State of Washington
ALBERT D. ROSELLINI, Governor

Department of Conservation
EARL COE, Director

DIVISION OF MINES AND GEOLOGY
MARSHALL T. HUNTTING, Supervisor

Bulletin No. 51

BARITE IN WASHINGTON

By
WAYNE S. MOEN

For sale by Department of Conservation, Olympia, Washington.
Price, $1.00.

FOREWORD

Barite is an essential raw material in several important industries, but it is familiar to relatively few people. It is not unusual in appearance, and a person might fail to recognize the mineral upon visual examination, but almost anyone who might pick up a sample would notice its unusually high specific gravity (heavy weight). It is this high specific gravity that gives barite its value in its most important use—as a weighting agent in oil well-drilling mud.

In recent years about half a million tons of barite has been mined annually in the United States, and during the past few years Washington deposits have made small contributions toward that total. Our recent production has averaged about one-half of one percent of the total for the United States. Although this may not seem to be a major item in our economy or even in our total State mineral production, it is considered to be important and has provided employment to a few people here.

We have felt that the expected continued demand for barite for drilling muds to be used in Alaska will result in a long-term demand for Washington barite. Because of this anticipated demand and because we have felt that there is an excellent possibility that new and larger deposits of barite could be found and mined in Washington, an investigation of our barite resources was initiated. This report is the product of that investigation.

Recognition of the need for more information on barite resources of the Northwest was evident when the Industrial Raw Materials Advisory Committee of the Department of Commerce and Economic Development recommended that a comprehensive survey be made of the barite resources of Washington. The committee also recommended that its Department proceed with a barite market survey. We had already started the barite resource survey at the time the recommendation was made, and the market survey made by the Department of Commerce and Economic Development showed that there was, in fact, an expanding market in the region.

We feel that this report, giving details of 28 known barite mines and prospects in Stevens and Pend Oreille Counties, is especially timely and will be valuable to those who will be seeking new sources of barite in Washington in the future.

Marshall T. Huntting, Supervisor
Division of Mines and Geology
Olympia, Washington

December 1, 1963

CONTENTS

ILLUSTRATIONS

TABLES

BARITE IN WASHINGTON

By Wayne S. Moen

INTRODUCTION

Since about 1938 the barite deposits of Washington have supplied, to out-of-State markets, a small amount of barite for glass, paint, petroleum, and other industries that require barium or barium compounds. When new oil fields were discovered in Alaska in 1957, the demand for barite on the west coast increased. Because of its proximity to Alaska, Washington was in a favored position and was able to supply about 2,500 tons annually to the Alaskan market. This amount, however, represents only about 10 percent of the total barite that passes through Washington ports en route to Alaska; the remaining 90 percent is supplied by Montana, Nevada, California, and Missouri.

Within the United States the market for barite has been growing, but the market is subject to yearly fluctuations (fig. 1, p. 9). The oil and gas well-drilling industry is the major consumer of ground barite, but its changing demands are responsible for the greatest fluctuations in the market. The demand for ground barite by other industries tends to remain steady. Since 1952 the demand for lump barite in the manufacture of lithopone has decreased, because titanium pigments are being substituted for lithopone in many uses.

This report describes the barite deposits of Washington and presents general information on the properties, uses, specifications, possible markets, and prices of barite. The report is divided into two parts; the first part contains general information on barite, and the second part gives the geology of the barite deposits of the State and their ore reserves. Where known, the history of the property is briefly discussed.

The barite deposits of Washington were examined by the writer in the fall of 1961 and the spring of 1962. In the course of the field studies, 29 deposits were geologically mapped and sampled in order to establish the approximate quality and quantity of the State's barite deposits.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation for the courtesies extended to him by the owners of the barite deposits. Special thanks go to Mr. Robert Sell, Mr. A. G. Lotze, and Mr. Clarence Carr, who accompanied and assisted the writer in the examination of their properties. Much credit is due to Mr. Everett Hougland for information on the barite deposits of Deer Park Pine Industry, Inc. and to the Sunshine Mining Company for valuable information on the O'Toole Mountain prospect and the Shallenberger mine. The writer is also indebted to the entire staff of the Division of Mines and Geology for generous assistance during the writing of the report, and especially to Marshall T. Huntting for his critical reading and helpful suggestions.

Except where noted in the text, the chemical analyses of the barite were made by Northwest Testing Laboratories, Portland, Oregon.

PART I: GENERAL INFORMATION

PROPERTIES OF BARITE

Barite, the sulfate of barium, has the chemical formula $BaSO_4$ and theoretically contains 65.7 percent barium oxide (BaO) and 34.3 percent sulfur trioxide (SO_3). The name is derived from the Greek word meaning heavy. It is also known as barytes, or heavy spar. The barium in the barite may in part be replaced by strontium, forming celestite (strontium sulfate, $SrSO_4$).

Pure barite is white, and opaque to transparent. Its streak is white on unglazed porcelain. Due to contained impurities, some barite is gray, black, brown, red, blue, or green. It has a pearly or vitreous luster and has perfect cleavage in several directions. Barite crystallizes in the holohedral class of the orthorhombic system. Many crystals are tabular, parallel to the "a" or "b" crystal axes, and are sometimes bounded on the sides by short prisms. The tabular crystals often occur in divergent groups forming "barite roses" or "crested roses." Barite may also be granular, earthy, fibrous, lamellar, or occur in globular forms.

The specific gravity of barite is 4.5, which is heavy for a nonmetallic mineral. In comparison, the specific gravity of quartz is 2.6 and of limestone is about 2.7. Barite varies from 3 to 3.5 on Moh's scale of hardness, and it can be scratched easily by a knife blade. It fuses on thin edges at about 1,200° C and imparts a yellowish-green color to the flame. When fused with sodium carbonate on charcoal, the residue, when moistened, produces a dark stain of silver sulfide on a clean silver surface. Barite is insoluble in pure water but soluble in warm concentrated sulfuric acid. The diagnostic features of barite are its high specific gravity, its characteristic cleavage, and its crystal forms.

OCCURRENCE OF BARITE

Barium is the 15th most abundant element in the earth's crust, and according to Clark and Washington (1924, p. 20) the average igneous rock contains 0.05 percent barium. The highest content of barium is found in acidic igneous rocks, particularly in alkalic rocks such as syenite and nepheline syenite. Sedimentary rocks also contain barium, the greatest content being found in shale. Table 1 lists the barium content of selected rocks as reported by Rankama and Sahama (1950, p. 476, 482).

TABLE 1.—Barium content of selected rocks.

	Grams per metric ton
Syenite and trachyte	1,600
Nepheline syenite and phonolite	520
Granite and rhyolite	430
Diorite and andesite	230
Gabbro, basalt, and anorthosite	60
Dunite and pyroxenite	3
Quartzite (average)	110
Shale (average)	460
Red clay	200
Sandstone (average)	170
Limestone (average)	120

The barium content of soils ranges from 300 to 5,000 grams per ton, the average being about 500. Some mineral waters contain as much as 11,900 grams of barium per ton, whereas the barium content of fresh water ranges from 0.004 to 0.035 grams per ton, and of sea water averages about 0.05.

Commercial deposits of barite occur as veins, beds, and as residual masses in clay overlying limestone. Other deposits, though not of commercial value, occur as a sinter deposited from the waters of hot springs. Barite also forms the cement in some sandstones. Some deposits contain almost pure barite; however, in most deposits the barite is associated with one or several of the following minerals: quartz, calcite, fluorite, ankerite, dolomite, and many sulfide minerals, especially pyrite. Barite is also a common gangue mineral of many ore deposits, mainly with the ores of lead, zinc, copper, silver, cobalt, antimony, and manganese. However, as a gangue mineral it is seldom of economic importance.

Other barium minerals are: witherite, $BaCO_3$, which occurs in ore veins; hyalophane, $BaAl_2Si_2O_8$, which is common in dolomite; barylite, $BaBe_2Si_2O_7$, which is found in some limestones; and the zeolites brewsterite, $Na(Sr,Ba,Ca)_5$-$Si_{29}Al_{11}O_{80} \cdot 25H_2O$, harmotome, $Ba_2Si_{12}Al_4O_{32} \cdot 12H_2O$?, and edingtonite, $BaSi_3Al_2O_{10} \cdot 4H_2O$. Of these minerals, witherite is the only one that is mined commercially. Witherite is not mined in the United States at present (1962), but in 1961 crude witherite was imported from the United Kingdom and Japan, and crushed or ground witherite was imported from Canada, West Germany, and Italy.

USES AND SPECIFICATIONS

Barite is used because of its relatively high specific gravity, its color, inertness, or barium content. It is marketed in either lump, crushed, or ground form. Lump, or crude barite, is used mainly in the lithopone and chemical industries. Ground or crushed barite is used chiefly in well-drilling muds and in the glass, paint, and rubber industries.

Well-drilling mud.—About 90 percent of the barite consumed in the United States is used as a heavy medium in well-drilling muds, especially by the oil and gas industry. It is generally mixed with bentonite mud that gels when the drill stops rotating. The gelling action of the bentonite keeps the barite particles and drill cuttings from sinking to the bottom of the hole. The barite-weighted mud assists in controlling liquid and gas pressures, helps prevent "blowouts," lubricates the area between the drill stem and the wall, and floats the drill cuttings.

Barite is used in drilling mud because it is clean, easy to handle, relatively inexpensive, chemically inert, and nonabrasive. As much as 5 tons of barite per 1,000 feet of high-pressure well drilling may be required. Some muds having a specific gravity as great as 2.5 are used.

Barite for use in well-drilling mud should have a specific gravity of at least 4.2. For crude barite to be this heavy, the barium sulfate content must be around 90 percent. Soluble salts or calcium sulfate are undesirable impurities because they cause the bentonite suspension medium to flocculate. Several percent iron is not objectionable, nor are small amounts of other impurities. Before the barite is mixed with its suspension medium, it is ground so that 90 to 95 percent passes through a 325-mesh Tyler screen.

Paint.—For use as a pigment or extender in paints, barite should be as white as possible. However, some off-color barite is used as an extender in dark paints. The color of stained barite can sometimes be improved by bleaching with dilute hydrochloric or sulfuric acid, if the staining is on the surface or confined to cleavage planes. Manganese oxide usually cannot be removed by this method.

The American Society for Testing Materials Standard Specification No. D602-42 for barite in pigments requires a minimum of 94 percent $BaSO_4$. The maxima for other ingredients are: ferric oxide, 0.05 percent; water-soluble matter, 0.2 percent; moisture and volatile matter, 0.5 percent; quartz, clay, or other foreign substances, 2 percent.

Lithopone.—Lithopone is an intimate mixture of zinc sulfide and barium sulfate that is used as a white pigment in paints. It is also used as a filler or pigment in the manufacture of rubber, linoleum, and plastics. Theoretically, it contains 29.4 percent zinc sulfide and 70.6 percent barium sulfate. Lithopone is produced by the interaction of solutions of barium sulfide and zinc sulfate, which results in the coprecipitation of zinc sulfide and barium sulfate. The precipitate is filtered, washed, dried, and calcined to yield the white pigment known as lithopone.

Barite used in the production of lithopone should contain at least 94 percent barium sulfate, not more than 1 percent iron oxide and strontium sulfate, and not more than 0.1 percent lime. As much as 5 percent silica may be present, but only traces of fluorine are allowable. Most consumers request a size of 4 to 20 mesh, but some purchase lump barite.

Glass.—In the production of glass, barite acts as a flux and makes the glass more brilliant and workable. It reacts with the silica to give gaseous sulfur dioxide and oxygen, which tends to stir the melt and remove occluded gases.

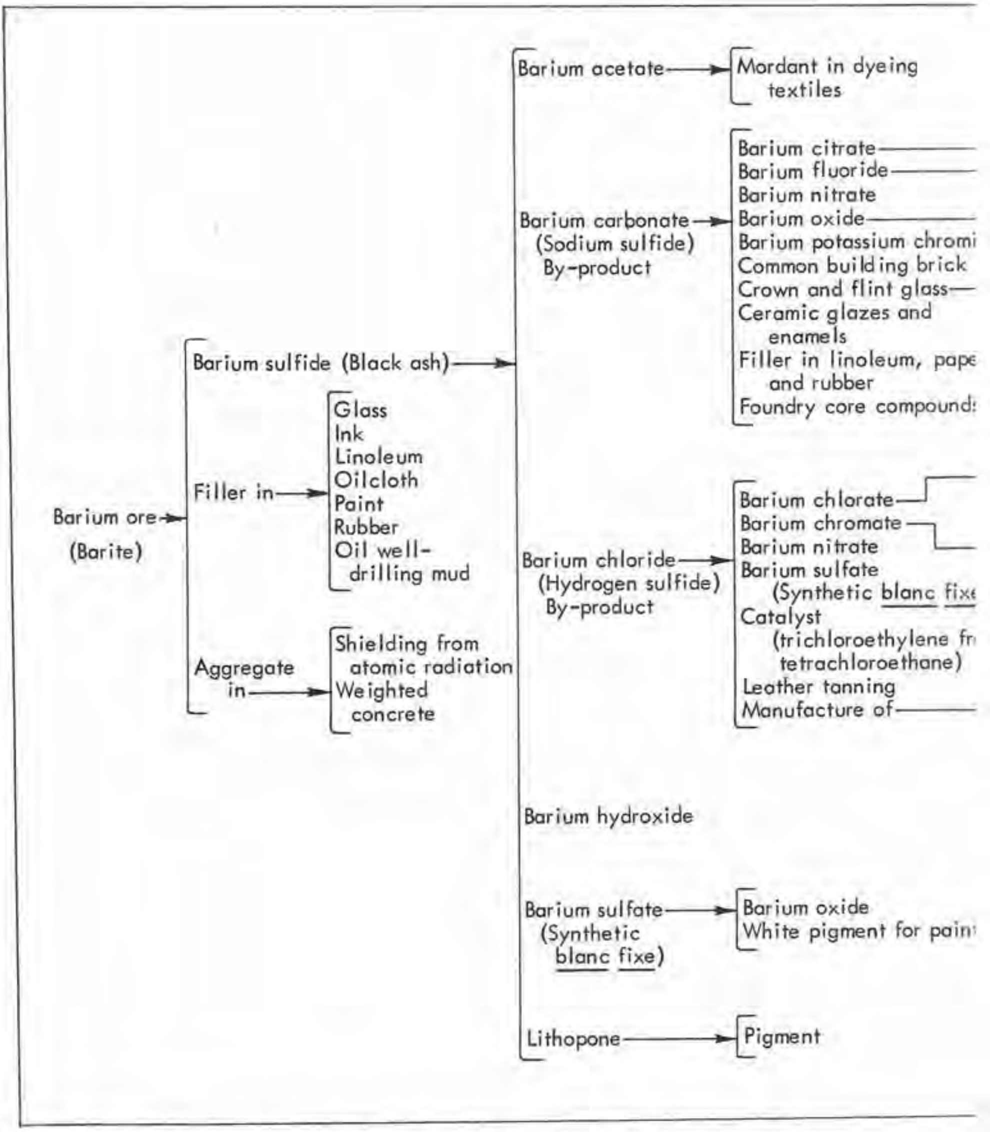
Some specifications require at least 96 percent barium sulfate, maximum silica content of 1.5 percent, maximum alumina content of 0.15 percent, and a maximum iron content of 0.40 percent. A mixture ranging in particle size from 30 to 140 mesh, with a maximum moisture content of 3 percent, is generally preferred. The barite used in certain ceramic glazes should not contain more than 0.05 percent of iron oxide.

Barium chemicals.—The main barium chemicals consumed in the United States are barium; barium hydrates, oxides, carbonates, chlorides, chlorates, titanates, and nitrates; lithopone; and *blanc fixe*. Barium metal acts as a deoxidizer in the smelting of copper. Barium oxide is used in glass and in the manufacture of barium peroxide. Barium carbonate is used in ceramic glazes and enamels. Barium chloride is used in case hardening, in processing leather and cloth, and in the production of magnesium metal. Barium titanate is used in the miniature-electronic-components and communications industry.

Barite chemicals have many other uses, but it is beyond the scope of this report to discuss them. Most of the compounds of barite and their uses are shown in table 2. Specifications are similar to those for lithopone. Barium sulfate content must be at least 94 percent, iron oxide and strontium sulfate may be 1 percent, and only traces of fluorine are allowable.

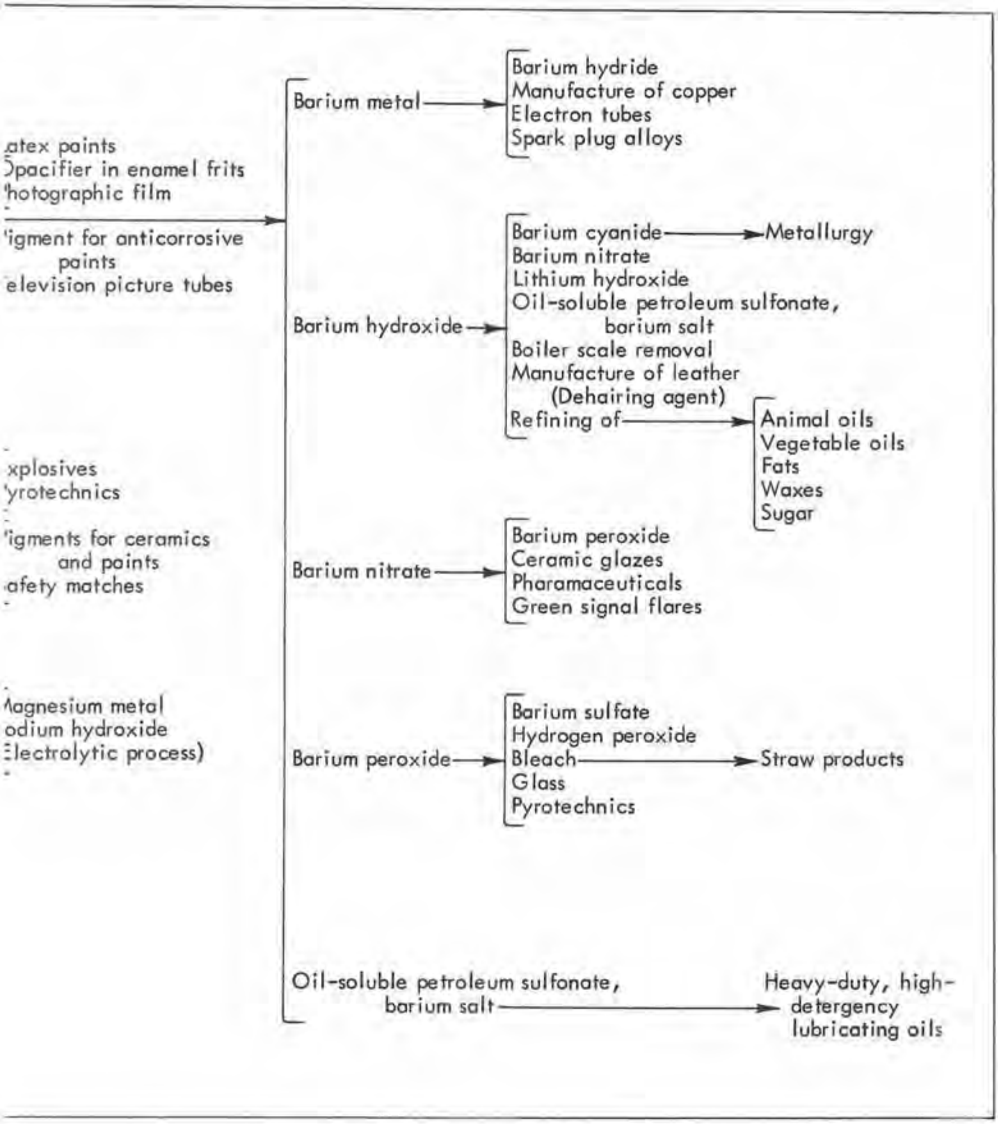
Rubber and paper.—When used as a filler in rubber and paper, barite should contain at least 99.5 percent barium sulfate, with only traces of silica, iron oxide, alumina, and manganese. As natural barite rarely approaches this purity, the chemically prepared *blanc fixe* is used. *Blanc fixe* is artifically precipitated pure barium sulfate. The requirements for barite used to produce *blanc fixe* are the same as those required for barium chemicals.

TABLE 2.—Industrial uses o



Data from: Chemical Origins and Markets, Flow Charts and Tables, p. 44-45
Stanford Research Institute
Chemical Economics Handbook

ɔarite and barium compounds



Radiation shielding.—In recent years barite has been used as an aggregate in the concrete of radiation-proof shields in atomic power plants. Magnetite is also commonly used for the same purpose. The U.S. Atomic Energy Commission, Hanford, Washington (written communication, 1959), makes the following statement regarding the use of barite for shielding purposes:

> For some shielding purposes, barite is somewhat better than magnetite; however, in others, magnetite may be just as good as barite, especially if the magnetite has a high specific gravity of more than 4.4 to 4.5. Thus, barite is in competition, price-wise, with magnetite. To be of value in constructing concrete radiation shields, barite should contain a minimum amount of materials, such as free silica or chalcedony and opal, that might possibly be chemically reactive with portland cement. A high barium content and specific gravity greater than 4.2 is required, while a specific gravity of 4.4 is desired. In general, the barite ore must be suitable for processing both coarse and fine aggregates, which requires that the ore be massive and strong. . . . To date we have not used barite aggregates in concrete at Hanford. This is due to the fact that magnetite aggregates having a specific gravity of around 4.5 could be obtained at less cost than barite.

Sugar refining.—Barite is used in refining beet-sugar molasses in the Steffens process. Barium hydroxide is added to the discard molasses to aid in the extraction of solutions of pure sugar. The requirements for barite used in sugar refining are the same as those for barite used in compounding barium chemicals.

Other uses.—Ground barite is used as a filler in the manufacture of Bristol board and similar heavy stiff paper products, also where a brilliant white finish is required, as for playing cards. A suspension of finely ground barite and clay is used in the Barvois system of coal washing. Lead-calcium-barium alloys, known as Frary metal, are self-hardening and have been used for bearings. Barium ferrite is used in permanent magnets, and barium fluoride is the key material in a new, highly sensitive photographic film. When weight is desirable in concrete, such as in holding pipelines under water, barite is used as an aggregate.

UNITED STATES PRODUCTION, CONSUMPTION, AND PRICES

Production.—Barite production in the United States for 1961 was 731,381 short tons. This represents a decline of 39,587 tons as compared with the production for 1960. In addition to the domestic production, 615,128 tons of crude and ground barite was imported into the United States during 1961, mainly from Canada, Mexico, and Peru. Although domestic production and imports of barite receded from the quantities of 1960, the consumption increased slightly (fig. 1).

The leading state in output and sales for 1961 was Arkansas (277,855 short tons). In order of rank the other producing states were Missouri, Georgia, Nevada, California, Tennessee, Washington, Texas, South Carolina, Kentucky, Idaho, Utah,

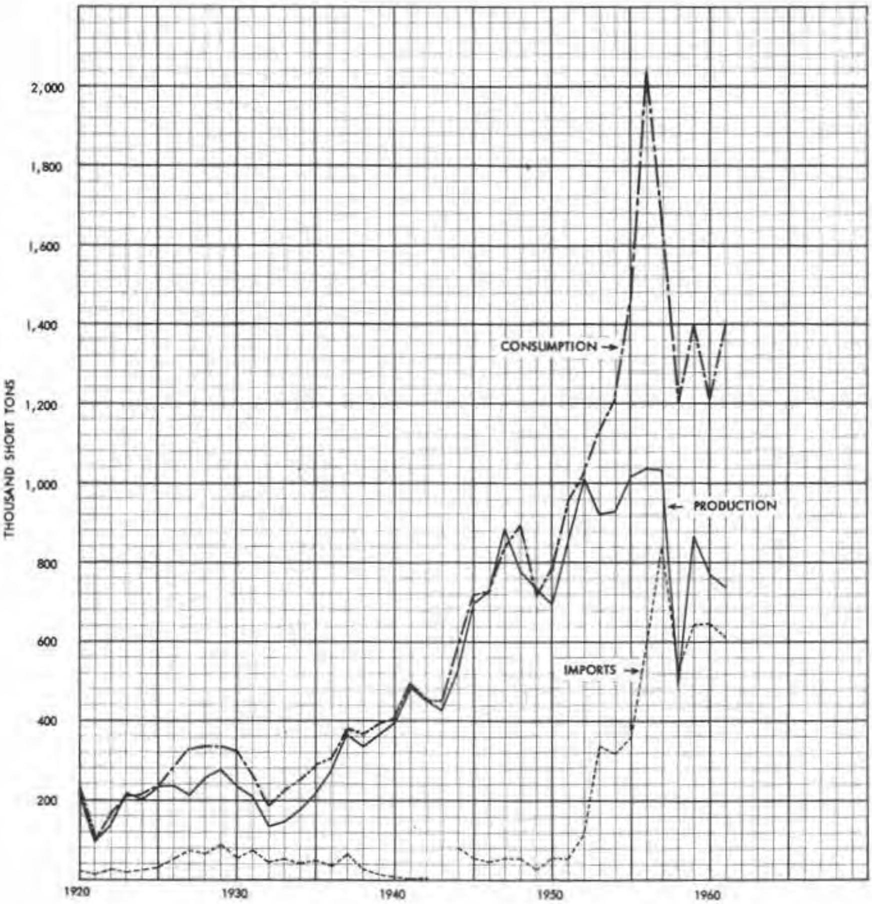


Figure 1.—Domestic production, consumption, and imports of barite, 1920-1961.

New Mexico, Montana, and North Carolina. The production of Washington barite is discussed on page 15 of this report.

Consumption.—According to the U.S. Bureau of Mines (Skow and Schreck, 1962, p. 296), the total consumption of barite in the United States in 1961 was around 1,391,399 short tons. The oil and gas well-drilling industry was the major consumer and utilized 91 percent of the crushed and ground barite; the remainder was consumed by glass, paint, rubber, and chemical industries. The general distribution of the crushed and ground barite sold by producers in the United States in 1961 is shown in table 3.

TABLE 3.—Ground and crushed barite consumed in the United States in 1961 [1]

Industry	Short tons	Percent of total
Well drilling ----------	941,539	91
Glass ---------------	30,713	3
Paint ----------------	16,128	2
Rubber --------------	24,007	2
Undistributed ----------	23,395	2
Total -------	1,035,782	100

[1] U.S. Bureau of Mines Minerals Yearbook, 1961, vol. 1, p. 298.

Crude barite (domestic and imported) used in the manufacture of barium chemicals and lithopone for 1961 was 167,218 tons.

The consumption of barite by the oil and gas well-drilling industry, the main outlet for domestic producers, is subject to considerable fluctuation from year to year.

Prices and markets.—The prices of crude and ground barite have remained unchanged since 1957. The general overall price for crude barite is about $16 to $18 per ton f.o.b. mines. Water-ground, floated, and bleached barite sells for about $45 to $49 per ton f.o.b. mine or mill. These prices apply to barite that contains at least 94 percent barium sulfate and less than 1 percent iron.

If the barite is to be used solely for drilling muds, the barium sulfate content may be as low as 85 percent, as the barite can be blended with higher-grade material to achieve the minimum 4.2 specific gravity required for drilling muds. However, the prices for lower grade barite are adjusted accordingly, the average price being about $7 per short ton f.o.b. mine.

Barite prices for Georgia and Missouri ores are quoted weekly in the Engineering and Mining Journal Metal and Mineral Markets.

Federal tax laws allow producers of barite a depletion allowance of 15 percent of gross income, but not to exceed 50 percent of the net income without depletion deduction.

The present markets for Washington barite are outside the State, and for this reason barite producers are subject to competition from producers closer to the out-of-State markets. The Alaskan market appears to be the most favorable outlet for Washington barite at present (1962). Possible purchasers for the Alaskan market, which consists wholly of the petroleum industry, are as follows:

Macco Corporation
14409 S. Paramount Blvd.
Paramount, Calif.

Baroid Sales Division
National Lead Company
P. O. Box 1675
Houston, Texas

Wyo-Ben Products Company
Greybull, Wyo.

Roy R. Kelly
1022 North "G" Street
Tacoma, Wash.

Possible purchasers of barite other than the petroleum industry, as listed in the 1961 Mining World Ore Buyers Guide, include:

The Glidden Co.
Chemical and Pigment Division
766 50th Ave.
Oakland 1, Calif.

Westvaco Mineral Production Division
Food Machinery & Chemical Corp.
P. O. Box 920
Modesto, Calif.

Fisher Thorsen & Co., Inc.
2100 N.W. 22nd Ave.
Portland 10, Oreg.

General Paint Corp.
2627 Army St.
San Francisco 19, Calif.

Industrial Minerals & Chemical Co.
Sixth and Gilman Sts.
Berkeley, Calif.

Owens-Illinois Pacific Coast Co.
135 Stockton St.
San Francisco, Calif.

W. P. Fuller & Co.
301 Mission St.
San Francisco, Calif.

Wesco Waterpaints
Fifth and Grayson Sts.
Berkeley 2, Calif.

Past purchasers of Washington barite include:

Great Western Sugar Co.
Johnston, Colo.

Manufacturers Mineral Co.
P. O. Box 3543
Seattle, Wash.

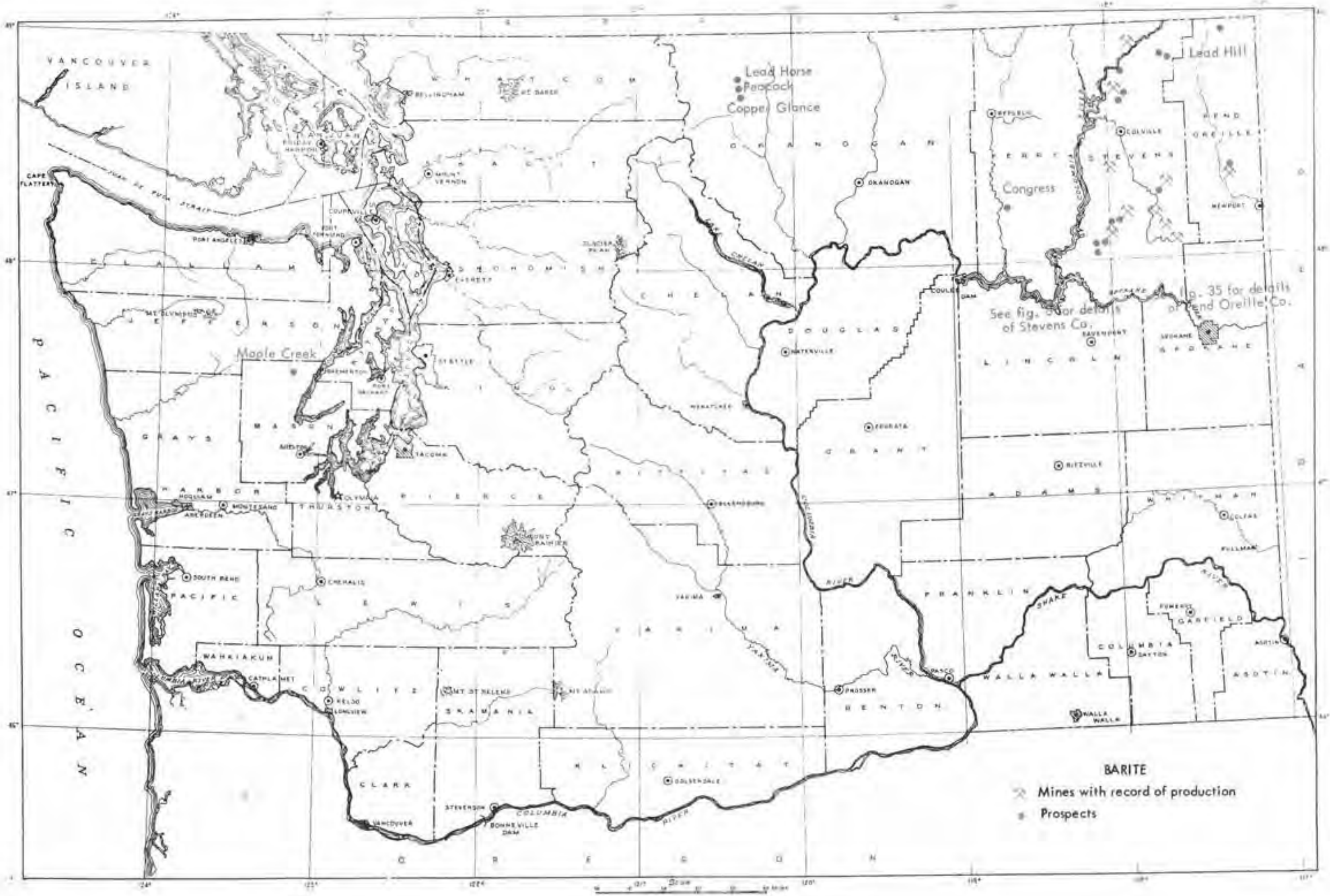
Sunshine Mining Co.
W. 300 Mission Ave.
Spokane 1, Wash.

E. I. du Pont de Nemours & Co.
1007 Market St.
Wilmington, Del.

Custom grinding mills for barite:

Northwest Talc & Magnesium Co.
Clear Lake, Wash.

Manufacturers Mineral Co.
P. O. Box 3543
Seattle 24, Wash.
Plant at Chewelah, Wash.



BARITE
Mines with record of production
Prospects
Lead Hill
Lead Horse
Peacock
Copper Glance
Congress
Maple Creek
See fig. 5 for details of Stevens Co.
fig. 35 for details of Pend Oreille Co.
VANCOUVER ISLAND
PACIFIC OCEAN
OREGON
WHATCOM
SKAGIT
OKANOGAN
FERRY
STEVENS
PEND OREILLE
SNOHOMISH
CHELAN
DOUGLAS
LINCOLN
SPOKANE
CLALLAM
JEFFERSON
KING
KITTITAS
GRANT
ADAMS
WHITMAN
MASON
GRAYS HARBOR
THURSTON
PIERCE
YAKIMA
FRANKLIN
GARFIELD
COLUMBIA
WALLA WALLA
ASOTIN
PACIFIC
LEWIS
WAHKIAKUM
COWLITZ
SKAMANIA
KLICKITAT
BENTON
CLARK

PART II: BARITE DEPOSITS OF WASHINGTON

Of the 33 reported occurrences of barite in the State, 26 are in Stevens County, 4 in Pend Oreille County, 3 in Okanogan County, and one each in Ferry and Mason Counties. Figure 2 shows the general distribution of these occurrences.

Little is known about the early discoveries of barite in Washington. One of the first to mention its occurrence is Weaver (1920, p. 125), who reports barite as occurring in the calcareous argillite of the Chamokane district, near the headwaters of Chamokane Creek in southwestern Stevens County. Here it occurred mainly as a gangue mineral in the copper deposits and was not mined for its barium content. According to Clarence Carr, Valley, Washington (oral communication), two carloads of barite was shipped from the Wells Fargo mine as early as 1912; however, the barite was shipped to a smelter in Helena, Montana, in the belief that it was a secondary ore of lead. Perhaps the earliest shipment of barite in which the barite was utilized for its barium content was made in 1938. According to an article in The Spokesman-Review (Spokane) of September 22, 1938, 8,000 tons of barite was to be mined and shipped to the E. I. du Pont de Nemours & Co., in Delaware, from the Shallenberger mine in Stevens County. The barite was to be used in the paint industry.

Listed below in chronological order are the major events in the history of barite mining in Washington.

1912 - Wells Fargo mine shipped two carloads of barite to the smelter in Helena, Montana.

1938-1939 - A small amount of barite was mined from the Allan mine by Earl Fields.

1938 - Sleight and Moon acquired a lease to the Shallenberger mine and were reported to have an 8,000-ton order from E. I. du Pont de Nemours & Co. No record that this order was filled.

1940-1942 - Earl Fields operated the Shallenberger mine and shipped barite to the Sunshine Mining Company, Kellogg, Idaho, and to the Coeur d'Alene Hardware Company, Wallace, Idaho.

1942 - Carr Brothers, Valley, shipped 100 tons of barite from the Yellow Jacket mine to the Sunshine Mining Company.

1951-1955 - Manufacturers Mineral Company, Chewelah, mined barite intermittently from the Madsen deposit.

1957 - Big Red Uranium Corporation shipped two carloads of barite to an Illinois sugar plant.

1958 - W. R. Green, Spokane, shipped 3,000 tons of 98.3 percent barite from deposits on Eagle Mountain to the Great Western Sugar Company, Johnston, Colo.

1958 - Sunshine acquired a lease on the O'Toole Mountain barite deposit and began exploration of the deposit.

1958 - Bruce Creek (Uribe) barite deposit was diamond drilled by the National Lead Company, who held a lease on the property.

1958 - Gilbert Bakie, Valley, shipped 200 tons of barite from his mine to the Great Western Sugar Company.

1959 - An initial 1,200-ton shipment of barite was sent from Anacortes, Washington, to Alaska by the Macco Corporation of Los Angeles, Calif.

1960 - Elmer Malley, Valley, leased the Pease barite deposit and shipped 200 tons of barite to Clear Lake, Wash., for milling. Barite was shipped to Alaska for use in well-drilling mud.

1960 - Darrell Newland acquired a lease to the Uribe barite deposit. The deposit was subleased to Smith and Williams, who mined 1,500 tons of barite destined for Alaska.

1960 - D. L. Lewis, Chewelah, acquired a lease to the Eagle Mountain barite deposits. The mine produced daily up to 60 tons of barite that was processed at Clear Lake and shipped to Alaska.

1960 - The Smith deposit near Valley produced a small amount of barite for use in well-drilling mud.

1960 - Three carloads of barite was mined from the Wells Fargo and Yellow Jacket mines. Barite was processed in Clear Lake for shipment to Alaska.

1960 - Two barite deposits on property owned by the Deer Park Pine Industry, Inc. produced several carloads of barite for use in well-drilling muds.

1961 - Darrell Newland subleased the Uribe mine to the Fred Kennedy Construction Company, Sandpoint, Idaho. Several thousand tons of barite was shipped to Clear Lake for milling.

