R. I. 4481 JUNE 1949

UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
JAMES BOYD, DIRECTOR

REPORT OF INVESTIGATIONS

DIAMOND DRILLING IN THE METALINE DISTRICT PEND OREILLE COUNTY, WASH.

BY

N. L. WIMMLER AND W. B. COLE

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1949

A Century of Conservation

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By N. L. Wimmler[2]/ and W. B. Cole[2]/

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ILLUSTRATIONS

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 4481."

2/ Mining engineer, Bureau of Mines, Mining Division, Albany Branch.

ILLUSTRATIONS (Cont'd.)

SUMMARY

The Metaline mining district was examined in 1942 by Bureau of Mines engineers with the cooperation of geologists of the Federal Geological Survey. Because the demands of war production were rapidly depleting reserves in some of the older zinc-lead producing districts of the United States, it was decided that an attempt should be made to increase the proved or indicated ore reserves of the Metaline district. With this objective, certain areas to be explored by diamond drilling were selected. The Bureau of Mines began work on this program January 15, 1943; work terminated September 8, 1945. Forty-five holes were drilled in seven areas. The holes ranged from 154 feet to 2,050 feet in length. Their combined length was 38,150 feet. Thirty-three of the holes were drilled in the North Pend Oreille and the West Bella May areas.

The Metaline mining district is an important producer of zinc and lead concentrates from relatively low-grade replacement-type ores in the Metaline limestone formation. The first recorded production from the district was a small shipment of high-grade lead ore in 1906. In 1915, 3,111 tons of ore valued at $8.76 a ton was shipped from the Clark property, later the Pend Oreille Mines & Metals Co. mine. Some years later the Grandview mine and the Metaline, or Bella May, mine were developed. Both of these mines are now operated by the American Zinc, Lead & Smelting Co. From 1906 to 1944, inclusive, the Metaline district produced 2,560,331 tons of ore that yielded 206,986,618 pounds of zinc and 72,970,556 pounds of lead. The three mines mentioned have accounted for virtually all this production. The Pend Oreille Mines & Metals Co. selective flotation mill at its Josephine mine has a daily capacity of 800 tons; the American Zinc, Lead & Smelting Co. has a 500-ton flotation mill at the Grandview mine. High-grade zinc and lead concentrates are produced; they are shipped to East St. Louis, Ill., for smelting. Freight to East St. Louis is $10.50 a ton.

Figure 1. - Looking south from Grandview mine showing Pend Oreille power plant, Metaline Falls on the Pend Oreille River, the town of Metaline Falls, and the Metaline mine in the distance.

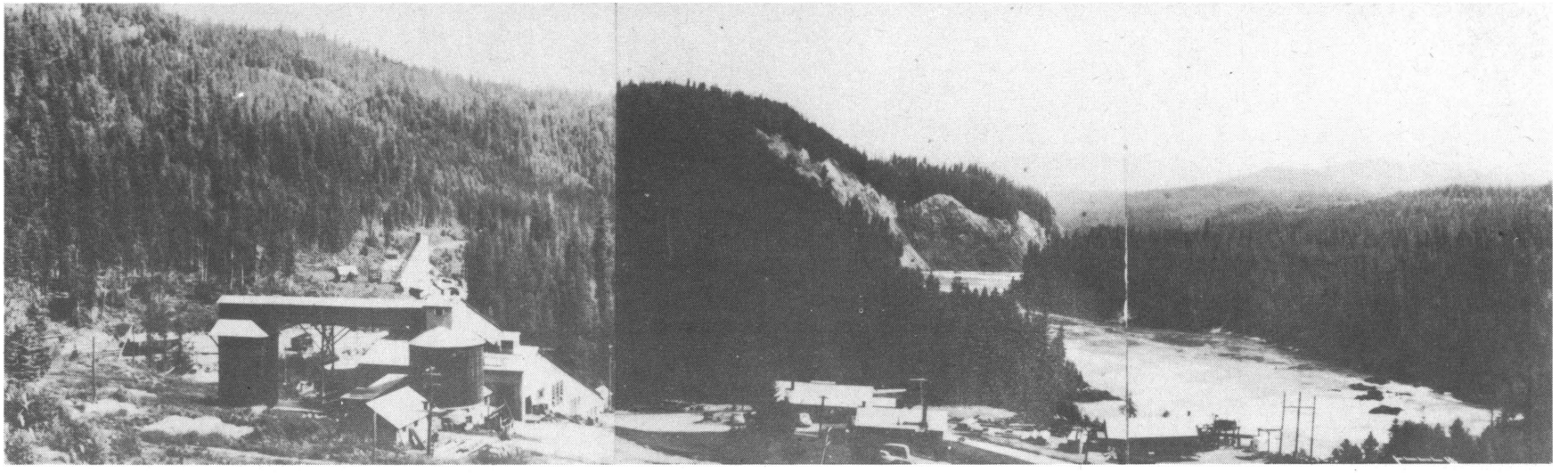


Figure 2. - View showing Pend Oreille mill, No. 1 shaft, Josephine mine, and Pend Oreille River. Slate Creek Canyon in center background.

Figure 3. - View of the Pend Oreille Mines & Metals Co. The light-colored cliff behind buildings marks the Yellowhead mine.

The operating mines and the principal known ore deposits are within a highly shattered fault block between the Flume Creek fault on the west and the Slate Creek fault on the east. The vertical downward displacement of the Flume Creek fault is at least 10,000 feet. This faulted block trends northeast and ranges in width from 1-1/2 to 4-1/2 miles. Several periods of deformation have produced folding, overthrusting, and normal and reverse faulting. The principal known ore-bearing horizon occurs within the upper 50 to 500 feet of the Metaline limestone formation. Drilling and other exploration so far conducted indicate that this ore-bearing horizon in the upper Metaline limestone in this faulted block is more than 4,500 feet wide in places and extends northeasterly to Three Mile Creek, a distance of about 28,000 feet. It may extend as far as Slate Creek and beyond.

Preceding the ore deposition, the upper part of the Metaline limestone formation was dolomitized. This dolomitization was very irregular; it does not conform to the bedding. Ore deposition was accompanied by hydrothermal solutions that altered the limestone and dolomite to jasperoid. In general, the ores replaced jasperoid rather than dolomite; they were deposited mainly in the brecciated zones and the less strongly developed fissures.

The mineralized bodies are irregular in form and differ greatly in size. Usually they cross the bedding. In the Pend Oreille mine area and to the east and northeast, the dip of the principal ore-bearing horizon averages 10° to 20° northeast but varies locally. The thickness of the ore bodies ranges from a few feet to 200 feet and more. Because of minor faults, the thickness may differ greatly within a few feet horizontally. Open stopes, by benching downward from the top of the ore body, have been mined 50 to 120 feet and more in height, 50 to 100 feet in width, and 100 to 300 feet in length without timber support. Such stopes have remained open for more than 10 years without subsidence or sloughing from the back and walls. Low-grade or barren material is left for pillars.

The zinc-lead ores are siliceous and generally massive but in some places may be vuggy and porous. The predominating economic mineral is sphalerite. Galena is most abundant; it may predominate locally. Pyrite, marcasite, smithsonite, and cerrusite are present in small amounts. Small quantities of silver, copper, and a little gold and cadmium may be present in some of the ores. Locally, the combined zinc-lead content may be 20 percent or more. The over-all tonnage, as mined, has averaged between 5 and 7 percent in combined zinc and lead.

INTRODUCTION

The Metaline mining district in Pend Oreille County, Wash., is an important producer of zinc and lead concentrates from relatively low-grade replacement-type ore. The geology and the ore deposits of the Metaline Quadrangle have been described by Park and Cannon.3/ Their description is based upon extensive field work in the Metaline district before 1941. Because of the exceptionally large wartime requirements of zinc and lead, Bureau of

3/ Park, C. F., Jr., and Cannon, R. S., Jr., Geology and Ore Deposits of the Metaline Quadrangle, Wash.: U. S. Geol. Survey Prof. Paper 202, 1943, p. 78.

Mines engineers, with the cooperation of C. F. Park, Jr., and other members of the Federal Geological Survey, investigated the district during 1942. As a result of that investigation, an extensive program of diamond drilling was recommended.

The Bureau of Mines drilling program was started January 15, 1943. Drilling continued until August 6, 1945. The project was terminated September 8, 1945. Diamond core-drilling was conducted in seven areas, referred to as the North Pend Oreille, West Bella May, Washington Rock, Josephine, South Josephine, Slate Creek, and the Flume Creek areas.

ACKNOWLEDGMENTS

The Metaline project was under the general supervision of P. E. Oscarson, district engineer, Washington district office at Spokane, Wash.; W. B. Cole was the project engineer. Samples were analyzed by the Metallurgical Division laboratories at Reno, Nev., and Salt Lake City, Utah.

The valuable cooperation and assistance of the officials and staff of the Pend Oreille Mines & Metals Co. and the American Zinc, Lead & Smelting Co. are acknowledged gratefully. These companies provided much information regarding the properties owned or operated by them.

