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FLUORITE IN WYOMING

by

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Introduction

Fluorite, also called fluorspar or rarely florspar (Thrush, 1968), is a strategic industrial mineral with the chemical composition calcium fluoride (CaF_2). It is a major source of fluorine and except when used as a flux, it is converted into a different fluorine compound prior to its use. Fluorine is also obtained from fluosilicic acid (H_2SiF_6), which is produced as a by-product from phosphoric acid plants that process phosphate rock. The amount of fluorine produced from this source has actually exceeded the amount produced from mined fluorspar for the past three years (Pelham, 1985, 1986).

Fluorite is used primarily for the manufacture of hydrofluoric acid (70 percent) and as a flux in steel making (26 percent). Hydrofluoric acid (HF) is made by reacting acid-grade fluorspar (97 percent CaF_2) with sulfuric acid. Other grades of fluorspar contain less calcium fluoride. Users of fluorspar usually specify the limits for impurities. Because of the limited quantities of this mineral available in the United States and its use in the steel and aluminum industry, fluorite is classified as a strategic and critical commodity by the U.S. Bureau of Mines. Its most essential uses are in the production of synthetic cryolite and aluminum fluoride for use in refining aluminum, and as a flux in steel making. In addition, uranium hexafluoride (UF_6) gas is used in the process of uranium isotope enrichment. Fluorine in various forms and compounds is also used in gasoline catalysis, electroplating, glass manufacturing, welding-rod coatings, enamels, water fluoridation, and various fluorochemicals (Fulton and Montgomery, 1983; Pelham, 1985).

Fluorite is quite variable in color (yellow, green, purple, pink, red, blue, white, or brown) due to many complex and interrelated factors (Naldrett and others, 1987). Fluorite has a Mohs hardness of 4, is isotropic to light, has perfect octahedral cleavage, and is fluorescent. In fact, the phenomenon of fluorescence was named after fluorite. Fluorite often contains relatively high concentrations of rare-earth elements, especially europium, lanthanum, cerium, and samarium. Yttrium, thorium, and uranium are also important common impurities. Because fluorite usually contains uranium and thorium, it is slightly radioactive (Deer and others, 1966).

Fluorite is commonly associated with Mississippi Valley-type lead-zinc mineralization, where it is found in veins and stratiform deposits in limestone and dolomite. In this type of deposit, fluorite is present as a gangue mineral with lead-zinc mineralization and as a fluorite ore containing only minor lead and (or) zinc. The other common source of fluorite is veins, replacement deposits, stockworks, and breccia pipes in carbonate and igneous rocks, where the fluorite is the product of mineralizing fluids from igneous intrusions. Fluorite is also a common mineral in carbonatites, alkaline igneous complexes, some pegmatites, lake sediments in areas of fluorine-rich volcanic rocks, and in the residue left from surficial weathering of other fluorite deposits (after Shawe, 1976; Fulton and Montgomery, 1983).

Fluorite is produced in the United States in three areas. Ninety percent of all domestic fluorite is produced in southern Illinois and adjacent Kentucky from Mississippi Valley-type deposits. The remaining production comes from small deposits in Nevada and Texas that were formed from mineralizing fluids related to igneous activity (after Pelham, 1985, 1986; White, 1988). Until 1974, the Ozark-Mahoning Company shipped fluorspar from a mine in Colorado adjacent to the Wyoming border, 40 miles southwest of Laramie (Fulton and Montgomery, 1983). A stockpile of ore is present at this mine, and the size of this stockpile has decreased since the last shipments were reported in the U.S. Bureau of Mines' *Mineral Yearbooks*.

Recent U.S. fluorite production is summarized in Table 1. Fluorite production has been declining due to increased recycling in the aluminum industry, the decline in steel production, and cheaper imports of fluorite. The use of fluorite products in other industries is actually increasing slightly (Pelham, 1985, 1986). Fluorite production in the U.S. is expected to decrease in the future due to increasing imports (Pelham, 1987; Morse, 1988). Countries from which the U.S. imported fluorite during 1981 through 1984 were: Mexico (50 percent of all imports), Republic of South Africa (29 percent), China (8 percent), Italy (7 percent), and all other (6 percent) (Pelham, 1986).

