FLUORITE OCCURRENCES IN UTAH

by K. C. Bullock

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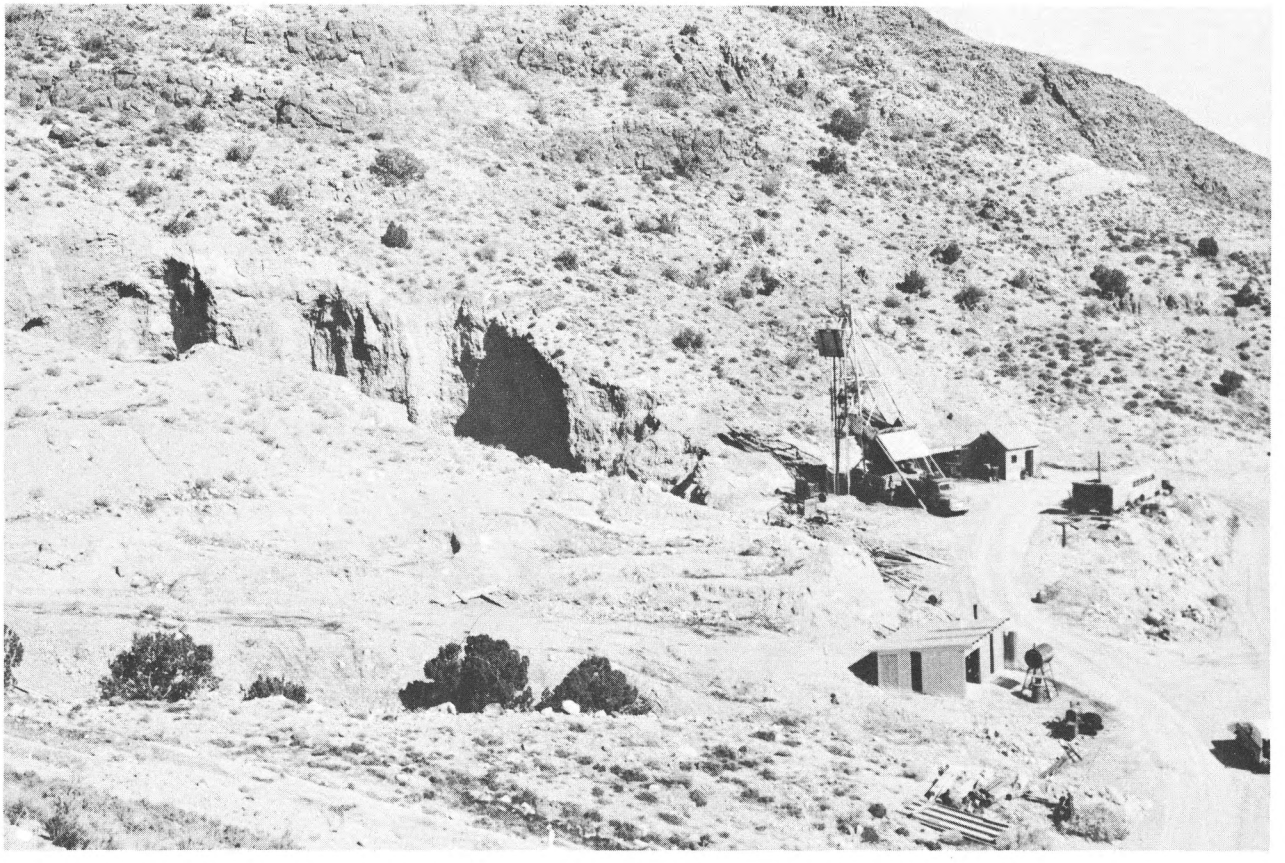

Frontispiece: Purple pit fluorspar pipe, Lost Sheep mine, Spor Mountain, Juab County.

