in 1872, and after spending about \$80,000 on roads and development work abandoned it as being too isolated.

In 1885 the property was acquired by Patrick Sheahan and partners, but little work was done. In 1915 it was leased to John McCormick who produced steadily for two years, and the partners produced steadily for one year thereafter.

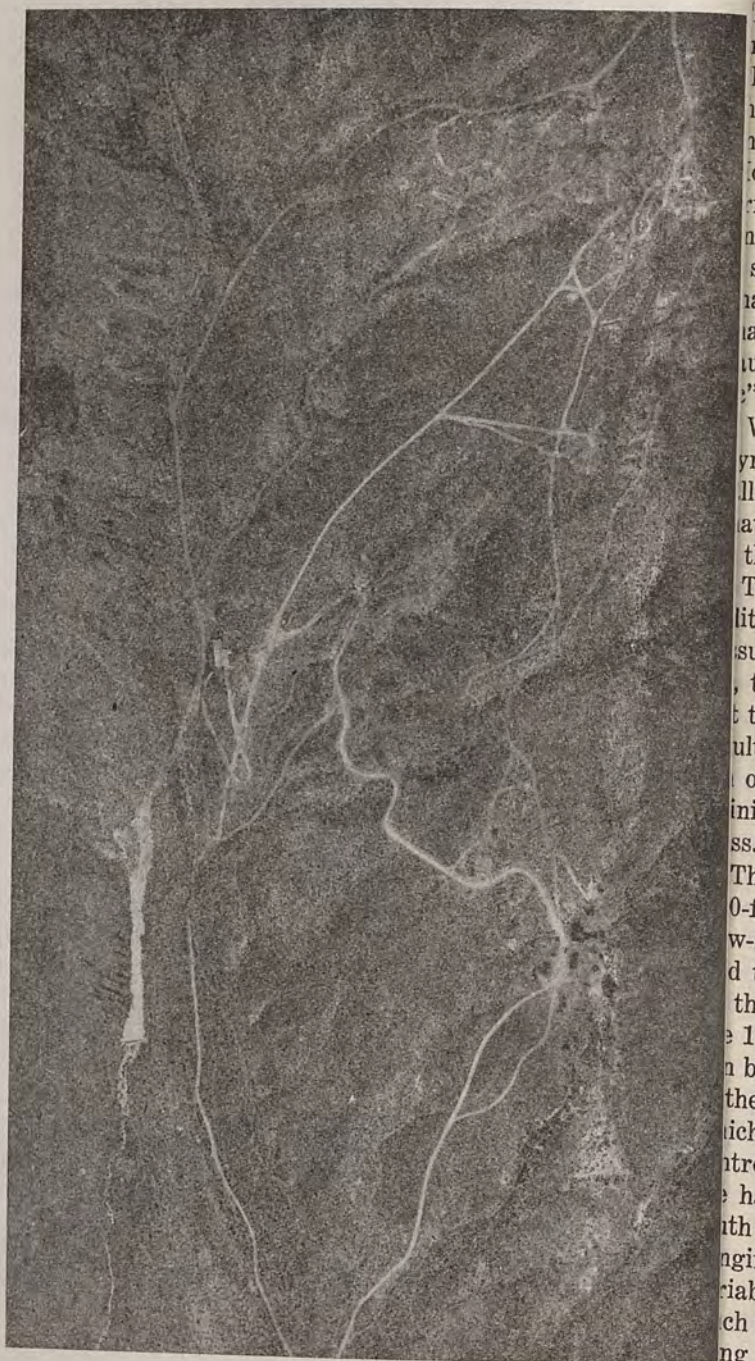
From 1918 to 1942 sporadic shipments were made by leasers.

In 1942 Patrick Sheahan bonded the property and entered into a partnership with the International Mining Corporation of New York to operate it. Steady shipments have been made since, and men and equipment could be obtained. Adequate machinery has now been obtained and a substantial increase in ore production is expected.

Records of the Groom mine, from shipment receipts in the files of Patrick Sheahan and Dan Sheahan, for the years 1915 to 1926, inclusive, show a total of 6,145 tons of ore shipped. The ore contained 100,341 ounces of silver and 5,926,371 pounds of lead. These figures give an average of 16.3 ounces of silver and 48.2 percent of lead per ton; or a ratio of slightly over $\frac{1}{2}$ ounce of silver per percent of lead. Some of the shipments were jig concentrates, so that it is impossible to calculate the true "run of mine" grade of the ore. The net smelter returns amount to \$8,393, which is but 63.0 percent of the gross value, as figured in the average yearly metal prices published by the Engineering and Mining Journal.

Approximately 900 tons of ore were shipped in 1942 and 1943 by the International Mining Corporation, being partly mill concentrates and partly "run of mine" ore. The shipments of about 10 tons in 1944 represent "run of mine" ore. No milling was done in 1944 because of the scarcity of skilled labor.

