History of the Ima Mine, Lemhi County, Idaho

Victoria E. Mitchell

Staff Report 99-2
August 1999

Idaho Geological Survey
Morrill Hall, Third Floor
University of Idaho
Moscow, Idaho 83844-3014

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INTRODUCTORY NOTE

This report was prepared under a cooperative agreement with the U.S. Forest Service, Region IV, as part of a project to identify and describe inactive and abandoned mines in the state of Idaho. Work on this project included preparing detailed histories of mines in Region IV that had significant recorded production. The information in this report is take from published and unpublished sources in the Idaho Geological Survey's mineral property files. Unless otherwise noted, most mine production data are drawn from 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 the present). Information on underground workings and mine equipment is generally from the annual reports of the Idaho Inspector of Mines (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 mostly 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. Reports of recent developments are taken from the Idaho Geological Survey's (IGS) annual reports on mining and minerals in Idaho (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. Other published sources are referenced in the text. A complete bibliography is included at the end of the report. Where direct quotations are taken from source materials, the original spelling and grammar are preserved.

History of the Ima Mine, Lemhi County, Idaho

Victoria E. Mitchell[1]

The Ima Mine is in the Blue Wing mining district on the west side of the Lemhi Range near the town of Patterson (Figure 1). The mine is about a mile north of Patterson at the mouth of the canyon of Patterson Creek (Figure 2). The mine workings cover a 2-square-mile area on the north side of the creek.

The Ima is a porphyry-type lead-copper-silver, tungsten, and molybdenum deposit associated with a granitic stock that was discovered in the lower level of the mine. The deposit is zoned, with an outer zone hosted by quartzites of the Gunsight and Apple Creek Formations and an inner zone associated with the granite (Figure 3). The minerals in the outer zone include pyrite, huebnerite, scheelite, tetrahedrite, galena, sphalerite, and chalcopyrite in veins of quartz, fluorite, calcite, orthoclase, and rhodochrosite (Figure 4). This zone is up to 900 feet wide, 2,000 feet long, and 700 feet deep. The inner zone is below the mine workings and has been explored mainly by drilling. Ore minerals include molybdenite, huebnerite, chalcopyrite, and pyrite disseminated in sericitized and silicified granitic rock and in quartz-calcite veins. This zone is up to 800 feet wide and 2,300 feet long. Both zones trend to the northwest. All the ore produced to date has come from the outer zone (McHugh and others, 1991).

Claims were located in Patterson Canyon as early as 1881, but little development took place until 1900. In that year, Ima Consolidated Mining & Milling Co. started exploratory work at the mine (Umpleby, 1913). (See Table 1 for

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

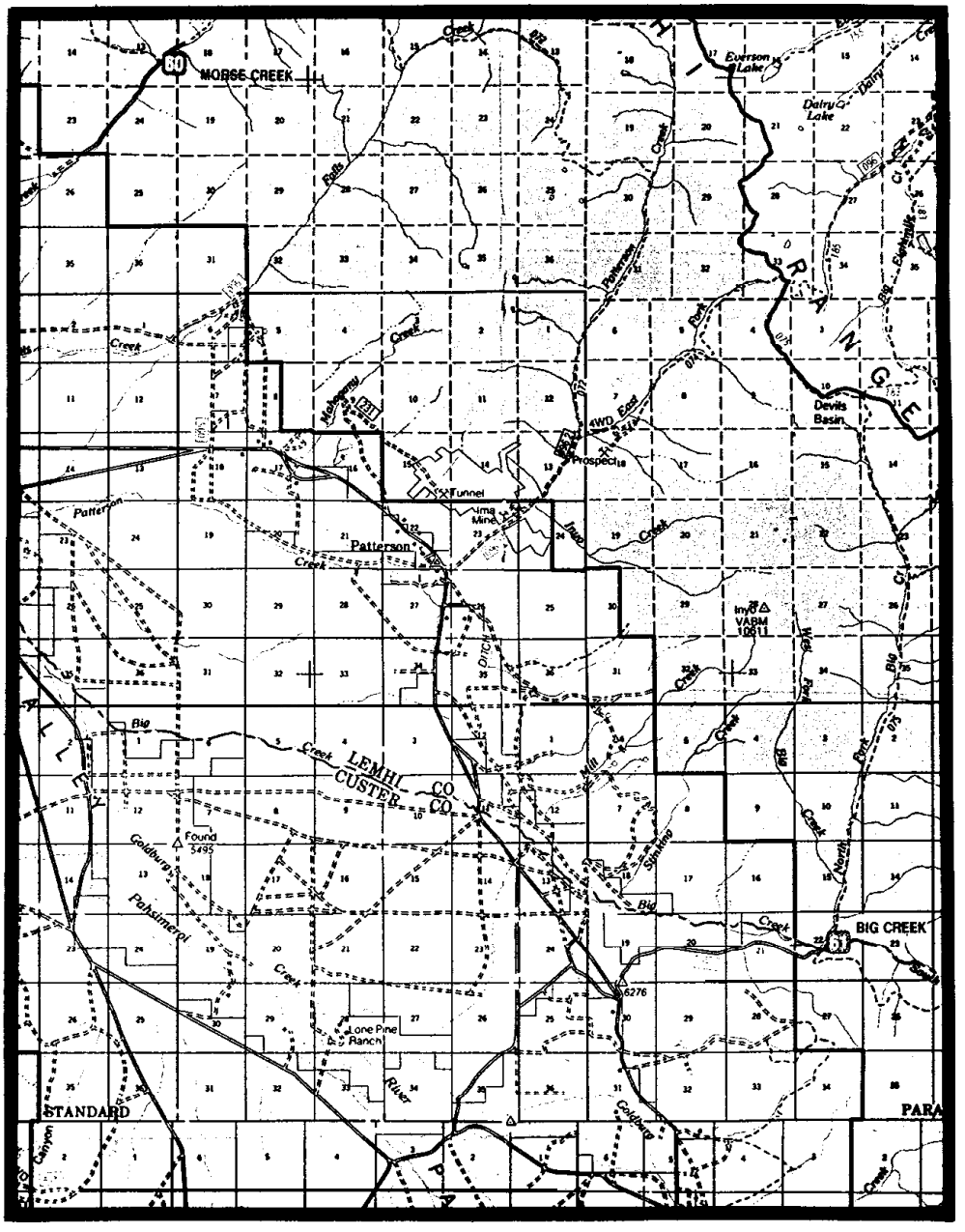

Figure 1. Location of the Ima Mine and vicinity, Lemhi County, Idaho (U.S. Forest Service Challis National Forest map, scale ⅜ inch = 1 mile).

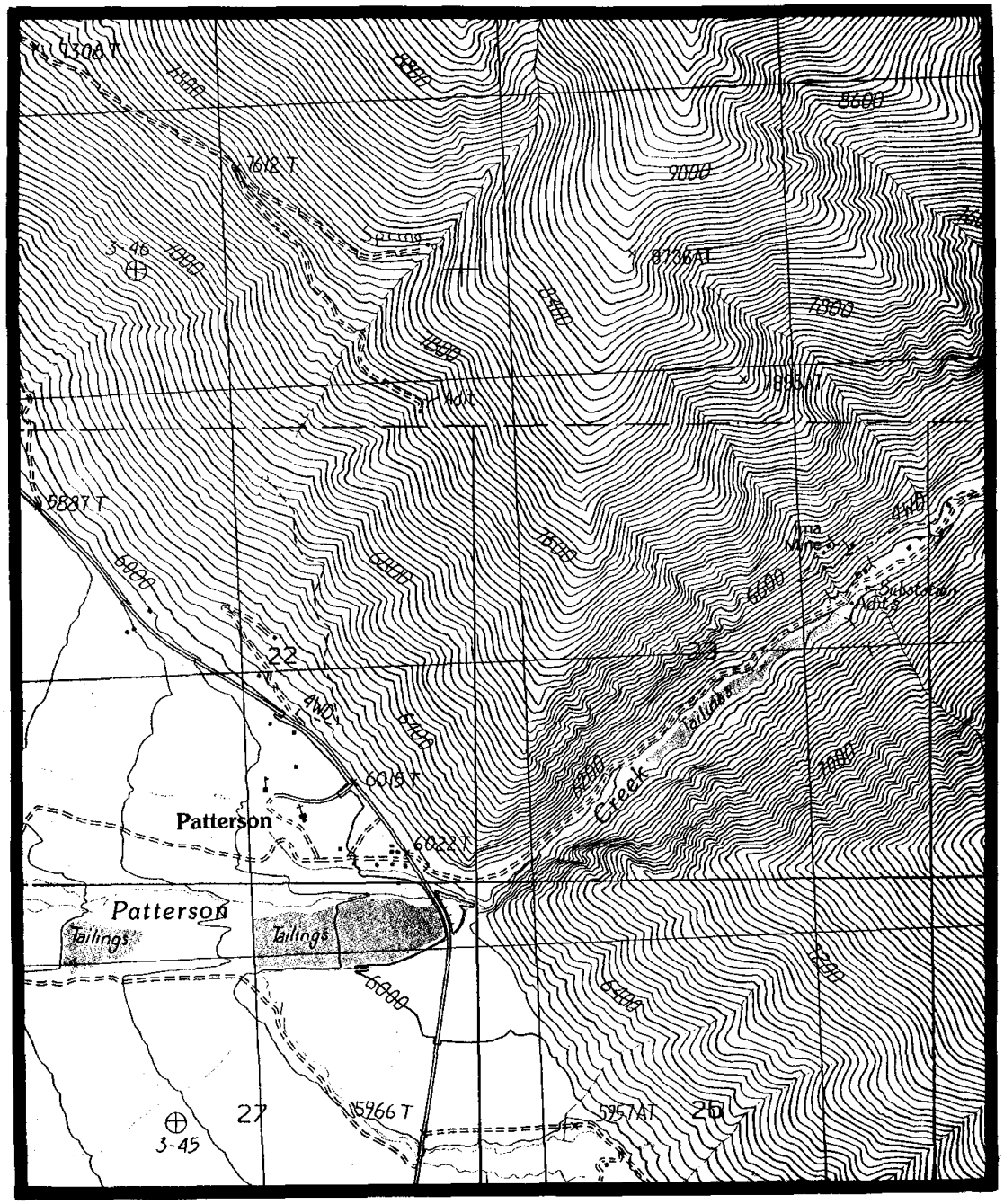

Figure 2. Topographic map of the Ima Mine and vicinity (U.S. Geological Survey Patterson 7.5-minute topographic map).