1961 - Robert and Leonard Sell, Northport, mined several carloads of barite from a deposit on Flagstaff Mountain. Barite was processed in Clear Lake for oil well-drilling mud.

1961 - Lloyd Jacobson's mine north of Colville produced several carloads of barite destined for the Alaskan market.

1961 - Several carloads of barite was produced from the Allan, Madsen, and Eagle Mountain deposits. The barite was to be used in well-drilling muds.

1961 - F. W. Bailor, Newport, mined barite from the Bobcat mine, near Kings Lake in southern Pend Oreille County. About 500 tons of it was mined in November, and plans were made to increase production to 300 tons per week. Barite was shipped to Clear Lake for milling.

1962 - D. A. Newland resumed mining at the Uribe deposit and made shipments to Clear Lake prior to shipment to Alaska for use in well-drilling mud.

Detailed production figures are not available for individual properties; however, from 1940 through 1961 the approximate barite production from 17 mines in Stevens and Pend Oreille Counties was 15,367 short tons. The production figures, as obtained from newspaper accounts and mine operators' reports, are shown in table 4. For the unlisted years there is no record of production.

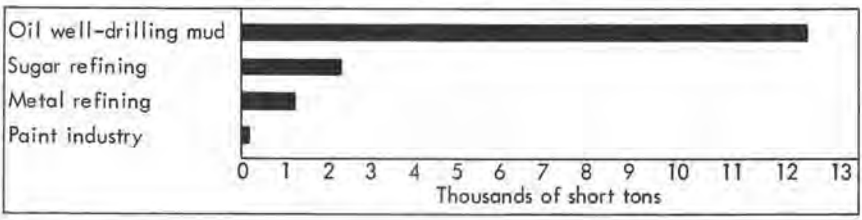
TABLE 4.—Washington barite production, 1940-1961

Year	Short tons
1940	153
1942	1,068
1951	250
1953	97
1955	50
1957	100
1958	2,200
1959	250
1960	5,499
1961	5,700
Total	15,367

Prior to 1959 the barite from Washington deposits was consumed by out-of-State markets that represented the petroleum industry, sugar refineries, metallurgical plants, and paint manufacturers. Because of the increase in oil-well drilling in Alaska during 1960 and 1961, all the barite mined in Washington during those years was destined for the Alaska market, for use in well-drilling muds.

The approximate distribution, by consuming industries, for the barite produced in Washington between 1940 and 1961 is shown in table 5.

TABLE 5.—Consumption of Washington barite, 1940-1961



In this report an attempt is made to describe all the significant barite deposits of the State. No examination was made of those occurrences in which barite is the gangue of other minerals. However, those occurrences are described at the end of the report so as to provide data on their locations and general geology.

LOCATION, PHYSIOGRAPHY, AND ACCESS

The barite deposits of Washington are confined mainly to Stevens and Pend Oreille Counties, in the northeastern corner of the State (fig. 2). The Canadian border forms the northern boundary for both counties, and the Idaho border is the eastern boundary for Pend Oreille County. Stevens County adjoins Pend Oreille County on the west.

Both counties are in the Okanogan Highland province of Washington. Much of the region is more than 4,000 feet above sea level, and several peaks reach altitudes above 6,000 feet. The region is characterized by intermediate slopes and broad rounded summits; however, steep rocky cliffs and narrow slotted valleys occur locally. The major valleys are occupied by Franklin D. Roosevelt Lake and the Colville and Pend Oreille Rivers. Elevations in the major valleys range from 1,500 to 2,500 feet above sea level.

The regional precipitation is moderate, ranging from 15 inches or less in the low areas to about 25 inches in the higher, northern areas. In some areas as much as 60 inches of snow falls between October and March. The average temperature for the warmest month is about 68°, and the average for the coldest month is around 22°.

Precipitation is sufficient to support open stands of timber in the drier parts and dense vegetation in the higher, wetter parts. The trees consist mainly of pine, fir, and western larch. Bunchgrass covers most of the open areas.

Both counties are accessible by State and Federal highways from Spokane. State Highway 6 extends from the southern to the northern boundary of Pend Oreille County, and U.S. 395 and State Highway 3 and 22 extend in a northerly direction across Stevens County. From these major highways, well-maintained county roads reach most parts of the counties. Many logging and mining roads provide access to the more remote areas. The full length of Stevens County is served by the Great Northern Railway. In Pend Oreille County the Chicago, Milwaukee, St. Paul and Pacific Railroad extends as far north as Metaline Falls. Spokane, the major supply center for the region, is no more than 120 miles by road or rail from the northernmost part of both counties.

GENERAL GEOLOGY

All the eras of geologic time are represented by the rocks of Stevens and Pend Oreille Counties. As much as 30,000 feet of Precambrian rocks, consisting mainly of greenstone and metasedimentary rocks, extend as a northeastward-trending belt across both counties. The Precambrian sequence is overlain unconformably by rocks representing all periods of the Paleozoic era. The Paleozoic rocks, which are confined chiefly to the western and south-central parts of Stevens County, are predominantly clastic sedimentary rocks, limestone, and dolomite, and have a total thickness of about 25,000 feet. In northwestern Stevens County the Paleozoic sequence is overlain by about 7,000 feet of middle Mesozoic volcanic rocks consisting chiefly of massive augite andesite and latite flows.

In late Mesozoic time the rocks of this region, as well as those elsewhere in northern Washington, were intruded by granitic rocks, which in Stevens and Pend Oreille Counties consist mainly of quartz monzonite and granodiorite. These granitic rocks form extensive outcrops throughout both counties.

The Tertiary record is essentially one of deposition of sediments into lake basins and the eruption of lavas upon the surfaces of the sediments. The sediments are represented by as much as 2,000 feet of massive conglomerates and sandstones, and the volcanics by as much as 1,100 feet of basalt and andesite flows. Also during the Tertiary the rocks were intruded by dikes, sills, and irregular bodies that are mainly diabase. The Tertiary intrusives are confined to northern Stevens County.

During the Pleistocene epoch most of the region was covered by the continental ice sheet; in the southern halves of the counties several mountains above 3,000 feet in altitude appear to have been free of ice. After the ice melted, a mantle of glacial debris covered much of the region. Reworking of the glacial deposits by present-day streams formed fluvial and lacustrine deposits in many of the larger valleys.

Apart from the orogeny that produced the unconformity between the Precambrian and Cambrian rocks, the major structural trends in northeastern Washington appear to have been developed near the close of the Jurassic period. At this time the rocks were folded into a series of northeastward-trending folds. Many of the folds were overturned and accompanied by low-angle thrust faults and high-angle normal faults that parallel the trend of the folds. Related transverse faults were also developed at this time.

After the development of the major structural features, and probably during Early Cretaceous time, granitic rocks intruded the area. Many of the ore deposits of Stevens and Pend Oreille Counties probably were formed by the hydrothermal solutions of the invading magmas. However, not all the mineral deposits were formed at this time, for in northern Stevens County several mineral deposits appear to be related to the Tertiary intrusive rocks. Thus it appears that there were at least two periods of mineralization in Stevens County; one was near the close of the Mesozoic era, and the other near the middle of the Tertiary period.

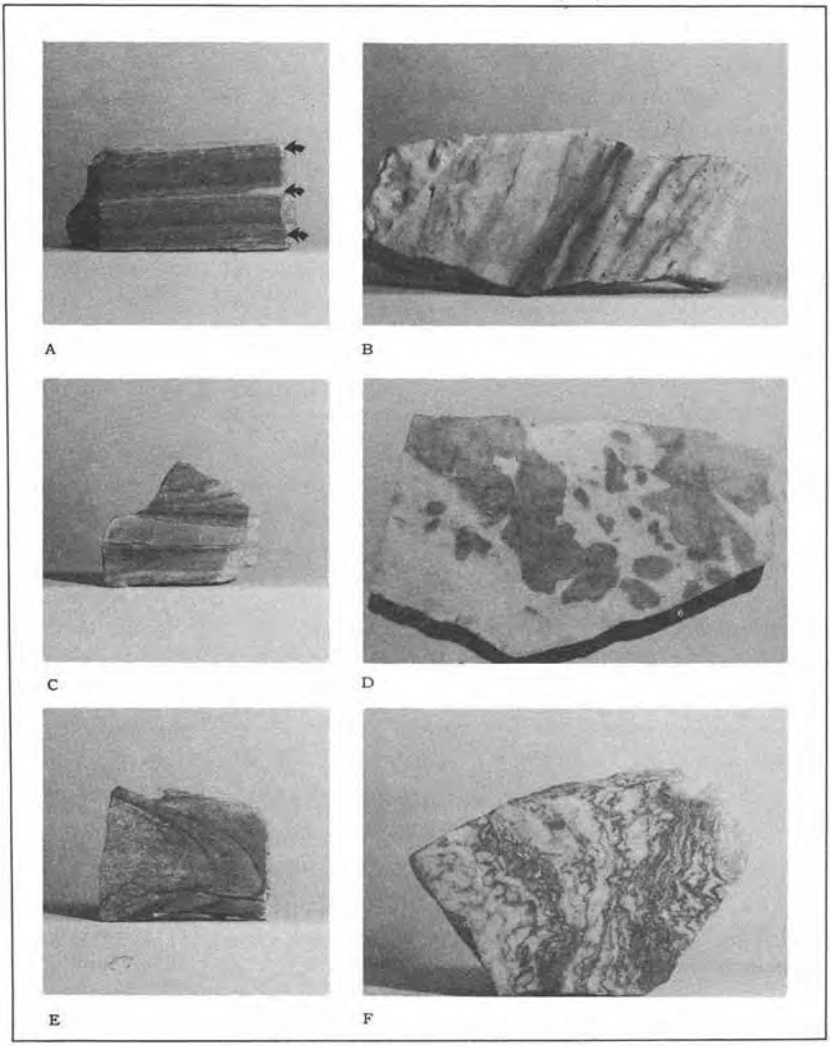


PLATE 1

In this area the metals of greatest economic importance are zinc, lead, copper, silver, gold, and uranium. The nonmetallic minerals of greatest commercial value are magnesite, limestone, marble, dolomite, silica, and barite. Most of the mineral deposits are in the northern parts of Stevens and Pend Oreille Counties and along a southwestward-trending belt that extends from Chewelah to the Spokane River. Although over 200 properties have at some time had ore mined and shipped, in 1962 only 8 mines were in full-time operation. Part-time exploration at many of the mines still continues.

GEOLOGY OF THE BARITE DEPOSITS

The barite occurrences of Washington appear to be of three types. They may be classified as fissure veins, replacement veins, or bedded deposits.

FISSURE VEINS

These veins fill fissures along shear zones in argillite, quartzite, limestone, and dolomite. They range in thickness from thin hairlike stringers to massive veins up to 12 feet wide. The maximum length of the veins is about 1,300 feet; however, the average length is about 200 feet. Although it has not been determined to what depth the veins extend, several barite veins have a minimum depth of 200 feet.

Most of the veins exhibit well-defined contacts with the wall rock, though brecciation of some of the veins near their contacts indicates movement of the veins after they had formed. Many of the veins contain crude banding, which in most instances parallels the contacts (pl. 1, B). This banding is due to differences in grain

Plate 1.—Structural and textural features of Washington barite. (Specimens half size)

A.—Interbedded barite and argillite of the Uribe mine. Arrows point to barite.

B.—Typical banded barite of the hydrothermal vein type. Banding due to iron oxide staining. Allan prospect No. 1.

C.—Crossbedded barite. Bedding due to grain size and iron oxide staining. Lotze prospect.

D.—Coarsely crystalline barite (shaded) in a matrix of fine-grained, sugary-textured barite. Yellow Jacket mine.

E.—Folded barite offset by small fault. Lotze prospect.

F.—Ptygmatic folded barite. Iron oxide-stained barite forms dark bands. Flagstaff Mountain mine.

sizes and color of the barite. The difference in grain size is a distinct textural feature in several of the fissure veins. In the majority of the barite veins of Huckleberry Mountain, clear crystals of barite up to 1 inch in length occur disseminated in a groundmass of fine-grained barite having a sugary texture (pl. 1, D).

Almost all of the fissure veins parallel the bedding planes or fissility of the host rocks. At only two occurrences (Yellow Jacket and Cedar Canyon) were the veins observed to be at high angles to the bedding planes of the host rocks. Along their strikes the veins are fairly uniform in width, but minor pinching and swelling are present in many places. Most veins terminate by pinching out both along their strike and dip; faults are known to terminate several of the veins.

The fissure veins occur singly or as sheeted veins that consist of several parallel or nearly parallel veins. Where several veins are in groups having approximately parallel strikes and dips, they form fissure systems. Along their strikes the veins seldom merge; however, along the dip of the veins merging is more common.

Very little comb structure, which is typical of fissure filling, is present in the barite. However, some of the barite is vuggy and the vugs are lined with well-formed, large crystals of barite. In addition to the barite the veins contain, in order of abundance, one or several of the following gangue minerals: quartz, calcite, iron oxide, iron pyrite, dolomite, chalcopyrite, malachite, azurite, and sphalerite. The quartz and (or) calcite may make up as much as 60 percent of the barite vein, whereas the metallic minerals are sparsely disseminated and make up less than 1 percent of the vein. Inclusions of the wall rock are present in some of the veins, but in minor amounts.

REPLACEMENT VEINS

The replacement veins occur as replacements of limestone, dolomite, and calcareous argillite and siltstone. Like most of the fissure veins, the replacement veins parallel the bedding or fissility of the host rocks. Although the veins in general represent replacement of certain beds, or replacement of the rocks along a shear zone, and tend to retain the structure of the unit they replaced, some veins are extremely irregular, indicating selective replacement. Several veins in limestone and dolomite show that the barite replaced only certain parts of the calcareous rocks and not the complete bed. The chemical composition of the host rocks, and the shape of the fracture system through which the barite-rich solutions permeated, were probably the main features that determined the shapes of the veins.

Individual veins range from 0 to 10 feet in width and are as much as several hundred feet long. In several places parallel veins form single mineralized zones up to 20 feet wide. Where there has been a uniform replacement of sedimentary beds, the veins are fairly uniform in width and do not pinch and swell as do the typical fissure veins. Also, individual replacement veins show less tendency to merge into other veins, along both the strike and dip of the veins.

The barite of the replacement veins is similar in appearance to the barite in the fissure veins. The gangue minerals are quartz and calcite, and, other than iron pyrite, metallic minerals are not as common as in the fissure veins. Pre-existing rock structures are preserved in some of the barite. Crossbedding and folds are present in the barite at the Lotze prospect (pl. 1, C and E). Inclusions of wall rock are also common, and in places the contacts with the wall rock are gradational, which makes it difficult to distinguish the barite from light-colored wall rock such as limestone and dolomite.

Some of the barite veins are no doubt composite, consisting of fissure filling and replacement. The possibility also exists that several of the deposits that are thought to be replacement deposits are actually of sedimentary origin.

BEDDED DEPOSITS

The bedded barite deposits appear to have been formed at the same time as the sedimentary rocks with which they are associated. The barite may occur in a single bed or as a series of beds that are interbedded with the sedimentary rocks (pl. 1, A). Individual beds range in thickness from 0 to 10 feet; however, some mineralized zones are as wide as 50 feet. In some of the thinly bedded deposits, as many as 30 veins are present across a 10-foot width. Along their strikes the beds either lens out or are gradually replaced by the sedimentary rocks. The maximum length of any one vein is not known; however, several appear to be at least 300 feet long.

The barite of the bedded deposits is fine to medium grained and appears to have a more uniform texture than the barite of the fissure and replacement veins. Most of the barite is medium gray to light brownish gray, in contrast to the predominant white of the fissure-type veins. When crushed, much of the barite emits a distinct fetid odor.

TENOR OF THE DEPOSITS

Several of the veins consist almost entirely of barite, and assay as high as 97.03 percent $BaSO_4$. Those high in calcite and (or) quartz contain as little as 40 percent $BaSO_4$. Six of the deposits contain barite assaying 95 percent or better, which is suitable for use in the chemical industries. Eight deposits contain barite that assays from 90 to 94 percent $BaSO_4$, which meets the specifications for well-drilling mud.

Several of the barite deposits contain large tonnages of barite that is below the grade required for industrial uses. However, metallurgical testing of the barite from three deposits indicates that it is amenable to flotation and (or) jigging. (See Mining and Milling, p. 24.)

The barite from most of the deposits was chemically analyzed for its barium sulfate content. In addition to the barium sulfate, silica and iron assays were run on the barite from several of the larger deposits. (See Appendix A.)

The most complete chemical analyses were furnished by the Great Northern Railway on barite from the Shallenberger deposit, which represents a fissure vein type deposit, and the Uribe deposit, which is of the bedded type. These analyses are as follows:

	Shallenberger barite (percent)	Uribe barite (percent)
$BaSO_4$	91.40	66.90
SiO_2	4.12	10.90
S	12.60	9.62
CaO	nil	7.44
MgO	0.89	0.75
CO_2	0.64	7.95
R_2O_3	0.76	5.72
Pb	nil	0.009
Zn	nil	0.068

Analyses by Willis H. Ott, Seattle, Wash.

No attempt was made to analyze the barite for strontium, which commonly substitutes for barium. However, in the course of spectrographing barite from the Uribe and Yellow Jacket mines the presence of strontium was noted. A sample of barite from the Yellow Jacket mine contained 3.9 percent strontium, and that of the Uribe deposit contained 0.8 percent. It is probable that other barite deposits of the State contain strontium.

STRUCTURE

Most of the barite veins are tabular bodies that are elongated parallel to the regional structural trend. The predominant strikes of the veins are N. 20° to 35° E., and the dips range from 35° to 90°, mainly to the west.

Except for fracturing, which is common to all the deposits, as well as shearing and minor brecciation of the barite adjacent to the wall rock, most of the veins exhibit little deformation. The most intense deformation was noted at the Flagstaff

Mountain occurrence, where parts of the barite vein display ptygmatic folding (pl. 1, F). At the Uribe deposit the barite has been folded into a closed anticline with drag folding on both limbs. Intense shearing along the contacts of the vein as well as in the argillite wall rock accompanied the folding. At the Ohman property the barite veins have been isoclinally folded, so that a single vein is repeated several times in less than 200 feet. Major folding, accompanied by drag folding and faulting, has deformed several of the barite veins at the Lotze prospect.

The veins that exhibit little, if any, deformation are the fissure veins. The highly folded and faulted veins are chiefly replacement and bedded deposits. Although some of the deformation is definitely postdepositional, much of it is probably apparent deformation caused by the replacement of beds that had been folded prior to the barite mineralization.

ORIGIN AND AGE

Most of the barite veins appear to have been formed from barium-rich hydrothermal solutions that originated in the magma that solidified into the granitic rocks of the region. On the surface the barite deposits are 6 miles or less from the granitic rocks; at depth the granitic rocks are probably much closer.

It is probable that stresses, caused by the intruding granitic rocks, produced fractures in the overlying rocks, allowing solutions to escape from the crystallizing magma. These barium-rich hydrothermal solutions filled existing fractures to form fissure veins and, under favorable conditions, replaced certain rocks to form replacement veins. In addition to the barite, quartz and calcite formed contemporaneously in most veins.

According to R. T. Walker and W. J. Walker (1956, p. 85-109), barite forms from hydrothermal solutions in the upper and lower epithermal zones (100° C to 200° C). This would be at some distance from the parent magma, which probably had temperatures in excess of 1,200° C. The low temperatures at which barite crystallizes might be the reason why the barite deposits in Stevens and Pend Oreille Counties do not occur as veins in the granitic rocks or as contact deposits between the granite and the intruded rocks, where higher temperatures existed.

too high, more li 700-90

The origin of the bedded barite deposits is still in doubt. The barite originated either as replacement or calcareous sedimentary rocks by hydrothermal solutions, or by precipitation on the floor of the sea.

According to Dunbar and Rodgers (Brobst, 1960, p. 56), a possible source of barium exists in the environment of carbonate rocks. Barium cannot substitute for calcium in calcite but it can in aragonite. Aragonite appears to be the form of calcium carbonate normally produced by the precipitation of sea water. During the conversion of metastable aragonite to stable calcite, the contained barium could be expelled and, if SO_3 ions were present, barite could form. If the barium expelled from aragonite were moved and concentrated by some means, a bedded deposit of barite might be formed.

The bedded deposits of barite at Meggon, Germany, (Sackett, 1962, p. 58) occur in marine rocks of late Middle Devonian age. In the latest detailed study of these deposits, evidence indicates that the barite was introduced to the area by submarine igneous emanations. The concentration of the barite then became so great that it was precipitated and deposited along with the accumulating sediments.

In north-central Nevada, large bedded deposits of barite have been found in late Paleozoic and Devonian sedimentary rocks (Sackett, 1962, p. 47). However, the barite there appears to have been formed by selective replacement of the sedimentary rocks.

The bedded barite deposits of Stevens County, Washington, occur in sedimentary rocks of Ordovician and Carboniferous age. The stratigraphy of these rocks is not well enough known so that the exact stratigraphic position of the barite beds can be determined.

If the bedded barite deposits are of sedimentary origin, they are of Ordovician or Carboniferous age. If they are replacement deposits, they are probably of Late Cretaceous age and related to the Late Cretaceous granitic rocks of the region, as are all the fissure-type barite veins.

MINING AND MILLING

Barite in Washington has been mined almost entirely by surface mining methods from pit quarries and side-hill or shelf quarries. Inasmuch as most of the barite veins crop out on the sides of hills, mining from a shaft has not been necessary. In most mining operations the overburden and wall rock are stripped from the vein by a bulldozer, after which the barite is blasted and then loaded by front-end loaders into dump trucks. To date (1962), very little hand sorting of the ore has been undertaken.

Where the vein parallels the contour of the hill, it is mined along its strike from a single level. The mining is continued until the waste-to-ore ratio exceeds that established for profitable mining. Most veins have not been mined to depths exceeding 30 feet by this method.

The veins that extend up and down the slopes of the hills are mined from a series of benches along the strike of the vein. A new bench is started, usually upslope from the old one, when mining from the old bench becomes impractical. The usual factors that limit the mining are: the mining face becomes too high to work with the equipment being used, or the amount of waste that must be removed is in excess of the cutoff for profitable mining operations.

Although surface mining methods are preferred in mining low-value minerals such as barite, underground mining may be undertaken when conditions are favorable. The barite veins are usually mined from drifts and stopes by conventional mining methods, after which the barite is moved by a slusher or in mine cars to storage facilities near the portal of the mine. Underground mining has been employed at only three of the Washington barite deposits — the Shallenberger, Uribe, and Eagle Mountain mines.

Although screening has been used at several of the mines to obtain a higher grade product, there has been no attempt to upgrade the barite by flotation or jigging methods. All the barite mined in Washington to date (1962) has been shipped in lump form. Barite destined for shipment to Alaska for use in drilling muds is first processed at the Northwest Talc & Magnesium Company, Clear Lake, Washington. The ore arrives at the plant as 12-inch or minus mine-run material; there it is crushed in a jaw crusher to minus 1½ inches. The crushed ore is then carried by conveyor belts to a Raymond mill and air separator, where it is ground to 325 mesh, after which the dust and moisture are removed. The finished product is conveyed on belts to storage bins, from which it is later sacked in 100-pound paper bags or trucked in 22-ton tankers to bulk storage facilities at the Port of Anacortes. Treatment at the plant is confined to grinding, and no upgrading is done.

In other states, flotation is commonly used to upgrade the barite. Standard milling procedure is to crush the ore and wet-grind it in a ball mill until 95 percent passes 325 mesh. The slurry goes to an agitator and conditioner, where it is mixed with flotation reagents, and then to flotation cells, where the barite is floated and (or) depressed. The barite concentrate is filtered, dried, and calcined to remove the flotation reagents. The concentrate then goes to storage bins for later bagging or shipping in bulk form. Mills usually recover about 90 percent of the barite and yield a product that contains about 95 percent barium sulfate. A typical flowsheet for the processing of barite ore by flotation is shown in figure 3; testing data are given in table 6.

Laboratory flotation tests have been carried out on the ores from two Washington barite deposits. The Sunshine Mining Company reports that barite from the O'Toole Mountain deposit, which averages about 72 percent $BaSO_4$, could be concentrated to 94 percent with a recovery of up to 72 percent. Tests on the barite from the Olympic Peninsula (Hughes, 1939) indicate that a concentrate containing

Data from Denver Equipment Company, Bulletin No. M7-F40, "Flowsheet Study of Barite."

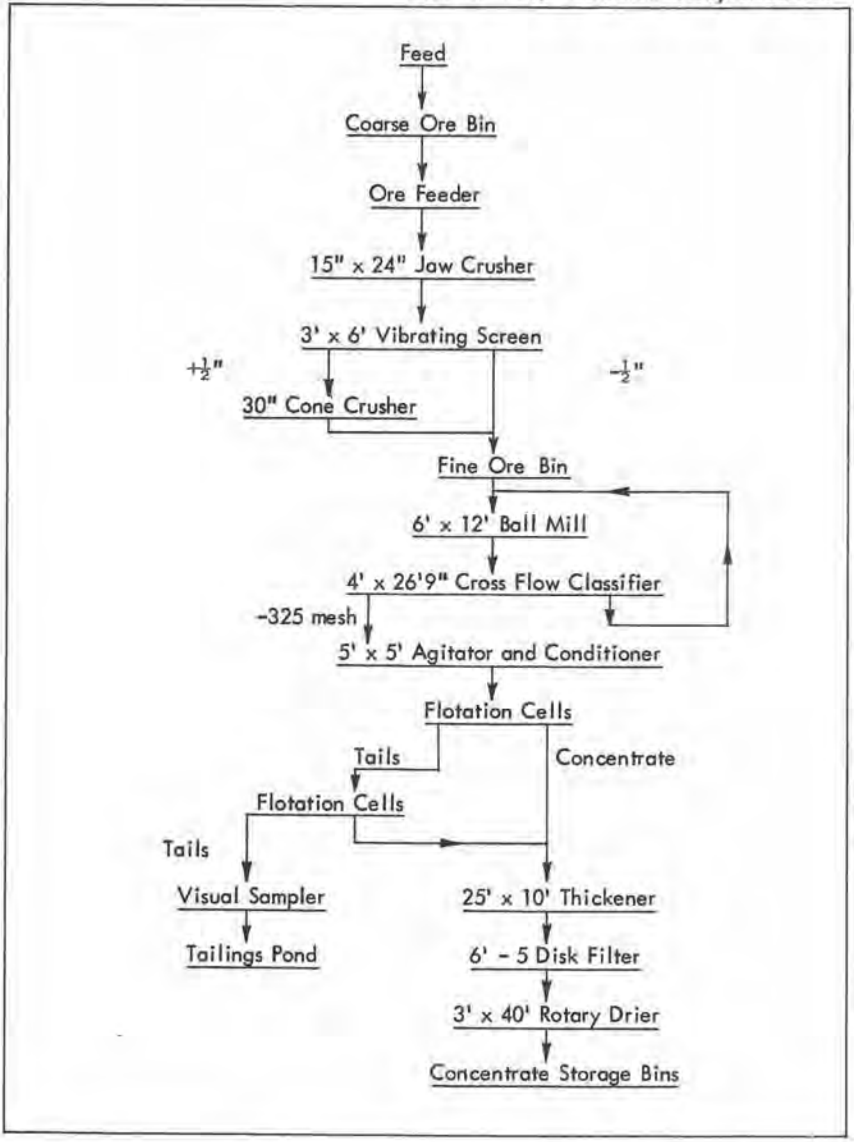


FIGURE 3.—Typical flowsheet for concentration of barite by flotation.

TABLE 6.—Flotation data on typical barite ores

Testing agency	(1)	(2)	(3)
Type of ore	Barite, silica, minor calcite and iron	Barite, silica, alumina, and iron oxide	Barite, silica, calcite, alumina, and iron oxide
Assay of ore	$BaSO_4$ --- 80.8% SiO_2 ---- 16.3%	$BaSO_4$ ---- 88.8% SiO_2 ----- 9.2% Al_2O_3 ---- 0.5%	$BaSO_4$ ---- 71.9% SiO_2 ----- 20.0% Fe_2O_3 ---- 2.0%
Assay of concentrate	97.0% $BaSO_4$	94.6% $BaSO_4$	93.95% $BaSO_4$
Recovery	65% $BaSO_4$	85.5% $BaSO_4$	72% $BaSO_4$
Reagents lbs./ton	Soda Ash -- 1.5 Sodium silicate-- 3.0 Calgon ---- 0.25 Oleic acid- 2.5 Quebracho- 0.65 Alcohol --- 2.5 Fuel oil --- 0.25	Amine 220 -- 0.30 (Acidified with HCl)	Oleic acid - 0.5 Sodium hydroxide 1.8 Sodium silicate -- 1.3
Method or process	Denver "Sub-A" flotation (Floating barite)	Denver "Sub-A" flotation (Floating impurities)	Denver "Sub-A" flotation (Floating barite)
Miscel-laneous data	pH, 8.6 Grind, flotation feed -325 mesh	pH, 7.8 Grind, flotation feed -325 mesh	pH, 9.7 Grind, flotation feed -325 mesh

(1) Denver Equipment Company; source of barite unknown.

(2) Denver Equipment Company; source of barite unknown.

(3) Institute of Technology, Washington State University; O'Toole Mountain barite.

95.88 percent $BaSO_4$ could be obtained by flotation from ore that averaged 88 percent $BaSO_4$.

Several barite mines in other states employ jigging methods to upgrade their ore to the 4.2 specific gravity required for well-drilling mud. The Macco Corporation, at its southern California barite deposit northeast of Rosamond, recovers between 60 and 70 percent of the barite by jigging (Denver Equipment Company, 1957, p. 7-10). The ore, which contains 75 percent $BaSO_4$ and 20 percent silica sand, is upgraded from a specific gravity of about 3.8 to a concentrate of 4.2. The tailings, which have a specific gravity of 3.25, are being stockpiled for flotation at a later date. The milling method used by the Macco Corporation is shown in figure 4.

Data from Denver Equipment Company, Bulletin No. M4-B91, "Jigging Barite."

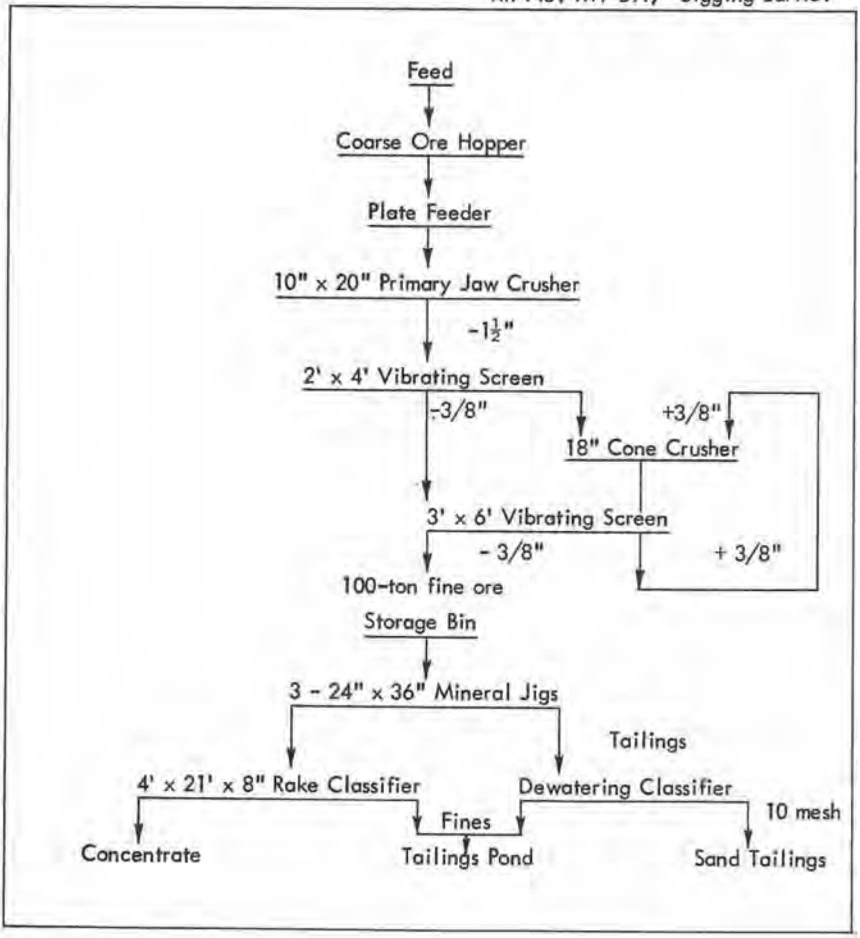


Figure 4.—Typical flowsheet for concentration of barite by jigging.

PROSPECTING FOR BARITE

Generally speaking, the most favorable place to prospect for minerals is in areas of known deposits. In most mining districts significant discoveries have been made, often many years after the initial discovery. In a few instances these later discoveries became the major mines of the district. It is likely that undiscovered barite veins are present in most of the areas discussed in this report. A few of the veins may crop out; however, most of them are probably concealed by overburden, and trenches will have to be dug to uncover the veins.

Starting from known barite occurrences, the area should be examined in both directions along the projected strike of the vein. Many of the shear zones in which minerals were formed extend for miles, whereas the mineralization is confined to only certain parts of the shear zones. Because veins commonly occur as systems, undiscovered veins might parallel the known veins.

In Stevens and Pend Oreille Counties most of the barite appears to be related in origin to Mesozoic granitic rocks. The general distribution of the granitic rocks in Stevens County and the southern half of Pend Oreille County is shown in figures 5 and 6. Also shown are the locations of the barite occurrences that were examined for this report. None of the deposits occur within the granitic rocks or along their contacts. As discussed under Origin of barite, on page 23, the absence of barite in the granitic rocks is probably the result of the formation of the barite at low temperatures (100° C to 200° C) and at a distance from the magma. From data gathered in the examination of the known barite deposits, it appears that in Stevens and Pend Oreille Counties the granitic rocks or their contacts do not favor barite mineralization.

The barite of the bedded deposits appears to favor Ordovician and Carboniferous sedimentary rocks. When prospecting in areas underlain by these rocks, one should examine closely the calcareous parts of the sequence for deposits of the bedded type.

Because of the softness of barite (3-3.5 on Mohs' scale of hardness), fragments of pebble and boulder size are seldom found more than a short distance from the source of the barite. Attrition, especially by streams, tends to reduce the barite to sand-size particles. In some areas, panning the stream sediments or even the soil will disclose the presence of barite that in some instances may be traced to its source.

A rough estimate of the barium sulfate content of barite ore can be made by determining the specific gravity of the sample. The graph in figure 7 gives the approximate $BaSO_4$ content for the determined specific gravity. This graph is based on the assumption that quartz and (or) calcite forms the gangue. The presence of pyrite, galena, or other heavy minerals will indicate higher $BaSO_4$ percentages for the determined specific gravity than actually exist.

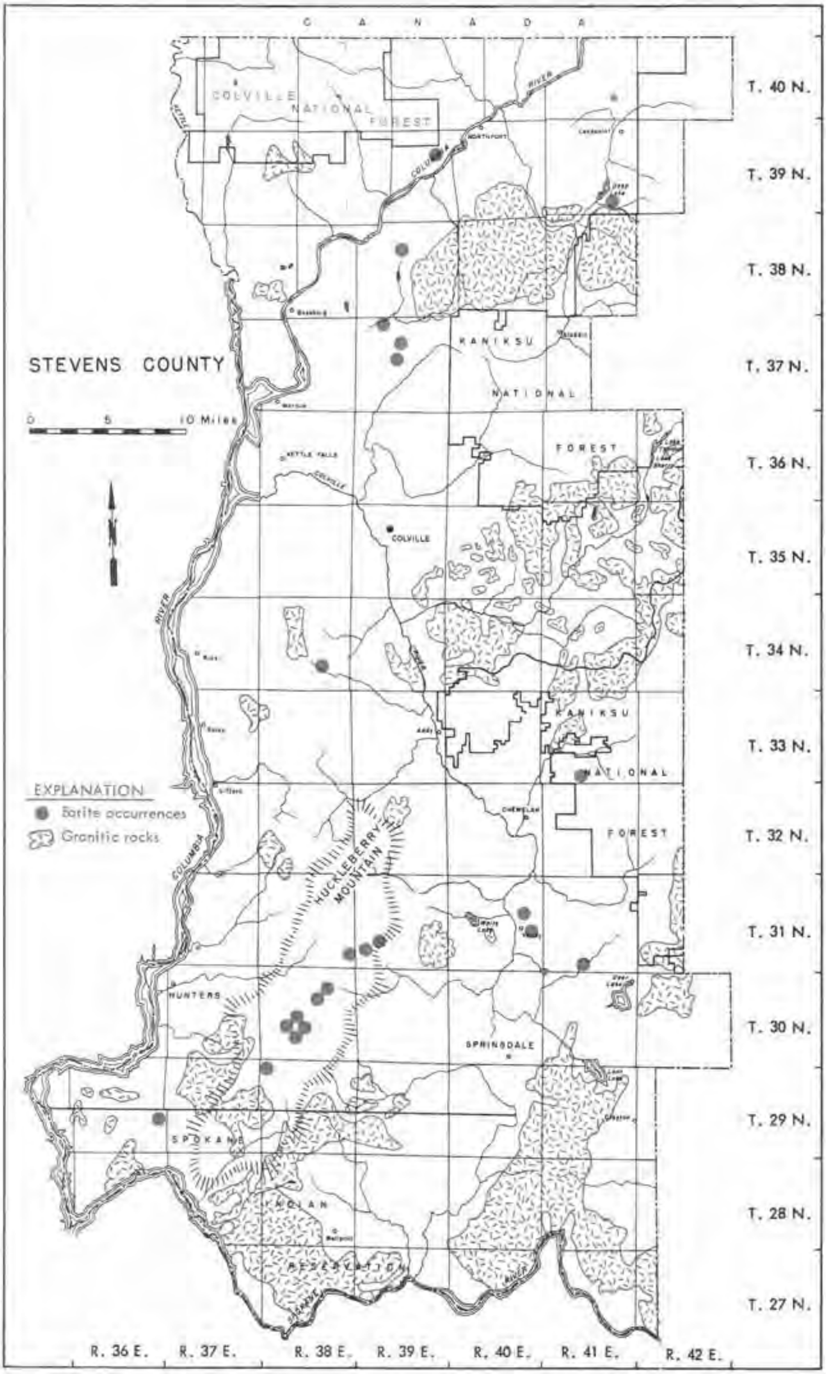


Figure 5.—Distribution of granitic rocks and barite occurrences of Stevens County.

