History of the Deadwood Mine, Valley County, Idaho

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Staff Report 07-2
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INTRODUCTORY NOTE

This report was prepared under a cooperative agreement with the U.S. Forest Service as part of an ongoing project to identify and describe inactive and abandoned mines in Idaho. The information in this report is from a number of published and unpublished sources in the Idaho Geological Survey's mineral property files. Where not otherwise noted, information on underground workings and mine equipment is generally from the annual Idaho Mine Inspector’s reports (IMIR) published from 1899 to 1979. After 1974, the Mine Inspector's office was known as the Mine Safety Bureau, a section of the Idaho Department of Labor and Industrial Services. Detailed accounts of mine operations are, for the most part, drawn from the annual reports prepared by the companies for the State Inspector of Mines; these reports were required by law, and the information contained in them formed the basis of the Mine Inspector's annual reports. Annual reports on recent developments in mining in Idaho by the Idaho Geological Survey's (IGS; from 1984 to present) or from similar reports produced by the Survey's predecessor, the Idaho Bureau of Mines and Geology (IBMG) from 1975 to 1984 were consulted, as were the U.S. Geological Survey's (USGS) annual volumes on *Mineral Resources of the United States* (1882-1923) and the equivalent volumes produced by the U.S. Bureau of Mines (USBM), *Mineral Resources of the United States*, 1924-1931, and *Minerals Yearbook*, 1932 to 1984; since 1995, the *Minerals Yearbook* has been published by the U.S. Geological Survey. Other published and unpublished sources that were consulted are referenced in the text. Where direct quotations are taken from source materials, the original spelling and grammar are preserved even in cases where they do not conform to currently accepted usage.

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Victoria E. Mitchell[1]

INTRODUCTION

The Deadwood Mine is in the Deadwood mining district in secs. 11 and 12, T. 13 N., R. 7 E., on the Bernard Mountain 7.5-minute topographic quadrangle. The mine is approximately 25 air miles east-southeast of Cascade, Idaho (Figures 1, 2, and 3). The mine is at about 6,000 feet in elevation, and the mill ruins are about 200 feet lower. The mine is on Pilgrim Mountain near the head of Deadwood River.

The Deadwood Mine is actually a consolidation of the properties owned by two separate mining companies: the Lost Pilgrim Mining Company and the Hall Interstate Mining Company (Table 1). The claim blocks of these companies adjoined each other and covered parts of the same vein system. A third company, the Deadwood Mining Company, Limited, owned claims adjacent to the Hall Interstate Mining Company.

Access to the property from Cascade is 35 miles of paved road and 17 miles of gravel road. Between January and June, snow closes the road, and the only access is by snowmobile (Reimers, 1981). The first time Idaho Mine Inspector Stewart Campbell visited the property in 1922, he left Boise at 5:30 a.m. by automobile, traveled via Lowman and Bear Valley, and reached the mine at 11:30 p.m. that night after walking the last 8 miles from the end of the wagon road (Campbell, 1931). Conditions had improved greatly over that arduous trip by the time Bunker Hill took over operation of the property in the mid-1920s, but the following description from Campbell (1930, p. 38) shows how isolated the mine was:

> From about the 10th of November to the 20th of June each year the roads are closed to wheeled vehicles, and the only means of communication, other than Forest Service telephone, is by dog sled [Figure 4]. The teams are employed under contract, and two are necessary to meet the schedule of three mail deliveries to the mine per week. The trip between the mine and Cascade requires two days. The contract calls for a 100-pound load and the transportation of one company official or injured employee when necessary, but the contractor is obliged to carry only the mail. Two cents per pound is paid for freight and five cents per pound for personal baggage.
>
> During the summer months three 5-ton dump-body trucks [Figure 5] are used for hauling the concentrates and supplies. The trucks operate on a 24-hour schedule and make two round trips per day. All hauling is done under contract at a price of $10.00 per ton in

[1]Idaho Geological Survey, Main Office at Moscow, University of Idaho, Moscow.

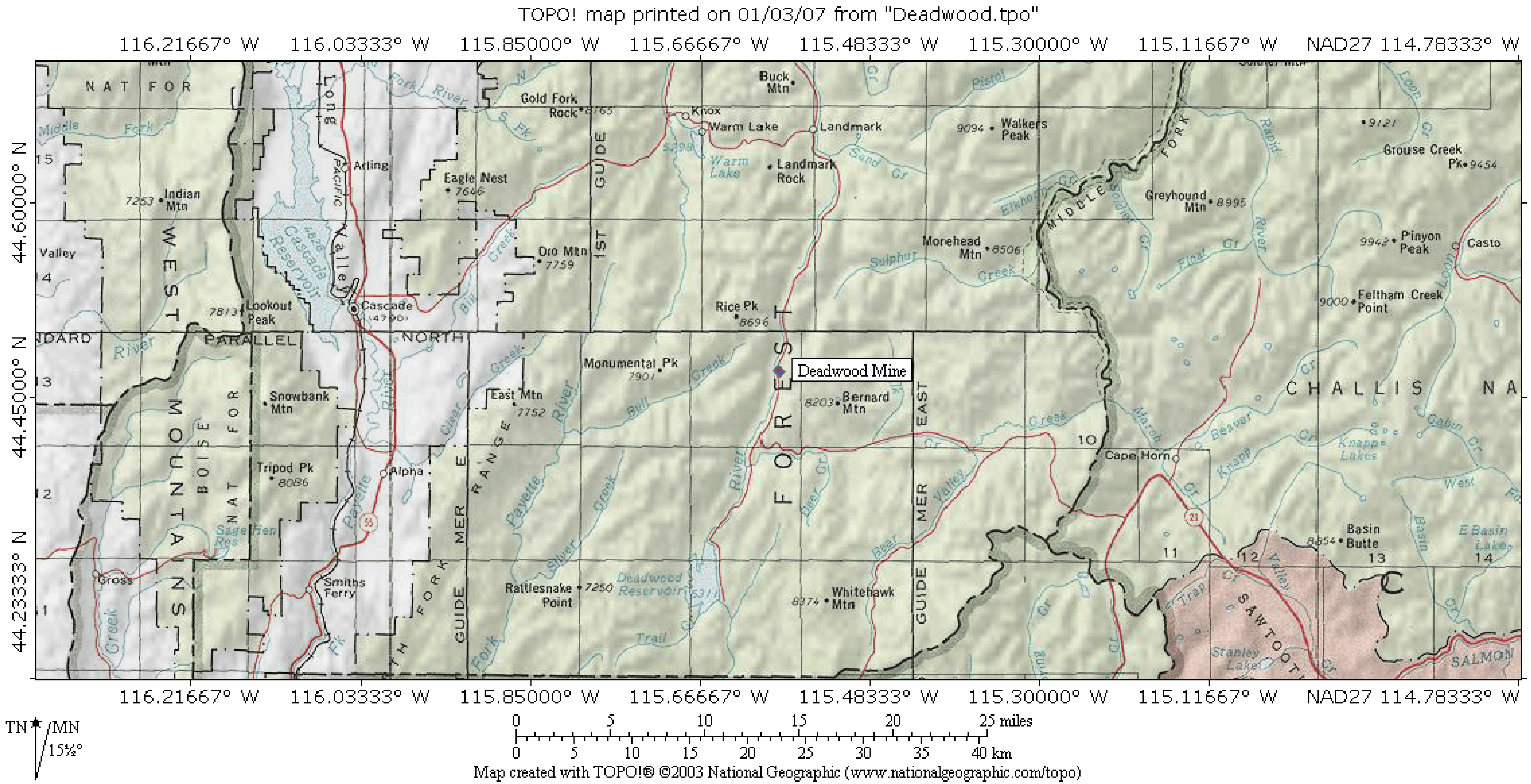

Figure 1. Region surrounding the Deadwood Mine, showing Cascade and the Middle (eastern) and North (western) Forks of the Payette River (National Geographic TOPO! map, scale approximately 1:500,000).