Figure 3. Geologic map of the Blue Wing district, showing claims (Callaghan and Lemmon, 1941, Plate 1).

Figure 4. Tungsten ore from the creek level tunnel at the Ima Mine (natural size). *q* = quartz; *hu* = huebnerite; *sp* = sphalerite (resembles huebnerite but gives a white streak instead of a brown streak; *py* = pyrite; *te* = tetrahedrite; *mo* = molybdenite (Umpleby, 1913, Plate XIII-C).

Table 1. Companies and individuals operating at the Ima Mine.

Company Name	Officer	Date Incorporated	Charter Forfeited	Year(s) at Mine
Ima Mining Company	[1]	[1]	[1]	[1]
Ima Consolidated Mining & Milling Co.	Oscar W. Moyle, President	Dec. 16, 1902	1935	1902-1934
J. Nolan (lessee)	---	---	---	1914?
Callahan & Duffield (lessees)	---	---	---	1915?
Jeffs and Johnson Leasing Co.	E.W. Johnson	May 19, 1916	1917	1916-1917
J. Nolan and D.R. Wheelwright (lessee)	---	---	---	1917-1918
Blue Wing Tungsten Mining & Milling Co. (lessee)	Mark T. Lyon, President; W.P. Barton, Secretary	March 23, 1921	Nov. 30, 1923; taken over by Republic	1921-1922
Republic Consolidated Mining & Refining Co.	W.P. Barton, President-Manager	August 9, 1922	December 1, 1924	1922-1924
W.P. Barton (lessee)	---	---	---	1924-1927
Patterson Mines Corporation (lessee)	Finis Bentley, President; W.P. Barton, Manager	April 3, 1927	1931	1927-1929
W.P. Barton (lessee)	---	---	---	1929
Ima Mines Corporation	E.R. Miller, President; W.P. Barton, Manager	March 12, 1930	corp. dissolved: August 1, 1961	1930-1955
Lemhi Metals Company (owner)	[1]	[1]	[1]	1938-1941
Bradley Mining Co.	Worthen Bradley, President	filed in Idaho: July 28, 1938	[2]	1945-[3]
American Metal Climax, Inc. (lessee)	Erwin A. Weil, Secretary	Dec. 12, 1960	certificate of withdrawal: August 12, 1974	1961-1962
Midwest Oil Co. (lessee)	G.G. Snow, Manager	October 8, 1951	inactive	1970-1972
Inspiration Development Co. (lessee)	John B. Howkins, President	Oct. 18, 1973	inactive	1979-1982

[1]Information not available in IGS's files.
[2]Corporation still in existence for last date information is available in IGS's files (1991).
[3]Owner of record for the last date information is available in IGS's files (1991).

companies and individuals working at the mine.) The company was apparently working the mine for silver, which is contained in tetrahedrite. Operations ceased in 1902, and the property was turned over to lessees (Livingston, 1919). Tungsten was first recognized at the mine in 1903, but serious operations did not begin until 1911, when the Idaho Tungsten Company secured a 7-year lease and let two or three subleases on parts of the mine.

A 50 ton-per-day (tpd) mill was installed around 1911 (Umpleby, 1913). Equipment included a crusher, rolls, jigs, and five Wilfley tables. The mill was powered using water from Patterson Creek. Ore was carried from the upper tunnel by a gravity incline tram. Livingston (1919) speculated that the recovery rate from this mill was low. Tungsten ore from the mine was concentrated in the mill in 1911. The 1911 IMIR contained the following description of the property (p. 87-89):

> [A] proposition is on foot to connect this camp with Leadore by a wagon road for a railway shipping point. These tungsten deposits are owned by the Ima Mining Company and are of considerable magnitude for this class of ore. They occur in a rather lensy but very persistent link fissure and carry considerable development. They are being operated under a long lease by some Utah mining men, who have incorporated their company under the name of the Idaho Tungsten Company, with head office in the Continental Building, Salt Lake City, Utah. These tungsten bearing fissures strike into the steep canyon slope of Patterson Creek and are developed by adit tunnels and numerous open cuts, with which the ore courses are traced out for several thousand feet up the canyon slope. The two principal tunnels are 700 and 900 feet long, respectively, and each shows swells of ore ranging up to ten feet in thickness. The ore is hard white quartz, quite well sprinkled with sulphide of lead, zinc, copper and iron containing low gold and silver values, together with coarse splashes of bright black tungstate of iron, wolframite, and coarse, oblong crystals of hubnerite, tungstate of manganese. These tungsten minerals have a very high specific gravity and appear to separate quite readily by ordinary concentration methods.
>
> A very strong demand has been created in recent years for this rare mineral for use in toughening steel, in which connection there is a great demand both in this country and Europe, and this class of ore is now being insistently sought after by the big steel manufacturers of the world. The clean mineral brings high prices, about $6.50 per unit of tungstic acid contents, which means that 60 per cent concentrates free from other objectionable minerals would be worth $390 per ton. The ore of this deposit is said to average 4 per cent tungsten and the concentration tests of this ore sent to Denver indicates that a saving of 87 1-2 per cent of tungsten concentrates may be made with proper equipment.
>
> Credit for the discovery and classification of this mineral at this point is due to Professor James E. Talmidge of Salt Lake City, who examined and reported on it over ten years ago, at which time, however, the market for this class of mineral was not very well developed.
>
> This deposit occurs in a schist formation and it seems rather unlikely that it should be alone in this district, which is a promising field for further prospecting for this class of ore, as it is in big demand and finds a ready market, and with the construction of the new road proposed from this property to Leadore, an added resource of shipping mineral can be figured on from this point.

In 1910 or 1911, the mine had about 2,000 feet of workings, including four or five tunnels and an inclined shaft 75 feet deep. The lowest tunnel entered the west wall of the canyon near the level of the creek, and the other tunnels were spaced at irregular intervals farther up the hill. The second tunnel above the creek level, known as the No. 4, was 900 feet long (Umpleby, 1913). Umpleby's report contains a detailed list of the minerals found in the mine.

In 1912, the company was rumored to be enlarging the mill to 100 tpd, but apparently did not. Two shipments of concentrates were made in 1913 (Callaghan and Lemmon, 1941). In 1913 or 1914, the mine was leased to J. Nolan of Salt Lake City. Nolan sold his interest to Callahan and Duffield, who worked the surface and the creek level tunnel for tungsten. When they had little success, Callahan and Duffield sold out to Jeffs and Johnson, also of Salt Lake City (Livingston, 1919).

The 1915 IMIR carried the following information about the property (p. 120-121):

> The largest operation in Idaho worked exclusively for tungsten was at the Ima Mines, operated by the Idaho Tungsten Company, and situated on Patterson Creek, in Lemhi County. At this point the tungsten deposits occur in pronounced white quartz fissure veins in a formation of precambrian sediments resembling siliceous schist. The veins are from a foot to ten feet thick and outcrop plainly up a very steep canyon slope for hundreds of feet. The tungsten ore in this instance embraces both wolframite and hubnerite, the latter mineral predominating. The quartz gangue also carries sulphide of zinc, lead and iron. The average tungsten contents of the veins have been estimated at two per cent, but this is probably too liberal an estimate; however, no systematic sampling has been done.
>
> The property is equipped with a concentrating mill of fifty tons daily capacity, which, however, was very poorly designed but has lately gotten into the hands of more intelligent operators who have added flotation cells and are making an intertesting [sic] production of high grade tungsten concentrates and shipped about 12 tons during the closing months of the year of an average value of 60 per cent tungstic acid.
>
> The development of these veins by short adit tunnels is very limited, but they present a very attractive prospect for a considerable tonnage resource of profitable tungsten ore, especially under present exaggerated prices for the mineral.

Table 2 contains selected production data for the Ima Mine.

According to the 1916 IMIR (p. 40-41):

> At Patterson Creek, a tributary of Pahsimaroi River, the Ima Consolidated Company's property, operated by the Jeffs & Johnson Leasing Company of Salt Lake City, produced and marketed thirty tons of high grade hubnerite concentrates, containing an average value of 60 per cent tungstic oxide (WO_3) during 1916. This mineral was shipped in small lots as produced and totaled a small car load. It brought an average price of $1,525 per ton and represented what is probably the highest value per ton for mineral produced that has been shipped from Idaho since the bonanza days of Silver City and DeLamar.

Table 2. Production data for tungsten and sulfide concentrates from the Ima mine, for selected years.

