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Item 72

THE PIOCHE MINING DISTRICT, NEVADA

L. D. Hayes

Humble Oil & Refining Co. 5/11/71

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THE PIOCHE MINING DISTRICT, NEVADA

L. D. Hayes

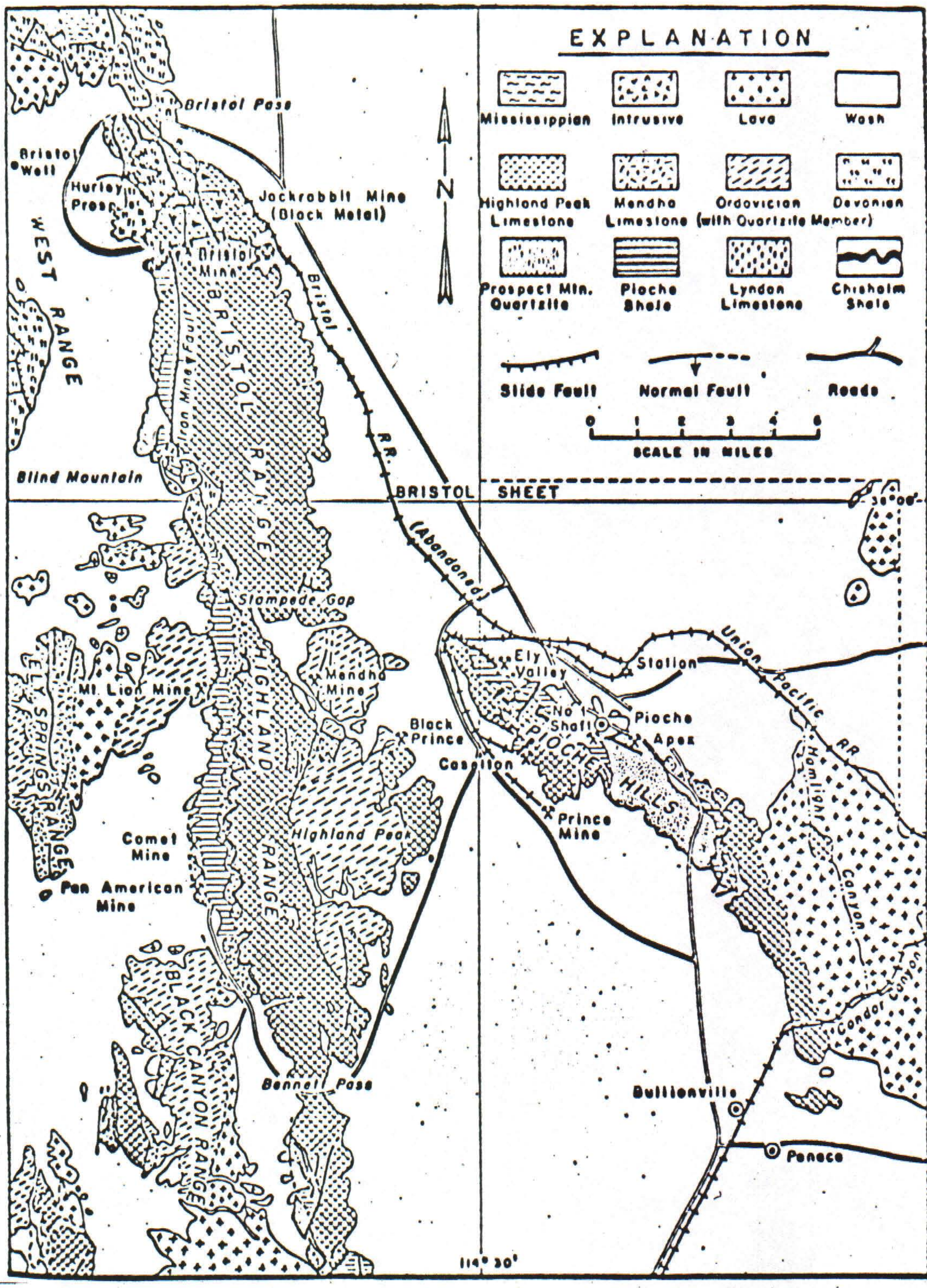
Introduction

The Pioche District in eastern Nevada produced over 6 million tons of ore valued at $100 million during the period 1869-1966. Most of this production has come from elongate stratabound Pb-Zn-Ag bodies replacing the Lower Cambrian Combined Metals limestone member of the Pioche shale. Replacement Pb-Zn-Ag-Cu bodies in limestone formations younger than the Pioche shale and precious metal vein deposits in lowermost Cambrian Prospect Mountain quartzite have accounted for lesser production.

Because the Pioche District shows earmarks of being a major zoned district and because the area had been explored only sporadically by major mining companies, it was selected among the first of Humble Mineral's exploration targets in the western United States. An integrated program, including geologic mapping, geochemistry, geophysics and drilling, was conducted in the Highland Range during the period of January 1969-December 1970. The primary objective of the work was to evaluate the minerals potential in the northern part of the range, where the Cambrian sedimentary section is intruded by hydrothermally altered quartz monzonite dike, sills and small stocks. The project was terminated when drilling in the more favorable areas had encountered only minor quantities of Pb, Zn, Cu and Mo sulfides in addition to abundant pyrite and pyrrhotite.

Location

The Pioche District is located in Lincoln County in eastern Nevada, approximately 110 miles south of the town of Ely, and 170 miles north of Las Vegas. As used in this report, the district includes mining operations in the Bristol, Pioche and Highland ranges. Pioche, a town of some 250 inhabitants located on the eastern flank of the Pioche Hills, is the only muncipality within the area of discussion (Fig. 1).



<u>FIGURE 1.</u> Geologic Map of the Pioche District (from Genmill)

Physiography and Climate

Topography is typical of the Basin and Range Province: North to northwest-trending mountain ranges are separated by almost featureless, gravel-filled basins. Elevations range from as low as 5,000 feet up to 9,305 feet at Highland Peak. The valleys and low slopes are covered with sage brush, mountain mahogany, juniper and pinyon pine; sparse ponderosa pine and rare aspen grow at higher elevations.

