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Preliminary Report

# ZINC-LEAD DEPOSITS OF THE LEAD HILL AREA ON SLATE CREEK, METALINE DISTRICT

Pend Oreille County, Washington

44-54

by

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## ECONOMIC CONCLUSIONS AND RECOMMENDATIONS

### General Character of the Ore Bodies

Conclusions which have been drawn regarding the ore deposits at Lead Hill can be stated as follows:

1. The ore consists of sphalerite-galena replacements of brecciated and dolomitized upper Metaline limestone. Zinc predominates over lead in the ratio of more than two to one on the average, although either may be developed to the exclusion of the other.

2. The mineralized zones are essentially blanket-form and are roughly parallel to the bedding of the enclosing limestone. In the north and central areas of Lead Hill, the mineralized zone is localized in a cherty dolomite bed which underlies the greater part of the area mapped. In the south area, the mineralized zone is in a calcite-bearing dolomite which is stratigraphically below the cherty bed. Ore is found through a total stratigraphic range of about 375 feet.

3. The enclosing limestone dips at an angle nearly parallel to the topographic slope so that the main mineralized zones, which are in places exposed at the surface, probably nowhere reach a depth of more than 450 feet in the Lead Hill area.

4. Within the mineralized zone, runs or shoots of mineable grade ore are present which appear to have a general north to northeast trend, parallel to the major faults.

Possible Size and Value of the Ore Deposits

The producing mining companies of the Metaline district have virtually abandoned attempts to compute tonnages of reserve ore directly from drill hole data, because of the highly irregular distribution of ore within the mineralized horizon. They point out that, even in areas that are subsequently mined out, approximately 40 percent of their drill holes showed practically no mineralization. The Pend Oreille Mines and Metals Co., the largest producer in the district, has adopted instead a much simpler calculation, based on more than 15 years of successful mining in the district, which assumes that, in mineralized ground, it will be possible to mine out one ton of ore (6 percent of combined lead and zinc) for each square foot of area. Ore thicknesses at Lead Hill are roughly comparable to those at the Pend Oreille Mine, but whether this generalization can be extended to the Lead Hill area is open to question. It is, however, a simple approximation that may indicate the right order of magnitude of the reserve tonnage.

The cherty dolomite at Lead Hill appears to have been the most favorable horizon for ore deposition. Of the area mapped, approximately 3,000,000 square feet are underlain by this rock, and of this about 25 percent has been reasonably well tested by earlier exploration work. Somewhat more than half of this tested area, or about 400,000 square feet, may be classed as mineralized. Of the remaining part of the 3,000,000 square feet underlain by the cherty dolomite, perhaps one-third, including the area between the central and southern blocks, can be classed as definitely unpromising, on the basis of the testing and unfavorable surface indications of critical parts of the section. The approximately 1,500,000 square feet remaining may be classed as promising ground. Additional ground below the cherty dolomite in the southern part of the area is known to be ore bearing, but the extent of the mineralization is not well enough known to class the lower zone as promising or unpromising except in a very limited area.

Unfavorable features of the prospect area as a whole are given below:

1. A considerable part of the known ore in the northern part of the area is in the oxidized form. The areal extent of this oxidation is unknown. At the present time no producer in the district is equipped to recover non-sulfide ore.

2. The Lead Hill area, compared with the producing areas of the Metaline district, is considerably farther from the highway and from the railroad, and farther from sources of hydroelectric power. It is also at a higher elevation and the winters are correspondingly more severe.

The proposed exploration program outlined in this report recommends between 2500 and 5300 feet of diamond drilling. Favorable results from this drilling might indicate, on the square-foot basis, approximately 750,000 tons of ore which could be added to a possible 400,000 tons now indicated.

Summary of Proposed Exploration Program

The structure of the Lead Hill area, the habit of the ore bodies, and the experience of previous exploration all indicate that diamond drilling is the most feasible method to explore the prospect adequately.