BARITE RESERVES

The barite deposits of Washington that were examined for this report contain an estimated 59,000 tons of measured and indicated ore, and 455,000 tons of inferred ore. The term "ore" as used in this report does not necessarily adhere to the definition that includes only those minerals that can be mined at a profit. "Ore," as used herein, refers to the part of the vein that contains in excess of 60 percent barium sulfate. Whether or not the barite can be mined at a profit will depend upon the mining methods

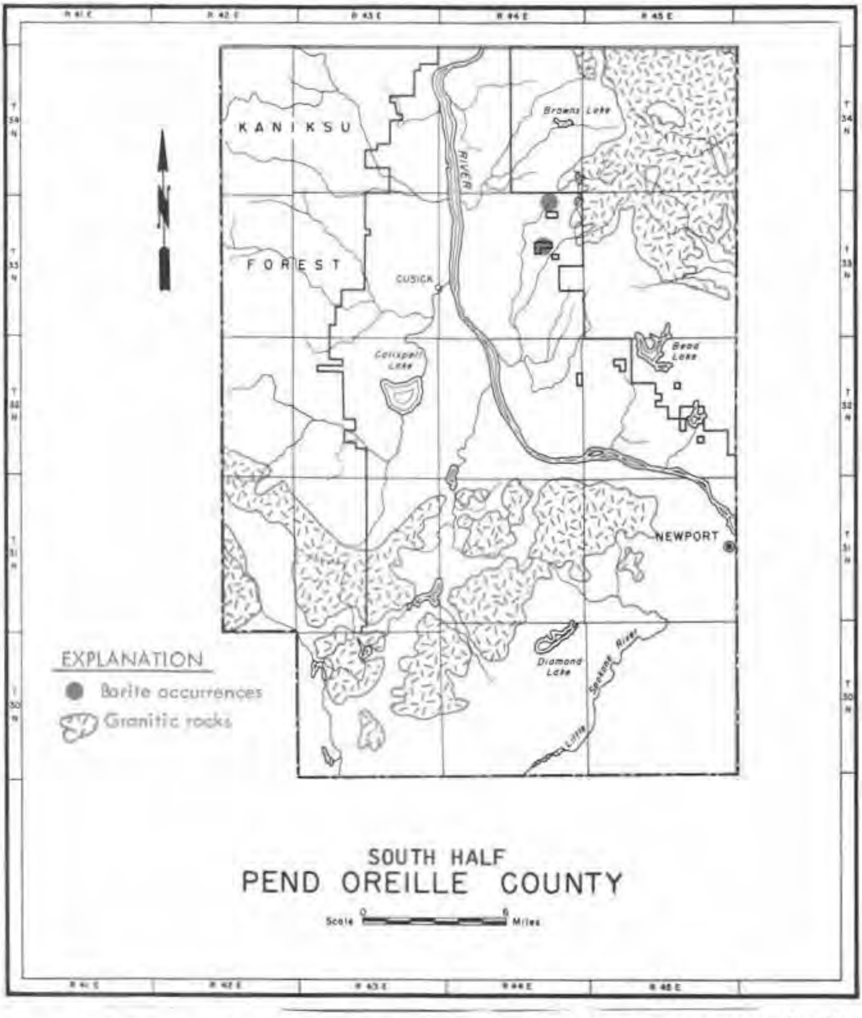
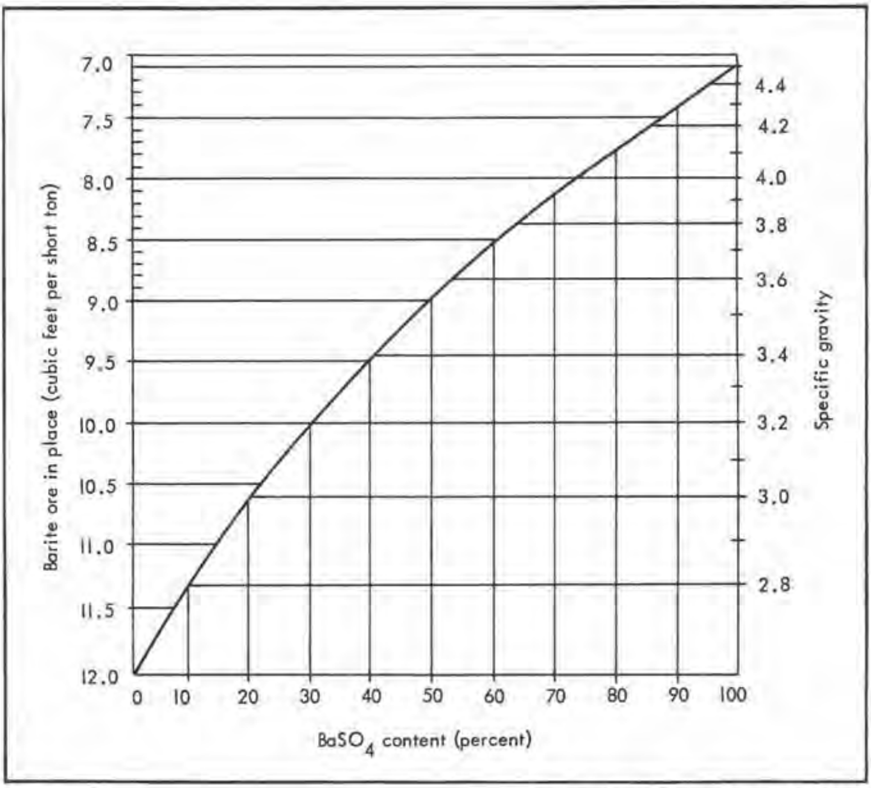


Figure 6.—Distribution of granitic rocks and barite occurrences of the south half of Pend Oreille County.

that are used, the current price for barite, and, in several cases, whether the ore can be milled to upgrade the barite.

In estimating the ore reserves, no vein was projected in depth beyond 100 feet. The maximum depth of most veins is assumed to be one-half of the vein's exposed strike length. When the extensions of the outcrops along their strikes were concealed by overburden, and the vein showed no signs of pinching out, one and one-half times the exposed length of the vein was used for the total length of the vein.

The ore reserves for individual deposits are included in the discussion of each specific property. Where no ore reserves are given, the barite is not sufficiently exposed, or insufficient data are available from which to calculate reserves.



Source: Barite Deposits of Arizona
Stewart and Pfister, 1960

Figure 7.—Graph showing relation of specific gravity, percent $BaSO_4$, and volume of ore.

BARITE DEPOSITS OF STEVENS COUNTY

HUCKLEBERRY MOUNTAIN AREA

Location and accessibility.—The Huckleberry Mountain referred to in this report is in southwestern Stevens County (fig. 8). The crest of the mountain is 9 miles east of Hunters and 12 miles west of Valley and Springdale. Lake Roosevelt is about 6 miles west of the mountain, and the Colville and Chamokane valleys form the eastern boundary.

The county road between Hunters and Springdale crosses Huckleberry Mountain near its center, the elevation of the pass being about 3,400 feet. From this road and other county roads, logging and mine roads provide access to most parts of the mountain.

Topography.—Huckleberry Mountain consists of a series of peaks that form a northeastward-trending mountain. Elevations of the peaks that form the crest range from 3,800 to 5,814 feet above sea level. The average elevation of the crest of the mountain is about 4,500 feet over a distance of about 20 miles. The topography is mountainous but not rugged. Most of the summits are rounded, and the slopes are moderately steep. Hunters, Harvey, Sand, Chamokane, Deer, and Huckleberry Creeks have incised into the slopes of the mountain many steep-sided ravines. The streams west of the divide drain into Lake Roosevelt (Columbia River), and those east of the divide flow into the Colville River and Chamokane Creek.

Most parts of Huckleberry Mountain contain good stands of pine, fir, and western larch. Open grassy meadows and steep rocky cliffs occur at random throughout the timbered areas.

The largest concentration of barite occurrences in the State is in the Huckleberry Mountain area, amounting to 13 of the 33 occurrences that are known by the Washington Division of Mines and Geology.

Allan Deposits

Four occurrences of barite are within 1 mile of the Springdale-Hunters road in T. 30 N., R. 38 E. All are on the western slope of Huckleberry Mountain at altitudes between 3,200 and 3,400 feet.

By road, Hunters is 9 miles to the west of the occurrences, and Springdale, the nearest railroad shipping point, is 20 miles to the east. The mineral rights to the properties belong to the C. F. Allan estate, of which Harry Allan, of Springdale, is trustee. Most of the surface rights in the area are owned by the Deer Park Pine Industry, Inc., of Deer Park, Washington.

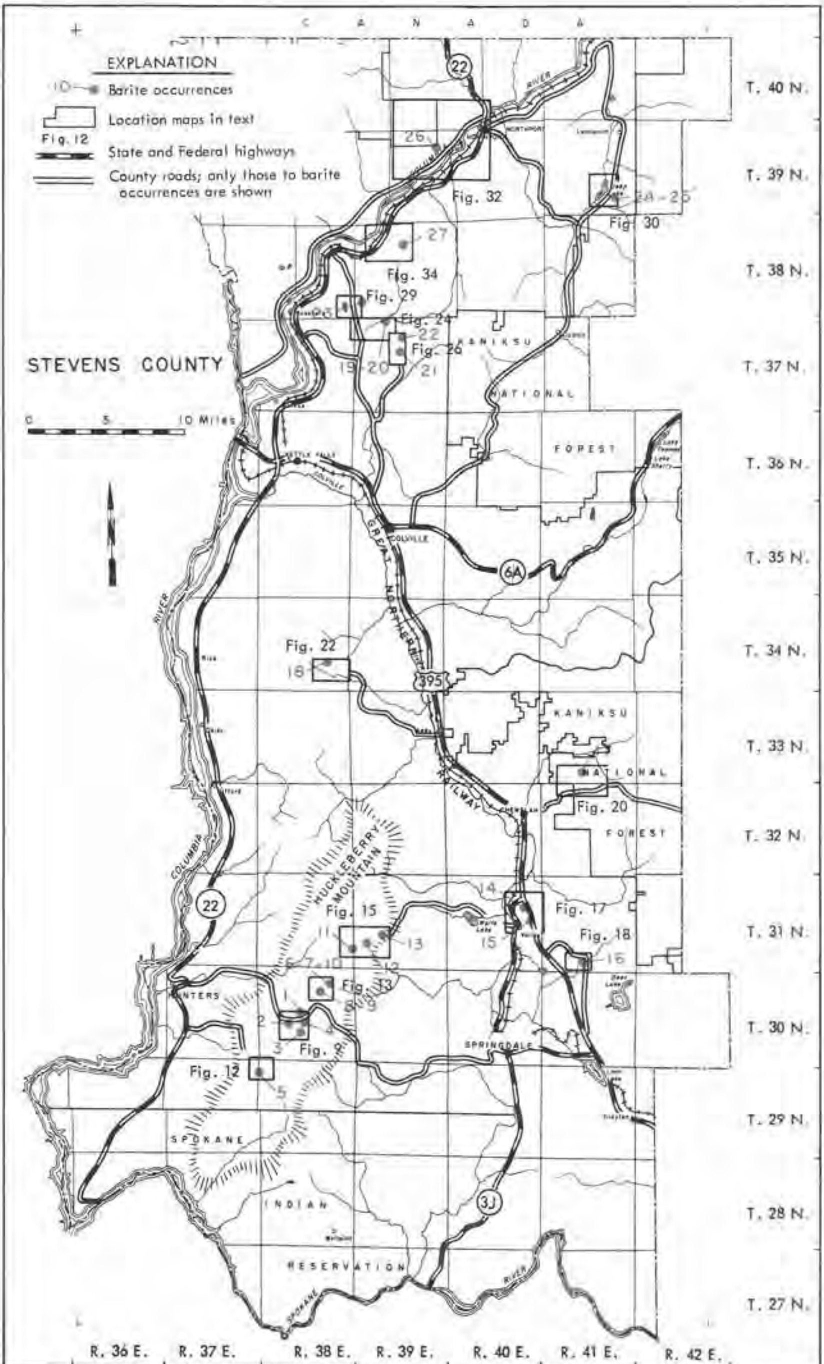


Figure 8.—Index map showing the barite deposits of Stevens County.

LOCATION MAPS

BARITE DEPOSITS

Number		Number	
1.	Allan prospect No. 1	16.	Pease (Loon Lake) mine
2.	Allan prospect No. 2	17.	Eagle Mountain (Lynx Cat) mine
3.	Allan prospect No. 3	18.	Madsen mine
4.	Allan Barite (Four A) mine	19.	Uribe (Bruce Creek) mine
5.	Cedar Canyon prospect	20.	Ohman prospect
6.	Shallenberger mine	21.	Jacobson mine
7.	Deer Park Barite No. 1 mine	22.	Rose prospect
8.	Deer Park Barite No. 2 mine	23.	Williams Lake prospect
9.	Chamokane prospect	24.	Deep Lake prospect
10.	Hillside (Copper Butte) mine	25.	Lotze prospect
11.	Wells Fargo mine	26.	Flagstaff Mountain mine
12.	Cardinal mine and prospect	27.	O'Toole Mountain (Riverview and Ellingwood) prospect
13.	Yellow Jacket mine		
14.	Smith (Inklers Point) mine		
15.	Bakie mine		

The locations of the Allan barite deposits are shown in figures 8 and 9 and are designated as the Allan prospects 1, 2, and 3, and the Allan barite mine.

Allan Prospect No. 1

Location and accessibility.—This prospect is in the E$\frac{1}{2}$SW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 21, T. 30 N., R. 38 E., from 300 to 1,000 feet north of the Springdale-Hunters road on a southern slope of a south-trending ridge. A trail leads from the foot of the slope,

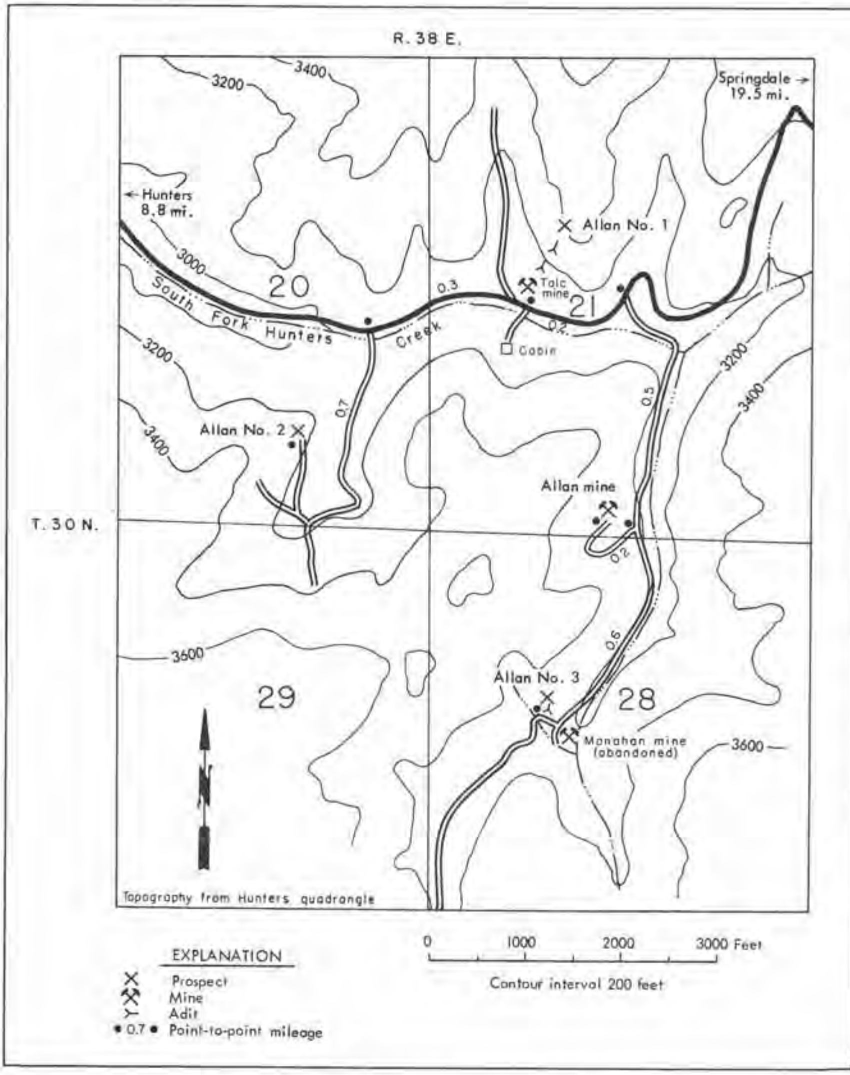


Figure 9.—Location map of the Allan barite deposits.

at 3,080 feet in elevation, to the uppermost dozer cut at about 3,400 feet in elevation. The dumps of several 'dozer cuts as well as two caved adits are plainly visible from the road. All exposures of barite are uphill from an old talc mine that is at the foot of the slope.

General geology.—The area is underlain by argillite, quartzite, and dolomite that Bennett (1941, p. 7-8) has mapped as the Deer Trail Group (Precambrian). The regional trend of the rocks ranges from N. 25° to 35° E.; the dips range from 30° to 80° both east and west. About 400 feet east of the barite occurrences the argillite, quartzite, and dolomite have been faulted against Precambrian slate. This fault strikes N. 10° E. and is steeply dipping; the slate is on the down-dropped block.

Geology of the ore bodies.—Although barite occurs as float on the hillside and also on the dumps of several caved adits, only at the uppermost 'dozer cut at 3,400 feet in elevation is the barite sufficiently exposed to show the nature of the deposit. The barite vein, as exposed in the bottom of the 'dozer cut, strikes N. 35° E. and dips 73° W. (fig. 10). The hanging wall and footwall consist of greenish-gray slaty argillite, some of which is phyllitic. The argillite has a general strike of N. 35° E. and dips 60°-70° W. Light-tan quartzite that contains irregular bodies of white massive quartz as much as 12 feet long and 4 feet wide underlies the argillite.

The barite vein ranges from 18 to 36 inches in width, is white to light tan, and fine grained. Banding, which parallels the walls of the vein, is present in much of the barite (pl. 1, on p. 18). Near its contact with the wall rock some of the barite is brecciated. The brecciation is more distinct in the barite that has been subjected to weathering. Parts of the vein contain numerous vugs, many of which are filled with iron oxide. The barite is free of inclusions but does contain grains of quartz that are visible only in thin sections. A 3-foot sample of the vein (fig.10) assayed 92.32 percent $BaSO_4$, 6.71 percent SiO_2, and 0.35 percent Fe. The average specific gravity of samples taken from different parts of the vein is 4.42.

In an old prospect hole 20 feet south and downhill from the uppermost 'dozer cut, two barite veins are exposed. The west vein is 18 to 24 inches wide and appears to be the southern extension of the vein that is exposed in the 'dozer cut. The east vein is about 14 inches wide. About 18 inches of platy argillite separates the two veins.

Barite also occurs on the dumps of two caved adits between the 'dozer cut at 3,400 feet in elevation and the valley floor. Although the barite vein is not exposed on the surface at either adit, fragments of the barite indicate the vein to be as much as 36 inches wide. Pinching and swelling of the vein is indicated by the inconstant width of the barite vein fragments found on the dumps.

Although the longest continuous vein, which is exposed in the uppermost 'dozer cut, is but 35 feet long, the total length of the barite-mineralized zone appears to be at least 400 feet. The minimum depth of the mineralization is about 160 feet.

Assuming that the barite vein averages at least 24 inches in width, the ore reserves are calculated at 300 tons of measured and indicated ore and 12,850 tons of inferred ore. To date (1962) there has been no production from this deposit.

Allan Prospect No. 2

Location and accessibility.—The Allan prospect no. 2 is in the NE¼SW¼SE¼ sec. 20, T. 30 N., R. 38 E., about 3,000 feet southwest of prospect no. 1. It is at an elevation of about 3,230 feet on the eastern slope of a north-northeastward-trending ridge. Three-tenths of a mile west of Allan prospect no. 1, a logging road leads south from the Springdale-Hunters road for 0.7 mile to the prospect (fig. 9). The road to the prospect is accessible by conventional vehicles.

Geology of the ore body.—The host rock for the barite vein is quartzite of the Deer Trail Group that strikes N. 50°-60° E. and dips 60° W. The vein appears to parallel the bedding of the quartzite and has been exposed, by stripping, for 75 feet along its strike. The vein pinches and swells along its strike from a minimum width of 2 feet on its north end to a maximum of 10 feet on its south end. The south end of the vein contains many fractures, which strike mainly N. 35° W. and dip 70° NE. This end of the vein is also underlain by dark-green fine-grained diorite that resembles a sill. Similar basic igneous rocks are present in other parts of the Deer Trail Group, either as dikes or sills, and were formed prior to the barite mineralization.

The barite is medium to coarse grained and has a sugary texture. Most of it is white, but abundant iron oxide gives part of it a reddish color. The iron oxide is most abundant on the south end of the vein and fills numerous vugs that are from an eighth to a quarter of an inch across. A 10-foot chip sample across the south end of the vein assayed 94.44 percent $BaSO_4$. The average specific gravity of four samples collected at random from the vein is 4.37.

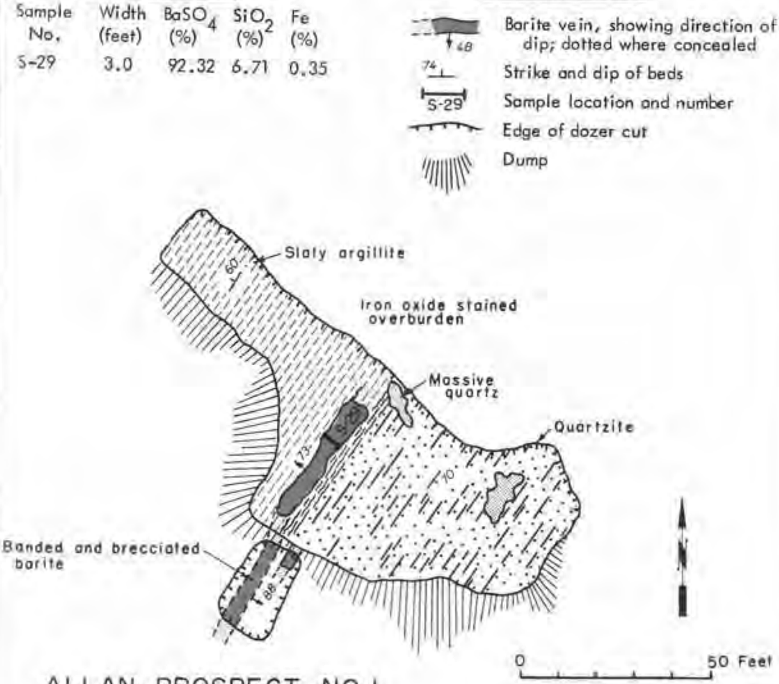
Althougth the barite is high in barium sulfate, much of it would have to be sorted to remove the material that contains an excess of iron oxide. Judging from the little exploration work that has been done on the property, it is probable that at least 400 tons of measured and indicated ore and 1,000 tons of inferred ore are present. A few tons of barite was stockpiled at the time of the examination (September 1961), but there is no record of shipments.

ASSAY DATA

Sample No.	Width (feet)	$BaSO_4$ (%)	SiO_2 (%)	Fe (%)
S-29	3.0	92.32	6.71	0.35

EXPLANATION

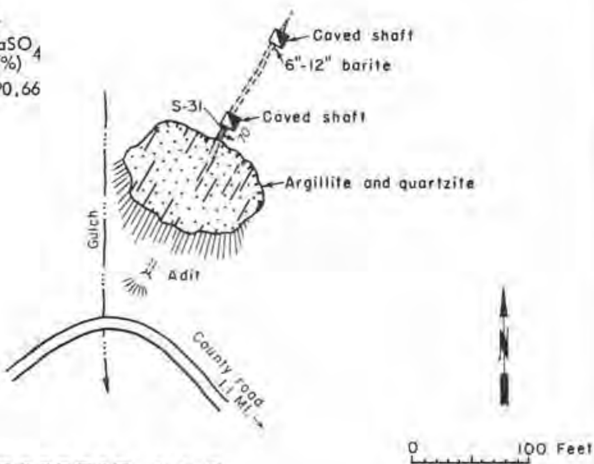
- Barite vein, showing direction of dip; dotted where concealed
- Strike and dip of beds
- Sample location and number
- Edge of dozer cut
- Dump



ALLAN PROSPECT NO. 1

ASSAY DATA

Sample No.	Width (feet)	$BaSO_4$ (%)
S-31	2.0	90.66



ALLAN PROSPECT NO. 3

Figure 10.—Sketch map of Allan prospects No. 1 and No. 3.

Allan Prospect No. 3

Location and accessibility.—Prospect no. 3 is in the NE¼SW¼NW¼ sec. 28, T. 30 N., R. 38 E., at the site of the abandoned Monahan mine (fig. 9). It is at an elevation of about 3,300 feet and is 0.7 mile west of the crest of Huckleberry Mountain. From the Springdale-Hunters road, 1.1 miles west of the summit, a logging road leads south for 1.1 miles to the prospect. At this point a new mine adit has been started about 50 feet northeast of the road. The barite is exposed about 250 feet northeast of the road, and the caved workings of the Monahan mine are to the southwest and below the road level.

Geology of the ore deposit.—The country rock of the area consists of greenish-gray argillite and light-gray quartzite of the Deer Trail Group that strike N. 30°-50° E. and dip 55°-70° NW. The rocks are highly fractured and contain lenses and irregular bodies of white quartz up to 24 inches wide and 15 feet long. Fine-grained dioritic rocks are also present but are poorly exposed.

The barite is exposed on the walls of two old prospect shafts that were sunk on the copper-mineralized parts of the vein. The best exposure of the barite vein is in the shaft at a point about 175 feet along a N. 30° E. bearing from the adit near the level of the road (fig. 10). At the surface the vein is 9 inches wide, and at a depth of 4 feet, which is the bottom of the shaft, it widens to 12 inches. The vein strikes N. 30° E. and dips 70° SE. Argillite, which is highly sheared and is stained green by copper carbonate, forms the wall rock of the vein. Abundant iron oxide is also present. Along the hanging wall the copper-iron-mineralized zone is from 30 to 48 inches wide, and along the footwall it is 2 to 12 inches wide.

The barite is white to light gray and medium to coarse grained. Many crystals of transparent barite up to 1 inch across are scattered throughout a finer grained groundmass. Some of the barite has been stained light green by copper carbonate, and other parts of the barite contain small vugs, some of which are filled with iron oxide. A representative sample of the vein on the southwest wall of the shaft assayed 90.66 percent $BaSO_4$ and had a specific gravity of 4.30.

About 65 feet northeast of the above-mentioned shaft is another caved prospect shaft, which is about 10 feet deep. The barite vein, as exposed on the southwest wall of the shaft, is 6 inches wide. Adjacent to the barite vein a small amount of copper carbonate staining is present in the sheared argillite wall rock. On the northeast wall of the shaft the barite vein has pinched to less than 1 inch in width. This vein has the same strike and dip as the vein in the other shaft and appears to be an extension of that vein.

To the southwest of the 4-foot shaft an area has been stripped by bulldozing for about 65 feet along the strike of the vein (fig.10). Copper and iron mineralization is exposed in the stripped area, but the barite vein does not crop out. Much of the stripped area is covered by waste that contains fragments of barite up to 1 foot across, indicating that barite was uncovered during stripping operations. However, some of the barite may have been float in the overburden.

Because of the narrow width of the vein — 12 inches at its widest point — the deposit is not of commercial value. The vein pinches out along its strike, though possibly it is wider at depth.

Allan Barite (Four A) Mine

Location and accessibility.—The Allan Barite mine is in the SW¼SE¼SW¼ sec. 21, T. 30 N., R. 38 E. It is 0.4 mile south of the Springdale-Hunters road and 0.6 mile west of the crest of Huckleberry Mountain (fig. 9). From the Springdale-Hunters road, 1.1 miles west of the summit, a logging road leads south for 0.5 mile to the mine turnoff. An unimproved road leads west for about 0.2 mile to the mine, which is at an elevation of about 3,320 feet on the east slope of a northeastward-trending ridge. The road to the mine is accessible by conventional vehicles.

General geology.—The area is underlain by slate, slaty argillite, and impure dolomite of the Deer Trail Group (Precambrian) that have been intruded by basic igneous dikes. The regional trend of the beds is N. 35°-60° E., and steep dips to the northwest predominate. Several thrust and high-angle normal faults that parallel the regional trend interrupt the normal sequence of the rocks. Shear zones, some of which are mineralized, parallel several of the major faults. In addition to barite, the shear zones have been mineralized by copper, silver, and gold.

Geology of the ore deposit.—In the vicinity of the barite deposit the predominant rocks are greenish-gray argillite and dark-green fine-grained diorite. Adjacent to the barite veins the argillite is highly sheared and fractured. The fissility in the argillite, which parallels the bedding, strikes N. 25°-35° E. and dips 75°-90° NW. Most of the fracture surfaces of the argillite are coated with iron oxide.

The barite, as seen at the site of the mining operations, occurs as three veins in a 12½-foot shear zone (fig. 11). The veins range from 6 inches to 4 feet in width and parallel the fissility of the argillite. Minor pinching and swelling occur along the strike and dip of the veins, which appear to merge at depth. Malachite- and azurite-stained argillite 4 to 5 inches wide parallels the easternmost vein, and along the eastern edge of the barite-mineralized shear zone iron oxide-stained diorite

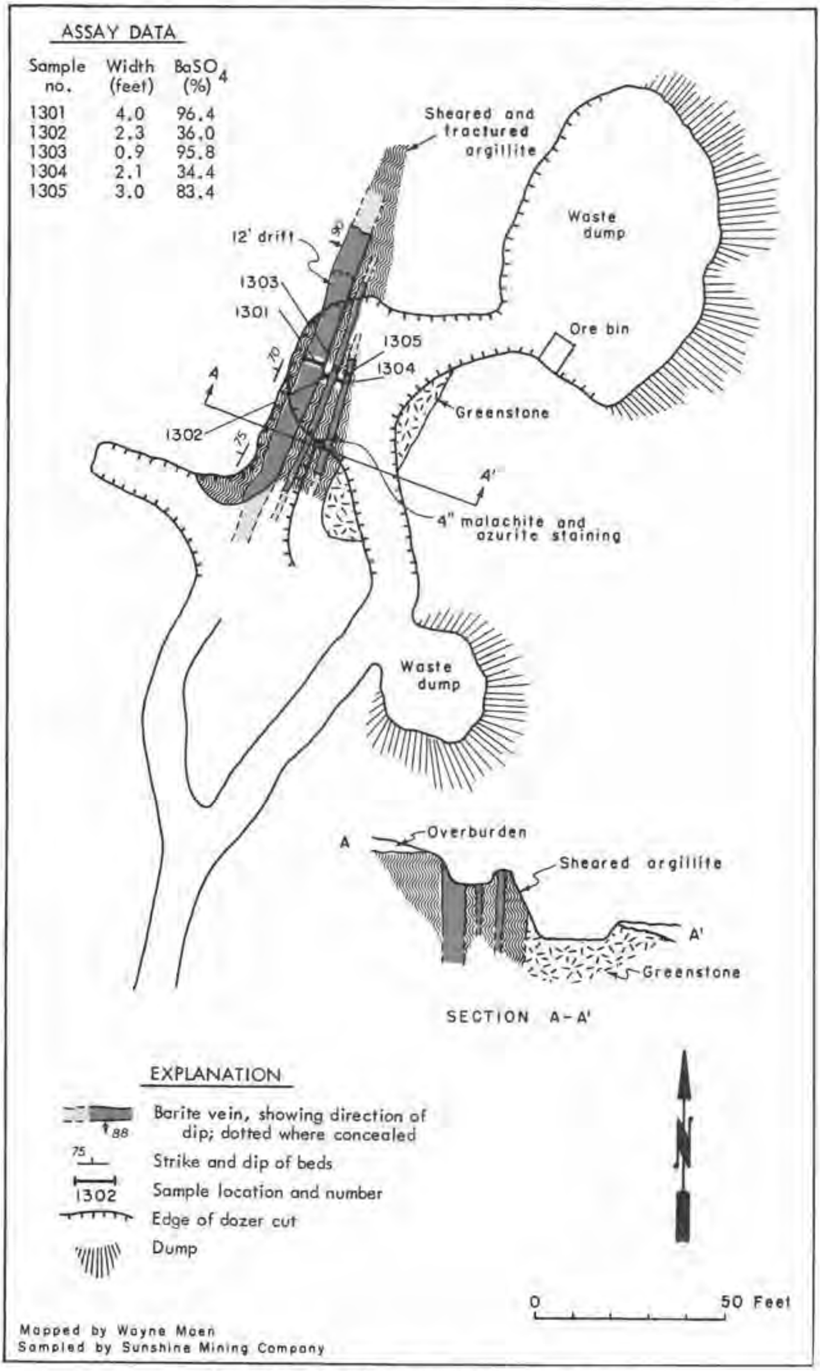


Figure 11.—Sketch map of the Allan barite mine.

is exposed. The diorite is so poorly exposed that its relationship to the barite could not be ascertained.

The barite is white to light gray and mainly fine grained. It has a sugary texture and contains scattered crystals of translucent barite up to one-half inch across. Most of the barite is massive and exhibits very little banding. Very fine grains of chalcopyrite are disseminated in parts of the vein, and a small amount of iron oxide, from the oxidation of chalcopyrite, occurs on the fracture surfaces of the barite. Assays by the Sunshine Mining Company show that the veins contain from 83.4 to 96.4 percent $BaSO_4$ (fig. 11). The copper-mineralized argillite contains 0.6 percent copper and 0.84 percent silver. Specific gravity determinations by the Washington Division of Mines and Geology on representative samples from the veins ranged from 4.00 to 4.40.

Mining operations.—Surface mining operations have exposed the barite over a strike length of 100 feet and to a depth of about 25 feet. The barite was first mined by stripping along the vein, and later a single quarry face was developed to gain depth on the barite. In October 1961 the quarry face was about 30 feet wide and 25 feet high. On the north end of the quarry the widest barite vein has been mined from a drift for about 12 feet along the strike of the vein. Harry Allan (oral communication, 1961) reported that about 200 tons of barite was mined by Hyram Davis of Ione, Washington, in the winter of 1961, and an unknown amount by Earl Fields in 1938-1939. Most of the barite was trucked to the railroad at Springdale, a distance of about 20 miles, for shipment to Clear Lake to be processed for well-drilling mud.

Additional barite still remains at the Allan Barite mine, and development work should substantially increase the known ore reserves. At least 1,400 tons of measured and indicated ore and 2,750 tons of inferred ore are present.

Cedar Canyon Prospect

Location and accessibility.—The Cedar Canyon prospect is about 5 miles east-southeast of Fruitland, on the western slope of Huckleberry Mountain about 1 mile from the crest. It is in the NW¼SE¼ sec. 1, T. 29 N., R. 37 E., in the bottom of Cedar Canyon, at an elevation of about 3,280 feet. The Deer Trail mine is half a mile to the south, and the Turk mine is three-quarters of a mile to the northeast (fig. 12). The prospect is on land owned by the Three Peaks Corporation, of Salt Lake City.

From the cookhouse at the Deer Trail mine, the prospect may be reached by following the abandoned Deer Trail mine road in the bottom of Cedar Canyon for about 0.25 mile north of its junction with the road to the Turk mine. At a point 120 feet beyond an old copper prospect, the adit of which is on the east side of the road and the dump on the west side, abundant barite float may be found on the road. Barite is also exposed in the bed of the creek about 100 feet northwest of where it occurs on the road.

Geology of the deposit.—The barite is white, massive, fine grained, and has a sugary texture. Clear crystals of barite up to a quarter of an inch across are disseminated in the barite but comprise less than 5 percent of it. Calcite is also present as thin stringers and disseminated grains, and makes up about 2 percent of the barite vein. Sparsely disseminated fine-grained magnetite and minor iron oxide that gives some of the barite a banded appearance are also present. The specific gravity of six samples ranged from 4.35 to 4.45.

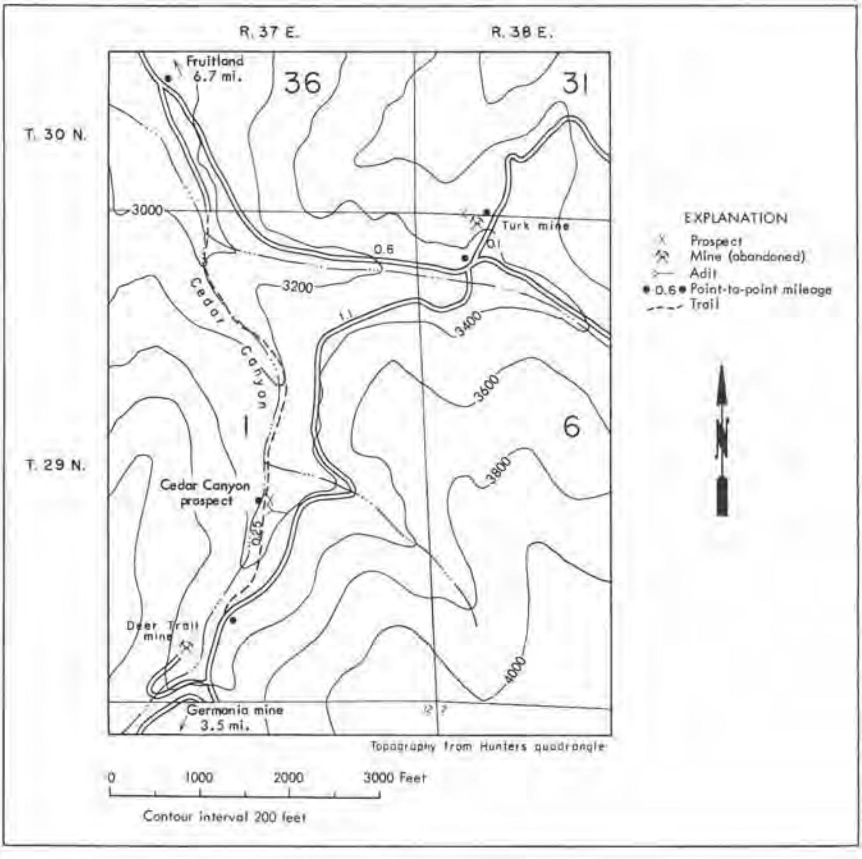


Figure 12.—Location map of the Cedar Canyon prospect.