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ABSTRACT

Commercial production of fluorspar from Utah began in 1918 and continued erratically to the present. Most shipments of ore have come from one county and from one district. Over 225,000 tons of fluorspar ore has been shipped from Spor Mountain in west-central Juab County. About 25,000 tons of ore has come from the Indian Peak Range, southern Wah Wah Mountains, and the Star Range in Beaver County. A few hundred tons of ore have come from five other Utah counties, and fluorite is present as a minor occurrence in three more counties. Four types of fluorite deposits are recognized: (1) breccia pipe fillings and replacements, (2) veins and simple fissure fillings, (3) skarn and tactite deposits near contact zones, and (4) disseminations in sedimentary and volcanic rocks. No mantos or bedding replacement deposits have been discovered.

Fluorspar mineralization in the state is found in sedimentary, igneous, and metamorphic rocks that range from Precambrian to Tertiary in age. Nearly all fluorite occurrences in Utah are Tertiary. At least 90 percent of commercial fluorspar in Utah has been associated with breccia pipes at Spor Mountain. The known reserves of fluorspar are small, totaling only about 50,000 tons of material that could meet the metallurgical requirements of industry. Most of this reserve is at Spor Mountain, which also has the greatest potential for the discovery of new deposits.

INTRODUCTION

Fluorite deposits, ranging in importance from minor mineral occurrences to major producing fluorspar mines, have been investigated by the author in ten counties. A total of 112 prospects and mines were examined. Major production has come from Spor Mountain in west-central Juab County. Minor production has come from Beaver County and even lesser amounts from Grand, Millard, Piute, Tooele, and Weber Counties. Sevier, Summit, and Utah Counties possess only minor occurrences of fluorite. Total production of fluorspar in Utah from 1918 through 1975 was about 250,000 tons of ore. The known reserves of fluorspar in Utah are small, totaling only 50,000 tons of material that could meet metallurgical requirements.

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The fluorspar ores of Beaver County are low-grade and highly siliceous. The ore reserves are small, and future potential appears limited. Although the known deposits at Spor Mountain in Juab County are approaching exhaustion, the district still maintains a high potential for new discoveries. Further exploration of this district may be guided by the following observations: (1) production has come mainly from breccia pipes; (2) Ordovician and Silurian dolomites are the host rocks; (3) no ore deposits have been found below the Ordovician Swan Peak Quartzite; (4) the ores are slightly radioactive; (5) the pipes are usually covered by shallow to deep regolith; (6) the pipes lie near intrusive rhyolite breccia; and (7) a few pipes have had bleached outcrops with little or no overburden.

This study details a research project by the author, which was conducted from the fall of 1974 to the fall of 1975, on the fluorite occurrences in Utah. The work consisted of a literature review, field investigations, and reports on the prospects and mines in the state. The project was sponsored and financed by the U. S. Bureau of Mines, Department of the Interior, under U.S.B.M. Grant No. GO 155-022 and by the Utah Geological and Mineral Survey. This bulletin is based upon an open-file report and a statistical analysis compiled for the U. S. Bureau of Mines Minerals Availability System.

HISTORY OF FLUORSPAR MINING IN UTAH

Commercial production of fluorspar in Utah began in 1918 and has continued to the present (table 1). Production has been erratic owing to varying industrial demands, government incentives, competition with out-of-state producers, and the health of the national economy. Total reported production of fluorspar from 1918 through 1975 was 246,852 tons of ore. Additional shipments of ore have been made by producers and not reported to the U. S. Bureau of Mines. The first recorded mining of fluorspar in the state was at the Silver Queen mine on the north end of Wildcat Mountain, Tooele County. From 1918 to 1924 a total of 904 tons of hand-sorted fluorspar was shipped by the Silver Mining Company to a San Francisco market. In the next decade from 1925 to 1934 no fluorspar was mined in Utah.

From 1935 to 1945 Beaver County was the largest fluorspar producer in Utah. In 1935 production

Table 1. Shipments of finished fluorspar in Utah.