The Groom mine is the only producing property in the district.



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The mineralization, so far as known, is largely confined to the limestone rib extending along the east side of the graben area. This rib extends almost continuously for about two miles from the Lane shaft to about one and one-half miles north of the Groom shaft where it is covered by over-thrust shale and quartzite. However, no indication of mineralization was noted in the northern portion. It varies in width from 30 feet to over 100 feet, and in places is covered by alluvium. It may be faulted out for a short distance beginning about 1,000 feet north of the Groom shaft, in an area covered by alluvium. A prospect shaft, now inaccessible, was sunk in this area within 30 feet of the Main fault. The shale on the dump resembles that which underlies the limestone bed, and no limestone was found.

Within the area mapped this limestone rib is largely of the Lyndon formation, although there are faulted segments of recrystallized Peasley limestone, as is shown on figure 8. It is evident that the faulting of these segments of Peasley limestone was prior to the displacement on the Main fault, and may also be pre-thrust. The mine is opened to a depth of 210 feet by a shaft and two adits. The upper adit, or 100-foot level, follows the north-south fracture mineralization, which in most instances is along, or close to, the contact of the Lyndon limestone with the Pioche shale. At the north end the adit crosscuts to the east toward the Main fault. The face of this crosscut is now inaccessible, but data from an old map shows the last 30 feet as being in fault gouge containing slabs of limestone and quartzite up to three feet in thickness. No mineralization is mentioned.

The zone of most intense mineralization is on, and above, the 100-foot level in an area about 250 feet long. It lies within a narrow-shaped area, shown in figure 10, between No. 3 thrust fault and the Groom fault. An arc of the thrust fault has been cut by the Groom fault so that it is exposed only within this area on the 100-foot level. However, above the 100-foot level the thrust fault can be found, on its upward dip, both to the north and the south of the points where it crosses the 100-foot level drift. This thrust, which has offset the beds about 40 feet, seems to have partially controlled the mineralization, as most of the ore is confined to the hanging wall. The ore has dominantly made along north-south fissures, but the prevalence of east-west fractures, in the hanging wall of the thrust, is important. The replacement is variable, with ore of present minable value, in places, being as much as 30 feet in width. The richest ore is either immediately along the north-south fissures, or where the replacement of the

massive limestone has been augmented by small east-west fissures. Most of the mining previously done was confined to high-grade fissures, with some shipments recorded to have as much as 70 percent lead. In addition to the fissure ore the three limestone beds of the upper Pioche shale, that are present in this area, show almost complete mineral replacement. These have the character of bedded deposits.

The ore extends both to the north and the south of this area to the hanging wall of the thrust above the 100-foot level. Ore obtained, during World War I, from the 75 intermediate level. An extension of the main mineralized fissures, for about 100 feet farther north than the extent of mineralization on the 100-foot level. But here the drift apparently enters the footwall of the No. 3 thrust fault and veers to the left, and then follows the contact of the limestone and shale for 150 feet to the face. The only minor indications of mineralization. It is not clear whether the operators chose to leave the zone of most probable mineralization, unless for the fact that the shale contact was not being dug. No crosscutting from this drift has been done to determine the possible northward extension of the ore fissures in the area mined.

These mineralized fissures are also found to extend to the hanging wall of the thrust fault, where they have been mined for a distance of about 100 feet. Some rich, but ore still remains confined to innumerable cross fractures in blocky limestone. It is not being mined at the present time due to the shortage of labor for hand sorting of the limestone.

The Groom fault was not found to be mineralized and is assumed to be post-mineral. Beyond the points at which the No. 3 thrust fault the fault forms the contact between the Pioche shale and the Lyndon limestone. An estimated total of 60 feet of the two formations has been faulted out on the 100-foot level along this contact.

Drill cores from the footwall of the Groom fault contain fragments of limestone scattered in the shale. Some of these, particularly within 85 feet of the surface, are mineralized, with erratically distributed ore values in the shale. These probably faulted segments of the Lyndon limestone and Pioche shale that were cut by the fault. There are also minor faults which have further broken up the beds in the wall of the Groom fault.

The north-south ore fissures south of No. 3 thrust fault at the 100-foot level do not appear to be directly connected to the

within the area previously described. Most of the stopes are now inaccessible, but indications are that the ore was usually confined to a width of two or three feet along the fissures. In some places, however, where several fissures converge, the ore was of greater width and steep ore shoots have been mined to the surface. Many thin stringers of galena with secondary cerussite can be seen in the surrounding wall rock. The Indians are said to have mined the surface exposures of these rich ore shoots to obtain lead for bullets.

An intermediate drift from a 30-foot winze, from the 100-foot level, shows ore of good grade along a fissure for an average width of about two feet. There is undoubtedly ore below the 100-foot level in this area which could be mined through raises from the 200-foot level.