The area is blessed with a moderate climate. Winter temperatures average above freezing and seldom fall as low as +10° F. Snowfalls one-foot deep are not uncommon, but usually disappear from the ground within a week's time. Summer temperatures rarely reach 100° F, and daytime temperatures are usually in the comfortable 80's, falling at night to the 50's or 60's. Summer storms are fairly uncommon.

Mining History

Bonanza ore was discovered in 1869 in the Pioche Hills just south of the present town of Pioche. During its heyday of the 1870's, the district produced over $21 million in bullion, mostly from cerargyrite-bearing quartz veins in the Prospect Mountain quartzite. When these rich ores had been depleted by the turn of the century, the district was given new life by production of direct smelting oxidized Pb-Zn-Cu ore at the Bristol, Jack-rabbit and Prince mines. Ore from these mines was first smelted locally at Bristol Wells and later in smelters in the Salt Lake Valley when a Union Pacific spur to the district was completed in 1912.

With the completion of Combined Metals Reduction Company's flotation mill in Bauer, Utah in 1923, mining of mixed sulfide replacement orebodies in the CM limestone bed was initiated. The Bauer mill, and the later one built by C.M.R. Co. at Caselton near Pioche, were fed by ore from the Caselton, Prince, and Ely Valley mines until 1957, by which time the mineable reserves of all three mines had been depleted. The Caselton mill was reopened in 1964 to process ore from the Pan American mine in the Highland Range, 16 miles

TABLE I. Mine Production, 1912–1964

I. Primary Ores

A. Pyritic Ores

Mine	Period	Dry Tons Produced	Ounces Per Ton Au	Ounces Per Ton Ag	% Pb	% Zn	% Cu	% WO$_3$ / Mn / Bi	x / y / z
Caselton	1924–58	2,642,831	.042	4.85	4.81	11.82	—	—	
Ely Valley	1944–52?	615,000*	.012	0.60	0.60	9.50	0.40	—	
Comet	1945–51	13,664†	.040	5.00	3.00	14.00	—	0.40	z
Prince	1941–49	197,922	.032	2.93	1.24	9.70	0.14	—	
Total Pyritic Ores		3,468,753							
B. Carbonate Gangue, Primary Sulfide Ores									
Caselton	1951–54	149,629	.026	1.49	1.39	2.66	—	9.70	y
Pan American	1955–66	496,853	.005	2.20	1.10	2.45	—	9.25	y
Total Carbonate Gangue		646,482 (Assay 18% to 22% Fe; minor pyrite)							
Total Primary Ores		4,102,235							

II. Oxidized Ores (Some semi-oxide)

Mine	Period	Dry Tons Produced	Ounces Per Ton Au	Ounces Per Ton Ag	% Pb	% Zn	% Cu	% WO$_3$ / Mn / Bi	x / y / z
A. Production—Oxidized Ores from Pyritic and Quartz Fissure Type Primary Sulfides									
Bristol	1924–64	452,917	—	11.72	4.17	4.73	3.37	—	
Prince	1912–49	16,581	.045	15.00	6.00	—	—	—	
Apex	1929–44	14,057	.096	57.20	21.50‡	—	—	—	
Comet	1925–50	2,000	.260	10.50	5.00	—	—	0.50	z
Yuba Dike	1958–60	739	.340	68.80	22.80	—	—	—	
Jackrabbit		54	.100	329.00	36.00	—	6.50	2.10	z
Total		486,348							
B. Production—Oxidized Ores from Primary Carbonate Type Deposits									
Prince§	1912–27	1,017,672	.010	2.72	3.01	3.50	—	12.35	y
Caselton	1951–55	64,255	.024	1.50	1.35	1.56	—	13.47	y
Ely Valley	1953	2,406	—	—	—	—	—	18.10	y
Jackrabbit	1919–24	24,000	—	12.00	0.70	—	—	8.60	y
Jackrabbit	1924–53	28,316	.010	3.40	0.20	0.50	—	21.00	y
Black Prince	1952–53	1,000+	.010	1.00	Trace	1.40	—	14.20	y
Bristol-Hurley	1952–53	871	.010	3.10	4.00	8.00	—	22.50	y
Total		1,138,520							

* Ely Valley production does not include ore milled in the Pioche Mines. Inc., Mill; including such milled ore, perhaps 10% more production was achieved during the period in question.

† Estimated.

‡ Approximate.

§ Prince mine production averaged 31.5% Fe.

TABLE 1. Production from the Pioche District 1912-1966 (from Genmill)

to the west. When the Pan American was closed in 1968 as a result of litigation, the mill was once again forced to close. Production in the district since 1968 has been limited to a few tons gouged here and there by leasers.

Total production from the Pioche District for the period 1869-1966 is estimated at about 6 million tons valued at $100 million (See Table 1).

Geology

The Pioche District falls within the Southern Nevada subprovince of the Utah-Nevada Precambrian province (Condie, p.85). The province consists of Late Precambrian Pahrump unmetamorphosed sediments which unconformably overlie plutonic-metamorphic complexes of the Churchill or Wyoming provinces. Masson and Smith (p.34) suggest that the northerly to northwest Precambrian structural trends do not influence mineralization in southeastern Nevada. It is notable, however, that both the Blind Mountain and Manhattan stocks, as well as the overall magnetic grain, have a northwest orientation. Also, the east-west mineralizing trend is probably related to a fundamental crustal break, as evidenced by east-west trending magnetic and gravity anomalys further east through Utah, that may or may not be related to Precambrian structure.

As a portion of the Cordilleran Geosyncline, the area received shallow-water marine sediments, mostly massive carbonates, throughout the Paleozoic Era and into Triassic time. During the Late Triassic and Jurassic periods, the region was elevated above sea level and was probably subject to minor erosion. This portion of eastern Nevada lay on the extreme western flank of the Rocky Mountain Geosyncline during Cretaceous time and probably received continental to very shallow-water sediments from the Manhattan positive area to the west. Tertiary deposits consist of a thick sequence of acid-to-intermediate ignimbrites that are apparently related to an extrusive center in east-central Nevada, near the geographic center of the Great Basin. Quartz monzonite stocks, dikes and sills intruded the sedimentary sequence during Laramide or mid-Tertiary orogenies.