Year	Quantity (short tons)
1918	20
1919	166
1920	268
1921	–
1922	78
1923	188
1924	184
1925-1934	–
1935	180
1936	700
1937	431
1938	370
1939	385
1940	142
1941	748
1942	1,018
1943	51
1944	3,952
1945	2,973
1946	2,370
1947	1,730
1948	9,523
1949	8,332
1950	18,936
1951	17,827
1952	17,304
1953	15,527
1954	4,403
1955	7,328
1956	10,581
1957	11,087
1958	15,877
1959	500[1]
1960	1,912
1961	610
1962	399
1963	247
1964	3,000[1]
1965	4,200[1]
1966	4,500[1]
1967	6,500[1]
1968	8,762
1969	6,667
1970	19,214
1971	10,947
1972	2,977
1973	4,778
1974	3,960
1975	15,000[1]
Total	246,852

Source: U. S. Bureau of Mines.
[1] Estimate by the author.

began at the Staats (Monarch) mine at the southern end of the Wah Wah Mountains. Production from this mine during the next few years was about 5,000 tons. In 1940 and 1941 Western Fluorite Company did development work and constructed a mill south of Milford. In 1942 this company produced about 1,000 tons of ore mainly from small fluorite deposits in the Star Range. In 1942 the Cougar Spar mine in Indian Peak Range was being developed by Tintic Standard Mining Company, and in 1944 mining and milling commenced. In the next few years about 17,000 tons of ore was shipped to the Cougar Spar mill with nearly all the production coming from the Cougar Spar mine. Minor production came from the nearby Blue Bell mine.

In 1943 fluorspar was discovered on Spor Mountain, Juab County. Production began in 1944, and the district slowly developed until 1948 when nearly 10,000 tons of ore was produced by four operators. From 1948 to the present the Spor Mountain district has been the dominant source of ore. The greatest period of production was from 1948 to 1958 when the federal government paid incentives to producers. The most productive year was 1970, when 19,214 tons of ore was shipped. The major operators in Spor Mountain have been Willden Fluorspar Company, Chesley and Black, Spor Brothers, Ward Leasing Company, and Bell Hill Mining Company.

BEAVER COUNTY

Bradshaw District

The Bradshaw district lies on the southwest side of the Mineral Mountains, a few miles northeast of Minersville (figure 1). The district was organized in 1875, and most production came in the thirty years following organization. Small quantities of oxidized ores of lead, iron, copper, gold, and silver were produced. The principal mine was the Cave mine, which yielded oxidized ores from a fissure replacement deposit. Other older mines that produced some ore are the Hecla and Jolly Boy mines. The district is described by Butler and others (1920, p. 530-531, 535-536) and Earll (1957, p. 89-93). The 2 R's (Skyline) mine was located during World War II for tungsten ore, which contains small quantities of fluorite.

2 R's (Skyline) Mine

The 2 R's mine, more recently known as the Skyline mine, is on the northwest side of Harkley Mountain on the western side of the Mineral Mountains. The property lies in the NW¼ sec. 33, T. 28 S., R. 9 W., Bradshaw mining district, Beaver County (figure 1). A group of three 2 R's mining claims were located in 1941 by Reese Griffiths and Ralph Meyers of Minersville. The property was held by assessment work for a number of years. In 1970 it was restaked as the Skyline claims, Nos. 1-7, by the Meyers brothers, Eugene, Oswald, Ernest, Kenneth, Verdon, and Orrin, of Minersville. The property is developed by several small open pits and a series of trenches. The largest opening from which 70 tons of tungsten ore was

LOCATIONS

BRADSHAW DISTRICT
1. 2 R's mine

GRANITE DISTRICT
2. Big Pass (Blue Star) mine
3. Bismuth mine
4. Contact (Cedar) mine
5. Garnet (Juniper) mine

NEWTON DISTRICT
6. Mystery-Sniffer mine

NORTH STAR DISTRICT
7. Wild Bill mine

PINE GROVE DISTRICT
8. Daisy mine
9. Iron Queen mine
10. Producer mine
11. Staats (Monarch) mine

SAN FRANCISCO DISTRICT
12. Cupric mine

STAR DISTRICT
13. Black Bart prospect
14. Fluorine Ledge prospect
15. Fluorite (Virginia) prospect
16. Hub mine
17. Ladie (Lady) Boy prospect
18. Luckie (Lucky) Boy prospect
19. Manassas mine
20. Monte Christo mine
21. Moscow mine
22. State Land prospects
23. Sullivan Group prospects