Recommended locations for 34 short diamond drill holes are given in the text under "Proposed Drilling Program" and are shown on the maps and sections. The "A" series of holes are located so as to extend or delimit ore now indicated in outcrops and in drill holes and are considered to be the essential minimum of drilling. The "E" series are locations contingent upon the results obtained from adjacent "A" hole drilling. The " W" series are "wildcat" holes in untested but geologically favorable areas, and should be drilled if the prospect is to be explored adequately.

| | Number of Holes | Probable Minimum Footage | Probable Maximum Footage |
|---|---|---|---|
| "A" Holes | 18 | 1800 | 2650 |
| "W" Holes | 4 | 700 | 850 |
| Sub-total | 22 | 2500 | 3500 |
| "E" Holes (optional) | 12 | 1200 | 1800 |
| Total | 34 | 3700 | 5300 |

It is recommended that inclined holes be drilled at an angle of -55 degrees to the northwest to take advantage of the direction of dip of the formation. It is unlikely that any hole will need to exceed 300 feet in length.

## INTRODUCTION

The Lead Hill property comprises 18 claims in sections 11 and 14, T. 40 N., R. 44 E., Pend Oreille County, Washington. The claims were located in 1930 by C. A. Bostrom and Iver Luhr and are in what is locally known as the Slate Creek district, which is geologically part of the better known Metaline mining district. The property is accessible by about 8 miles of secondary road from the paved highway and is about 15 miles from Metaline Falls. Except for a small amount of hand-sorted galena ore shipped in 1937, there has been no actual production from the deposits. A great deal of exploration work has been done, however. In 1931-1932, the Bunker Hill and Sullivan Mining and Concentrating Co. put down over 40 diamond drill holes, totaling 8400 feet, trenched the surface, and drove a 1400-foot crosscut. In 1937, C. A. Bostrom and his associates did some surface work. In 1942, the Butte-Highlands Mining Co. of Butte, Montana surveyed the property and put down two diamond drill holes totaling 930 feet in the slate east of the surface showings. At the present time, the property is held by Charles A. Bostrom, Ivar Luhr, Betty Thompson, and Mrs. Maude Lindstrom.

The present report is based on about six weeks field work in August and September 1943. The project, which was undertaken in line with recommendations made in June 1943 by C. F. Park, Jr., consisted of a detailed re-examination of the area mapped by Park and Cannon 1/ in 1937, and extension of the mapped area to the north and south. The following men participated in all or part of this work: J. P. Albers, C. S. Bacon Jr., H. L. James, and C. L. Rogers. Albers spent about 10 days in Kellogg, Idaho logging drill cores from the property which were kept by the Bunker Hill and Sullivan Mining and Concentrating Co. E. T. McKnight, James Gilluly, John J. Collins, M. G. Dings, P. J. Shenon and Edward Sampson visited the area during the progress of the work and offered many useful suggestions at the time and in reviewing the report later.

Acknowledgement is gratefully extended to Charles Bostrom, present majority share-holder in the claims, for assistance in locating diamond drill holes, for core assays, and for other valuable information regarding the drilling; to the Bunker Hill and Sullivan Mining and Concentrating Co. for permission to examine diamond drill cores; to the American Zinc, Lead and Smelting Co. for logs of three drill holes south of Lead Hill proper; and to the Butte-Highlands Mining Co. for permission to examine the cores of diamond drill holes and for use of their maps of the property.

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1/ Park, C. F. Jr., and Cannon, R. S., Geology and Ore Deposits of the Metaline Quadrangle, Washington. U. S. Geol. Survey, Prof. Paper 202, Pl. 28, 1943.

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## GEOLOGY

### General

In the Lead Hill area, mineralized Metaline limestone dips at a moderate angle southeastward, abutting down-dip against a downfaulted block of Ledbetter slate. Numerous northeast to northwest trending faults, ususlly with associated brecciation, appear to be related to the major northeast trending fault which forms the slate-limestone contact. The "limestone" has been completely or almost completely, dolomitized and silicification is common.