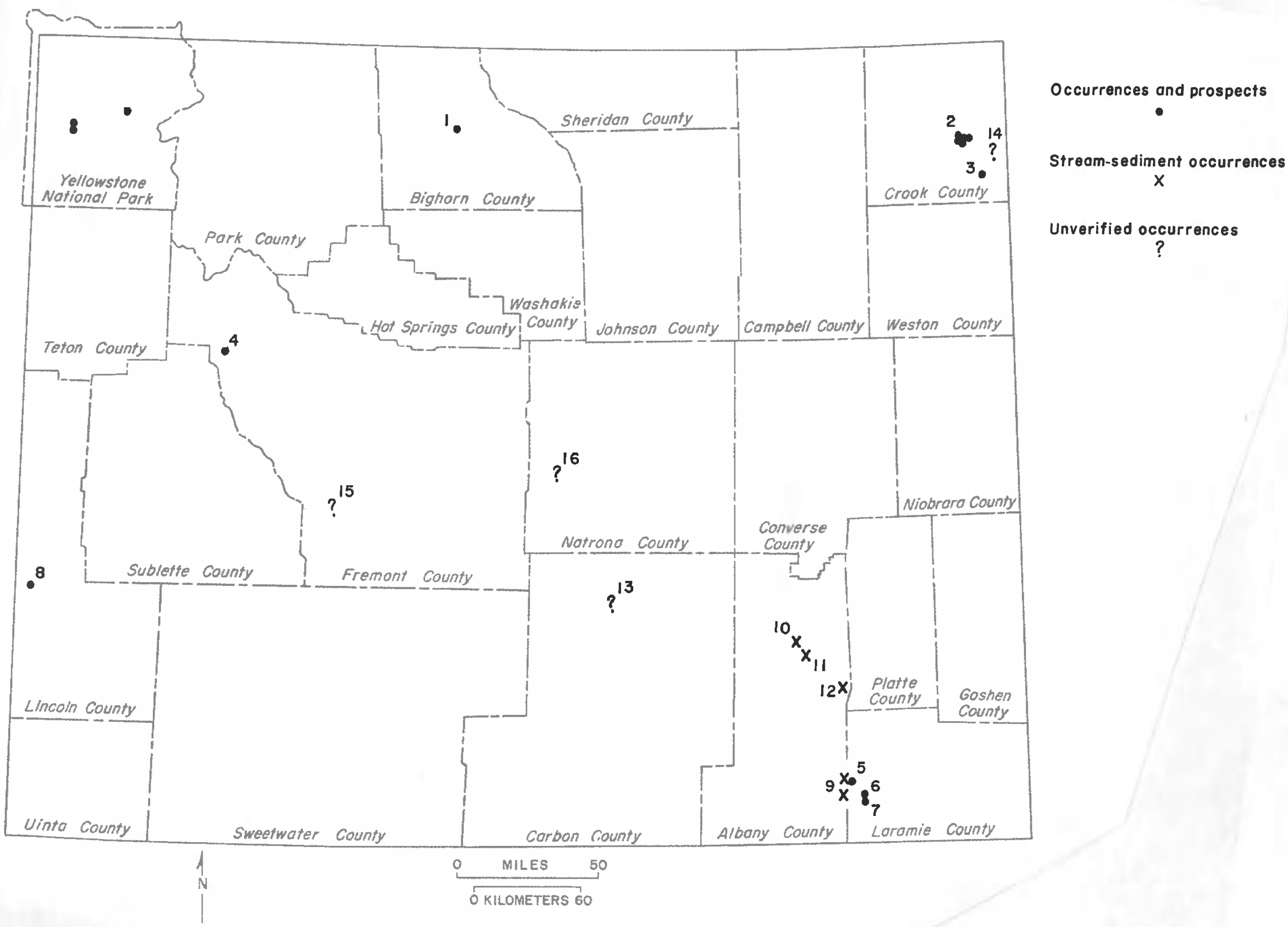
Table 1. U.S. fluorite production, 1981-1987 (Pelham, 1986; Morse, 1988) (data in short tons). Production for 1983 through 1987 is estimated.

1981	115,000
1982	77,000
1983	61,000
1984	72,000
1985	70,000
1986	78,000
1987	78,000

Small quantities of fluorite were mined in Wyoming during and immediately after World War II, but no record of production exists. A report that 19 short tons were shipped from Wyoming in 1944 (Bogrett *in* Osterwald and others, 1966) has not been verified. This tonnage is nearly the same amount as the stockpile reported at the Bear pegmatite (sec. 5, T.15N., R.70W.) in 1944 (Clabaugh and others, 1946), but this stockpile was never shipped. If fluorite were produced in Wyoming, it would most probably be as a by-product of rare-earth element, thorium, or gold mining in the Bear Lodge Mountains. Fluorine production as fluosilicic acid is also possible because plants in Wyoming produce phosphoric acid from phosphate mined in adjacent states, and phosphate deposits in western Wyoming could be developed. Samples of phosphorite in the Permian Phosphoria Formation in western Wyoming and adjacent States contain an average of about three percent fluorine (Gulbrandsen, 1966). Most actual fluorite occurrences in the Phosphoria Formation are in veinlets and cavities in phosphorite (Sheldon, 1963).

