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THE DOME MINING DISTRICT
BUTTE COUNTY, IDAHO

By

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Prepared in cooperation with
the United States Geological Survey

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ABSTRACT

The Dome district, in the southern part of the Lemhi Range, is one of the two areas in Butte County, Idaho, that contain ore deposits of present commercial interest, the Lava Creek district being the other.

The Wilbert is the only mine in the Dome district at which much has been done in recent years. All the deposits of the district, so far as known, are the result of replacement in Ordovician dolomitic beds, especially in one set of such beds. Mineralization was controlled by thrust faults and other structural features. The deposits are valuable mainly for lead and silver. Wherever the dolomitic beds of proved favorable character exist, ore deposits may occur, even though surface indications may be scanty or lacking.

No granitic rocks are exposed in the vicinity. The presence in the Wilbert mine of altered dikes resembling Miocene (?) dikes leads to the suggestion that the ore may be of that age.

THE DOME MINING DISTRICT, BUTTE COUNTY, IDAHO

LOCATION

The Dome mining district, in which the Wilbert lead mine is at present the principal property, is on the southwestern flank of the Lemhi Range in Butte County, Idaho. It was originally called the Blackburn district and was later included in the Hamilton district. Present local usage restricts the name Hamilton to the area north of the Dome district. The property of the Wilbert Mining Company comprises 36 claims in and near T. 7 N., R. 29 E. Boise Meridian. The present mill and camp are on North Creek just within the borders of the Lemhi Range. The property is about 18 miles by road from Howe and 40 miles from Arco, the nearest railroad station. The road from Howe crosses the silty plain of the Little Lost River Valley and is rutted and at times muddy, but from Arco to Howe there is a graded gravel road, part of which is oiled.

The Wilbert mine and the adjacent Lindy prospect were visited in June, 1930, in the course of a study of the ore deposits of south-central Idaho carried on in cooperation between the United States Geological Survey and the Idaho Bureau of Mines and Geology. The Wilbert and Johnson properties were studied by Umpleby [1] in 1912, and his report has been freely drawn upon in the present paper, particularly for data on the old mine workings, now largely inaccessible.

HISTORY [2]

Lead-silver ore was discovered in the district about 1880, and during the following decade most of the deposits now known were worked. At that time only high-grade ore could be handled, as it had to be hauled about 75 miles to a smelter at Nicholia. The Daisy Black, the older part of the present Wilbert mine, was discovered by Blackburn about 1882 and worked intermittently until 1891, but with little or no production. Operations were resumed and production started in 1906. The Wilbert Mining Company was incorporated in 1907. A 100-ton concentrating mill was built in the valley of Camp Creek in 1908 and continued in operation until destroyed by fire in 1918. In 1922 the site of operations was transferred to North Creek, and a long crosscut tunnel was started. (See pl. 1.) This tunnel, known as the Daylight tunnel, was completed the following year and was successful in finding ore below the old workings. A new mill was constructed in 1924, and the property was in continuous production from that time to 1931. In 1929 a transmission line was constructed from Howe, and the plant was electrified.

There are seven or eight mining properties in the Dome district. Of these, the Wilbert is the only one at which much more than assessment work has been done in recent years.

The first table below, compiled under the direction of C. N. Gerry of the United States Bureau of Mines, shows the entire production of the Dome district through 1928, except that of the early days for which no official

[1] Umpleby, J. B., Geology and ore deposits of the Mackay region, Idaho: U. S. Geol. Surv. Prof. Paper 97, pp. 23-24, 81-83, 113-118, 1917. Some of the historical data in the present account are taken from Mr. Umpleby's field notes.

[2] Data in part from Annual Reports of the Idaho State Inspector of Mines.

Production of the Wilbert mine
from the time of its discovery to January 1, 1930

By H. S. Knight

Period	Crude ore mined (tons)	Concentrates and sorted ore shipped (tons)	Silver content (ounces)	Lead content (pounds)
Prior to 1912	1,500	1,200	10,000	100,000
1912-18	59,000	19,295	173,655	20,452,700
1924 [a]	1,417	564	14,530	505,015
1925	3,862	1,014	8,003	1,200,000
1926	1,678	515	5,225	583,516
1927	7,901	2,175	44,392	2,418,081
1928	11,280	1,838	30,373	2,147,489
1929	14,355	3,152	55,530	3,842,836
	100,993	29,753	341,708	31,249,637

[a] No production in 1918-24.

Production of the Dome district [a]

(Butte County since 1917, formerly Blaine and Fremont counties)

Compiled under the direction of C. N. Gerry, U. S. Bureau of Mines

Year	Number of producers	Crude ore (tons)	Concentrates (tons)	Gold (fine ounces)	Silver (fine ounces)	Copper (pounds)	Lead (pounds)	Total value
1906	1	3	---	3.00	275	-----	6,553	$ 488
1907	3	75	---	.89	516	282	68,549	4,048
1908	2	237	---	.48	739	259	224,018	9,845
1909	2	418	---	----	4,488	-----	289,284	13,213
1910	1	78	---	----	277	53	48,724	2,300
1912	3	7,859	1,373	4.69	11,313	506	1,487,350	74,069
1913	1	18,223	4,862	----	36,804	-----	8,182,846	382,275
1914	1	8,026	2,144	1.77	18,118	6,226	4,147,642	172,642
1915	1	10,969	3,912	2.91	36,300	6,181	5,031,619	256,032
1916	3	11,269	3,077	----	36,170	7,959	3,305,465	253,835
1917	2	4,237	835	1.95	29,626	15,128	2,225,469	219,972
1918	1	799	132	----	3,061	-----	490,544	37,889
1921	1	300	50	----	237	-----	47,100	2,356
1924	2	1,419	267	1.24	14,586	1,124	551,312	54,051
1925	2	3,867	1,058	.23	8,016	582	1,204,922	110,479
1926	3	1,593	447	.27	4,361	1,071	491,770	42,219
1927	1	7,901	2,177	3.77	43,112	1,272	2,363,033	173,561
1928	2	11,283	1,881	.22	31,286	165	2,148,472	142,942
		88,556	22,215	21.42	278,285	40,808	32,314,669	1,952,216
Average content:								
Ounces to the ton		----	-----------	0.00024	3.12	----------	--------------	---------
Per cent		------	-----------	---------	--------	0.23	18.24	---------

[a] No production in 1902, 1903, 1904, 1905, 1911, 1919, 1920, 1922, and 1923.

record is available. Umpleby[3] estimates that about $75,000 was produced in the eighties, mainly from the Great Western group. The second table, kindly furnished by H. S. Knight, who has been connected with the development of the mine since 1906, records the production of the Wilbert mine through 1929.