The host rocks of the barite vein consist of argillite and quartzite of the Togo Formation (Precambrian) that strike N. 25° E. and dip 57° E. Exposures of the vein in the creek bed suggest that it strikes about N. 60° W. and is steeply dipping. Lack of good exposures makes it impossible to determine accurately the length and width of the vein; however, some fragments, which occur as float, are as much as 18 inches across, and exposures of the vein in the creek bed suggest a width of 3 feet. These same exposures indicate a strike length of at least 150 feet.

Barite is also exposed on the dump of an old adit about 120 feet south of the Cedar Canyon prospect; the adit is on the east side of the old road to the Deer Trail mine. Like that of the Cedar Canyon prospect, the barite occurs in argillite and quartzite of the Togo Formation. The barite veins parallel the strike and dip of the beds, which are N. 25° E. and 57° E., instead of crosscutting them. The underground workings were not examined to determine the extent of the barite mineralization; however, the barite probably occurs along the same shear zone as do the Turk and Deer Trail mines.

The barite, as exposed on the dump, resembles that at the Cedar Canyon prospect. Disseminated grains of chalcopyrite and stains of malachite and azurite are present in much of the barite. No barite fragments larger than 8 inches across were noted in the dump.

Because of inadequate data, ore reserves have not been calculated for the barite deposits of the Cedar Canyon area.

Shallenberger Mine

Location and accessibility.—The Shallenberger mine is near the center of the east line of the SE¼ sec. 10, T. 30 N., R. 38 E. It is 1 mile east of the crest of Huckleberry Mountain, at an elevation of about 3,200 feet. Springdale, the closest railroad shipping point, is 20 miles by road to the southeast.

The mine may be reached by driving west from Springdale on the Springdale-Hunters road for 13 miles to a county road that leads north. This road, which parallels Chamokane Creek, is followed north and northwest for 6.8 miles to the mine turnoff. From the turnoff it is about 0.3 mile to the mine adit on the southern slope of a ridge and near the bottom of a small gulch (fig. 13). All roads to the mine are accessible by conventional vehicles.

History and production.—The barite deposit was originally staked by H. H. Shallenberger in 1922 as the Barytes No. 1, and in 1927 he staked two more claims, recorded as the Barite and the Portland. In 1938, according to an article in the September 22 issue of The Spokesman-Review (Spokane), Sleight and Moon obtained a contract from E. I. du Pont de Nemours & Co. for 8,000 tons of barite for use in the paint industry. The barite was to be mined from the Shallenberger deposit, but it is not known whether the contract was filled. Between 1940 and 1943 about 1,100 tons of ore was mined by Earl Fields and shipped to the Sunshine Mining Company in Kellogg, Idaho, for use in the processing of antimony ores. In 1957 the Sunshine Mining Company obtained a lease on the property and undertook about 200 feet of drifting along the barite vein; they relinquished their lease a short time later. In 1960 the Deer Park Pine Industry, Inc., of Deer Park, Washington, acquired the property and sold a small amount of barite that was shipped to the west coast for use

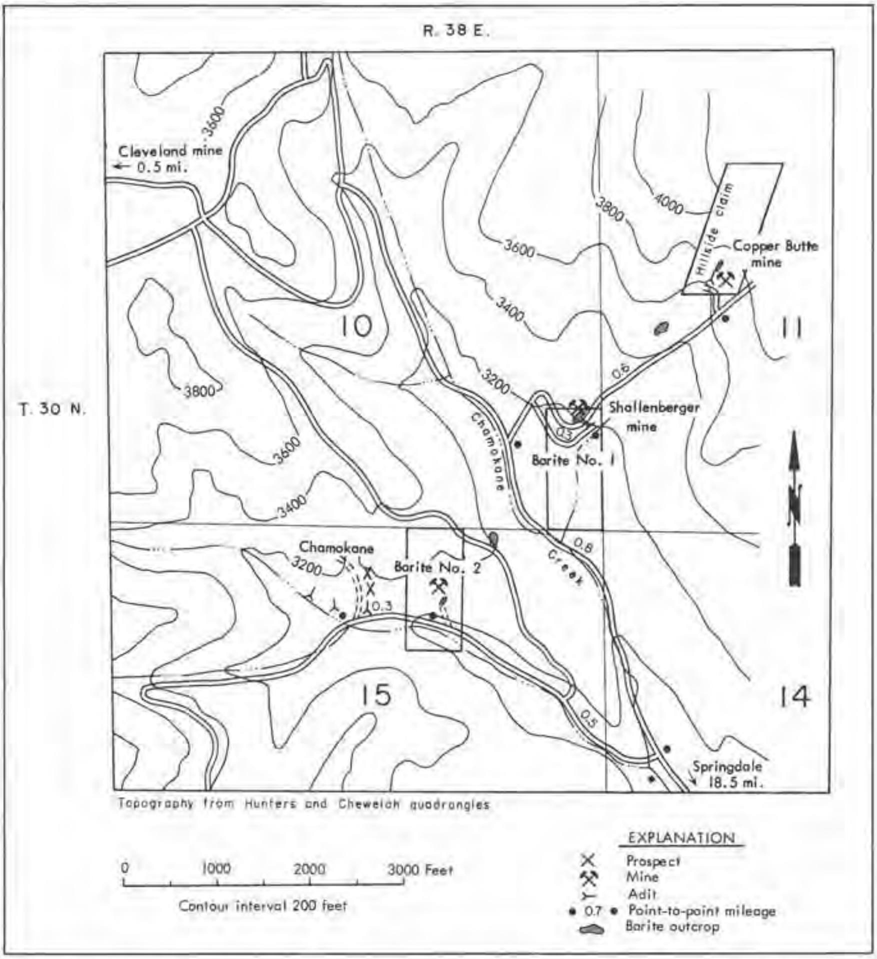


Figure 13.—Location map of the Shallenberger mine, Copper Butte mine, Deer Park Barite No. 1 and No. 2 mines, and Chamokane prospect.

in well-drilling mud. Most of the barite produced earlier came from the outcrop, now called the Deer Park Barite No. 1 deposit, which is above the Shallenberger mine level (see page 49). When the writer visited the property in the fall of 1961, the mine was idle.

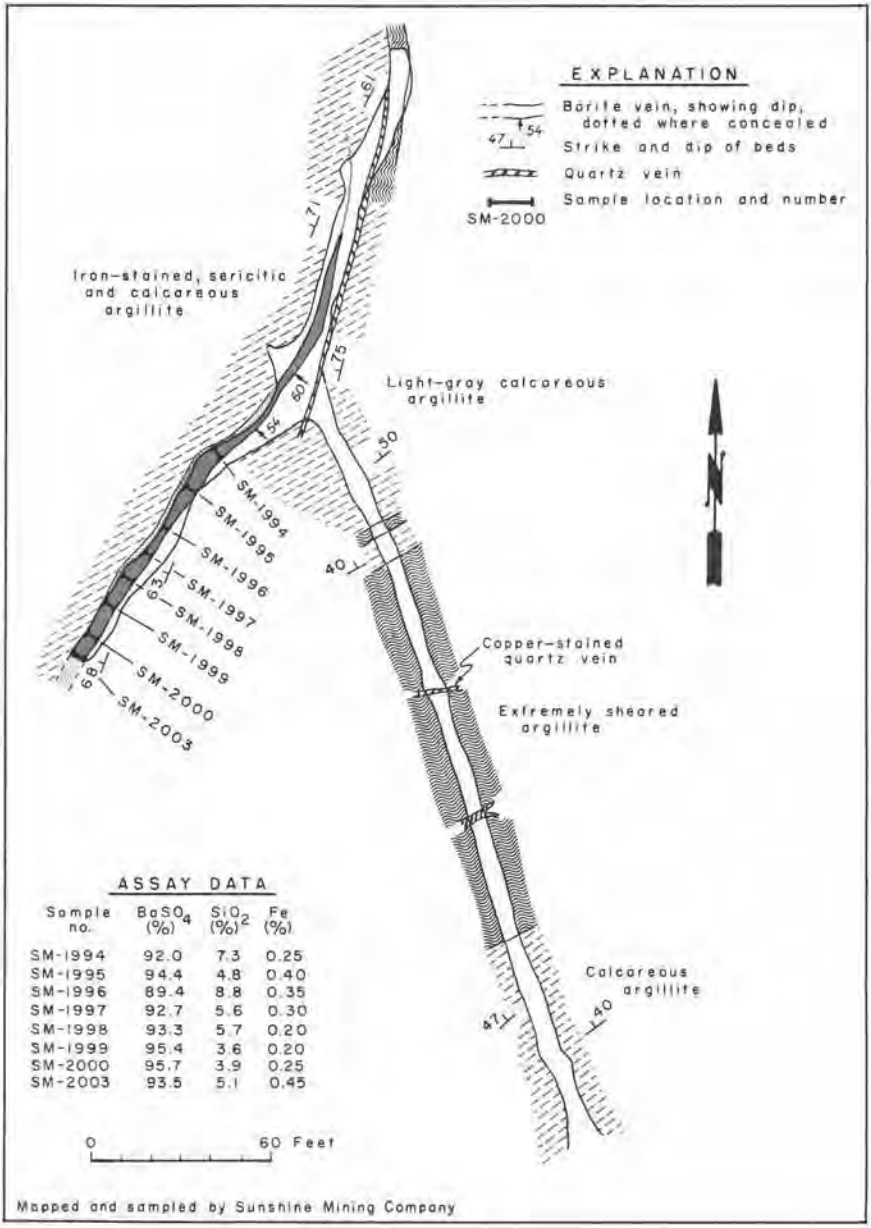
Regional geology.—The region is underlain by slate, slaty argillite, dolomite, and quartzite of the Deer Trail Group, of Precambrian age, the beds of which strike N. 40°-80° E. and dip mainly 50°-60° W. Much of the slate and argillite is foliated parallel to the strike of the beds, and the dip of the foliation is generally 70°-80° to the east or west. High-angle faults parallel the strike of the beds and are offset by transverse faults. Mineralized shear zones parallel several of the major faults of the region; the chief ore minerals are chalcopyrite, bornite, and barite.

Geology of the ore body.—The host rock of the barite vein is light- to dark-gray calcareous and sericitic argillite that has been mapped by Campbell and Loofbourow (1962, p. 10-13) as the McHale Slate. In the mine adit the beds strike N. 10°-45° E. and dip 35°-75° NW. Between 70 and 195 feet from the portal of the adit the argillite is highly sheared; the shear planes parallel the bedding and dip 30°-40° NW. Several malachite-stained quartz veins that range from 6 inches to 1 foot in width occur along the shear zones.

The Shallenberger mine adit was driven at a heading of N. 17° W. and intersects the barite vein 260 feet from the portal at a depth of about 80 feet beneath the outcrop of the vein. At the point of intersection the vein is 3 feet wide and has been drifted on, in a southwesterly direction for 110 feet and northward for 105 feet. In the face of the southwest drift the vein is 4 feet wide, and at 73 feet in the north drift it pinches to 2 inches and disappears into the hanging wall (fig. 14).

The barite vein, as exposed in the mine, has a general strike of N. 35° E. and dips 54°-70° NW. The barite is white, massive, and medium to coarse grained; some translucent barite crystals up to 1 inch across are disseminated in the vein. Parts of the vein are fractured, and the fracture surfaces contain a thin coating of iron oxide. The contacts between the vein and the wall rock are well defined, and no wall rock inclusions were noted in the vein. Sampling by the Sunshine Mining Company shows the vein to average 93.3 percent $BaSO_4$, 5.2 percent SiO_2, and 0.30 percent Fe (fig. 14). Specific gravity determinations by the Washington Division of Mines and Geology averaged 4.38.

Inasmuch as the barite vein in the Shallenberger mine and the barite that crops out at the Deer Park Barite No. 1 appear to be the same vein, the ore reserves are combined and given in the discussion of Deer Park Barite No. 1 on page 49 of this report.



ASSAY DATA

Sample no.	$BaSO_4$ (%)	SiO_2 (%)	Fe (%)
SM-1994	92.0	7.3	0.25
SM-1995	94.4	4.8	0.40
SM-1996	89.4	8.8	0.35
SM-1997	92.7	5.6	0.30
SM-1998	93.3	5.7	0.20
SM-1999	95.4	3.6	0.20
SM-2000	95.7	3.9	0.25
SM-2003	93.5	5.1	0.45

Figure 14.—Mine map showing underground workings of the Shallenberger mine.

Deer Park Barite No. 1 Mine

The Deer Park Barite No. 1 deposit of the Deer Park Pine Industry, Inc. is the outcrop of the Shallenberger vein. The barite has been exposed by mining operations 80 feet above and 200 feet to the northwest of the portal of the Shallenberger mine. The west line of the SW¼ sec. 11, T. 30 N., R. 38 E., passes about 200 feet to the east of the deposit. Directions for reaching the property are the same as those for the Shallenberger mine (see page 45).

Extensive stripping and trenching has exposed the vein for about 600 feet along its strike. The north end of the vein appears to pinch out, as it does in the drift of the Shallenberger mine, and the south end is concealed by a thick cover of overburden. When the property was examined in 1961, the vein was not visible in the bottom of several deep 'dozer cuts on the south extension of the vein, but none of the cuts appeared to have reached bedrock.

The barite vein in the surface cuts is 3 to 8 feet wide and resembles the vein in the Shallenberger mine. Most of the surface mining has been confined to the center of the vein, directly above the mine workings. The vein has been mined for almost 200 feet along its strike and to a maximum depth of 20 feet. It is difficult to ascertain the width of the vein in the bottom of the cuts, as most of them are filled with material that has sloughed from the sides. From the widest part of the vein, which appears to be about 8 feet, a sample was taken that assayed 92.51 percent $BaSO_4$; the specific gravity was 4.38.

The combined ore reserves of the Deer Park Barite No. 1 mine and the Shallenberger mine are 8,000 tons of measured and indicated ore and 10,000 tons of inferred ore. To date (1962), none of the ore in the Shallenberger mine has been stoped. The reserves can be increased by drifting southwest along the vein.

Deer Park Barite No. 2 Mine

Location and accessibility.—The Deer Park Barite No. 2 deposit is in the E½NW¼NE¼ sec. 15, T. 30 N., R. 38 E., about 2,500 feet southwest of Deer Park Barite No. 1. It is at an elevation of about 3,000 feet and is 1 mile east of the crest of Huckleberry Mountain. The deposit may be reached by following the west branch of a logging road that forks about 0.8 mile below the Shallenberger mine turnoff. Half a mile to the northwest on this road a 'dozer road leads north for about 250 feet to the deposit (fig. 13). The property is on public domain that has been staked as a mining claim by the Deer Park Pine Industry, Inc., which also owns most of the private land in the area.

Geology of the ore body.—The regional geology has been briefly mentioned in the discussion on the Shallenberger mine (see page 47). In the vicinity of the barite deposit the area is underlain by olive-green thin-bedded siltstone and argillite that strike N. 40° E. and dip 50°-80° NW. A 'dozer cut, which trends N. 35° E., has stripped the overburden from an area about 300 feet long and 12 feet wide. The barite is best exposed on the northern end of the cut and occurs as two veins, one 12 to 24 inches wide, and the other about 13 inches wide. The veins are separated by 6 feet of iron oxide-stained, contorted, and sheared argillite that contains veinlets of barite from ½ to 1 inch wide. The veins strike N. 35° E. and dip steeply; they are exposed for about 60 feet along the bottom of the cut. According to Everett Hougland, consulting geologist for the Deer Park Pine Industry, Inc., the barite vein has been folded into a southward-plunging anticline and mining was confined to the nose of the anticline, where the vein appeared to widen at the crest of the fold.

On the extreme northeast end of the 'dozer cut, massive fragments of barite up to 24 inches across are exposed. Some of the barite appears to be in place, but because of the overburden it cannot be traced for any distance.

The barite is cream to white and medium grained; some of it is distinctly brecciated. Iron oxide stains the fracture surfaces and also fills small cavities that were formerly occupied by iron pyrite. A representative sample of the barite assayed 94.89 percent $BaSO_4$ and had a specific gravity of 4.29.

In 1960 several hundred tons of barite was mined from the deposit for use in well-drilling muds. The bottom of the cut from which the barite was mined is mostly covered by waste, and the vein is poorly exposed. Based on several small outcrops, it is estimated that at least 50 tons of measured and indicated ore and 1,000 tons of inferred ore still remain.

Structurally, the Deer Park Barite No. 1 and No. 2 deposits appear to be on the same shear zone, which trends N. 30°-40° E. It is probable that the mineralization at the Copper Butte mine is also on this structure. The individual deposits are lenticular and are as much as 400 feet long. The maximum depth to which any one vein is exposed is 80 feet, at the Shallenberger mine. The area between the deposits contains a thick cover of overburden, and it is probable that additional deposits of barite are present along the shear zone, but have yet to be explored (fig. 13).

Chamokane Prospect

Location and accessibility.—The barite prospects in the W½NW¼NE¼ and the E½NE¼NW¼ sec. 15, T. 30 N., R. 38 E., are here referred to as the Chamokane prospect. According to Weaver (1920, p. 211), the original Chamokane group consisted of 38 unpatented claims that were in secs. 9, 10, 11, and 15, T. 30 N., R. 38 E., and staked to cover the copper mineralization in this area.

The Chamokane prospects are about 1,300 feet west-northwest of the Deer Park Barite No. 2 deposit and are accessible to within 300 feet by conventional vehicles (fig. 13, on page 46). 'Dozer trails lead from the road in the bottom of a gulch to several exploration cuts on the southern slope of a hill. The area of the barite mineralization is at elevations of 3,100 to 3,200 feet and is 0.8 mile east of the crest of Huckleberry Mountain.

Geology and mineralization.—The area is underlain by argillite, quartzite, and dolomite of the Deer Trail Group, of Precambrian age. The beds strike N. 20°-35° E. and are steeply dipping. No barite outcrops were discovered in the area, but fragments of barite up to 12 inches across were noted on the dumps of several caved shafts and adits. The recent 'dozer cuts were examined for barite, but no veins were noted; however, fragments of barite up to 15 inches across were uncovered in the dumps of the cuts. It could not be ascertained whether the barite came from a vein that was exposed during trenching operations or was float in the overburden.

The presence of barite on the dumps of excavations in the area suggests that the barite mineralization occurs along a N. 35° E.-trending zone. This zone appears to be nearly 500 feet long and to have a maximum width of about 130 feet.

A grab sample from one dump assayed 88.4 percent $BaSO_4$ and has a specific gravity of 4.25. It is impossible to calculate ore reserves for this area.

Hillside (Copper Butte) Mine

Location and accessibility.—The Hillside mine is in the SE¼SW¼NW¼ sec. 11, T. 30 N., R. 38 E., about 2,000 feet northeast of the Shallenberger mine (fig. 13, on p. 46). The mine is at an elevation of about 3,600 feet and is accessible from the workings of the Deer Park Barite No. 1 mine by a 'dozer trail that can be traversed without difficulty only by truck or jeep.

History.—The property was originally staked as the Copper Butte claims by M. B. Runyon in June 1916. Most of the early development work on the property appears to have been confined to a copper-mineralized zone near the center of the south line of the NW¼ sec. 11. From 1918 to 1926 the Security Copper Company, of Spokane, operated the mine and shipped a small amount of copper ore. In 1960 the Deer Park Pine Industries, Inc. relocated the mine as the Hillside claim and undertook a limited amount of exploration work, which consisted mainly of 'dozer trenching along the mineralized shear zone. In 1962 the portal of the adit was cleaned out and timbered; however, the barite was not mined.

Geology.—The mine workings at the Hillside mine are in a barite-copper-mineralized shear zone that strikes N. 35° E. and is steeply dipping. The country rock consists of sheared and sericitized argillite that is a unit of the McHale Slate, of Precambrian age. Everett Hougland reported (written communication, 1963) that the main mine workings consist of a 350-foot drift that follows an 8-inch to 2-foot barite vein containing chalcopyrite, bornite, pyrrhotite, pyrite, and some stringers and lenses of quartz. Along the drift the barite can be traced for 250 feet and inferred another 50 feet. At a station about 180 feet from the portal of the adit the mineralized zone is 15 feet wide and estimated to contain about 20 percent barite. The barite at this station occurs in a 6-inch and an 18-inch vein, and also in numerous stringers and lenses. Where the metallic minerals of the veins are absent, the barite is very white.

On the surface the barite is exposed by a series of pits, the highest of which is about 125 feet above the level of the drift. Based on the exposures in the drift as well as those in the surface pits, Hougland (written communication, 1963) estimated the ore reserves of the Hillside deposit at 5,000 tons of barite.

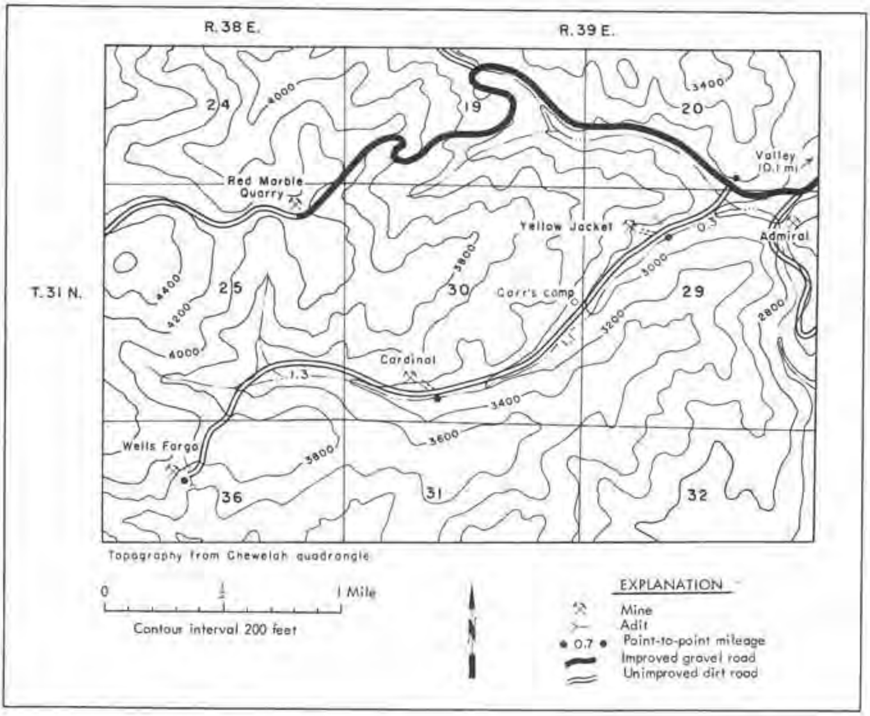


Figure 15.—Location map of the Wells Fargo, Cardinal, and Yellow Jacket mines.

Wells Fargo Mine

Location and accessibility.—The Wells Fargo mine is in the NE¼NW¼ sec. 36, T. 31 N., R. 38 E. By road it is 15.5 miles west of Valley, the nearest railroad shipping point. The mine is at an elevation of about 3,900 feet, and is 1 mile east of the crest of Huckleberry Mountain. The Red Marble magnesite quarry is 1 mile to the north. From a turnoff near the south quarter corner of sec. 20, T. 31 N., R. 38 E., on the road to the Red Marble quarry, an unimproved road may be followed to the southwest for 2.7 miles to the mine (fig. 15).

History.—The property was originally located by C. Passons and others in 1898. The principal development work was done by the Wells Fargo Mining Company until 1917. During this time two crosscuts were driven to intersect a quartz-stibnite vein at depth (Weaver, 1920, p. 212-213). Since 1935 C. R. Carr, J. M. Carr, and F. B. Carr have held a mining lease on the property from the State and have shipped a small amount of stibnite ore, some of which contained 7 percent antimony (Purdy, 1951, p. 148). Clarence Carr reported (oral communication, 1961) that in 1916 two railroad cars of barite was shipped to a smelter in Helena, Montana, in the belief that it was lead carbonate. In 1960 about 50 tons of barite was mined and shipped to the west coast to be used in well-drilling mud.

Regional geology.—The region is underlain by slate, argillite, dolomite, and quartzite of the Deer Trail Group, of Precambrian age. The beds have a general strike of N. 35° E. and dip 50°-70° NW.; however, drag folds produce variations in the attitude of the beds as much as 90° from the regional trend. In secs. 29 and 30, T. 31 N., R. 39 E., a northward-trending anticline and syncline also interrupt the regional trend.

High-angle normal faults and thrust faults parallel the regional trend of the Deer Trail beds; high-angle transverse faults offset several of the major faults of the region. Less than a quarter of a mile southwest of the Wells Fargo mine the continuity of the beds is interrupted by a transverse fault.

The Deer Trail rocks appear to be on the northwest limb of a northeastward-plunging syncline, the axis of which is to the east of Huckleberry Mountain. A major fault is indicated by the fact that the rocks of the Deer Trail Group do not crop out to form the southeast limb of the syncline.

Geology of the ore body.—The underground workings of the Wells Fargo mine are in gray slaty argillite and thin-bedded quartzite that strike N. 20° E. and dip 70°-85° NW. The barite vein and the slaty cleavage in the argillite are parallel to the bedding planes of the rocks.

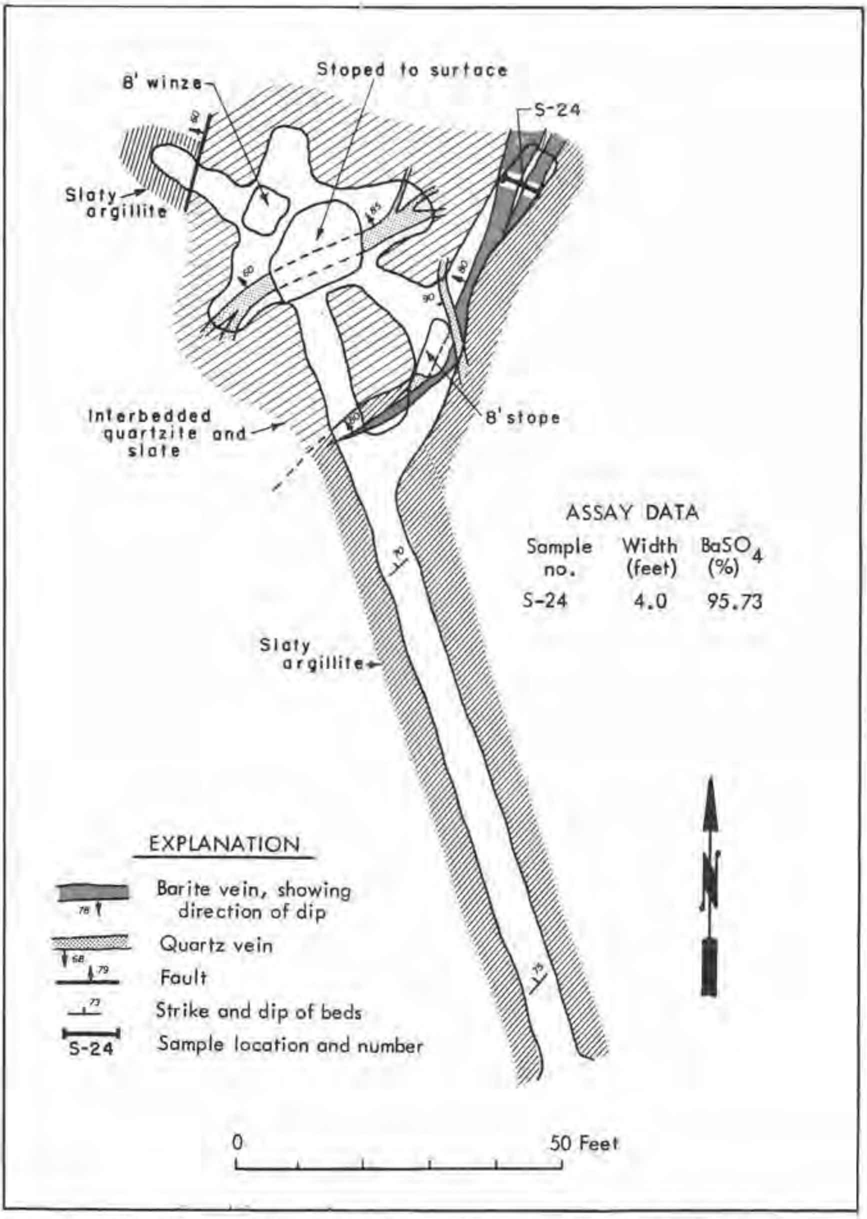


Figure 16.—Sketch map of underground workings of the Wells Fargo mine.

The barite is white to light gray, fine to medium grained, and has a sugary texture. Near its contact with the wall rock the barite contains one-sixteenth-inch discontinuous stringers of siderite, much of which has weathered to iron oxide. The barite that is exposed in the upper crosscut ranges in thickness from 0 to 4 feet (fig. 16). The crosscut intersects the vein about 102 feet from the portal of the mine, and a drift follows the vein northeastward 55 feet. At its widest point, which is about midway in the drift, the barite vein is 4 feet wide. At the face of the drift the vein splits, forming two veins, each about 13 inches wide. A representative sample of the vein assayed 95.73 percent $BaSO_4$; the specific gravity of the sample was 4.42.

White sugary quartz veins that range from $1\frac{1}{2}$ to 2 feet in width occur parallel to and also crosscut the barite vein. On the hillside about 150 feet north of the portal of the upper crosscut, a small outcrop of barite and quartz is exposed. It is not known whether this is the same barite vein that is exposed in the mine.

The lower crosscut of the mine, at an elevation of 3,750 feet, is about 200 feet south of the upper workings. According to Clarence Carr (oral communication, 1961), no barite is exposed in the crosscut, which is about 125 feet long.

Lack of good exposures and little development work at the Wells Fargo mine make it difficult to estimate the ore reserves with any accuracy. However, the deposit probably contains at least 175 tons of measured and indicated ore and 1,800 tons of inferred ore.

Cardinal Mine

Location and accessibility.—The Cardinal mine is in the NW$\frac{1}{4}$SE$\frac{1}{4}$SW$\frac{1}{4}$ sec. 30, T. 31 N., R. 39 E., at 3,200 feet in elevation, about 1 mile northeast of the Wells Fargo mine (fig. 15). The Red Marble magnesite quarry is 1 mile to the northwest. Near the north quarter corner of sec. 29, T. 31 N., R. 39 E., on the road to the Red Marble quarry, an unimproved dirt road leads southwest for 1.4 miles to the turnoff to the mine. The Cardinal mine is about 300 feet south of the road and can be reached only by low-geared vehicles.

History.—The early history of the property is not known; however, the presence of barite in the area has been known since 1940. Mrs. J. R. Brown, of Spokane, owns the mineral rights on the property, and in 1961 the deposit was under lease to Felix Cardinal, of Spokane. In 1960 Mr. Cardinal mined and shipped about 100 tons of barite for use in well-drilling muds. In 1962 nearly 300 tons of ore was stockpiled at the mine, but the mine was idle.

Geology of the ore body.—The regional geology has been discussed in the section on the Wells Fargo mine (see p. 53). At the Cardinal mine the host rocks for the barite veins are green slaty argillite and tan quartzite that strike N. 10°-20° E. and dip 55°-60° NW. Dark-green dioritic rocks are exposed along several roadcuts but are not associated with the barite veins.

At the site of the mining operations, two veins of barite are exposed for about 100 feet along their strikes. The veins are 3 to 8 feet wide and are separated by as much as 4 feet of slaty argillite. Argillite also forms the hanging walls and footwalls for both veins. The veins commonly pinch and swell along their strikes and dips, and they appear to widen at depth.

The barite is white to light brown, and fine to coarse grained. Much of it has a sugary texture and contains disseminated crystals of translucent barite up to 1 inch across. A thin coating of iron oxide occurs on the fracture surfaces of the barite. Iron oxide also fills small cavities in the barite, and some finely divided iron oxide is aligned, giving the barite a banded appearance. A 4-foot sample of the vein assayed 88.28 percent $BaSO_4$ and had a specific gravity of 4.38.

About 200 yards west of the main mining operations another barite vein has been exposed by trenching and stripping. The vein is 12 to 25 inches wide, strikes N. 10° E., and dips 80° W. The hanging wall consists of cream-colored fine-grained dolomite, and the footwall is greenish-gray slaty argillite, the bedding of which parallels the barite vein. The barite of this vein resembles the barite that is being mined, and contains green malachite staining. A 24-inch sample across the vein assayed 96.46 percent $BaSO_4$, 2.72 percent SiO_2, and 0.19 percent Fe; the specific gravity was 4.35.

A copper-mineralized zone 6 to 18 inches wide occurs between the barite vein and the argillite footwall. The predominant minerals are dark-brown vitreous hisingerite; green, earthy to finely crystalline malachite; chalcopyrite; and rust-colored iron oxide. The copper-mineralized zone also contains inclusions of barite and sericitized argillite, as well as numerous vugs. The barite vein adjacent to the zone contains grains of chalcopyrite; however, most of the chalcopyrite has oxidized, leaving residual iron oxide in the cavities. C. R. Carr (oral communication, 1961) reported that samples of the copper-mineralized zone have assayed as high as 25 percent copper.

Mining operations and ore reserves.—Mining at the Cardinal property has been confined to the easternmost occurrence, where the barite is mined from a single quarry face and trucked to railroad loading facilities at Valley. When the property was examined by the writer in the fall of 1961, the quarry face was about 100 feet long and 10 feet high. According to Mr. Cardinal (oral communication, 1961), no explosives have been used in the mining operations. At least 1,100 tons of measured and indicated ore and 6,800 tons of inferred ore are present at the site of the current mining operations. Limited trenching along the strike of the barite veins should substantially increase these reserves.

All the work at the western occurrence has consisted of exploratory trenching and stripping. The barite vein has been exposed intermittently along its strike for about 100 feet. Although 10 to 15 tons of barite is stockpiled, there has been no production to date (1962). The measured and indicated ore is calculated at 100 tons and the inferred ore at 1,850 tons.

Yellow Jacket Mine

Location and accessibility.—The Yellow Jacket mine is in the E½NW¼NW¼ sec. 29, T. 31 N., R. 39 E., about 1½ miles east of the Red Marble magnesite quarry (fig. 15). It is 3 miles east of the crest of Huckleberry Mountain and at an elevation of about 3,000 feet. Valley, the closest railroad shipping point, is 11 miles to the east by road. Near the north quarter corner of sec. 29, T. 31 N., R. 39 E., on the road to the Red Marble quarry, an unimproved dirt road leads southwest for 0.3 mile to the turnoff to the mine. From the turnoff, a road that is accessible only by four-wheel-drive vehicles may be followed 0.3 mile west to the site of the latest mining operations.

The Yellow Jacket barite deposit was discovered by C. R. Carr, J. M. Carr, and F. B. Carr in the fall of 1935. The Carr brothers obtained a lease on the deposit from Mrs. J. R. Brown, Spokane, who owns the mineral rights to the land. According to C. R. Carr (oral communication, 1961), 100 tons of barite, which assayed 94 to 96 percent $BaSO_4$, was shipped to the Sunshine Mining Company in 1942. In 1960 about 80 tons of barite was shipped to Clear Lake, Washington, to be processed for use in well-drilling muds. When the writer visited the property in the fall of 1961, it was idle.

Geology of the ore body.—The regional geology has been discussed in the section on the Wells Fargo mine (see p. 53). At the Yellow Jacket mine the host rocks for the barite veins are argillite, quartzite, and dolomite of the Deer Trail Group. The barite is exposed as two separate occurrences that are about 150 yards apart and are here referred to as the northern and southern occurrences.

The southern occurrence is the site of the original discovery and consists of a small outcrop of barite in the bottom of a caved trench. The host rock of the barite vein is gray slaty argillite that strikes N. 65° W. and dips 70° N. About 30 feet east of the barite, white to tan quartzite crops out as a small rocky knob; the quartzite overlies the argillite. The barite vein, which is about 4 feet wide, strikes N.

15° E. and dips 50° W. It is one of the few veins of the region that occur at nearly 90° to the strike of the beds of the host rock; however, the strike of the vein does parallel the regional trend of the rocks. With the exception of this and one other deposit (Cedar Canyon prospect), the barite veins in the Huckleberry Mountain region are parallel to the bedding in the host rocks.

The barite is white, fine-grained, and has a sugary texture. Translucent crystals of barite up to 1 inch across are disseminated in the fine-grained barite (pl. 1, p. 18). A small amount of iron oxide occurs as thin coatings on the fracture surfaces of the vein, but no iron pyrite or chalcopyrite, the common sulfide minerals of other barite veins, are present. A representative sample of the vein assayed 93.06 percent $BaSO_4$; the specific gravity was 4.48.

Because the sides of the trench have caved, very little barite is exposed. The outcrop is 4 feet wide and 6 feet long, but, according to C. R. Carr (oral communication, 1961), the concealed part of the vein is 3 to 6 feet wide and has a minimum length of about 45 feet. About 100 tons of ore has been mined by trenching along the strike of the vein. The remaining ore reserves are calculated at 25 tons of measured and indicated ore and 500 tons of inferred ore.

The northern occurrence is 150 yards along a N. 20° E. bearing from the southern occurrence and is the site of the most recent mining operations. Trenching and stripping have exposed two barite veins for about 45 feet along their strikes and to a maximum depth of 15 feet. The east vein strikes N. 20° E. and dips 45° NW. The north end of the vein is 6 feet wide; the south end splits into two veins, each 12 to 20 inches wide, that are separated by highly sheared argillite. Greenish-gray, iron oxide-stained slaty argillite, the cleavage of which parallels the vein, forms the footwall. Light-brown, iron oxide-stained, quartzitic dolomite, which strikes N. 30° E. and dips 5°-35° NW., forms the hanging wall. The wall rock contains abundant iron oxide that forms a distinct reddish-brown halo around the barite veins. The presence of abundant iron oxide in the wall rock is a characteristic feature of most veins that have a high barium sulfate content. The veins, themselves, are low in iron.