Although Paleozoic rocks ranging in age from Lower Cambrian to Pennsylvanian outcrop in the general area (Westgate and Knopf, 1932), mineral deposits are restricted to the Cambrian and Ordovician units. Consequently, this report will be concerned only with the Cambrian Prospect Mountain, Pioche, Lyndon, Chisholm and Highland Peak formations and the Cambro-Ordovician Mendha limestone (Fig. 2). These are shallow-water marine, miogeosynclinal sedimentary rocks consisting almost entirely of carbonates in the upper part of the section, with clastics predominating in the Lower Cambrian. A brief description of the section is as follows:

Prospect Mountain quartzite - Lowermost Cambrian - +2,500 feet of white, medium-grained orthoquartzite. Surface exposures commonly stained pink to red as result of oxidation of fine disseminated pyrite. Good, brittle host for metal-bearing quartz veins.

Pioche shale - Lower Cambrian - ±960 feet of thin- to medium-bedded, micaceous shale and siltstone with minor limestone members including the ±75 feet Combined Metals member 250 feet above the base of the shale and the 20 feet Susan Duster member 100 feet above the CM bed. The CM bed consists of 10-15 feet of thick-bedded, dark-gray, medium-crystalline algal limestone at the base, overlain by 50-60 feet of thin-bedded, nodular, carbonaceous micrite. Being the most favorable host for replacement ore in the district, the CM has received a great deal of attention and in the Pioche Hills has been subdivided as in Figure 2.

Lyndon (Prince) limestone - Middle Cambrian - ±250 feet of thick-bedded to massive limestone. The formation is divided into dark-colored "Black Prince" lower unit and light-colored, coarse-crystalline "White Prince" upper unit. Contains relatively minor oxidized replacement Pb-Zn bodies at the Prince Mine south of Caselton.

Chisholm shale - Middle Cambrian - ±100 feet of thin-bedded, fissile, calcareous shale. Contains minor replacement Pb deposits at Abraham Lincoln Mine in Pioche Hills.

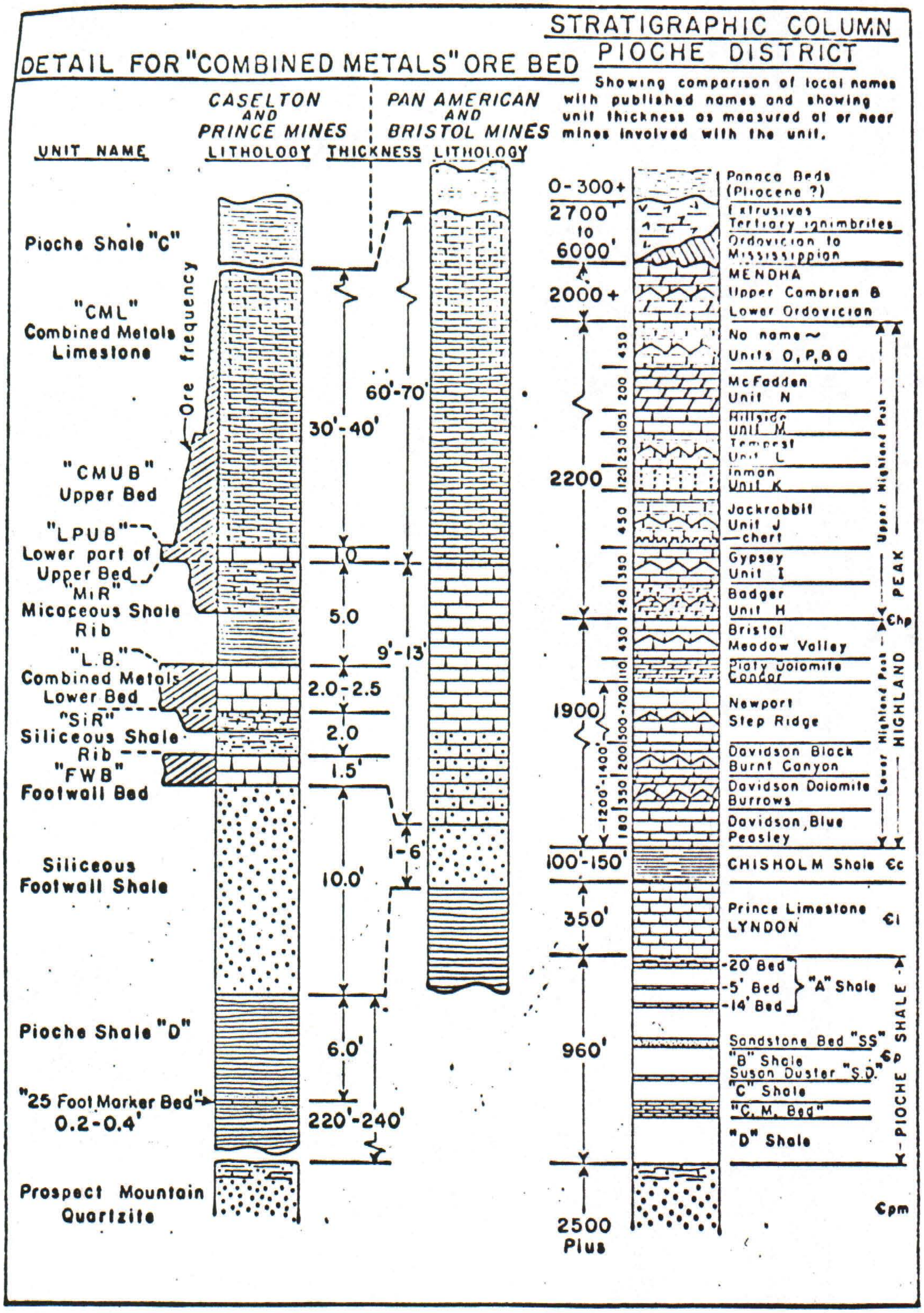


Figure 2. Stratigraphic Column, Pioche District. (from Gemmill)

Highland Peak formation - Middle and Upper Cambrian - ±4000 feet of generally thick-bedded to massive limestone and dolomite. Irregular replacement Pb-Zn-Cu ore bodies in the Bristol and Jackrabbit mines.

Mendha formation - Upper Cambrian, Lower Ordovician - ±2000 feet of thick-bedded to massive limestone and dolomite. Contains no known replacement ore, but is good host for Pb-Ag-Au-bearing quartz-jasperoid veins.