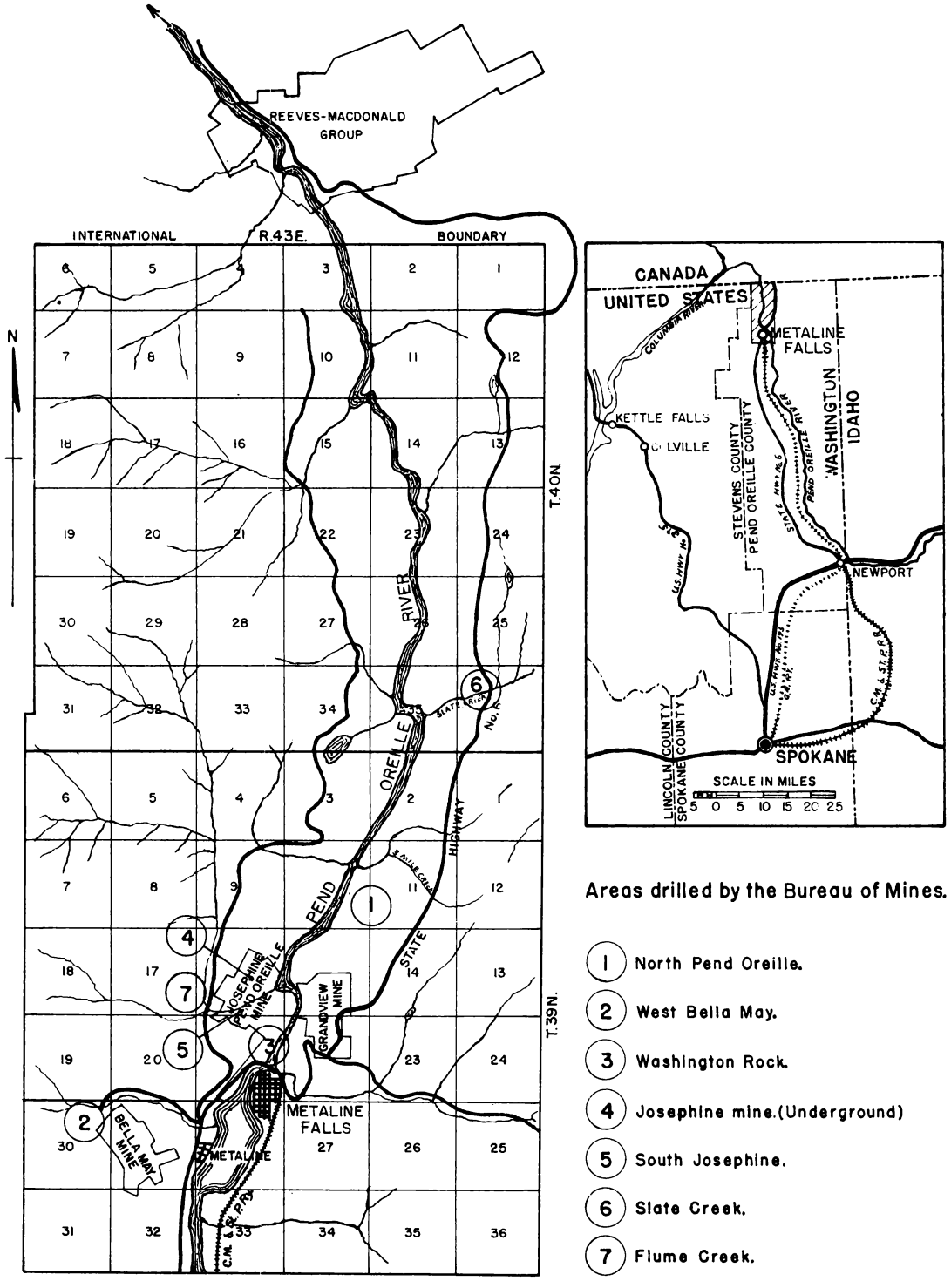
PHYSICAL FEATURES AND COMMUNICATIONS

The Metaline mining district is in the northern part of Pend Oreille County in the northeastern corner of the State of Washington. Metaline Falls, the principal mining center, is 108 miles north of Spokane by highway; it has a population of about 900. The town of Metaline, with about 400 inhabitants, is 2 miles southwest of Metaline Falls. The three operating mines are near these two towns (fig. 4).

State Highway 6, leading northward from Spokane via Newport, the county seat, serves the Metaline district and connects with the Canadian Highway to Trail and Nelson in British Columbia. A network of county roads from this highway leads to the various mines and prospects. The Auto Interurban Bus Line maintains daily passenger and express service over Highway 6 between Spokane and Metaline Falls. The Chicago, Milwaukee, St. Paul & Pacific Railroad provides freight service but no passenger service over its branch line between Spokane and Metaline Falls.

The dominant topographic feature is the Pend Oreille River, which flows northerly through the west-central part of the district and joins the Columbia River in Canada close to the United States-Canada border. The topography to the east and west of this river is moderate to rugged in relief, ranging in altitude between 2,000 and 5,500 feet. Some of the more distant mountain peaks rise to altitudes as high as 7,300 feet.

Climatic conditions during the winter months are generally moderate, although the temperature may occasionally drop to 20° below zero. The normal annual snowfall around the towns and mines ranges from 18 to 30 inches but is considerably more at higher altitudes. The other seasons are temperate. The average annual precipitation during the past 8 years has been 28.85 inches.



Areas drilled by the Bureau of Mines.

1. North Pend Oreille.
2. West Bella May.
3. Washington Rock.
4. Josephine mine.(Underground)
5. South Josephine.
6. Slate Creek.
7. Flume Creek.

Figure 4. - Index map of the Metaline mining district, Pend Oreille County, Wash.

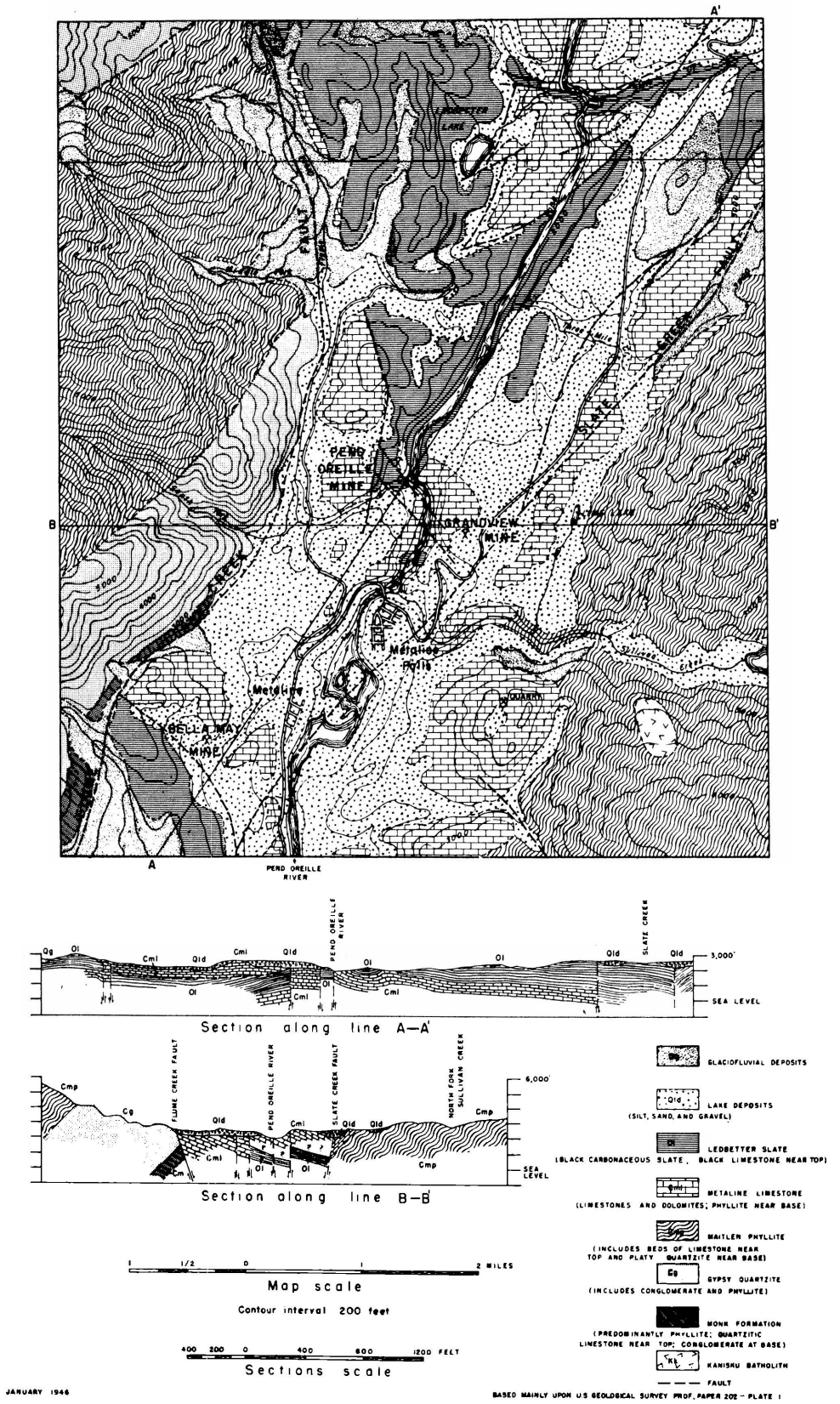


Figure 5. - Geologic map and sections of part of Metaline quadrangle.

Fir, spruce, white pine, cedar, lodgepole pine, and various other trees abound in the nearby forest areas. These provide an abundant supply of timber and lumber for mining and building purposes.

POWER

Power is generated in the Pend Oreille Mines & Metals Co.'s 2,250 kilowatts hydro-electric plant on the Pend Oreille River at Metaline Falls. Foundations for an additional installation of a 2,000- horsepower water wheel and a 2,250-kilowatt generator were laid when this plant was originally constructed. This plant operates under a variable low head ranging from 26 to 18 feet, according to the river level; it normally generates about 1,780 kilowatts. The American Zinc, Lead & Smelting Co. obtains some power from the Pend Oreille Mines & Metals Co. plant, but when additional power is required it also operates a 720-kilowatt generator plant driven by two Diesel engines. The Lehigh Portland Cement Co. utilizes the water from Sullivan Lake and Creek to generate power in its hydroelectric plant at Metaline Falls. This plant also provides electricity to the local power and light company. The War Department, U. S. Army Engineers, has completed plans and foundation drilling for the contemplated Boundary dam and hydroelectric plant on the Pend Oreille River near the United States-Canadian border, 11 miles downstream (north) from Metaline Falls. This project later was abandoned because of threatened damage to the mines by flooding with water back of the dam. Bonneville Power Administration in 1948 made power from Grand Coulee dam available to the district.

LABOR AND LIVING CONDITIONS

Adequate labor was available before the war. At that time the wage scale for the district was based upon the price of prime western zinc at East St. Louis, Ill. The hourly rates differed according to eight classes of labor. All the mines now operate under a closed-shop agreement with a union affiliated with the C. I. O. With the approval of the N L R B, wages no longer are based upon changing metal prices. The present average wage scale (1948) for an 8-hour shift is $11.65 for miners, $12.40 for timbermen, and $11.15 for muckers. A serious shortage of manpower developed during the war, but good workers are again becoming available.

Living and housing facilities at Metaline Falls and Metaline have been adequate for past operations, but additional facilities will be required in the future. Plans are under way to meet this situation. Board and room for mine employees have been made available at Metaline Falls at $47.50 to $55 a month.

HISTORY AND PRODUCTION

According to Mineral Resources,[4/] deposits of lead ore were known in the Metaline district as early as 1869. Apparently some attempt at mining was made about 1886. Prior to 1906 the district was, however, accessible only by river and wagon road. It was not until the railroad branch was completed to Metaline Falls that the region entered a new era of development and exploitation of its mineral and timber resources. The successful growth and the mining development of the district is due largely to the efforts of

4/ U. S. Geol. Survey, Mineral Resources, 1906, p. 451.

L. P. Larsen. Larsen first became interested in the district in 1906, when he acquired control of what was then known as the Clark property. Larsen and his associates repeatedly tried to develop ore and construct plants capable of handling the low-grade zinc-lead ores profitably. It was, not until 1928-29 however, that, as a result of diamond core drilling, a considerable body of minable ore was found on the property of the Pend Oreille Mines & Metals Co. From then on development was rapid, and the limits of the known ore deposits have been greatly extended.5/

The first recorded production of ore from the district was in 1906, when a small shipment was made. This shipment contained 73.1 percent lead, 2 percent zinc, and 1.1 ounces silver per ton. Production was negligible however, until 1915, when 3,111 tons valued at $8.76 a ton were shipped from the Pend Oreille mine (Clark property). Production has been made yearly since 1915, except in 1920, 1921, 1928, and 1935. During the early period of mining, the principal product was lead, but in recent years zinc has been the metal of predominant economic importance to the district.

The approximate total metal production of the Metaline district to January 1, 1945, as compiled by the Mineral Resources Branch of the U. S. Bureau of Mines, and from the recent records of the producing companies, is given in the following table.