About 45 feet to the west a 24-inch-wide vein of barite parallels the eastern vein. Both the hanging wall and the footwall of the vein consist of dark-green slaty argillite.

The barite in both veins is white to transparent and coarsely crystalline. Individual crystals average about ½ inch across; a few as large as 1½ inches long are present. The barite contains numerous cavities that range from 1/16 to 1/8 inch across and are filled with iron oxide. Other cavities contain small euhedral crystals of barite. The shape of many of the cavities indicates that they were formerly occupied by siderite or pyrite. A representative sample of the east vein assayed 97.03 percent $BaSO_4$, 2.32 percent SiO_2, and 0.21 percent Fe. The average specific gravity of six samples taken from different parts of both veins was 4.45.

About 80 tons of barite has been mined from the northern occurrence. The ore reserves are calculated at 400 tons of measured and indicated ore and 1,750 tons of inferred ore. These reserves can be increased by additional exploration work along the northward extension of the vein; however, pinching of the vein can be expected, as most of the occurrences of the region occur as lenticular-shaped bodies along shear zones.

VALLEY AREA

Three occurrences of barite are within a 5-mile radius of Valley (fig. 8, p. 34). Railroad loading facilities are available at Valley, and well-maintained county roads lead to within several hundred feet of the deposits.

The area is characterized by rounded mountains that rise from flat valley floors. The elevations range from 1,667 feet at Valley to 4,103 feet on the summit of Bald Mountain, which is 2 miles east of the Pease barite deposit. Much of the area is covered by moderate stands of pine, fir, and western larch. Steep rocky cliffs and associated talus deposits occur on the flanks of several mountains. All the barite deposits are on privately owned land and are within the Chewelah mining district.

Areal geology.—The area is underlain by the Deer Trail Argillite (Precambrian), Addy Quartzite (Cambrian), Carboniferous limestone, and Miocene volcanic rocks that are predominantly basalt. Pleistocene glacial drift fills most of the valleys and also occurs as a veneer on parts of the mountains. The Loon Lake batholith (Late Cretaceous), which is mainly granite, lies at depth beneath the area. The main outcrops of the batholith are to the east and south of the area; however, several small roof pendants crop out a few miles west of Valley.

The regional trend of the sedimentary rocks is N. 10° W. to N. 10° E., and the dips range from 30° W. to vertical. It is not uncommon to find overturned beds and beds that strike at right angles to the regional trend. Only one major fault has been mapped in the Valley area (Jones, 1927-28); it is in the W½ of T. 31 N., R. 41 E. This high-angle fault, which parallels the regional trend, has displaced Precambrian argillite against Carboniferous limestone, and is accompanied by minor faults and shear zones. The barite mineralization of the area occurs as veins and lenses along several of the shear zones. Other shear zones are mineralized with copper, the major mines being the Loon Lake Copper and the Loon Lake Blue Bird, which are in the NE¼ sec. 33, T. 31 N., R. 41 E. These mines are no longer in operation.

Smith (Inklers Point) Mine

Location and accessibility.—The Smith barite occurrence is in the NE¼NW¼-NE¼ sec. 14, T. 31 N., R. 40 E., at an elevation of about 2,200 feet. It is 1 mile north of Valley, near the top of a small hill that is shown as Inklers Point on the Chewelah 30-minute quadrangle (fig. 17). Valley, the closest railroad shipping

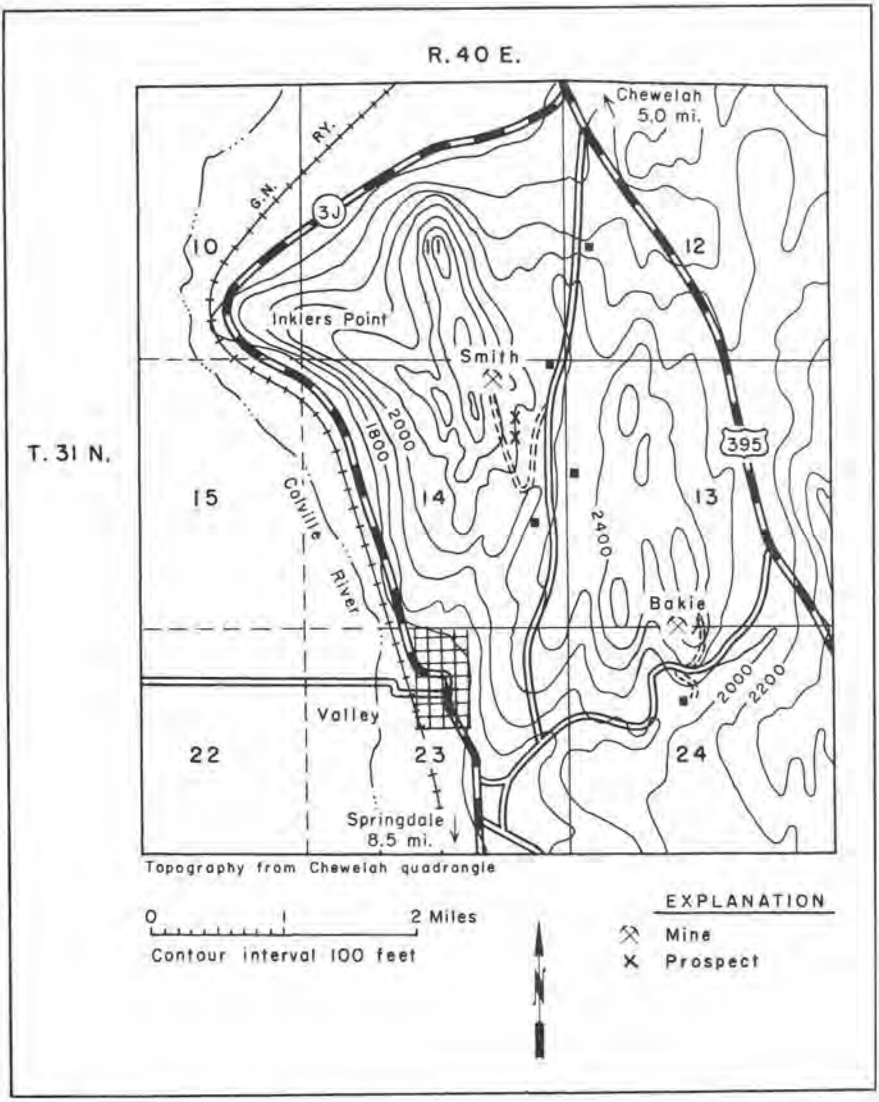


Figure 17.—Location map of the Smith (Inklers Point) and Bakie mines.

point, is 3.6 miles by road from the property. County and unimproved dirt roads, which are accessible by conventional vehicles, lead to the property.

The deposit is on land owned by Michael Smith, whose ranch house is near the common corner of secs. 11, 12, 13, and 14, about a quarter of a mile east of the deposit. In the fall of 1961 the mine was idle. Mr. Smith (oral communication, 1961) reported that 34 tons of barite was mined in December 1960 and shipped to the west coast for use in well-drilling muds.

Geology of the ore body.—The host rocks of the barite veins are argillite, quartzite, and limestone of Precambrian age. At the site of the mining operations they form a small elongate rocky hill that projects through the glacial drift of the area. Thin-bedded gray siliceous argillite forms the hanging wall of the barite veins, and cream-colored, very fine grained siliceous limestone forms the footwall. The beds strike N. 30° W. and dip 50°-58° NE. Thin veins of white quartz occur parallel to the beds of argillite on the north end of the outcrop and in much of the limestone of the footwall.

The barite occurs as a series of parallel veins over a 3- to 6-foot-wide zone. Individual veins range from 2 to 12 inches in width, and pinch and swell along their strikes, which range from N. 20° W. to N. 25° W. The veins dip 47°-55° NE., which is almost parallel to the dip of the wall rock.

The barite is white to medium brown and fine to medium grained. Much of the white barite has a sugary texture, and the brown barite exhibits a crude banding that parallels the strike and dip of the vein. Much of the barite is siliceous, grading from almost pure barite to siliceous barite within the same vein, which makes selective mining based on the appearance of the ore difficult. A thin coating of iron oxide covers fracture surfaces of the barite and the wall rock. A small amount of copper staining in the form of malachite and azurite is present in the barite and has been derived from fine-grained chalcopyrite that is sparsely disseminated in the barite and in the wall rock adjacent to the contact.

A 4-foot sample across the barite-mineralized zone, which includes thin interbeds of argillite, assayed 59.74 percent $BaSO_4$, 19.89 percent SiO_2, and 0.89 percent Fe. The specific gravity of the barite from several veins within the sampled zone ranged from 3.80 to 4.40.

About 1,500 feet south of the main deposit, several veins of barite crop out on small rocky ridges of argillite, quartzite, and limestone. The veins, which parallel the strike and dip of the beds of the wall rock, strike N. 10° E. to N. 10° W. and have nearly vertical dips. One vein has been exposed by stripping for about 12 feet along its strike. The vein ranges from 3 to 5 feet in width and exhibits gradational contacts with the wall rock. Thin veinlets of barite also occur in the wall rock parallel to the main vein.

The barite is white, fine to coarse grained, and contains small inclusions of limestone and disseminated grains of siderite. A small amount of iron oxide occurs as coatings on the fracture surfaces of the barite. A representative sample of the vein assayed 90.2 percent $BaSO_4$; the specific gravity was 4.28.

About 250 feet farther south, thin veins of barite and quartz 1 to 3 inches wide occur in small outcrops of argillite, quartzite, and limestone. No barite was noted in outcrops to the south beyond this point.

Mining operations and ore reserves.—Mining has been confined to the northernmost occurrence, near the north line of sec. 14, T. 31 N., R. 40 E. The overburden and the argillite hanging wall have been stripped to expose the veins for about 50 feet along their strikes. Several veins are exposed for a maximum distance of 12 feet along their dips. According to Michael Smith (oral communication, 1961), only 34 tons of barite was mined and shipped from the deposit. Mining of the barite is difficult and requires sorting to remove the limestone and quartz that resemble the barite. Because of a high quartz and calcite content, much of the barite would have to be milled in order to obtain a marketable product. The deposit contains about 400 tons of measured and indicated ore and 750 tons of inferred ore.

Bakie Mine

Location and accessibility.—The Bakie mine is 1 mile east of Valley, in the E½NE¼NW¼ sec. 24, T. 31 N., R. 40 E., at an elevation of about 2,100 feet (fig. 17). The deposit is on land owned by Gilbert Bakie, who resides about 1,000 feet south of his mine. Access to the property is provided by graded county roads to within 500 feet of the southern end of the barite deposit. From the county road, several 'dozer roads, all of which are accessible by conventional vehicles, provide access to the mine workings and several prospects.

In the fall of 1961 the property was idle. Mr. Bakie (oral communication, 1961) reported that in 1958 he shipped 200 tons of barite to the Great Western Sugar Company in Johnston, Colorado, to be used in sugar refining. The shipment averaged 98 percent $BaSO_4$.

Geology of the ore body.—The barite occurs as scattered lenses in Precambrian slaty argillite that strikes N. 25° W. and is nearly vertical. Individual lenses range from 2 to 10 feet in width and from 20 to 50 feet in length. The width of the shear zone along which the barite lenses occur is not known; however, a stripped area on the southern end of the deposit indicates a minimum width of 100 feet. Four lenses of barite are exposed across the width of the shear zone.

About 300 feet north along the shear zone, which parallels the strike and dip of the argillite, one barite lens has been mined for 50 feet along its strike and to a depth of about 20 feet. The maximum width of the lens is 10 feet. It is not known whether or not other barite lenses occur within the shear zone at this location, as all the work has been confined to the one lens.

The barite is medium gray to white, fine to medium grained, and has a sugary texture. Some of the barite contains disseminated and thin discontinuous stringers of fine-grained chalcopyrite and pyrite. Iron oxide is common and is concentrated along the contacts between the barite and the argillite in the form of a halo around the lenses. Mr. Bakie (oral communication, 1961) reported that past exploration work has shown that when an iron oxide zone is encountered during stripping operations, further stripping will reveal a barite lens beneath the iron oxide capping. As pointed out in the discussion on the Yellow Jacket mine, an excess of iron oxide in the wall rock adjacent to the barite usually indicates that the barite will have a low iron content.

A representative sample from the site of the mining operations on the northern end of the deposit assayed 95.45 percent $BaSO_4$, 2.88 percent SiO_2, and 0.15 percent Fe. The specific gravity of samples collected from the different lenses ranged from 4.42 to 4.48.

Ore reserves.—At least 1,000 tons of measured and indicated ore and 6,000 tons of inferred ore remain at the Bakie mine; however, only the larger lenses are favorable for mining. Although the barite sampled by the writer assayed 95.45 percent $BaSO_4$, shipments by Bakie have averaged 98 percent.

Pease (Loon Lake) Mine

Location and accessibility.—The Pease barite mine is 5.5 miles due north of the town of Loon Lake and 0.3 mile southwest of the Loon Lake Copper mine (fig. 8, on p. 34, and fig. 18). It is in the SW¼SE¼NW¼ sec. 33, T. 31 N., R. 41 E., at an elevation of about 2,510 feet. A hard-surfaced and graveled county road may be followed north from Loon Lake for 6 miles to the mine, which is 50 feet south of the road. Mr. J. E. Pease, whose ranch is half a mile west of the mine, owns the surface and mineral rights to the property.

A caved shaft on the north end of the deposit indicates that it was explored in the early days. However, there is no record of production until 1960, at which time about 400 tons of barite was mined for use in well-drilling mud. In 1961 the mine was idle.

Geology of the ore body.—The area is underlain by maroon slaty argillite and white quartzite of early Paleozoic age. The beds strike N. 2°-10° W. and dip 55°-90° SW. A thick mantle of glacial drift covers much of the area, and the barite crops out along a northward-trending rocky ridge that projects through the drift.

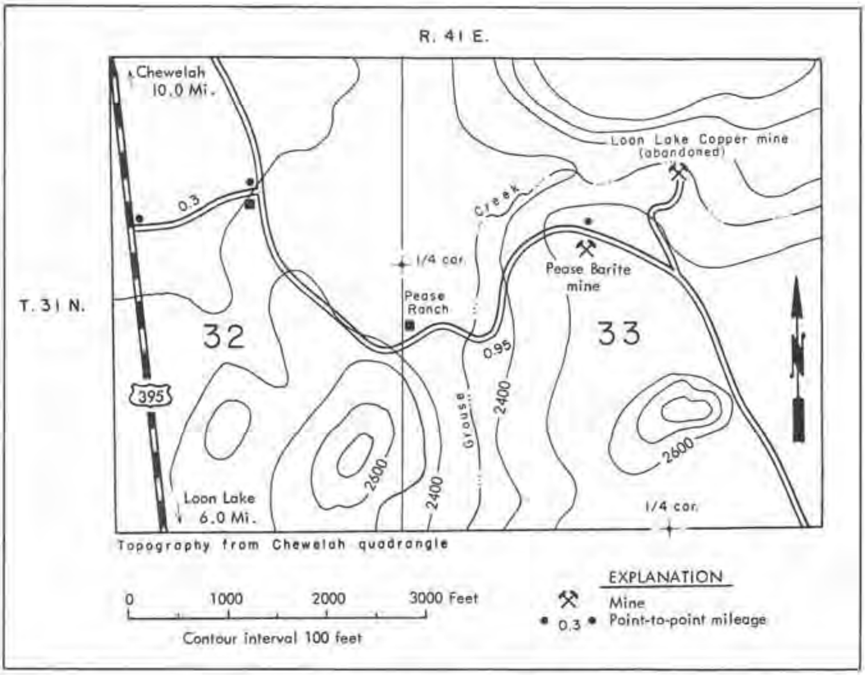


Figure 18.—Location map of the Pease (Loon Lake) mine.

The vein is 6 to 8 feet wide and is exposed for about 300 feet along its strike (fig. 19). The general strike of the vein is northerly, and the dip ranges from 85° to 90° W. In hand specimens the barite is dark maroon to white, but under the microscope the maroon part of the vein is seen to be composed of thin parallel discontinuous stringers of gray to white barite separated by thin stringers of maroon argillite. As the percentage of barite stringers increases, the vein becomes gray or white. As the percentage decreases, the vein grades into the wall rock. The specific gravity of individual barite veins averaged 4.42; this would indicate a barium sulfate content of about 95 percent (see p. 32). However, an 8-foot sample across the minable width of the vein assayed 78.80 percent $BaSO_4$, 18.38 percent SiO_2, and 2.33 percent Fe.

The argillite wall rock to the east of the main vein contains several veins of white fine-grained barite that are as much as 12 inches wide and 40 feet long. Whereas the main vein appears to have formed as a replacement along a shear zone, these smaller veins appear to be fracture fillings that parallel the shear zone.

Mining operations and ore reserves.—The barite-mineralized shear zone has been mined for 300 feet along its strike. To date (1962), mining has consisted of

ASSAY DATA

Sample no.	Width (feet)	$BaSO_4$ (%)	SiO_2 (%)	Fe (%)
S-23	8.0	78.8	18.38	2.33

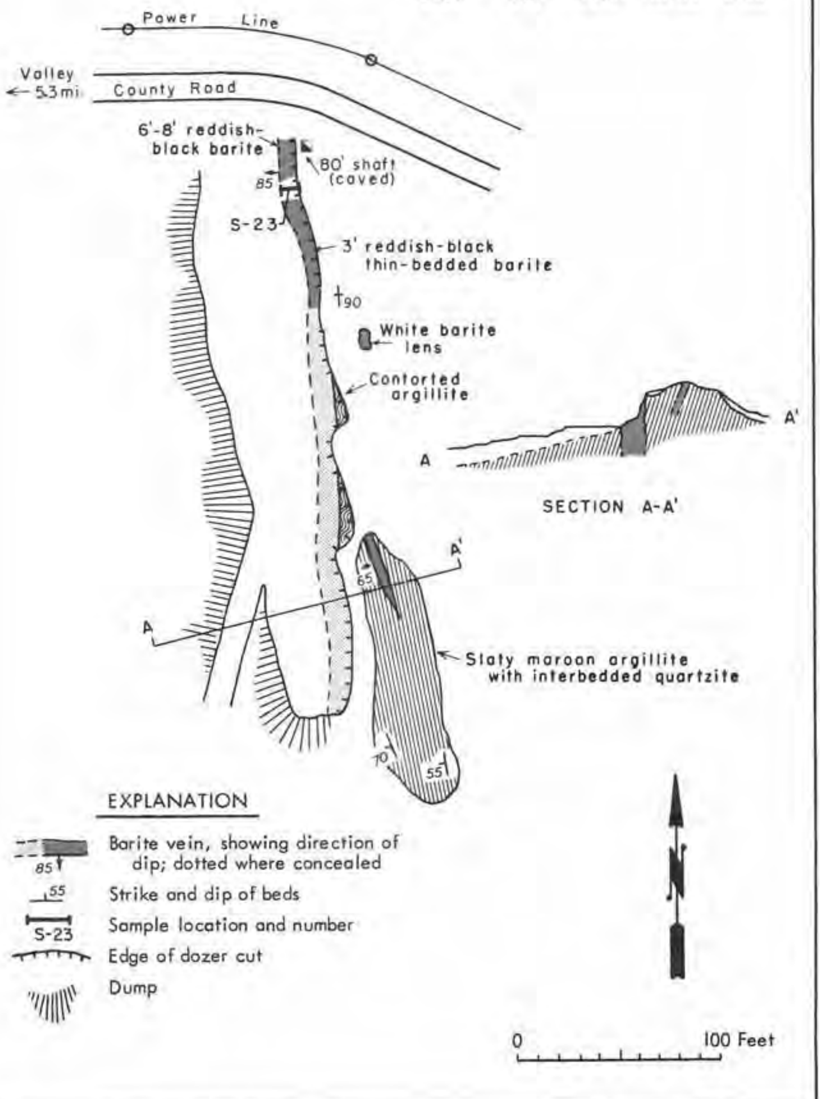


Figure 19.—Sketch map of the Pease barite deposit.

stripping away the hanging wall, after which the barite is drilled, blasted, and loaded by front-end loaders on bulldozers into dump trucks. The ore is trucked 4 miles to railroad loading facilities at Valley, from where it is shipped to the coast for use in well-drilling muds. Only the part of the vein that cropped out above the general ground level was mined, the maximum height above ground level being about 10 feet.

Additional barite still remains along the vein, because mining stopped at ground level. Beyond the section that has been mined, a thick mantle of glacial drift conceals the vein. The ore reserves are calculated at 900 tons of measured and indicated ore and 15,000 tons of inferred ore.

CHEWELAH AREA

Eagle Mountain (Lynx Cat) Mine

Location and accessibility.—The Eagle Mountain barite deposits are on the southeastern slope of Eagle Mountain at an elevation of about 4,400 feet and are 5

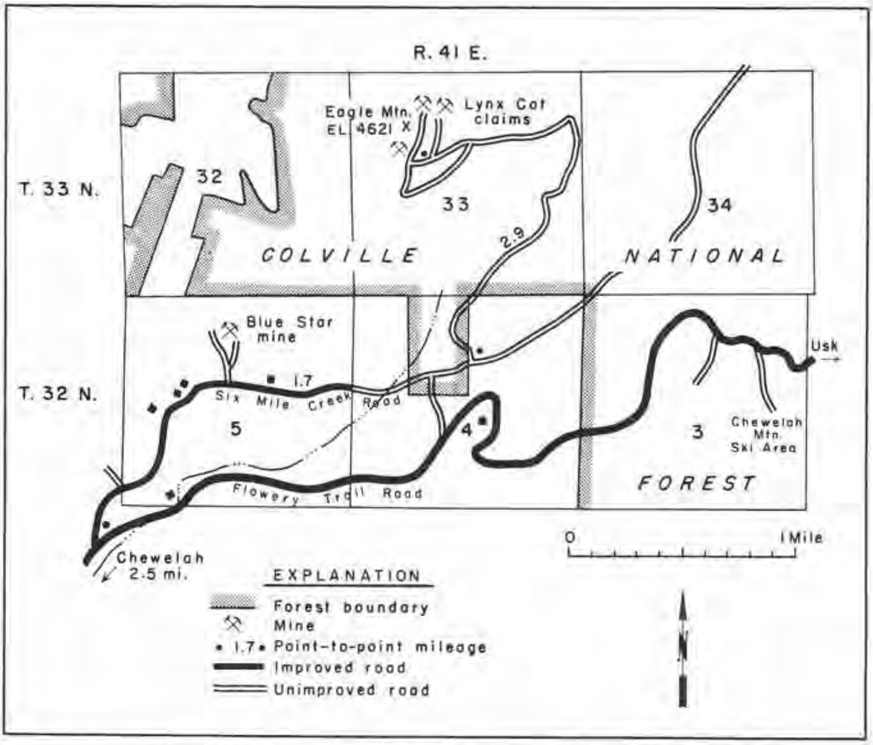


Figure 20.—Location map of the Eagle Mountain (Lynx Cat) mine.

miles northeast of Chewelah. The surface and underground workings from which barite has been mined are in the E½NW¼ sec. 33, T. 33 N., R. 41 E. (fig. 20). The mine is 7.1 miles by road from Chewelah, the nearest railroad shipping point, and is accessible according to the following road log:

Mileage

0.0-Junction of State Highway 3 and Main Street in Chewelah. Travel east on Main Street to Flowery Trail Road, which leads to the Chewelah ski area.

2.5-Turn left (north) on Six Mile Creek road.

4.2-Turn left (north) on graded dirt road.

7.1-Arrive at portal to mine at southwest end of claims.

The property consists of 6 unpatented mining claims in the Colville National Forest that are located as the Lynx Cat No. 1 through No. 6. The claims are owned by Gordon Lavigne, W. B. Moorhouse, and Alm Ole, of Chewelah. In the fall of 1961 the property was under lease to Don Lewis, of Chewelah.

Between 1958 and 1961 at least 3,000 tons of barite was shipped from the Lynx Cat claims. The initial shipment was in 1958, at which time W. R. Green of Spokane leased the property and shipped 2,000 tons of barite to the Great Western Sugar Company in Johnston, Colorado. The shipments averaged 98.3 percent barium sulfate. In 1960 and 1961 Don Lewis shipped about 1,000 tons of barite to the west coast for use in well-drilling muds. The specific gravity of the barite averaged 4.25. At present (1962), the property is idle.

Areal geology.—Eagle Mountain consists mainly of argillite, quartzite, and dolomite of Precambrian age. Argillite is the predominant rock and has been mapped by Jones (1927-28) as the Deer Trail Argillite. On the northwestern slope of Eagle Mountain near its summit, the Deer Trail Argillite is overlain by Addy Quartzite, and near the southern base of the mountain the argillite has been intruded by small plugs of Loon Lake Granite of Mesozoic age. This granite also crops out as small rocky knobs in the Pleistocene glacial-drift-filled valleys of the area.

The structure of Eagle Mountain is poorly known. Jones (1927-28) has mapped the Addy Quartzite as being thrust over the Deer Trail Argillite and subsequently folded into a N. 10° E.-trending syncline that plunges to the south. No major high-angle faults have been mapped on Eagle Mountain, but the mountain is cut by several N. 10° E.-trending shear zones, some of which are mineralized with barite.

Geology of the ore bodies.—At the site of the most recent mining operations a crosscut has been driven about 150 feet in a westerly direction through the Deer Trail Argillite (fig. 21). In the face of the crosscut, two veins of barite, one 12 inches wide and the other 3 to 4 feet wide, are exposed. Both veins strike N. 10° E. and dip 40° SE. Along the hanging wall of the largest vein is an iron oxide gouge

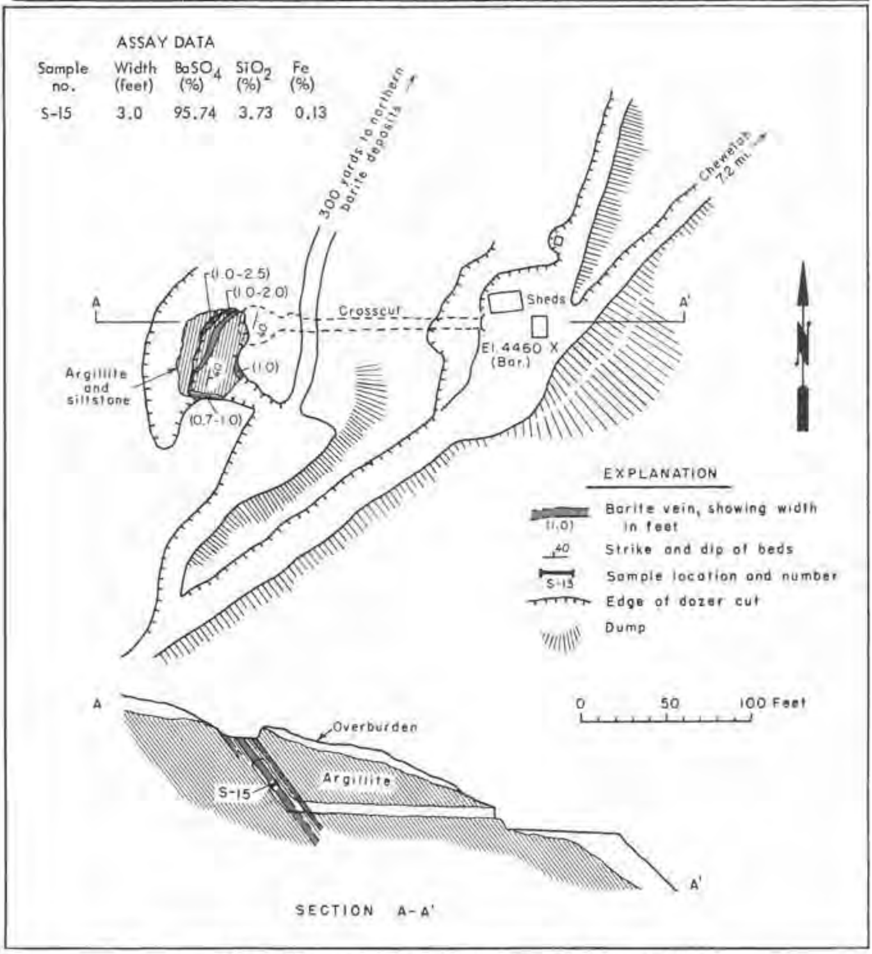


Figure 21.—Sketch map of the Eagle Mountain mine workings.

zone of laminated red clay and argillite fragments. The gouge occurs as lenses as much as 12 inches in maximum dimension. The barite veins, which pinch and swell along their strikes and dips, contain white to light-tan and fine- to medium-grained barite. Most of the barite is massive; however, some barite near its contact with the wall rock is brecciated, indicating postdepositional movement along the shear zones. A 3-foot sample of the vein assayed 95.74 percent $BaSO_4$; four samples from different parts of the veins range in specific gravity from 4.30 to 4.38.

About 40 feet above and 150 feet west of the portal of the crosscut, barite has been mined from an open cut (fig. 21). Two veins of barite, which resemble those in the crosscut, have been mined along their strikes for 25 feet and down dip for about 18 feet. The argillite host rocks lie flat in some parts of the open cut and strike N. 50° E. and dip 25° NW. in other parts. The wall rock adjacent to the veins is brecciated, and a red iron oxide gouge, like that in the crosscut, occurs along the hanging wall contact of the lower vein. As much as 2 feet of thinly laminated gouge is present along parts of the vein. Much of the argillite is highly fractured and contains abundant iron oxide staining.

In the open cut the barite veins strike N. 12° E. and dip about 45° SE. The upper vein is about 8 inches wide at the surface and widens to 30 inches in the bottom of the cut. The lower vein, which is parallel to the upper vein, is 12 to 36 inches wide and is separated from the upper vein by as much as 4 feet of gray metasiltstone. An iron oxide gouge zone forms the southern boundaries of both veins.

The barite is white to reddish brown, medium to coarse grained, and contains disseminated crystals of translucent barite as much as 1 inch across. Much of the barite is fractured, and the fracture surfaces are coated with iron oxide. Parts of the lower barite vein contain thin seams of pyrite and chalcopyrite as much as a quarter of an inch wide. A 30-inch sample from this vein assayed 94.6 percent $BaSO_4$.

From the portal of the crosscut a 'dozer road leads north for about 300 yards to an area of considerable 'dozer trenching and stripping. The area is underlain by folded and sheared greenish-gray metaquartzite and metasiltstone, the beds of which strike N. 55° W. to N. 40° E. and dip 50° to 90° NE. and NW.

In this northern area the barite occurs as lenses and irregular-shaped bodies along a N. 65° W.-trending shear zone that dips from 50° SW. to vertical. The lenses are 12 to 40 inches wide and as much as 20 feet long. Waste fills most of the cuts, so it is impossible to determine the maximum length of the lenses.

The barite-mineralized shear zone has been trenched at different intervals for about 400 feet along its strike. Only at the west end of the shear zone is the barite exposed; however, most of the outcrops are small. A representative sample from one of the exposures on the west end of the shear zone assayed 92.93 percent $BaSO_4$; the specific gravity of samples collected from most of the barite outcrops ranges from 4.38 to 4.40.

Mining operations and ore reserves.—On Eagle Mountain the barite has been mined from two shear zones by surface and underground mining methods. At the southern occurrence (see fig. 21) a crosscut intersects the barite veins about 60 feet beneath the surface. From a stope 15 feet wide and 25 feet high the barite was moved by a slusher to a set of grizzlies at the portal of the mine. Dump trucks, which served as ore bins when parked beneath the grizzlies, transported the barite to railroad loading facilities at Chewelah. Standard underground mining methods were used in the crosscut and stope. On the surface above the underground workings the barite was mined from a small open pit about 100 feet long and 60 feet wide. The pit is about 20 feet deep, and accessible on the downslope side to permit dump trucks to load within the pit.

The barite-mineralized shear zone to the north of the crosscut was mined by surface mining only. Barite was removed from several 'dozer trenches that parallel the shear zone, the largest trench being about 100 feet long and 20 feet deep. Other open cuts, which range from 30 to 50 feet in length, indicate that mining was undertaken on at least four lenses of barite. Most of the early production was from these workings, whereas the barite mined in 1960 and 1961 was from the southern deposit.

Barite reserves on the Lynx Cat claims are calculated at 1,100 tons of measured and indicated ore and 3,000 tons of inferred ore. Of this total, the southern deposit, which has been developed to a depth of 60 feet, contains 1,000 tons of measured and indicated ore and 2,500 tons of inferred ore. This deposit remains to be fully explored, as there are indications that the veins should continue along their strikes and dips from where mining ceased. Extending the crosscut might expose other parallel veins in the shear zone.

Because of the lenticular nature of the northern deposits and their poor exposures, the ore reserves for the northern area cannot be calculated accurately. At least 100 tons of measured and indicated ore and 500 tons of inferred ore probably remain in the northern deposit.

Madsen Mine

Location and accessibility.—The Madsen mine is 10.3 miles by road northwest of Addy, near the headwaters of Stranger Creek (fig. 8, on p. 34, and fig. 22). It is in the NE$\frac{1}{4}$SW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 26, T. 34 N., R. 38 E., at an elevation of about 2,570 feet. The property is accessible from Addy by following maintained county roads that lead to within 0.3 mile of the mine. W. A. Madsen, Route 3, Colville, holds the mineral rights to the property, and Morris Nelson, of Spokane, owns the surface rights.

The Madsen barite deposit has been mined intermittently from 1951 to 1961, chiefly by Manufacturers Mineral Company, of Seattle. Mr. Madsen (oral communication, 1961) reported that about 750 tons of barite has been mined for use as paint filler and as well-drilling mud.

Regional geology.—The region is underlain by Precambrian volcanic rocks; Cambrian limestone, dolomite, and quartzite; and Ordovician slate and argillite. The beds have a general northerly strike, and their dips are mainly toward the west at moderate angles. High-angle normal faults and thrusts parallel the regional trend

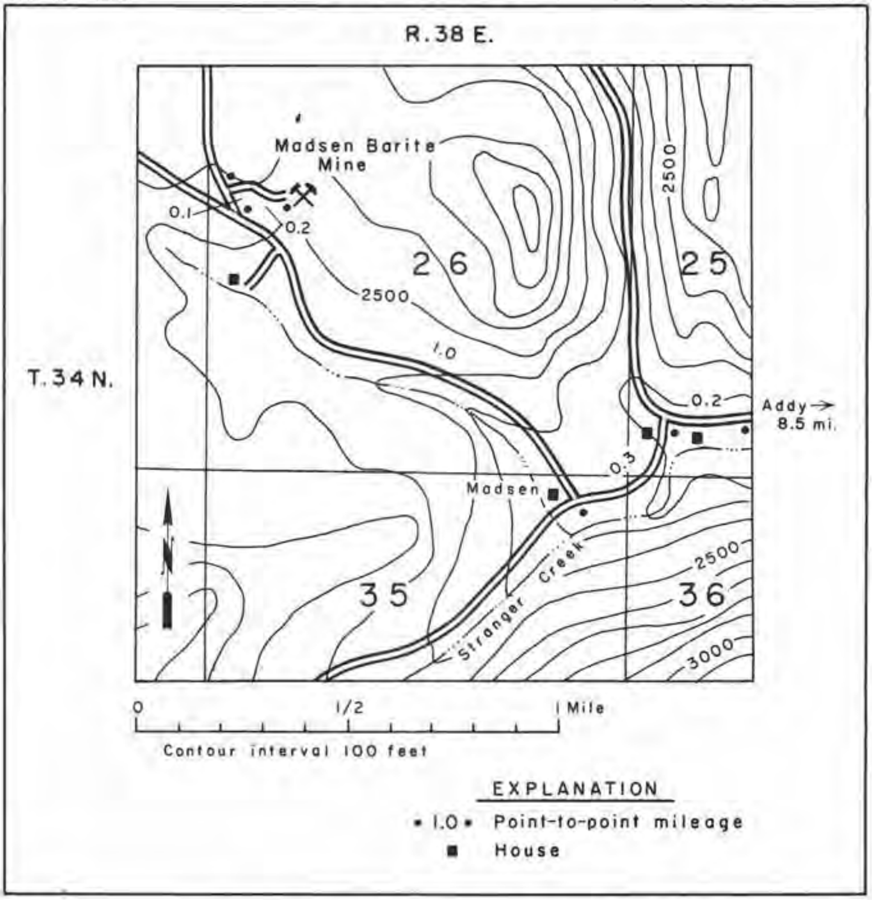


Figure 22.—Location map of the Madsen mine.

of the rocks. The sedimentary and volcanic rocks have been intruded by Mesozoic granite, which crops out about 3 miles to the east of the Madsen barite mine. Many of the valleys are filled with Pleistocene glacial drift.

Geology of the ore body.—Medium-gray Cambrian dolomite that strikes N. 80° E. and dips 35° NW. is the host rock for the barite vein. Part of the dolomite is well jointed and contains several small faults. The barite vein has been exposed by mining operations for about 75 feet along its strike and to a depth of 40 feet along its dip (fig. 23). The vein ranges from 3 to 8 feet in width and is parallel to the beds in the dolomite. The west end of the vein pinches out, and the east end terminates against a N. 55° E.-trending fault. According to Mr. Madsen (oral communication, 1961), the vein continues beyond the fault but is concealed by waste from the mining operations.