The limestone, particularly in the southern portion of the 100-foot level, has been considerably twisted with many local irregularities in the bedding attitudes. Strikes vary as much as 50 degrees on either side of faults, and the bedding dips range from ten degrees to near vertical.

The shale near the portal of the 100-foot adit is thought by the writer to be Chisholm shale in fault contact with lower syndon limestone. A small amount of the same shale is exposed on the surface, just south of the portal of the 100-foot adit, overlain by recrystallized Peasley limestone.

Indirect evidence that the east-dipping faults are younger than the Main fault is apparent from section C-C' (see figure 11). A diamond drill hole No. 1 drilled into quartzite breccia at 302 feet, which would mean that the Main fault either becomes much steeper below the surface or has been offset by later faulting. Similarly the face of the 200-foot adit is in quartzite gouge and breccia about 50 feet west of the projection of the Main fault from the surface. The dip here varies between 60 and 70 degrees and slips within the gouge. This agrees favorably with the average 70-degree dip of the Main fault observed at the surface, and with data from an old map of the east crosscut at the north end of the 100-foot adit.

The 200-foot level adit crosscuts northeast for a distance of 100 feet from the portal, through a maze of faults in upper "b" limestone and shale of the Pioche formation. Massive limestone was encountered beyond the No. 4 thrust fault, and a drift was seen north for 500 feet in the footwall of the fault. To the north the limestone is badly faulted and twisted, with the last 300 feet of the drift being almost entirely in a black carbonaceous gouge

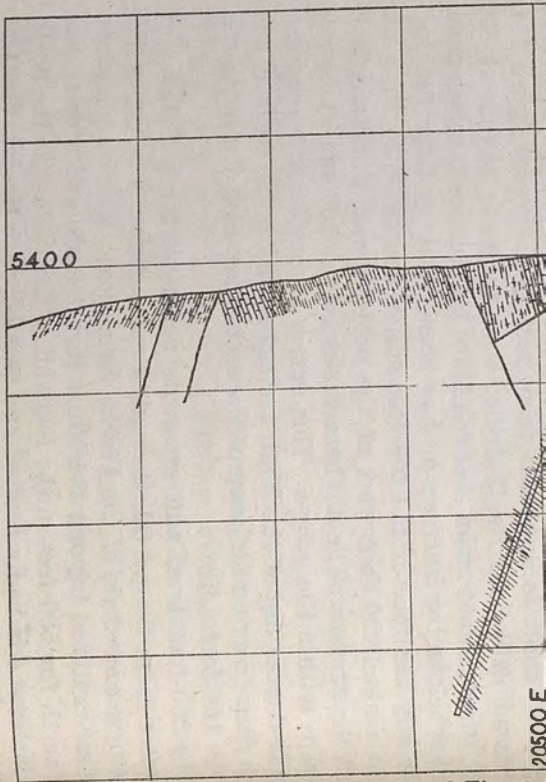
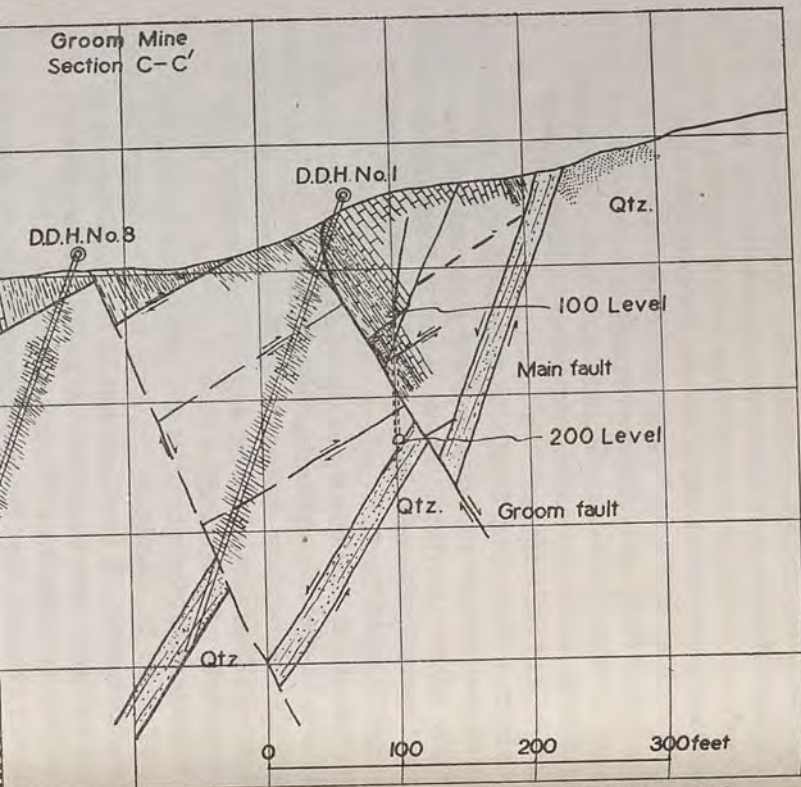


FIGURE 11—Cross-section C-C', of Figure



8 showing structural and stratigraphic features near the Groom shaft.