TABLE 1

Year	Tons of ore	Zinc, lb.	Lead, lb.
1906-1936, incl.	297,138	39,914,460	11,201,397
1937-1940, incl.	887,765	74,375,158	25,314,201
1941-1943, incl.	1,069,912	74,226,000	25,899,958
1944-Jan. 1, 1945.....	305,516	18,471,000	10,555,000
1906-1944, incl.	2,560,331	206,986,618	72,970,556

Three mines have accounted for most of this production. These are the Pend Oreille mine, owned and operated by the Pend Oreille Mines & Metals Co.; the Grandview mine, owned by the Grandview Mining Co., and operated since 1940 by the American Zinc, Lead & Smelting Co.; and the Bella May, also known as the Metaline mine, of the Metaline Mining & Leasing Co., operated since 1936 by the American Zinc, Lead & Smelting Co. The two companies above mentioned are the only companies now producing in the district; each operates its own flotation plant. In the past, small shipments of ore have been made from the Oriole, Z. Canyon, Lead Hill, Lead King, Lucky Strike, Cliff, Diamond R., and a few other claims.

GEOLOGY AND ORE DEPOSITS

The geology of the ore deposits of the Metaline Quadrangle has been mapped and recorded by members of the Federal Geological Survey, particularly by Park and Cannon.7/ The following general resume has been compiled mainly from their report. The reader is referred to that report for details.

5/ Park, C. F., Jr., and Cannon, R. S., Jr., op. cit., p. 48.
6/ U. S. Geol. Survey, Mineral Resources, 1906, p. 451.
7/ Park, C. F., Jr., and Cannon, R. S., Jr., op. cit.

The most extensive and productive of the known ore deposits in the Metaline district are those in the upper part of the Metaline limestone. The Metaline limestone formation is of a middle Cambrian age; it has a maximum thickness of 3,000 feet. It is overlain by the Ordovician Ledbetter slates, which are as much as 2,500 feet thick. These formations form most of the valley floor of the Pend Oreille River and some of the lower hills and lower parts of the valley walls in this area. The Maitlen phyllite and the Gypsy quartzite formations beneath the Metaline limestone are exposed in valley walls at distances up to a mile and more to the east and west of the river. Sand and gravel terraces occur irregularly along the debris-covered slopes up to altitudes of about 2,600 feet. Sand and gravel overburden covers much of the rock formation in the valley to depths of 10 to 250 feet (fig. 5).

The operating mines and the principal known ore deposits are within a highly shattered fault block lying between the Flume Creek fault on the west and the Slate Creek fault on the east. The vertical downward displacement of the Flume Creek fault is at least 10,000 feet. This faulted block trends northeast and ranges from 1-1/2 to 4-1/2 miles in width. Several periods of deformation have produced folding, overthrusting, and normal and reverse faulting. The principal known ore-bearing horizon is in the upper 50 to 500 feet of the Metaline limestone formation. Drilling and other exploration so far conducted indicate that this ore-bearing horizon within this faulted block is more than 4,500 feet wide in places and extends northeasterly to Three Mile Creek, a distance of about 28,000 feet. It may extend as far as Slate Creek and beyond.

The upper 500 feet of the Metaline limestone formation is composed largely of mottled, dense, gray, magnesium limestone containing chert nodules; it is underlain by a fine-grained cream-colored dolomite with alternating layers of white and black dolomite. The Metaline limestone was dolomitized regionally before ore deposition. This dolomitization was very irregular in the upper part, where, generally, it does not conform with the bedding. Ore deposition was accompanied by hydrothermal solutions that altered the limestone and dolomite to jasperoid. In general, the ores replace jasperoid rather than dolomite and were deposited mainly in the brecciated zones and lesser breaks. Other than a few minor exceptions, no ore has been found along the major faults.

One important ore body, known as the Yellowhead, is in an environment that differs materially from that described. This ore body is in a fault block that has been upthrust with relation to the principal ore-bearing fault block mentioned. Its stratigraphic position in the Metaline limestone formation has not been determined definitely but is believed to be about 800 feet below the contact of the Metaline limestone with the overlying Ledbetter slate formation.

The strike of the favorable beds in the principal ore-bearing horizon differs from place to place. The mineralized bodies are irregular in form and differ greatly in size. They usually cross the bedding, although some follow the bedding in a general way. In the Pend Oreille mine area and to the east and northeast the dip of this ore-bearing horizon averages between 10 to 12 northeast, but locally may be flat. The ore bodies range in thickness from a few feet to 200 feet and more. One stope now being mined in the

Josephine mine has a maximum height of 240 feet. The thickness of the ore may differ greatly within a few feet horizontally; such differences are associated usually with minor faults.

Large blocks of calcite and large blocks of low-grade or unmineralized limestone or dolomite occur irregularly within the ore horizon between and within the ore bodies. Open caves have been found in the Pend Oreille mine. These caves may be a few feet to 120 feet in length, up to 110 feet in width, and 15 feet in height. Their backs usually are lined with paligorskite, or "mountain leather", and the floors are covered with large pieces of waste, under which high-grade zinc and lead ore generally are found.8/

DESCRIPTION OF THE ORES

The general character of the mineralization and the associated gangue material is similar in the Pend Oreille, Grandview, and Bella May mines.9/ The ores are siliceous. The predominating economic mineral is sphalerite. Galena is distributed through the ores but appears to occur in larger concentrations nearer to the peripheries of the ore bodies than elsewhere. Pyrite, marcasite, smithsonite, cerussite, and chalcopyrite are present in varying but small amounts. The ore at the Yellowhead mine differs in that it has much pyrite associated with the sphalerite and galena. Some of the sphalerite in the Yellowhead ore is of a rich yellow color, which has not been observed elsewhere. These replacement zinc-lead ores are generally massive but in some places are porous and vuggy. The vugs generally are lined with crystals of sphalerite and quartz.

Sphalerite occurs in a variety of colors, pale yellow (resin jack), a brilliant reddish type (ruby jack), and a brown, all of which may be present in a single ore shoot. The texture of the zinc ores usually is fine-grained to dense, but sometimes is coarse-grained and massive. The galena crystals probably average larger than the sphalerite crystals.

The gangue is customarily dark-gray or black jasperoid, which in places grades into milky quartz. Crystalline dolomite and coarse calcite are abundant. In some places sphalerite and galena are disseminated in dolomite and limestone.

The ores are very spotty and irregular in occurrence and tenor. Even in the larger stopes the mineralization may change from high-grade to low-grade within a few feet. Locally the combined zinc-lead content of the ore may be 20 percent or more. The over all tonnage as mined normally will average 5 to 7 percent in combined zinc and lead. Small quantities of silver and copper, as well as a little gold and cadmium, may also be present in some of the ores.

8/ Lambly, C. A. R., Methods and Costs of Mining Zinc-Lead Ores at the Pend Oreille Mines & Metals Co., Metaline Falls, Wash.: Bureau of Mines Inf. Circ. 7152, March 1941, p. 3.

9/ Park, C. F., Jr., and Cannon, R. S., Jr., p. 50.

MINING

The Pend Oreille-Josephine mine is entered by a main vertical shaft 320 feet deep and a 1,500-foot adit known as the "500" level. The 1,000-foot "zero" level adit and the old Josephine shaft, which is a 300-foot, 80° incline, have not been in use for the past 8 years. The "500"-level adit intersects the ore body below the "300" level; it is used as the main haulage level for ore mined on the "300" level and above. Diamond drilling from the surface proved the ore body to dip under the "500" level. The main 320-foot vertical shaft, therefore, was sunk to meet this situation and be located as near to the center of the ore body as then developed by drilling and still be near the mill. Two levels, the "700" and "800", lead from this shaft. The "800" level is the main haulage level. In extending the underground workings into the area east of the Pend Oreille River, an incline was driven from the end of the "800" level down to the "1,000" level, which is 100 feet below the deepest bedrock surface in the river.

Mine development from these workings is by drifts and raises. The ore is mined in open stopes by benching downward from the top of the ore body. The broken ore is transferred to raises with mechanical scrapers.10/ The drifts, raises and stope workings stand very well without timbering. Low-grade or barren material is left for pillars and for wall support. Open stopes have been mined 50 to 120 feet and more high, 50 to 100 feet wide, 100 to 300 feet long. Such stopes have remained open for more than 10 years without any sloughing from the backs or walls.

The Grandview mine, 1 mile northeast of the town of Metaline Falls, is opened by a main adit 2,200 feet long and a 190-foot inclined shaft. The underground development includes about 3,000 feet of laterals. Conditions in the underground workings are similar to those in the Pend Oreille mine. Similar methods of mining are employed.

The Bella May mine workings include those of the Blue Bucket at the east and the Bella May at the west. The old Bella May mine was formerly entered by two adits. The Blue Bucket mine was entered by a shallow shaft. The old upper workings now are inaccessible. These two groups now are opened and worked from a new lower adit, the 2,050 level. This adit is 6,375 feet long; it trends westerly from its portal on the west bank of the Pend Oreille River, about 1/2 mile south of the town of Metaline, and attains a maximum depth of 1,000 feet below the surface. Including the 1,905 level below this main adit and the 2,179 level above it, the total accessible underground workings in the Bella May property are more than 12,000 feet in length. Underground conditions in general are similar to those at the Pend Oreille and Grandview mines.

MILLING AND SMELTING

Ore from the Pend Oreille-Josephine mine is treated in the company's 800-ton flotation plant. The ore is ground in closed circuit to 60-percent minue 200-mesh. The average recovery is a little over 90 percent. The zinc concentrates average 60 to 62 percent zinc; the lead concentrates average 70 to 80 percent lead.

10/ Lambly, C. A. R., Methods and Costs of Mining Zinc-Lead Ores at the Pend Oreille Mines & Metals Co.: Bureau of Mines Inf. Circ. 7152, March 1941, pp. 14.

The ores from the Grandview mine and the Bella May mine are treated in the 500-ton flotation plant of the American Zinc, Lead & Smelting Co. This mill is situated at the Grandview mine. The Bella May ore is transported by truck 4 miles to this mill. The treatment and results are reported as similar to those attained at the Pend Oreille mill.

The American, Zinc, Lead & Smelting Co. ships concentrates to its smelter at East St. Louis, Ill. The Pend Oreille Mines & Metals Co. has a contract with the same smelter but, under special instructions from the War Production Board, shipped its concentrates to Great Falls, Mont., during part of the war. The freight charges on zinc and lead concentrates to East St. Louis, Ill., are $10.50 a ton. The treatment charges are $31.50 a ton. Several interests have plans under consideration for the establishment of an electrolytic zinc plant in or near the district.

COST OF PRODUCTION

A decrease in production and an increase in costs were experienced during the war years by the operating companies of the district. This situation is attributed mainly to higher wages and Federal taxes and manpower shortage. In 1940 these companies were drilling extensively to extend the limits of the ore deposits and were active in opening and developing ore reserves by underworkings. Because of conditions brought about by the war, such company exploration and development soon had to be curtailed drastically and had almost ceased by 1944. Owing to the serious labor shortage, the Pend Oreille Mines & Metals Co. by the end of the war was able to operate its mine on a one-shift basis only. It employed but 20 men underground. This condition forced the mill to operate at less than half its normal capacity. Other operations in the district were affected similarly.