GENERAL GEOLOGY

Stratified rocks

The west side of the Lemhi Range in this vicinity is made up of a thick sequence of Paleozoic sedimentary rocks, intricately folded and broken. Only the lower beds have been studied, but inspection of the range indicates that here as elsewhere in this part of Idaho most of the Paleozoic is represented. Along the lower courses of Camp and North creeks dominantly quartzitic beds are overlain by dolomite, all now regarded as of Ordovician age. The dolomite contains fossils which, according to Edwin Kirk, show that it is of Upper Ordovician age and is to be correlated with a part at least of the Fish Haven dolomite of Utah. He has identified the following in a collection made by the writer and S. S. Philbrick in the canyon of North Creek near the Lindy prospect, which is somewhat over a mile from the Wilbert camp:

Dalmanella cf. *D. corpulenta* Sardeson
Dinorthis subquadrata Hall
Rhynchotrema capax Conrad
Streptelasma sp.

The character, general stratigraphic position, and fossil content of the dolomite indicate that it is essentially equivalent to the Upper Ordovician dolomite that is widespread in the Lemhi and Lost River ranges and in neighboring areas. Below this dolomite in many places there is a thick sequence of quartzite beds without diagnostic fossils. Umpleby[4] tentatively assigned this quartzite in most exposures to the Ordovician, but supposed that the quartzite at the Wilbert mine might be Cambrian; however, the fossils listed above support the concept that the quartzitic beds here have the same stratigraphic relations and hence are to be correlated essentially with the similar beds in neighboring areas, which he regarded as Ordovician. As will be more fully discussed in later papers, the corresponding quartzitic and dolomitic beds in the Lost River Range and the Bayhorse region are regarded as of Middle (?) Ordovician age. In the Bayhorse region they are underlain by argillite, which locally contains Lower Ordovician fossils. Below this are two non-fossiliferous formations, possibly Cambrian.

The quartzitic beds have been mapped on plate 1 and are there divided into pebble quartzite, shale, purple quartzite, lower white quartzite, quartzitic dolomite, and upper white quartzite. Although these subdivisions are locally distinct and useful, it is improbable that they could be carried far along the strike in either direction. It appears that all six should be regarded as members of a single formation.

The lowest beds exposed near the Wilbert mine are mapped as the pebble quartzite, which corresponds to the lower quartzite of Umpleby. This member

[3] Umpleby, J. B., Op. cit., p. 113.
[4] Umpleby, J. B., Op. cit., pp. 23-25.