WASHINGTON DISTRICT
24. Blue Bell mine
25. Cougar mine
26. Doughout (Dugout) prospect
27. J. B. mine
28. Lost Sheep prospect
29. Noonday prospect
30. Utah mine

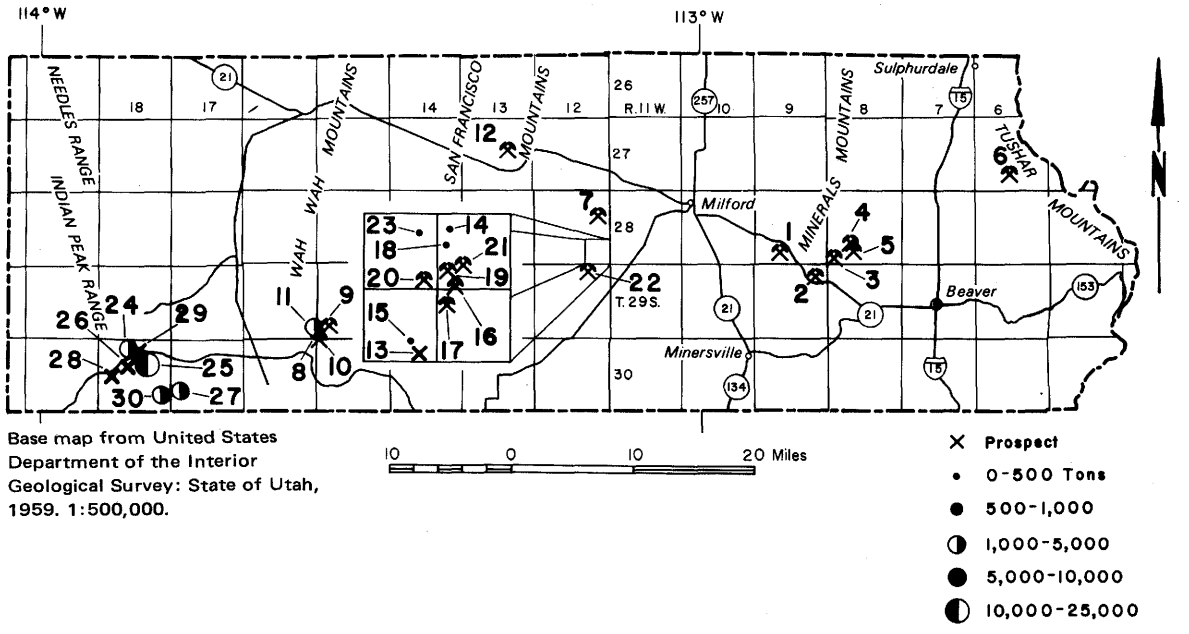

Figure 1. Beaver County fluorite occurrences.

shipped measures 10 feet wide, 20 feet long, and 10 feet deep. A short adit lies about 50 feet below the open pit. The mine is described by Crawford and Buranek (1945, p. 45-47), Hobbs (1945, p. 110), Earll (1957, p. 93), and Everett (1961, p. 39). The mine is mentioned briefly by Buranek (1948, p. 16), Thurston and others (1954, p. 50), and Bullock (1967, p. 14, 119).

Bedrock at the 2 R's mine consists of a large roof pendant probably of Permian Kaibab Limestone that is intruded by the Tertiary Mineral Mountain stock. The contact zone between the sedimentary rock and granite is well exposed on the property at several points. The strata immediately above the open pit strike N. 30° E. and dip 60° SE. A tactite zone in the limestone more or less parallels the contact with granite. Beyond the tactite zone the limestones are little affected by the intrusive. The limestone is bluish gray and weathers to light gray hues.