The following production and cost figures were compiled from the published annual reports of the Pend Oreille Mines & Metals Co. for the year ended April 30, 1940, a fairly normal year, and for the year ended April 30, 1945. These figures provide comparative data for the last pre-war year and the last war year:

TABLE 2. - Production data and costs, Pend Oreille Mines & Metals Co.

	Year ended April 30, 1940	Year ended April 30, 1945
Tons of ore mined and milled	233,339	139,516
Dry tons of concentrates produced	18,851	8,677
Yield of zinc, lb.	19,625,300	7,616,502
Yield of lead, lb.	4,645,870	3,781,677
Operating costs, per ton:		
Mining	$1.31	$2.059
Diamond drilling	0.06	-
Milling	0.51	0.783
Other direct operating costs	0.20	0.304
Total direct operating costs	2.08	3.146

TABLE 2. - Production data and costs, Pend Oreille Mines & Metals Co. (Cont'd.)

	Year ended April 30, 1940	Year ended April 30, 1945
Operating costs, per ton: (Cont'd.)		
Taxes	$0.13	$0.152
General expenses	0.13	0.185
Total operating costs	2.34	3.483
Income: Receipts from ore sales	770,231.66	684,458.03
Total operating costs	554,914.64	486,033.79
Operating profit 1/	215,317.02	198,424.24

1/ Before depreciation, depletion, and Federal taxes.

WORK BY THE BUREAU OF MINES

The Bureau of Mines project in the Metaline district began January 15, 1943. Drilling started February 8, 1943, and, except for several recesses during the most severe winter months, continued until August 6, 1945. The project was terminated September 8, 1945.

During this period 45 holes were drilled in seven areas. The total footage drilled was 38,149.69 feet. Table 3, which follows, provides data on the number of holes, the range in depth of holes, the footage drilled, footage drilled in the various formations, and the ore summarized according to the area and in total. Additional and more detailed information on the drilling done in the various areas is given under their separate headings and in table 4.

TABLE 3. - Summary of Bureau of Mines drilling Metaline District, Washington

Area	No. of holes	Range in depth, ft.	Total footage	Footage drilled in -		
				Overburden	Ledbetter slate	Metaline limestone, dolomite, ore, etc. 1/
North Pend Oreille	15	691-1821	20,840.37	659.00	17,063.75	3,117.62
West Bella May	18	176-957	10,349.15	398.25	5,386.45	4,564.45
Washington Rock	3	293-624	1,433.42	24.00	509.00	900.42
Josephine mine, underground	1	1361	1,361.00	-	-	1,361.00
South Josephine	4	154-229	745.00	128.00	-	617.00
Slate Creek	1	2050	2,050.00	10.00	2,040.00	-
Flume Creek	3	220-608	1,370.75	922.00	-	1/448.75
Total	45	-	38,149.69	2,141.25	24,999.20	11,009.24

1/ Includes quartzite, phyllite and schist.

Drilling Equipment and Procedure

All drilling was done under contract by J. L. Havlick, diamond core-drill contractor of Spokane, Wash., under Bureau of Mines supervision.

A Sullivan 22HD-E screw feed drill was used for drilling the deeper holes and a Boyles Bros. BBS-1E screw feed drill for shallower holes. Drilling through overburden was accomplished with the diamond drill rig by churn drilling and standpiping with 3-inch or 6-inch standard well casing. The size of hole and casing was governed by the depth of overburden to be penetrated. Nearly 92 percent of all drilling in rock was of EX size. Larger bit sizes were used only for relatively short distances below bedrock in badly fractured rock. EX plug bits with a small central opening were used in drilling in the Ledbetter slate; their use in this formation greatly increased the speed of drilling and lowered the cost. These plug bits, with a special adapter in the EX core barrel, provided pencil cores 3/16 or 5/16 inch in diameter. In addition to pencil cores, regular-size EX cores also were taken in 2- to 5-foot sections at each 100- or 200-foot interval.

Double-tube ball-bearing core barrels were used for all core drilling. All bits were set with bortz. Over 90 percent of the drill bits were hand set; other bits were of the cast type.

A summary of this drilling follows:

Size or type	Feet
BX hole	77.75
AX hole	1,064.00
EX standard and plug-bit drilling	34,905.69
Standpipe drilling	2,102.25
Footage reamed	3,166.07
Footage cased	3,357.49
Footage cemented	351.16

The average contract cost of all drilling was $4.745 a foot. This included the cost of standpiping through overburden, all drilling, reaming, casing, and cementing. Also included was payment for the use of the drill and for drilling time lost to the contractor while the holes were surveyed.

Sampling

Core recovery from ore and mineralized sections generally ranged from 90 to 100 percent, except where badly fractured or when solid sulfides or porous or vuggy ores were encountered. Sludges were recovered, also, from most of the ore and mineralized sections. When the core recovery in the ore sections was less than 90 percent and sludge recoveries were dependable, the assays of the core and sludge were adjusted according to the Longyear formula.

4,076 core and sludge samples were taken for assay. These samples were assayed in the laboratories of the Bureau of Mines at Reno, Nev., and at Salt Lake City, Utah.

Surveying of Drill Holes

All holes except No. 24 were drilled from surface locations. Hole 24 was drilled from an underground station. With the exception of hole 5, which was a 55° down hole, all holes were started in a vertical position.

Drill holes were first surveyed with a Mass compass, but its use soon was discontinued in favor of the Carlson compass. The gelatine solutions used and the procedure at first followed were found unsatisfactory and unreliable owing to temperature increases in the deeper holes. Dependable gelatin solutions were developed after much experimentation. This permitted the development of a reliable technique for drill-hole surveying with the Carlson compass. Carlson compass surveys were checked by acid etch tube readings.

Twenty-five drill holes (hole 10 and holes 15 to 38, inclusive) with a combined length of 26,251 feet were surveyed both by the Bureau of Mines and the Federal Geological Survey. The respective results were in close agreement. These surveys showed that most of these holes, particularly the deeper ones, had been deflected both horizontally and vertically. Such deflection or drifting is common in drilling in the district, especially in the Ledbetter slate formation. Maximum horizontal deflections from the vertical position occurred in holes 10, 16, and 19. These deflections were, respectively, 860, 845, and 660 feet.

Tests and studies made by the Bureau engineers and the drill contractor indicated that an off-center, nonconcentric reamer shell might have caused excessive deflection. A worn reamer shell of true concentricity was next used in drilling hole 23, and everything possible was done to hold deflection to a minimum. The same reamer shell was used, and the same procedure was followed in drilling hole 25. Surveys showed the maximum deflection in these two holes to be 360 and 280 feet, respectively. With such procedure, deflection was found to be reduced considerably in all subsequently drilled holes. Studies disclosed that holes in the slate formation had a marked tendancy to be deflected normal or nearly normal to the observed cleavage planes. The holes in the limestone formation usually went quite straight.

AREAS DRILLED

North Pend Oreille Area

The North Pend Oreille area is on the east side of the Pend Oreille River, adjacent to the Pend Oreille mine area, and extends from the Grandview mine property northward to Three Mile Creek. This area comprises 320 acres of unpatented lode mining claims and 320 acres of patented homestead and mineral rights. It is owned by the Pend Oreille Mines & Metals Co. The Pend Oreille Mines & Metals Co. had drilled 80 holes immediately south of this area. The Bureau of Mines drilled 15 holes at irregular spacing, ranging from 800 to 1,500 feet, within an area of approximately 275 acres. The company later drilled four holes, intermediately spaced, between some holes drilled by the Bureau of Mines.

Drilling by the Bureau of Mines in this area greatly extended the formerly known limits of the ore-bearing horizon. The location of the holes drilled by the Bureau of Mines is shown in figure 6. Graphic logs of the drill holes are shown in figure 7. Additional details are given in table 4.

West Bella May Area

The West Bella May area adjoins and lies northwest of the Bella May mine workings. It comprises about 130 acres of patented and unpatented lode claims and mineral rights on patented homesteads in sec. 30, T. 39 N., R. 43 E. The claims and other mineral rights are owned by the Metaline Contact Mines Co., which is controlled by the Metaline Mining and Leasing Co. It is a much faulted area of rugged relief and was virtually unexplored prior to the drilling done by the Bureau of Mines.

The Bureau of Mines drilled 18 irregularly spaced holes 100 to 650 feet apart within an area of about 50 acres. This drilling provided valuable data on ore deposition and also provided geologic and structural information that will be most helpful for further exploration and development of the area. The ore reserves indicated by this drilling are at an altitude well above the main haulage level of the Bella May mine, from which they can be developed and mined. The location of the Bureau drill holes in the area is shown in figure 6. Graphic logs of the drill holes are shown in figure 8. Additional details are provided in table 4.

Washington Rock Area

The Washington Rock area is in an overthrust block in the vicinity of Washington Rock, southeast of center between the Slate Creek fault and the Flume Creek fault. Washington Rock is just north of Metaline Falls, on the west side of the Pend Oreille River, about 4,000 feet south of the Pend Oreille mine. A detailed survey and geological study was made of this area by the Federal Geological Survey. Their conclusion was that the Metaline limestone in this area had been thrust over the Ledbetter slate and that, in normal succession, the limestone should be found to underlie this slate. Some drilling in this area was considered justified.

With such recommendation the Bureau of Mines drilled three holes in this area at places designated by the Survey. Figure 9 shows the locations of these holes, pertinent geological data, and other features.

Hole 20, after passing through 7 feet of overburden and 125 feet of slate, entered a light-gray dolomitic limestone and continued in it for 161 feet without encountering any mineralization. This dolomitic limestone is not characteristic of the upper 500 feet of the Metaline formation. Hence, the possibilities for encountering any ore deposition at a reasonable depth were considered to be unfavorable; consequently, the hole was discontinued at a depth of 293.17 feet.