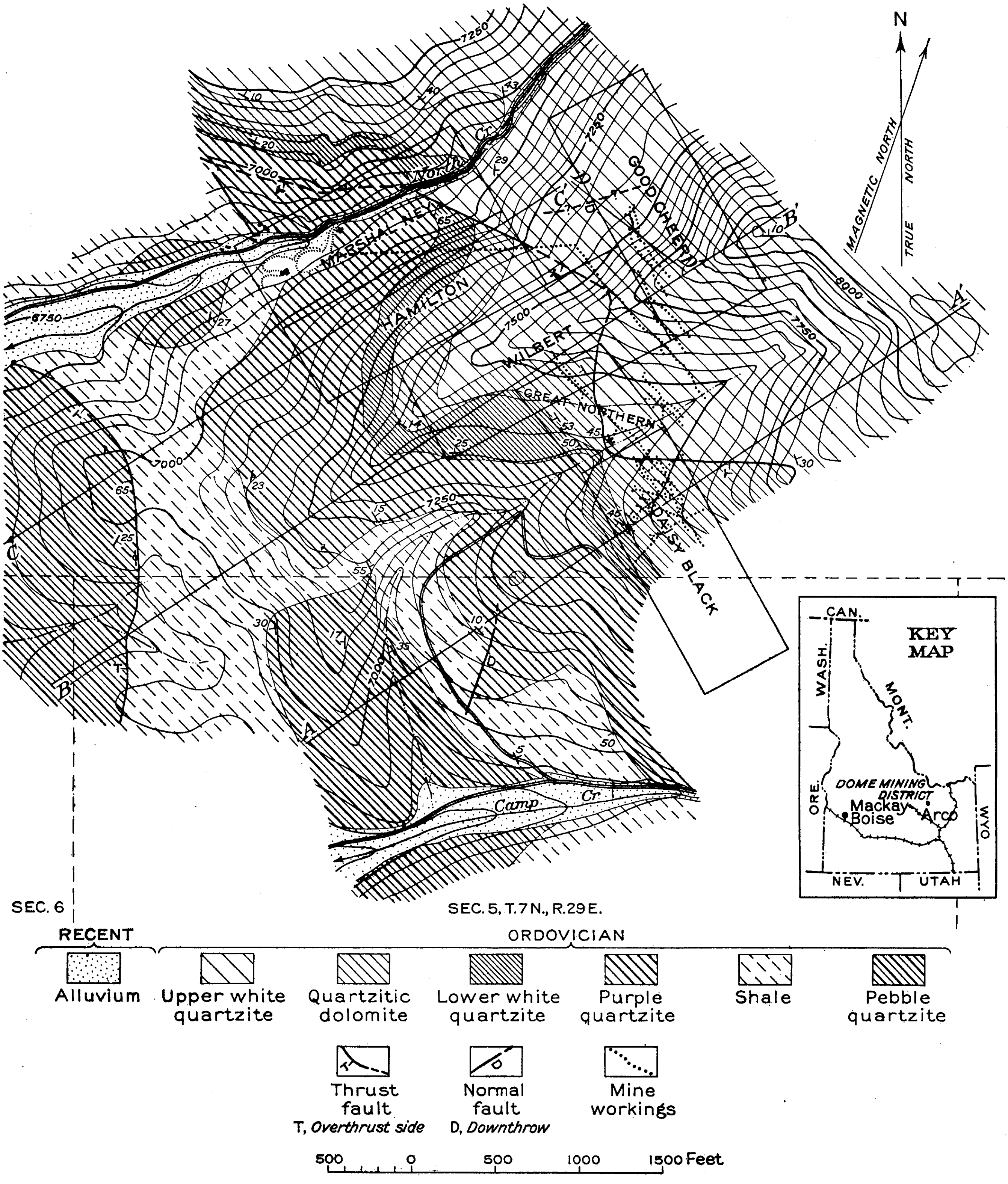

Plate 1. Geologic map of the vicinity of Wilbert mine, with key map showing the location of the Dome district.

is at least 200 feet thick [5], somewhat cross-bedded, usually almost white but locally purplish, and characterized by the fact that most of its beds contain numerous small pebbles, the largest observed being half an inch in diameter.

The argillaceous member next above is about 165 feet thick. Following Umpleby, we may term this rock a shale, although, like all the other strata in this vicinity, it has suffered marked metamorphism. It is greenish, weathers rusty, and has schistose cleavage approximately parallel to the bedding. The original argillaceous matter has been largely converted to sericite and chlorite.

The next succeeding member is a crossbedded quartzite about 400 feet thick, termed by Umpleby the middle quartzite and in this report purple quartzite. It is distinguished from the other members by its darker purplish or maroon color. Locally, it contains shale beds near the top.

Umpleby included the rest of the quartzitic beds in his upper quartzite, although suggesting that subdivision was possible. In the present study his upper quartzite has been subdivided into the lower white quartzite (about 65 feet thick), quartzitic dolomite (about 85 feet thick), and upper white quartzite (well over 1,000 feet thick). The upper and lower white quartzites closely resemble each other. Both contain some rusty and purplish beds, and both are cross-bedded. Both consist almost entirely of quartz in grains ranging from 0.1 to 0.5 millimeter in diameter in most beds.

The unit that lies between the upper and lower white quartzites is distinctly dolomitic. This fact was not recognized by Umpleby but is appreciated by the mine officials. This quartzitic dolomite, which throughout the Wilbert mine is associated with the ore, is a dense rock, light pinkish buff to white on fresh surfaces, in which the diameter of grain ranges in different specimens from less than 0.1 to about 0.3 millimeter. Weathered exposures of the dolomite are rusty and show much small-scale cross-bedding, which distinguishes it from the superficially similar quartzites above and below. It consists of dolomite and quartz in varying proportions, with scattered shreds of chlorite and locally some feldspar. Much of the dolomitic rock from the new Wilbert workings is almost exclusively dolomite with a few scattered grains of quartz and shreds of chlorite, but some of that in the lower stopes contains nearly 50 per cent of fine-grained quartz, apparently an original constituent. Umpleby noted that the cement of some of the unaltered quartzite in the Daisy Black workings was in part calcareous and that some of the disseminated ore effervesced slightly in acid, but stated that he found no carbonate, other than supergene cerusite, in the ore specimens that he had examined microscopically. Study by the writer of specimens collected by Umpleby in the Daisy Black workings, which are now inaccessible, shows that here as elsewhere in the mine the mineralized beds are dolomitic. These specimens were found to contain only about 15 to 30 per cent of dolomite, but they came from an oxidized part of the ore body and have lost some carbonate by leaching. Fresh rock from the surface at a distance from the ore bodies contains over 40 per cent of dolomite. Most of the carbonate has a maximum index of refraction of about 1.69 and hence has the composition of a dolomite, probably somewhat ferruginous. Some of the dolomitic rock from the

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[5] Estimates of thickness of the various members of the quartzitic strata are based both on the graphically constructed sections of plate 2 and on mathematical calculation and are believed to be correct within about 10 per cent

new Wilbert workings has reddish mottlings, containing appreciable manganese. A little calcite occurs in cracks and interstices in most specimens of the dolomitic rock.

At the northwest end of the 1,450 level of the new Wilbert workings within the dolomitic zone there is a small amount of a greenish rock. Most of this rock is composed of detrital grains of quartz with some sodic plagioclase and microcline, and a little interstitial chlorite and bleached mica. Some of the feldspar retains rectangular form, and all is remarkably free from alteration. The dolomitic rocks obtained by Umpleby in the Daisy Black workings contain some feldspar, mainly plagioclase of the approximate composition of oligoclase-andesine, and small amounts of epidote and chlorite.

Dike rocks

The only igneous rocks known in or near the Dome district are small dikes in the Wilbert mine. The nearest known granitic masses are the two small bodies of quartz diorite on both sides of the Lemhi Valley, near Leadore [6], over 50 miles north of the Dome district, and the granite near Mackay [7], over 30 miles to the west. The writer believes that the quartz diorite is probably of Mesozoic age and that the granite is Tertiary. Both have ore deposits nearby and genetically related to them.

Two kinds of intensely altered dike rocks are exposed in the new Wilbert workings. One of these is chalky white with gray phenocrysts; the other is nearly black and speckled with numerous small white phenocrysts.