Year	Tungsten Produced (Standard Units WO_3)	Huebnerite Concentrate (tons)	Scheelite Concentrates (tons)	Percent WO_3 in Concentrates	Sulfide Concentrate (tons)	Ore (tons)
1915	---	12[7]	---	60[7]	---	---
1916[1]	---	30[7]	---	60[7]	---	---
1934[1]	---	1.15[1]	---	56[1]	---	---
1936[1]	unknown	8[1]	---	---	---	800[1]
1937[1]	5,768[3]	79.4[1]	---	---	667.4[1]	---
1938[1]	9,210[3]	138.5[1]	---	66.54[1]	1,356.0[1]	26,823[6]
1939[1,2]	13,161[3]	199.41[1]	---	66.19[1]	1,431.0[1]	38,778[6]
1940[1]	15,580[3]	180.09[4]	---	67.00[1]	1,215.0[1]	41,946[6]
1941	11,520[3]	---	---	---	---	29,000[6]
1942	7,345[3]	113[6]	---	---	640[6]	25,340[6]
1943	9,124[3]	---	---	---	946[6]	27,857[6]
1944	12,439[3]	---	---	---	1,046[6]	29,587[6]
1945	11,673[5]	---	---	---	1,083[6]	32,000[6]
1946	10,126[5]	168[6]	---	---	923[6]	30,605[6]
1947	8,905[5]	147[6]	---	---	692[6]	20,195[6]
1949	12,314[5]	225[6]	---	---	1,066[6]	32,243[6]
1950	8,213[5]	160[6]	---	---	701[6]	21,914[6]
1951	16,342[5]	---	---	---	---	41,132[6]
1952	---	275[6]	9[6]	---	1,605[6]	46,443[6]
1953	---	335[6]	16[6]	72[6]	1,691[6]	53,792[6]
1954	[8]	[8]	---	---	1,832[5]	57,981[5]
1955	31,610[6]	---	---	---	2,210[6]	63,400[6]
1956	---	476[6]	29[6]	71[6]	2,420[6]	71,742[6]
1957	15,000+[6]	---	---	---	1,191[6]	30,824[6]
Total	198,333	2,547.55	54	---	22,715.4	722,402

(Footnotes for Table 2.)
[1]Callaghan and Lemmon, 1941.
[2]Company reports state production for the year was 184 tons of concentrates averaging 66% WO_3.
[3]Hobbs, 1945.
[4]USBM production records report 311,598 pounds of WO_3 for 1940.
[5]Data from USBM production records.
[6]Data from USBM Yearbook chapters.
[7]Data from Idaho Mine Inspector's reports.
[8]Information was not reported.

> The high grade of these tungsten shipments is gratifying from the fact that it is separated from a complex ore carrying a variety of base sulphide minerals. The deposit from which it was derived is a strong quartz fissure vein rather lensy in its nature but varying from a foot up to as much as twenty feet wide and persistent for over 2,000 feet up this steep canyon slope of Patterson Creek in a formation of silicious schist and slate of pre-cambrian age. The property was equipped several years ago with a concentrating mill of fifty tons daily capacity, which, however, was very poorly designed, but under the present management, the machinery available has been handled to the best advantage with several additions, including flotation cells, and considering the mixed character of the ore available the high grade tungsten mineral shipped is a commendable result.
>
> The principal gangue of the vein is quartz and the tungsten mineral in the mixture of other minerals, which are mostly sulphides, will average low grade, under 2 per cent, but the size and persistency of the veins under the present careful handling of the deposit promises continued profitable results and the probable permanent establishment of a source of tungsten ore from this county, as the tungsten minerals are primary oxides and should go deep.

In 1916, Jeffs and Johnson sank a 70-foot incline near the entrance of the lower shaft. From this incline, they recovered 8 tons of tungsten concentrates in one month (Callaghan and Lemmon, 1941). The mine produced a small amount of concentrates during 1917. In May 1917, J. Nolan, in partnership with D.R. Wheelwright of Ogden, Utah, took over the lease. Nolan and Wheelwright operated the mine until January 1918. See Figure 4 for the workings in 1918.

Barton and Arentz (1939) described the mill operations during World War I. The ore was sent through a Blake crusher to Wall corrugated rolls and then to a hydraulic classifier. The over-size material from the classifier was sent to smooth rolls and then back to the classifier; the fines from the classifier went to the jigs and then to the Wilfley tables. The recovery rate was approximately 26 percent, and the concentrate was 45 to 50 percent WO_3. Barton and Arentz examined the tailings from this operation and noted that about 30 percent of the huebnerite was not separated from the gangue because of the coarseness of the material produced by the roll crushers (much of it plus 12 mesh).

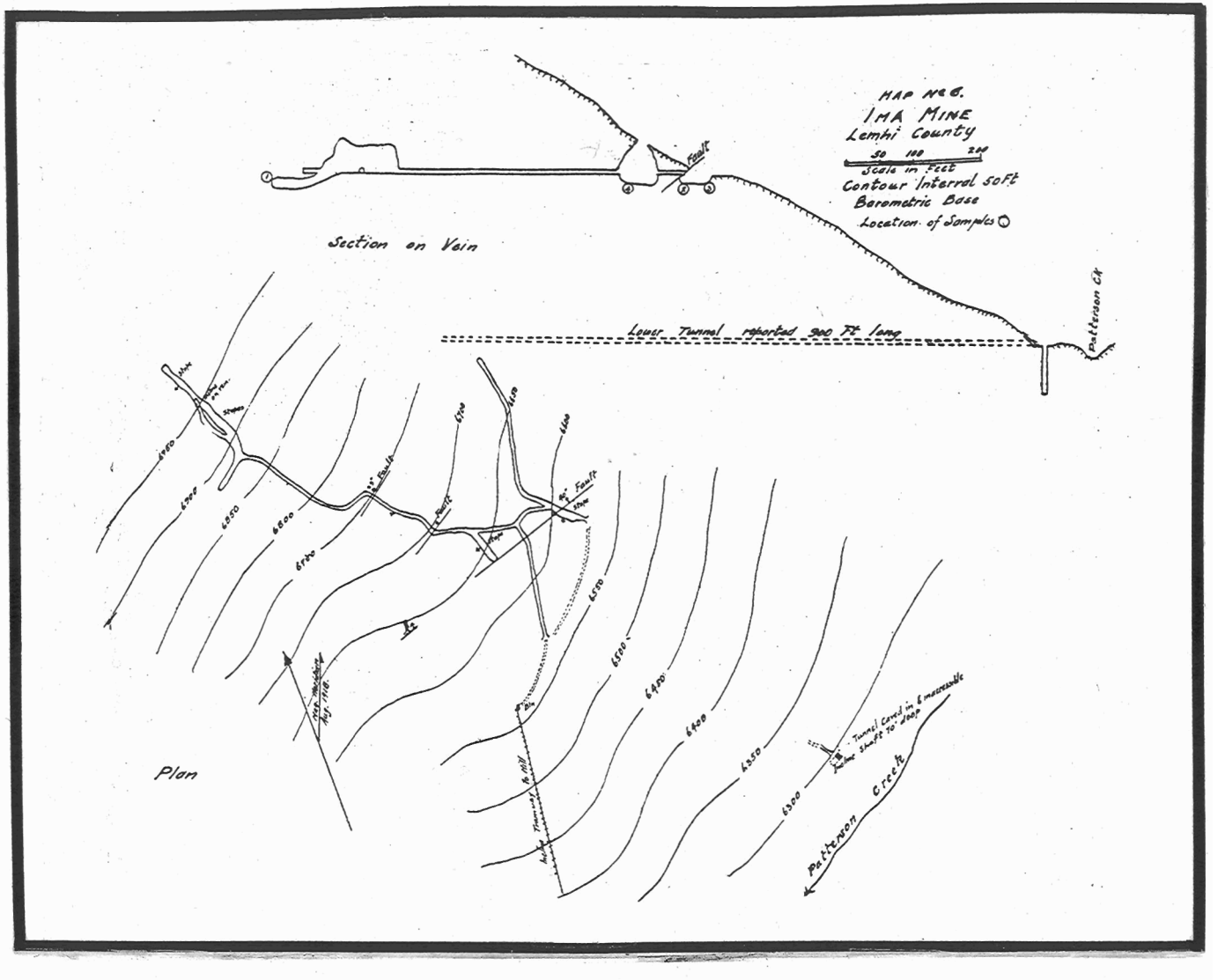

Figure 5. Map and cross-section of the Ima Mine (1918; Livingston and Thomson, 1919, Map No. 6).

Blue Wing Tungsten Mining & Milling Co. took over the property under lease and bond for $75,000 in 1921. During the year, the mine was repaired, and the concentrator and power plant were rehabilitated and enlarged. The mine had about 3,000 feet of tunnels. Blue Wing did 50 feet of drifting during 1922. (See Table 3 for development work at the mine.) The company was working only two tunnels at the mine. The No. 1 tunnel was 560 feet long and the No. 2 tunnel was 820 feet long. Equipment in the mill was listed as five tables, a small ball mill, and three flotation cells. The company made a short mill run on material from the tailings dump.

In 1922, Republic Consolidated Mining & Refining Co. took over Blue Wing. The new company announced plans for erecting a large milling plant at the Ima. Republic apparently worked the mine for most of 1924, but the IMIR noted that the company had not filed any reports on its activities. Republic forfeited its charter on December 1, 1924, but the mine remained under lease to W.P. Barton (Republic's president and manager) for the next three years.

Patterson Mines Corporation (W.P. Barton, manager) acquired a lease on the property in 1927. The new company repaired the mill and power plant and started development work in December. The company continued to rehabilitate the mine during 1928. Additions included air drilling equipment for the mine, flotation cells and auxiliary equipment for the mill, and new buckets for the water wheel in the power plant. The mine had a Platt 2-cylinder air hoist and a Platt 12x12[2] belt-driven compressor that was powered by the water wheel. Mill capacity was given as 125 tpd, and equipment at the mill included a Blake crusher, a Marcy ball mill, a Dorr classifier, eight Fagergren flotation cells, and Wilfley tables. The company did 1,000 feet of tunnel work during the year.

Patterson Mines' lease was canceled in January 1929, and W.P. Barton leased the property in his own name. In 1930, Barton organized the Ima Mines Corporation, which took out a lease and option on the mine. This was the fourth company organized by Barton to operate the Ima mine. In correspondence from Barton to the Idaho Mine Inspector, Barton vehemently denied the implication that he was profiting from the frequent turnover of the operating companies. Ima Mines did a little development work in 1931, but for the most part, the mine and mill were closed until 1934 due to the low price of metals. Development in 1931 totaled about 7,000 feet, including 200 feet of shafts, 400 feet of raises, and 6,200 feet of tunnels, crosscuts, and drifts. The mine had six tunnels, two shafts, one raise, and ten crosscuts. The No. 1 tunnel was 1,200 feet long, the No. 2 was 1,400 feet long, and the No. 3 was 1,000 feet long. A 400-foot tram ran from the ore bins to the mill. Power for the mill and most of the equipment on the property was generated by a 6-foot Pelton water wheel. A separate water wheel generated power for the electric lights.