FIGURE 11—Cross-section C-C', of Figure 8 showing structural and stratigraphic features near the Groom shaft.

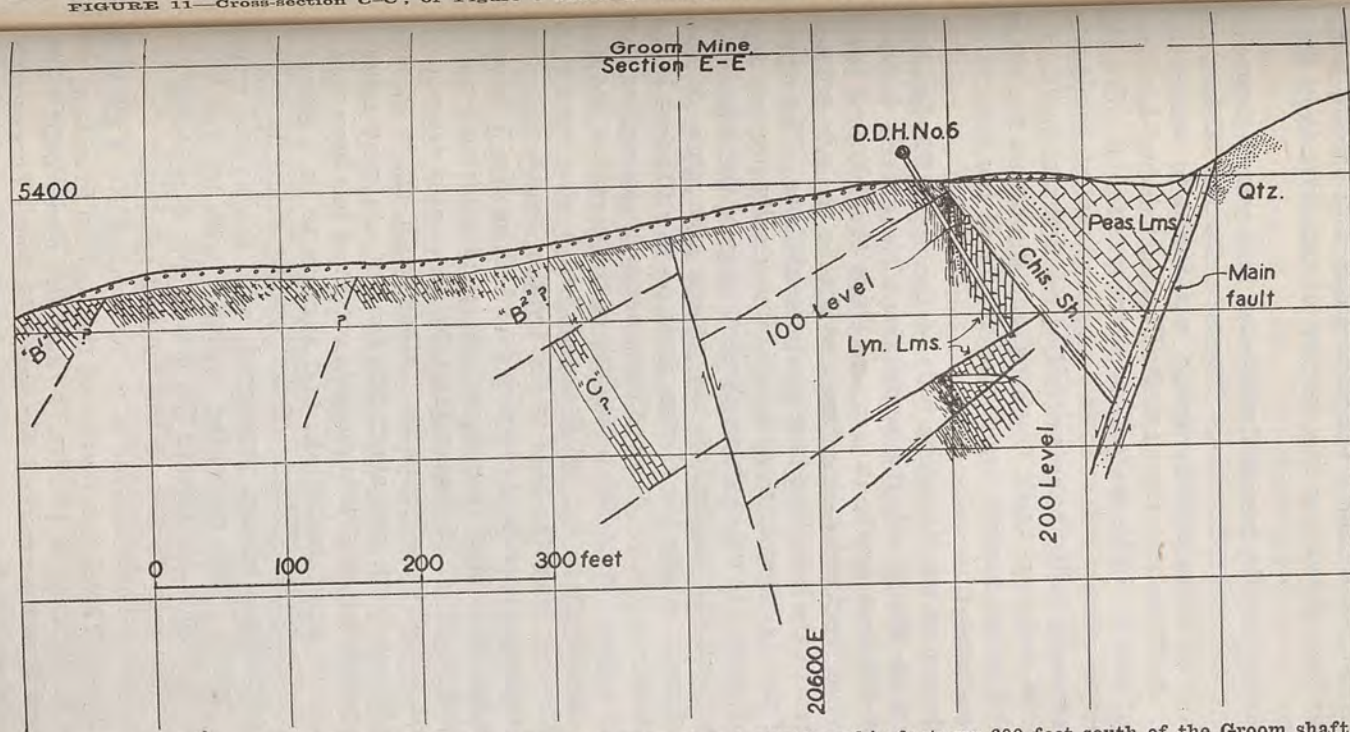


FIGURE 12—Cross-section E-E', of Figure 8, showing structural and stratigraphic features 600 feet south of the Groom shaft.

of limestone and shale. Quartzite gouge and breccia is exposed at the face, indicating this portion of the drift is in the Main fault.

A raise from the face of the 200-foot level passed through No. 4 thrust fault and entered massive green shale at 30 feet. About six feet of dense rubbery gouge was found to accompany the fault. At 70 feet the raise cut the Pioche shale and Lyndon limestone contact. Little indication of ore was found. Ore of good grade was encountered at 85 feet along steep west-dipping, north-south fissures in the hanging wall of No. 3 thrust fault. At this place the rocks are badly fractured and the thrust fault is indistinct. The ore fissures are the extension of the fissures on the 100-foot level.