The white rock is exposed near the northwest ends of the 1,100, 1,350, and 1,450 levels in dikes a few feet wide. On the 1,100 level the rock occurs in the hanging wall of the major normal fault, and below this level it occurs in the footwall. Possibly the different exposures are segments of a single irregular dike broken by faulting. It contains broken phenocrysts of quartz and altered feldspar in a rather fine granular groundmass, which was originally composed dominantly of the same minerals with a few shreds of colorless mica and a little apatite. The rock has been in large part replaced by quartz and carbonate (largely dolomite), and pyrite is finely disseminated through it.

The nearly black igneous rock occurs as a stringer in the ore zone and parallel to the bedding of the quartzitic dolomite near the northeast end of the 1,450 level (not shown on pl. 3). It is even more thoroughly crushed and replaced by quartz and carbonate than the white rock and has a poorly defined banding of the crushed material, suggesting slight shearing subsequent to alteration. Some of the phenocrysts are oligoclase, and the groundmass was largely composed of small feldspar laths, but both are now largely replaced by quartz grains. Evidently both the white and black rocks were originally fine-grained porphyries of silicic to intermediate composition, but they have been so intensely altered during ore deposition as to preclude closer determination.

The information at hand offers no direct means of dating these dikes. They are tentatively regarded as of approximately Miocene age, because the

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[6] Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Surv. Bull. 528, pp. 42, 43, 1913.

[7] Ross, C. P., Geology and ore deposits of the Seafoam, Alder Creek, Little Smoky, and Willow Creek mining districts, Custer and Camas counties, Idaho: Idaho Bureau of Mines and Geology Pamphlet 33, pp. 13, 14, 1930.

numerous porphyritic dike rocks in other parts of the general region are known to be of that age.[8] Most of the dikes believed to be related to the Idaho batholith (Mesozoic?)are aplite or lamprophyre in or adjoining granitic masses and thus are dissimilar both in character and in mode of occurrence to those in the Wilbert mine.

Structure

The rocks of the Dome district, in common with the rest of the Lemhi Range, have been intricately folded, and they have also been broken by both normal and reverse faults. In the area of a little over two-thirds of a square mile, shown in plate 1, there are two overturned anticlines, two thrust faults, and at least four normal faults. Even greater complexity of structure exists in the Upper Ordovician dolomite and associated strata farther up North Creek. The rocks are overturned and overthrust toward the northeast, the structural axes trending about N. 55° W., about parallel to the Lemhi Range. The known thrusts are not of great displacement. They are probably incidental to the folding. The shapes of the folds, especially the sharply overturned one in the central part of the area, can be seen rather clearly in distant views of the exposures and are shown somewhat generalized in the structure sections on plate 2. The isolated patch of lower white quartzite west of the Daisy Black workings is part of the upper limit of the overturned fold. Its low position with reference to the principal outcrop of the lower white quartzite is in part the result of local contortion and in part, perhaps, the result of downthrow on a continuation of the normal fault exposed a short distance to the south.

The more easterly of the two thrust faults appears to have somewhat the greater displacement and persistence. It extends northwestward across North Creek with considerable variation in dip and displacement, as shown on plate 1. This fault and the fractures more or less closely related to it localized the mineralization in the old Daisy Black workings. According to those familiar with the old workings the fault zone for some distance above the 600 level of the Daisy Black was much contorted. The fault must cut the rocks exposed in the Daylight tunnel of the new Wilbert workings (pl. 3), although here it is inconspicuous and is not mineralized. It is doubtless marked by the two slips dipping 60° and 65° NW. about 400 feet west of the end of the tunnel. This position, coupled with some contortion of the adjacent rocks, accounts for the fact that the lower white quartzite, which is about 65 feet thick, is exposed for nearly 700 feet along the Daylight tunnel. The assumed position of the fault in the Daylight tunnel, coupled with other data, shows that it must curve.

The normal faults observed during the present study range in strike from N. 65° E. to N. 33° W. With the exception of a few of the minor slips exposed in the mine workings, the downthrow is on the east side and the hanging wall is offset toward the south. The normal faulting was obviously subsequent to the folding, and displacement of ore in the Wilbert workings proves that some of the movement, at least, was later than the mineralization. These general observations are in accord with those of Umpleby.[9]

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[8] Ross, C. P., Mesozoic and Tertiary granitic rocks in Idaho: Jour. Geology, vol. 36, no. 8, pp. 682-684, 1928; also, unpublished data on the Casto and Bayhorse quadrangles, Boise Basin, and elsewhere.

[9] Umpleby, J. B., op. cit., (Prof. Paper 97), p. 115.