---

[2]The diameter and stroke, in inches, of the piston in the compressor's cylinder.

Table 3. Development work, men employed, and operating companies at the Ima Mine, by year.

Year	No. of Men Employed	Tunnels (feet)	Sinking (feet)	Cross-cutting (feet)	Drifting (feet)	Raising (feet)	Operator
1922	[1]	---	---	---	50	---	Blue Wing Tungsten Mining & Milling Co.
1928	15	500	70	---	---	---	Patterson Mines Corp.
1931	12	200	---	---	---	---	Ima Mines Corp
1936	16	800	---	---	---	---	Ima Mines Corporation
1937	10	500	---	---	---	---	Ima Mines Corporation
1938	30	1,000	---	---	---	---	Ima Mines Corporation
1939[2]	35	2,000	---	1,000	1,000	1,000	Ima Mines Corporation
1940[2]	35	3,000	---	1,000	1,000	1,000	Ima Mines Corporation
1941[2]	30	---	100	500	500	1,900	Ima Mines Corporation
1942	30	400	---	200	---	200	Ima Mines Corporation
1943	25	1,300	---	---	---	250	Ima Mines Corporation
1944	25	500	---	---	---	500	Ima Mines Corporation
1945[3]	40	---	---	---	2,400	---	Bradley Mining Co.
1946	80	---	---	---	3,599	---	Bradley Mining Co.
1947[4]	80	---	---	---	1,845	---	Bradley Mining Co.
1949[5]	80	---	---	150	1,143	895	Bradley Mining Co.
1950[6]	80	---	---	202	1,189	202	Bradley Mining Co.
1951[7]	80	---	---	117	2,045	646.5	Bradley Mining Co.
1951[8]	[9]	---	---	---	947	---	DMEA
1952	[9]	---	---	---	4,000	---	DMEA[10]
1953[11]	[9]	2,000	---	---	1,000[12]	---	DMEA[10,13]
1974[14]	[1]	---	---	---	870[12]	---	Midwest Oil Co.

[1]Number of men employed was not reported.
[2]Development work for the year also included 2,270 feet of diamond drilling.
[3]Development work for the year also included 3,000 feet of diamond drilling.
[4]Development work for the year also included 7,300 feet of diamond drilling.
[5]Development work for the year also included 349 feet of diamond drilling.
[6]Development work for the year also included 423 feet of diamond drilling.
[7]Development work for the year also included 2,350 feet of diamond drilling.

(Footnotes for Table 3, continued.)
[8]Development work for the year also included 1,358 feet of diamond drilling.
[9]Number of men working on DMEA projects was not reported.
[10]Exploration work conducted during the year by Bradley Co. was not reported.
[11]Exploration work for the project also included 2,000 feet of diamond drilling.
[12]Number reported is combined figure for drifting and crosscutting.
[13]Work reported for this project may have extended for more than one year.
[14]Development work during the year included 2,055 feet of diamond drilling and 250 feet of percussion drilling.

In 1934, the Ima produced silver-copper-tungsten ore which was treated in the company's 100-ton flotation plant. Tungsten concentrate in the form of huebnerite was separated from silver-copper concentrate, which was shipped to Utah for smelting. According to Callaghan and Lemmon (1941), this production amounted to 2,300 pounds of concentrate which averaged 56 percent WO_3. The company claimed the mine was idle all year except for retimbering the tunnels. Presumably the ore shipped was either stockpiled material or ore used for mill tests.

Development work continued through 1935, and the mill began operation in July. The entire output of the Blue Wing district in both 1935 and 1936 was tungsten-silver-copper ore from the Ima. The company mined and milled 800 tons of ore late in 1936 (Callaghan and Lemmon, 1941). Also during the year, the company installed an additional 42-inch Pelton water wheel. Additions to the mill included six Diester slime tables (all individually motor driven) and a 12-inch, 4-pole Rounds-Weatherall high intensity magnetic separator to improve the tungsten recovery. According to the company, the mill was operating with satisfactory results.

There was a large increase in production from the mine in 1937. The tungsten concentrate was shipped to eastern markets, and the copper-lead-silver concentrate was shipped to the smelter at Midvale, Utah. The Ima produced 1,000 pounds of tungsten concentrate per day during at least part of the year. The company made extensive additions to the mine and mill equipment. It installed a Platt Iron Works $6x10^{3}$ hoist and replaced the compressor with a Gardner-Denver diesel unit. A Mancha storage battery trammer was installed in the mine, replacing the horses previously used for haulage. Fourteen cars were added to system, bringing the total up to twenty-five. New rails and pipeline were installed throughout the mine. A diesel power unit was added to the mill, and additional equipment was purchased. This included Denver Sub-A flotation cells, a Denver mineral jig, a Dorr classifier, and six motor-driven Platt-O tables. The mill had "all the necessary auxiliary equipment" and a well-equipped laboratory.

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*The diameter and stroke, in inches, of the piston supplying power for the hoist.

The Ima was the second largest tungsten producer in the United States in 1938 (the largest was in Nevada). During the year, the mill treated 26,823 tons of ore by flotation and magnetic separation. A second Gardner-Denver diesel compressor was installed at the mine, an extra storage battery was purchased for the trammer, and additional cars were added to the haulage system. The capacity of the mill was increased to 150 tpd with the addition of a Dings magnetic separator, a 4-foot 2D Oliver filter, and a rotary oil blast furnace drier built to the company's specifications. Total development in the mine was about 10,000 feet of workings. The mine had two tunnels, four shafts, four raises, six crosscuts, and six drifts. The No. 1 tunnel was 1,700 feet long and the No. 2 tunnel was 2,700 feet long. The principal inclined shaft was 100 feet long and gained a vertical depth of 40 feet.

Barton and Arentz (1939) described operations at the Ima during 1938 or 1939. The original workings consisted of about 2,000 feet of drifts and crosscuts driven from an outcrop 220 feet above the bottom of the canyon. Later, a tunnel was driven from just above creek level along the same vein, and crosscuts and raises were driven along the vein and along parallel veins. A raise connected the two tunnels, and an intermediate level about halfway between the two levels was driven in both directions along the vein. Several stopes were worked between the lower and intermediate levels, but about half the ore came from work done on the two levels. There were approximately 3,500 feet of drifts and crosscuts on the lower level and nearly 1,000 feet of drifts on the intermediate level.

Milling required several steps (Figure 6). After crushing, the ore was sent to a flotation cell to remove the coarse sulfides, which were sent to the thickener, the filter, and then to market. The bulk of the ore was sent to the mineral jigs. The sulfide-rich products were again sent through the flotation circuit while the tungsten-rich splits were sent to the roaster. After cooling, the roasted ore was passed through a low-intensity magnetic separator to remove the roasted pyrite and bits of iron from the ball mills, and then through a high-intensity magnetic separator remove the huebnerite from the gangue. This process produced tungsten concentrate with 66 to 70 percent WO_3. The recovery rate was about 85 percent (Barton and Arentz, 1939).

In 1939, the Ima was the only producer in the Blue Wing district. The company treated 38,778 tons of tungsten ore by flotation and magnetic separation. Several hundred tons of silver-lead-copper concentrate was shipped to the Midvale smelter, and the tungsten concentrate was shipped to eastern markets. The 1939 IMIR contained the following report on the Ima (p. 230):

> Ima Mines Corporation, B. R. Tillery of Twin Falls, president, has completed its 700 ft. haulage tunnel[4] which is now being put into operation. All haulage tracks are

[4]The K. C. Li tunnel, which started near the mill and connected with the lower level of the mine. The location of this tunnel is shown on Figure 7. This tunnel was on the "main" level, which was also referred to as the 360 level of the mine when it was operated by Bradley Mining Company.