Only two of the limestone beds of the upper Pioche shale are present in the raise; the remainder having been faulted out. About 100 feet south, in a winze from the 100-foot level, the contact of the Lyndon limestone and Pioche shale is exposed and only two of the limestone beds are present there. The writer has found that faulting of these beds is universally present throughout this area. In other places three or four of the limestone beds are in place, but nowhere in the graben area were all seven of them found. Along the Groom fault on the 100-foot level they are missing entirely. Four of them are well exposed on the surface in a gulch about 700 feet south of the portal of the 100-foot adit. At this place the "c" limestone bed is also exposed and is only 140 feet from the base of the Lyndon limestone.

Partially oxidized lead ore was found along No. 5 thrust fault on the 200-foot level (see figure 13), and continued northwest until this fault joined thrust fault No. 4. Later crosscutting to the east, through the limestone farther south, again encountered No. 5 thrust fault, and about 100 tons of ore were mined. No further exploration of this possible ore shoot has been done. The thrust is of small magnitude, and appears to be a lateral from No. 4 thrust fault. Flexure of the bedding along the fault indicates post-thrust normal movement, with consequent reopening of the fissure. This reopening, together with the fact that the fault strikes obliquely toward the Main fault, is probably responsible for the introduction of the mineral solutions.

The limestone encountered in the footwall of No. 4 thrust fault, in the 200-foot level, is a portion of the Lyndon limestone. Immediately to the east of the No. 4 fault the north drift follows a shale and limestone contact for about 75 feet. This is undoubtedly the Pioche shale and Lyndon limestone contact, as a thin limestone bed is exposed in the shale along the west side of the drift.

This contact is about 40 feet west of the surface contact of Pioche and Lyndon limestone, indicating a displacement of possibly 100 feet on No. 4 thrust fault. The innumerable small normal faults make any accurate calculation difficult. The limestone is about 40 feet in thickness, bounded on both sides by faults. The limestone cuts to the east through the limestone cuts a fault contact with shale. This shale is probably a part of the Chisholm formation. The contact may also be seen in the 100-foot level as mentioned above.

For a distance of 700 feet north of the Groom shaft, ore fissures are found in the Lyndon limestone. These are notably small and highly mineralized east-west fractures. Some mineralization is also present in the "c" limestone bed close to its contact with No. 2 thrust fault. However, the "c" bed is cut off a short distance below the surface by the thrust fault. Little exploration work has been done in this area other than a diamond drill hole shown in section D-D', figure 14. This hole, as seen on the section, was drilled entirely in shale, and verifies the fact that "c" was cut off at shallow depth by the thrust fault.

One hundred and eighty feet northwest of the Groom shaft a small area of rich but erratically distributed ore was found in the calcareous shale. It seemed to be mainly concentrated in the footwall of a flat fault. The ore occurs as nodular and irregular shaped blobs or lumps of galena and cerussite. The shale in the footwall is of an entirely different character than the thin-bedded steep-dipping greenish shale in the hanging wall. It is blocky, and has the appearance of having been somewhat metamorphosed, with only very indistinct bedding planes. This appearance may be partly due to the presence of considerable disseminated iron pyrite. The color and blocky character resemble the upper portion of the Chisholm shale, although the shale in the hanging wall is certainly of the Pioche formation. The fault could not be traced as this area is mostly covered with alluvium. A diamond drill hole, dipping 45 degrees to the east was collared 50 feet west of the fault, and drilled 200 feet of blocky shale with bands of limestone. Scattered zones of mineralization were noted throughout the entire length of the hole, with the best ore showing between 90 and 115 feet. The limestone bands are indicative of upper Pioche shale.

A small amount of ore has been taken from a shaft about 400 feet south of the portal of the 100-foot adit. The shaft was sunk through a fracture in the Lyndon limestone close to the surface fault contact with the Chisholm shale. The ore was reported by Mr.