Fluorite is found in several areas of Wyoming (Figure 1). The most abundant fluorite is found in the Bear Lodge Mountains of Crook County, but it is impure. It contains thorium, uranium, and rare-earth elements, which lower its value as a source of fluorine compounds.

The following pages contain descriptions of fluorite occurrences and prospects, occurrences in stream sediment samples, and unverified occurrences in Wyoming. Occurrences in stream sediment samples are included because they are indicative of undiscovered occurrences in bedrock in the same area, usually upstream from the stream sediment sample. Unverified occurrences are those for which information is incomplete and later examinations have failed to support the presence of fluorite. Numbers that precede descriptions are the numbers on Figure 1 (page 5).



1. Sheep Mountain
2. Bear Lodge Mountains
3. Black Buttes
4. Whiskey Mountain
5. Bear pegmatite
6. Silver Crown mining district
7. Sherman Granite
8. Coal Canyon
9. Lodgepole Creeks
10. Laramie River
11. Dodge Ranch
12. Grant Creek
13. Seminoe Mountains
14. Mineral Hill
15. Little Popo Agie River
16. Rattlesnake Mountains

Figure 1. Locations of fluorite prospects and occurrences in Wyoming.

Occurrences and prospects

Big Horn County

1. *Sheep Mountain*. NE1/4 sec. 20, T.53N., R.93W.

DeKoster (1960) reported 12 to 15 percent fluorite in one of 78 samples from Permian carbonate rocks sampled during measurements of three stratigraphic sections in the eastern Bighorn Basin. The lone fluorite-bearing sample was from petroliferous rocks in the upper third of the section on the west flank of Sheep Mountain (DeKoster, 1960). These rocks are now known as the Park City Formation (Sheldon, 1963; Peterson, 1980), and are included in Permian Phosphoria Formation and related rocks in Love and others (1987). The extent of the mineralization is not known.

Crook County

2. *Bear Lodge Mountains*. Roughly T.52N., R.63W.

The southern portion of these mountains contains Tertiary trachytes, phonolites, and carbonatites that intrude lower Paleozoic sedimentary rocks. These igneous and sedimentary rocks contain fluorite and are enriched in rare earths, thorium, uranium, barium, strontium, and columbium. These rocks have not been systematically analyzed for fluorine. The rocks are notably enriched in the commercial light rare earths (Staatz, 1983; Staatz and others, 1980). A partial evaluation of the thorium, uranium, and rare-earth resource potential for this area is available in Staatz (1983; see also King and Harris, 1987).

Fluorite is present in two types of occurrences in the Bear Lodge Mountains. It is associated with thorium, uranium, and rare-earth elements in Tertiary trachytes, phonolites, and carbonatites, and it is found without radioactive minerals in lower Paleozoic sedimentary rocks adjacent to the Tertiary igneous rocks. The mineralization in the Ogden Creek area (page 11), has characteristics of both types of occurrences.

Minor fluorite, which is considered a gangue mineral, and rare earths, thorium, uranium, barium, strontium, and columbium occur in a porphyry deposit in Tertiary igneous rocks. This porphyry deposit is physically similar to porphyry copper deposits. In these porphyry-type mineral deposits, minerals are disseminated in extensive systems of microfractures. In the Bear Lodge Mountains, clear to purple fluorite mineralization is concentrated in veins and veinlets that contain manganese and(or) iron oxides. Minor quartz, crystobalite, and sometimes altered trachyte and phonolite, and(or) calcite are also present in the veins and veinlets. The veins and veinlets are soft and porous to hard and highly siliceous. Fluorite mineralization in these fractured areas has not been examined, but would be a possible by-product if rare earths were mined (after King and Harris, 1987; Jenner, 1984; Staatz, 1983; Wilkinson, 1982; Staatz and others, 1980; Wilmarth and Johnson, 1953; Brown, 1952).

Fluorite is more conspicuous in sedimentary rocks surrounding the igneous complex, and some evaluations of potential resources have been performed. Fluorite in these occurrences would probably be the only commodity produced or it could be produced along with rare earth elements if they are present. Unfortunately these rocks have not been analyzed for rare earths. Counterclockwise from the west these fluorite-rich sites in sedimentary rocks include: (1) the Royal Purple fluorspar claims, (2) the Petersen fluorite lode claims, and (3) the Lytle Creek area. As noted in these subsections on the richest fluorite occurrences, fluorite-bearing sedimentary rocks are not restricted to these sites.

Fluorite-bearing veins

SE1/4 sec. 7, NW1/4 sec. 16, sec. 17, center E1/4 sec. 18, center sec. 19, N1/2 sec. 20, NW1/4 sec. 22, center sec. 21, N1/4 sec. 27-28 line, T.52N., R.63W.