### Stratigraphy of the Metaline Limestone

A generalized stratigraphic section of the hill shows cherty, medium-grained dolomite at the top, underlain by non-cherty, medium-grained dolomite in which coarse calcite is abundant. The non-cherty dolomite grades downward into fine-grained dolomite which is commonly dark-banded and pyritic. (Fig. 1)

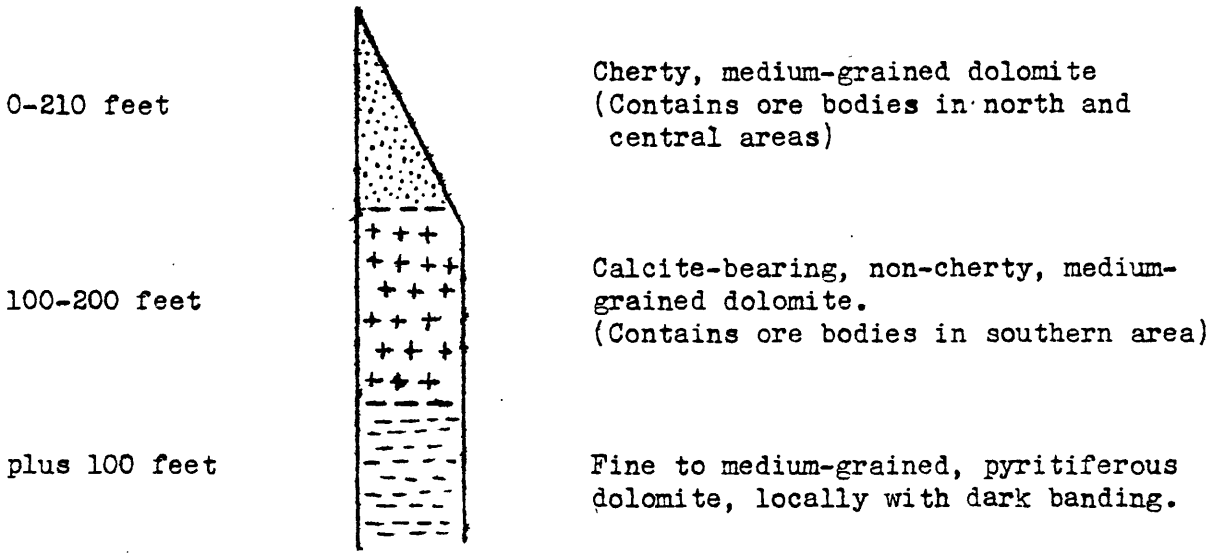


Fig. 1. Stratigraphic section of Metaline limestone at Lead Hill.

The cherty dolomite is made up of medium-grained, medium gray dolomite containing as much as 75% silica. The "chert", which is actually white, sugary quartz, occurs locally as definite nodules (for photograph see U. S. Geol. Survey Professional Paper 202, Pl.8), but elsewhere is found as irregular patches and seams which are continuous into definitely nodular structures. Close correlations based on the amount of chert in certain zones could not be established even in immediately adjacent drill holes. In outcrops, the cherty dolomite exhibits a rough, uneven surface due to the greater solubility of the interstitial carbonate in weathering. In places, a planar structure is recognizable due to alignment of nodules or patchy chert. This is generally parallel to bedding, although a few exceptions were noted. The thickness of the remnant of cherty dolomite reaches a maximum of about 210 ft.

Approximately half a mile southwest of the mapped area, the cherty dolomite passes along the strike into cherty, dense, gray limestone, thus indicating that the granular dolomite matrix of the rock may be of hydrothermal origin, with the chert remaining as relict material that has withstood replacement.