The mineralized tactite zone, which was mined for tungsten, consists of soft decomposed rock ranging from brown to green. Some tactite is hard and massive, especially south of the main pit. In 1942 about 70 tons of scheelite ore, which averaged 0.58 percent WO_3, was shipped from the 2 R's mine. Scheelite occurs as tiny crystals disseminated throughout the tactite rock. The principal minerals forming the tactite rock are garnet, epidote, diopside, vesuvianite, quartz,

wollastonite, and calcite. Along the margin near the granite contact fluorite, tourmaline, pyrite, chalcopyrite, and malachite are common. The mine has no commercial fluorspar ore but rather contains a minor occurrence of fluorite in an igneous-metamorphic contact zone.

Granite District

The Granite district lies on the east side of the Mineral Mountains about 10 miles northwest of Beaver (figure 1). The district was organized in 1863 after which small amounts of bismuth, copper, lead, iron, zinc, and gold were shipped intermittently. Most of the ore produced came from the Beaver View mine. The district is described by Butler and others (1920, p. 531) and Earll (1957, p. 98-99). From 1939 to 1950 the Big Pass (Blue Star), Contact, and Garnet mines were developed and exploited for tungsten ore. Fluorite is present as a minor occurrence in tactite zones along igneous-sedimentary contacts.

Big Pass (Blue Star) Mine

The Big Pass mine, more recently called the Blue Star mine, is on the north side near the mouth of Cherry Creek, on the southeastern side of the Mineral Mountains. The property lies in the NW¼ sec. 12, T. 29 S., R. 9 W., Granite mining district, Beaver County (figure 1). In 1927 Ross B. Cutler staked three Hope Chest claims; in 1937 James E. Robinson restaked the area with 12 Contact claims. The early workings were in search of lead, silver, and gold. In 1939 Louis Lessing restaked the area with five Lucky Lu claims and operated the property in search of gold. Tungsten ore was discovered on the property in 1943. Cutler, Robinson, and Lessing asserted their alleged rights and became involved in a lawsuit. The suit was settled by compromise and the property became known as the Big Pass group of claims. In 1958 the area was relocated as the Hope Chest claims, Nos. 1-12, by Harry Fotheringham who quit-claimed the property to Louis Lessing, Karla N. Tattersall, Ross Cutler, and Abe Murdock. The property was sold and now is owned by Escalante Enterprises of Salt Lake City.

Development work consisted of a 150-foot vertical shaft, a shallow inclined shaft, and a 300-foot adit along which most of the mining was concentrated. Several trenches were cut in search of tungsten ores. In its early history, the property is reported to have produced some lead ores containing precious metals. Some high grade gold was mined in the late 1930's. The property was worked for tungsten in 1943 and 1944 by McGarry and Dewey. Output in 1944 was 241 tons, containing 203 units of WO_3. In the year 1953 the property was worked by the Free brothers. Ore production was combined with that from the Garnet mine, and it totaled 449 tons averaging 0.45 percent WO_3. The Big Pass mine is described by Crawford and Buranek (1945, p. 28-31), Earll (1957, p. 97-98), and Everett (1961, p. 37). The mine is mentioned briefly by Buranek (1948, p. 16), Thurston and others (1954, p. 50), Dasch (1964, p. 167), Bullock (1967, p. 14, 119), Elevatorski (1974, p. 80), and Worl and others (1974, p. 10).

The Big Pass mine is on an igneous-metamorphic contact zone between Permian Kaibab Limestone and phases of the Tertiary Mineral Mountains granite stock. Dikes, sills, and apophyses of granite extend irregularly into metamorphosed limestone. Aplite, pegmatite, and lamprophyre dikes are not uncommon and occasionally show some mineralization. Tactite zones have developed along the intrusive contacts in the limestone strata. Most of the zones strike N. 30° E. and dip steeply to the southeast. The average thickness of the tactite zone is about 20 feet. The rock consists mainly of garnet, epidote, wollastonite, tremolite, diopside, fluorite, pyrite, and calcite. The tactite zones differ somewhat in mineral composition and appearance. Some contain large quantities of pyrite, now altered to limonite, and weather to a yellowish brown rock. Other tactite is more massive and contains large quantities of tremolite, fluorite, and calcite. A third type consists largely of brown to greenish brown garnetite that forms resistant outcrops. All types contain some scheelite mineralization. Small, irregular fissure veins have also mineralized the tactite zones. Metallic ore minerals found underground include galena, cerussite, jarosite, malachite, aurichalcite, pyrite, and limonite. The best grade tungsten ore is closely associated with fluorite, which mostly surrounds the scheelite crystals. One large stope in the Big Pass mine was primarily fluorite. About 50 tons of fluorspar ore was mined, but the silica was too high in content to be accepted by Geneva Steel Works. Although fluorite is widely distributed in the tactite rock, no commercial ore is in sight. Its presence is regarded only as a minor occurrence at the Big Pass mine.