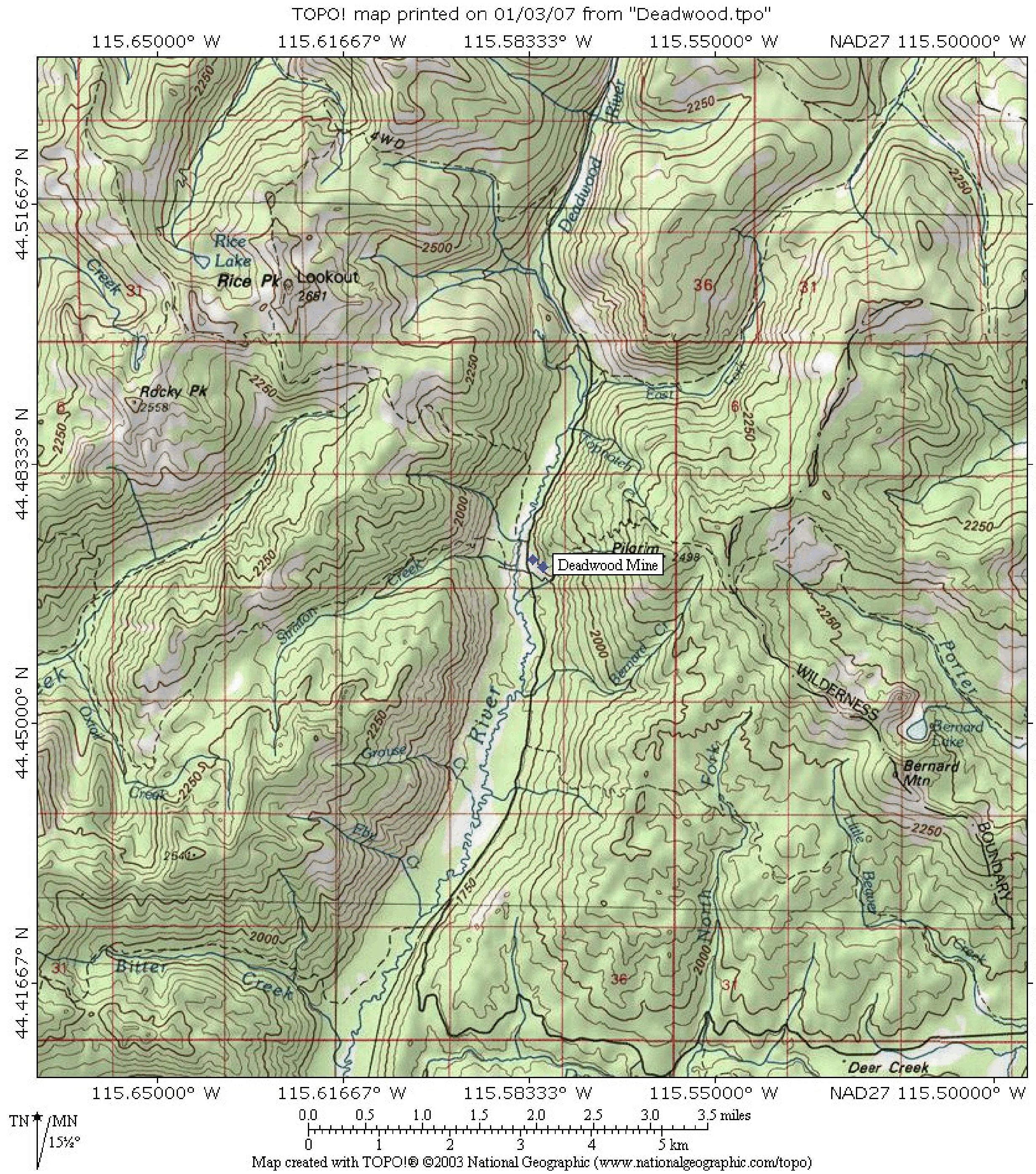

Figure 2. General location of the Deadwood Mine, showing the Deadwood River and the topographic features of the surrounding area (National Geographic TOPO! map, scale approximately 1:100,000).

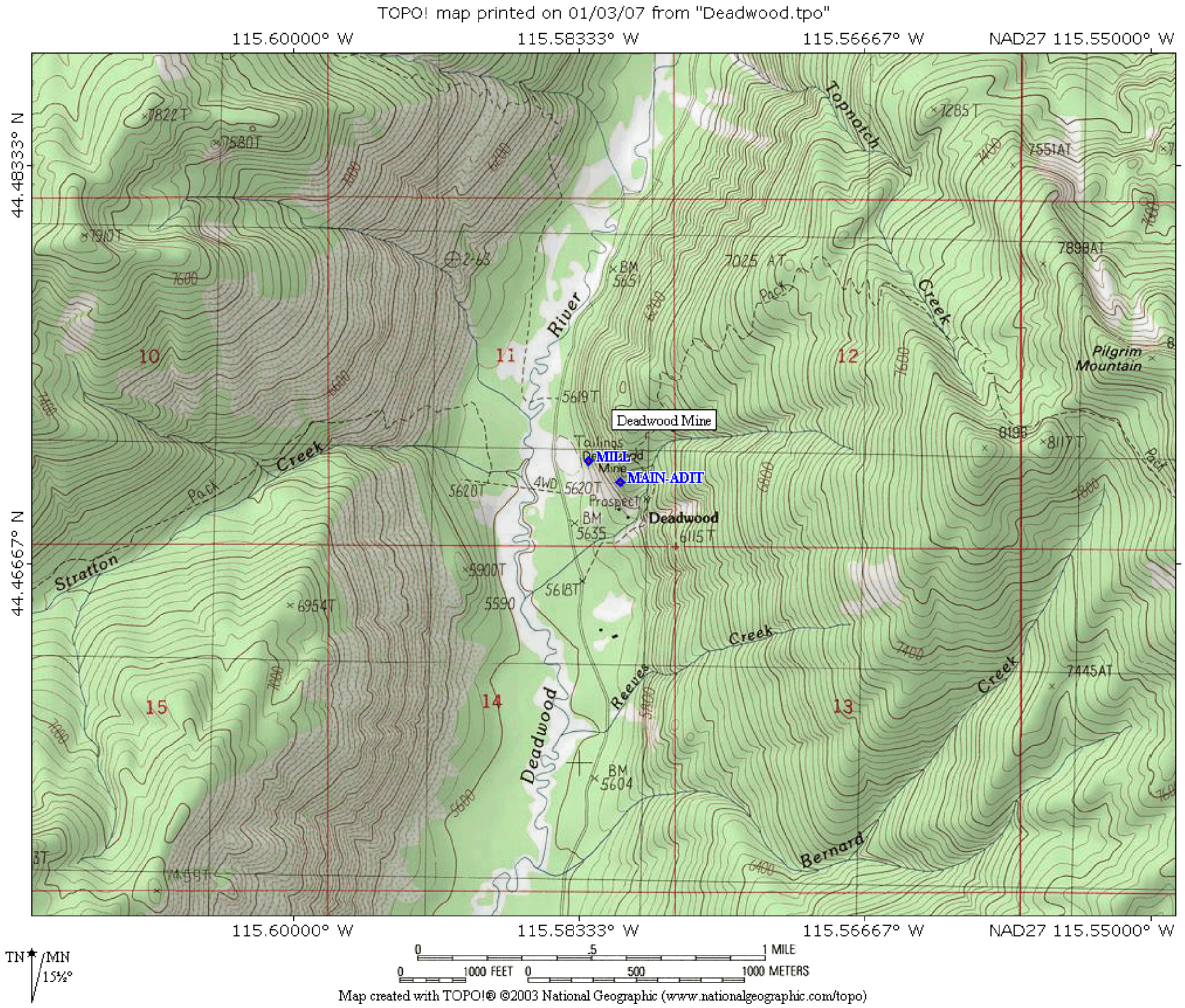

Figure 3. Topographic map of the Deadwood Mine (National Geographic TOPO! map, scale approximately 1:24,000).

Table 1. Companies and individuals operating at the Deadwood Mine. Information is taken from company reports to the Idaho Inspector of Mines and from data reported on the Idaho Secretary of State's website.

Company Name	Officer	Date Incorporated	Charter Forfeited	Year(s) at Mine
Companies and Individuals operating the Hall-Interstate claim block.				
Hall Brothers	---	---	---	1907(?)-1917
Hall Interstate Mining Company	James H. Hawley, President	30 October 1915	1 December 1952	1915-1952
Bunker Hill & Sullivan Mining & Concentrating Company	F.W. Bradley, President	23 September 1891	18 June 1968 (merged out)	1924-1932
Callahan Zinc-Lead Company	Henry B. Van Sinderen, President	filed in Idaho: 18 July, 1912	good standing with Idaho Sec. of State	1941-
L.J. Bills	---	---	---	1946-1947
Companies and Individuals operating the Lost Pilgrim claim block.				
Lost Pilgrim Mining Company	James H. Hawley, President	22 November 1922	30 November 1940	1921-1940
Bunker Hill & Sullivan Mining & Concentrating Company	F.W. Bradley, President	23 September 1891	18 June 1968 (merged out)	1924-1932
Hall Interstate Mining Company	James H. Hawley, President	30 October 1915	1 December 1952	1915-1952
Callahan Zinc-Lead Company	Henry B. Van Sinderen, President	filed in Idaho: 18 July, 1912	good standing with Idaho Sec. of State	1941-
L.J. Bills	---	---	---	1946-1947
Companies and Individuals operating the Deadwood claim block.				
Deadwood Mining Company, Limited	James H. Hawley, President	10 June 1921	30 November 1941	1921-1941

Figure 4. Winter transportation to and from the Deadwood Mine in the early 1930s (page 35 from Campbell, Stewart, 1931, Thirty-second Annual Report of the Mining Industry of Idaho for the Year 1930).