These are the 26 veins that Staatz (1983) mapped and described. By his definition, they exceed 2 inches in average width; he calls smaller features veinlets. Because the difference between the two forms is actually gradational, the section on veinlets (page 9) is also applicable. Seven of Staatz's (1983) veins contain trace to moderate amounts of fluorite. The apparent absence of fluorite in other veins is not necessarily conclusive; fluorite in other veins could be obscured by the fine-grained nature of the vein material or the dark coloration due to manganese and(or) iron oxides.

The veins are sinuous, pinch and swell along strike and dip, and have variable dip along strike. No pattern is apparent in the strike of these veins except for a lack of veins that strike N45°-75°E, perpendicular to the long axis of the igneous complex. The veins are usually steeply dipping, but dips vary from 25° to vertical, both into and away from the center of the complex. The veins are often only exposed in pits and trenches. Exposed dimensions are from about one to 100 inches wide and 1.5 to 400 feet long. The extensive cover in the area means the veins could be larger, and more veins are probably present in the complex (after Staatz, 1983).

Previous work on veins provides additional information about them. Wilmarth and Johnson (1953) described the purple, fluorite-bearing, northwest-trending vein 22 of Staatz (1983) and named it the Sunrise lode. This vein and vein 21 of Staatz (1983) are the only veins that are in contact with sedimentary rocks. Wilmarth and Johnson (1953) also provided additional information about a purple fluorite-bearing vein on the Home Fire no. 43 claim, also known as the Old Clark lode. This claim is on vein 24 of Staatz (1983), or is northwest of and adjacent to this vein (after Wilmarth and Johnson, 1953; Staatz, 1983). Veins might be present in igneous rocks in the Ogden Creek area, but only the presence of veinlets has been positively established (after Haff, 1944a; Cox, 1945; Hagner, 1943; Wilkinson, 1982). Chenoweth (1955) noted fluorite fissure fillings up to one-foot wide in igneous rocks in the NW1/4 sec. 8, T.52N., R.63W., but Wilkinson (1982) mapped fluorite-bearing intrusive breccia (veinlets) and radioactive fractures (veinlets) in the same area.

Fluorite-bearing veinlets

Probably E1/2 sec. 7, W1/2 sec. 8, W1/2 sec. 16, sec. 17, sec. 18,
E1/2 sec. 19,sec. 20, sec. 21, SW1/4 sec. 22, sec. 28,
N1/2 sec. 29, N1/2 sec. 33, T.52N., R.63W.

The exact extent of fluorite-bearing veinlets is not known because the fine-grained veinlet material makes identification of minerals difficult, iron and manganese oxides also obscure vein mineralogy, fluorine analyses have not been performed, and mapping of mineralization related to alteration is incomplete. The probable area of fluorite-bearing veinlets listed above includes the radioactive, iron and manganese oxide stained, fracture systems (veins and veinlets) mapped by Wilkinson (1982); the highly radioactive disseminated mineralization of Staatz (1983); and intrusive breccias mapped by White (1980), O'Toole (1981), Wilkinson (1982), Staatz (1983); and Jenner (1984). The documented fluorite-bearing veinlets occur in altered Precambrian granitic rocks, altered Tertiary igneous rocks, and intrusive breccias that contain either kind of rock (Brown, 1952; Wilkinson, 1982; Staatz, 1983; Jenner, 1984).

Fluorite-bearing carbonatites

surface: S1/8 sec. 7-8 line, NW1/4NW1/4NE1/4 sec. 20, T.52N., R.63W.
subsurface: NW1/4 sec. 17, NE1/4 sec. 18, T.52N., R.63W.

Carbonatite dikes and stringers in the Bear Lodge igneous complex contain disseminations, streaks, and lenses of purple fluorite, as well as rare-earth-bearing minerals (Wilkinson, 1982; Staatz, 1983; Jenner, 1984). The exposure on the Section 7-8 line contains about five percent fluorite (Wilkinson, 1982). Because the carbonatites are only exposed in trenches with no visible float (Wilkinson, 1982), the exact extent and size of the carbonatites is not known. The reported size of the surface exposure on the section 7-8 line varies. Staatz (1983) reports it as about 15 by 80 feet while Wilkinson (1982) reports it as 4.5 by 160 feet. The exposure in section 20 is about 20 feet by 330 feet (Wilkinson, 1982). In subsurface, the carbonatites are tenths of an inch to about 11 feet thick and are steeply dipping (Staatz, 1983). These are probably actual thicknesses because Jenner (1984) reports thicknesses of tenths of an inch to several tens of yards in cores from angled (non-vertical) drill holes.