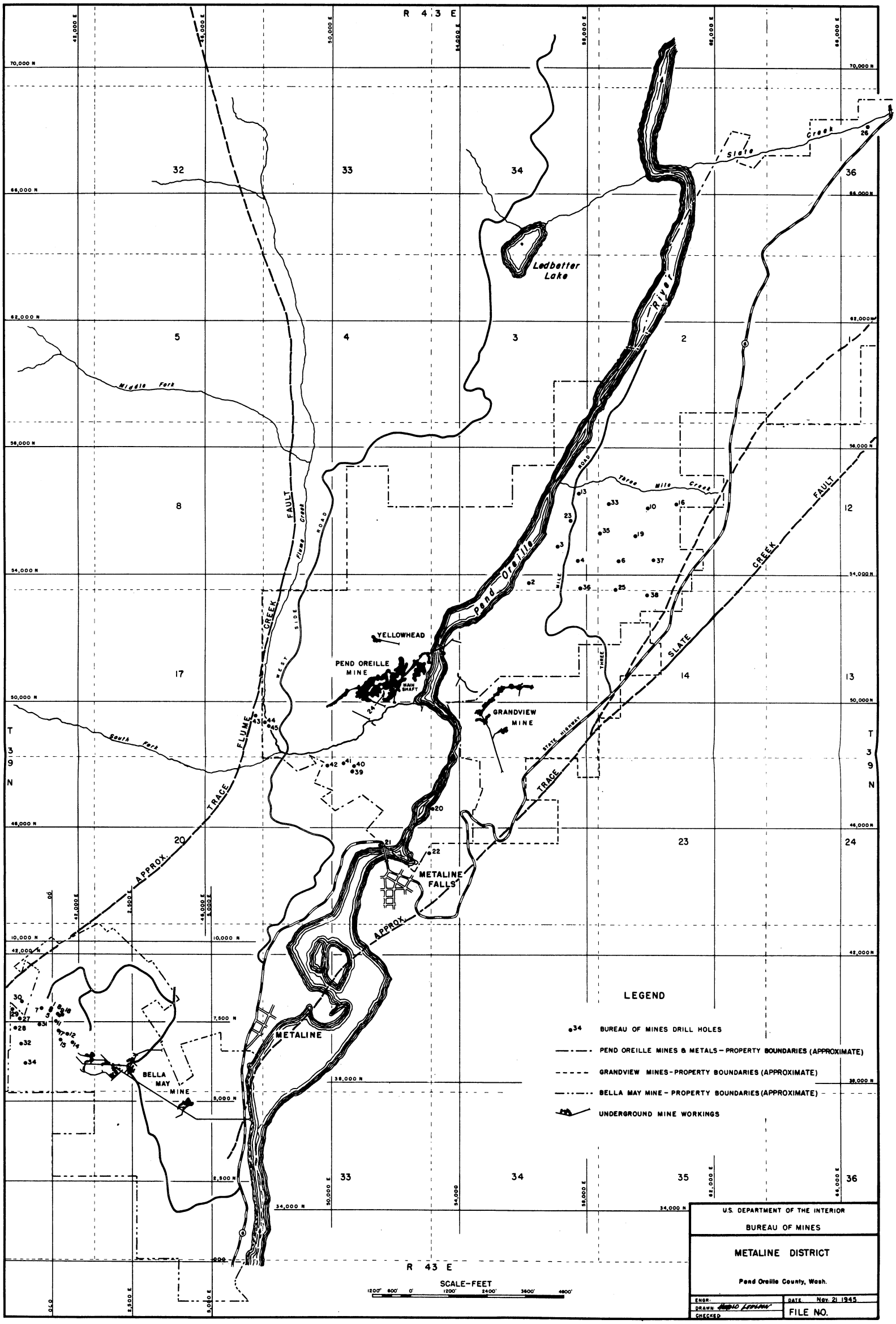


Figure 6. - General map showing location of Bureau of Mines drill holes and the principal mine workings.

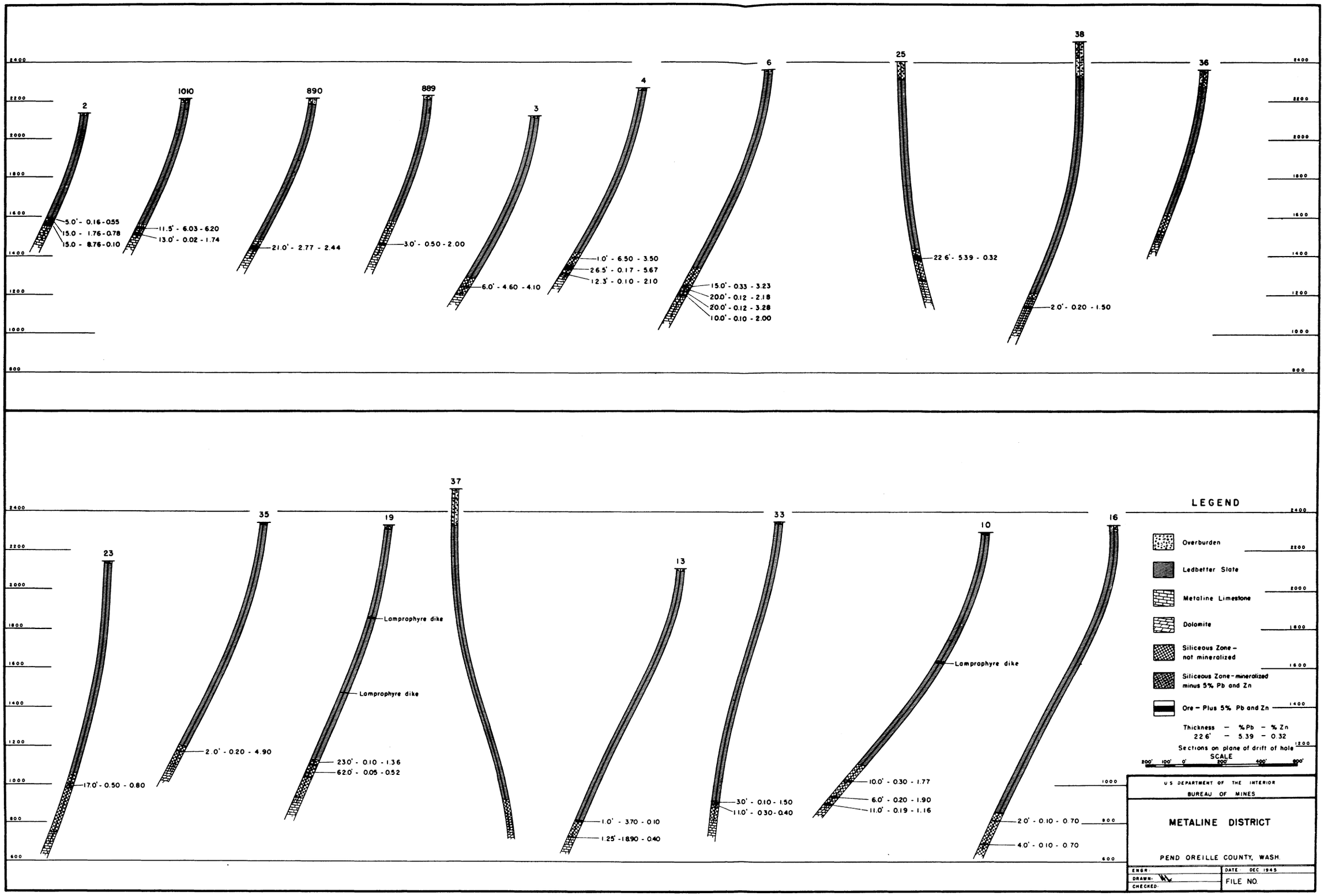


Figure 7. - Graphic drill hole logs with assays - North Pend Oreille area.

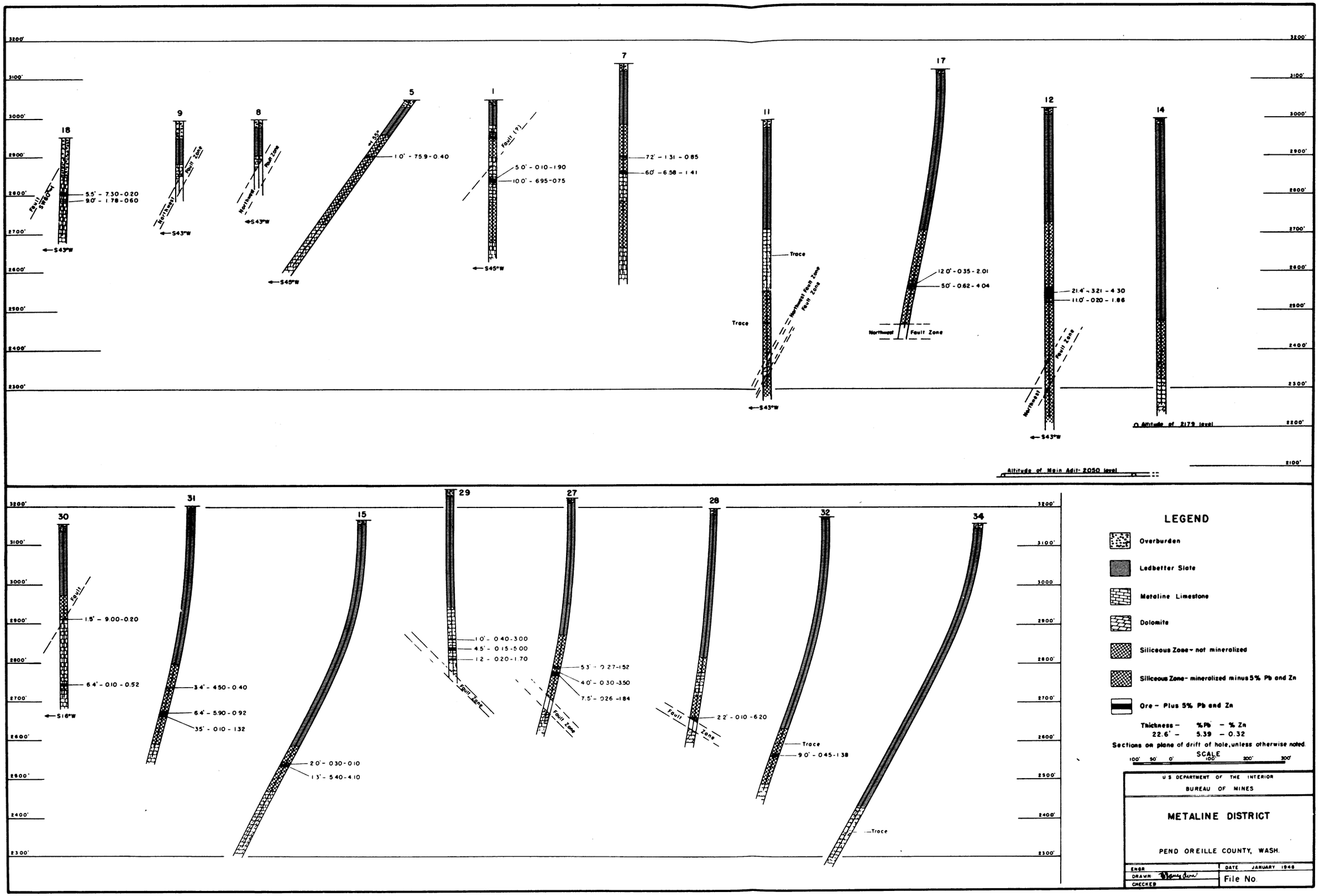


Figure 8. - Graphic drill hole logs with assays - West Bella May area.