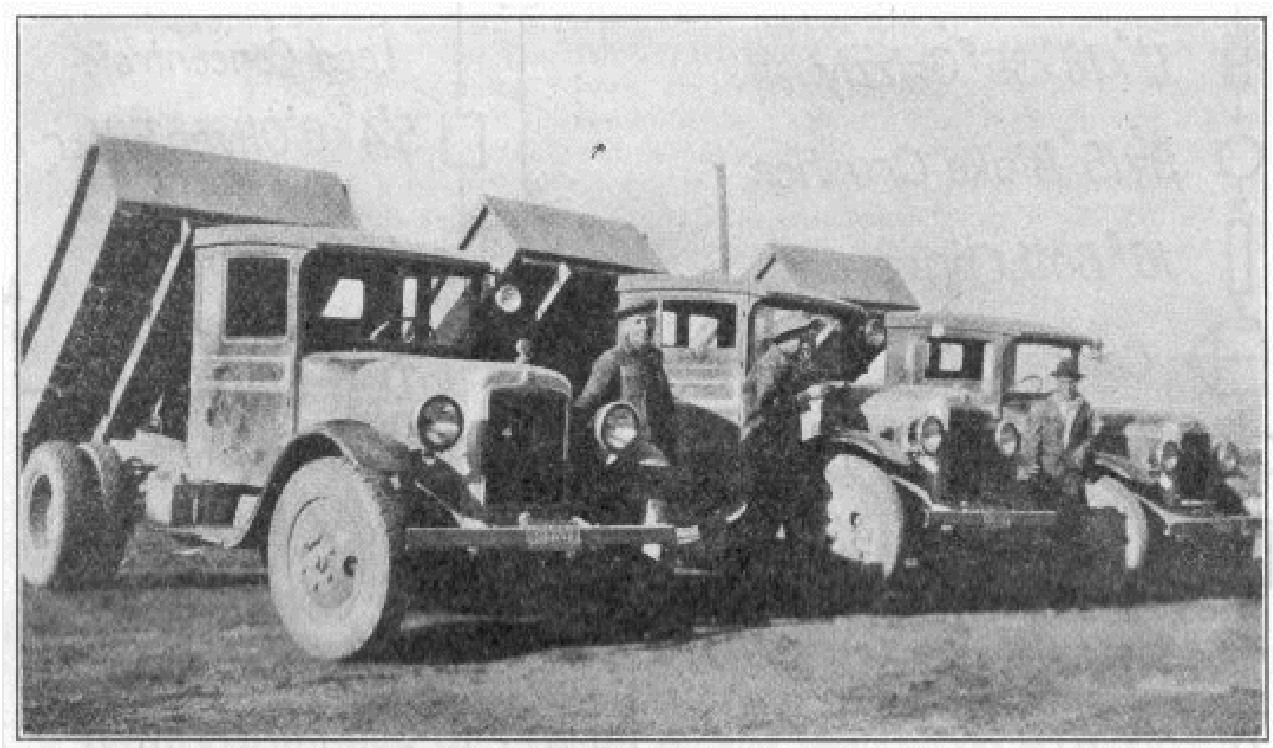

Figure 5. Summer transportation to and from the Deadwood Mine in the early 1930s (page 34 from Campbell, Stewart, 1931, Thirty-second Annual Report of the Mining Industry of Idaho for the Year 1930).

each direction. As supplies of all kinds in sufficient quantities to maintain operations throughout the winter months must be hauled during the open season, the trucks moving in both directions are usually fully loaded.

GEOLOGY

The Deadwood Mine is in Cretaceous biotite granodiorite and hornblende-biotite granodiorite of the Idaho batholith (Figure 6). The Deadwood fault separates the two types of igneous rocks. The hornblende granodiorite contains quartzite and schist roof pendants (Kiilsgaard and others, 2006; Fisher and others, 1992). Campbell (1931, p. 34-35), quoting from the report of his October 1922 visit as reported in the November 2, 1922 edition of *The Idaho Daily Statesman*, summarized the geology as follows:

> The Deadwood mining district is a part of the great granite area of central Idaho, and this rock exists exclusively throughout the entire district. It is a normal granite, sometimes roughly porphyritic by the development of large pink and white orthoclase crystals, which occasionally exceed one-half inch in diameter. The grain is coarse, and reddish orthoclase crystals are prominent. The color is light gray, and the outcrops have a brilliant white tone. Included in the granite, islands of metamorphosed schist are occasionally found.
>
> The schists vary in color from white to dark green and often inclose bands of white metamorphosed quartzite. The entire district is intruded by many dikes, which in places become very numerous. These dikes vary from white rhyolite to black diabase, and almost every variation in color and character between the two phases is present. The dark-colored diabase and diorite-porphyry dikes are more numerous and are always present in and near all the veins so far found. Adjacent to the dikes pegmatitic granite often occurs, but in no place does the pegmatite appear in the forms of dikes, but rather as a segregation in the granite.
>
> **Veins.**
>
> The veins of the district appear to owe their origin to these intrusive dikes, and after they were formed considerable faulting has taken place. In many places faulting has occurred within the vein fissures and in other along the dikes. The faulting along the dikes seems to have been the more consistent, and in many places the black dike rocks have been transformed into a heavy black clay gouge.
>
> Practically all of the veins are fissures striking northeast and southwest and dipping to the south at a small angle. They vary in width from a few inches to over 40 feet. In the north end of the district all of the ore is silver or lead-silver. These veins vary from about three feet to over 40 feet in width, while in the southern part of the district gold is the only mineral so far discovered, and here the veins are narrow, varying from a few inches to not over two feet in width, although exceedingly rich. On account of the dense forest growth and heavy overburden but few veins have been discovered, these as the result of placer operations.

Campbell's (1931, p. 37) description of the ore ran as follows:

> The ore is a coarse mixture of galena, sphalerite, and tetrahedrite, which occur as segregations, with sphalerite predominating. The lead and zinc minerals are coarse-grained, distinctly recognizable, and easily distinguished from each other. The gangue minerals are siderite, quartz, and decomposed wall rock. The ore is exceedingly friable, and mining operations reduce it to a fine mass in which no particle seldom exceeds one inch in diameter. Down to 20-mesh in size it is easily crushed, but grinding to lower sizes is difficult. When it is ground to 65-mesh, the ore minerals are liberated from the gangue.