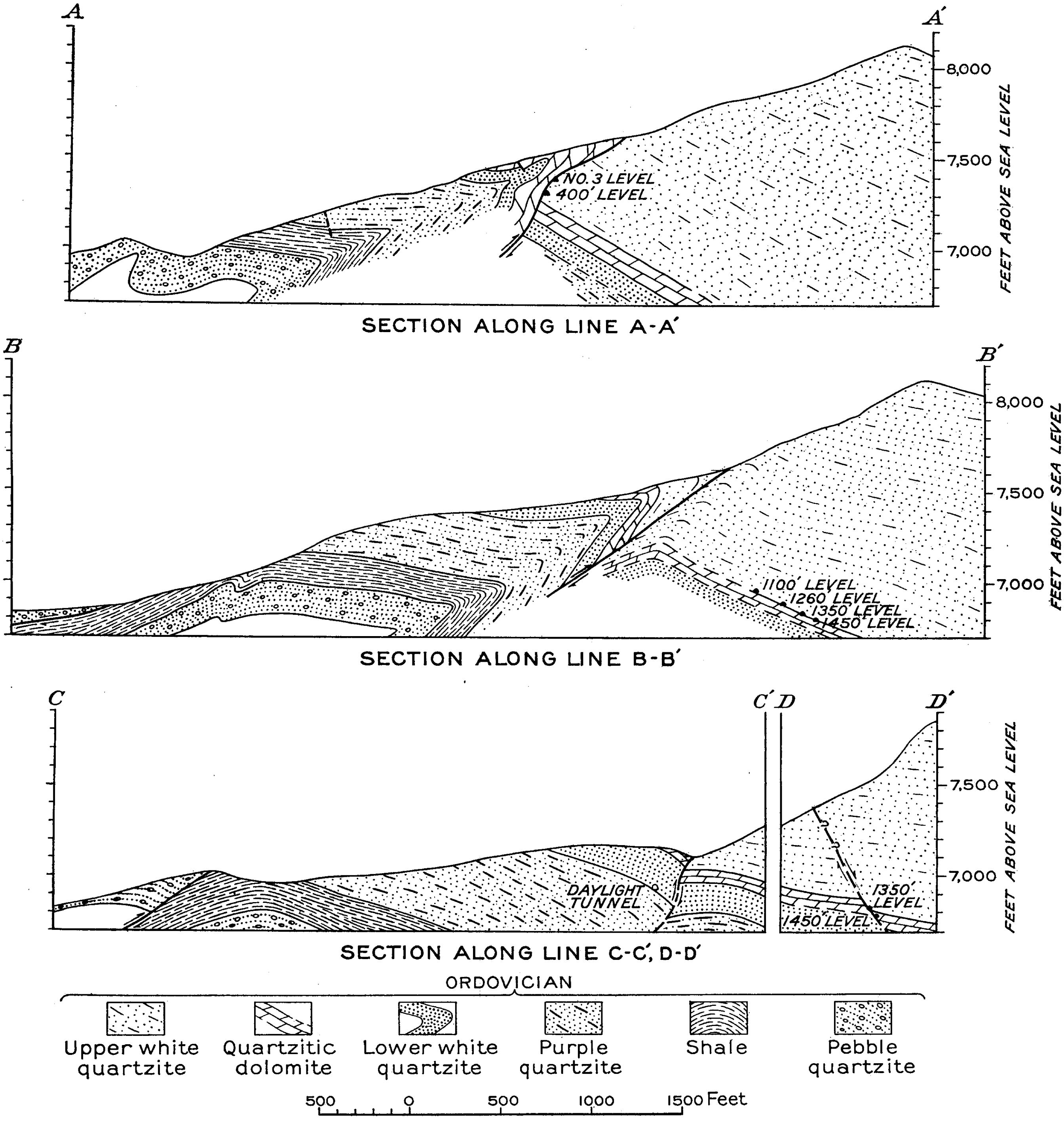

Plate 2. Structure sections in the vicinity of the Wilbert mine.

Slips of small displacement are exposed in several places in the new Wilbert workings (pl. 3), but the only fault zone there which appears to be of any magnitude is that exposed on several levels near the northwest end of the workings. The faulting along this zone, like that in the approximately parallel zone along North Creek (see pl. 1) appears to have been normal, with the downthrow on the southeast side. This fault is located on plate 1 by projection from the mine workings, as much of the bedrock surface where it should appear is concealed beneath talus. The scanty outcrops here indicate, however, that considerable disturbance and distortion have occurred, a fact that doubtless accounts for the failure of the beds below the upper White quartzite to crop out in the vicinity of point F.

Available data do not permit accurate determination of the displacement along the fault zone in the new Wilbert workings. In a general way, the observed relations indicate that the block on the southeast side is relatively downthrown and shifted somewhat to the southwest. The displacement is nowhere great but is probably larger on the 1,100 or Daylight tunnel level than in the lower part of the mine. On the lower levels the displacement is distributed through a comparatively broad zone in which certain of the fault planes dip northwest, opposite to the prevailing dip of the zone. On the 1,100 level the fault strikes about N. 60° E. and dips steeply southeast. It brings the lower white quartzite across the truncated ends of both the quartzitic dolomite and the upper white quartzite. If the total displacement was directly down the dip, a downthrow of over 100 feet would be required, but the probability is that there was some lateral shift and that in consequence the vertical displacement is much less than 100 feet.

The relation of the principal fracture surfaces on the 1,350 and 1,450 levels to those at the end of the Daylight tunnel on the 1,100 level indicates that the fault zone has an average dip of 50° SE., although the observed dips on individual slips are greater. The segments of white porphyry that are exposed on the 1,100, 1,350, and 1,450 levels presumably form parts of a single dike broken and somewhat rotated by the faulting. They are, however, so nearly in line that the total vertical displacement can not have exceeded 100 feet and may have been much less.

The maximum apparent shift along the parallel fault in the channel of North Creek above the present Wilbert camp (pl. 1) is about 700 feet, and the vertical discrepancy between the beds on opposite sides of the creek is at least 200 feet. However, sharp local folding here makes the apparent displacement in both directions materially greater than that resulting from faulting alone. Even with this qualification the total displacement of the dolomitic sequence by the fault zone along North Creek is probably much greater than has yet been found in the new Wilbert workings.

ORE DEPOSITS

Structural relations

The lodes of the Dome mining district so far as known are all replacement deposits in dolomitic beds, valuable mainly for lead. The ore in the Wilbert mine (including the old Daisy Black) is localized by the dolomitic member of the quartzitic beds. The old Great Western mine and the South Creek properties are similar to the Wilbert [10] and at about the same horizon.

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[10] Umpleby, J. B., op. cit., pp. 117-118.

The Lindy and Johnson properties are in the Upper Ordovician dolomite that overlies the quartzitic beds.