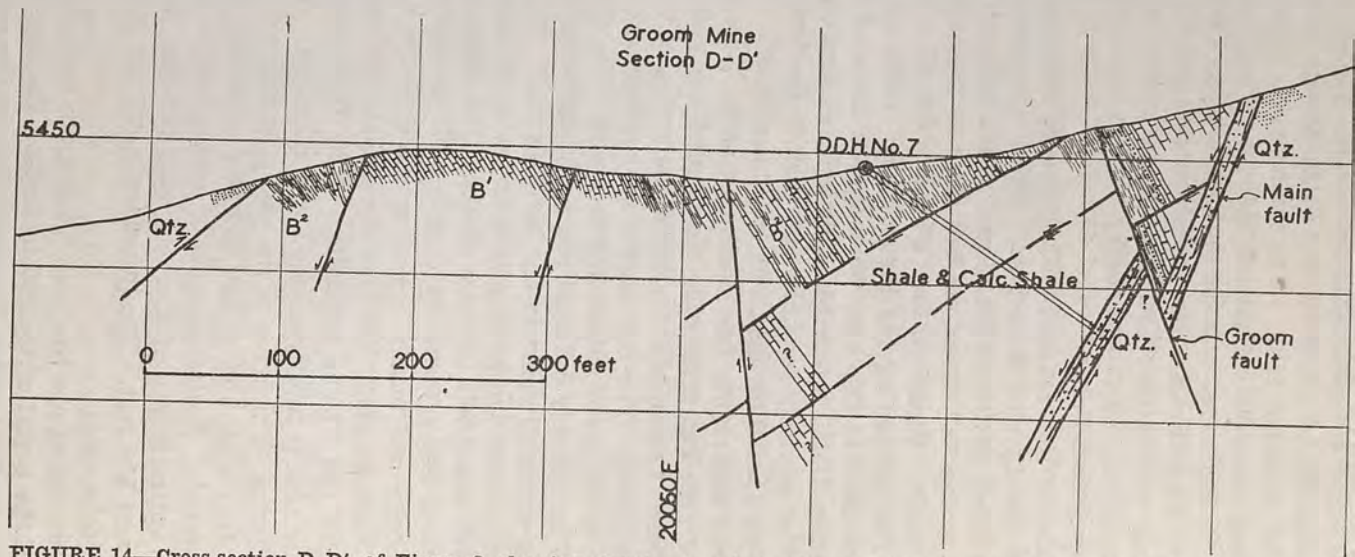


FIGURE 14—Cross-section D-D', of Figure 8, showing structural and stratigraphic features 400 feet north of the Groom shaft.

than to have carried much more zinc than is normally found in the Groom mine.

Scattered mineralized areas occur in exposures of "c" limestone in the Groom shaft. However, as the bed apparently lies on the hanging wall of the No. 2 thrust fault it is undoubtedly well off at shallow depth.

Purple shale, characteristic of that underlying "c" bed is found in two shafts near the Groom camp buildings. The shafts are inaccessible, and outcrops are covered with alluvium, but indications are that the "c" bed has been faulted out here by the extension of the No. 2 thrust fault.

THE LANE CLAIMS

The Lane claims, situated just south of the Groom mine, were patented in 1917. The only outcrops are on the Black Medal claim, shown on figure 15, all the others being covered by alluvium. The Black Medal is separated from the other claims, on the south, by the claim owned by the Groom mine.

It is thought that the Black Medal claim was originally located on the "Black Metal."

An 85-degree incline shaft has been sunk to a depth of 110 feet on the Black Medal claim. This shaft is in a dark-gray limestone, similar lithologically to the limestone at the Groom shaft, and is about 50 feet west of the Main fault near the west edge of the limestone. Some ore has been stoped from above a short distance on the 110-foot level north of the shaft.

The ore carries much more zinc than is normally found in the Groom mine. The erratic distribution of sphalerite, however, is not apparent here, as a selected sample of rock from the stope on the 110-foot level assayed¹⁵ 6.3 percent zinc, while a sample from a shallow winze, about 25 feet distant, assayed 22.2 percent zinc. Sphalerite can be seen megascopically in the rock of the

east of the Black Medal claim is covered by alluvium, and insufficient development work has been done to permit a detailed outcrop of the structure. A small outcrop exposed in the alluvium of the shaft includes faulted portions of both the Pioche and Prospect Mountain quartzite. No underground mapping was done, but the fact that the shaft is in limestone for the depth, argues strongly the presence of thrusting, and possible overturning of the beds.

¹⁵Smith, Wm. I., Analyst, Nevada State Analytical Laboratory.