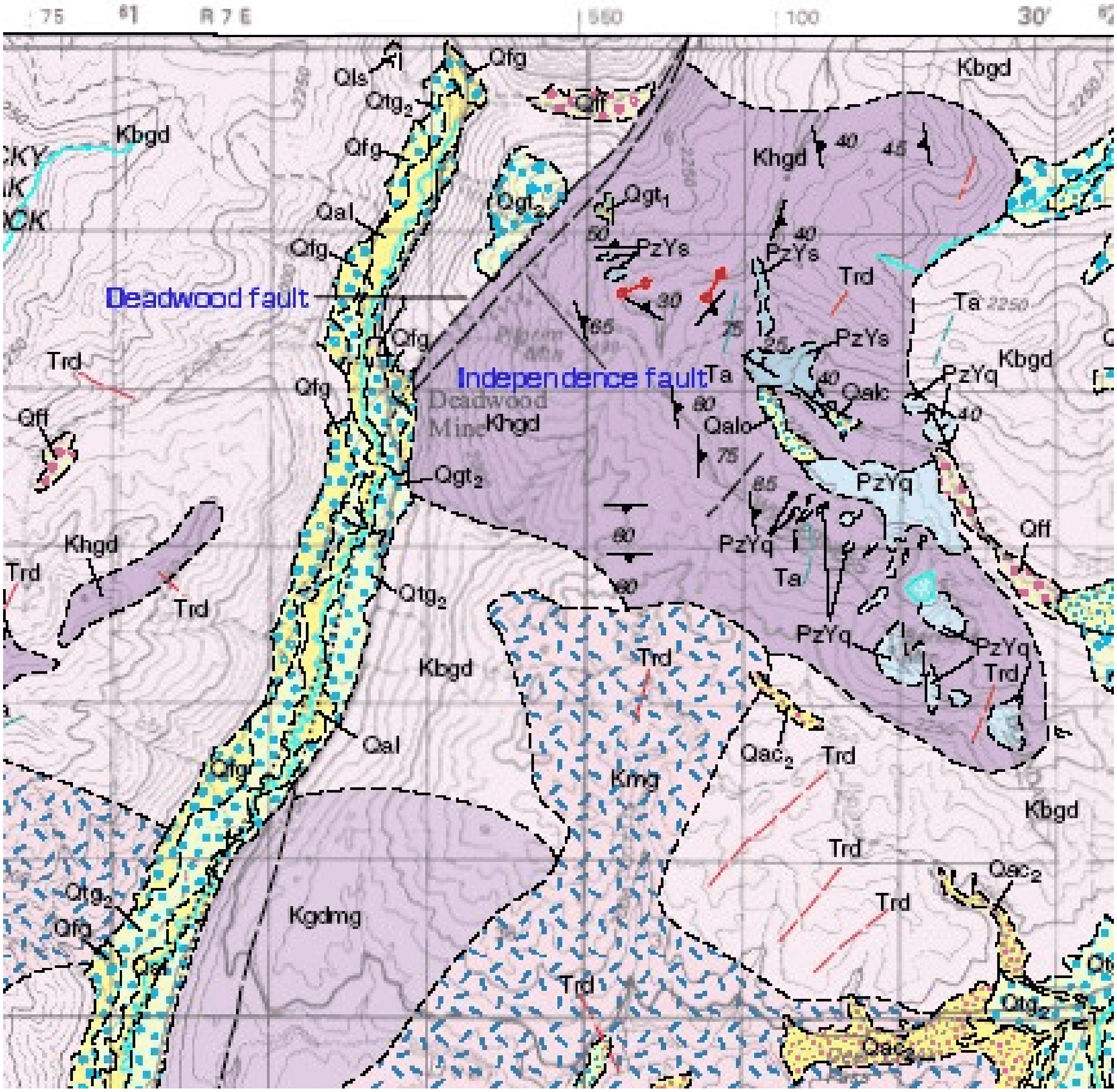

Figure 6. Geology of the Deadwood Mine and surrounding area (Kiilsgaard and others, 2006). t = mill tailings; Qal = Holocene alluvium; Qls = Holocene landslide deposits; Qfg = Quaternary fan gravels; Qff, Qalc = Quaternary glaciated valley deposits; Qtg_2 = Pleistocene terrace deposits; Qac_2 = Pleistocene alluvium; Qgt_1, Qgt_2 = Quaternary glacial deposits; Trd = Eocene rhyodacite dikes; Ta = Eocene andesite dikes; Kmg = Cretaceous muscovite-biotite granodiorite; Kbgd = Cretaceous biotite granodiorite; Khgd = Cretaceous hornblende-biotite granodiorite; Kgdmg = Cretaceous megacrystic granodiorite; PzYs = Proterozoic to Paleozoic schist; PzYq = Proterozoic to Paleozoic quartzite.

Hershey (1923) also observed the coarse crystallization of the quartz and galena. Full (1944b, p. 1-2) added more information to the descriptions of the geology and ore:

> As previously reported, the mine is in a large shear zone in what is probably a monzonite or diorite. The ground is badly broken by both pre- and postmineralization movement, and as a result all workings are tightly lagged. This makes geologic mapping very difficult, and in many cases, impossible to obtain much detail. . . .
>
> The ore is found in quartz-siderite veins in the shear zone. The quartz appears to be a combination of replacement and fissure filling, but dominantly replacement. The siderite appears to have come in after a period of brecciation of the quartz aones [zones]. There has been repeated brecciation and cementing by quartz both before and after emplacement of the sulphide minerals.
>
> The earliest sulfide appears to be a marmatitic sphalerite followed by galena and chalcopyrite. A resin color sphalerite is also found in some stopes, and while it appears to be a late stage of the sulfide mineralization, its relation is not definite. Most of the ore carries from 1 to 7 per cent silver, but as yet the mineral has not been identified. It's association does not appear constant as in places it is found in stopes which are high in lead while in others the lead content is low and the zinc and silver high. I hope that the silver mineral can be identified in the polished sections or in the bricketted concentrates.
>
> The sulfides have come in at the expense of the quartz and siderite, but siderite is not necessary for sulfide mineralization as massive quartz is often mineralized. However, it appears that the siderite is more easily replaced than the quartz if it is present. . . .
>
> The veins are badly shattered, and as a result square-set mining is used. The ground is not exceptionally heavy or fast, but timbering must be kept close to the face. By the time the ore reaches the mill about 75% of it is minus half an inch and very little of it is over one inch in size. This fact alone represents the degree of shattering of the vein.
>
> The vein appears to be fairly continuous, but the mineralization is lensy. Lenses, however, are often 100 to 200 feet long and 50 to 150 feet high with a 80º to 90º dip. Several of the vein structures have been worked in the mine, but their relation will be better known after the level maps and sections are completed.

HISTORY OF THE DEADWOOD MINE

Placers in Deadwood Basin first attracted miners in the early summer of 1863, and a second Deadwood Basin placer gold rush began in 1867. By 1868, miners had started to locate the quartz outcrops which would lead to the discovery of the Deadwood lead-zinc deposits. However, many of the miners left the following year in the rush for the Loon Creek gold discoveries, and the area was all but abandoned by 1876 (Wells, 1983). James H. Hawley (whose career included the varying occupations of prospector, lawyer, and governor of Idaho) discovered a narrow outcrop of high-grade silver-bearing quartz on the Lost Pilgrim ground in the 1880s. A small shipment of ore, sent by pack mule to the Ketchum smelter, proved unprofitable (Bell, 1929).

By 1905 the Idaho Mine Inspector noted that the gold veins in the Deadwood Basin were starting to attract considerable attention. About this time, the Hall brothers found some galena float on strike with the Lost Pilgrim vein on an adjacent property (Bell, 1929). In 1907, the IMIR (p. 43-44) described the discovery of the main surface exposure at the Hall-Interstate Mine, as well as noting the difficulties to developing this deposit:

> Aside from its gold mines, one of the most important ore developments of the year in Boise[1] County was the disclosure of an extensive deposit of lead-silver mineral,

[1]Valley County was not created until 1917.

> carrying good gold and copper values in addition, at Deadwood Basin, where the Hall Brothers succeeded in running down the source of some rich float, the source of which had been a prospector's problem for years. This discovery was made by sluicing off the deep surface debris with water conveyed through a long ditch dug for that purpose, and disclosed a lode or zone of rich concentrating ore 100 feet in width, of which 20 to 30 feet is said to carry lead values of 10 to 20 per cent with masses of clean galena mineral that runs 60 to 70 per cent lead.
>
> Numerous samples have shown from 1 to 2 ounces silver to each unit of lead, together with several dollars per ton in gold. The situation of this mine is rather remote for a base ore proposition, but it is of such magnitude and promise that if its present size and values are maintained for any important length along its strike, its extensive development would doubtless warrant railway construction for no other purpose than to handle the mineral traffic it could produce, and it will doubtless receive the attention of mining investors as important discoveries of lead mineral have been very few and far between during late years.

In 1917, Mine Inspector Robert Bell sampled a 10 foot vein in an open cut that ran 10 percent lead, 22 ounces per ton silver, and $2.00 per ton gold. The price of gold at that time was $20.67 per ounce.

The Hall Interstate[2] Mining Company was organized in October 1915 and originally held a group of five claims along the vein exposed by the Hall brothers. The Deadwood Mining Company, Limited, was organized in June 1921 and controlled seven claims to the south of the Hall Interstate Company. The Lost Pilgrim Mining Company, organized in November 1921, owned six claims to the north of the Hall-Interstate. For the Deadwood Mining Company, the 1921 IMIR (p. 123) reported: "This company was actively engaged in developing a large body of high-grade lead-silver-gold ore, and reports sufficient tonnage available to justify the installation of a milling plant and the construction of a road." This sounds suspiciously like claims made later about the adjacent Hall-Interstate claims, especially in light of the Deadwood Mining Company's report to the Mine Inspector for the same year: "We have reached the ledge and drilling through to hanging wall. Ledge seems to be about 50 feet thick. Last assays show no values. First assays run as high as $50.00 per ton in silver and gold, mostly silver. Unless more valuable rock is reached in the hanging wall, claims may be abandoned." The Hall Interstate Mining Company reported development work throughout the year.