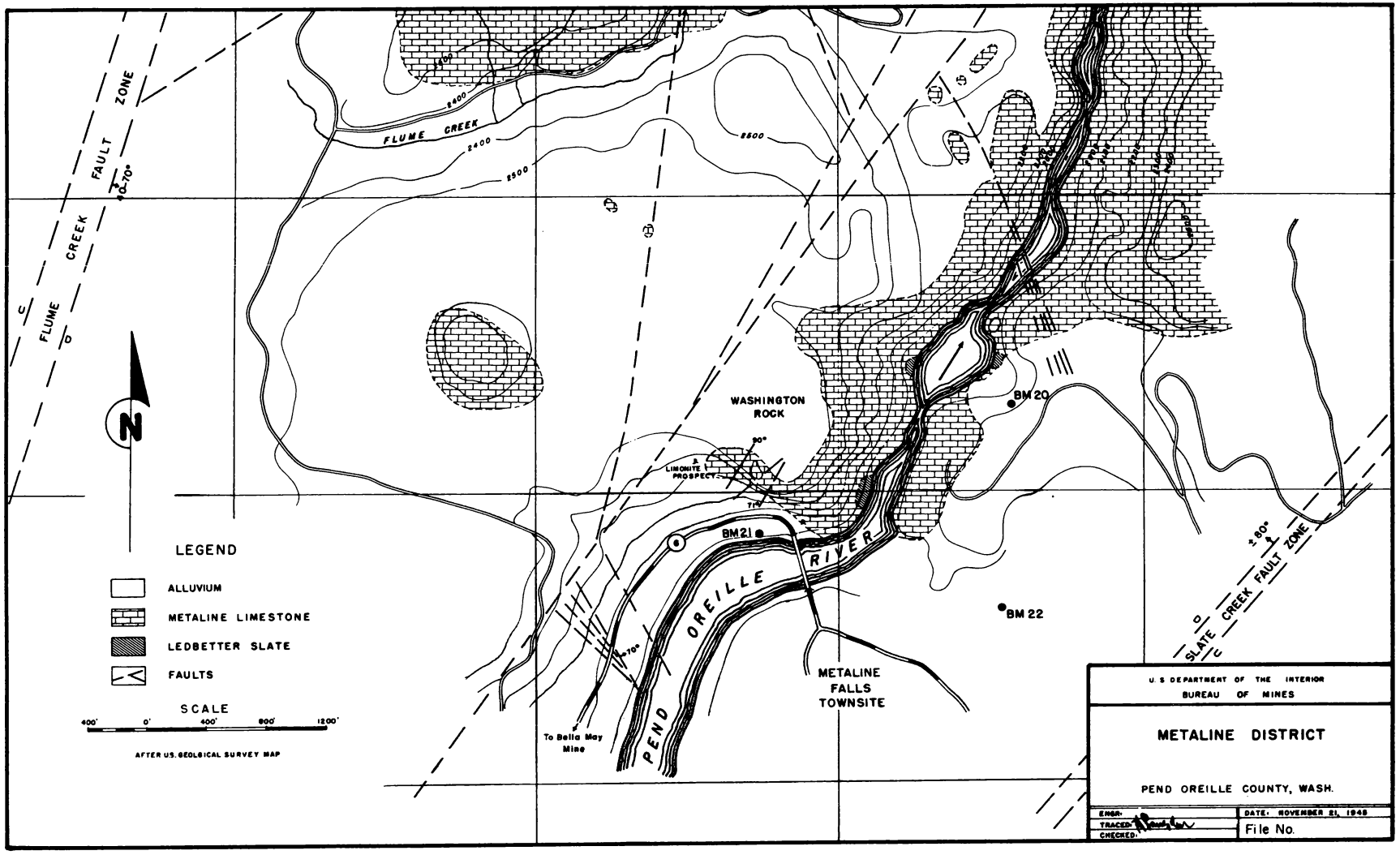


Figure 9. - Washington Rock area.

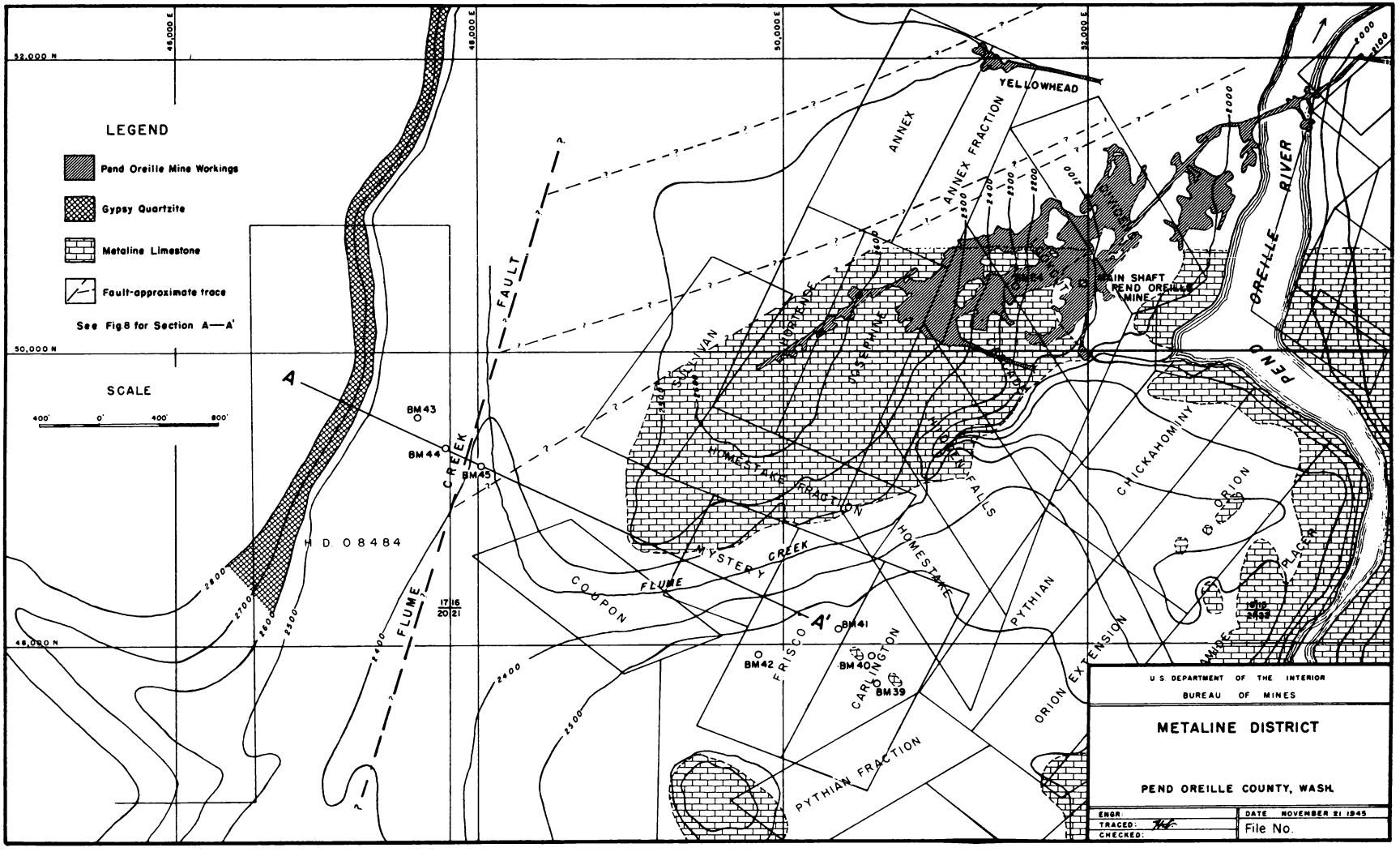


Figure 10. - Pend Oreille mine, South Josephine, and Flume Creek areas.

Hole 21 went through 5 feet of overburden and for the next 49 feet was in limestone. The upper 4.83 feet of this limestone was mineralized only with pyrite, but directly beneath the drill passed through 2.67 feet of ore containing pyrite, sphalerite, and a little galena assaying 15.1 percent zinc and 0.20 percent lead. The character of this ore resembles that of the Yellowhead ore body. From a depth of 54 feet to 372 feet the drill passed through 316 feet of slate and 2 feet of schist. From 372 feet to 624 feet it passed through 252 feet of unmineralized phyllitic limestone similar to that of the lower Metaline series. The hole was stopped at a depth of 624 feet.

Hole 22 was drilled mainly as a triangular control for the correlation of the underlying limestone formation. It was drilled to a depth of 516.25 feet. It passed successively, through 12 feet of overburden, 48 feet of limestone, 22 feet of slate, 4 feet of limestone, 44 feet of slate, 272 feet of dolomitic limestone, and 114.25 feet of phyllitic limestone. No mineralization was encountered.

Where drilled in this area, the limestone underlying the slate appears to be similar in general character to the limestone of the lower Metaline series; therefore, it may be much lower in the geologic column than the principal known ore-bearing horizon that is in the upper Metaline formation.

South Josephine Area

The South Josephine area is southwest of and adjacent to the Pend Oreille mine; it is south of Flume Creek and west of the Pend Oreille River. Some mineralization is exposed in an outcropping in the Metaline limestone on the Carlington claim. Four holes were drilled by the Bureau of Mines - two on the Carlington claim and two on the Frisco claim, which adjoins the Carlington claim on the west.

Hole 39 was drilled near the outcropping on the Carlington claim to a depth of 198 feet, all in an unmineralized dolomite and limestone. Hole 40, after passing through 20 feet of overburden, continued in unmineralized dolomite and calcite to a depth of 154 feet. Hole 41 was drilled to a depth of 229 feet. It passed through 69 feet of overburden, 70 feet of dolomite and limestone with some calcite, and then into 90 feet of gray dolomite and limestone. A fractured zone containing some slate drag, indicating a fault zone, was encountered at a depth of 139 feet. Hole 42 went through 39 feet of overburden into unmineralized gray dolomite for 125 feet. The hole was stopped at a depth of 164 feet.

These four holes encountered no mineralization. They indicate that the mineralized ore horizon in this area has been almost entirely removed by erosion. The location of these holes and other features are shown in figure 10.

Josephine Mine Area

The operating companies in the Metaline district had for some time considered further testing of the Metaline limestone series to depths well below the principal known ore horizon. The Yellowhead deposit in an upfaulted block north of the Josephine mine is generally considered to be in an ore horizon about 800 feet below the Ledbetter slate-Metaline limestone contact. The ore

horizon in the Reeves McDonald mine, just over the border in Canada, is in a still lower horizon. Some geologists are of the opinion that the Reeves-McDonald ore is in the lower Metaline limestone series, probably about 2,500 feet below the slate-limestone contact. Other geologists consider it to be still lower, possibly in the upper part of the Maitlen formation.

Equipment capable of core drilling to a depth of 3,000 feet or more was not available at the time. Nevertheless, the Bureau of Mines decided on an initial test hole to be drilled as deep as the available equipment could go. For this purpose hole 24 was drilled from the bottom of stope 7-71 in the Josephine (Pend Oreille) mine, where the Metaline limestone is exposed overhead and at the surface. The collar of this hole is at an altitude of 2,025 feet 140 feet below the surface. Its location for such testing was considered to be one of the most favorable in the area.

Hole 24 was started vertical and drilled to a depth of 1,361 feet. The first 837 feet were drilled AX size and the remainder EX size. Surveys show that its maximum horizontal deflection at the bottom was 90 feet. The summarized log of hole 24 follows:

Depth, feet	Thickness, feet	Formation and assays
0-9	9	Silicified, fine-grained, gray limestone; no mineralization.
9-25	16	Silicified, fine-grained, gray, mineralized limestone. Assay, 10.7 percent zinc, 0.01 percent lead.
25-452	427	Fine-grained, gray limestone (footwall of principal ore-horizon); no mineralization.
452-516	64	Coarse crystalline calcite.
516-525	9	Fine-grained, gray limestone; no mineralization.
525-968	443	Gray dolomite, mainly. From 938-944, brecciated, a trace of mineralization.
968-1007	39	Fault zone; brecciated dolomite.
1007-1012	5	Gray dolomite, mineralized. Assay, 2.8 percent zinc, 0.2 percent lead.
1012-1361	349	Gray dolomite mainly. No mineralization.

No ore was found below 25 feet. Mineralization at 1007 to 1012 feet, however, may indicate another ore horizon.