Surface and fresh subsurface carbonatite contain different mineral suites including the rare-earth-bearing minerals. The only mineral common to both suites is fluorite. Iron oxide staining controls the color of surface exposures and altered subsurface carbonatite. Most minerals in these iron oxide stained rocks are so fine grained and powdery that they are almost unrecognizable. In the subsurface, fresh carbonatites contain discernible minerals including metal sulfides and are usually light gray in color (after Staatz, 1983; Jenner, 1984).

Jenner (1984) mapped fluorite-bearing, strontium-poor carbonatites in the Ogden Creek area, south of other carbonatites, but the origin of these carbonate rocks is uncertain (see Ogden Creek section below).

Ogden Creek area (Allen-Wright fluorspar prospects)

SW1/4 sec. 27, SE1/4 sec. 28 and possibly NW1/4 sec. 34, T.52N., R.63W.

Fluorite, associated with intrusive breccias, and possibly carbonatites, is present at this locality. As with most of the Bear Lodge igneous complex, rocks in this area are poorly exposed. The rocks are trachytes and phonolites that surround recrystallized carbonate rocks (marble) (Jenner, 1984; Wilkinson, 1982; Staatz, 1983). The carbonate rocks have been variously interpreted as Precambrian limestone (Chenoweth, 1955); Paleozoic limestone (Haff, 1944a; Staatz, 1983; Wilkinson, 1982); and, on the basis of physical, chemical, and isotopic analyses, melted Paleozoic limestone (Jenner, 1984). The carbonate rocks do not exhibit the strontium enrichment that is present in the rare-earth-bearing carbonatites to the north (after Jenner, 1984; Wilkinson, 1982; Staatz, 1983). The Ogden Creek rocks, incidentally, have not been analyzed for rare earths.

The fluorite claims are on and near the ridge crest between Ogden and Tent Creeks, mostly in Sections 27 and 28. Within these claims, the so-called limestones were the most extensively prospected areas (Haff, 1944a) before exploration for radioactive rocks began. Fluorite is relatively abundant in these carbonate rocks, particularly at their margins, but is also present in the trachytes and phonolites. Limonite stained, vuggy, siliceous masses that contain fluorite and fluorite-bearing intrusive breccias are present in the trachyte-phonolite (Haff, 1944a). Intrusive breccias have been mapped in both

Sections 28 (Wilkinson, 1982) and 27 (Haff, 1944a). The concentrations of fluorite are greatest in the western exposure of carbonate in a trench that straddles the Section 27-28 line. A zone 100 feet long and tens of feet wide in this exposure contains 5 to 10 percent fluorite with smaller zones containing even higher percentages (Cox, 1945). The presence or absence of veins has not been established (after Haff, 1944a; Cox, 1945; Hagner 1943; Wilkinson, 1982).

The nonweathered fluorite in all the occurrences is lavender to deep purple, and is irregularly distributed. When weathered, the fluorite is greenish white (Haff, 1944a; Hagner, 1943). Fluorite is present as fine grains in veinlets and disseminations throughout the trachyte-phonolite and intrusive breccia, and as more coarsely crystalline disseminations, aggregates, and masses in the carbonate rocks (Haff, 1944a). Chenoweth's (1955) observations of larger fluorite crystals contradict statements by Haff (1944a). Chenoweth (1955) also reported that insoluble residues of the carbonate rocks only contain fluorite.

Royal Purple fluorspar claims

roughly W1/2 sec. 30, T.52N., R.63W., E1/2 sec. 25, T.52N., R.64W.

The location given for these claims is inferred from the description of Cox (1945), using Darton (1905) and Staatz (1983). Brown (1952) did not depict or mention these claims. The geology and topography at the claim location given by Haff (1944c) (section 5, T.51N., R.63W. and section 32, T.52N., R.63W.) do not match the geology and topography as described by Cox (1945) and Haff (1944c).

The Royal Purple claims are on roughly northwest-trending ridges on both the north and south banks of Bear Den Canyon (middle fork of Houston Creek). The fluorite mineralization is in pockets, lenses, and disseminations in the Minnelusa Formation. The mineralization is near a northwest-southeast elongate exposure of phonolite-trachyte with an undetermined intrusive form (after Haff, 1944c; Staatz, 1983).

South of Bear Den Canyon, deep purple and black fluorite is present in sandstone as disseminated grains and crystal aggregates up to 3 inches across. Ten to 15 percent fluorite was reported in some prospect pits (Haff, 1944c).