During 1922, both the Hall Interstate and Deadwood companies did assessment work. Only the Lost Pilgrim Mining Company noted a large amount of development. The company's report to the Mine Inspector described the deposit as: "Simple fissure vein, carrying quartz, in granite country rock. The quartz contains silver up to 212 oz. per ton, and averages 40 oz. Width of quartz 18 inches to 3½ feet, averaging 2 feet." The company further noted that it was continuing development by extending existing tunnels and that it was building cabins and a 20 tons-per-day (tpd) mill.

All three companies did only assessment work during 1923. In October of that year, the property was visited by Oscar Hershey, long-time consulting mining engineer for the Bunker Hill & Sullivan Mining & Concentrating Company. Hershey (1923a, p. 1) introduced the mine to Bunker Hill's management as follows: "The Hall-Interstate

---

[2]The official name of the Hall Interstate Mining Company is not hyphenated, but common usage generally inserts a hyphen between "Hall" and "Interstate." This practice first appears in written materials about the time Bunker Hill & Sullivan became interested in the property. In this report, the company name will remain unhyphenated, while common usage will be observed for the name of the claim block and the mine.

impresses me as being the prospect for which we have been looking for a long time, I recommend that the company take an option on it, and hence please read this fully as a decision has to be made within 30 days from October 11th." A detailed, ten-page account of Hershey's observations of the geology and other pertinent factors follows. Hershey (1923a, p. 4-5) summarized of the economic potential of the Hall-Interstate Mine:

> From the evidence it seems reasonable to think that a mineralized band from 10 to at least 30 feet wide runs across the property. A lower tunnel certainly is justified. It has been driven 280 feet in granite, pegmatite, lamprophyre dikes and glacial debris. Hall[3] estimates that 800 feet further cross-cutting will be required to cut the vein at a point about 800 feet southwest of the Anderson tunnel and 700 feet deeper than the big cut. These figures should be checked by a survey. Here is a easy prospecting proposition. Continue the tunnel to the vein say 800 feet and drive along the mineralized band 1500 feet. Thus with 2300 feet of work at a cost of say $50,000 not including equipment, you would develop the vein across the property at a depth of 400 to 700 feet. You might find for the entire distance, 1500 feet, a streak of ore at least as wide as in an ordinary mine and you might find several ore-shoots 200 feet long and 10 feet wide and the big shoot 200 feet long and 30 feet wide. The big shoot carries primary sulphides at a short distance below the surface and there is no reason why it should not go deep. To 700 feet it may contain 420,000 tons. If it contained only 5% lead, 5% zinc and 10 oz. silver per ton it would have a gross value of $7,560,000.00.
>
> The property is owned by the Hall-Interstate Mining Company whose address is Cascade, Idaho. Mr. J.S. Hall is manager and vice-president. James H. Hawley is president and Charles W. Mack is secretary and treasurer. Hall says it is capitalized at 1,000,000 shares of a par value of 25 cts. each, non-assessable. There are probably over 200,000 shares in the treasury. Hall seems to have control. He has given Mr. Gwinn[4] a 30-day option from October 11th to decide to take a more formal option at a price of $200,000.00, no payments for three years from next June 1st, payments after the three year period not specified. The showing seems to fully justify the price and the three-year period will probably be sufficient time to develop the mine, construct a reduction plant and take out the purchase price.

Hershey (1923a) examined the adjacent claim groups and recommended Bunker Hill lease the Lost Pilgrim property at the same time it leased the Hall-Interstate. His assessment of the Deadwood claims was much less encouraging, and he suggested that Bunker Hill lease those claims only under extremely favorable terms. This apparently did not happen, although Deadwood eventually became the name by which the larger, adjoining property became known.

In late October 1923, when Hershey received the assay results from samples taken on his trip to the mine, he became more enthusiastic about the property even while commenting (Hershey, 1923b, p. 1): "These assays do not bear out the claims made by Mr. Hall as per my report of October 13th, but there is not as much discrepancy as we usually find between the claims of a prospect owner and the contents as determined by our sampling." He continued the letter with an analysis of the assay results and his own conclusions about the property (Hershey, 1923b, p. 2-3):

> It now appears to me that copper is an important constituent of the entire ore-shoot where unoxidized and may average 3 or 4 %. The zinc content is probably at least equal to the

---

[3]The manager of the Hall-Interstate Mine.

[4]James W. Gwinn was Bunker Hill's local manager for most of the time the company operated the Deadwood property.

> lead. The entire ore-shoot may average 7% lead, 7% zinc, 3% copper, 13 ozs. silver and $1.20 gold per ton, a gross value of $ 33.00 per ton or $13,860,000 gross value of ore that may be developed by the proposed expenditure of $50,000, aside from equipment, and not counting what may be in the vein outside of the main big ore-shoot. It seems to me that I must have figured wrong somewhere for I can hardly think that a thing like that is lying loose in the State of Idaho.

Bunker Hill began negotiations, which were not concluded until the following year, with the Hall Interstate and Lost Pilgrim companies. The 1924 IMIR (p. 211) described the year's activities:

> The properties controlled by this company [Bunker Hill] were acquired in May after many months of negotiation; immediately thereafter arrangements were completed for the construction of the necessary buildings and the installation of the equipment.
>
> A large two-story boarding house, a power house [Figure 7], shop, barn, and outbuildings were built. The power plant was constructed, the compressor and mining equipment were installed, and sufficient supplies were put in to permit operations throughout the winter months, before the roads were closed. Everything was hauled in from Hailey through Stanley Basin and Bear Valley. Construction work was completed and mining operations were commenced on Oct. 24.
>
> The development campaign outlined consists of extending the Independence tunnel, of the Hall group, a distance of 1500 feet, at which point it will intersect the Hall vein at a vertical depth of 600 feet below the apex. The Hall vein will be explored first, and if conditions warrant, the main tunnel will then be extended into the Lost Pilgrim vein.

The 1925 IMIR announced that Bunker Hill had located the main vein, which was 50 feet wide and consisted mostly of commercial ore. Hershey's (1925) description of work at the mine was less glowing and more candid, as he described the detailed underground occurrences of the differing rocks in the lower tunnel and attempted to unravel the structural relationships between various faults and the ore veins. He also noted a zone of finely textured, fault granulated, wet biotite schist just beyond the Deadwood fault that ran like wet sand when the hard dike next to it was penetrated by a tunnel. In one instance, this crushed material filled 40 feet of tunnel in 5 hours.

Bunker Hill ran nearly 2,200 feet of drifts and tunnels in 1926, but the large vein the company was seeking remained elusive. Hershey and Gwinn identified two major faults underground, which they called the Deadwood and the Independence (Figure 5; Hershey, 1926a). The Independence fault, farther to the east, is now mapped as a branch of the Deadwood fault system (Breckenridge and others, 2003). In the 600 feet between the surface and the lower tunnel, the Deadwood fault changed dip from about 65º SE. to a northwest direction. Ore-bearing zones were present on the lower level, but it remained to be determined whether any of them were rich enough, thick enough, or long enough to be considered commercial ore (Hershey, 1926a). By mid-year, although some promising showings had been found, the development had come no closer to finding an answer to the structural problems found on the lower level (Hershey, 1926b). By September the main crosscut, which had been driven from the lower tunnel obliquely between the Deadwood and Independence faults, had nearly reached the Independence fault. Because the ore-bearing quartz veins were concentrated in the area between the two faults, the angle of the crosscut was deflected to avoid cutting the Independence fault (Hershey, 1926c).