Hole 24 and the formation overhead provide a section of the Metaline limestone formation about 1,500 feet thick. This hole would have to be deepened about 1,500 feet to cut the entire thickness of the Metaline series. The collar casing in this hole was left intact and capped, should its deepening later be desirable. The location of hole 24 is shown in figure 10.

Slate Creek Area

Drilling by the Bureau of Mines in the North Pend Oreilla area confirmed the extension of the favorable ore horizon east of the Pend Oreille River as far north as Three Mile Creek. It also proved that the Ledbetter slate overlying the Metaline limestone becomes thicker to the north. However, it was

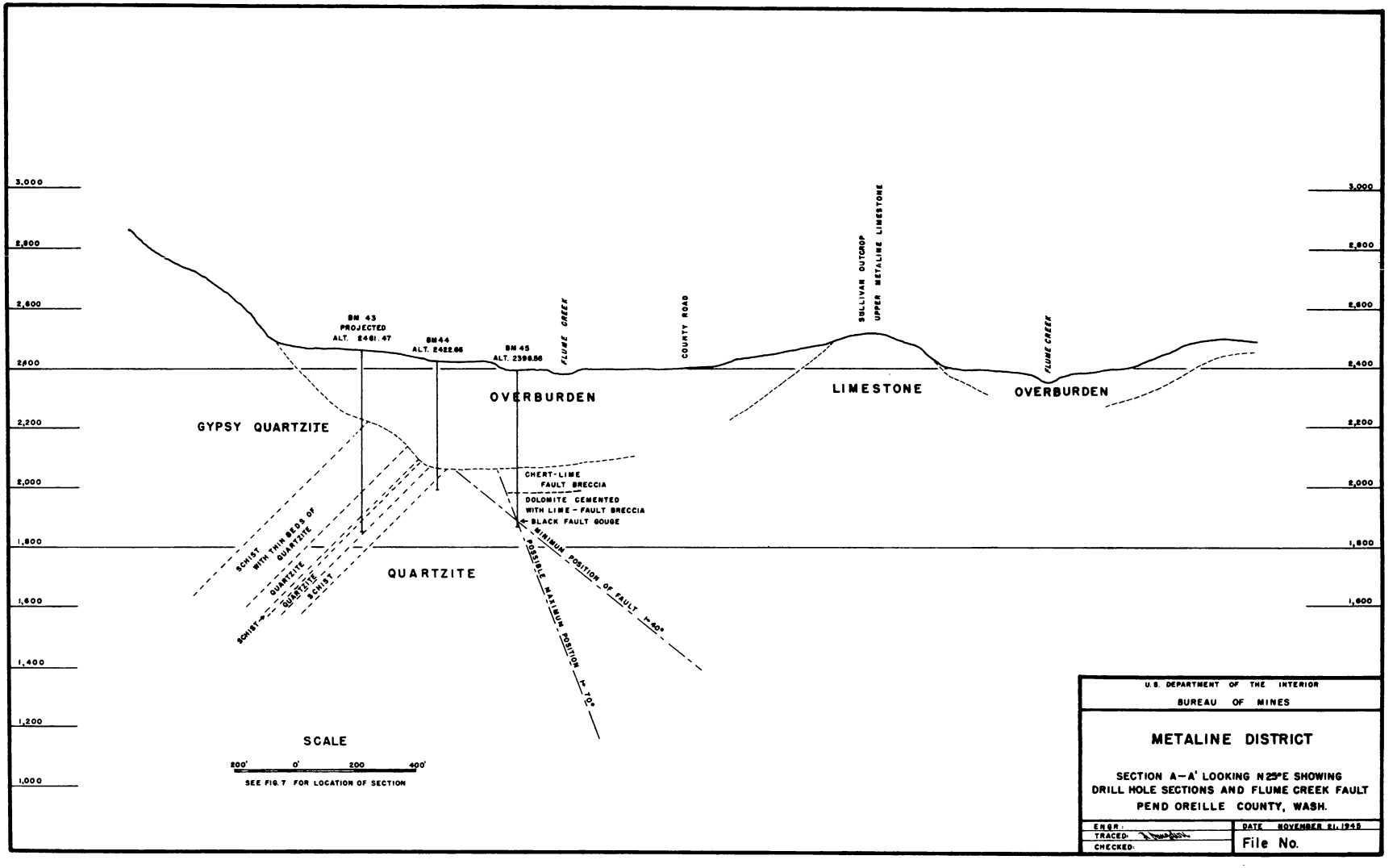


Figure 11. - Flume Creek area cross-section.

not known whether the Ledbetter slate would maintain its normal northerly dip in the area north of Three Mile Creek. The distance from Three Mile Creek to Slate Creek is about 14,000 feet. Detailed surveys and geological studies were made in that area by the Federal Geological Survey. As a result drilling a deep hole at the site designated was recommended.

Hole 26 therefore was drilled in the gorge of Slate Creek at an altitude of 2,340 feet. The location selected was several hundred feet downstream from the bridge on Highway 6, in the NE 1/4 of sec. 36, T. 40 N., R. 43 E., on the No. 80 lode mining claim of the Pend Oreille Mines & Metals Co. This hole was drilled to a depth of 2,050 feet, the limit of the equipment. Except for 10 feet of overburden, the hole was entirely in the Ledbetter slate formation. Some thin beds of quartzite were interstratified with the slates.

Above the 1,100-foot mark, the only core that showed bedding was obtained at 302 feet; at this point the bedding dipped 17-1/2°. Below the 1,100-foot depth, the dip ranged from 74° to 79°. This was interpreted to mean folding or faulting. The survey of this hole showed a deflection of 8° from the vertical in the upper portion to 16-1/2° at the bottom. The total horizontal deflection from the vertical was 295 feet.

Hole 26 was the longest drilled in the district by the Bureau of Mines and was also the deepest penetration in the Ledbetter slate formation. The depth at which the Metaline limestone contact could be reached at this point remains unknown.

Flume Creek Area

The Flume Creek fault, according to Park and Cannon,[11] has a known vertical displacement of at least 10,000 feet. Although its attitude is not accurately known, its comparatively straight trace indicated the dip as probably being steep or vertical. Most of the area west of this fault within the Flume Creek-Russian Creek fault block is underlain by the Maitlen phyllite and the Gypsy quartzite formations. Some of the upper part of the underlying Monk formation is exposed along the Flume Creek fault.

An area along Flume Creek between the Flume Creek fault and the exposed Metaline limestone to the east, southwest of the Sullivan outcrop, was considered to be one of the most favorable areas in which to explore for the western and southern extensions of the Metaline ore horizon. It also was considered to be a favorable area in which to obtain structural data on the Flume Creek fault. The Bureau of Mines therefore drilled three holes, Nos. 43, 44, and 45, in this area. The locations of these holes and other data are shown in figures 10 and 11.

Hole 43 was drilled through 231 feet of overburden, then through 19 feet of slightly fractured Gypsy quartzite that contained some scattered sparse mineralization of pyrite, galena, chalcopyrite, and molybdenite. The hole then passed through 16 feet of unmineralized quartzite and then 208 feet of phyllitic schist containing some thin beds of quartzite. Considerable

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11/ Park, C. F., Jr., and Cannon, R. S., Jr., op. cit., p. 28.

specular hematite is present in the schist. From a depth of 474 feet down to the bottom of the hole at 608 feet, the formation was mainly quartzite. Bedding planes crossed in the lower part of this hole showed a dip of 45°.

Hole 44, after going through 361 feet of overburden, 34 feet of schist, and 37.75 feet of quartzite, was stopped at a depth of 432.75 feet. No mineralization was found.

Hole 45 was drilled through overburden to a depth of 330 feet. The Pend Oreille Mines & Metals Co. continued this hole and reached bedrock at 331.5 feet. From 331.5 to 411 feet, the drill was in an unmineralized chert-lime fault breccia; from 411 to 503 feet, in unmineralized fault breccia of dolomite cemented with lime. From 503 to 511 feet, the drill went through 8 feet of tough black fault gouge. From there to the bottom of the hole, at 526 feet, the drill was in an unmineralized schistose quartzite. This quartzite is considered to be on the footwall side of the Flume Creek fault.

The drilling in the Flume Creek area indicates the relative positions of the foot and hanging walls of the Flume Creek fault. It also indicates that the fault dips to the east at an angle somewhere between 40° and 70°. To establish the possibilities of an ore horizon in the Metaline limestone on the hanging-wall side of the fault, additional drilling east of the fault will be required. Such drilling, if continued deep enough to cut the Flume Creek fault also, should provide information that would determine the attitude of the fault more definitely. Figure 11 is a cross section looking north along Flume Creek and the Flume Creek fault.

PERTINENT DATA ON BUREAU OF MINES DRILL HOLES AND ANALYSES

Table 4, which follows, provides additional pertinent data on all of the holes drilled by the Bureau of Mines in the various areas in the Metaline district.

TABLE 4. - Pertinent data on Bureau of Mines drill holes Metaline District, Pend Oreille County, Wash.

Hole no.	Altitude collar of hole	Length of hole as drilled, feet	Ore and mineralized sections as drilled,		Assay, percent		Consolidated data		
			Interval	Thickness	Pb	Zn	Thickness as drilled, feet	Weighted assay, percent Pb	Weighted assay, percent Zn
North Pend Oreille area									
B.M. 2	2138.0	691.0	595-600	5.0	0.16	0.55			
			600-605	5.0	1.65	1.84			
			605-610	5.0	1.80	0.40	15.0	1.76	0.78
			610-615	5.0	1.84	0.10			
			615-620	5.0	6.40	0.10			
			620-625	5.0	11.78	0.10	15.0	8.76	0.10
			625-630	5.0	8.13	0.10			
B.M. 3.....	2125.78	1011.5	954-955	1.0	13.30	5.60	6.0	4.60	4.10
			955-960	5.0	2.84	3.80			
			960-961	1.0	0.10	0.40			
B.M. 4.....	2270.14	1084.9	972-973	1.0	6.50	3.50	1.0	6.50	3.50
			998.5-1000	1.5	0.30	3.50			
			1000-1005	5.0	0.30	7.40			
			1005-1010	5.0	0.10	3.60	26.5	0.17	5.67
			1010-1015	5.0	0.10	10.40			
			1015-1020	5.0	0.20	3.20			
			1020-1025	5.0	0.10	4.40			
			1042.7-1045	2.3	0.10	2.00			
			1045-1050	5.0	0.10	2.30	12.3	0.10	2.10
			1050-1055	5.0	0.10	2.00			
B.M. 6.....	2361.75	1386.7	1200-1205	5.0	0.20	3.00			
			1205-1210	5.0	0.40	3.00	15.0	0.33	3.23
			1210-1215	5.0	0.40	3.70			
			1215-1220	5.0	0.20	1.80			
			1220-1225	5.0	0.10	1.90	20.0	0.12	2.18
			1225-1230	5.0	0.10	2.40			
			1230-1235	5.0	0.10	2.60			

TABLE 4. - Pertinent data on Bureau of Mines drill holes Metaline District, Pend Oreille County, Wash., Cont'd.