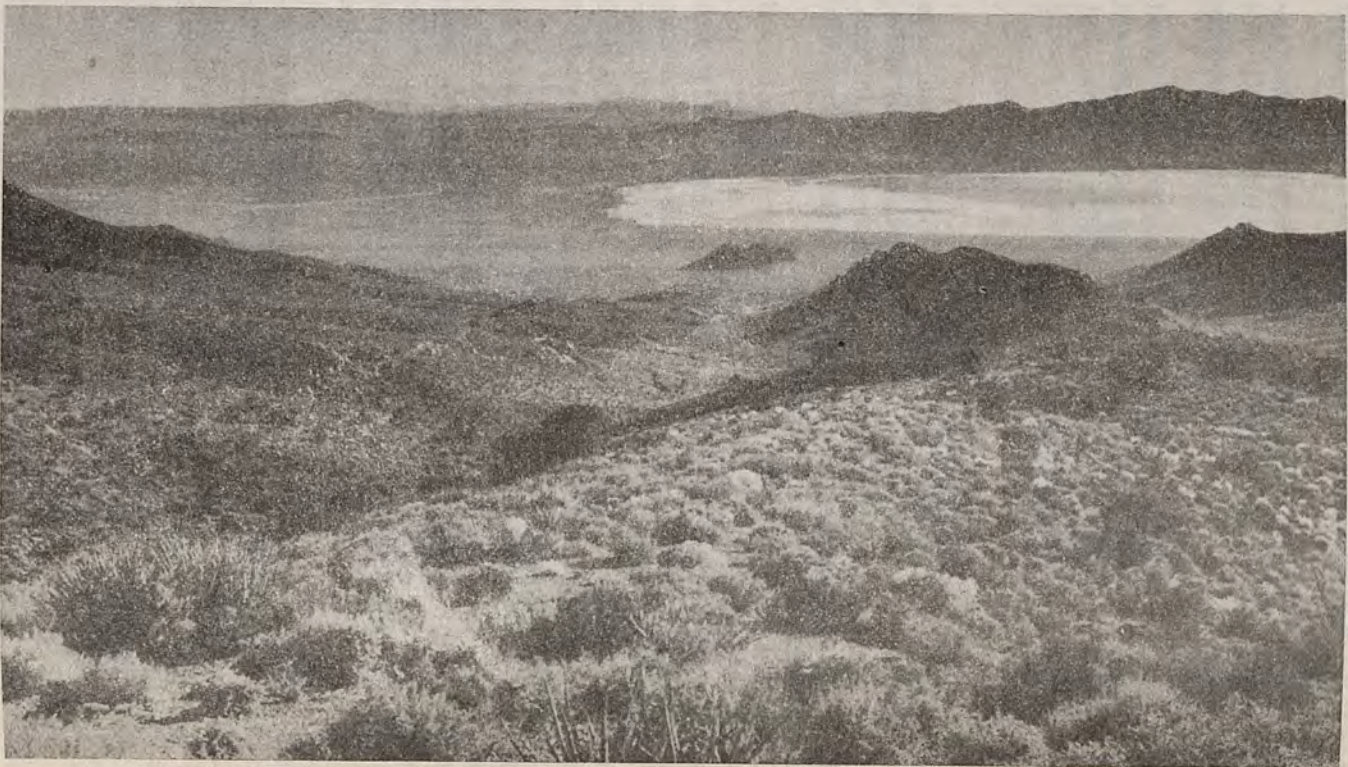


FIGURE 16—View of graben area, looking south from one and one-half miles north of Groom shaft.

HANUS SHAFT

The Hanus incline shaft is a gold prospect in the quartzite about 1.5 miles northwest of the Groom mine. The shaft is sunk to a depth of about 60 feet along a west dipping fracture. A sample taken from the small ore dump assayed 1.08 ounces of gold per ton. However, the gold-bearing quartzite breccia was seen not to exceed six inches in width, and the values are very spotty.

OTHER GOLD PROSPECTS

Near the middle of the range, in the vicinity of the small basalt previously mentioned, are numerous shallow diggings in the quartzite, some of which undoubtedly produced a small amount of gold. Here again, from the nature of the workings, the values are likely to have been very spotty, and the occurrence of any quantity of ore is doubtful. It is very unlikely that the basalt has any bearing on the ore genesis.

The writer was told¹⁶ that some placer gold has been recovered from the heavy-washing gravels in the gulches below these workings. A few gold nuggets up to the size of a grain of wheat were said to have been recovered.

RECOMMENDATIONS FOR FURTHER EXPLORATION IN THE DISTRICT

The only known favorable area for base metal exploration in the southern portion of the Groom Range is the fault inlier, or graben, in the quartzite. No mineralization was found in the excellent exposures to the east. The graben extends from the alluvium covering at the edge of the valley, north to the volcanic rocks which have covered it; or a distance of approximately five miles.

As shown on figure 2, the southern portion contains several miles of overthrust quartzite. These disappear to the north as a result of erosion. The only quartzite remaining in the graben to the north, is the extension of the block overlying the No. 1 thrust fault (see figure 16). It gradually trends closer to the east contact of the graben, until about one and one-half miles north of the Groom shaft it has been cut by the Main fault. The over-thrust quartzite here is in normal fault contact with the Main fault. Figure 17 gives a generalized picture of the probable structural relationships two miles north of the Groom mine. The intercalated limestone beds in the Pioche shale might make

¹⁶ Sheahan, personal communication.