Immediately below the cherty dolomite is an essentially non-cherty, medium-grained dolomite in which patches of coarse white calcite are abundant. The contact between the calcite-bearing rock and the cherty rock is in places fairly sharp, but in others the chert and calcite appear to overlap in a zone as much as 50 to 100 feet thick. The contact is particularly indefinite in the central part of the Lead Hill area. As with the cherty dolomite, bedding is very inconspicuous. Below the calcite-bearing dolomite, grain size decreases and dark banding, stylolites, and pyrite occur commonly. The rock, however, remains essentially a dolomite, and on the map is included with the calcite-bearing rock as the "non-cherty dolomite".

The use of the above-described rock types as true stratigraphic units is open to some question. The cherty member, though not continuous throughout the Metaline district, has been recognized in the No. 6 tunnel of the Bella May mine, in the outcrops above the Blue Bucket workings, and on the ridge east of the Lead King prospect. At these localities the chert is in a matrix of gray, non-dolomitic limestone that appears to be in the upper 200 feet of the Metaline limestone. It seems probable that the cherty horizon is a valid stratigraphic unit, though some confusion of "chert" with later introduced silica is almost inevitable, particularly in mineralized areas such as Lead Hill.

The calcite-bearing, medium-grained part of the non-cherty dolomite is assigned a stratigraphic position only with reservations. Both the cherty and the calcite-bearing dolomite members appear to grade, southwestward along the strike, into gray limestone. It is probable, therefore, that these two dolomites are of hydrothermal origin. The presence of coarse calcite in the upper part of the non-cherty dolomite is apparently reliable for stratigraphic correlations within the Lead Hill area, though its origin is not clearly understood. It might be accounted for by assuming that dolomitization, which was complete in the upper, cherty, part of the gray limestone immediately beneath the Ledbetter slate, was less complete in the lower part and was accompanied by recrystallization of the remaining limestone to coarse calcite. Possibly, however, the rock was originally dolomitic limestone which has been simply recrystallized to coarser dolomite and calcite.

The fine-grained, non-cherty dolomite is identical with the rock that, in the operating mines of the Metaline district, generally underlies the "gray lime" section of the upper Metaline limestone. The top of this dolomite most commonly is found 350 to 450 feet stratigraphically below the Ledbetter slate, and nowhere is it known to be more than 650 feet below the slate. On the basis of the scanty stratigraphic evidence afforded by this dolomite and by the cherty zones, the Lead Hill section is tentatively placed in the upper 500 to 700 feet of the Metaline limestone.

Structure

The Lead Hill fault is the most important structural feature of the area. It marks the slate-limestone contact, thereby limiting the economic ore possibilities to the southeast, and it probably played an important part in the localization of the ore. This fault, which was cut in the Bunker Hill tunnel, in Butte-Highlands Hole No. 2, in Bunker Hill Hole No. 48, and in two American Zinc holes south of Lead Hill, strikes northeast, essentially parallel with the bedding strike of the limestones, and dips about 80 degrees to the southeast. The fault has dropped a quartzite member of the Ledbetter slate into a position opposite the cherty dolomite although the original fault contact between these two units has been removed by erosion. The exact position of the quartzite within the Ledbetter is not known, but judging from evidence elsewhere in the area, it is probably at least 1100 feet above the base of the formation. Considering the probable stratigraphic positions of the quartzite and the cherty dolomite a minumum vertical displacement on the fault of over 2000 feet is indicated.

Apparently branching out from the Lead Hill fault are other northeast to northwest trending faults. The presence of extensive brecciation and silicification, with occasional mineralization, indicates that the faults are pre-ore, although there appears to have been post-ore movement on at least one (the Bostrom fault).

The Metaline limestone generally dips at angles between 25 and 35 degrees to the southeast in the Lead Hill area and, as most of the topographic slopes are about 30 degrees in the same direction, the outcrop pattern of the contacts between different units in the limestone is highly irregular, and relatively small vertical throws on the faults produce very large apparent horizontal offsets in the beds. On the southeast side of the Lead Hill fault, however, dips appear to be steeper; evidence from the outcrop pattern and from intersection in drill holes indicates a dip of 40-45 degrees southeast for the quartzite member of the Ledbetter slate.