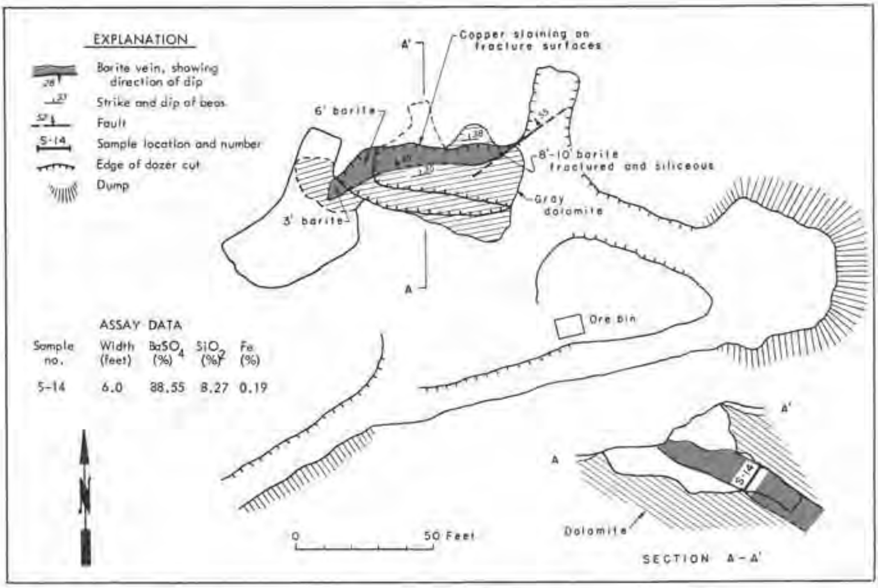


Figure 23.—Sketch map of the Madsen mine workings.

The barite is white, massive, fine to medium grained, and has a sugary texture. It contains numerous fractures, many of which are filled with thin seams of iron oxide. A minor amount of malachite and azurite staining is present, but no primary copper minerals were noted. Near the western end of the vein, sphalerite occurs as small irregular blebs in the barite. A 6-foot sample from near the middle of the vein assayed 88.55 percent $BaSO_4$, 8.27 percent SiO_2, and 0.19 percent Fe. The specific gravity of samples collected from different parts of the vein ranged from 4.32 to 4.5. Mr. Madsen reported (oral communication, 1961) that several carloads of barite that have been shipped in the past averaged 97 percent barium sulfate. Because of the difference in the barium sulfate content between the barite that has been shipped and that which was sampled by the writer, it is possible that the barium sulfate content of the vein is decreasing at depth. However, additional sampling should be undertaken to check this.

Mining operations and ore reserves.—The barite has been mined by conventional surface mining methods for 30 feet along the strike of the vein and for 30 feet along its dip. Near the center of the vein a "gopher hole" extends an additional 10 feet down dip (fig. 23). Most of the ore was transported in trucks to the Manufacturers Mineral Company plant in Chewelah, 20 miles from the pit. The absence of exploration work away from the site of the open pit indicates that no attempt has been made to determine the extent of the deposit.

The ore reserves of the Madsen barite deposit are calculated at 450 tons of measured and indicated ore and 1,450 tons of inferred ore.

BRUCE CREEK-CLUGSTON CREEK AREA

Location and topographic features.—Four occurrences of barite were examined by the Washington Division of Mines and Geology in the Bruce Creek-Clugston Creek area of northern Stevens County. This area is about 12 miles north of Colville in T. 37 N., R. 39 E. (fig. 8, on p. 34, and fig. 24). Clugston Creek forms the southern and eastern boundaries of the area, Bruce Creek the northern boundary, and Echo Valley the western boundary. Hard-surfaced and graveled county roads provide access from Colville and Evans, and railroad loading facilities are available at Palmer Siding, west of Colville, and at Evans, which is 3 miles west of the area.

The area is mountainous, and the ridges, in general, trend north. The elevations range from 1,800 feet in Echo Valley to 3,933 feet on Queen of Sheba Hill; the summits of most mountains are above 3,100 feet. The slopes of the mountains are intermediate in steepness and are covered by pine, fir, and western larch; however, a few slopes are steep and rocky. Clugston and Bruce Creeks and their tributaries provide drainage for the area. Water for mining needs is available a short distance from most deposits.

Areal geology.—The area is underlain by argillite, graywacke, and grit of late Paleozoic age. The strikes of the rocks range from N. 10° W. to N. 10° E., and the dips from 10° to 90° to the northeast and northwest. In the northern part of the area the rocks are compressed into a series of tight folds, some of which are isoclinal and overturned. In the southern half of the area the folds are open. There is insufficient evidence for major faulting within the area; however, the highly contorted and sheared nature of some of the argillite suggests the possibility of faulting.

On the eastern edge of the area late Paleozoic rocks are underlain by slaty argillite of Ordovician age. On the western edge of the area they are overlain by Carboniferous-Permian volcanic rocks that consist chiefly of sheared greenstones. The only known intrusive igneous rock in the area is a dioritic plug of Tertiary age that crops out in Echo Valley; however, less than 4 miles northeast of Bruce Creek there are extensive exposures of Mesozoic granitic rocks.

Pleistocene glacial drift fills the major valleys and also occurs as isolated patches on the mountains. The valley deposits are thick, whereas the isolated patches are generally thin.

Uribe (Bruce Creek) Mine

Location and accessibility.—The Uribe mine is in the NW¼NE¼ sec. 5, T. 37 N., R. 39 E., on the north side of Bruce Creek at an elevation of 2,200 feet (fig. 24). The Ohman barite prospect, which is on the south side of Bruce Creek near creek level, adjoins the Uribe mine on the south. Colville is 14 miles south, and Evans is 5 miles west.

The mine is accessible from the Bruce Creek School at the north end of Echo Valley, as follows: From Bruce Creek School travel north on county road; at 0.2 mile turn right (east) on Dead Medicine road; and at 1.6 miles arrive at the mine.

History and production.—The Uribe mine is on property owned by Charles Uribe, whose ranch is about 0.75 mile northeast of the mine. Prior to 1958 the deposit was leased to several parties, who undertook a limited amount of exploration

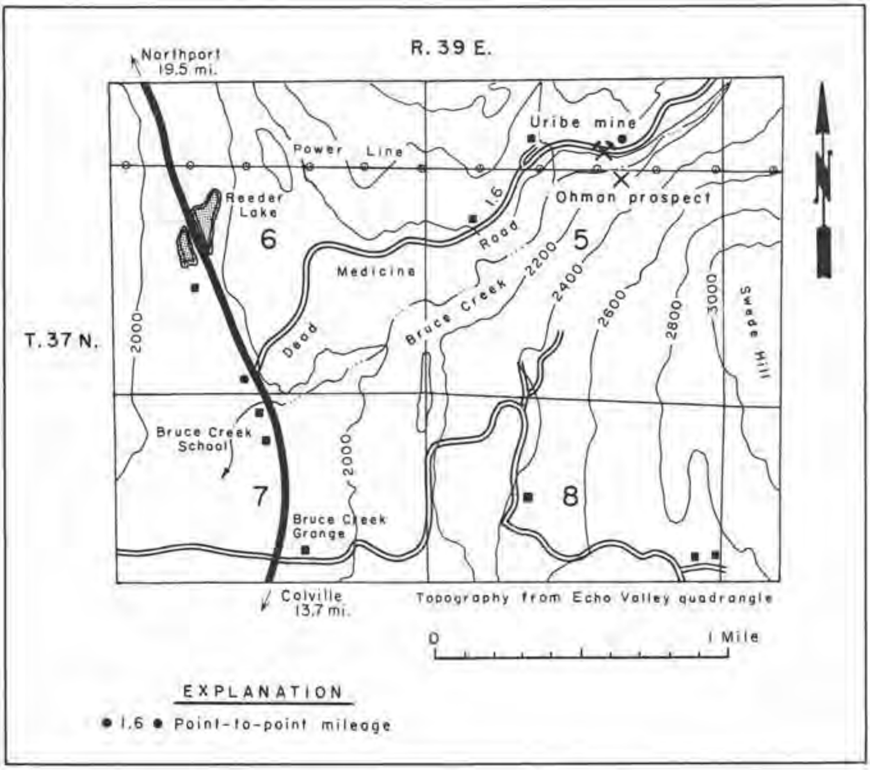


Figure 24.—Location map of the Uribe mine and the Ohman prospect.

work. Several trenches were dug along the strike of the barite vein, but no barite was mined. In 1958 the property was leased to the National Lead Company, which diamond-drilled the deposit. Mr. Uribe (oral communication, 1961) reported that two drill holes penetrated 100 feet and 140 feet, respectively, of barite at a depth of about 150 feet beneath the outcrop. For reasons unknown, the company dropped its lease in the spring of 1959.

In 1959 Darrell Newland, of Colville, acquired a lease to the property; he has been mining barite intermittently since then. To date (1962), about 5,500 tons of ore has been mined and shipped to Clear Lake, Washington, to be processed for use in well-drilling muds.

Geology of the ore body.—The host rocks of the barite veins are thin-bedded siliceous siltstones and argillites that contain intercalated massive limestone beds up to 3 feet in thickness. Much of the argillite is slaty to phyllitic and contains disseminated fine-grained pyrite. Veins of white quartz, 2 to 8 inches wide, fill fractures in the siltstone and argillite. Most of the bedrock is covered by glacial sand and gravels that are as much as 10 feet thick.

In the vicinity of the Uribe mine the rocks have been folded into a closed anticline, the axis of which strikes N. 30° W. and plunges 15° N. The strikes of the beds range from N. 30° to 50° W. and the dips range from 40° to 90° to the southwest and northeast (fig. 25).

Two well-developed sets of joints are present. One set parallels the axial planes of the folds and is vertical; the other set is at right angles to the axial planes and dips 70° SE. Numerous shear planes have developed along the bedding planes of the argillite and siltstone, and well-developed "b" lineation is present on many of the shear planes.

The barite occurs as a series of parallel veins interlaminated with the beds of the argillite and siltstone (pl. 1, p. 18). The veins range in width from thin stringers less than a sixteenth of an inch wide to massive veins almost 10 feet wide. Between the individual veins the wall rock ranges from thin beds less than a sixteenth of an inch thick to massive beds up to 2 feet thick. The veins are uniform in width and show little pinching and swelling.

The barite is white to medium gray, thin banded to massive, and fine grained. The banding, which parallels the contacts of the veins, is caused by alternating bands of light and dark shades of barite and thin seams of iron oxide. Minor iron oxide also occurs as thin coatings on the fracture surfaces of some of the highly fractured barite. No inclusions of wall rock were noted in the barite.

In thin section the barite veins may be seen to be composed of subhedral to anhedral grains of barite that average about 0.10 millimeter across. Less than 3

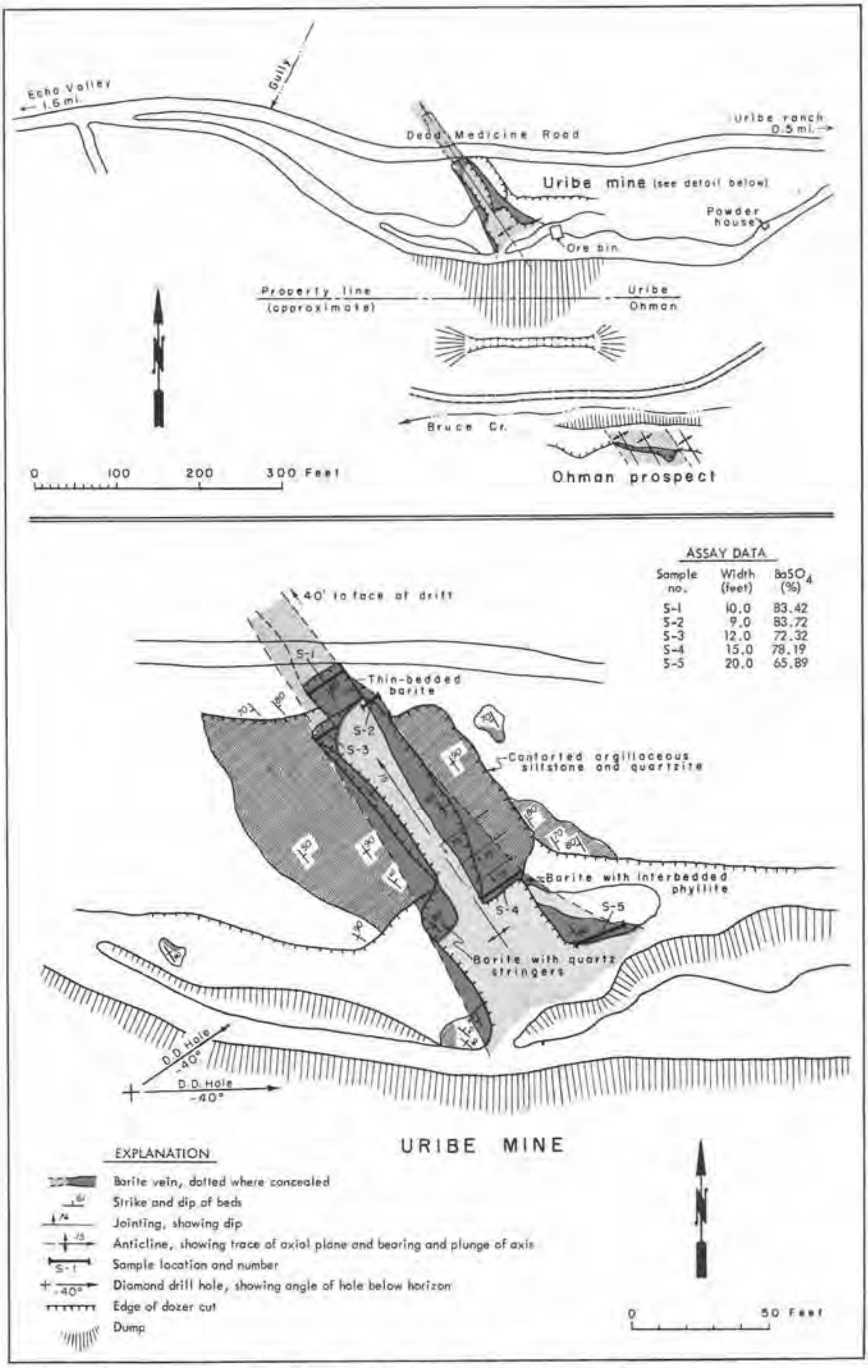


Figure 25. —Sketch map of surface workings of the Uribe mine and Ohman prospect, and the geology of the Uribe mine.

percent quartz is present. The quartz occurs as anhedral grains that have replaced the barite or as twinned quartz that surrounds cubes of pyrite. The pyrite is disseminated in the barite and is also concentrated as thin hairlike stringers along the contacts between the barite and the wall rock.

At the Uribe mine the barite-mineralized zone ranges from 10 feet to as much as 80 feet in width. The barite appears to be confined to the crest of a tightly folded anticline, which, due to its northward plunge, causes the mineralized zone to widen toward the south (see fig. 25). Whether the structure consists of a single closed fold or several isoclinal folds has not been determined; however, it does appear that the veins have been duplicated by folding. At the Ohman barite prospect about 300 feet to the southeast of the Uribe mine (fig. 24), isoclinal folding has repeated a single barite vein several times.

The central part of the mineralized zone over a width of about 8 to 10 feet is composed mainly of barite with little intercalated argillite and siltstone. Outward from the central part of the zone the argillite and siltstone beds are more numerous and increase in thickness.

A tabulation of the samples from the Uribe deposit and their barium sulfate content follows; the location of the samples is shown in figure 25.

Analyses of samples from the Uribe barite deposit

Sample no.	Width of sample (feet)	$BaSO_4$ (percent)
1	10	83.42
2	9	83.72
3	12	72.32
4	15	78.19
5	20	68.89

The specific gravity of parts of the vein that appear to be composed wholly of barite ranges from 3.91 to 4.40.

Mining operations and ore reserves.—The barite has been mined on the surface and underground for about 250 feet along the strike of the mineralized zone. The width of the surface cuts ranges from 20 feet on the north end of the mined area to 40 feet on the south end. On the north end a 70-foot drift extends northward from the surface cuts along the barite veins. The drift is about 8 feet wide, and the back is from 10 to 35 feet above the floor of the drift. After the barite was mined it was trucked 7 miles to railroad loading facilities at Evans.

There are good indications that substantial reserves of barite still remain at the Uribe deposit. To date (1962), only that part of the vein that requires no milling has been mined, and the mining has extended only to a maximum depth of 40 feet in places. The barite-mineralized zone has not been mined to its limits along its strike, and diamond-drill holes indicate that the barite extends at least 100 feet more in depth.

The remaining ore at the Uribe deposit is calculated at 10,000 tons of measured and indicated ore and 200,000 tons of inferred ore. If selective mining methods are employed, some of the ore would be marketable for use in well-drilling muds; however, most of the ore will have to be milled to meet the requirements of the barite-consuming industries.

Ohman Prospect

Location and accessibility.—The Ohman prospect is about 300 feet southeast of the Uribe mine and is on land belonging to the Ohman estate, which is administered by August Ohman, of Spokane. The prospect is in the SW¼NE¼ sec. 5, T. 37 N., R. 39 E., on the south side of Bruce Creek at an elevation of 2,120 feet (figs. 24 and 25). There is no record of production from the property, and the only exploration work consists of a 'dozer cut that exposes the barite.

Geology of the ore body.—The host rocks for the barite veins are medium-gray siliceous siltstone and argillite that have been isoclinally folded into N. 35° W.-trending folds. The siltstone beds range from ½ inch to 2 inches in thickness and are traversed by numerous fractures. Veins of white quartz up to 6 inches in width occur in the siltstone and argillite parallel to the bedding.

The barite veins parallel the bedding in the host rocks and range in thickness from ½ inch to 4 feet. The isoclinal folding of the veins, as seen along the 'dozer cut, causes them to be repeated several times; one 4-foot vein is repeated at least three times by folding.

The barite is light gray, fine to medium grained, and massive to thin bedded. When crushed, some of the barite gives off a fetid odor. Like the wall rock, much of the barite is fractured and is covered with a thin coating of iron oxide. Fine-grained quartz and iron pyrite are disseminated in the barite. Pyrite has been noted also as thin discontinuous stringers along the contacts between the barite and the wall rock. A 4-foot sample across the widest vein assayed 87.61 percent $BaSO_4$ and had a specific gravity of 3.91. However, select samples from smaller veins had specific gravities as high as 4.4.

Ore reserves.—Poor exposures and folding of the veins make it difficult to calculate the ore reserves. The only 'dozer cut, which is at a right angle to the strike of the veins, has exposed the veins to a depth of about 10 feet and not more than 15 feet along their strikes. However, because of the folding of the veins, they are exposed for about 40 feet along the cut. The ore reserves of the Ohman prospect are estimated to be 150 tons of measured and indicated ore and 2,500 tons of inferred ore; however, with additional trenching and stripping these tonnage figures can be increased.

Jacobson Mine

Location and accessibility.—The Jacobson mine is in the NW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 16, T. 37 N., R. 39 E. It is at an elevation of 2,900 feet, three-quarters of a mile south of the summit of Queen of Sheba Hill. The Lucky Stone mine is a quarter of a mile to the northeast (fig. 26). Colville is 11 miles to the south, and Echo is 4 miles to the southwest. From Echo, the mine may be reached by following the Clugston Creek road northeast for 3.3 miles to Harbison Gulch; about 1.1 miles north on the Harbison Gulch road, a 'dozer road leads northeast for 1 mile to the mine. All roads are accessible by conventional vehicles. From the mine the distance is 12.6 miles by road to Palmer Siding (west of Colville), the closest railroad shipping point.

The Jacobson barite deposit is on State land, to which Lloyd Jacobson, of Colville, has been issued a mining lease. In the fall of 1961 the property was idle. Mr. Jacobson reported (oral communication, 1961) that in January 1961 about 200 tons of ore was shipped to the west coast for use in well-drilling muds.

Geology of the ore body.—The bedrock of the area is greenish-gray to light-gray thin-bedded argillite of late Paleozoic age. The general strike of the beds is N. 10° E., and the dips range from 20° to 40° W. Some of the argillite is highly contorted and sheared, and contains lenses of white quartz up to 6 inches across. In other parts of the argillite, seams of iron oxide as much as half an inch wide parallel the bedding planes. Associated with the iron oxide are abundant euhedral crystals of pyrite.

The barite occurs as several veins that parallel the beds of the argillite (fig. 27). The veins are $\frac{1}{2}$ inch to 48 inches wide and are intercalated with the argillite to form a mineralized zone about 8 feet wide. Along their dips several of the veins merge into single veins; however, the veins in general have fairly uniform widths along their strikes and dips.

The barite is light to medium gray, fine grained, and has a sugary texture. Much of it is fractured, and the fracture surfaces are coated with iron oxide. Some of the barite emits a fetid odor when it is crushed. In parts of the barite, fine-grained euhedral crystals of pyrite form thin discontinuous stringers that parallel the contacts of the veins. Other parts of the barite contain small vugs, the walls of which are lined with clear euhedral crystals of barite. Most of the contacts of

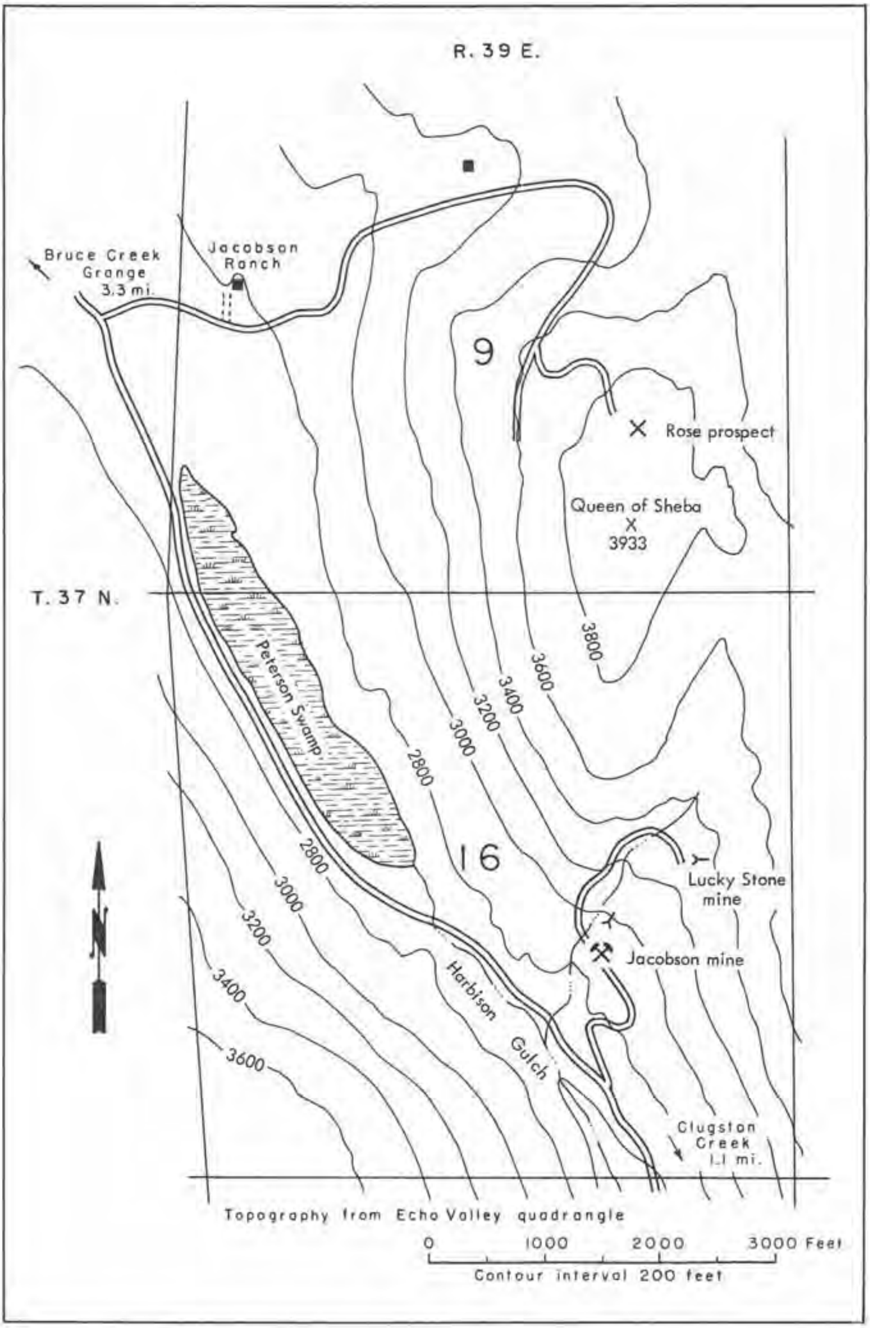


Figure 26.—Location map of the Jacobson mine and the Rose prospect.

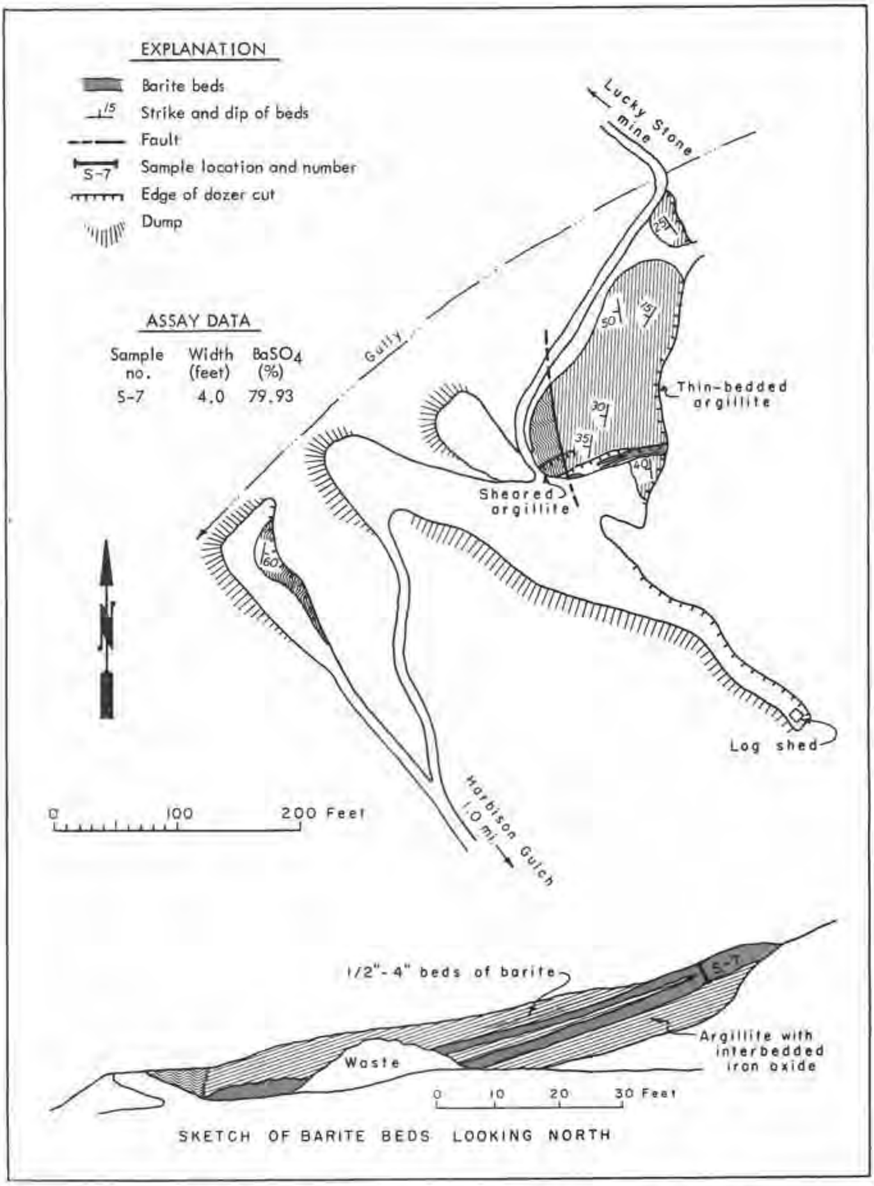


Figure 27.—Sketch map of the geology of the Jacobson barite deposit.

the veins are well defined, but some veins grade into the wall rocks and exhibit no definite contact.

A representative sample from a 4-foot vein on the east end of the deposit assayed 79.3 percent $BaSO_4$. The specific gravity of samples from several veins ranged from 3.82 to 4.25.

Mining operations and ore reserves.—An area approximately 200 feet long and 100 feet wide has been stripped of overburden to expose the barite veins. Because the low dips of the veins are nearly parallel to the slope of the terrain, it was possible to expose about 100 feet of barite along the dips in a cut that is not more than 15 feet deep (fig. 27). From the face of the 'dozer cut, the barite was mined along the strike of the veins by employing conventional surface mining methods. In order to maintain as high a specific gravity as possible, some sorting was required. The ore was loaded into dump trucks by means of a front-end loader on a tractor and was trucked 15.5 miles to railroad loading facilities at Evans.

About 240 feet southwest of the site of the mining operations, exploration work was undertaken to uncover the westward extension of the barite veins. A 'dozer cut has exposed highly sheared and contorted argillite and at least one barite vein, which is about 15 inches wide. Not enough work has been done in this area to determine the extent of the mineralization, nor was any mining attempted.

The main deposit of barite at the Jacobson lease contains an estimated 800 tons of measured and indicated ore and 2,000 tons of inferred ore. The southern and eastern extensions of the deposit appear to have been removed by erosion, and a fault that is visible in the face of the main cut (fig. 27) forms the western boundary. The northern limits of the deposit are not known.

Rose Prospect

Location and accessibility.—The Rose prospect is near the center of the SE¼ sec. 9, T. 37 N., R. 39 E., 900 feet north of the summit of Queen of Sheba Hill and at an elevation of about 3,900 feet (fig. 26). The Jacobson barite mine is three-quarters of a mile to the south. From the Bruce Creek Grange hall in Echo Valley a county road may be followed east for 3.5 miles to the Jacobson ranch. An unimproved logging road may be followed for about 1.1 miles from the ranch to the prospect, which is in an open grassy meadow. The last 0.4 mile is accessible only by truck or jeep.

The prospect is on State land, on which Carl Rose, of Colville, holds a mineral lease. To date (1962) there has been no production of barite from the deposit, but it has been partly explored by 'dozer trenching and stripping.

Geology of the ore body.—The host rock of the barite vein is gray siliceous argillite that strikes N. 5°-10° W. and dips 40°-60° SW. Much of the argillite is fractured, and the fracture surfaces are coated with iron oxide; adjacent to the barite vein it has a bleached appearance. The argillite also contains small lenses of white quartz up to 3 inches wide and 6 feet long that parallel the bedding planes of the argillite, as does the barite vein.

The barite vein has been exposed, by stripping, for about 65 feet along its strike and not more than 4 feet along its dip (fig. 28). The vein is 3 to 5 feet wide, and near the center of the stripped area it is offset 3 to 4 feet by several cross faults. On its north end the vein appears to widen; however, this apparent widening of the vein is caused by the flattening of the dip to about 5°. Several other barite veins occur parallel to the main vein, but they are not over 6 inches wide.

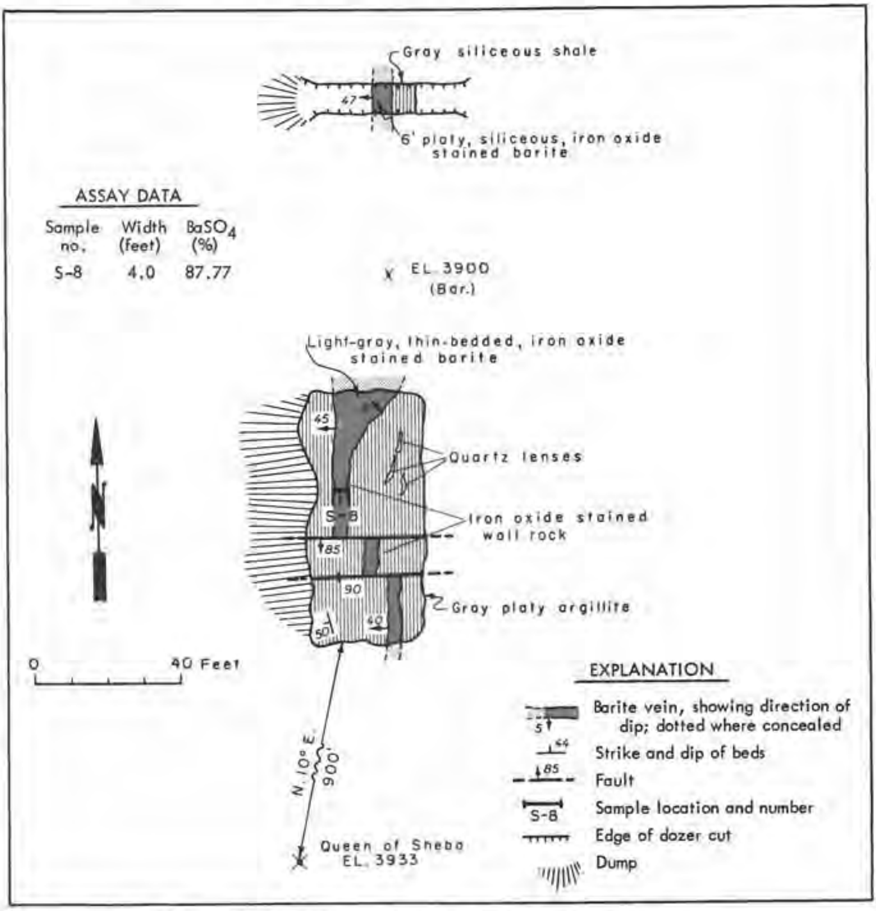


Figure 28.—Sketch map of the geology of the Rose prospect.

The barite is light gray to white, fine grained, and thinly banded. It contains numerous fractures, the surfaces of which are coated with iron oxide. No pyrite has been noted in the barite, but some iron oxide pseudomorphs after pyrite are present. Quartz occurs as disseminated grains. A representative sample from near the center of the vein assayed 87.77 percent $BaSO_4$; the maximum specific gravity of the barite was 4.26.

A 6-foot-wide barite vein is exposed (fig. 28) in the bottom of a 'dozer cut about 90 feet north of the stripped area. The vein appears to be an extension of the vein that is exposed in the stripped area, as it has the same general strike and dip. However, the barite in the 6-foot vein is more siliceous and contains abundant iron oxide.

Ore reserves.—The exploration work undertaken to date (1962) has produced a stripped area about 65 feet long and 30 feet wide, and one 'dozer trench 45 feet long and 4 feet deep. Exposures of barite in both areas indicate a minimum length of a least 90 feet for the vein. The vein could not be found in outcrops of argillite to the north and south of where it is exposed, indicating that the vein pinches out along its strike.

The ore reserves of the Rose prospect are estimated at 250 tons of measured and indicated ore and 3,500 tons of inferred ore.

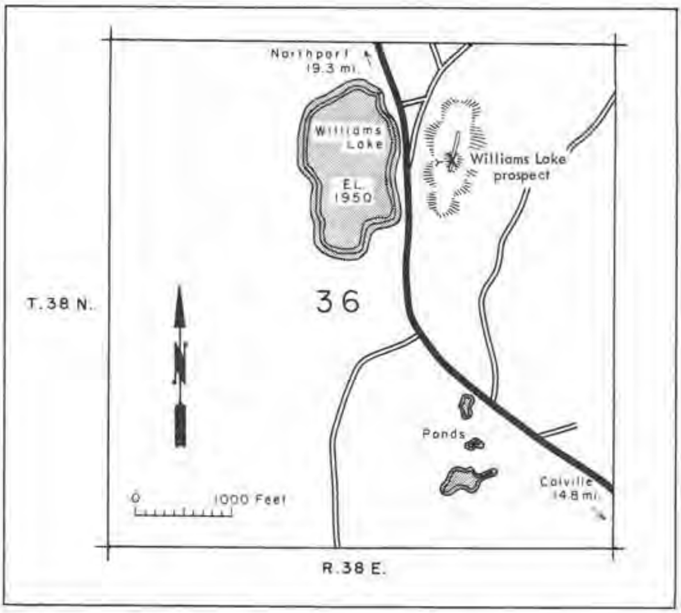


Figure 29.—Location map of the Williams Lake prospect.

Williams Lake Prospect

Location and accessibility.—The Williams Lake prospect is in the center of the NE$\frac{1}{4}$ sec. 36, T. 38 N., R. 38 E., about 700 feet east of the east shore of Williams Lake. It is 15 miles north of Colville and 4 miles northeast of Evans (fig. 8, on p. 34, and fig. 29). The prospect is at an elevation of 2,215 feet on a northward-trending ridge that is about 500 feet to the east of, and 235 feet above, the county road that follows the east shore of Williams Lake. Most of the barite mineralization is on State land, on which the mineral rights have been leased to Ed Rutz, of Colville.

Geology of the deposit.—A series of barite veins is exposed along the eastern slope of a rocky ridge for about 300 feet and over a maximum width of 25 feet. The host rocks for the veins consist of greenish-gray argillite and quartzite of late Paleozoic age that strike N. 20°-35° E. and dip 35°-60° W. The veins, which range in thickness from 2 inches to 3 feet, are intercalated with the argillite and quartzite; however, a few veins exhibit a crosscutting relationship to the beds. Pinching and swelling of the veins is common, and several veins are drag folded.

The barite is mainly light gray to cream, fine grained, and banded. Some veins are stained red by iron oxide, and others contain numerous vugs up to 2 inches in diameter. The specific gravity of samples from different parts of the barite-mineralized zone ranges from 4.00 to 4.35, and as much as 25 percent quartz is present in some of the veins. The barite-mineralized zone is as much as 25 feet wide in places, and the veins within the zone make up about 25 percent of it, the remainder being interbedded argillite and quartzite.

Other than a shallow inclined shaft about 15 feet deep on the southern end of the deposit, and minor 'dozer stripping along the crest of the ridge, the barite veins have been poorly explored. The intercalated nature of the barite veins and the host rock would make it necessary to sort much of the material in order to achieve the 90-percent barium sulfate content or 4.2 specific gravity required for use in well-drilling muds; however, the barite could be upgraded by jigging or flotation.

DEEP LAKE AREA

The Deep Lake referred to here is in northeastern Stevens County about 10 miles south of the international border between the United States and Canada (fig. 8, on p. 34). It is 9 miles southeast of Northport and 25 miles northeast of Colville. Excellent county roads provide access from U.S. Highway 395 at Colville and from State Highway 22 at Northport, which is the nearest railroad shipping point.