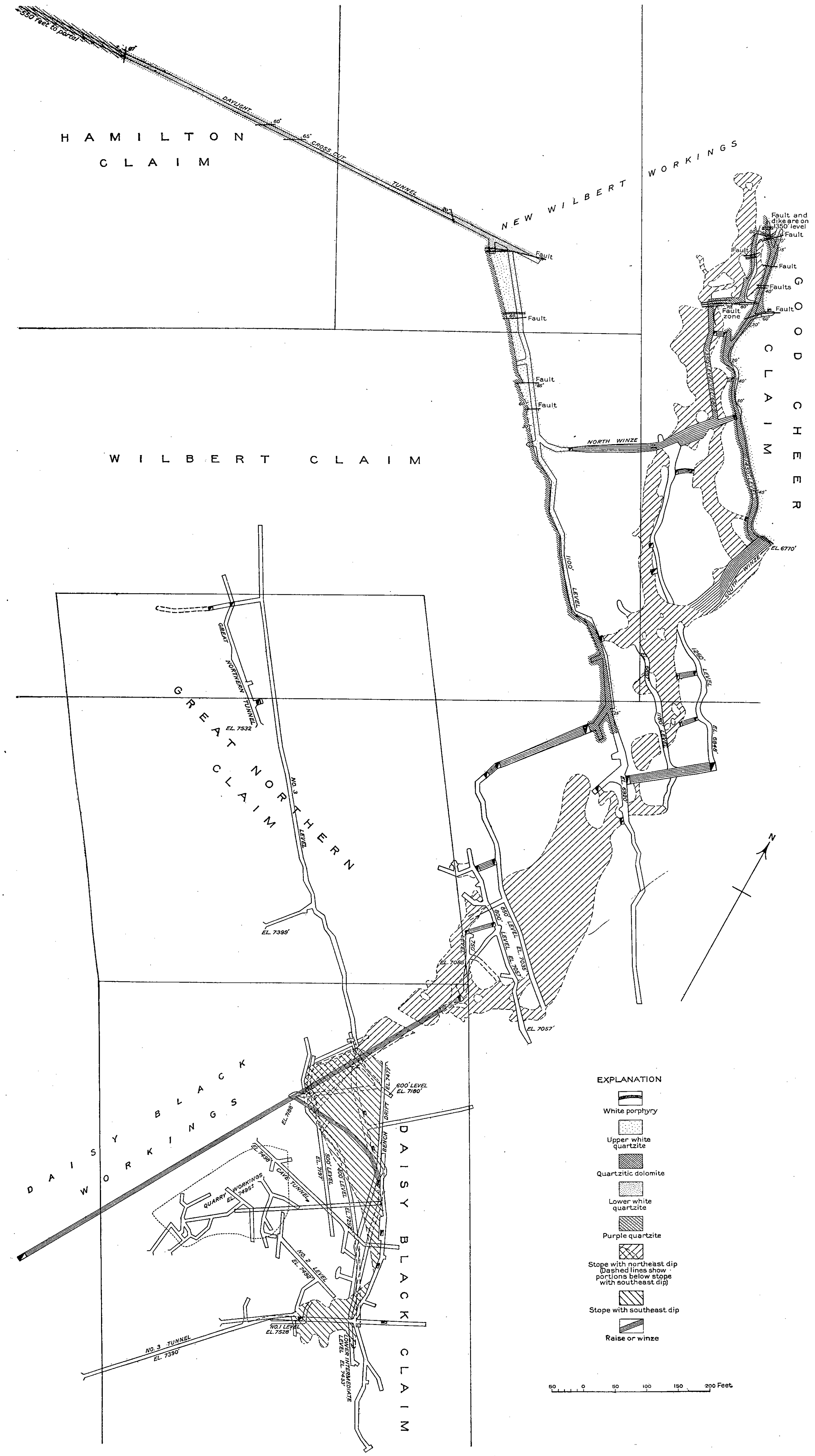
The Wilbert workings extend from an altitude of 7,560 feet above sea level at the top of the Daisy Black open cut to 6,770 feet on the 1,450-foot level of the new Wilbert workings, as is shown in plate 2. In this vertical distance of nearly 800 feet there is considerable variation in structural conditions. The upper Daisy Black workings, including the minor tunnels on the Great Northern and Wilbert claims, are on ore bodies controlled to some extent by fault zones but extending irregularly out into the quartzitic dolomite. This is illustrated in plate 3 of the present report and in more detail in plate 21 of Umpleby's report. Little development had been undertaken below tunnel 3 (altitude about 7,400 feet) at the time of Umpleby's visit. The fault zones strike N. 20°-40° W. and dip both northeast and southwest in different places. The irregularity of the ore bodies and the fact that the ore minerals are in large part disseminated in unbrecciated rock show clearly that replacement was a dominant factor in the mineralization. The faults aided in so directing the flow of the solutions that deposition was sufficiently localized to produce ore bodies of commercial size.

Umpleby states that on the lower levels accessible to him (nos. 3 and 4) the ore follows a thrust fault. According to H. S. Knight, the ore from tunnel 3 down to about the 600 level followed a curved thrust fault through highly contorted strata. Although this part of the mine is partly caved and was not entered during the present investigation, the mutual relations of the workings (pl. 3) and such other information as is available are in accord with Mr. Knight's statement.

Conditions in the new Wilbert workings (1,100 to 1,450 levels) are different. In this part of the mine the ore follows the contact between the quartzitic dolomite and upper white quartzite, and the ore bodies are confined to the dolomitic rock, without conspicuous faulting or brecciation in most parts of the ore bodies. In places minor fractures and partings are filled with vein quartz. The thickness of the mineralized rock varies, but in much of the stoped ground is well over 10 feet. The upper white quartzite forms a fairly definite hanging wall, but within the dolomite the limit of stoping is determined by the grade of the ore, which fluctuates so irregularly that it is rare for any large tonnage to be blocked out in advance of stoping. Nevertheless, new ore has been so consistently found when needed that the mine was in constant production from 1906 to 1930, except for 1911 and the period of four years following the fire of 1918, during which the new workings were opened and the new mill built. The total production (judging by the table) has been about $2,000,000, and in steadiness of production the Wilbert compares favorably with other mines in south-central Idaho during the same period.