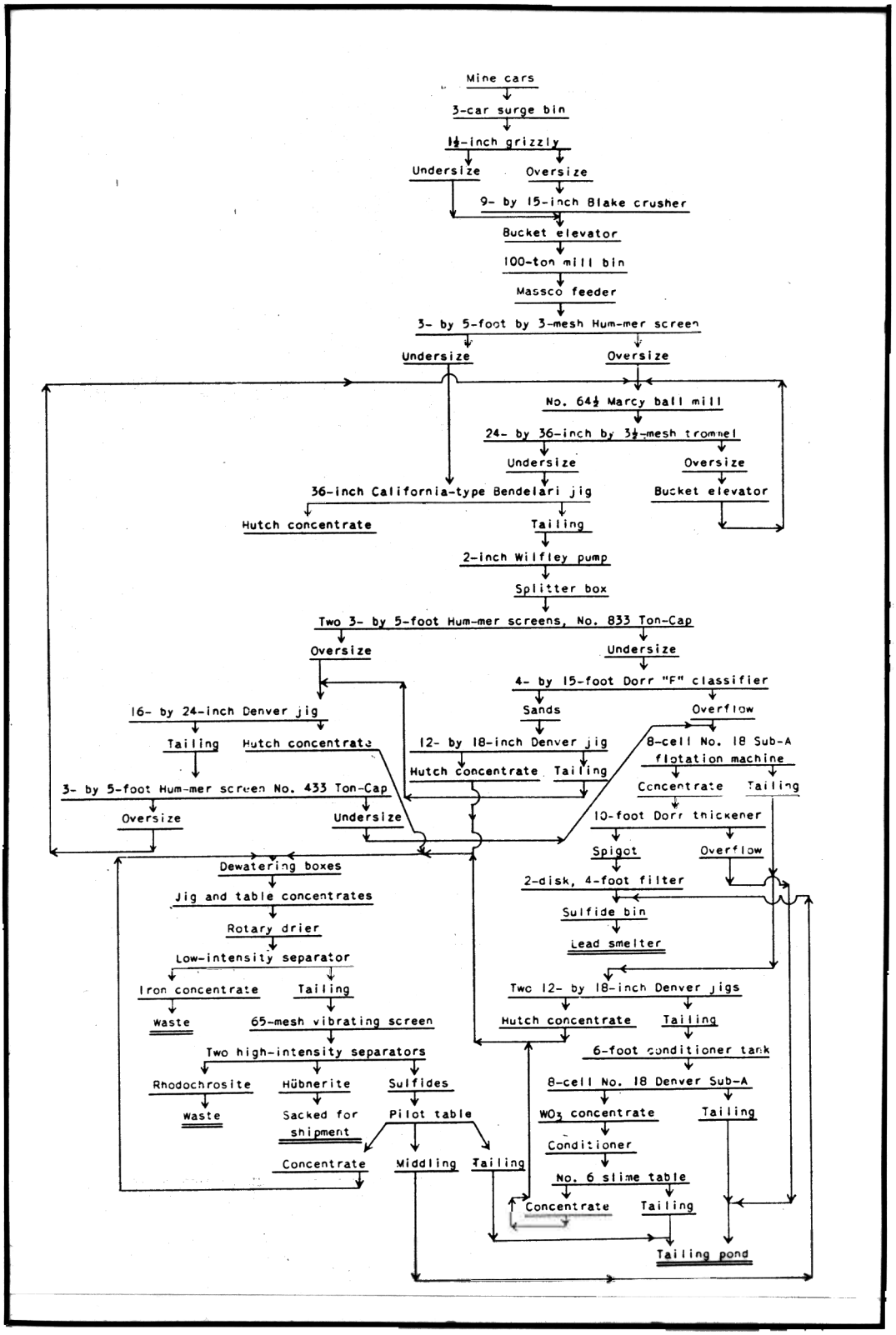

Figure 6. Flow sheet for the Ima mill (Dice, 1943, Figure 1).

> being equipped with 30-pound rails and electric haulage. Mine development work is being carried forward continuously and the company states that sufficient ore is now developed for 10 years at the present operating rate. About 120 tons of tungsten, silver, copper, and lead ore are produced and milled daily. The plant is a 150-ton flotation and gravity concentration mill. An additional Diesel engine and compressor will be installed in the near future. Plans also call for the complete change to screen classification; larger crushing capacity; 10 additional flotation cells; one additional Rowland Weatheril magnetic separator, equipped with a 24-inch belt and magnets of a 150,000 ampere rating; conditioners, reagent feeders; and other equipment necessary to bring the mill capacity to 250 tons of ore daily. All equipment has been ordered. W. P. Barton of May is general manager. Others on the operating staff at May include: Owen Hickey, general superintendent; C. Fullmer, assistant mine superintendent; Afton Crofts, mill superintendent; C. M. Dice, chief mine engineer and metallurgist; and Floyd Harper, chief clerk. An average crew of 50 men was employed in the early part of the year. The crew has since been increased to 72 men. 5,270 ft. of development work was completed during the year.

Mine equipment included two Gardner-Denver high-speed compressors (330 and 440 cubic feet, respectively), one Mancha trammer with batteries and rack, twenty-two 16-cubic-foot cars, two horses, five self-rotating stoping drills, three drifting drills, one mucking machine, and a Caterpillar D-13000 diesel motor driving a 25 KVA direct current generator. The company noted that it did not do any hoisting in the shafts, but that it had two tugger air hoists and a bigger air hoist that it used in the raises. Additions made to the mill included two Denver mineral jigs and a dust collector. The company report stated that the mine development had substantially increased the ore reserves and that the mine had sufficient ore to justify the proposed increase in mill capacity.

The Ima operated continuously in 1940. The mill treated 41,946 tons of ore containing huebnerite, galena, tetrahedrite, pyrite, and molybdenite. Additions made to the mine and mill during the year included a second Caterpillar D-13000 diesel motor, ten Denver flotation machines, one Bendalari jig, one Denver conditioner and reagent feeder, and four Hummer screens and auxiliaries. Callaghan and Lemmon (1941) visited the mine late in 1940 (Figures 2, 7, and 8). At time of their visits, most of the work in the mine was being done upward from the lower level. All the ore shoots pinched and swelled, with the wider parts of the veins containing the richer ore. The maximum length of a stope without a pinch was 250 feet. In late 1940, the mine contained 50,000 tons of blocked-out ore, and 40,000 tons of probable ore lay below the lower level of the mine (Callaghan and Lemmon, 1941). A fire during the year destroyed the compressor room, blacksmith shop, and dry room.

In 1941, the Ima produced about 29,000 tons of ore containing "galena, pyrite, and certain strategic minerals" (USBM, p. 351). Iron concentrate containing gold, silver, copper, and lead was shipped to a smelter in Utah. The company bought the mine during the year; the price was $75,000. New construction included replacing the buildings which had burned down the previous year. The mine had nine tunnels, one

Figure 7. Composite level map of the Ima Mine (Callaghan and Lemmon, 1941, Plate 4).

LEVEL MAPS AND SECTIONS OF THE IMA MINE, SHOWING GEOLOGY

100 0 100 300 Feet

Figure 8. Level maps of the Ima Mine, showing geology (Callaghan and Lemmon, 1941, Plate 2).

shaft, fifteen raises, ten crosscuts, and five drifts, totaling about 19,000 feet of workings. The No. 1 tunnel was 2,500 feet long and the No. 2 tunnel was 3,500 feet long. The principal vertical shaft was 100 feet deep. There was a strike at the mine during August, September, and October.

The Ima operated continuously in 1942. The 150-tpd mill treated 25,340 tons of ore containing 45,612 ounces of silver, 75,000 pounds of copper, 126,000 pounds of lead, 506,000 pounds of iron, and 253,000 pounds of tungsten. Iron concentrate, totaling 640 tons and containing silver, copper, and lead, was shipped to a Utah smelter, and 113 tons of tungsten concentrate was shipped east. Equipment added to the mine during the year included a third D-13000 Caterpillar diesel motor, a 100-kilowatt alternating current generator, a 2□-inch D.E. Worthington pump, and a 40-horsepower Vulcan hoist.

In 1943, the mine ran all year, producing 27,857 tons of ore. This material contained 52,000 ounces of silver, 100,000 pounds of copper, 139,000 pounds of lead, 557,000 pounds of iron, and some tungsten. The lead-copper-silver concentrate, which totaled 946 tons, was shipped to Utah, and the tungsten concentrate was again sent east. The mine was operated all of 1944, and the mill treated 29,587 tons of ore, producing tungsten concentrate and 1,046 tons of lead-copper-silver concentrate.

From June 1941 to February 1943, the USBM did diamond drilling and tunnel work to locate extensions of the Ima veins beneath Patterson Creek and across the creek on the south side of the canyon (Figure 9). Three holes were also drilled upward from the upper mine workings to test the extent of the veins above the mined-out areas (Hobbs, 1945). Most of the work done at the mine during 1943 and 1944 was done on three levels opened above the upper parts of the old workings (the 0 level, the 100 level, and the 150 level. The 150 level was slightly lower and to the northwest of the original upper level.) Some of the work was also done on a level (the "shaft level") 100 feet below the old lower level. The old workings were largely abandoned, with the exception of those sections that were used to haul ore from the new workings (Hobbs, 1945). Total development at the mine was about 15,500 feet. As of September 1944, Hobbs estimated that the Ima had 23,600 tons of measured reserves, 122,200 tons of indicated reserves, and 109,000 tons of inferred reserves. Tungsten content of this ore was 16,560 units[5] in the measured reserves, 85,550 units in the indicated reserves, and 40,000 units in the inferred reserves.

Bradley Mining Co. leased the mine with an option to purchase on January 5, 1945 (Figure 10). Bradley worked the mine and 150-ton concentration plant continuously throughout the year. The company treated about 32,000 tons of ore containing huebnerite, galena, tetrahedrite, and pyrite in the mill. The tungsten

[5]A short ton unit of WO_3 is equivalent to 1 percent of a short ton, or 20 pounds, of WO_3 and contains 15.862 pounds of tungsten metal (W). A short ton of concentrate with 60 percent WO_3 contains 60 short ton units, equivalent to 1,200 pounds of WO_3, which equals 951.72 pounds of tungsten metal.