Deep Lake is at an elevation of 2,025 feet above sea level, and from the shores of the lake, mountains rise steeply to elevations of about 6,000 feet. The mountains have good stands of fir, pine, and western larch; on some parts of the mountains steep rocky cliffs predominate. Deep Creek and its many tributaries provide drainage for the area.

The Deep Lake area is within the Northport (Aladdin) mining district, which is one of the most highly mineralized districts in the State and has been the site of mining activity since the late 1800's. Although there are no major mineral producers in the district at present (1962), exploration and development as well as some small-scale mining continue at several mines.

At least two barite occurrences are within a mile of Deep Lake. Other barite occurrences may exist in the area, but if so, they have not been brought to the attention of the Division of Mines and Geology. Geologically, the area is favorable for barite mineralization, and there is no reason why additional occurrences should not be discovered.

Deep Lake Prospect

Location and accessibility.—The Deep Lake barite prospect is in the NW$\frac{1}{4}$SE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 27, T. 39 N., R. 41 E., near the southern end of Deep Lake (fig. 30). It is within the right of way of the county road that follows the southeastern shore of the lake, and about 0.3 mile north of the Deep Lake Resort. Northport, the nearest railroad shipping point, is 14 miles by road west of the occurrence.

Geology of the deposit.—The predominant rocks of the area include the Ledbetter Slate (Ordovician) and dolomite and limestone that Yates and Ford (1960) have mapped as the upper member of the Metaline Formation (Middle Cambrian). About half a mile south of the prospect, granodiorite and quartz monzonite of the Spirit pluton (Cretaceous?) crop out. The surficial deposits consist of alluvium, which fills the bottoms of the larger valleys, and glaciofluvial deposits of sand and gravel that occur as a veneer over much of the area.

The beds of the sedimentary rocks are steeply dipping and some are overturned. Isoclinal folding is present in several areas; in other places the rocks have been faulted by high-angle normal faults and low-angle thrust faults.

In the roadcut that exposes the barite vein, the Ledbetter Slate strikes N. 22° W. and dips from 65° to 90° SW. The vein, which is 4 feet wide and parallel to the bedding planes of the slate, consists of barite, quartz, and minor calcite. It is medium gray to white, fine grained, and has a sugary texture. The vein is banded parallel to its contacts, and parallel to the banding are fractures that are filled with iron oxide.

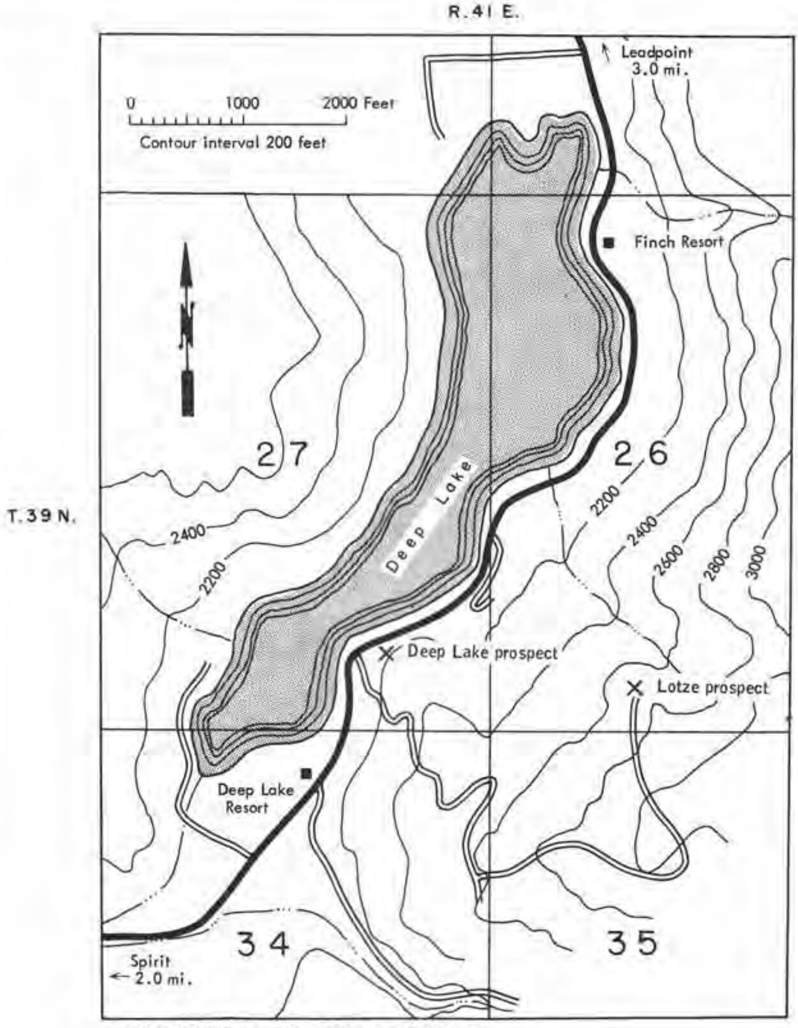


Figure 30.—Location map of the Deep Lake and Lotze prospects.

A 4-foot sample across the vein assayed 48.11 percent $BaSO_4$, and the examination of specimens from different parts of the vein showed that as much as 50 percent quartz and 5 percent fine-grained calcite are present. The specific gravity of the vein material ranges from 3.87 to 3.92.

Other than the roadcut in which the barite vein is exposed, no exploration work has been undertaken on this deposit. In the roadcut the vein is exposed along its dip for about 25 feet beneath the surface and along its strike for about 8 feet. The vein is not known to crop out elsewhere in the immediate area because of a cover of glacial debris. At least 60 tons of measured and indicated ore and 280 tons of inferred ore are calculated for the Deep Lake prospect.

Lotze Prospect

Location and accessibility.—The Lotze prospect is in the SE¼SW¼ sec. 26, T. 39 N., R. 41 E., about a mile east of the Deep Lake prospect. It is at an elevation of about 2,700 feet on the northwestern slope of a mountain that rises from the southeastern shore of Deep Lake (fig. 30). At 0.27 mile north of the Deep Lake Resort an

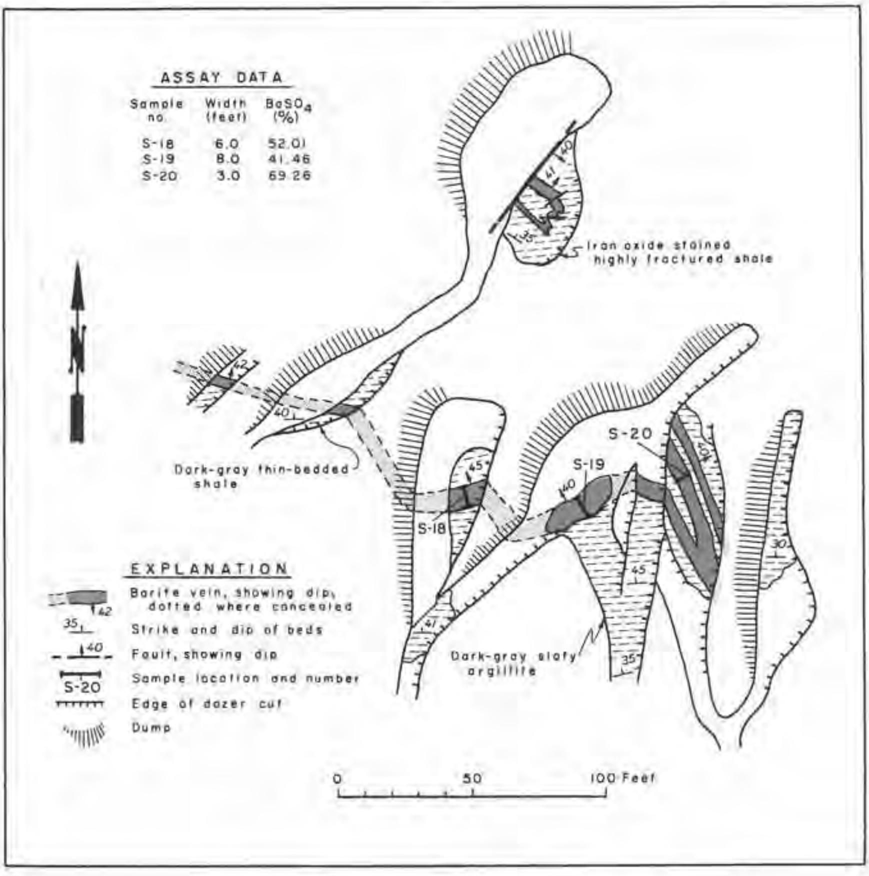


Figure 31.—Sketch map of the Lotze barite deposit.

abandoned logging road leads south from the county road for 1.8 miles to the prospect. Steep grades on the logging road make it accessible only by low-geared vehicles, and because of the many spurs on the road, the prospect is difficult to find unless one is guided by an individual who is familiar with the area.

The mineral rights to the property are owned by A. G. Lotze, of Aladdin Route, Colville, and the surface rights are owned by the B. J. Carney Company, of Spokane. The nearest railroad shipping point is Northport, which is about 16 miles by road west of the property.

Geology of the ore body.—The host rocks of the barite veins are dark-gray slate and slaty argillite, which Yates and Ford (1960) have mapped as the Ledbetter Slate (Ordovician). The bedding in the slate has strikes that range from east to N. 50° W. and dips from 30° to 45° NE. and NW. Adjacent to the barite mineralization some of the slate is highly sheared and contorted, and several overturned beds were noted.

The barite veins have been folded to the same degree as the host rocks; the general trend of the largest vein is easterly (fig. 31). In the face of the largest 'dozer cut three veins are exposed, two of which merge near the top of the cut. In the northernmost 'dozer cut a single vein is highly folded and faulted.

The veins range from 1 to 4 feet in width and appear to be fairly uniform in width along their strikes and dips, in contrast with the pinching and swelling of many of the barite veins of Stevens County. 'Dozer trenching on different parts of the veins indicates a minimum length of 200 feet and a minimum depth of 80 feet.

The barite is tan to dark gray, fine grained, massive to thin banded, and when crushed emits a fetid odor. A small amount of very fine grained iron pyrite occurs as thin seams in parts of the veins. All the veins contain fine-grained disseminated quartz, which in places makes up most of the vein. Minor calcite is present in most of the veins.

Representative samples contained from 41 to 69 percent $BaSO_4$, and the specific gravity of selected specimens from different parts of the vein ranged from 2.64 to 4.25.

Exploration work and ore reserves.—To date (1962) the exploration work at the Lotze prospect consists of 'dozer trenching and stripping over a distance of about 250 feet along the strike of the veins. In the westernmost cut the vein is 1½ feet wide, and in the stripped area on the eastern end of the vein it is 6 feet wide. An attempt was made to expose the vein about 30 feet east of the stripped area; however, the 'dozer cut did not reach bedrock in the area of the extension of the vein. About 100 feet northwest of the stripped area a vein of barite having a specific gravity of 4.25 is exposed in the southern bank of a cut. Although this vein contains more barium sulfate than the other veins, its folded and faulted nature would make it difficult to mine.

The ore reserves of the Lotze prospect are calculated at 1,600 tons of measured and indicated ore and 2,000 tons of inferred ore, most of which would have to be milled to obtain a marketable product.

NORTHPORT AREA

Flagstaff Mountain Mine

Location and accessibility.—The Flagstaff Mountain group, consisting of five unpatented claims, is about $3\frac{1}{2}$ air miles west-southwest of Northport, near the center of the NW$\frac{1}{4}$ sec. 9, T. 39 N., R. 39 E. (fig. 32). The claims are on the southern slope of Flagstaff Mountain at an elevation of about 3,750 feet, and are accessible from Northport according to the following road log:

Mileage

0.0- Customs office at north end of town. Travel north on State Highway 22 across Columbia River.

0.7- Turn left (southwest) on graveled county road that follows the northwest bank of the Columbia River.

6.8- Turn right on a dirt road that leads up the southeast slope of Flagstaff Mountain.

10.8- Arrive at site of mining operations.

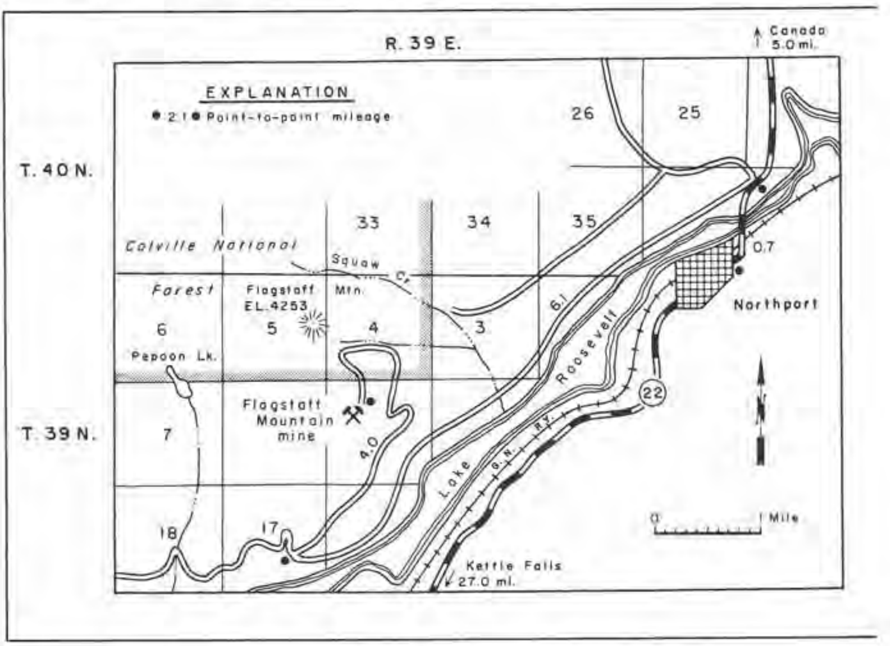


Figure 32.—Location map of the Flagstaff Mountain mine.

From the county road, the unimproved dirt road to the mine is accessible only by low-geared vehicles.

History and ownership.—The Flagstaff Mountain claims were originally staked for silver by George Van Stone and Harry Maylor in 1924. Later, the claims were abandoned, and in 1927 they were relocated by Fred Martin and Howard Featherkile for silver and nickel. In 1957 L. L. Wartes, of Westport, Connecticut, leased the property with the intention of producing barite. Although some road work was done and some shallow excavations were made, no barite was produced. In 1961 a partnership was formed between Fred Martin and Leonard and Robert Sell, of Northport. About 300 tons of barite was shipped to the west coast for use in well-drilling mud. In September 1961 the property was idle.

Geology of the ore body.—The barite mineralization is within a northeastward-trending belt of Ordovician slate and argillite, which Weaver (1920, p. 72) calls the Mission Argillite. The argillite is underlain to the southeast by Cambrain limestone, and to the northwest it is overlain by Permian clastic sedimentary rocks and Mesozoic volcanics. Less than 6 miles southeast of the barite deposit, Mesozoic granitic rocks crop out. Most of the larger valleys contain deposits of Pleistocene glacial drift. Detailed studies of the geology of the area have yet to be made.

At the site of the mining operations the barite is underlain by dark-gray contorted and sheared argillite and overlain by medium-gray limestone and white thin-bedded quartzite (fig. 33). The contact between the barite and the limestone and quartzite is gradational, whereas the argillite appears to be in fault contact with the barite. The limestone and quartzite strike N. 20°-60° E. and dip 6°-90° SE. They are traversed by many white quartz veins and lenses, some of which are stained by azurite and malachite. About 50 feet northeast of the area that has been stripped for mining, the limestone and quartzite are faulted against dark-gray phyllitic slate. To the southwest the rocks crop out along a rocky ridge for more than 1,500 feet.

Most of the barite is white to dark gray, fine to medium grained, and flaggy to massive; when crushed, it has a strong fetid odor. It is distinctly banded, the banding being caused by alternating seams of white and gray barite and thin seams of brown iron oxide. Near its contact with the underlying argillite the barite is brown because of much iron oxide. Some seams exhibit ptygmatic folding (pl. 1, p. 18).

Much of the barite has a sugary texture; however, along parts of the argillite-barite contact it is coarsely crystalline and vuggy. Euhedral crystals of barite up to 3 inches in length have partially filled the vugs; they are clear to smoky and have crystallized as bipyramidal crystals that are elongated parallel to the "a" axis. Some tabular crystals are also present.

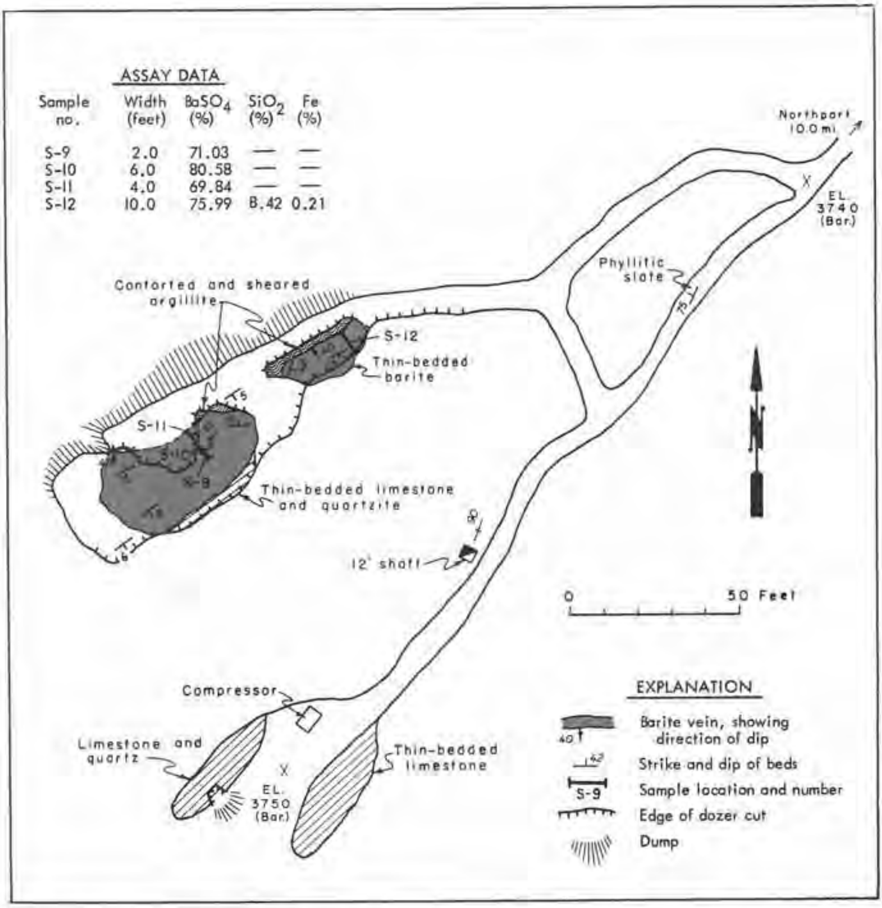


Figure 33.—Sketch map of the mine workings and geology of the Flagstaff Mountain mine.

In thin section the barite vein is seen to be composed of thin bands of calcite and barite. The barite grains are anhedral and average about 0.15 millimeter in length. The borders of the individual calcite grains are difficult to distinguish, but the calcite bands average about 1.0 millimeter wide. Dark fine-grained carbonaceous matter occurs disseminated in the calcite bands, and anhedral to rounded quartz grains from 0.017 to 0.025 millimeter across are present in the calcite and barite.

The barite vein is 6 to 10 feet wide, but where it is being mined it appears wider because of its low dip (fig. 33). To the southwest the vein dips steeply and averages about 8 feet in width. The presence of barite mineralization in 'dozer cuts and prospect pits and shafts along the strike of the vein indicate a length of at least 1,300 feet. The vein terminates on its northeast end against a fault, and is concealed by overburden on its southwest end.

Samples of the vein at the site of the mining operations assayed from 71.03 to 80.58 percent $BaSO_4$. A 10-foot representative sample contained 75.99 percent $BaSO_4$, 8.42 percent SiO_2, and 0.21 percent Fe. (For the location of the samples, see figure 33.) A 6-foot sample from the southernmost exposure of the vein assayed 75.63 percent $BaSO_4$, 8.97 percent SiO_2, and 0.19 percent Fe. The specific gravity of samples collected from all the outcrops of the vein ranged from 3.81 to 4.27.

Mining operations and ore reserves.—The mining operation to date (1962) has been confined to the northern end of the vein, where, because of the low dips of the vein, a minimum amount of stripping is required. Within a stripped area two bodies of barite are exposed; the largest is about 75 feet long and 35 feet wide, and the other is 45 feet long and 15 feet wide. The barite has been mined to a depth of about 10 feet.

Mining operations consist of stripping the overlying limestone and quartzite with a bulldozer. The exposed barite is then drilled with a jackhammer, blasted, and loaded by means of a bucket loader into a 2½-ton dump truck. Some sorting of the barite is required in order to maintain as high a specific gravity as possible. The barite is hauled 10.8 miles to railroad loading facilities at Northport.

The structure is such that the vein can be expected to narrow as the dip steepens. However, it will be possible to mine some barite by trenching along the strike of the vein; also, parts of the vein might be favorable for underground mining operations.

To date, about 300 tons of barite having an average specific gravity of 4.20 has been shipped. At least 8,000 tons of measured and indicated ore and 24,000 tons of inferred ore remain.

O'Toole Mountain (Riverview and Ellingwood) Prospect

Location and accessibility.—The Riverview and Ellingwood claims are near the center of the NW¼ sec. 9, T. 38 N., R. 39 E., 9 miles northwest of Northport. They are on the southwest slope of O'Toole Mountain at an elevation of about 3,500 feet (fig. 34). The summit of the mountain is 3,000 feet east-southeast of the claims. The terrain is steep and consists of grassy and rocky slopes and sparsely timbered areas of pine, fir, and western larch. Except for several small springs, the nearest adequate supply of water is about a mile southwest of the claims.

Two and one-half miles south of Marble on State Highway 22, a single-track dirt road leads eastward for about 3 miles to an old ranch. From a log barn in the center of a grassy meadow a 'dozer road may be followed north for 0.2 mile to the claims, which can be recognized by the extensive 'dozer trenching and stripping.

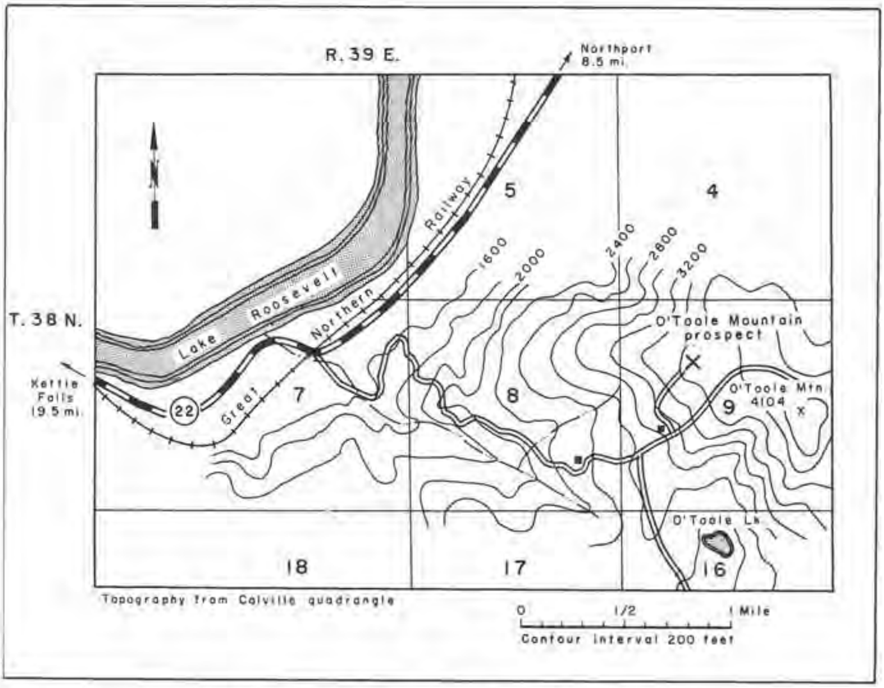


Figure 34.—Location map of the O'Toole Mountain prospect.

From the prospect the distances are 5.9 miles by road to Marble and 12.9 miles to Northport, both of which have railroad loading facilities.

History and ownership.—The barite deposit was discovered in 1940 by a hunting party, consisting of F. L. Ellingwood, Alvina Ellingwood, W. A. De Coy, and R. A. Kangas, who staked several claims and undertook a limited amount of exploration work. In the years that followed, the claims were relocated by different individuals, but little if any work was done on them. In 1957 W. R. Green, of Spokane, obtained releases from all former claimants and leased the property to the Sunshine Mining Company.

In 1958 the Sunshine Mining Company undertook an investigation of the deposit. Work was confined to the Riverview No. 2 and Ellingwood claims, and consisted mainly of stripping and trenching to determine the extent of the barite mineralization. The veins were sampled, and metallurgical tests were run on the samples. Testing indicated that much of the barite is high in silica and iron and that the ore would have to be milled in order to obtain a marketable product. In 1960 the company relinquished its lease, and to date (1962) the property has not produced barite.

Geology of the ore body.—The area is underlain by dark-gray to brown argillite that has been mapped by Weaver (1920, p. 72) as the Mission Argillite. This argillite is massive to slaty, and carbonaceous or calcareous with interbeds of quartzite, shale, and limestone. The regional trend of the argillite is northeast, and the beds dip mainly to the southeast. Probably the Mission Argillite is of late Paleozoic age.

The argillite is bordered on the southeast by granitic rocks of the Colville batholith (late Mesozoic) and on the northwest by Cambrian limestone. To the southwest of the barite deposit the argillite is overlain by Tertiary continental clastic sedimentary rocks and tuffs. Parts of the area are covered by Pleistocene glacial drift.

The host rocks for the barite veins are shale and argillite that strike north to N. 40° E. and dip 50°-80° SE. The veins, which are of the fissure and replacement types, occur along shear zones. Two main veins, which are here referred to as the north vein and south vein, are exposed intermittently along a combined strike length of about 1,600 feet (pl. 2, in pocket). The south vein, which has a strike length of over 900 feet, ranges from 10 to 45 feet in width. It strikes north and dips 60°-80° E. Although this vein has not been explored to its limit at either end, it appears to be pinching out at the south end and widening at the north end. Several small veins that range from 4 to 8 feet in width occur parallel to the south vein, but they have not been exposed for much more than 50 feet along their strikes.

The north barite vein strikes N. 40° E. and dips 73°-77° SE. It is exposed in several 'dozer cuts for about 700 feet along its strike. The width of the vein ranges from 8 to 40 feet, its maximum width being near the center of the vein. The northern end of the vein appears to be lensing out, and the southern end, which is 30 feet wide, grades into a heavy iron gossan.

The barite of the veins is white to light brown, fine grained, and massive to thin banded. Much of the barite is fractured, and in the iron-rich parts of the vein the fracture surfaces contain a thin coating of iron oxide. Very fine grained pyrite occurs as disseminated grains and hairlike discontinuous stringers in the barite. The gossan on the south end of the north vein suggests that the pyrite occurs in larger concentrations, but none is exposed in the outcrops of the veins.

Under the microscope the barite can be seen to be composed mainly of anhedral crystals of barite and quartz, in which much of the quartz appears to have replaced the barite. In several specimens muscovite occurs interstitially to the barite and quartz; no calcite was noted.

Sampling by the Sunshine Mining Company indicates that the barium sulfate content of the veins ranges from 6.0 to 91.3 percent. From 0.50 to 5.15 percent iron and 6.6 to 85.7 percent silica is present. The south vein averages 60.87 percent $BaSO_4$, 35.8 percent SiO_2, and 2.5 percent Fe. The north vein, excluding the gossan on its southern end, averages 72.0 percent $BaSO_4$, 22.9 percent SiO_2, and 1.5 percent Fe. (See assays on plate 2, in pocket, and in appendix A.)

The specific gravity of the barite veins varies considerably, as can be expected because of the differences in the barium sulfate content. Samples from outcrops of what appeared to be the richer parts of the veins gave a maximum specific gravity of 3.76.

Exploration work and ore reserves.—The early exploration work on the Riverview and Ellingwood claims consisted of shallow prospect pits and trenches along the veins. A 200-foot adit was driven, but because it is now inaccessible, whether or not the veins were crosscut is not known.

The work undertaken by the Sunshine Mining Company in 1958 consisted of 'dozer trenching and stripping. The barite remains exposed in the stripped areas, but in the trenches the sides have caved and covered most of the barite. The Sunshine Mining Company had milling tests run on the barite. These tests indicated that a marketable product could be obtained through flotation. (See pages 25 and 27, under Mining and Milling.)

Ore reserves of the O'Toole Mountain deposit, calculated to a depth of 100 feet, are estimated at 17,000 tons of measured and indicated ore and 150,000 tons of inferred ore. The average $BaSO_4$ content is about 65 percent; however, a concentrate containing 94 percent $BaSO_4$ might be obtained through flotation.

BARITE DEPOSITS OF PEND OREILLE COUNTY

SKOOKUM CREEK AREA

Location and accessibility.—The Skookum Creek area as referred to in this report is in southern Pend Oreille County in T. 33 N., R. 44 E. (figs. 35 and 36). It is 13 miles northwest of Newport and 5 miles northeast of Usk, and is within the Kaniksu National Forest. Access to the area is by way of State Highway 6 to Usk, from which graded County and Forest Service roads extend into the area. From these roads, unimproved mine and logging roads, many of which can be traveled only by means of low-geared vehicles, may be followed to the mines. Railroad loading facilities are available on a branch line of the Chicago, Milwaukee, St. Paul and Pacific Railroad at Usk.

Topography.—The area, which is in the Okanogan Highlands province of Washington, is characterized by mountainous topography. The mountains are in a

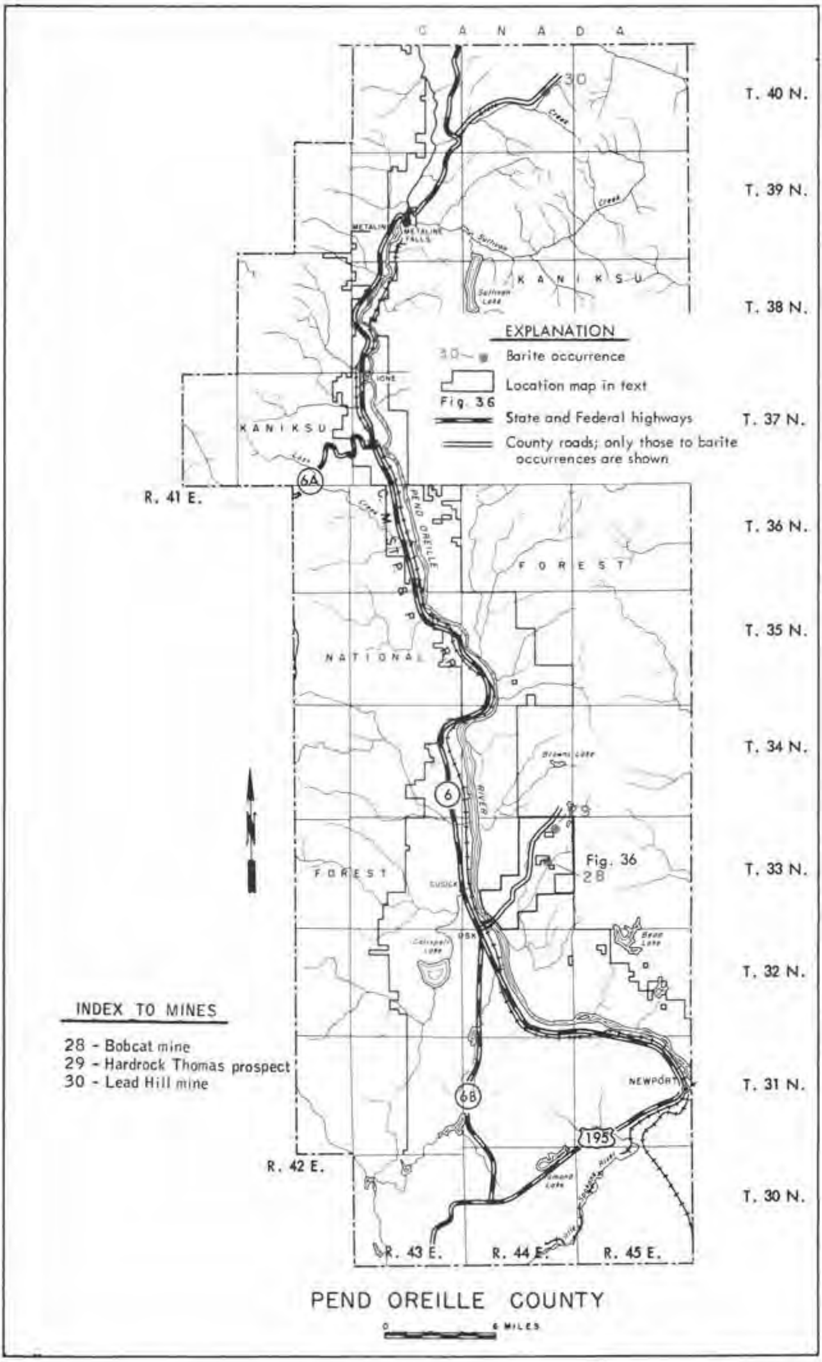


Figure 35.—Index map showing the barite deposits of Pend Oreille County.

mature state of erosion and contain good stands of pine, fir, and western larch on their gentle and intermediate slopes; most of the steep slopes are grassy or rocky. Skookum Creek and the North Fork of Skookum Creek, which provide the drainage for the area, flow into the Pend Oreille River near Usk. Several lakes of glacial origin occur in the area, the largest being Kings Lake and South Skookum Lake. The elevations range from 2,057 feet in the valley of the Pend Oreille River near Usk to 4,409 feet on Kings Mountain.

Areal geology.—The Skookum Creek area is underlain by rocks of the Skookum Formation (Precambrian), the Kaniksu batholith (Cretaceous?), Pend Oreille Andesite (Tertiary), and the Tiger Formation (Tertiary). The Skookum Formation consists mainly of quartzitic sandstone containing quartzite, argillite, and limestone beds; the Kaniksu batholith is predominantly granodiorite and quartz monzonite; and the Tiger Formation is made up of semiconsolidated gravel and conglomerate. Detailed descriptions of these units may be found in "Geology of the Bead Lake District, Pend Oreille County, Washington" (Schroeder, 1952).

The rocks of the Skookum Formation dip to the west and form the east limb of the Newport syncline and the west limb of the Snow Valley anticline (Schroeder, 1952, p. 25). In the Skookum Creek area the beds strike from N. 5° W. to N. 30° E. The dips range from 30° to 70° NW. and SW. The Skookum Formation is overlain unconformably by the Pend Oreille Andesite and the Tiger Formation. The Kaniksu batholith, which crops out mainly to the northeast of the Skookum Creek area, appears to have been intruded along the axis of the Snow Valley anticline.

Several high-angle faults have been mapped by Schroeder, and much of the mineralization of the area occurs along shear zones that are probably related to these faults. Most of the faults appear to have been formed prior to the intrusion of the Kaniksu batholith.

The barite deposits of the area consist of fissure and replacement veins that were probably formed from hydrothermal solutions during the intrusion of the Kaniksu batholith. The largest occurrence of barite is at the Bobcat mine, where veins up to 25 feet wide have been exposed by mining operations. Henry Holmes, of Newport, reported (oral communication, 1962) that veins of barite up to 8 inches in width crop out to the northwest and southeast of the Bobcat mine; however, these veins are too small to be of commercial value. Barite also occurs as gangue in the Hardrock Thomas mine, about 1 mile north of the Bobcat mine.

Bobcat Mine

Location and accessibility.—The Bobcat mine is in the NW¼NE¼ sec. 14, T. 33 N., R. 44 E. It is 3,300 feet in elevation on the southeastern slope of a ridge that trends southwestward from Kings Mountain toward the Pend Oreille River. Skookum Creek is on the northwest side of the ridge, and the North Fork of Skookum Creek is on the southeast side. The mine is 1.6 miles southwest of Kings Mountain and 5 miles northeast of Usk (fig. 36).

The mine may be reached by traveling northeast from Usk on the Kings Lake road for 2.5 miles; at this point a Forest Service road may be followed eastward along the North Fork of Skookum Creek for 4.4 miles to the turnoff to the mine; about 1¼ miles of unimproved road leads northward to the mine.

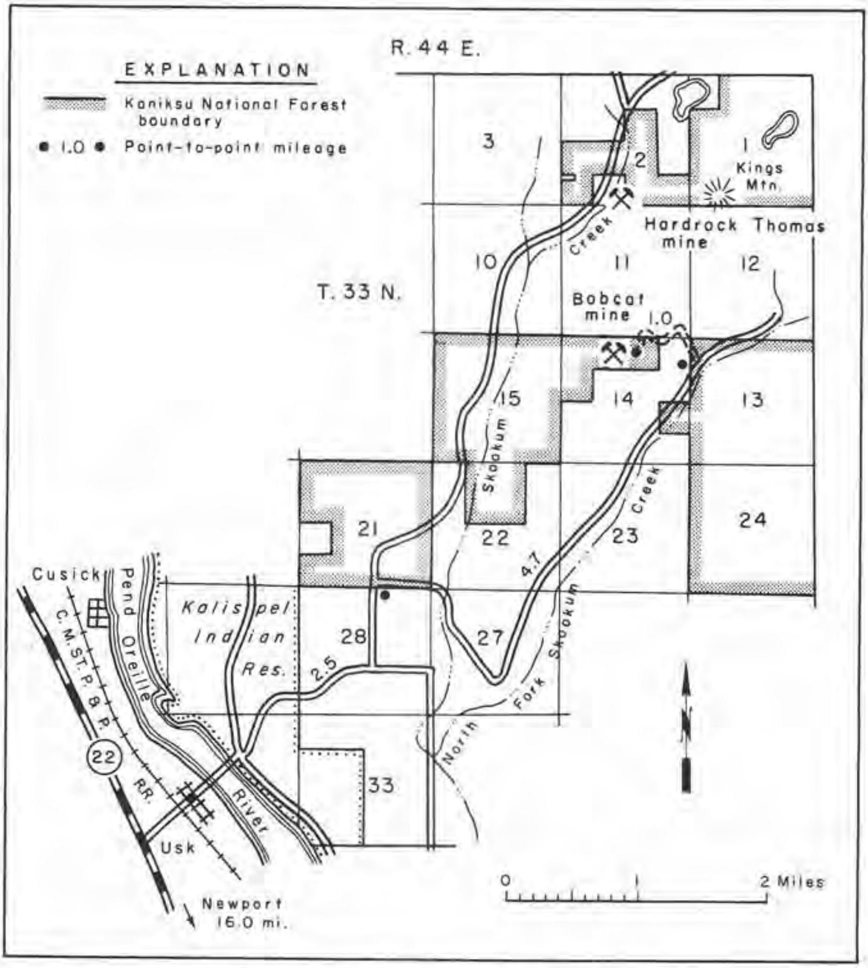


Figure 36.—Location map of the Bobcat mine.