Intrusive Rocks - Laramide (?) - Northwest-trending Blind Mountain quartz monzonite stock, smaller hydrothermally altered Manhattan stock, and altered quartz porphyry dikes and sills in both the Pioche Hills and Highland Range. Dikes serve as hosts for irregular pods of bonanza ore, and Manhattan stock gives rise to broad pyrite replacement body in CM bed as well as minor disseminated molybdenite and chalcopyrite in the intrusive itself.

Structure

Other than east-west faulting of possible Laramide origin, the rocks of the Pioche District show remarkably little effect of orogeny other than that associated with Basin and Range normal faulting in the Late Tertiary. The Tertiary ignimbrite flows, dated at 15-25 m.y., disconformably overlie the older sediments at an old erosion surface, indicating the previously undisturbed condition of the Paleozoic section. Since both the volcanics and underlying Paleozoic sedimentary rocks are tilted gently to the east, the regional dip of 10-15° is dated as Late Tertiary (Basin and Range).

An east-west fault system that is apparently associated with mineralization in the district (see Mineralization below), is offset by north-south faulting and may be Laramide in age. The northwest-to north-trending normal fault system is thought to be of Pliocene-Pleistocene age. Probably the latest structural features in the area are relatively flat-lying gravity slide faults (earlier mapped as thrust faults) associated with Basin and Range uplift. No folds are recognized in the district and all faults appear to be the result of extensional stresses (i.e. normal).

Mineralization

As previously mentioned, east-west to east-northeast fractures commonly control mineralization in the Pioche District. This is a common Laramide mineralizing trend recognized, among others, at Butte, Montana and in Arizona at Magma, San Manuel and Copper Creek. At Pioche, practically all the major veins (including the Raymond and Ely, Mendha, Comet, and Mt. Lion veins) have this orientation and the three largest replacement orebodies, the Caselton, Pan American and Bristol, are apparently controlled by east-west faults. The only exceptions to the rule are the smaller Ely Valley and Prince replacement orebodies which may have been controlled by northwest faults (Genmill, p. 1141-42).

The Pioche District is thought to represent the western extension of the Wah Wah-Tushar mineral belt which is clearly defined through south-central Utah. Mineralized districts occur along this east-west trend from the Stateline District on the Nevada-Utah line as far east as the Marysvale District. The lineament is expressed as a strong east-west magnetic anomaly in the Milford, Utah vicinity and as a possible gravity anomaly extending from the Nevada border to the Wasatch Front that passes south of Richfield, Utah. The mineralized trend is marked by a series of uplifts that suggests an east-west regional arch (Masson and Smith, p. 25d).

Mineralizing fluids rising along the east-west "plumbing" system commonly reacted with the lowermost carbonate unit in the section, the CM bed, replacing the limestone unit first by mangano-siderite and later by metallic sulfides. Several factors have been suggested as possibly influencing the role of the CM bed as a perfect host for ore, including: (1) Reactiveness of the limestone to metal-bearing solutions that had passed upward through several thousand feet of siliceous rocks, (2) impervious nature of the shale and carbon partings in the thin-bedded, nodular upper portion of the bed, and (3) free carbon content as a precipitating agent for the ore fluids. In addition to the above factors, I would add,

(4) structural preparation of the bed. It is probably more than coincidence that the richest and largest orebody mined to date, the Caselton "channel", is situated in the most structurally complex area in the district. It is possible that good "feeder" channels such as those at the Log Cabin and Forlorn Hope mines in the Highland Range gave rise to little replacement ore as a result of a lack of good structural preparation.

There is a suggestion of lateral metal zoning both in the Pioche Hills and in the Highland Range. In the Pioche Hills, this zoning progresses from Zn-Cu at the Ely Valley Mine in the northern part of the range through a Pb-Zn-Ag zone in the Caselton-Prince area to a Pb-Ag-Au zone further south and east in the area of the Raymond and Ely and the Pacific mines. A similar north-south metal zonation may be present in the Highland Range where Cu-Mo veins and disseminated deposits grade southward to Pb-Zn-Ag orebodies in the area of the Pan American mine. Small, poorly exposed altered quartz porphyry stocks near the Ely Valley mine and at Manhattan Gap may represent a part of the intrusive center away from which the metals are zoned. In fact, if the area between these two outcropping intrusives were not covered by thousands of feet of gravel and Tertiary volcanics, it would be prime prospecting ground for porphyry copper mineralization.

Age of Mineralization

Paul Genmill, who worked as a geologist in the district for over thirty years, has assigned two ages to mineralization at Pioche: An early (Laramide?) age for the pyrite bodies associated with intrusives and skarn zones in the Stampede Gap-Manhattan Gap area and a "very late" age (Late Tertiary?) for replacement mineralization of the Caselton-Pan American type. As evidence for an early age for the pyrite-skarn bodies, Genmill (p. 1144) cites the fact that this mineralization is cut in the Bristol Range by the north-south Iron Mine Fault, which he considers to be one of the oldest in the Bristol-Jackrabbit fault pattern. He further maintains that the Iron Mine Fault predates ore-controlling faults in the Bristol Mine and concludes that the pyrite mineralization is earlier than Bristol replacement orebodies.

As evidence for the very late age of replacement mineralization Genmill cites the presence of premineral faults along the Caselton east-west ore channel (although he ascribes post-mineral adjustment to the transverse, i.e. north-south, faults). As further evidence he mentions instances of mineralization post-dating gravity slide faulting which is generally though to be Late Tertiary in age.

Probably the most compelling evidence for a very late age for Pioche mineralization is the presence of the east-west Mt. Lion jasperoid vein in a brecciated block of Mendha limestone in the upper plate of a gravity slide block on the east flank of the Highland Range. If one assumes that the gravity slide faulting is associated with Basin and Range uplift, then either the vein must be very late Tertiary in age, or it slid into its present position intact. Since the vein cannot be traced out of the Mendha limestone block either laterally or in depth, I am inclined to accept the latter alternative.

In general, throughout the district the east-west mineralizing fissure system is offset by northerly trending Basin and Range faults. Consequently, mineralization is dated as pre-Pliocene. I further suggest that the east-west system may be related in time to intrusive activity in the Pioche and Bristol ranges, as witness the east-west altered quartz porphyry dikes in both ranges, and that the mineralization is of probable Early to Middle Tertiary age. Age dating of the intrusives would be of great assistance in further pinpointing the probable age of mineralization.