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## ORE DEPOSITS

### General Character and Localization

The ore deposits of Lead Hill are similar to those of the adjacent Metaline district. They consist of sphalerite-galena replacements of brecciated and dolomitized Metaline limestone. The galena is generally coarse-grained, and occurs as irregular blebs as much as an inch across. The sphalerite is much finer-grained and has a brown to resin color. Summation of the drill hole assays shows that zinc predominates over lead in a ratio of at least two to one. Locally, however, either zinc or lead may be present to the practical exclusion of the other. Barite, rare in other parts of the Metaline district, is a common gangue mineral and occurs in large white patches resembling calcite.

Galena is frequently found unaltered at the surface but the sphalerite has generally been oxidized and leached for several feet below the surface. In the northern part of the Lead Hill area oxidation, possibly with some enrichment of zinc, appears to be extensive. Zinc ore cut in holes 25, 26, and 28 at depths of as much as 80 feet was largely in the form of the carbonate.

Ore is found in both the cherty dolomite and the upper part of the non-cherty dolomite, through a stratigraphic range of nearly 400 feet (Fig. 2, pg. 12). In the northern area the ore bodies are found in the lower 80 feet of the cherty dolomite, but the total thickness of this member remaining is less than 100 feet. The major ore zones of the central area appear to be somewhat higher in the section, centering at a stratigraphic level about 120 feet above the base of the cherty dolomite, and they show a stratigraphic range of about 150 feet. Over much of the southern area the cherty dolomite has been stripped off by erosion, but ore has been found at two horizons in the calcite-bearing part of the non-cherty dolomite. Low grade mineralization is found in the northern and central areas at stratigraphic levels approximately equivalent to these lower ore horizons.

It is to be noted that although barite and galena, with few or no traces of even oxidized zinc, are plentiful in the surface croppings for 1000 feet north of the Bunker Hill tunnel, most of the ore found at greater depth stratigraphically is characterized by a high zinc content, strong silicification, and virtual absence of barite; and the ore found at the deepest stratigraphic levels--that in the southern area--contains zinc to the complete exclusion of lead.

Judging from the present known distribution of ore at Lead Hill, the major control of ore deposition has been stratigraphic. Mineralized zones are found at several stratigraphic levels in both the cherty and the non-cherty parts of the medium-grained dolomite that overlies the fine-grained dolomite (lower part of the "non-cherty dolomite" on the map). This medium-grained dolomite is probably hydrothermal in origin, since it may be traced, southwest along the strike, into gray limestone, whereas the fine-grained dolomite may possibly be of primary (diagenetic) origin. It seems likely that an original difference in rock types, together with the original presence of overlying Ledbetter slate, provided the larger control for dolomitization and ore deposition. The reason for localization of mineralized zones at a few horizons within the now-dolomitized gray limestone is not known, but it is probably related to greater brittleness of certain layers, which permitted fracturing and access of ore solutions. Breccia zones, some of which are ore