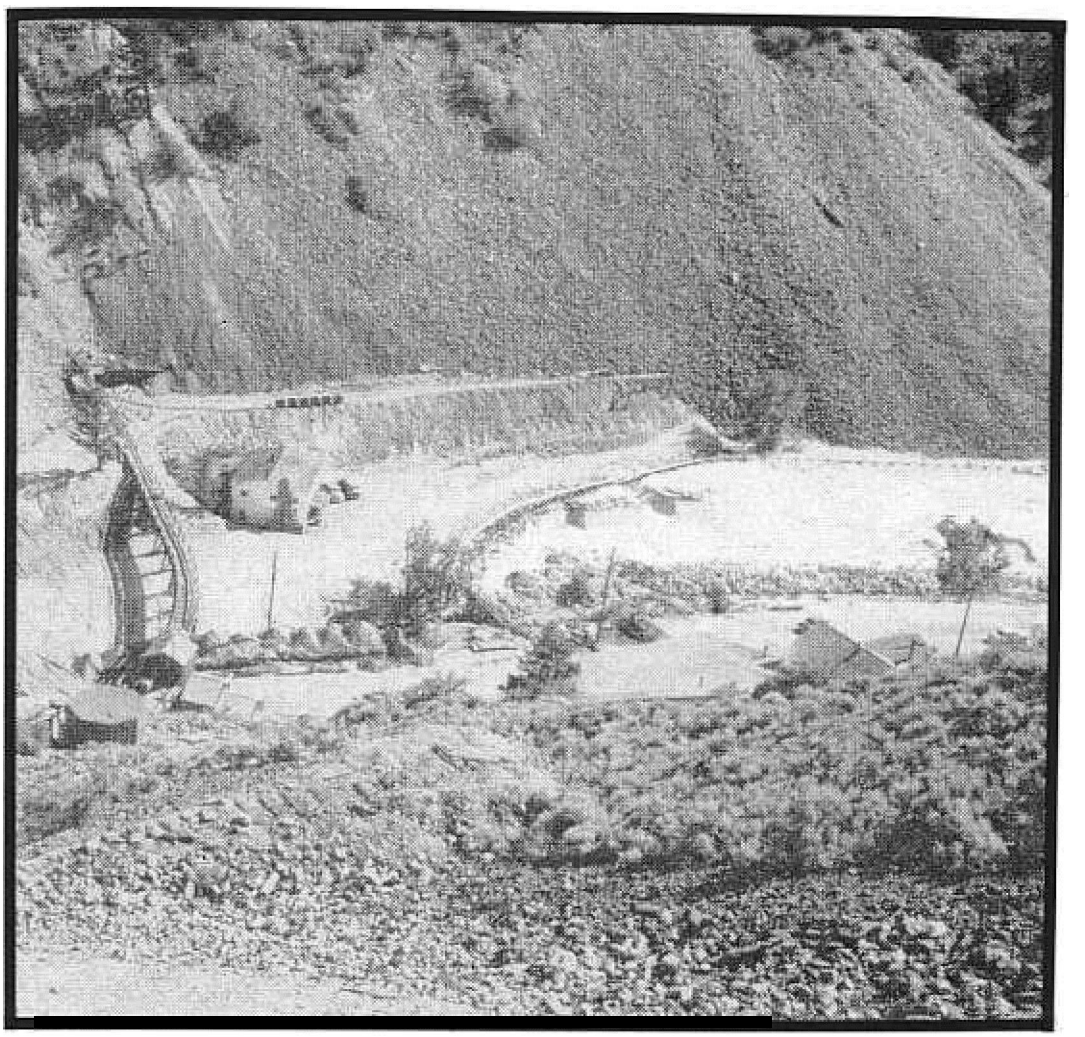

Figure 9. Bureau of Mines' adit on the south side of Patterson Creek. The trestle from the mill to the adit crosses the tailings area in the creek bottom (*Engineering and Mining Journal*, 1953, p. 152).

Figure 10. Office and mill at the Ima Mine (c. 1945; Idaho Historical Society photograph).

concentrate was sent to an eastern market, and 1,083 tons of lead-copper-silver concentrate was shipped to Utah. The following year, Bradley processed 30,605 tons of ore containing huebnerite, galena, tetrahedrite, and pyrite in the 150-ton mill. This yielded 168 tons of tungsten concentrate, recovered by gravity and flotation followed by magnetic separation, and 923 tons of lead-copper-silver concentrate, recovered by bulk sulfide flotation. Bradley also acquired a lease on the adjoining Miller (General Electric) Mine and operated the two properties together. (See Table 4 for ownership data on the Miller Mine.)

Up to this point, only an experimental lot of 40 tons of ore had been shipped from the Miller Mine (Callaghan and Lemmon, 1941). General Electric did diamond drilling on the property on 1939. In late 1940, most of the exploration work consisted of trenching and short tunnels, but General Electric was driving a long crosscut tunnel (700 feet at that time) on its Mazda No. 33 claim. By late 1944, the crosscut tunnel was over 2,000 feet long, and other exploration included diamond drilling and numerous bulldozer cuts and trenches. Mineralization had been located on strike with the main veins in the Ima (Hobbs, 1945).

The Ima operated throughout 1947, but the mill was destroyed by fire in December. Before that, the company processed 20,195 tons of ore containing 1.96 ounces of silver to the ton, 0.164 percent copper, 0.279 percent lead, and 0.547 percent tungsten. The mill produced 147 tons of tungsten concentrate and 692 tons of lead-copper-silver concentrate.

A new mill, built by Bradley in 1948, began operating in January 1949 (Figure 11). During the year, it treated 32,243 tons of ore containing 2.028 ounces of silver per ton and 0.507 percent tungsten (WO_3), as well as a little copper and lead. The company shipped 1,066 tons of lead-copper-silver concentrate to smelters in Utah and 225 tons of tungsten concentrate to various destinations.

In 1950, Bradley treated 21,914 tons of ore, which contained 35,832 ounces of silver, 10,429 pounds of tungsten (WO_3), and a little copper and lead. The mill produced 701 tons of lead-silver-copper concentrate and nearly 160 tons of tungsten concentrate.

Bradley was awarded a Defense Minerals Administration (DMA; later Defense Minerals Exploration Administration, or DMEA) contract in 1951 for $122,400. Government participation was 75 percent, or $91,800. This project had two parts. The first involved driving 2,000 feet of drifts and crosscuts on the 360 level (the "main" level in earlier reports) to explore to the north and below the 9C thrust fault, which separated the mine into two areas with dissimilar vein patterns. The second involved doing 1,200 feet of diamond drilling and 500 feet of drifting and crosscutting on the south side of Patterson Creek to look for the continuation of the orebody in that area (Figure 12). Work started in July 1951, and both parts of the project were successful. The crosscut on the 360 level was driven through the granitic intrusion and into quartzite on the far side. At a distance of 890 feet, the crosscut intersected

Table 4. Companies operating at the Miller Mine.

Company Name	Officer	Date Incorporated	Charter Forfeited	Year(s) at Mine
General Electric Co.	[1]	[1]	[1]	1939-1945(?)
Tungsten Mining Corp.	H. V. Door	June 22, 1945	unknown	1945(?)-1955(?)
Bradley Mining Co.	Worthen Bradley, President	filed in Idaho: July 28, 1938	[2]	1945-[3]

[1]Information not available in IGS's files.
[2]Corporation still in existence for last date information is available in IGS's files (1991).
[3]Owner of record for the last date information is available in IGS's files (1991).

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an 8-foot, high-grade, tungsten-bearing vein. On the south side of Patterson Creek, three 400-foot diamond drill holes found two tungsten-bearing veins that represented the continuation of the Ima vein system. Because this mineralization was somewhat to the east of where it was expected, the DMA contract was amended to increase the drifting from 500 to 1,000 feet, which was to be carried out from the old Bureau of Mines tunnel (Figure 9).

The Ima operated throughout 1952 (Figures 13 and 14), and milled ore increased from 41,132 tons in 1951 to 46,443 tons. The mill produced 1,605 tons of copper-lead-silver concentrate, 275 tons of huebnerite concentrate, and 9 tons of scheelite concentrate. Work continued on the DMEA project throughout 1952. Drifting off the main haulage (360) level eventually totaled 2,500 feet and located three significant tungsten veins. On the south side of Patterson Creek, 1,500 feet of underground work exposed one significant tungsten vein for more than 250 feet and located several smaller veins, which were further explored by diamond drilling. On October 28, 1952, a second DMEA contract was approved for $112,000, with government participation of 75 percent ($84,000). Work under this contract involved extending the 0 level 2,000 feet in a northwesterward direction. Following this, 1,000 feet of exploratory drifting and crosscutting and 2,000 feet of diamond drilling examined the area opened by the tunnel. This area had been explored ten years earlier by General Electric with encouraging results.

In 1953, the Ima produced 53,792 tons of ore, which yielded 1,691 tons of copper-lead concentrate, 335 tons of huebnerite concentrate, and 16 tons of scheelite concentrate. The copper-lead concentrate contained 86,149 ounces of silver, 165,893 pounds of copper, and 219,315 pounds of zinc. Reserves were estimated at over 1 million tons of ore. Two DMEA exploration projects were active during the year. An

Figure 11. Office and mill at the Ima Mine (c. 1950; *Mining World*, 1952, p. 37).

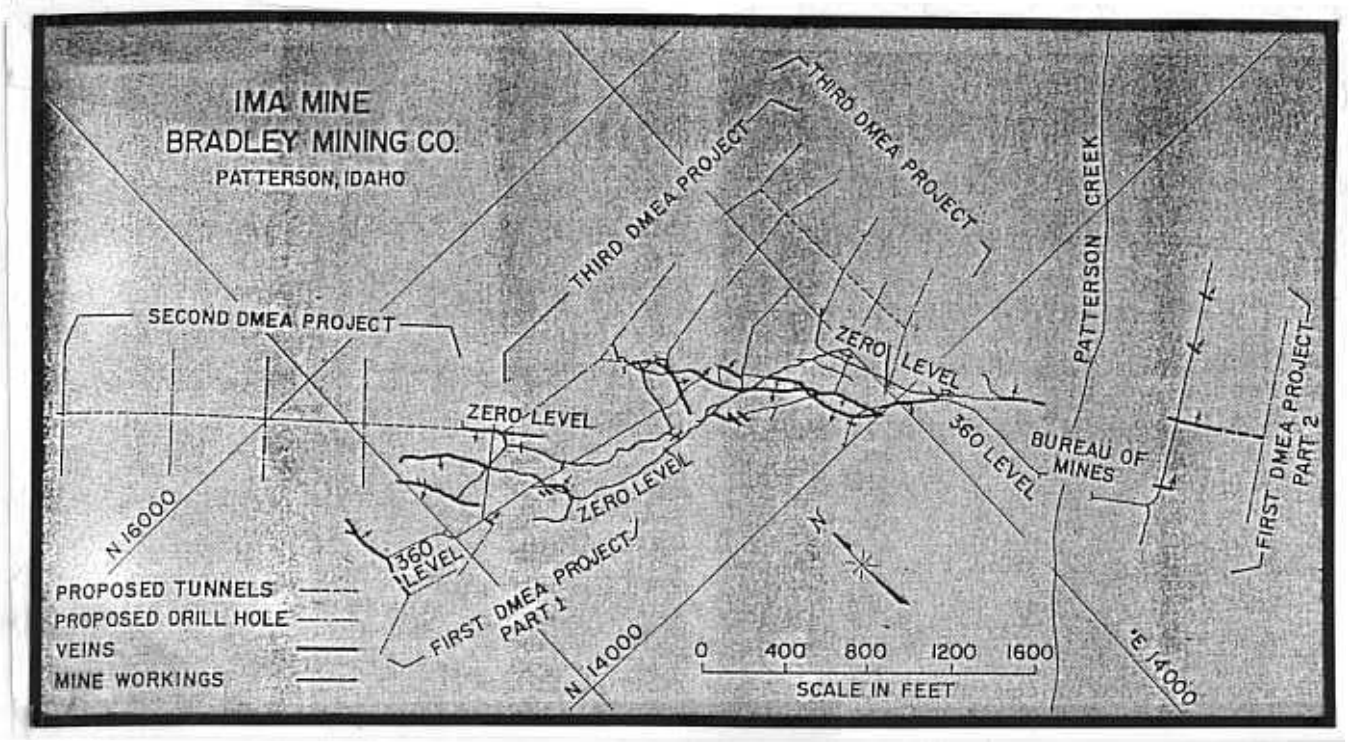

Figure 2. Map showing locations of the three DMEA projects conducted at the Ima Mine *(Engineering and Mining Journal,* 1953, p. 151).