Although, as noted above, the structural conditions governing ore deposition varied markedly, ore has been found almost continuously through an irregular zone which trends diagonally across the strike of the beds in the lower part of the mine. This zone pitches N. 5° W. at an average angle of 20° 30' from the horizontal through a horizontal distance of about 2,000 feet and a vertical range of about 750 feet.

Comparatively little ore was exposed on the lowest (1,450) level of the Wilbert mine when it was visited in 1930. However, development on that level had scarcely extended far enough north to reach the zone of maximum mineralization if it continues downward with the pitch above stated. Ore has been


HAMILTON CLAIM
DAYLIGHT CROSS CUT TUNNEL
NEW WILBERT WORKINGS
Fault and dike are on 1350' level
Fault
Faults
Fault zone
GOOD CHEER CLAIM
WILBERT CLAIM
NORTH WINZE
1100' LEVEL
EL. 6770'
1250' LEVEL
1180' LEVEL
EL. 6848'
GREAT NORTHERN TUNNEL
EL. 7532
GREAT NORTHERN CLAIM
NO. 3 LEVEL
EL. 7399'
850' LEVEL
EL. 7057'
DAISY BLACK WORKINGS
600' LEVEL EL. 7180'
BENCH DRIFT
QUARRY WORKINGS
CAVE TUNNEL
500' LEVEL
NO. 2 LEVEL
NO. 1 LEVEL EL. 7528
NO. 3 TUNNEL EL. 7390'
LOWER INTERMEDIATE LEVEL
DAISY BLACK CLAIM
N
EXPLANATION
White porphyry
Upper white quartzite
Quartzitic dolomite
Lower white quartzite
Purple quartzite
Stope with northeast dip (Dashed lines show portions below stope with southeast dip)
Stope with southeast dip
Raise or winze
50 0 50 100 150 200 Feet

found on the footwall side of the fault zone near the north end of the 1,350 level, so that it is clear that this fault, the only one of any consequence in the new Wilbert workings, does not offer a serious impediment to continued development. It may be pointed out, however, that a similar but larger fault zone is present along North Creek, and the rocks in that vicinity are much contorted. Consequently, it is probable that increasing difficulty in picking up new ore may be encountered as development is carried northwest.

It appears that the deposits in the Upper Ordovician dolomite are even more irregular and individually smaller than those in the strata below. Umpleby [11] states that in the Johnson prospect, roughly two miles northwest of the Wilbert camp, galena occurs at several places along slips and as bunches in the country rock, but at the time of his visit no ore body of commercial size had been recognized. Since then development has continued, and the owner reports favorable results but no production as yet. In the shallow workings on the Lindy property, about a mile up North Creek from the Wilbert camp, bunches of galena exist in a number of places, but no considerable ore body is exposed. In the principal tunnel, about 100 feet long, stoping has yielded some massive, fine-grained galena ore which occurs on slips striking N. 5°-10° E. and dipping about 40° E.

Mineralogy

The hypogene lead mineral is galena, generally fine-grained, individual grains being rarely in excess of two millimeters in maximum dimension. This fineness of grain is mainly a feature of original crystallization, steel galena produced by subsequent crushing, such as is common in the Wood River [12] and other regions in Idaho, being comparatively rare. Anglesite and cerusite were abundant in the oxidized ore of the old Wilbert or Daisy Black mine. As the production table shows, the ore contains gold, silver, and locally copper. As in most of the other base-metal deposits of the region, the gold content is very low. There is much less silver in proportion to the lead than is customary in the lead deposits of the region. Conceivably the variation in gold and silver content indicated by the table may have some relation to supergene redistribution, but the data on this point are inconclusive. Such variation may result in part from changes in methods of ore treatment. No copper mineral was found in the present study, but Umpleby [13] noted a few copper stains and a little linarite (hydrous copper-lead sulphate) in tunnel 3 of the Daisy Black. Chemical tests on high-grade galena ore from the present stopes by Charles Milton, of the United States Geological Survey, show the presence of a small fraction of one per cent of copper. Some pale zinc blende is present in the hypogene lead ore, and Umpleby notes the presence of a vein of calamine in tunnel 3 of the Daisy Black workings and one of comparatively pure smithsonite 14 inches wide near the Johnson prospect; but evidently not enough zinc is mined to be of commercial consequence. Pyrite is rare in the more massive ore but is disseminated in fine grains in the nearby wall rocks, both quartzite and dolomite. The hypogene gangue minerals are quartz and carbonates (mainly dolomite), in part as constituents of the original rocks, in part as products of mineralization.

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[11] Umpleby, J. B., op. cit.,(Prof. Paper 97), p. 117.

[12] Umpleby, J. B., Westgate, L. G., and Ross, C. P., Geology and ore deposits of the Wood River region, Idaho: U. S. Geol. Survey Bull. 814, pp. 97, 108, 1930.

[13] Umpleby, J. B., op. cit. (Prof. Paper 97), p. 117.

Umpleby [14] describes ore of three types in the part of the Wilbert mine that he saw. These varieties differ from one another in textural features arising from differences in the mode of deposition. One of these has a pepper and salt appearance due to specks of galena, mostly altered to anglesite, scattered through light-gray quartzite. This variety contains 12 to 20 per cent of lead. It is characteristic of the flat bodies between tunnels 2 and 3. The higher-grade ore, containing 20 to 35 per cent of lead, consists of thin lenses and stringers of anglesite and galena and occurs extensively on the lower intermediate level (above tunnel 3). In a third variety, found on the tunnel 3 level, the galena occurs in a fissure between fairly well defined walls in the plane of a thrust fault and in part forms the cement for a breccia of unaltered quartzite. Brecciated rock is common in the parts of the old workings now accessible but is generally absent and nowhere conspicuous in the new workings. Umpleby notes that calcite accompanies the oxides of iron and manganese which have spread into the wall rocks near oxidized ore.