Bismuth Mine

The Bismuth mine is on the southeastern side of the Mineral Mountains. The property lies near the center of sec. 31, T. 28 S., R. 8 W., Granite mining district, Beaver County (figure 1). The property, originally discovered in 1865 as the Major lode, was restaked in 1876 as the San Francisco Bismuth and Star King Bismuth claims by John O'Neil and H. L. A. Culmer and then relocated in 1880 as the Bismuth lode by Miles Doran. The property was again staked in 1915 as the Bismuth Nos. 1-3 and Bismuth Extension claims by James Moyes and M. C. Powers. The property remained inactive until 1955 when Melvin

Bradshaw of Milford staked the property as the Minnie Nos. 1 and 2 claims. Old workings consist of several shallow shafts up to 40 feet deep, an adit about 150 feet long, and recent trenching by Bradshaw. The Bismuth mine is described by Butler and others (1920, p. 531, 534). The property is mentioned briefly by Huntley (1885, p. 484), Thurston and others (1954, p. 50), and Bullock (1967, p. 14, 119).

The Bismuth mine is near an igneous-metamorphic contact zone. Bedrock consists of Permian Kaibab Limestone and Tertiary Mineral Mountains granite stock. The Kaibab Limestone strikes N. 35° E. and dips 85° SE. The main granite stock lies a short distance to the west and forms the high mountain mass of the Mineral Mountains. The Bismuth property is on Kaibab Limestone that is cut by sills and granite apophyses that parallel the strike of the sedimentary rocks. Granite rock is exposed a few hundred feet both northeast and southwest of the mineralized area. The limestone must be underlain by granite since a steeply dipping limestone bed is preferentially metasomatically replaced by tactite rock. The tactite zone is about 6 feet thick and dips 85° SE. It is overlain and underlain by white siliceous limestones that have been recrystallized. Along the strike the tactite zone can be traced by open cuts and shallow shafts for several hundred feet and on the surface for a greater distance.

The principal minerals in the tactite zone are garnet, vesuvianite, amphibole, wollastonite, fluorite, calcite, sulfides, and some scheelite. The sulfides include pyrite, galena, bismuthinite, and molybdenite. The mine was worked in its early history for bismuth. A few tons of ore were shipped and reported to average from 7 to 10 percent bismuth. Fluorite is present as a minor occurrence scattered in the tactite rock. No commercial fluorspar has been exposed at the Bismuth mine.

Contact (Cedar) Mine

The Contact (Cedar) mine lies on the eastern side of the Mineral Mountains. The property lies in the W½ sec. 29, T. 28 S., R. 8 W., Granite mining district, Beaver County (figure 1). The mine adjoins and lies to the northeast of the Garnet mine. The group originally consisted of two unpatented claims, one known as the Contact lode staked in 1940 and the other as the Contact No. 1 claim staked in 1941. Both properties were held by Arch Fotheringham and Ray Morgan, who prospected the area for gold. In 1943 and 1944 the property was operated by the Daily Metal Mines Incorporated; the principals involved were Ambrose McGarry and Ezra Barton of Beaver and Dr. Hartley G. Dewey of Los Angeles. Considerable development work was accomplished in search of tungsten ores. Workings consist of three shafts, Nos. 1, 2, and 3, sunk to depths of 100, 40, and 80 feet respectively, of limited drifting to the southeast in the deeper shaft and of several shallow trenches at the surface. In 1950 E. S. Tattersall of Beaver relocated the property by staking three Cedar claims. Presently the property is held by performance of annual assessment labor and is owned by Karla N. Tattersall and Jay Gillies of Beaver. The property is described by Hobbs (1945, p. 106), Crawford and Buranek (1945, p. 38-39), and Everett (1961, p. 37-38) and mentioned briefly by Dasch (1964, p. 167) and Bullock (1967, p. 15, 119).