Humble Exploration

Because the Pioche District offered multipe targets in a zoned district, it was selected early as an area of exploration for Humble Minerals. Chances were thought to be good for discovering stratabound Pb-Zn orebodies in the relatively little-explored Highland Range; the intrusive-skarn area in the northern part of the range offered a good secondary target. At the initiation of the exploration project, the priorities were as follows:

1. Replacement Pb-Zn-Ag bodies in the CM bed along the western flank of the Highland Range.

2. Replacement Cu-Pb-Zn bodies in the silicified CM bed adjacent to the quartz monzonite stock at Manhattan Gap (Manhattan Stock).

3. Replacement Pb-Zn-Cu bodies in the CM bed, or in stratigraphically higher carbonate units, adjacent to the N70°W quartz porphyry dike traversing the Manhattan Gap area.

4. Cu-Mo-W mineralization in skarn associated with the Manhattan stock.

5. Porphyry copper mineralization in the altered Manhattan stock.

The odds appeared best for discovering relatively large, low-grade stratabound Pb-Zn-Ag replacement orebodies in the CM bed. A few million tons of ore averaging 1.1% Pb, 2.2% Zn and 2.0 oz./t. Ag had been developed in the Pan American mine and published U.S.B.M. data indicated an eastward and northward extension of the orebody (Fig. 3). Humble's search for similar targets began with detailed mapping of the CM bed from the Pan American mine northward some 8 miles to the vicinity of Manhattan Gap. Manganese oxides from the oxidation of mangano-siderite, almost universally present with Pioche replacement ores, was looked for as a primary guide to ore. Although the CM bed outcrops fairly continuously in this area, only a disappointingly few narrow "channels" were found between the Pan American and Mt. Lion mines. It was noted, however, that upon approaching the Manhattan Stock in the north, the CM bed became completely replaced by goethite gossan, apparently from the oxidation of pyrite.

Soon after the initial mapping project, in early 1969, it became obvious that the area between the Pan American and Mt. Lion mines would be tied up indefinitely by litigation. Consequently, Humble's major effort was shifted north to the Manhattan and Mt. Lion claim blocks, optioned from Combined Metals Reduction Co., and Paul Genmill, respectively (Fig. 4).

The most likely prospect in this area was thought to be replacement

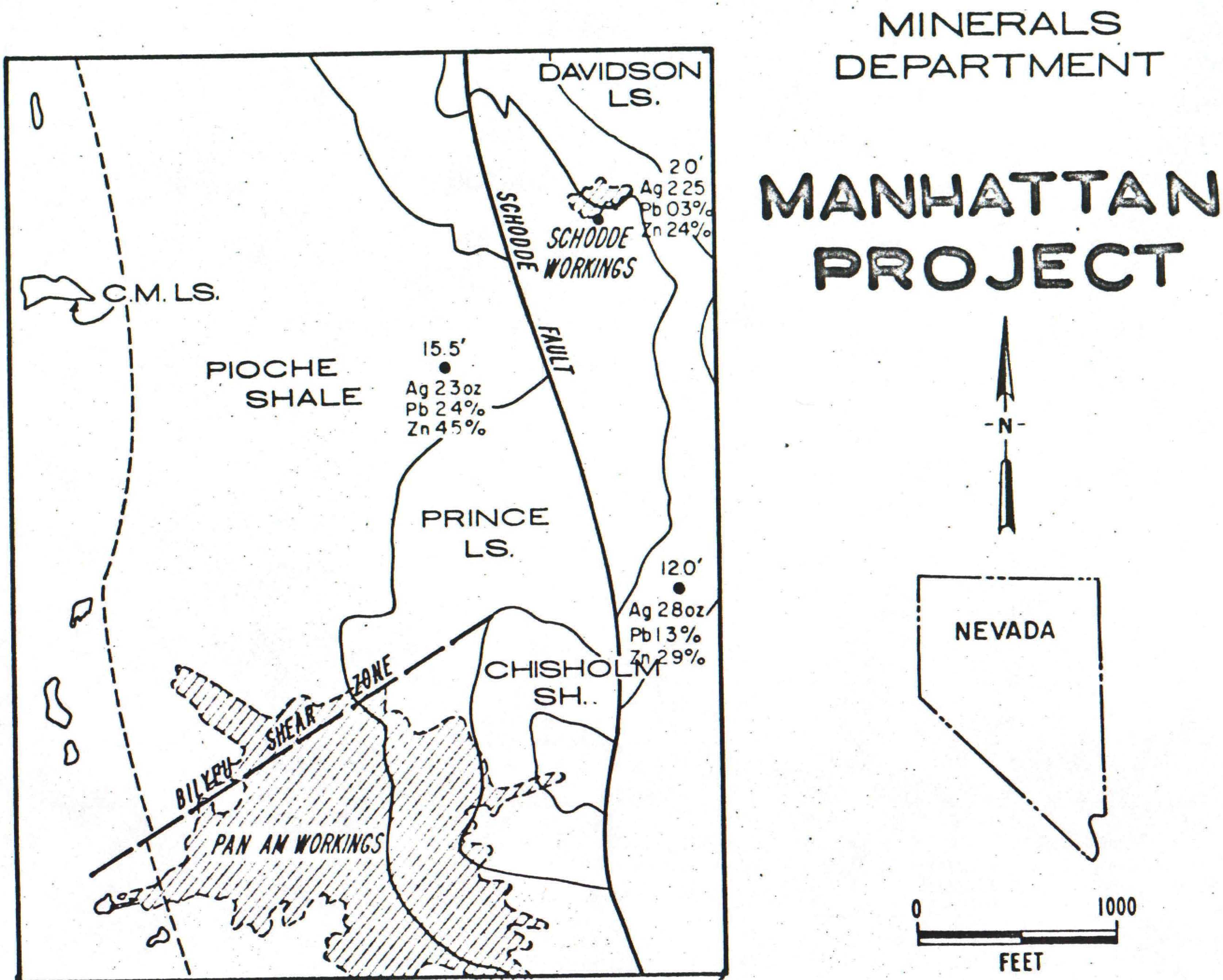
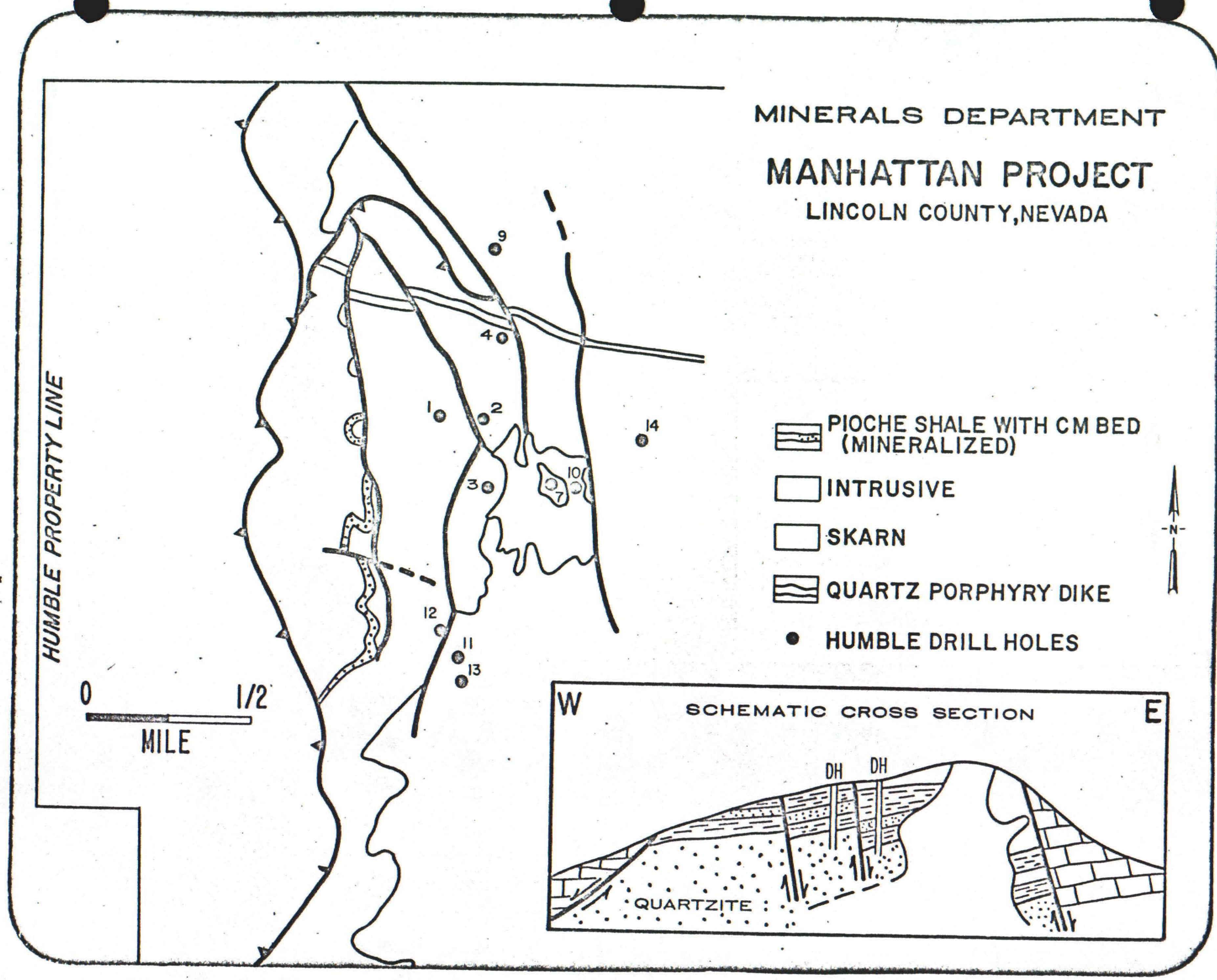