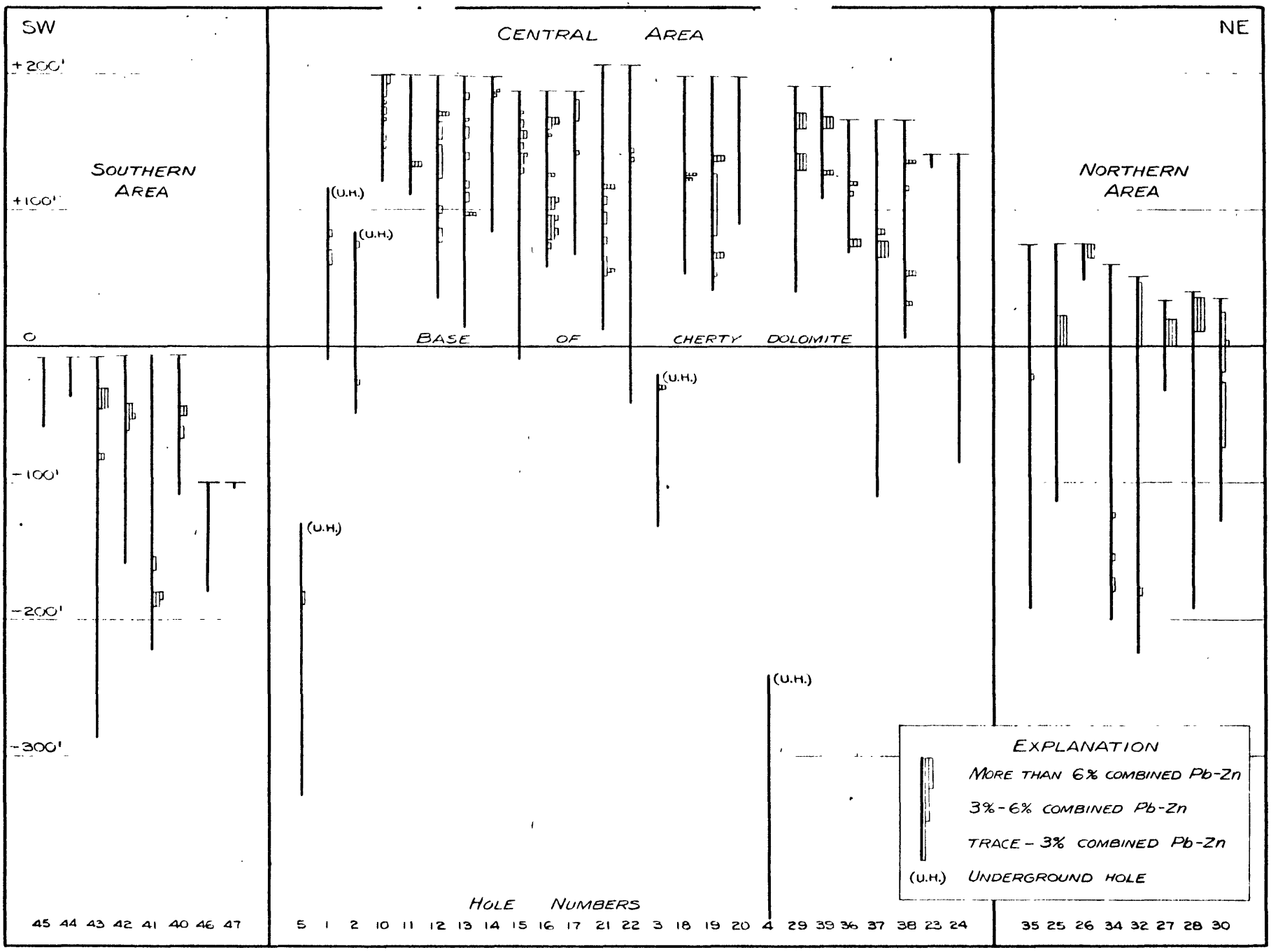


FIG. 2 GRAPH SHOWING APPROXIMATE STRATIGRAPHIC POSITION OF COLLAR, BOTTOM, AND ORE INTERSECTIONS IN BUNKER HILL AND SULLIVAN DIAMOND DRILL HOLES, LEAD HILL AREA, METALINE DIST., PEND OREILLE COUNTY, WASH. HOLES NOT ARRANGED GEOGRAPHICALLY AS TRUE PROFILE.

bearing, appear to be most common in the cherty part of the section.

It seems likely that the Lead Hill fault, together with the northeast to northwest branches from the main fault, has provided the structural control for ore deposition. The present known distribution of ore bodies suggests a general north to northeast linear trend, parallel to the major structures and some distance northwest of the Lead Hill fault itself. Subsequent exploration, however, may also reveal ore closer to this fault, inasmuch as surface showings of low grade ore are found very close to or along the fault trace southwest of the mapped area.