The Contact claims are on a pediment surface that is covered by considerable alluvium. Mineral Mountains granite stock has intruded Permian Kaibab Limestone and formed an igneous-metamorphic contact zone. The sedimentary strata strike N. 35° E. and dip 75° to 85° SE. Two tactite zones have been exposed during exploratory work in limestone near the granite contact. One zone measures about 20 feet wide about 30 feet from the granite contact; a second zone measures 13 feet wide about 100 feet from the granite contact. Shaft No. 1 lies to the southwest and is sunk in the steeply dipping tactite zone for 85 feet; then it cuts 15 feet of border zone rock and bottoms in granite. Shaft No. 2 is sunk in coarsely crystalline limestone. Shaft No. 3 lies to the northeast, cuts limestone and tactite, and bottoms in granite. Scheelite mineralization is not abundant in the tactite zone, and no commercial production of tungsten has come from this property.

Tactite rock is composed mainly of garnet, epidote, diopside, and wollastonite. Near the contact fluorite, quartz, tourmaline, pyrite, hematite, chalcopyrite, and molybdenite are present. Fluorite is not abundant. It is present only as a minor occurrence in the tactite zone nearest the contact with granite. No commercial fluorspar ore is present at the Contact mine.

Garnet (Juniper) Mine

The Garnet (Juniper) mine is on the eastern side of the Mineral Mountains. The mine lies in the SW¼ sec. 29, T. 28 S., R. 8 W., Granite mining district, Beaver County (figure 1). The property was staked in 1940 as the Garnet, Garnet No. 1, and Contact Fraction claims by Collis Huntington, James Fotheringham, and K. L. McGarry. The mine was operated for its tungsten ores in 1943 and 1944 by Daily Metal Mines Incorporated. The operators were Ambrose McGarry and Ezra Barton of Beaver and Dr. Hartley G. Dewey of Los Angeles. A total of 634 tons of ore, averaging 0.64 percent WO_3, was mined in 1943 and 1944, all from Garnet No. 1 claim. The property was staked as six Juniper claims by E. S.

Tattersall of Beaver in 1950. In 1953, 449 tons from the Big Pass mine and Garnet mine was milled by the Free brothers. The claims were leased to Minnesota Mining and Development Company in 1955, and some additional development work was done in 1956 and 1957 until the federal government purchase program was discontinued. The mine workings consist of two shafts, one 40 feet deep and the other 96 feet deep, 700 feet of drifts and crosscuts, and 20 surface trenches. The mine is owned by Karla N. Tattersall and Jay Gillies of Beaver, who maintain their ownership by performing annual assessment work on the claims. The Garnet mine is described by Hobbs (1945, p. 102-106), Crawford and Buranek (1945, p. 35-38), Earll (1957, p. 98), and Everett (1961, p. 37-38). The mine is mentioned briefly by Dasch (1964, p. 167) and Bullock (1967, p. 15, 119).

The Garnet mine is on the upper part of a gently sloping pediment surface, east of the steeper slopes of the Mineral Mountains. Most of the surface is mantled by a thick layer of grus and slope wash, which is derived from the granite bedrock to the west. The surface is slightly dissected exposing some outcroppings of bedrock. Tungsten mineralization occurs in tactite layers in the limestone adjacent to the granite stock. The limestone is a fairly massive rock, which strikes N. 35° E. and dips 75° to 85° SE. The granite is medium grained and porphyritic in texture; it lies to the northwest of the tactite zone. Pegmatite dikes and quartz veins are associated with its border facies. The strike of the limestone and granite contact is remarkably straight for a distance of about ½ mile on the adjoining property of the Garnet and Contact mines.