MINERALS
DEPARTMENT
MANHATTAN
PROJECT
N
NEVADA
0
1000
FEET
DAVIDSON
LS.
20'
Ag 2.25
Pb 0.3%
Zn 2.4%
SCHODDE
WORKINGS
SCHODDE
FAULT
C.M. LS.
PIOCHE
SHALE
15.5'
Ag 2.3oz
Pb 2.4%
Zn 4.5%
PRINCE
LS.
12.0'
Ag 2.8oz
Pb 1.3%
Zn 2.9%
CHISHOLM
SH.
BILYEU
SHEAR
ZONE
PAN AM WORKINGS

FIGURE 3.

bodies in the CM bed. Although early mapping and geochemical sampling had indicated pyrite replacement of the CM bed, it was hoped that a more or less concentric zoning pattern was developed around the Manhattan Stock and that copper, zinc and lead zones would be found with further exploration. While 30 trenches were being cut in the CM bed on the western flank of the range, five east-west lines were surveyed across the Highland Range to serve as bases for an IP survey, a ground magnetometer survey and for geochemical sampling. Meanwhile, geologic mapping was begun on 1"=200' scale to augment an earlier map by Genmill and Richard.

The IP survey showed a strong north-south anomaly on the west flank of the range, thought to represent the mineralized CM bed. Geochemical values both of surface rock chips and of the trenches were disappointingly low. Only a few metal values were above threshold and these were usually in the area of known mineralized veins. The ground magnetometer survey substantiated the strong magnetic anomaly over andradite skarn surrounding the Manhattan stock previously shown on a Humble airborne survey, and also showed a low intensity anomaly on the east flank of the range, northeast of the stock.

Three holes (DDH-1,2,3) drilled in the IP anomaly west of the stock showed the CM bed to be silicated and almost completely replaced by pyrite, pyrrhotite and magnetite (Figs. 4,5). Consequently, it was decided to step both north and south, away from the stock, to attempt to hit the Pb-Zn and/or Cu zones. The northern area was considered to be particularly favorable since it is traversed by an east-west quartz porphyry dike of the same type as the Yuba dike, which parallels the Caselton orebody in the Pioche Hills. In drill hole #4, collared just south of the almost vertical dike, the CM bed was replaced by quartz and pyrite with minor magnetite and very minor chalcopyrite. The CM bed in DDH-9, 1400 feet further north, was not mineralized and only mildly altered. Drilling to the south encountered only minor Cu and Zn values in the sideritized and pyritized CM bed in DDH-11,12 and 13. A hole further south in the Mt. Lion claim block, cut only minor disseminated pyrite in the fresh, unaltered CM bed. This


MINERALS DEPARTMENT
MANHATTAN PROJECT
LINCOLN COUNTY, NEVADA
PIOCHE SHALE WITH CM BED (MINERALIZED)
INTRUSIVE
SKARN
QUARTZ PORPHYRY DIKE
HUMBLE DRILL HOLES
N
SCHEMATIC CROSS SECTION
W
E
DH
DH
QUARTZITE
HUMBLE PROPERTY LINE
0
1/2
MILE
1
2
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4
7
9
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12
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FIGURE 4.