By early 1927, Hershey (1927a) had unraveled the structure of the Hall-Interstate vein and recommended that Bunker Hill build a small mill on the property. In June,

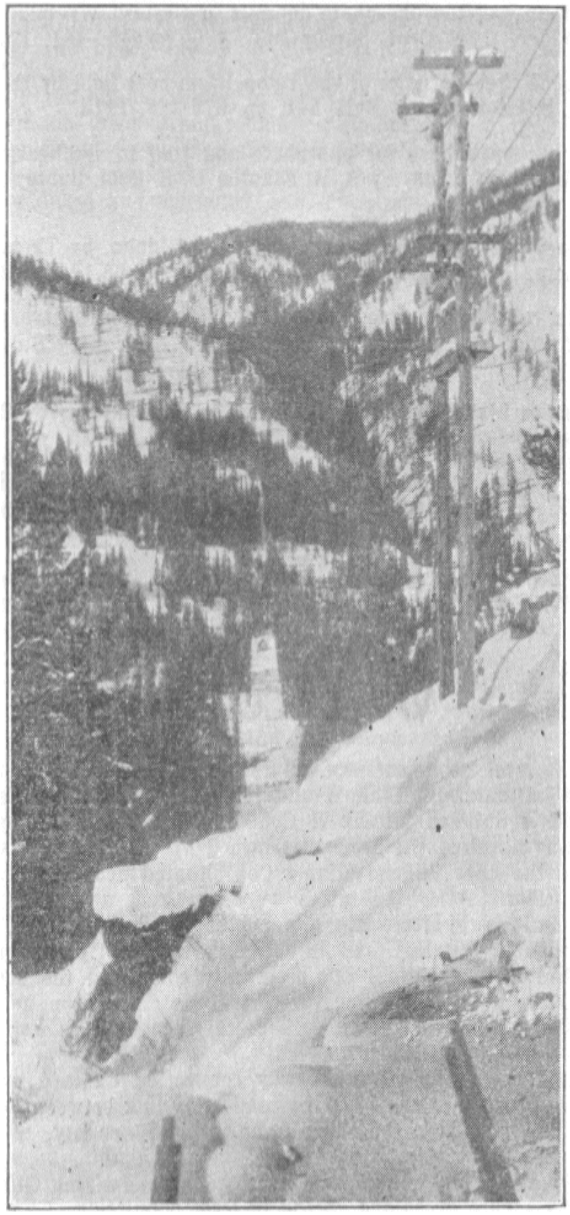

Figure 7. Looking across Deadwood Basin toward the power house (center of photograph) for the Deadwood Mine (page 210 from Campbell, Stewart, 1925, Twenty-sixth Annual Report of the Mining Industry of Idaho for the Year 1924).

Hershey again recommended the immediate construction of a mill, estimating that the mine contained a minimum of 140,000 tons of ore with a gross value of $2,131,544 (Hershey, 1927b). During the summer, the company began construction on a 100-tpd flotation mill and a 250-horsepower hydroelectric power plant, as well as additional camp buildings (1927 IMIR). During Hershey's March visit, a location was selected to begin a raise from the lower tunnel to the surface. The main reason for the raise was to help unravel the vertical structure of the vein (Hershey, 1927a). By October, Hershey was convinced that locating the pieces of the highly segmented ore veins would depend on unraveling the structure of the numerous faults that crisscrossed the property (Hershey, 1927c).

The 700-foot raise from the lower (Independence) tunnel to the upper (Anderson) tunnel on the Hall-Interstate property was completed by late January, and plans were being made to drive four levels off it. By contrast, the main drift heading into the Lost Pilgrim claims had stalled in a section of crushed schist that swelled and was wet. This broke the timbers in the tunnel, which had to be constantly replaced (Hershey, 1928a). In late May, efforts were still continuing to find the downward extension of the large ore body exposed in the surface cut. Exploration on the Anderson tunnel level and on the No. 2 level off the raise below the tunnel had yet to provide an answer to this problem. In the lower tunnel, plans were made to drive parallel to the main drift and bypass the zone of crushed, wet schist (Hershey, 1928b). Exploration continued for the rest of the year, with plans made in late August to start the first stope on the No. 1 (Anderson tunnel) level (Hershey, 1928c). In November, the mill (Figure 8) was completed. Although only enough flotation equipment to process 100 tpd was installed, the ore bins, crushing machinery, and mill building were large enough to handle 300 tpd. The mill produced very rich silver-lead concentrates containing considerable copper and high-grade zinc concentrates. Campbell (1931, p. 38-40) described the mill and its operations:

> **MILL**
>
> The test work and the designing of the mill were done by Mr. C. Y. Garber, to whom the inspector is indebted for assistance in the preparation of the following description of the mill.
>
> At the present time the mill has a capacity of 100 tons per 24 hours; however, the building is sufficiently large to house milling equipment for a capacity of 300 tons, and it is necessary to add but little more machinery to bring the mill up to the latter capacity.
>
> **Grinding.**
>
> The ore is transported from the mine by a one-ton, storage-battery locomotive pulling 10 cars and is delivered directly into the 250-ton crude-ore bin [Figure 9] from which it is drawn through a chute on to a 24-inch belt conveyor. The conveyor dumps on to a tapered bar grizzly, 36 inches long by 18 inches wide with 1½-inch slots. After passing over the grizzly, the ore is crushed to a maximum size of 1½ inches in a 9 by 15[5] Blake crusher. The undersize from the grizzly and discharge from the crusher go to a 16-inch belt conveyor, which delivers it (dry) to a Colorado impact-screen with a $^{3}/_{8}$-inch screen opening. The undersize from the screen goes to the fine-ore bin and the oversize to a 3-foot[6] Symons cone crusher that discharges directly into the fine-ore bin, which has a capacity of 300 tons.

[5]The gape, or maximum working cross-section, of the jaw crusher, in inches.

[6]Maximum diameter of the cone in the crusher.

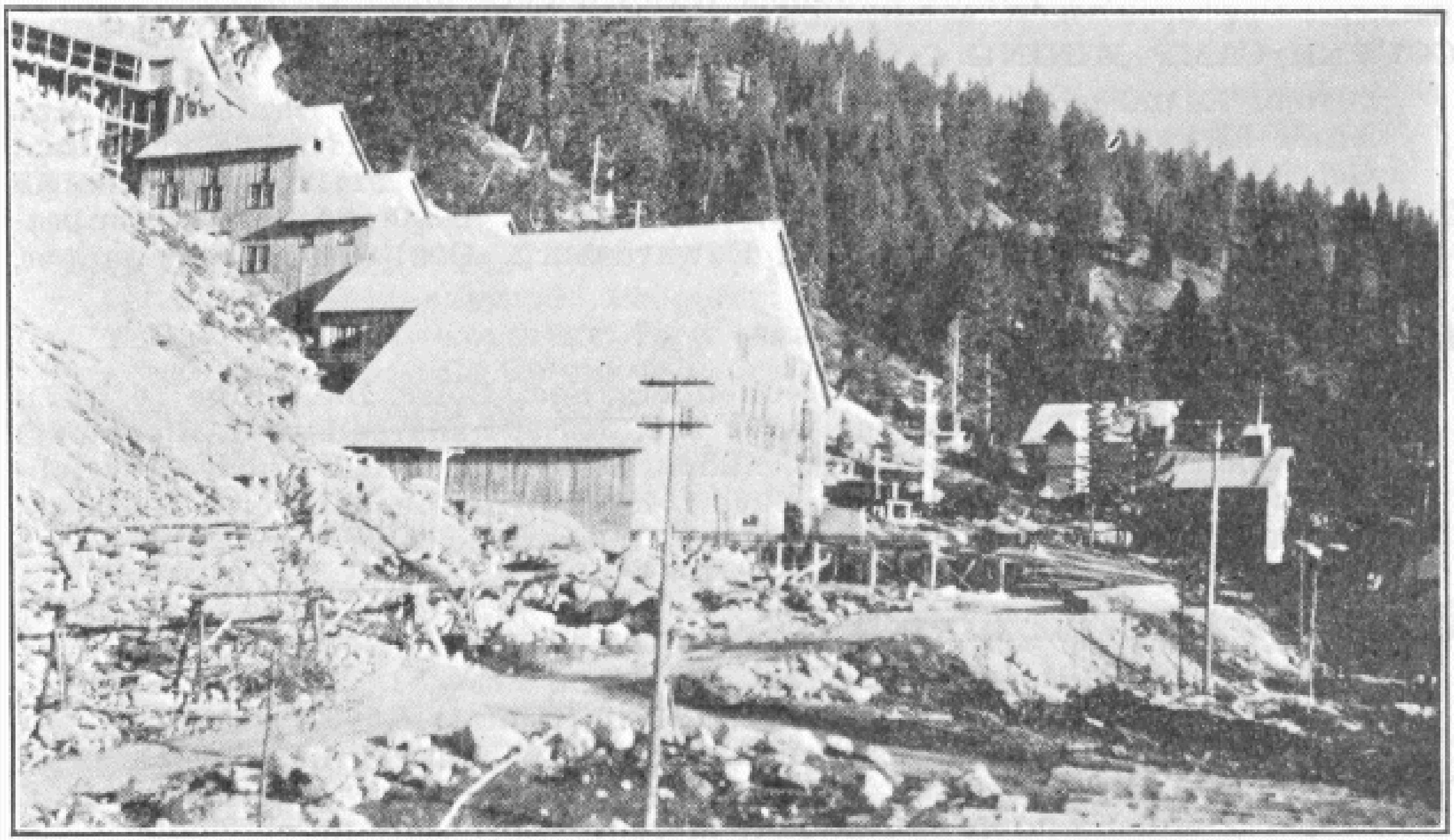

Figure 8. Mill building at the Deadwood Mine, with the boarding house in the background (page 265 from Campbell, Stweart, 1930, Thirty-first Annual Report of the Mining Industry of Idaho for the Year 1929).