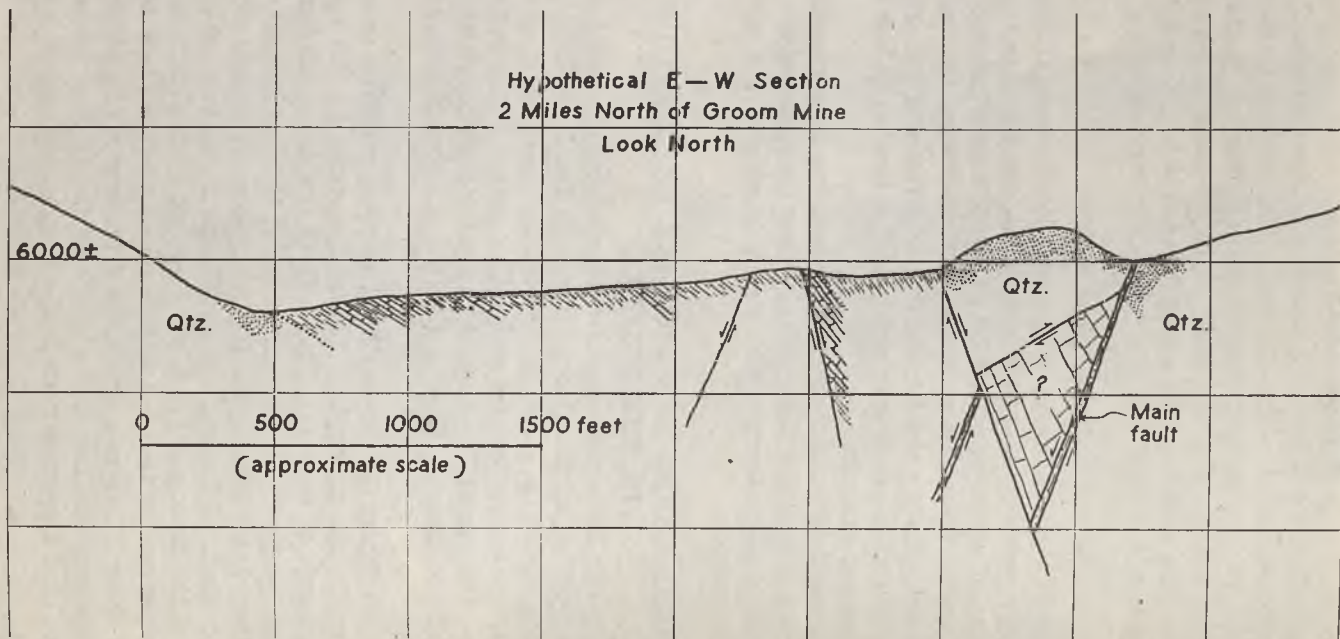


FIGURE 17—Cross-section of graben area two and one-half miles north of Groom shaft, showing possible stratigraphy below block of over-thrust Prospect Mountain quartzite. Note Pioche shale in center in fault contact with Lyndon limestone (?).

bodies, at depth, where they approach the Main fault. This is the case where the prospectors adage of "ore at depth" has reasonable possibilities. From all indications the entire Pioche formation should be encountered along the Main fault, probably with considerable repetition. It is not known, however, whether the lower limestone beds are amenable to replacement. No mineralization could be found in the "a" and "b" limestone beds, on the surface. The surface croppings, east of No. 1 thrust fault, are considerably iron stained, however, while the same beds to the west of the fault are not.

The structural problems confronting any operator, attempting to explore these beds at depth, are many and varied. The surface outcroppings of the intercalated limestones cannot be projected downward, along their exposed dip, due to being faulted off. In other words, the surface exposures in the Groom mine area are a veneer. Information available from surface and underground mapping, and from diamond drill holes, shows five thrust faults and many normal faults to have displaced the beds. The approximate displacement of these faults might be calculated, but the occurrence of unknown faults must be expected. The variations in fault attitudes along with the pronounced variations in bedding dip make further complications. A deep drill hole sunk 400 feet west of the Groom shaft, would aid materially in planning any further systematic exploration at the Groom mine. It would also lend invaluable information to any proposed exploration of the remainder of the fault block.

In the writers opinion, the known occurrence of ore minerals in the Lane shaft warrant further exploration in the southern portion of the fault block. The alluvium covers the surface croppings south of the shaft, but undoubtedly the fault extends east some distance under it.

The northern portion of the fault block should be studied in detail, before any explicit statement could be made as to the possible existence of ore minerals. Even then, as shown by figure 17, the over-thrust quartzite covers the most probable ore horizon. As shown in figure 17, limestone does underlie the quartzite and it is likely to be a formation stratigraphically higher in the Cambrian sequence than the Lyndon limestone. Such rocks may or may not be susceptible to mineralization. The narrow exposure of limestone shown, on the figure, a few hundred feet west of the quartzite, is thought, by the writer, to be a faulted portion of the Lyndon limestone.

The well-known affinity between gold and quartz, and the

almost complete absence of gold in the limestone ore bodies might be construed to favor the possibility of gold having been deposited along the Main fault, at depth, in the quartzite. If the period of mineralization in the graben could, in any way, be shown to be related to the gold deposition previously mentioned in the quartzite, such a conjecture might be logical.

Reconnaissance of the carbonate rocks in the vicinity of the volcanics is recommended. On the east side of the range, below Mount Baldy, erosion may have removed sufficient lava to expose limestone in fairly close proximity to the main volcanic feeder. Further, it is very possible that the larger faults in the graben have provided openings for igneous penetration. Some study of these faults, close to the volcanics, should be made with this in mind.

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