North of Bear Den Canyon, fluorite is more abundant and is apparently restricted to the west margin of the phonolite-trachyte intrusion. Prospect pits in the host Minnelusa sandstone and limestone reportedly contain 20 to 30 percent fluorite with rich pockets containing as much as 50 to 90 percent fluorite. In the prospect pits, dark purple to almost black fluorite was present in veinlets and blebs that form five to six vuggy lenses. The lenses are from 1 to 3 feet wide and at least 8 to 10 feet long. The prospect pits did not completely expose the length of these lenses, but they are elongate northwest-southeast. The fluorite is associated with brown calcite, quartz, and siderite(?). Disseminated fluorite and scattered veinlets of fluorite are also present north of Bear Den Canyon in limestone and well-indurated sandstone (after Haff, 1944c; Cox, 1945). Cox (1945) also reports fluorite mineralization in a fault contact between the phonolite-trachyte intrusion and a limestone in the Minnelusa Formation.

Fluorite mineralization on the west side of the intrusive complex is probably more widespread than just these claims. Fluorite has been reported at other sites near Bear Den Canyon, and disseminated fluorite could easily be overlooked in this heavily vegetated terrain, which has few exposures. In Bear Den Canyon, Cox (1945) described fluorite-calcite veinlets and low-grade fluorite boulders in the Pahasapa Limestone east of the Royal Purple claims. Fluorite has also been reported north of the Royal Purple claims, probably along strike, in sec. 24, T.52N., R.64W. (Hilton *in* Osterwald and others, 1966). However, Staatz (1983) does not show any claims in this area. Staatz (1983) does show claims in the Pahasapa Limestone north of Bear Den Canyon in sec. 30, T.52N., R.63 and north and east of Jim Wayne Spring in both the Pahasapa Limestone and Minnelusa Formation in the western quarter of sec. 19, T.52N., R.63W.

Petersen fluorite lode claims (Bear Lodge fluorite property)
roughly center S1/4 sec. 15, center E1/2 sec. 22, T.52N., R.63W.

Fluorite is present in the Mississippian Pahasapa Limestone on these claims. Pits and trenches have also revealed altered porphyritic igneous rocks on the claims, but only Hagner (1943) mentioned fluorite mineralization in the igneous rocks. Exploration has been hampered by a mantle of gravel (Haff, 1944b; Cox, 1945; Dunham, 1946). Jenner (1984) mapped exposures of Cenozoic igneous rocks near these claims. Replacement and vein fluorite mineralization, and gradations in between, are present on the property. The deep or dark purple fluorite is associated with calcite, quartz, chert, and feldspar. Samples of material from trenches, shafts, and drifts contain about 20 to 85 percent fluorite (after Haff, 1944b; Cox, 1945; Dunham, 1946; see also Batty and others, 1947; U.S. Bureau of Mines, 1944). Hagner (1943) also reported colorless fluorite. The report of feldspar in the ore (Dunham, 1946) supports the presence of mineralized porphyritic igneous rocks on these claims.

Replacement deposits follow bedding in the limestone. Replacement mineralization varies from widely disseminated fluorite grains to bands as much as one foot thick that are mostly fluorite. The full extent of the replacement deposits has not been determined. In workings, they have been followed to a depth of 24 feet, are up to 5 feet thick where bands are stacked, and are probably up to 50 feet long (after Haff, 1944b; Cox, 1945).

Smaller fluorite veins are narrow and appear to be in joints while larger fluorite-bearing veins are actually brecciated zones. The breccia zones contain clay and limestone clasts with cherty masses and vuggy masses of fluorite. These breccia zones have irregular shapes, and the entire lengths have not been excavated. In workings, the zones are up to 9 feet thick, two extend to depths of 28 and 44 feet, and most are probably less than 20 feet long. Vein mineralization is both parallel to and crosscuts bedding in the limestone. The longest dimensions of the breccia zones are usually parallel to the strike and dip of bedding, but apparently dip at steeper angles (25° to 60°) than bedding (after Haff, 1944b; Cox, 1945). Bedding in this area has a northwest strike and dips about 25° to the northeast (Staatz, 1983).

Wilmarth and Johnson (1953) briefly examined and described fluorite mineralization in the Pahasapa Limestone on the Peterson claims and in the Lytle Creek area. The information they presented contradicts some preceding information by Haff (1944b) and Cox (1945) on the Peterson claims. The sizes of fluorite-bearing zones as reported by Wilmarth and Johnson (1953) are smaller than those presented in the previous paragraph on the Peterson claims (vein-breccia zones up to one-foot wide and 6 feet long, and disseminated replacement deposits up to 2 feet wide and 10 feet long). Wilmarth and Johnson (1953) also stated: (1) colorless fluorite is interbanded with deep purple fluorite, (2) iron and manganese oxides are present in fractures in fluorite grains in veins, and (3) chert and feldspar are not associated with the fluorite. Other authors have only reported colorless fluorite in the Ogden Creek area and in the igneous complex. Interbanded fluorite coloration has not been reported in the southern Bear Lodge Mountains by any other investigator. The iron and manganese oxides have only been reported in veins and veinlets within the igneous complex. From this information, it is possible that these divergent features are confined to the Lytle Creek area, rather than being present at both the Petersen claims and the Lytle Creek area.