Hole no.	Altitude collar of hole	Length of hole as drilled, feet	Ore and mineralized sections as drilled, Interval	Thickness	Assay, percent Pb	Zn	Consolidated data: Thickness as drilled, feet	Weighted assay, percent Pb	Zn
North Pend Oreille area, cont'd.									
B.M. 6.....			1235-1240	5.0	0.10	2.90			
			1240-1245	5.0	0.10	4.50	20.0	0.12	3.28
			1245-1250	5.0	0.20	2.30			
			1250-1255	5.0	0.10	3.40			
			1255-1260	5.0	0.10	2.70			
			1260-1265	5.0	0.10	1.30	10.0	0.10	2.00
			1265-1270	5.0	0.10	0.50			
B.M. 10.....	2292.29	1683.67	1470-1475	5.0	0.30	0.60			
			1475-1480	5.0	0.30	2.15			
			1480-1485	5.0	0.30	1.40	10.0	0.30	1.77
			1555-1559	4.0	0.20	1.00			
			1581-1585	4.0	0.20	1.85			
			1585-1587	2.0	0.20	2.00	6.0	0.20	1.90
			1624-1625	1.0	0.10	1.05			
			1625-1630	5.0	0.20	1.20	11.0	0.19	1.16
			1630-1635	5.0	0.20	1.15			
			1635-1638	3.0	0.20	0.60			
B.M. 13.....	2115.42	1547.0	1415-1420	5.0	0.10	0.10			
			1420-1421	1.0	3.70	0.10	1.0	3.70	0.10
			1508.75-1510	1.25	18.90	0.40	1.25	18.90	0.40
B.M. 16.....	2331.19	1821.0	1683-1685	2.0	0.10	0.70			
			1795-1799	4.0	0.10	0.70			
B.M. 19.....	2325.44	1643.67	1281-1285	4.0	0.10	1.30			
			1285-1290	5.0	0.10	1.40	23.0	0.10	1.36
			1290-1295	5.0	0.10	2.00			
			1302-1304	2.0	0.10	4.60			

TABLE 4. - Pertinent data on Bureau of Mines drill holes Metaline District, Pend Oreille County, Wash., cont'd.

Hole no.	Altitude collar of hole	Length of hole as drilled, feet	Ore and mineralized sections as drilled, Interval	Thickness	Assay, percent Pb	Assay, percent Zn	Consolidated data: Thickness as drilled, feet	Consolidated data: Weighted assay, percent Pb	Consolidated data: Weighted assay, percent Zn
North Pend Oreille area, cont'd.									
B.M. 19 (cont'd.)			1311-1316	5.0	0.10	0.95			
			1326-1330	4.0	0.10	1.15			
			1330-1335.9	5.9	0.10	0.75			
			1342.4-1344.2	1.8	0.10	1.35	62.0	0.05	0.52
			1345-1348.8	3.8	0.10	0.75			
			1350-1355	5.0	0.10	0.30			
			1355-1358	3.0	0.10	0.50			
			1363-1368	5.0	0.10	0.75			
			1368-1373	5.0	0.10	1.20			
			1433-1438	5.0	0.10	0.15			
			1495-1496	1.0	0.10	0.40			
			1520-1525	5.0	0.10	0.20			
B.M. 23.....	2141.19	1493.0	1164-1167	3.0	0.15	0.80			
			1171-1176	5.0	0.50	1.30			
			1179-1181	2.0	2.40	1.10	17.0	0.50	0.80
			1186-1188	2.0	0.50	2.25			
B.M. 25.....	2409.5	1230.0	1003-1005	2.0	5.10	1.40			
			1012.5-1014	1.5	33.20	0.20			
			1018-1019	1.0	33.80	0.20	22.6	5.39	0.32
			1024.3-1025.6	1.3	21.40	3.00			
B.M. 33.....	2348.37	1597.83	1493-1496	3.0	0.10	1.50	3.0	0.10	1.50
			1502.6-1505	2.4	0.30	0.50			
			1505-1510	5.0	0.30	0.40	11.0	0.30	0.40
			1510-1513.6	3.6	0.30	0.30			
			1517-1518.2	1.2	0.30	0.60			

TABLE 4. - Pertinent data on Bureau of Mines drill holes Metaline District, Pend Oreille County, Wash., cont'd.

Hole no.	Altitude collar of hole	Length of hole as drilled, feet	Ore and mineralized sections as drilled, Interval	Thickness	Assay, percent Pb	Assay, percent Zn	Consolidated data: Thickness as drilled, feet	Consolidated data: Weighted assay, percent Pb	Consolidated data: Weighted assay, percent Zn
North Pend Oreille area cont'd.									
B.M. 35.....	2341.67	1381.0	1264-1266	2.0	0.20	4.90	2.0	0.20	4.90
B.M. 36.....	2364.65	933.0	No mineralization						
B.M. 37.....	2513.06	1789.0	No mineralization						
B.M. 38.....	2513.57	1547.1	1419.8-1422	2.2	0.20	1.50			
West Bella May area									
B.M. 1.....	3049.2	390.0	200-205	5.0	0.10	1.90	5.0	0.10	1.90
			205-210	5.0	5.50	0.60			
			210-215	5.0	8.40	0.90	10.0	6.95	0.75
			215-220	5.0	0.10	0.40			
B.M. 5.....	3049.2	530.0	182-183	1.0	75.90	0.40	1.0	75.90	0.40
B.M. 7.....	3140.22	543.66	241.6-243.6	2.0	0.10	1.50			
			243.6-248.8	5.2	1.80	0.60	7.2	1.31	0.85
			248.8-255.6	6.8	0.30	0.10			
			255.6-257.7	2.1	0.10	0.10			
			281-284.8	3.8	8.10	1.60			
			284.8-287.0	2.2	4.00	1.10	6.0	6.58	1.41
			287.0-289.6	2.6	0.10	1.10			
B.M. 8.....	2995.7	176.0	No mineralization						
B.M. 9.....	2995.2	187.4	No mineralization						

TABLE 4. - Pertinent data on Bureau of Mines drill holes Metaline District, Pend Oreille County, Wash., cont'd.

Hole no.	Altitude collar of hole	Length of hole as drilled, feet	Ore and mineralized sections as drilled,		Assay, percent		Consolidated data		
			Interval	Thickness	Pb	Zn	Thickness as drilled, feet	Weighted assay, percent Pb	Zn
West Bella May area, cont'd.									
B.M. 11.....	3098.8	692.17	527-530	3.0	0.10	0.10			
B.M. 12.....	3027.3	800.0	468.6-470	1.4	3.40	4.90			
			470-475	5.0	2.80	7.80			
			480.5-484	3.5	8.80	7.40	21.4	3.21	4.30
			484.5-490	5.5	3.50	3.70			
			493-494.6	1.6	0.50	0.60			
			501.2-504	2.8	0.60	7.10	11.0	0.20	1.86
B.M. 14.....	3000.09	742.17	No mineralization						
B.M. 15.....	3164.2	916.0	666-668	2.0	0.30	0.10			
			672.7-674	1.3	5.40	4.10	1.3	5.40	4.10
B.M. 17.....	3126.0	676.15	558-560	2.0	1.60	2.10			
			560-565	5.0	0.10	2.50	12.0	0.35	2.01
			565-570	5.0	0.10	1.50			
			570-572	2.0	1.40	6.20			
			572-575	3.0	0.10	2.60	5.0	0.62	4.04
			575-579	4.0	0.50	0.70			
B.M. 18.....	2952.4	251.0	143-148.5	5.5	7.30	0.20	5.5	7.30	0.20
			159-164	5.0	0.10	0.20			
			164-168	4.0	3.90	0.60	9.0	1.78	0.38
B.M. 27.....	3222.6	586.0	434.5-437	2.5	0.40	2.80			
			438.7-439.8	1.1	0.40	1.00	5.3	0.27	1.52
			450.5-454.5	4.0	0.30	3.50	4.0	0.30	3.50
			457.5-462	4.5	0.30	2.60			
			462-465	3.0	0.20	0.70	7.5	0.26	1.84

TABLE 4. - Pertinent data on Bureau of Mines drill holes Metaline District, Pend Oreille County, Wash., cont'd.

Hole no.	Altitude collar of hole	Length of hole as drilled, feet	Ore and mineralized sections as drilled, Interval	Thickness	Assay, percent Pb	Assay, percent Zn	Consolidated data: Thickness as drilled, feet	Consolidated data: Weighted assay, percent Pb	Consolidated data: Weighted assay, percent Zn
West Bella May area, cont'd.									
B.M. 28.....	3196.05	590.0	544.5-546.7	2.2	0.10	6.20	2.2	0.10	6.20
B.M. 29.....	3242.9	475.0	384-385	1.0	0.40	3.00	1.0	0.40	3.00
			408.5-411.3	2.8	0.20	6.60			
			412.2-413	0.8	0.20	4.90	4.5	0.15	5.00
			436.8-438	1.2	0.20	1.70	1.2	0.20	1.70
B.M. 30.....	3156.7	444.0	241.8-243.3	1.5	9.00	0.20	1.5	9.00	0.20
			410.5-411.3	0.8	0.12	0.92			
			416.2-416.9	0.7	0.45	2.42	6.4	0.10	0.52
B.M. 31.....	3202.7	660.0	477.6-481	3.4	4.50	0.40	3.4	4.50	0.40
			540.8-547.2	6.4	5.90	0.92	6.4	5.90	0.92
			551-554.5	3.5	0.10	1.32	3.5	0.10	1.32
B.M. 32.....	3172.9	732.0	630-635	5.0	0.20	1.20			
			635-639	4.0	0.10	1.60	9.0	0.45	1.38
B.M. 34.....	3155.3	957.0	878-879	1.0	Trace	Trace			
Washington Rock area									
B.M. 20.....	1970.14	293.17	No mineralization						
B.M. 21.....	2012.0	624.0	9.8-12.5	2.7	0.20	15.10	2.7	0.20	15.10
B.M. 22.....	2007.75	516.25	No mineralization						

TABLE 4. - Pertinent data on Bureau of Mines drill holes Metaline District, Pend Oreille County, Wash., cont'd.

Hole no.	Altitude collar of hole	Length of hole as drilled, feet	Ore and mineralized sections as drilled, Interval	Thickness	Assay, percent Pb	Zn	Consolidated data: Thickness as drilled, feet	Weighted assay, percent Pb	Zn
Josephine mine, underground									
B.M. 24.....	2025.0	1361.0	9-14	5.0	0.10	4.30			
			14-15	1.0	0.10	21.90	16.0	0.10	10.07
			15-20	5.0	0.10	20.20			
			20-25	5.0	0.10	3.35			
			1007-1012	5.0	0.20	2.80			
South Josephine area									
B.M. 39.....	2546.1	198.0	No mineralization						
B.M. 40.....	2538.73	154.0	No mineralization						
B.M. 41.....	2536.68	229.0	No mineralization						
B.M. 42.....	2539.87	164.0	No mineralization						
Slate Creek area									
B.M. 26.....	2340.0	2050	No mineralization - All in slate.						
Flume Creek area									
B.M. 43.....	2461.47	608.0	231-250	Sparse mineralization in Gypsy quartzite.					
B.M. 44.....	2422.66	432.75	No mineralization						
B.M. 45.....	2398.56	526.0	No mineralization						