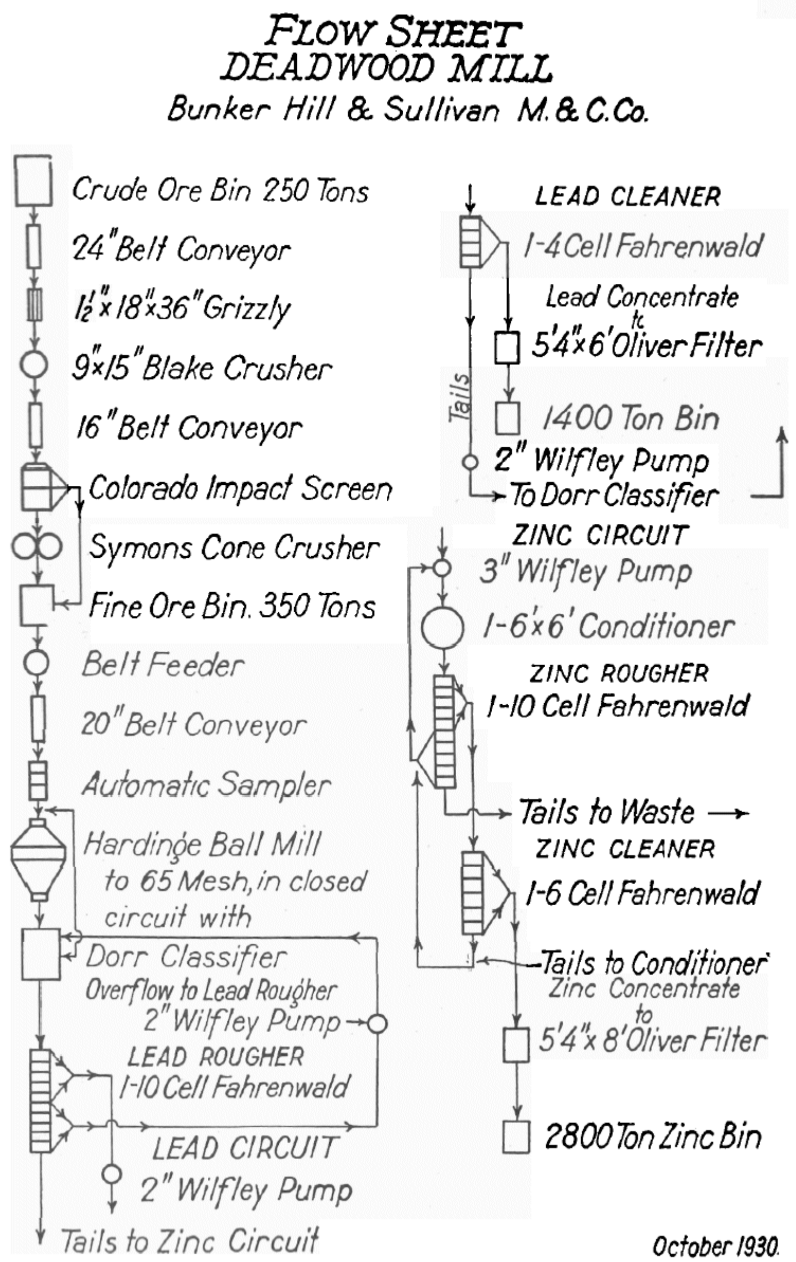

Figure 9. Flow sheet for the Deadwood mill (page 33 from Campbell, 1931).

The ore is fed from the fine-ore bin by a belt-feeder on to a 20-inch belt conveyor equipped with an automatic sampler, and then goes to a 6-foot by 22-inch[7] Hardinge ball mill where it is ground to 65-mesh. The ball mill operates in closed circuit with a 4½-inch, duplex-type Dorr classifier[8] without the use of pump or elevator.

Rougher Circuit.

The overflow from the classifier goes direct to a 10-cell Fahrenwald flotation machine, termed the lead rougher cells. The first five cells of this machine make a rough lead concentrate, which goes to the lead circuit; the last five cells make a low-grade concentrate, which is returned to the Dorr classifier by a 2-inch Wilfley pump, and the tails go to the zinc circuit.

Lead Circuit.

The product from the first five cells of the rougher circuit goes to a 4-cell Fahrenwald flotation machine, which makes a high-grade lead concentrate and a tailing. The tailing is returned to the Dorr classifier by a 2-inch Wilfley pump, and the lead concentrate passes through a 5-foot 4-inch by 6-foot [9]Oliver filter, which discharges into a 1,400-ton storage bin.

Zinc Circuit.

The tailings from the rougher circuit are delivered into a 6 by 6-foot conditioner tank by a 3-inch Wilfley pump. The product from the conditioner is fed directly into a 10-cell Fahrenwald flotation machine, termed the zinc rougher cells. The first five cells of this machine make a rough zinc concentrate, which goes to the zinc cleaner; the last five cells make a low-grade zinc concentrate, which is returned to the conditioner tank; and the tailings go to waste where they are settled in a pond and clear water only overflows.

The product from the first five cells of the zinc rougher goes to a 6-cell Fahrenwald flotation machine, which makes a high-grade zinc concentrate and a tailing. The tailing is returned to the conditioner, and the concentrate passes through a 5-foot 4-inch by 8-foot Oliver filter, which discharges into a 2,800-ton storage bin.

Reagents and Where Used.

- Grinding circuit.
  - 1.4 pounds of zinc sulphate and 0.17 pounds of aerofloat per ton of ore are fed into the Hardinge ball mill.
- Rougher circuit.
  - .01 pound of cresylic acid per ton of ore is added to the sixth cell.
- Lead circuit.
  - None.
- Zinc circuit.
  - To each ton of ore 1 pound of copper sulphate, 2 pounds of aerofloat, and .025 pounds of zanthate [xanthate] are added in the conditioner—cresylic acid and zanthate are added to the product from the last five cells of the zinc rougher before being returned to the conditioner.

Drives.

- Grinding circuit.
  - Line shaft, belt connected to 30-horsepower motor drives:
    - Blake crusher.
    - Belt conveyors.

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[7]The diameter and length of the ball mill.

[8]A two-compartment classifier with a sloped tank along which the ore was raked to sort it into finer and coarser materials.

[9]The diameter and the length of the drum of the filter.

Feeders.
Automatic sampler.
Impact screen.
Symons cone crusher, by 50-horsepower motor, Tex rope connected.
Hardinge ball mill, by 50-horsepower motor, Tex rope connected.
Classifier, by 3-horsepower motor, belt-connected.

Flotation Circuit.

Each individual cell in all flotation machines is driven by a 3-horsepower motor, Tex rope connected.
The two filters are driven from a line shaft belted to a 15-horsepower motor.

Pumps.

Six 2-inch Wilfley pumps direct-connected to a 5-horsepower motor.
One 3-inch Wilfley pump direct-connected to a 10-horsepower motor.

Blower.

Ten-horsepower motor, belt-connected.

Average Assays of Ore and Mill Products.

The average assays of the mill feed and products are as follows:

	Au. $	Ag. Oz.	Pb. %	Zu. %	Cu. %
Mill feed	1.00	10.00	3.50	10.00	0.50
Lead cons.	15.00	160.00	55.00	9.00	5.00
Zinc cons.	0.60	5.00	1.20	58.00	0.40
Tails	0.01	0.33	0.07	0.71	0.07
Average total recoveries .	76.50%	95.00%	97.00%	85.00%	60.00%

Other construction during the year included a sawmill, and a large new office and residence (Figure 10). The mine had nearly 9,000 feet of workings, with 2,469 feet of development done in 1928.

During 1929, the mill treated 2,729 tons of lead-zinc ore, which yielded 415 tons of lead concentrates and zinc concentrates, which together yielded 25 ounces of gold, 17,723 ounces of silver, 13,118 pounds of copper, 165,208 pounds of lead, and 324,164 pounds of zinc. The mill operated for only four months because of insufficient power, but a new 400-kilowatt hydroelectric power plant was installed during the year. Additional ore bins were also built at the mill. The mine operated all year; in addition to stoping operations, the company did more than 600 feet of development. The 700-foot raise between the Independence and Anderson tunnels was widened to three compartments. Hershey (1929a, p. 7), while still trying to puzzle out the exact structure of the underground veins, still predicted large amounts of ore to be found at the mine:

> It is fairly clear that the bands rich in siderite and ore sulphides are fairly persistent for long distances on the tunnel level but strike faulting along the Independence fault and cross-faulting has given the ore a bunchy appearance it did not have originally. I see no reason why the ore-bands should not, in a more or less faulted and bunchy condition, extend to near the surface and to great depths. In other words, just for the purpose of determining the possibilities of the combined properties and for no other purpose, I would consider an average heighth of 1000 feet and average depth of 1000 feet below the main tunnel and possible average of 1000 tons per foot depth as within the reasonable bounds of possibility.