Fluorite mineralization in the Pahasapa Limestone is probably more extensive on the eastern and southern margins of the igneous complex than just that found on the Petersen claims. A few additional prospect pits and trenches are located on these margins, and the northeastern portion of the margin is covered by an extensive gravel (Brown, 1952; Staatz, 1983). Also, Chenoweth (1955) reported finely disseminated fluorite in numerous exposures of Pahasapa Limestone on these margins of the igneous complex.

Lytle Creek area

E1/4 sec. 13, T.52N., R.64W.; NW1/4 sec. 7, W1/4 sec. 18, T.52N., R.63W.

Wilmarth and Johnson (1953) visited at least four claims in this area that they stated contain fluorite in the Pahasapa Limestone. These claims are the James Walter, Baker lode, Nichols lode, and Nichols No. 1 lode (see Wilmarth and Johnson, 1953; and Everett, 1951 for exact locations). Brown (1952) depicted two fluorite prospects in this area. Staatz (1983) showed prospect pits in the Permian Minnelusa Formation near Lytle Creek. Mapping by Staatz (1983) showed that the Pahasapa Limestone in this area has been more thoroughly invaded by igneous rocks than on the northeastern margin of the complex.

As noted in the section on the Petersen fluorite lode claims, Wilmarth and Johnson (1953) combined their observations on the Lytle Creek claims with those for the Petersen claims. In some respects fluorite mineralization in the Lytle Creek claims is apparently similar to the Petersen claims. These similarities are: (1) the presence of deep purple fluorite, (2) the association of fluorite with calcite and quartz, (3) the presence of vein-breccia and replacement deposits, and (4) the mineralization is usually nearly parallel to bedding in the Pahasapa Limestone. Other than size, there are probably some other differences between the two sets of claims. Only Lytle Creek area is apparently characterized by the presence of colorless fluorite, iron and manganese oxide staining, and the absence of chert and feldspar (see section on the Petersen claims). These divergent characteristics may be a function of zoning related to more extensive invasion by igneous rocks.

3. *Carbonate No. 1 claim (Black Buttes).* NE1/4 sec. 26, T.50N., R.62W.

Some purple fluorite is present with lead-zinc-silver mineralization in the upper part of the Pahasapa Limestone (Mississippian) a few feet above the intrusive contact with a sill of Tertiary trachyte porphyry. Mineralization occurs in discontinuous, narrow (1 to 4 inches wide) stringers that are at high angles to bedding. The mineralization forms a steeply dipping zone along a joint or fracture system. Silicification accompanies the mineralization (Elwood, 1978, 1979).

Fremont County

4. *Whiskey Mountain area.* SW1/4NE1/4 sec. 12, T.40N., R.107W.

White and purple fluorite occur sparsely in fractures in a light gray brecciated claystone that is interlayered with dolomite along the contact between the Gallatin Limestone and overlying Bighorn Dolomite. The brecciated rocks are iron stained and also contain barite and carnotite (Granger and others, 1971).

Laramie County

5. *Bear pegmatite deposit*. SW1/4NW1/4 sec. 5, T.15N., R.70W.

In this pegmatite in the Precambrian Sherman Granite, a roughly triangular area 150 feet by 150 feet by 100 feet contains fluorite masses 1 foot to 5 feet across. The individual fluorite grains are 1/8 to 2.5 inches across. The fluorspar content of the pegmatite is low (<20 percent). Twenty tons of fluorite-rich material were in stockpiles on the property in 1944, as a by-product from feldspar mining by the Wyoming Feldspar Company (Clabaugh and others, 1946). Fluorite in the pegmatite indicates a potential for rare earth elements as well.

6. *Silver Crown mining district*. SW1/4 sec. 13, SE1/4 sec. 14, T.14N., R.70W.

Fluorite is present in small amounts with quartz-biotite gangue and copper mineralization in narrow fault-gouge zones (Klein, 1973). This is exemplified by Klein's description of the Comstock mines in this district.

7. *Sherman granite*. NE1/4SW1/4 sec. 23, T.14N., R.70W.

Klein (1973) reported a trace of fluorite in one of four samples of unmineralized Sherman Granite taken in the Silver Crown mining district. The location given is that of the fluorite-bearing sample. The presence of fluorite in pegmatites in the Sherman Granite was not noted.

Lincoln County

8. *Coal Canyon*. Sec. 7, T.26N., R.119W.