Distribution and Development

Most of the ore indicated at the present time at Lead Hill is known as a result of about 8400 feet of drilling done by the Bunker Hill and Sullivan Mining and Concentrating Co. Assays of the core from these holes were supplied by C. A. Bostrom, present majority share holder of the Lead Hill group of claims. The assays used in this report and on the sections are for the core only; sludge assays were available for only a few of the holes and were not evaluated. Core recovery was, in general, good in the ore sections of the holes, except in the oxidized zones cut in holes 25, 26, and 28 in the northern area.

For purposes of description, the deposits now known may be divided into the northern, central, and southern groups.

The northern group lies in the mapped area northeast of coordinate 1200 N. Surface showings are here limited to good exposures of lead and zinc ore near the collar of diamond drill holes 25 and 26, and slight mineralization exposed on the trail at approximately the coordinate position of 2300 N. - 300 E. As shown on sections P-P', R-R', and J-J', excellent zinc ore was cut at shallow depths in holes 25, 26, 27, and 28. The lead content, as shown by the core assays, is negligible except in hole 27 where it is, nonetheless, minor. Oxidation in this area is apparently extensive since much of the zinc found is in the form of the carbonate and some enrichment seems possible. Hole No. 27, however, cut 26 feet of sulfide ore at the same stratigraphic position as that occupied by the oxidized ore in holes 25 and 28. The ore lies immediately above the base of the cherty dolomite and close enough to the surface to make open cut mining possible for at least part of the area.

The central group covers the area between coordinates 400 S. and 1200 N. including the Bunker Hill tunnel. Low grade showings of galena ore may be found at the surface and in the numerous trenches and pits throughout this area. Diamond drill holes 10 to 21 are collared within a radius of 1100 feet north of the tunnel portal, and most of them cut mineralized rock in which sphalerite is predominant over galena. Of these holes, only 16, 19, and 21 intersected ore of mineable thickness and grade, but many of the others went through thicknesses of 2 to 4 feet containing more than 6 percent combined zinc and lead. A sixty-foot crosscut has been driven along hole 16. Only one hole, No. 20, was barren of mineralization. Holes 29, 36,37,38, and 39, located somewhat northeast of the 10-21 group of holes, all cut good sections of lead ore; hole 29 shows 50 feet averaging 9.2 percent lead and 0.2 percent zinc. An inclined shaft has been sunk for about 25 feet along hole 29. Practically all the ore found throughout the central area is in the form of sulfides; oxidation appears to be negligible.

The Bunker Hill tunnel, after passing through the Lead Hill fault, is in the footwall of the Bostrom fault for nearly 700 feet, then turns northeast across the fault and follows more or less along the strike of the bedding for another 700 feet. It thus remains in the non-cherty dolomite and below the main ore horizon for its entire length. Only slight mineralization was found in the adit. Five underground holes (Nos. 1-5) were drilled, but of these, only No. 5 intersected any appreciable amount of mineralized rock. However, the collars of all these holes were stratigraphically well below the main mineralized zone, and three were drilled to still greater depths.

The deposits of the southern group differ from those of the central and northern groups in that the ore is found in the non-cherty dolomite, as much as 190 feet stratigraphically below the base of the cherty dolomite. Good zinc "showings" in highly silicified breccia are exposed in pits near coordinate position 950 S. - 220C W., and fairly good sections of zinc ore, containing no lead, were cut in holes 40, 41, 42, and 43. Most of the ore intersected in the holes occurs in the upper 50 feet of the non-cherty dolomite, although hole 41 cut 6 feet of ore, assaying 6 percent zinc, at approximately 180 feet stratigraphically below the base of the cherty dolomite. "Rust" spots elsewhere in this area may indicate the former presence of zinc sulfide.