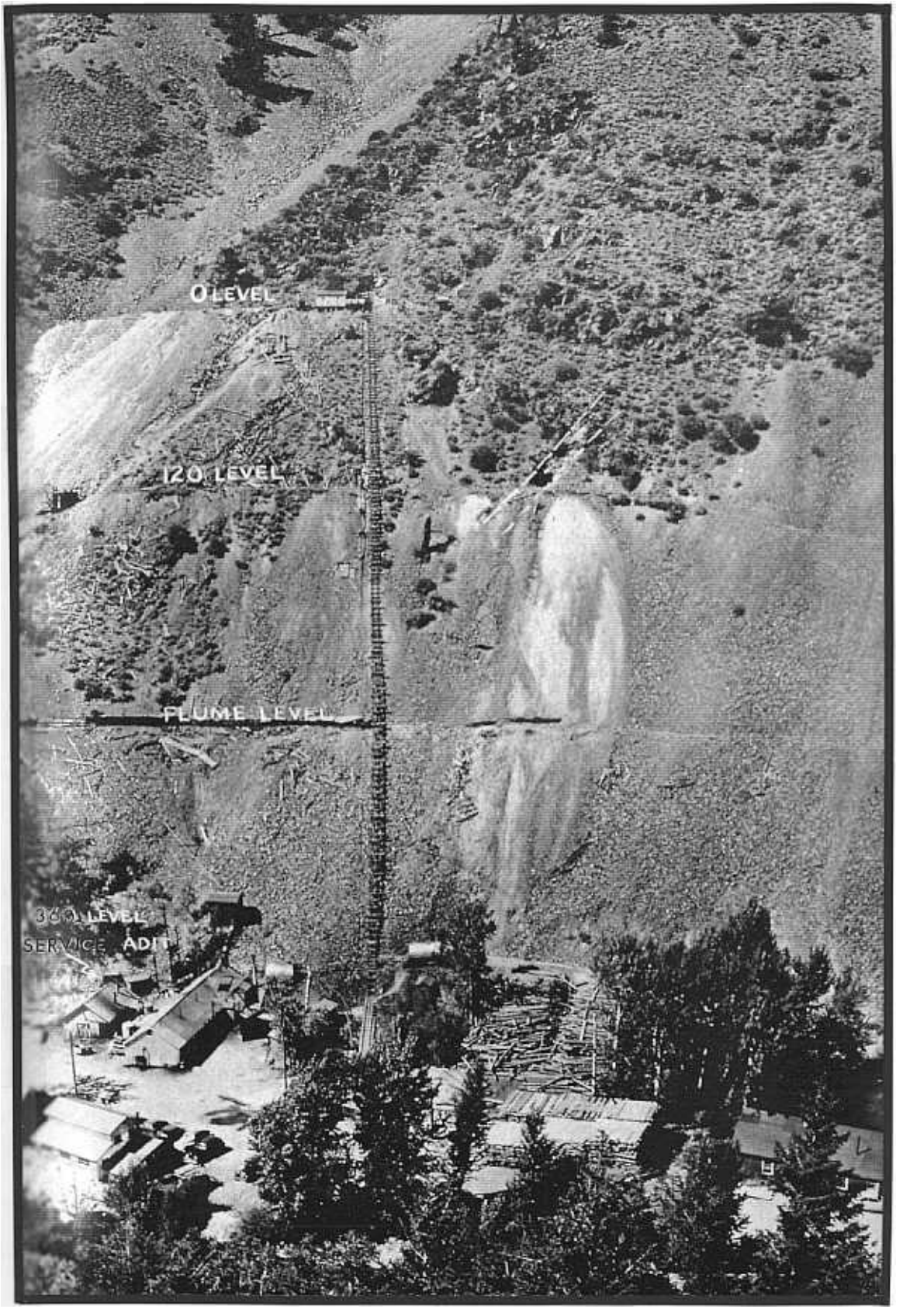
O LEVEL
120 LEVEL
FLUME LEVEL
360 LEVEL
SERVICE ADIT

Figure 13 (on previous page). Surface workings of the Ima Mine, with labels to identify the levels. The steep inclined track in the center of the picture is for hoisting timber to the 0 level. Area outlined with white to the right of the track on the 120 level is a surface expression of the Ima vein (*Mining World*, 1952, p. 35).

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article in *Engineering and Mining Journal* contained the following description of the mine (p. 151):

> Vein systems at the Ima mine have been developed and exposed by underground workings for a length of over 4,000 ft., and a vertical distance of more than 500 ft. The width across which the more or less parallel vein systems occur is nearly 1,000 ft. in some areas. Limits of the ore zone beyond these distances have not yet been found, but indications are that extensions are substantial, and that the Ima mine will have a long life.

The same article noted that the Ima's concentrate contained about 72 percent WO_3 with very few impurities (less than 0.01 percent each of molybdenum and phosphorus), which was one of the purest tungsten concentrates available in the world. All of the mine's production was sold to industry; none had been purchased by the government at its guaranteed floor price[6].

The Ima Mine continued to be the leading tungsten producer in Idaho in 1954, producing high-grade huebnerite concentrate and small amounts of byproduct scheelite concentrate. The company also produced copper-lead concentrate containing lead, copper, silver, and gold. Daily production at the mine was about 180 tons (Cook, 1956). One DMEA exploration program was active during the year. Work on the project included drifting, crosscutting, and diamond drilling. Although not explicitly stated, this work probably was the third DMEA project discussed by the 1953 *Engineering and Mining Journal* article. This project was to explore an area 3,000 feet perpendicular to the strike of the veins to determine the width of the mineralized zone. The USBM Yearbook showed an increase in the total amount of the October 28, 1952, contract to $136,000; apparently the new work was handled as an extension of the original contract.

Bradley completed the terms of its purchase agreement with Ima Mines in March 1955 and acquired title to the property. The company engaged in a substantial

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[6]Stockpile purchases of tungsten concentrates were authorized under the Strategic and Critical Materials Stock Piling Act (Public Law 520, approved July 23, 1946) and the Defense Production Act of 1950 (Public Law 774, approved September 8, 1950). Domestic prices under the domestic purchase program exceeded $60 per short ton unit of WO_3 throughout the period between 1951 and 1956. Purchase of concentrates from domestic producers was terminated in December 1956.

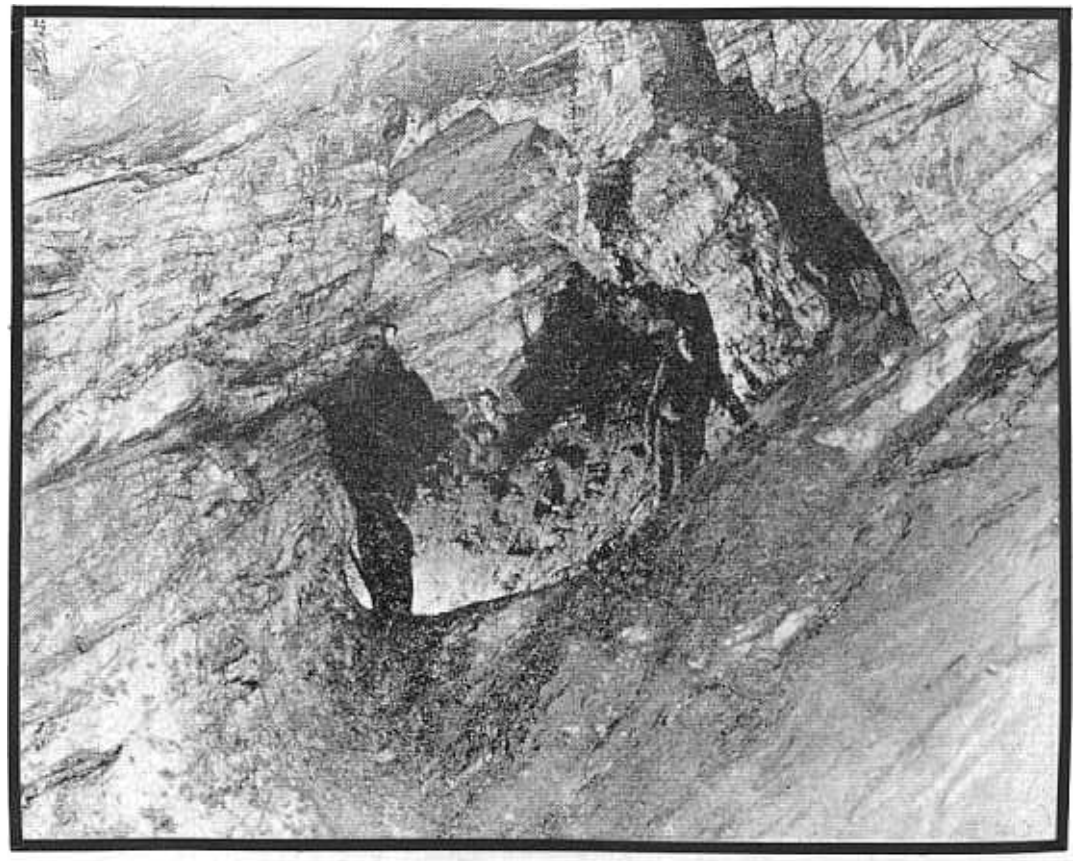

Figure 14. Stoping on the ore at the Ima Mine (McDowell, George A., 1953, 54th Annual Report: Mining Industry of Idaho for 1952, p.99).

expansion program at the mine. This included remodeling company buildings, constructing a new tramway to the mine entrance, and installing a new secondary crusher in the mill. The company also added facilities for treating old tailings, increasing the capacity of the mill to 200 tpd. The mine produced 63,400 tons of tungsten ore, averaging 0.66 percent WO_3 and containing copper, lead, and silver. The ore yielded 30,578 units of WO_3 in huebnerite concentrate, 467 units in scheelite concentrate, and 2,210 tons of copper-lead concentrate. In addition, the company recovered 387 units of WO_3 in huebnerite concentrate and 178 units in scheelite concentrate from 11,662 tons of old tailings. The amount of Bradley's DMEA contract was again increased, this time to $224,400. Government participation was still 75 percent.