In the stopes that were being worked in the summer of 1930 the best ore consisted largely of rather massive, fine-grained galena with some pale sphalerite, a very little copper in undetermined form, and subordinate quartz and carbonate. Much of the carbonate is calcite, but there are also numerous grains of dolomite. Chemical tests by Charles Milton indicate that there is nearly three times as much calcite as dolomite in the sample tested. The ore is generally porous, presumably because of the leaching of calcite, perhaps also of sphalerite, by the abundant ground water circulating here. The leaner ore in the new workings corresponds to the pepper and salt variety described by Umpleby. It consists of country rock, almost exclusively the quartzitic dolomite, partly replaced by jasperoid and containing disseminated galena and a little pyrite in small grains. The carbonate in such ore is largely dolomite similar to that in the original rock, but it is banded and has probably been rearranged as a result of the circulation of the mineralizing solutions. The jasperoid replacement spread beyond the limits of ore, increasing the resemblance of the dolomitic rock thus replaced to the overlying quartzite. In places underground there is almost no difference in the appearance of the two rocks. Locally the jasperoid tends to follow the bedding, giving a banded appearance to the rock. Here and there veinlets of coarser vein quartz are prominent.

Origin

The ore bodies examined by Umpleby and the writer in the Dome district were formed mainly by replacement, the solutions being guided by fault planes, breccia zones, and contact surfaces. The localization of the ore in the lower Wilbert workings along a zone transverse to the strike of the beds is presumably a result of some structural control not entirely understood. So far as present development goes, the dolomitic member in the quartzitic beds is the most favorable in the district to concentration in ore bodies of commercial size. Wherever these beds exist they are worthy of prospecting. Inasmuch as ore deposition was localized by a variety of factors, absence of metallic minerals at the outcrop is not proof that valuable deposits may not exist at depth.

The mineralizing solutions rose from below, and in the new Wilbert workings the upper white quartzite tended to retard and to direct the flow, resulting in ore deposition. In most parts of the new Wilbert workings where brecciation is inconspicuous and in the pepper and salt ore described by Umpleby deposition

[14] Idem, pp. 82-83, 116-117.

appears to have taken place dominantly by replacement. Where the sulphides are in lenses or gash veins or in the filling of breccia zones deposition in open spaces occurred, although even here replacement was also operative.

The magnesian carbonate of the country rock was recrystallized and redistributed sufficiently in connection with the mineralization to make it difficult to determine whether any additional carbonate was introduced. The variations in composition of the carbonate minerals, particularly the presence of manganese in some of them, suggest that the carbonate radicle was a constituent of the ore solutions. As the rock most thoroughly replaced by the hypogene minerals in the new Wilbert workings contains more calcite than dolomite, it appears that the relative concentration of lime and magnesia in the mineralizing solutions was such as to favor solution of magnesian carbonate, or deposition of calcium carbonate, or both.

Although some rearrangement of the carbonate in the dolomitic rock relatively close to the ore has undoubtedly taken place, it is probable that the mineralization affected no widespread alteration of the character of the dolomite of this region. The dolomitic rock everywhere beyond the vicinity of the ore zones has the fine, dense character generally associated with original dolomite, and, although some recrystallization has taken place here as in the adjacent quartzite, the texture of both the dolomite and the quartz grains under the microscope is such as is to be expected in a sedimentary rock.

It is clear that quartz was deposited in the ore and in nearby rocks by the mineralizing solutions. It may to some extent record redistribution of the silica already in the quartzitic beds, but, as the rocks examined show little evidence of solution of silica, it is probable that the mineralizing solutions brought up considerable quantities of this material from sources at depth. The coarser vein quartz, at least, was doubtless so derived. The presence of jasperoid in the wall rocks and of finely disseminated pyrite even farther from the ore shows that the influence of mineralization penetrated rather widely.

The deposits of the Dome district differ from most of the other known ore deposits of Idaho in certain noteworthy respects. Among their outstanding features are the distance from granitic masses, the fineness of grain, the relative paucity of introduced gangue minerals, and the fact that ore bodies formed primarily by replacement in dolomite, although irregular, have proved sufficiently persistent to be mined almost continuously for many years. The mineralization must have been subsequent to the intrusion of the dikes, now so thoroughly altered. Hence, if the assignment of the dikes to the Tertiary period is correct, the ore deposits must likewise be Tertiary. Most deposits of this age in Idaho are valuable mainly for precious metals, but lead minerals are abundant in some of them. For example, many of the deposits of the Lava Creek district, the only other mining district of any consequence in Butte County, are genetically related to Miocene (?) intrusive rocks, [15] and many of the lodes are valuable mainly for lead and other base metals. These deposits, however, differ quite as much in general character from the lodes of the Dome district as the lead deposits of Mesozoic age characteristic of most of the mining regions in the state. The reason for this difference is probably that the lodes of the Dome district were deposited much farther from the center of igneous intrusion to which they are genetically related than those of the Lava Creek district, or, for that matter, most of the lodes of either Mesozoic or Tertiary age elsewhere in Idaho.

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[15] Anderson, A. L., Geology and ore deposits of the Lava Creek district, Idaho: Idaho Bur. Mines and Geology Pamphlet 32, August, 1929.

The distance from exposures of granitic rock suggests the possibility of origin through circulation of meteoric water without direct relation to igneous intrusion, in a manner similar to that generally postulated for the lead-zinc deposits of the Mississippi Valley; but the apparent lack of a suitable source or mechanism for concentration, the comparatively large content of silver, and the depth of mineralization in the Dome district make this suggestion improbable. A more likely explanation is that the lodes of the Dome district represent a remote facies of mineralization from some deep-seated igneous source. In texture, low content of precious metals, and sparse gangue of jasperoid and reworked carbonate, these lodes are similar to the deposits remote from sources in such districts as Leadville, Tintic, and Ouray,[16] where the genetic relation to igneous rocks is more obvious.

16/ Loughlin, G. F., and Behre, C. H., Jr., Zoning of ore deposits in and around the Leadville district, Colo. (in preparation).