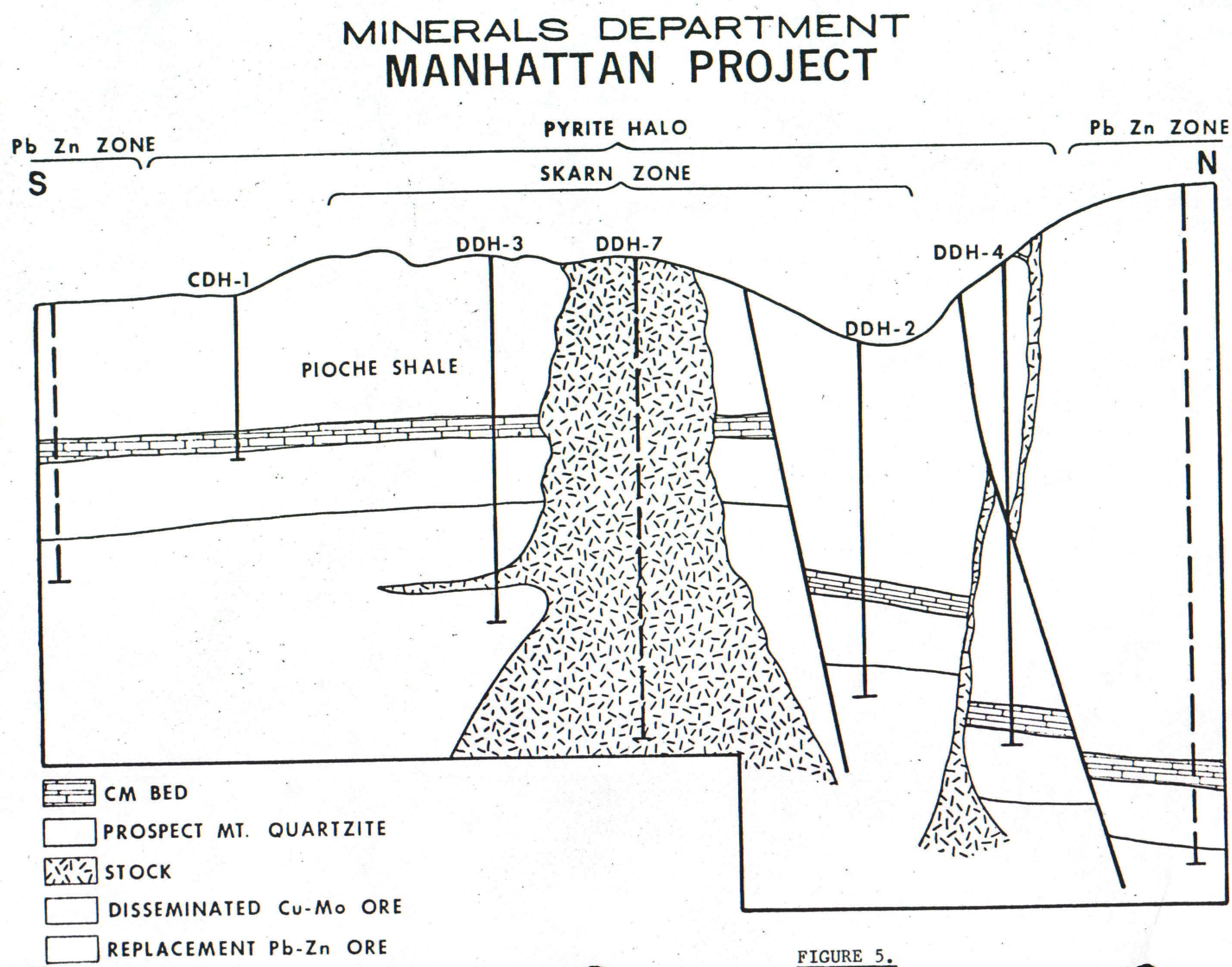
MINERALS DEPARTMENT
MANHATTAN PROJECT
Pb Zn ZONE
PYRITE HALO
Pb Zn ZONE
SKARN ZONE
S
N
CDH-1
DDH-3
DDH-7
DDH-4
DDH-2
PIOCHE SHALE
CM BED
PROSPECT MT. QUARTZITE
STOCK
DISSEMINATED Cu-Mo ORE
REPLACEMENT Pb-Zn ORE

FIGURE 5.