In 1956, the mine produced 71,742 tons of ore averaging 0.62 percent WO_3. From this, the company obtained 476 tons of high-grade (71 percent WO_3) huebnerite concentrate and shipped 437 tons, primarily to the federal government's stockpile. The company also produced 29 tons of scheelite concentrate and shipped 25 tons, averaging 20 percent WO_3, to the Salt Lake Tungsten Co., Salt Lake City, Utah. Sulfide concentrate totaling 2,420 tons was shipped to the Selby, California, smelter; this material contained gold, silver, copper, and lead. The facilities for treating old tailings were not operated in 1956. Although the Ima's production increased during the year, total tungsten production in the state fell during 1956 because the government first reduced its purchase price for tungsten, and then ceased making purchases for its stockpile. Bradley's DMEA contract was active during the year.

A sharp decline in the open-market price of tungsten and the cessation of government purchases for stockpiling forced Bradley to close the Ima at the end of June 1957. The state's tungsten production for the year was the smallest since 1936. Before the closure, Bradley processed 30,824 tons of ore in its mill, producing 1,191 tons of sulfide concentrate and over 15,000 units of tungsten, mostly from huebnerite. The company's DMEA contract was active during at least part of the year.

Although the mine was idle throughout 1958, Bradley shipped the rest of the huebnerite concentrate produced before the closure. The mine has remained closed ever since, although several major exploration projects have been conducted on the property and the mine was being actively developed in the early 1980s. In 1960, Bradley sold the mill and the equipment was removed from the property.

In 1961, American Metal Climax leased the Ima. The company also leased claims held by Howe Sound Co. adjacent to the Ima. A 10-man crew sampled the properties. Work included rehabilitating some of the mine openings and taking 4,214 feet of channel-chip samples and 1,419 feet of grab-chip samples. In 1962, the company conducted a drilling program at the mine.

Midwest Oil Co. of Denver conducted exploration work at the Ima in 1970. The company continued exploration and development in 1971. The work included 870 feet of drifting and crosscutting, 2,055 feet of diamond drilling, and 250 feet of

percussion drilling. Midwest was still leasing the property in 1972, but it did no work.

According to the 1973-1974 IMIR, Bradley was holding the Ima as a molybdenum prospect as well as for tungsten. Most of the annual reports for the following years list the Ima in both categories.

In 1979, Inspiration Development Co. explored the Ima for tungsten and molybdenum. This was the largest exploration project in Lemhi County. Inspiration continued feasibility studies in 1980 and conducted an exploratory diamond drilling program. In 1981, the Ima passed from exploration to the development stage as Inspiration drove a new adit and opened a new haulage level at the mine. A 300-pound bulk sample was run through a pilot plant for testing. Inspiration had been looking at the mine as a molybdenum prospect but decided to explore for tungsten. Early in 1982, the company started a 14- by 16-foot development drift. The drift was 150 feet long when all work on the property stopped because of lower tungsten demand and prices. The poor metals market caused Inspiration to close its Spokane office. Figures 15, 16, 17, 18, 19, and 20 show the mine as it appeared in 1994 when it was inspected by an Idaho Geological Survey geologist as part of a program to evaluate environmental hazards on abandoned and inactive mines in southern Idaho.

Total recorded production for the Ima between 1934 and 1982 was 743,069 tons of ore and 3,314 tons of old tailings. From this material was produced 302 ounces of gold, 1,296,358 ounces of silver, 1,813,758 pounds of copper, 2,921,509 pounds of lead, 20,581 pounds of zinc, and 198,333 standard units of WO_3. McHugh and others (1991) give the production between 1934 and 1958 as about 756,000 tons of ore that averaged 0.55 percent WO_3. Since no records are known for the early days of the mine and because the amounts produced were not reported for some years, these numbers must be considered a minimum.

Identified resources in the outer zone of the mine total about 350,000 tons of ore averaging 1.9 ounces of silver per ton, 0.19 percent copper, 0.22 percent lead, 0.2 percent zinc, and 0.5 percent WO_3. The grade of the inner zone is estimated to be 0.14 ounce per ton of silver, 0.05 percent copper, 0.1-0.3 percent molybdenum, and 0.03 percent WO_3, but insufficient data exist to estimate the tonnage (McHugh and others, 1991).

Figure 15. Relict of the inclined track that was used to haul timber to the 0 Adit (1994). The millsite is on the right center and hidden by the slope of the hill (Falma J. Moye, Idaho Geological Survey photograph).

Figure 16. Ima millsite and tailings area (1994). The Bureau of Mines' adit is in the upper center of the photograph in the deep shadow. Compare this view with Figure 9 (Falma J. Moye, Idaho Geological Survey photograph).

Figure 17. Upper tailings area at the Ima Mine (1994). The view is looking to the southwest down Patterson Creek. The Lost River Range is in the background (Idaho GeologIcal Survey photograph by Falma J. Moye).

Figure 18. Ima millsite (1994). The trees in the foreground are growing along Patterson Creek (Idaho Geological Survey photograph by Falma J. Moye).

Figure 19. Portal to the 360 level, or K. C. Li, tunnel (1994; Falma J. Moye, Idaho Geological Survey photograph).

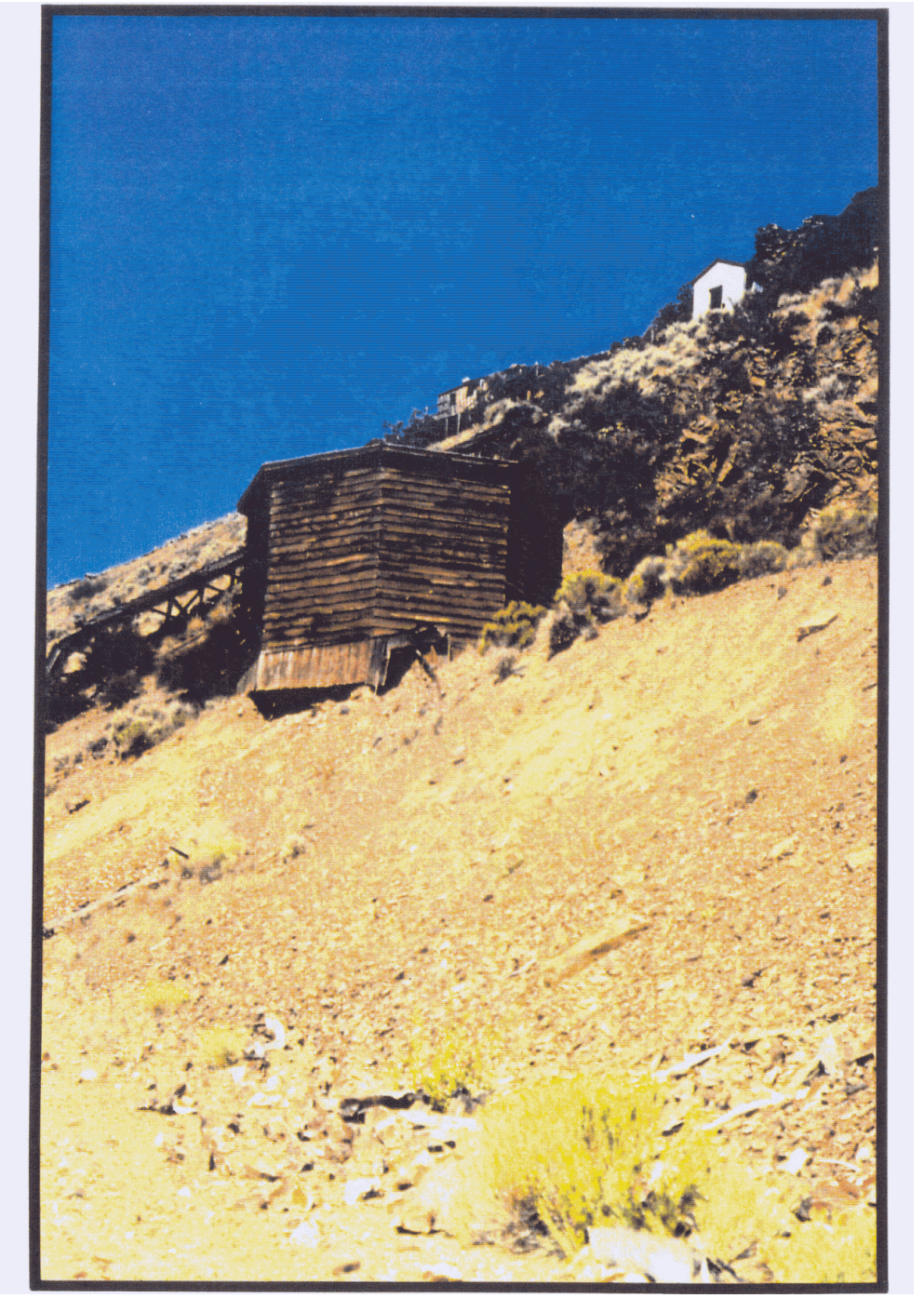

Figure 20. Water tank, which is lined with hay bales, at the Ima Mine (1994). The top of this structure is visible on the left side of Figure 9. The tank was probably used to supply water to the mill during the winter months when freezing prevented use of the flume, which supplied water during the rest of the year (Dice, 1943). The middle adit (120 level) is near the silver building in the upper right. Note the track behind the tank (Idaho Geological Survey photograph by Falma J. Moye).

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