Soon after Hershey's February visit, Bunker Hill shifted their focus to production, and all exploration work was discontinued (Hershey, 1929b).

Figure 10. Office at the Deadwood Mine (right center), with the mill in the background (page 36 in Campbell, 1931).

The Deadwood Mine operated throughout 1930 and nearly 25,000 tons of ore were mined and milled during the year. The concentrates were hauled 54 miles by truck to loading bins at Cascade, where the lead concentrates were shipped by rail to Bunker Hill's lead smelter near Kellogg and the zinc concentrates were taken to the company's electrolytic zinc plant nearby. The company was having trouble finding commercial ore in the Lost Pilgrim ground, as noted by Hershey (1930a) in February. In addition, the main drift had reached a wet, crushed section of the vein, and the miners were forced to drive the tunnel parallel to the vein until past this zone. At the beginning of July, C. Y. Garber replaced James Gwinn as the manager of the mine. At almost the same time, the ore dropped below commercial grade in three of the main stopes. However, following up on suggestions made by Gwinn, Garber started several new stopes and soon increased the grade of the ore being produced by the mine (Hershey, 1930b).

By 1931, two ore shoots (the Drake and the Grey) were defined in the Hall-Interstate workings, but the location of commercial ore in the Lost Pilgrim section of the mine was still uncertain (Hershey, 1931). At the end of May, the mine was closed and a small crew was left at the mine to maintain the property. Nearly 11,000 tons of ore were produced before the mine was closed. In June 1932, all the supplies were removed from the property and the options to the claims forfeited.

The Lost Pilgrim produced some ore in 1938. In July 1940, Leverett Davis obtained a lease on the Deadwood Mine. A crew averaging ten men under his supervision rehabilitated the mine in the second half of 1940. The main tunnel had caved in after the mine was closed, and by the end of the year, about 1,000 feet of adit had been reopened and retimbered (Davis, 1940). The Lost Pilgrim Mining Company forfeited its corporate charter at the end of November 1940, and the Hall Interstate Mining Company acquired the Lost Pilgrim claims. Callahan Zinc-Lead obtained a long-term lease. The company rehabilitated the property and repaired the mill during 1941.

In 1942, Callahan mined 7,733 tons of zinc-lead ore, which yielded 240 tons of silver-lead-copper concentrates and 590 tons of zinc concentrates. Initial work at the mine revealed less ore than expected, and in November, the company requested help from the government to do exploratory work at the mine (Van Sinderen, 1942a). At that time, the Bureau of Mines budget for work in Idaho was entirely allocated (Lorain, 1942). However, company president Van Sinderen's (1942b, p. 1) reply noted that the "Deadwood, which is being run today as a war operation and, therefore, like some others, really needs the promptest possible assistance." After receiving maps and other information concerning the Deadwood Mine, Shenon (1942, p. 1) evaluated it as follows:

> If I understand the Deadwood situation properly, there is considerable doubt as to whether the property can be expected to contribute much zinc and lead toward the fulfillment of the national requirements on a reasonable manpower and transportation basis. First of all, the figures we have make it appear doubtful whether the property could be made to pay at the present quota price of 11¢ per pound for zinc. If the W P B [War Production Board] should raise the quota price the question arises whether or not other less isolated properties of similar ore grade should not be given first consideration. The Deadwood property, I believe, is 60 miles from the railroad at Cascade and over three high summits. The truck and tire wear per pound of zinc would be high. However, as you know, the national requirements are such that the difficulties of transportation might be overlooked if a sizable body of good grade zinc ore could be developed by exploration work. The data available to us do not look too hopeful for the development of such a body by a reasonable amount of exploration work. If your information indicates otherwise, please advise us.

Despite this discouraging evaluation, Van Sinderen (1943) continued to urge the Bureau of Mines and U. S. Geological Survey geologists to explore the Deadwood Mine. On this subject, Collins (1944, p. 1) noted: "Operations have shown that it was not necessary for the Department of the Interior to start a project there. The vital thing was to raise the bonus prices so that the Company could afford to operate." During 1943, the mine produced 18,934 tons of zinc-lead-silver ore, which yielded 539 tons of silver-lead-copper concentrates and 1,358 tons of zinc concentrates. The government geologists took no action toward examining the mine during the year.

During the first eight months of 1944, Callahan only milled 5,263 tons of ore, concentrating instead on development work. Full operations resumed in September, and during the rest of the year, 10,525 tons of ore were treated. The company reported 9,737 feet of workings at the mine, not counting about 3,330 feet of old workings that were still caved. In June, the Non-Ferrous Metals Commission granted an increase in wages at the property. A Bureau of Mines Engineer visited the mine in early September (Full, 1944a). Collins (1944) recommended that the Deadwood Mine should be mapped while the workings were still open as it was likely the mine would close when the bonuses were withdrawn (at the end of World War II) and the workings cave almost immediately. Roy Full spent eleven days mapping the underground workings in December 1944. At that time, the mine had ten levels and sublevels, seven of which were open in part (Full, 1944b).

In 1945, Callahan produced 24,377 tons of ore, containing an average of 0.02 ounce of gold and 3.89 ounces of silver to the ton, 0.23 percent copper, 1.43 percent lead, and 3.53 percent zinc. The company's annual report noted that four years of work at the mine had failed to locate ore of the grade and quantity hoped for. Inadequate ore reserves and a shortage of labor forced Callahan to curtail its operations in 1946. L. J. Bills operated the mine on a sublease during the second half of the year. The mine produced 16,350 tons in 1946 and 3,297 tons in 1947. Various small items of equipment were transferred to other Callahan properties in the early part of the year, and Callahan surrendered its lease in October 1947.

In 1950, the Deadwood Mine produced 8 tons of zinc-lead-copper ore. The Hall Interstate Mining Company forfeited its corporate charter on December 1, 1952. In its final report to the Idaho Mines Inspector, the company noted that the underground workings were all abandoned and the surface rights had been sold to third parties.

From 1929 to 1950, the Deadwood Mine produced 125,793 tons of ore (Table 2), which yielded 2,658.46 ounces of gold, 634,277 ounces of silver, 444,343 pounds of copper, 4,978,449 pounds of lead, and 10,176,833 pounds of zinc. Almost all of this production was when the mine was operated either by Bunker Hill or by Callahan Zinc-Lead. Callahan produced over twice the tonnage as Bunker Hill, yet Bunker Hill produced 43-45 percent of the silver, lead, and zinc, and 50.6 percent of the gold. In contrast, Callahan produced 48.6 percent of the total gold mined[10]. Only in copper did Callahan's 62 percent of total metal produced outshine Bunker Hill's 37.6 percent.

[10]Percentages do not add to 100 percent because of the small amounts of ore mined and shipped by other producers.

Table 2. Production from the Deadwood Mine, Valley County, Idaho, by year. Data are from U.S. Bureau of Mines files.

Year	Ore (Tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Operator
1929	2,729	25.20	17,663	9,366	156,459	272,068	Bunker Hill & Sullivan Mining & Concentrating Company
1930	24,878	756.00	188,218	110,140	1,457,180	2,855,472	Bunker Hill & Sullivan Mining & Concentrating Company
1931	10,836	564.26	82,848	47,514	651,640	1,262,298	Bunker Hill & Sullivan Mining & Concentrating Company
1938	863	17	5,743	1,500	23,870	0	A. E. Robinson
1942	7,733	80	41,550	26,025	244,100	611,100	Callahan Zinc-Lead Company
1943	18,934	250	66,582	56,000	632,255	1,663,000	Callahan Zinc-Lead Company
1944	15,788	204	50,660	50,772	393,670	718,720	Callahan Zinc-Lead Company
1945	24,377	470	88,968	80,350	651,531	1,526,265	Callahan Zinc-Lead Company
1946	16,350	253	79,933	53,000	643,800	978,200	Callahan Zinc-Lead Company
1947	3,297	36	11,465	9,160	118,130	288,440	Callahan Zinc-Lead Company
1950	8	3	647	516	5,814	1,270	M. D. and M. C. Jorden (sp?)
Totals	125,793	2,658.46	634,277	444,343	4,978,449	10,176,833	

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