Fluorite is reported mainly in phosphorite in the Phosphoria Formation (Permian). It occurs within and among carbonate-fluorapatite pellets. A single occurrence in dolomite in a bed designated P-42 was also noted at this site (Gulbrandsen, 1960). Fluorite was also reported in phosphorite and carbonate rocks in the Phosphoria Formation elsewhere in western Wyoming (Sheldon, 1963), but exact locations were not reported.

Yellowstone National Park

Fluorite has been described in drill core from several research drill holes in thermal areas in Yellowstone National Park. However, percentages are small and chemical analyses for fluorine from these cores have not been reported (Beeson and Bargar, 1984). Clear to white octahedral fluorite crystals have been found in fractures, irregular open-space fillings, and vapor phase cavities in altered Quaternary rhyolitic ash-flow tuffs in research drill hole Y-6 near the upper Firehole River (Bargar and Beeson, 1984) and in drill hole Y-11 in the Mud Volcano thermal area (Bargar and Muffler, 1982). Fluorite was also found in drill holes Y-2, Y-4, and Y-13 (Bargar and Beeson, 1981, 1984; Keith and others, 1978; respectively), and occurred as clear, octahedral crystals in drill holes Y-3 and Y-5, all in the Lower Geyser Basin (Bargar and Beeson, 1985; Keith and Muffler, 1978, respectively).

These fluorite occurrences in Yellowstone are only described for completeness and are not meant to imply that they have any economic value.

Stream-sediment occurrences

Albany and Laramie Counties

9. *Middle Lodgepole and South Lodgepole Creeks.*

Middle Lodgepole Creek
SE1/4SW1/4, Center SE1/4, and NE1/4SE1/4* sec. 6; and SW1/4NW1/4 and SE1/4NW1/4 sec. 7, T.15N., R.70W., (*two samples from this location).

South Lodgepole Creek
NE1/4NE1/4 and Center SW1/4 sec. 18, T.15N., R.70W.

Fluorite was found in stream sediment samples taken by the Geological Survey of Wyoming at the locations listed above. The bedrock source(s) of the fluorite in these samples is not known; however, the samples are from locations that are near the Bear pegmatite (page 17) and are just north of the occurrences in Sherman Granite and the Silver Crown mining district (page 18). The fluorite in these stream-sediment samples could be from mineralization at any or all of these occurrences, or in similar but as yet undiscovered occurrences.

Albany County

10. *Laramie River.* SW1/4NE1/4 sec. 25, T.23N., R.73W.

A sample of alluvial material from this location contained fluorite. The source of the sediment could be a small drainage entering the Laramie River from the north or the Laramie River itself. The bedrock source of the fluorite is not known. The sample was collected by the Geological Survey of Wyoming.

11. *Dodge Ranch area.* SW1/4SE1/4 sec. 7, T.22N., R.72W.

A sample of stream sediment from a small drainage at this location contained fluorite. The sample was collected by the Geological Survey of Wyoming. The bedrock source of the fluorite is not known.

12. *Grant Creek.* SW1/4NW1/4 sec. 36, T.21N., R.71W.

Fluorite was found in a stream-sediment sample at this location. The sample was collected by the Geological Survey of Wyoming. The bedrock source of the fluorite is not known.

Unverified Occurrences

Carbon County

13. *Seminoe Mountains*

Fluorite was reported in limestone south of the Seminoe Mountains (Aughey, 1886). There has been no subsequent verification of this occurrence.

Crook County

14. *Mineral Hill (Tinton, Negro Hill) area,* in Wyoming roughly T.51N., R.60W. and N1/2 T.50N., R.60W.

Mineral Hill encompasses a Tertiary alkalic intrusive complex, with carbonatitic affinities and possibly carbonitites, which was intruded into Precambrian schists and lower Paleozoic sedimentary rocks. This type of geologic setting often contains fluorite mineralization (for example the southern Bear Lodge Mountains), so, although fluorite has not been reported in this area (Welch, 1974; Smith and Page, 1941; Darton, 1905), it is probably present. Furthermore these previous studies were not designed to find fluorite, and fluorine analyses were not performed in the geochemical studies on the area (Welch, 1974; Warren, 1980).

Fremont County

15. *Little Popo Agie River Canyon*

Fluorite was reported by Aughey (1886) "in limestone in Little Popo Agie Canyon". There has been no subsequent verification of the occurrence.

Natrona County

16. *Rattlesnake Mountains*

Fluorite was reported north of the Rattlesnake Mountains (Aughey, 1886). There has been no subsequent verification of this occurrence. Alkaline igneous intrusive rocks, which commonly contain anomalous amounts of fluorine, are present in the area, but fluorite has not been reported in these rocks or surrounding rocks (Pekarek, 1974; Carey, 1959).

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