Surface showings of lead and zinc continue for about half a mile south of the Lead Hill area but, in general, appear to be of lower grade. A number of trenches and pits have been dug.

## PROPOSED DRILLING PROGRAM

The excellent ore sections found in many of the drill holes over a linear distance of nearly a mile would appear to warrant further exploration. The program outlined below and shown on the map and sections is designed both to extend or delimit ore already indicated and to test areas in which ore is geologically possible. None of the holes need to be over 300 feet long; most maybe considerably shorter. The "A" series of proposed drill holes are located so as to test for extensions of ore shown by earlier exploration; the "E" series to determine the extension of ore which may be indicated by the "A" series, and the "W" series to explore untested ground with good geological possibilities for ore. The "A" and "W" holes represent the practical minimum of drilling necessary to adequately test the area.

In the northern part of the northern section, where some of the holes may be in oxidized ore and core recovery low, it will probably be advisable to use an AX bit (1-1/8" core) or possibly even BX (1 5/8" core); elsewhere core recovery will probably be good enough to permit the use of an EX bit, if the cost difference is appreciable. Otherwise the AX size would be desirable in view of the larger sample obtained and the desirability of splitting the core for geologic reference at later dates.

Recommended locations are shown on the map for 18 "A" holes, 12 "E" holes, and 4 "W" holes. The average length of the proposed holes would probably not exceed 150 feet. In order to take advantage of the dip of the formation, the holes should be drilled northwest at an angle of about -55 degrees.

### Northern Section

Proposed holes A1 to A9 are located on approximate 200 foot centers around the ore indicated in holes 25, 26, 27, and 28. These four holes, the most northeasterly group drilled by Bunker Hill and Sullivan, cut an average of 26.5 feet of 8 percent ore which was practically all zinc. In three of the holes (two from the same location), the zinc occurs mainly as smithsonite ($ZnCO_3$), but the fourth hole (No. 27) cut 26 feet of sulfide ore at about the same depth. Because of the possibility of intersecting friable, oxidized ore, it is recommended that either AX or BX core be drilled so as to give a better sample. Holes E1 to E8 are optional locations contingent on whether or not ore is found in adjacent "A" holes.

Hole W1 is a "wildcat" location several hundred feet removed from any ore known at present. It is in an area underlain by about 200 feet of cherty dolomite, however, and is along the strike from holes 25-28 which cut good thicknesses of ore.

Central Section

Inasmuch as most of the Bunker Hill drilling was concentrated in this area, only a few holes are recommended. However, the block of lead ore indicated in holes 29, 36, 37, 38, and 39 (see sections H-H' and M-M') is very incompletely outlined. The ore cut in these five holes ranges from 4 feet of 10.3 percent lead and 0.6 percent zinc to 12 feet of 22.5 percent lead and 0.3 percent zinc. Proposed holes A10 to A13 are located to test for northern, eastern, and western extensions of this ore. Location A13 is somewhat of a "wildcat" as a hypothetical fault passes between it and the ore holes. Locations E9 to E11 are optional, depending on results obtained in the "A" holes.

Holes A14 and E12 are located to test for possible continuation to the south and west of the ore cut in Bunker Hill Hole No. 16 (50 feet of 4.5 percent combined lead and zinc).

Location A15 is recommended on the basis of good surface showings a short distance to the west.

Location W2 is a "wildcat" hole in an area measuring at least 300 by 300 feet which is relatively untested. The nearest samples are low grade but this block is near the intersection of faults that may have localized ore. The stratigraphic position is also favorable.

Southern Section

Proposed holes A16 to A18 are designed to extend ore indicated by Bunker Hill holes 40, 41, 42, and 43(see sections A-A' and B-B') and by several good surface exposures. Locations W3 and W4 are on the downdropped side of a probable fault which separates them from the ore in holes 40-43, and may disclose the continuation of that ore. Brecciation and silicification shown in nearby surface outcrops may also be taken as favorable evidence for ore below.

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