MINERALS DEPARTMENT
MANHATTAN PROJECT

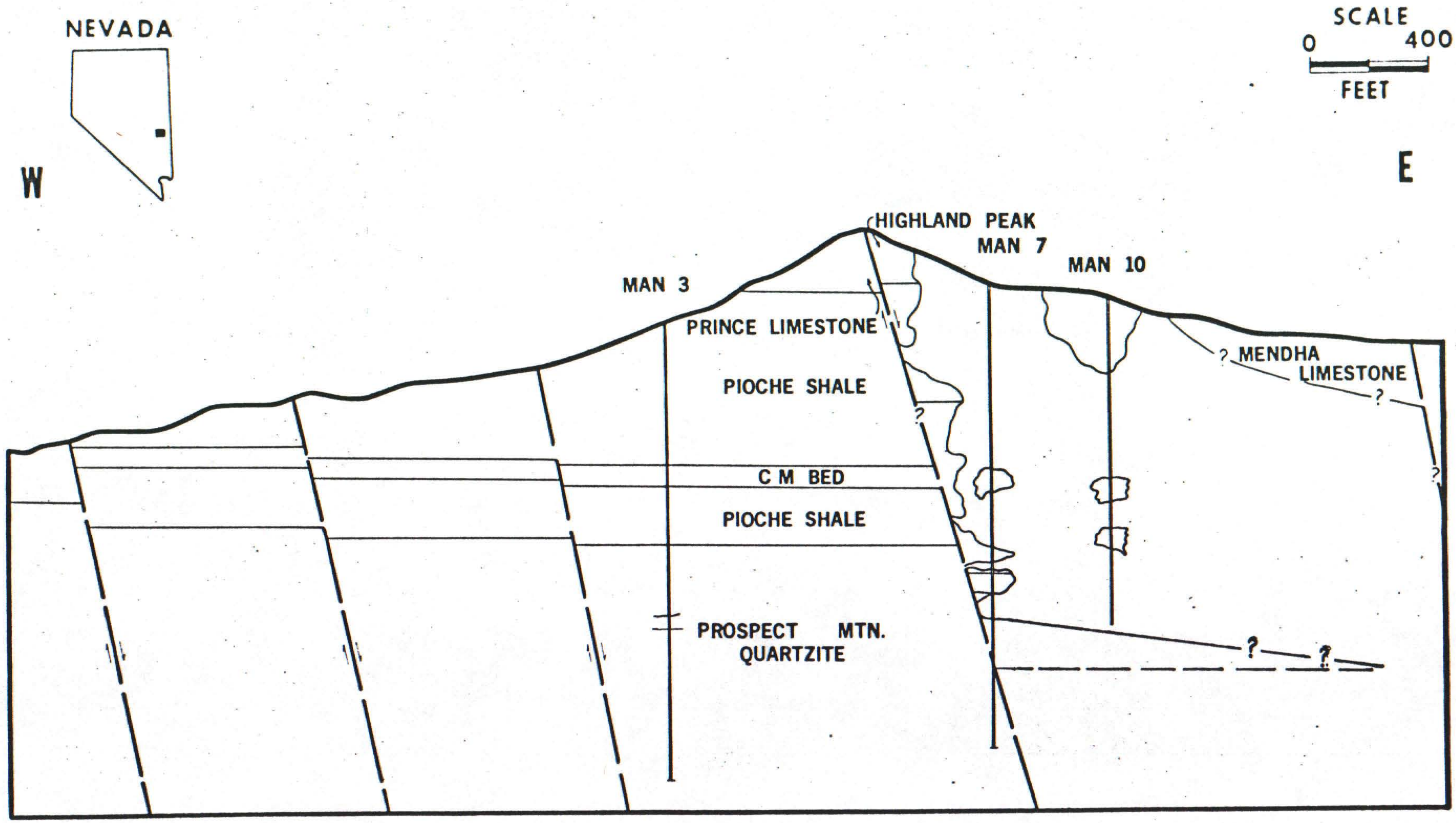

FIGURE 6.

last series of holes had effectively bracketed the possible mineral zones associated with the Manhattan stock and had found them to be lacking in commercial mineralization. Consequently, drilling on the west flank of the Highland Range was stopped.

Attention was next shifted to the Manhattan Stock itself. Early mapping had shown the small outcropping portion of the stock, 400' x 800' in area, to be intensely sericitized and fractured and to possess a good quartz stockwork. In addition, anomalous molybdenum values were obtained from trenches in the altered quartz monzonite. A drill hole, DDH-7, in the center of the outcrop intersected highly altered monzonite with a few blocks of hornfels and skarn, thought to be roof pendants, to a depth of 1,140 feet (Fig. 6). The sericitized and silicified quartz monzonite contained 2-3% pyrite as disseminations and in narrow veinlets, and very minor molybdenite usually disseminated in quartz-orthoclase veinlets. The hole went into Pioche shale (hornfels) at 1,140 feet and into Prospect Mountain quartzite at 1,390 feet. The hole bottomed at 1,466 feet in barren quartzite. A second hole, DDH-10, 400 feet east of DDH-7, intersected the intrusive in the interval 290-1150 feet. In this area the intrusive is altered to a mixture of quartz, sericite, calcite and kaolinite. Minor pyrite and very minor molybdenite occur in quartz-carbonate veins.

A final hole, DDH-14, was drilled 1,400 feet northeast of the Manhattan stock on a low-intensity magnetic anomaly. Surface exposures here are a jumbled mass of Highland Peak and Mendha brecciated blocks, probably in the upper plate of a gravity slide fault on the Chisholm shale. It was thought that the anomaly might result from skarn associated with a northeast extension of the intrusive, and that the intrusive-skarn zone might be reached by drilling through the upper plate of the fault. A secondary objective was to determine depth to the CM bed on the east flank of the range. The rotary drill hole was terminated in Chisholm shale after passing through 1,970 feet of Highland Peak limestone. The anomaly was apparently caused by minor skarn and disseminated magnetite within the Badger dolomite unit of the Highland Peak formation. If the section beneath the Chisholm shale is complete, the CM bed is still 550 feet below the bottom of the hole.

Conclusion

Upon completion of DDH-14, the more favorable targets in the northern part of the Highland Range had been adequately tested. In my opinion, the proper geologic tools had been used and their results had been verified. The intrusion of the Manhattan stock has given rise to metasomatic calcium silicate replacement of the CM bed near the stock and to silica and siderite replacement at increasing distances away from the intrusive center. In addition to gangue minerals, the bed is replaced by abundant magnetite, pyrrhotite and pyrite, and there is a suggestion of zonation to copper and zinc away from the Manhattan stock. Unfortunately, the commercial sulfides do not occur in sufficient enough grade or quantity to constitute an orebody. The Manhattan stock itself is intensely altered and contains disseminated pyrite and very minor Cu and Mo sulfides.

Some valuable lessons were learned from exploration in the Pioche District that may be applied in future exploration for stratiform deposits in the Basin and Range, and possibly elsewhere:

1. The east-west Laramide or Mid-Tertiary fracture trend is an important mineralizing system at Pioche, as well as in other parts of the western United States.

2. The first <u>favorable</u> limestone member above basement is subject to stratiform replacement by rising mineralizing fluids.

3. Good structural preparation of the host bed is probably just as important as the chemical reactivity of the formation.

4. An explorationist should constantly be aware of the concept of metal zoning. Many districts mined for precious metals and replacement Pb-Zn in their early years were later mined as porphyry copper deposits.

Lawrence D. Hayes

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