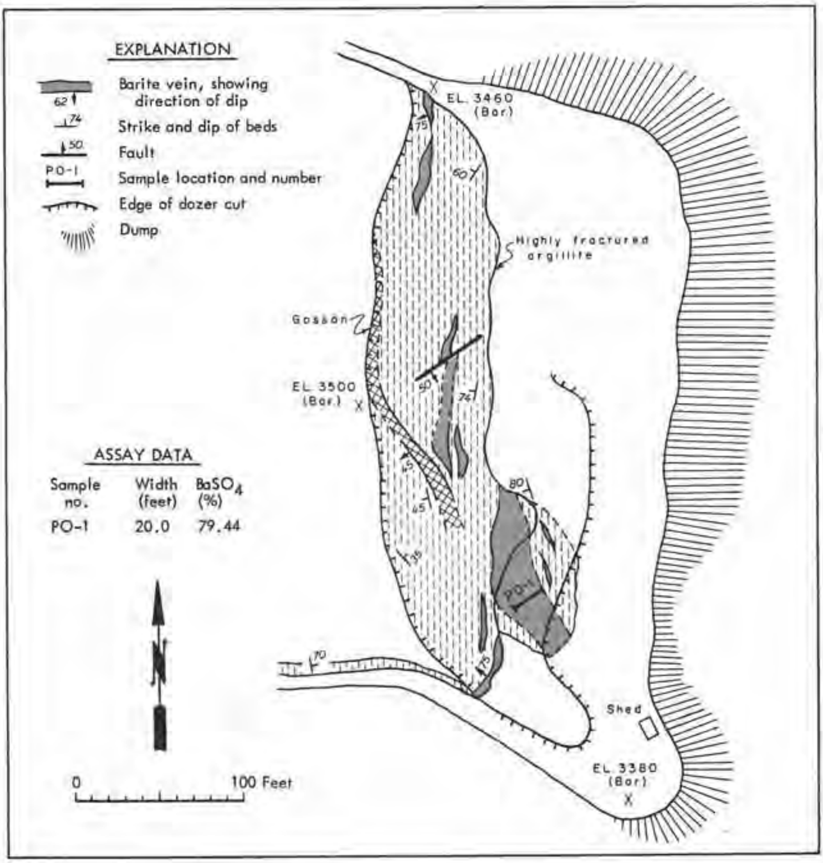


Figure 37.—Sketch map of the geology and mine workings at the Bobcat mine.

History and ownership.—The Bobcat mine, covered by two contiguous unpatented mining claims that are recorded as Ba 1 and Ba 2, is owned by Henry Monk and Frank Favor, of Newport. Henry Holmes and E. T. Brigham, both of Newport, hold a long-term lease on the property.

The first production of barite from the mine was in 1957, when the Big Red Uranium Corporation mined about 100 tons of ore to fill a contract with the Long Island Sugar Company, of Illinois. Mr. Holmes (oral communication, 1962) reported that the ore averaged 96 percent barium sulfate. In the winter of 1961 the property was subleased to Ford Bailor, who mined about 1,000 tons of barite that was shipped to the west coast and processed for use in well-drilling mud. The average specific gravity of the barite was reported by Mr. Holmes to be 4.1. In June 1962 the property was idle.

Geology of the ore body.—The host rocks of the barite veins are argillite and fine-grained quartzite of the Skookum Formation (Precambrian). The rocks are light green and thin bedded, and adjacent to the barite veins they are highly fractured and contorted. The general strike of the beds is N. 5° W., and dips range from 70° to 80° east and west. Fracture surfaces on most of the rocks are covered with iron oxide, and a heavy gossan occurs along the hanging wall of the barite veins. The gossan has a maximum width of 10 feet and has been exposed by stripping for about 150 feet along its strike.

The barite mineralization has been exposed by stripping over an area about 60 feet wide and 360 feet long. The veins are lenticular and occur along a shear zone that strikes about N. 8° W., which is parallel to the strike of the host rocks. Individual lenses are up to 25 feet wide and 50 feet long; they dip from 75° NW. to vertical (fig. 37). Many of the contacts between the barite and the wall rock are gradational, and along several veins, stringers of barite up to a quarter of an inch in width branch out into the wall rock. Several faults of small displacement have brecciated the barite and offset several of the veins.

The barite is white to reddish brown, massive, and coarse grained. Some crystals of barite are 1½ inches in length, and others, which occur as coatings in the vugs of the veins, are less than a sixteenth of an inch in length. Some of the barite contains small cubic cavities, a few of which are filled with iron oxide. Probably these cavities were formerly occupied by pyrite, suggested by the fact that pyrite occurs disseminated in parts of the wall rock. The barite contains numerous fractures, most of which contain a thin coating of iron oxide. Although the iron appears abundant, it makes up less than 1 percent of the barite. A 20-foot chip sample across the widest lens assayed 79.44 percent $BaSO_4$; however, past mining operations indicate that it is possible to mine barite containing as much as 96 percent $BaSO_4$. The specific gravity of 10 samples collected at random from different lenses averaged 4.00.

Mining operations and ore reserves.—To date (1962) the barite has been mined by conventional surface mining methods. Because of the location of the deposit on a steep slope, the disposal of the stripped waste rock has presented no problem. After stripping as much waste as possible, the barite was loaded by means of a 3/4-yard shovel and a front-end loader on a TD 6 tractor into dump trucks to be transported 7.7 miles to a railroad siding at Usk. The barite that was shipped to the Long Island Sugar Company was crushed to half-inch size by a portable crusher at the railroad siding. The barite destined for use in well-drilling muds was shipped in lump form to Clear Lake, Washington, for processing.

Because of poor exposures and the lenticular and faulted nature of the deposit, it is difficult to calculate the ore reserves with any certainty. The remaining reserves are estimated at about 5,000 tons of measured and indicated ore and 7,000 tons of inferred ore.

OTHER BARITE OCCURRENCES OF THE STATE

The following barite occurrences are found as gangue in metalliferous and nonmetalliferous veins. These occurrences have never been mined solely for their contained barite; however, it is possible that some barite might be recovered as a byproduct in the milling of the ores.

During the course of the field work for this report no attempt was made by the writer to examine these deposits. Many of the underground mine workings are inaccessible, but at several of the properties the vein crops out or the general nature of the barite can be seen by examining the material on the mine dumps.

FERRY COUNTY

Congress Mine

Location: At Congress mine in the NW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 35, T. 32 N., R. 33 E.

Description: Occurs with magnetite and epidote at contact of gabbro and metasediments.

Value: Unknown.

OKANOGAN COUNTY

Copper Glance Prospect

Location: At Copper Glance prospect in the N$\frac{1}{2}$ sec. 35, T. 38 N., R. 20 E.

Description: Gangue in copper-gold ore along shear zone in altered volcanics.

Value: Might be recovered as a byproduct.

Lead Horse Claim

Location: At Lead Horse claim on Billy Goat Mountain; approximately in sec. 10, T. 38 N., R. 20 E.

Description: Gangue mineral in small copper-lead veins.

Value: Below commercial grade.

Peacock Claim

Location: At Peacock claim on the southwest side of Billy Goat Mountain; approximately in sec. 10, T. 38 N., R. 20 E.

Description: Gangue mineral in copper vein.

Value: Unknown.

PEND OREILLE COUNTY

Lead Hill Mine

Location: At Lead Hill mine in sec. 14, T. 40 N., R. 44 E.

Description: Occurs as gangue in lead-zinc mineralized, brecciated, dolomitized limestone.

Value: Probably not commercial.

Hardrock Thomas Prospect

Location: At Hardrock Thomas prospect in sec. 2, T. 33 N., R. 44 E.

Description: Occurs as gangue in copper-mineralized shear zones in metasedimentary rocks.

Value: Probably noncommercial.

STEVENS COUNTY

Blue Star Mine

Location: At Blue Star mine in the north center of sec. 5, T. 32 N., R. 41 E.

Description: Forms important part of gangue in lead-silver-mineralized fracture zones in limestone and dolomite.

Value: Might be recovered as a byproduct.

Orazada Mine

Location: At Orazada mine in the SE¼NW¼ sec. 27, T. 29 N., R. 37 E.

Description: Quartz, calcite, and barite along narrow mineralized breccia zone in argillite and limestone. Silver, lead, antimony, gold, and zinc present.

Value: Probably noncommercial.

Turk (High Grade) Mine

Location: At High Grade mine in sec. 6, T. 29 N., R. 38 E.

Description: Occurs as gangue in copper-mineralized fracture zones in Precambrian argillite and quartzite. Lenses mined averaged 6 feet in thickness and 125 feet in width. Barite exposed on surface and in two adits.

Value: Might form commercial byproduct.

"Inventory of Washington Minerals - Part I, Nonmetallic Minerals" (Valentine, 1960) lists 31 barite occurrences, most of which were examined by the writer. Several of these occurrences could not be located in the field, and others appear to be the same deposits listed under different names. In an attempt to correct these discrepancies, the following comments refer to several of the barite occurrences that are listed on pages 8 through 10 of Valentine's report. The numbers preceding the comments refer to the specific occurrence.

1: The Maple Creek prospect in sec. 9, T. 24 N., R. 4 W., in Mason County, has been described by G. E. Hughes (1939). Using Hughes' description of this prospect, the writer attempted to locate it but was unsuccessful. Hughes reports that a barite vein 15 feet wide and 150 feet long crops out. The vein assays 88 percent $BaSO_4$, according to Hughes, and a product containing 95.88 percent $BaSO_4$ can be obtained by flotation.

6 and 6A: The Van Stone and Martin occurrences are the same and are discussed under the Flagstaff Mountain mine in this report (p. 90).

8A and 8B: The Bruce Creek and Uribe occurrences are the same (see Uribe mine in this report, p. 74).

11: The Inklers Point deposit that is reported to be in the SE¼ sec. 11, T. 31 N., R. 40 E., could not be located. It is possible that it may be the deposit described in this report as the Smith mine (p. 60).

11A: The Bettfreund occurrence, which is described as being in the NW¼SE¼ sec. 14, T. 31 N., R. 40 E., was not located. Barite crops out in the SE¼NE¼ sec. 14, T. 31 N., R. 40 E., and is discussed under the Smith mine (p. 60).

12: The Loon Lake Copper mine barite deposit is described as the Pease barite mine in this report (p. 63).

13: The Slate quarry deposit in sec. 19, T. 31 N., R. 39 E., could not be located by the writer.

14: The Red Marble deposits in secs. 19 and 30, T. 31 N., R. 39 E., are described in this report as the Cardinal and Yellow Jacket mines (p. 55 and 57).

14A: The Allan deposit in sec. 22, T. 31 N., R. 37 E., could not be located.

18: The location of the Dan Kauffman claims in the NW¼ sec. 15, T. 30 N., R. 38 E., was not definitely established. Barite occurs on the dumps of several old mine workings in this area. (See discussion on the Chamokane prospect in this report, p. 50).

APPENDIX A: CHEMICAL ANALYSES OF WASHINGTON BARITE

No. (a)	Property	Sample no.	Sample width (feet)	$BaSO_4$	SiO_2	Fe	Reference or analyst (b)
1	Allan prospect No. 1 --	S-29	3.0	92.32	6.71	0.35	A
2	Allan prospect No. 2 --	S-30	10.0	94.44	—	—	A
3	Allan prospect No. 3 --	S-31	2.0	90.66	—	—	A
4	Allan Barite (Four A) mine -----------	1301	4.0	96.40	—	—	B
	------ do -----------	1302	2.3	36.00	—	—	B
	------ do -----------	1303	0.9	95.80	—	—	B
	------ do -----------	1304	2.1	34.40	—	—	B
	------ do -----------	1305	3.0	83.40	—	—	B
5	Cedar Canyon prospect	—	—	—	—	—	–
6	Shallenberger mine ----	1994	—	92.0	7.3	0.25	B
	------ do -----------	1995	—	94.4	4.8	0.40	B
	------ do -----------	1996	—	89.4	8.8	0.35	B
	------ do -----------	1997	—	92.7	5.6	0.30	B
	------ do -----------	1998	—	93.3	5.7	0.20	B
	------ do -----------	1999	—	95.4	3.6	0.20	B
	------ do -----------	2000	—	95.7	3.9	0.25	B
	------ do -----------	2003	—	93.5	5.1	0.45	B
7	Deer Park Barite No. 1 mine -----	S-27	8.0	92.51	—	—	A
8	Deer Park Barite No. 2 mine -----	S-28	Grab	94.89	—	—	A
9	Chamokane prospect --	—	Grab	88.4	—	—	B
10	Hillside (Copper Butte) mine -----------	—	—	—	—	—	–
11	Wells Fargo mine -----	S-24	4.0	95.73	—	—	A
12	Cardinal mine --------	S-26	4.0	88.28	—	—	A
	Cardinal prospect ----	S-25	2.0	96.46	—	—	A
13	Yellow Jacket mine --	S-33	4.0	93.06	—	—	A
	------ do -----------	S-34	6.0	97.03	2.32	0.21	A

(a) Property number refers to appendix B and index maps, figures 8 and 35.
(b) Analyses of barite by following:
A - Northwest Testing Laboratories, Portland, Oregon.
B - Sunshine Mining Company, Spokane, Washington.
C - Reported by property owner or based on records of past production.

APPENDIX A: CHEMICAL ANALYSES OF WASHINGTON BARITE—Continued

No. (a)	Property	Sample no.	Sample width (feet)	$BaSO_4$	SiO_2	Fe	Reference or analyst (b)
14	Smith (Inklers Point) mine	S-21	4.0	59.74	19.89	0.89	A
15	Bakie mine ------------	S-22	6.0	95.45	2.88	0.15	A, C
16	Pease (Loon Lake) mine -	S-23	8.0	78.8	18.38	2.33	A
17	Eagle Mountain (Lynx Cat) mine --------	S-15	3.0	95.74	3.73	0.13	A
	----- do ------------	S-35	2.5	92.93	—	—	A
18	Madsen mine ----------	S-14	6.0	88.55	8.27	0.19	A
19	Uribe (Bruce Creek) mine	S-1	10.0	83.43	—	—	A
	----- do ------------	S-2	9.0	83.72	—	—	A
	----- do ------------	S-3	12.0	72.32	—	—	A
	----- do ------------	S-4	15.0	78.19	—	—	A
	----- do ------------	S-5	20.0	65.89	—	—	A
20	Ohman prospect -------	S-6	3.0	87.61	—	—	A
21	Jacobson mine --------	S-7	4.0	79.93	—	—	A
22	Rose prospect ---------	S-8	4.0	87.77	—	—	A
23	Williams Lake prospect -	—	—	—	—	—	–
24	Deep Lake prospect ----	S-17	4.0	48.11	—	—	A
25	Lotze prospect --------	S-18	6.0	52.01	—	—	A
	----- do ------------	S-19	8.0	41.46	—	—	A
	----- do ------------	S-20	3.0	69.26	—	—	A
26	Flagstaff Mountain mine	S-9	2.0	71.03	—	—	A
	----- do ------------	S-10	6.0	80.58	—	—	A
	----- do ------------	S-11	4.0	69.84	—	—	A
	----- do ------------	S-12	10.0	75.99	8.42	0.21	A
	----- do ------------	S-13	6.0	75.63	8.97	0.19	A
27	O'Toole Mountain (Riverview and Ellingwood) prospect	SM 2206	2.5	47.1	44.4	2.70	B
	----- do ------------	07	4.0	63.3	32.7	1.30	B
	----- do ------------	08	6.0	56.6	35.1	1.30	B
	----- do ------------	09	5.3	12.6	75.7	2.70	B
	----- do ------------	10	8.3	60.0	35.0	1.50	B

See footnotes (a) and (b) on page 106.

APPENDIX A: CHEMICAL ANALYSES OF WASHINGTON BARITE—Continued

No. (a)	Property	Sample no.	Sample width (feet)	$BaSO_4$	SiO_2	Fe	Reference or analyst (b)
27	O'Toole Mountain (River-view and Ellingwood) propect — Continued --	SM2211	8.0	56.0	37.3	2.05	B
	------- do -----------	12	7.8	56.7	37.1	1.70	B
	------- do -----------	13	21.0	49.5	41.7	5.15	B
	------- do -----------	14	30.0	37.6	53.8	2.25	B
	------- do -----------	15	8.3	69.3	25.5	1.45	B
	------- do -----------	16	6.3	63.4	31.1	1.70	B
	------- do -----------	17	9.3	66.0	28.3	1.75	B
	------- do -----------	18	9.0	74.9	19.1	2.05	B
	------- do -----------	19	14.0	15.1	72.6	2.90	B
	------- do -----------	20	7.3	63.3	28.5	1.70	B
	------- do -----------	21	6.0	69.4	25.2	1.60	B
	------- do -----------	22	7.7	56.0	37.1	2.10	B
	------- do -----------	23	7.6	51.1	41.0	2.40	B
	------- do -----------	24	9.3	6.0	85.7	3.90	B
	------- do -----------	25	5.0	45.2	45.1	4.65	B
	------- do -----------	26	5.0	17.0	72.5	1.45	B
	------- do -----------	27	5.0	13.3	70.3	1.80	B
	------- do -----------	28	3.5	16.0	67.3	3.80	B
	------- do -----------	29	5.0	75.0	20.4	1.50	B
	------- do -----------	30	5.0	64.6	29.6	3.30	B
	------- do -----------	31	3.0	30.6	59.4	1.65	B
	------- do -----------	32	9.0	75.7	15.8	2.25	B
	------- do -----------	33	10.0	35.4	54.1	3.45	B
	------- do -----------	34	10.0	69.2	24.3	3.15	B
	------- do -----------	35	13.0	51.9	40.2	5.05	B
	------- do -----------	SM660	5.0	86.0	11.5	0.65	B
	------- do -----------	661	5.0	86.9	10.0	0.80	B
	------- do -----------	662	5.0	82.6	14.4	0.70	B
	------- do -----------	663	5.0	84.0	13.0	0.90	B
	------- do -----------	664	6.0	91.3	6.6	0.50	B

See footnotes (a) and (b) on page 106.

APPENDIX A: CHEMICAL ANALYSES OF WASHINGTON BARITE—Continued

No. (a)	Property	Sample no.	Sample width (feet)	$BaSO_4$	SiO_2	Fe	Reference or analyst (b)
27	O'Toole Mountain (Riverview and Ellingwood) prospect—Continued ---	SM 665	5.0	74.4	19.8	2.25	B
	------- do ------------	666	5.0	69.8	29.8	2.00	B
	------- do ------------	667	10.0	68.3	25.8	2.00	B
	------- do ------------	668	10.0	64.3	28.0	2.40	B
	------- do ------------	669	10.0	66.7	27.6	2.15	B
	------- do ------------	670	13.0	56.3	36.0	3.20	B
28	Bobcat mine -----------	PO-1	20.0	79.44	—	—	A

See footnotes (a) and (b) on page 106.

SELECTED REFERENCES

Aitkenhead, W. C., and Jaekel, J. A., 1959, Preparation of barite concentrate: Washington State Inst. Technology, Div. Industrial Research, Research Project No. 475-11, 3 p.

Bennett, W. A. G., 1941, Preliminary report on magnesite deposits of Stevens County, Washington: Washington Div. Geology Rept. Inv. 5, 25 p.

Brobst, D. A., 1960, Barium minerals. In Am. Inst. Mining Metall. Engineers: Industrial Minerals and Rocks, 3d ed., p. 55-64.

Campbell, Ian, and Loofbourow, J. S., Jr., 1962, Geology of the magnesite belt of Stevens County, Washington: U.S. Geol. Survey Bull. 1142-F, 53 p.

Clark, F. W., and Washington, H. S., 1924, The composition of the earth's crust: U.S. Geol. Survey Prof. Paper 127, 117 p.

Colville Engineering Co., 1941, Report on minerals in Stevens County, for Stevens County P.U.D., 137 p.

——————— ca 1942, Report on minerals in Pend Oreille County, for Pend Oreille County P.U.D., 75 p.

Dana, E. S., 1948, A textbook of mineralogy, 4th ed., revised by W. E. Ford: New York, John Wiley and Sons, p. 748.

——————— 1952, Dana's manual of mineralogy, 16th ed., revised by S. Hurlbut, Jr.: New York, John Wiley and Sons, p. 255.

De Munck, V. C., and Ackerman, W. C., 1958, Barite deposits of Montana: Montana Bur. Mines and Geology Inf. Circ. 22, 30 p.

Denver Equipment Company, 1957, Macco Corporation Nine Mile Canyon barite concentrator: Deco Trefoil, vol. 21, no. 2, p. 7-10.

——————— Bulletin No. M7-F40, Flowsheet study of barite, 2 p.

——————— Bulletin No. M4-B56, Beneficiation of barite at Arizona Barite Company, Mesa, Arizona, 8 p.

Hawkes, H. E., and Webb, J. S., 1962, Geochemistry in mineral exploration: New York and Evanston, Harper & Row, 415 p.

Hughes, G. E., 1939, Geology of a barite prospect on the Hamma Hamma River and treatment of the ore: Univ. of Washington B.S. thesis.

Huntting, M. T., 1956, Inventory of Washington Minerals - Part II, Metallic minerals: Washington Div. Mines and Geology Bull. 37, pt. II, v. 1, 428 p.; v. 2, 67 p.

Jones, R. H. B., 1927-28, Geology of the Chewelah 30-minute quadrangle (unpublished map).

Purdy, C. P., Jr., 1951, Antimony occurrences of Washington: Washington Div. Mines and Geology Bull. 39, 186 p.

Rankama, Kalervo, and Sahama, Th. G., 1950, Geochemistry: Chicago, Univ. of Chicago Press, 912 p.

Rowland, Reginald, 1961, Barite: Engineering and Mining Jour., v. 162, no. 2, p. 118-119.

Sackett, E. L. H., 1962, Barite, little-known industry that means "mud" to oil men: Mining Engineering, vol. 14, no. 5, p. 46-49.

Schreck, A. E., and Roman, V. M., 1961, Barite: U.S. Bur. Mines Minerals Yearbook 1960, v. 1, p. 223-234.

Schroeder, M. C., 1952, Geology of the Bead Lake district, Pend Oreille County, Washington: Washington Div. Mines and Geology Bull. 40, 57 p.

Skow, M. L., and Schreck, V. R., 1962, Barite: U.S. Bur. Mines Minerals Yearbook 1961, v. 1, p. 295-308.

Stanford Research Institute, 1962, Chemical origins and markets; flow charts and tables: Chemical Economics Handbook, 77 p.

Stewart, L. A., and Pfister, A. J., 1960, Barite deposits of Arizona: U.S. Bur Mines Rept. Inv. 5651, 89 p.

Valentine, G. M., 1960, Inventory of Washington minerals - Part I, Nonmetallic minerals, 2d ed., revised by M. T. Huntting: Washington Div. Mines and Geology Bull. 37, pt. I, v. 1, 175 p.; v. 2, 83 p.

Walker, R. T., and Walker, W. J., 1956, The origin and nature of ore deposits: Colorado Springs, Colo., The Walker Associates, 384 p.

Weaver, C. E., 1920, The mineral resources of Stevens County: Washington Geol. Survey Bull. 20, 350 p.

Yates, R. G., and Ford, A. E., 1960, Preliminary geologic map of the Deep Lake quadrangle, Stevens and Pend Oreille Counties, Washington: U.S. Geol. Survey Mineral Inv. Field Studies Map MF-237.

No. (a)	Property	Location (b)	Property owner	Strike and dip of veins	Host rocks	Specific gravity of barite	Estimated reserves (tons)		Remarks (c)	
							Measured and indicated ore	Inferred ore		
	STEVENS COUNTY									
1	Allan prospect No. 1	E½SW¼NW¼ 21(30-38E)	C. F. Allan Estate, Springdale, Wash.	N.75° E, 73° NW.	Argillite, quartzite	4.42	300	12,850	B	
2	Allan prospect No. 2	NE¼SW¼SE¼ 20(30-38E)	do	N.10° E, 60° NW.	Quartzite, greenstone	4.37	400	1,000	A, B	Abundant iron oxide on fracture surfaces.
3	Allan prospect No. 3	NE¼SW¼NW¼ 28(30-38E)	do	N.30° E, 60° NW.	Argillite, quartzite	4.30	------	-------	B	Minor copper mineralization accompanies barite.
4	Allan Barite (Four A) mine	SW¼SE¼SW¼ 21(30-38E)	do	N.30° E, 80° NW.	Argillite, greenstone	4.00 - 4.40	1,400	2,750	A, B, D	Do.
5	Cedar Canyon prospect	NW¼SE¼ 1(29-37E)	Three Peaks Corp., Salt Lake City, Utah	N.60° W, 90°	Argillite, quartzite	4.35 - 4.45	------	-------	A, B	
6	Shallenberger mine	SE¼ 10(30-38E)	Deer Park Pine Industry, Inc., Deer Park, Wash.	N.35° E, 60° NW.	Argillite	4.38	8,000	10,000	A, B, D	
7	Deer Park Barite No. 1 mine	SE¼ 10(30-38E)	do	N.35° E, 60° NW.	Argillite	4.38			A, B, D	Outcrop of barite vein in Shallenberger mine.
8	Deer Park Barite No. 2 mine	E½NW¼NE¼ 15(30-38E)	do	N.35° E, 90° (?)	Argillite, siltstone	4.29	50	1,000	A, B, D	
9	Chamokane prospect	W½NW¼NE¼ 15(30-38E)	Unknown	N.35° E, 90° (?)	Argillite, quartzite	4.39	------	-------	B	Barite occurs as waste on old mine dumps; vein not exposed.
10	Hillside (Copper Butte) mine	SE¼SW¼NW¼ 11(30-38E)	Deer Park Pine Industry, Inc.	N.35° E, 90° (?)	Argillite		5,000	-------	C	
11	Wells Fargo mine	NE¼NW¼NW¼ 36(31-38E)	Washington State	N.20° E, 80° NW.	Argillite, quartzite	4.42	175	1,800	A, B, D	Leased from State by Carr Brothers, Valley.
12	Cardinal mine	NW¼SE¼SW¼ 30(31-39E)	J. R. Brown, Spokane, Wash.	N.15° E, 55° NW.	Argillite, quartzite	4.35 - 4.38	1,100	6,800	B, D	Leased by Felix Cardinal, Spokane.
	Cardinal prospect	NW¼SE¼SW¼ 30(31-39E)	do	N.10° E, 80° NW.	Argillite, dolomite	4.35	100	1,850	A, B	Leased by Felix Cardinal, Spokane; 6- to 12-inch copper vein along footwall of barite vein.
13	Yellow Jacket mine	E½NW¼NW¼ 29(31-39E)	do	N.15° E, 50° NW.	Argillite, quartzite	4.45 - 4.48	425	2,250	A, B, D	Leased by Carr Brothers, Valley.
14	Smith (Inklers Point) mine	NE¼NW¼NE¼ 14(31-40E)	Michel Smith, Valley, Wash.	N.20° W, 50° NE.	Argillite, limestone	3.80 - 4.40	400	750	C, D	Minor copper staining in barite.
15	Bakie mine	E½NE¼NW¼ 24(31-40E)	Gilbert Bakie, Valley, Wash.	N.25° W, 90° (?)	Argillite	4.42 - 4.48	1,000	6,000	A, B, D	Barite occurs in scattered lenses.
16	Pease (Loon Lake) mine	SW¼SE¼NW¼ 33(31-41E)	J. E. Pease, Valley, Wash.	N. 3° W, 90°	Argillite, quartzite	4.42	900	15,000	B, C, D	Much iron oxide present.
17	Eagle Mountain (Lynx Cat) mine	E½NW¼ 33(33-41E)	Gordon LaVigne, Chewelah, Wash.	N.10° E, 40° SE.	Argillite, siltstone	4.30 - 4.38	1,100	3,000	A, B, D	Leased by Don Lewis, Chewelah.
18	Madsen mine	NE¼SW¼NW¼ 26(34-38E)	W. A. Madsen, Colville, Wash.	N.80° E, 35° NW.	Dolomite	4.32 - 4.50	450	1,450	A, B, D	Minor sphalerite present in barite.
19	Uribe (Bruce Creek) mine	NW¼NE¼ 5(37-39E)	Charles Uribe, Colville, Wash.	N.30° W, 70°-90°	Argillite, siltstone	3.91 - 4.40	10,000	200,000	B, C, D	Leased by Darell Newland, Colville.
20	Ohman prospect	SW¼NE¼ 5(37-39E)	August Ohman Estate, Spokane, Wash.	N.35° W, 0°-90°	Argillite, siltstone	3.91 - 4.40	150	2,500	B, C	
21	Jacobson mine	NW¼SE¼ 16(37-39E)	Washington State	N.10° E, 20°-40° NW.	Argillite	3.82 - 4.25	800	2,000	B, D	Leased from State by Floyd Jacobson, Colville.
22	Rose prospect	SW¼NE¼SE¼ 9(37-39E)	do	N. 5° W, 40°-60° SW.	Argillite	4.26	250	3,500	B	Leased from State by Carl Rose, Colville.
23	Williams Lake prospect	Center NE¼ 36(38-38E)	do	N.30° E, 35°-60° NW.	Argillite, quartzite	4.00 - 4.35	------	-------	B, C	Leased from State by Ed Rutz, Colville.
24	Deep Lake prospect	NW¼SE¼SE¼ 27(39-41E)	E. J. McNinch, Deep Lake, Wash.	N.22° W, 65°-90° SW.	Argillite, slate	3.87 - 3.92	60	280	C	
25	Lotze prospect	SE¼SW¼ 26(39-41E)	A. G. Lotze, Aladdin Rte., Colville	N.85° E, 30°-45° NW.	Slate, argillite	2.64 - 4.25	1,600	2,000	B, C	
26	Flagstaff Mountain mine	Center NW¼ 9(39-39E)	Leonard Sell, Northport, Wash.	N.40° E, 6°-90° SE.	Limestone, argillite, quartzite.	3.81 - 4.27	8,000	24,000	B, D	
27	O'Toole Mountain (Riverview and Ellingwood) prospect.	Center NW¼ 9(38-39E)	W. R. Green, Spokane, Wash.	N. 0°-40° E, 60°-80° SE.	Argillite, shale	3.76	17,000	150,000	B, C	
	PEND OREILLE COUNTY									
28	Bobcat mine	NW¼NE¼ 14(33-44E)	Henry Monk, Frank Favor, Newport, Wash.	N. 5° W, 75°-90° NW.	Argillite, quartzite	4.00	5,000	7,000	B, D	Barite stained by iron oxide. Leased by E. T. Brigham and Henry Holmes, Newport.

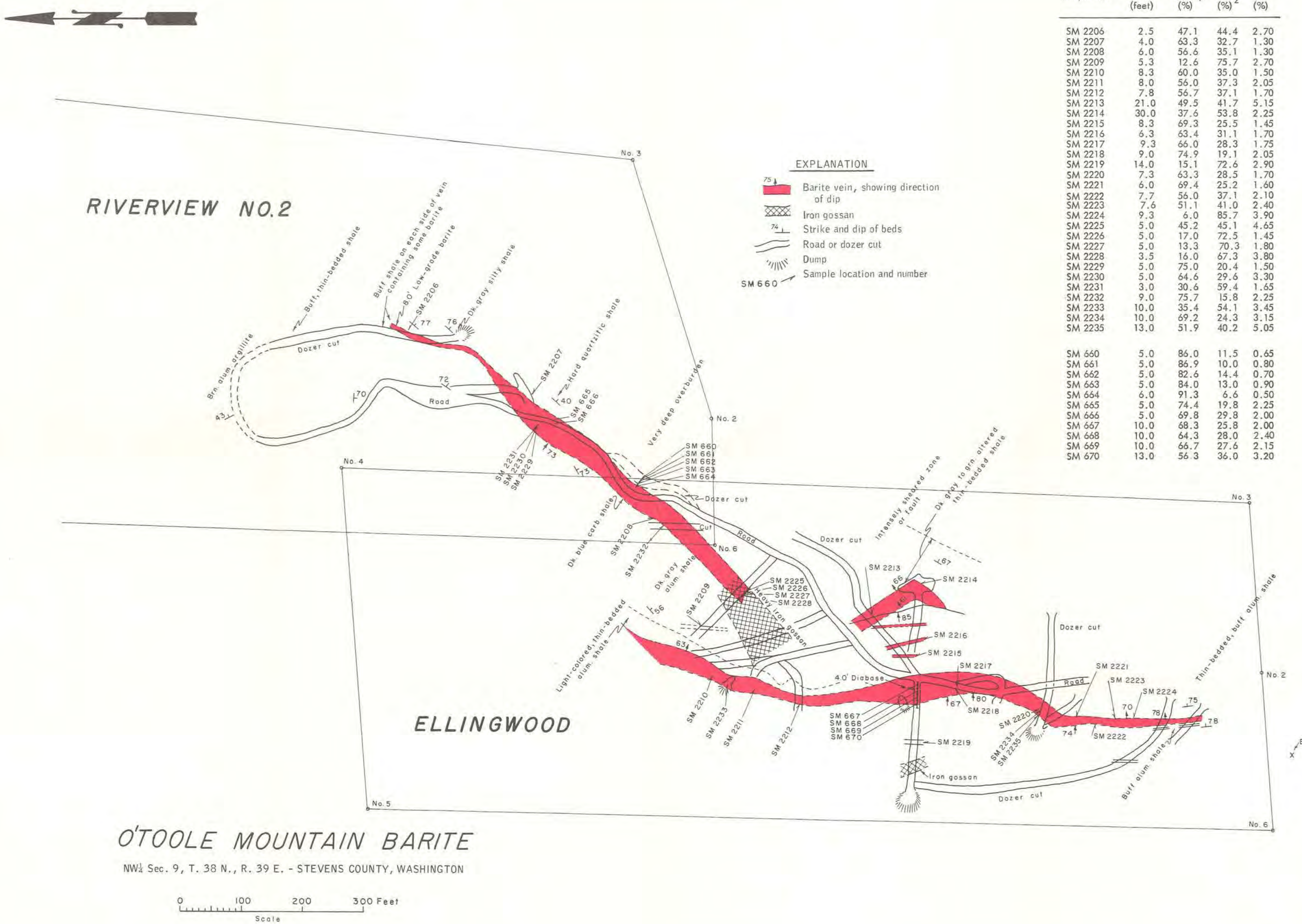
(a) Property number refers to index maps, figure 8, on page 34, and figure 35, on page 97.

(b) 21(30-38E) means sec. 1, T. 30 N., R. 38 E.

(c) A – Suitable for chemical purposes; B – Suitable for use in heavy media well-drilling mud; C – Milling required to upgrade much of the barite; D – Record of past production.

ASSAY DATA

Sample no.	Width (feet)	$BaSO_4$ (%)	SiO_2 (%)	Fe (%)
SM 2206	2.5	47.1	44.4	2.70
SM 2207	4.0	63.3	32.7	1.30
SM 2208	6.0	56.6	35.1	1.30
SM 2209	5.3	12.6	75.7	2.70
SM 2210	8.3	60.0	35.0	1.50
SM 2211	8.0	56.0	37.3	2.05
SM 2212	7.8	56.7	37.1	1.70
SM 2213	21.0	49.5	41.7	5.15
SM 2214	30.0	37.6	53.8	2.25
SM 2215	8.3	69.3	25.5	1.45
SM 2216	6.3	63.4	31.1	1.70
SM 2217	9.3	66.0	28.3	1.75
SM 2218	9.0	74.9	19.1	2.05
SM 2219	14.0	15.1	72.6	2.90
SM 2220	7.3	63.3	28.5	1.70
SM 2221	6.0	69.4	25.2	1.60
SM 2222	7.7	56.0	37.1	2.10
SM 2223	7.6	51.1	41.0	2.40
SM 2224	9.3	6.0	85.7	3.90
SM 2225	5.0	45.2	45.1	4.65
SM 2226	5.0	17.0	72.5	1.45
SM 2227	5.0	13.3	70.3	1.80
SM 2228	3.5	16.0	67.3	3.80
SM 2229	5.0	75.0	20.4	1.50
SM 2230	5.0	64.6	29.6	3.30
SM 2231	3.0	30.6	59.4	1.65
SM 2232	9.0	75.7	15.8	2.25
SM 2233	10.0	35.4	54.1	3.45
SM 2234	10.0	69.2	24.3	3.15
SM 2235	13.0	51.9	40.2	5.05
SM 660	5.0	86.0	11.5	0.65
SM 661	5.0	86.9	10.0	0.80
SM 662	5.0	82.6	14.4	0.70
SM 663	5.0	84.0	13.0	0.90
SM 664	6.0	91.3	6.6	0.50
SM 665	5.0	74.4	19.8	2.25
SM 666	5.0	69.8	29.8	2.00
SM 667	10.0	68.3	25.8	2.00
SM 668	10.0	64.3	28.0	2.40
SM 669	10.0	66.7	27.6	2.15
SM 670	13.0	56.3	36.0	3.20



O'TOOLE MOUNTAIN BARITE

NW¼ Sec. 9, T. 38 N., R. 39 E. - STEVENS COUNTY, WASHINGTON

Mapped and sampled by Sunshine Mining Company - 1958