Scheelite ore occurs in layers of tactite rock formed by contact metasomatism of Kaibab Limestone. There are at least four parallel northeast-trending, steeply dipping tactite zones that have replaced layers in the limestone. The zones range from a few inches to 40 feet in width within a belt 130 feet wide and parallel to the granite contact. These layers are separated by essentially unmetamorphosed limestone. All four tactite zones contain some scheelite, but only the second zone from the contact has produced commercial ore. This zone averages about 30 feet thick and can be traced along the strike for at least 800 feet.

The tactite rock consists mainly of garnet and epidote and smaller amounts of wollastonite, diopside, calcite, quartz, fluorite, malachite, and scheelite. Fluorite is found mainly on the 100-foot level of the mine. It is present only as a minor occurrence at the Garnet mine. No commercial fluorspar ore is exposed on the property.

Newton District

The Newton district lies along the west base of the Tushar Mountains, 10 miles northeast of Beaver (figure 1). The district was organized in 1892, and small shipments of gold were made from the Rob Roy and Sheep Rock mines according to Butler and others (1920, p. 543, 557-558). Veins containing tungsten ore are reported by Everett (1961, p. 42) from the Louis group of claims at the head of North Creek. Callaghan (1973, p. 51-52, 117-118) describes the Lost Sheep alunite deposit and the uranium occurrences in Indian Creek and North Fork. Fluorite is present as a minor occurrence at the Mystery-Sniffer uranium mine in Indian Creek.

Mystery-Sniffer Mine

The Mystery-Sniffer mine is on the north side of Indian Creek between the tributaries of Grassy Creek and Twitchell Canyon. The mine lies in the SW¼ sec. 28, T. 27 S., R. 6 W., Newton mining district, Beaver County (figure 1). The Mystery claims, Nos. 1-8, were staked in 1947 by Isadore and Louis Lessing, and three Sniffer claims were staked in 1950 by Louis Lessing and Thomas and LeRoy Harris. The property was restaked in 1973 as the Comet Nos. 1-7 and additional adjoining claims called the Mars Nos. 1-5, and the Juniper Nos. 1-10. Ownership is vested in Louis Lessing, Dale Lessing, and Victor Littlefield of Beaver and Joseph E. Jackson of Cedar City. The property was leased in the fall of 1974 to Western Nuclear, a subsidiary of Phelps Dodge Corporation. The property has been developed by three adits and numerous bulldozer cuts and shallow pits. The middle or main adit is at an elevation of 7,650 feet and has been explored by 975 feet of underground drifts and crosscuts; the lower adit is about 450 feet long, and the upper adit is about 900 feet long. The Mystery-Sniffer mine is described by Wyant and Stugard (1951) and Callaghan (1973, p. 51). The mine is mentioned briefly by Callaghan and Parker (1961), Dasch (1964, p. 167), Bullock (1967, p. 15, 119), and Elevatorski (1974, p. 79).

Uranium deposits at the Mystery-Sniffer mine occur in altered Tertiary volcanic rocks. The deposits occur in an intensely argillized zone along a normal fault which separates the Bullion Canyon latite and the younger Mt. Belknap rhyolite. An irregular mineralized zone trends east-west along the fault for about 1,000 feet, and dips 30°-60° N. The mineralized zone ranges from 20 to 100 feet in width and contains uranium minerals in lenticular shoots. The mine produced about $750,000 of uranium ores. Small flakes of secondary uranium minerals are sparsely disseminated in the argillized volcanic rocks. Ore minerals are autunite, torbernite, and probably pitchblende.

Purple fluorite, pyrite, and quartz accompany the uranium ore minerals. Fluorite is present mainly as tiny veinlets or irregular blebs in the volcanic rocks. The Mystery-Sniffer mine has no commercial fluorspar ore but rather represents a minor occurrence of fluorite.

North Star District

The North Star district lies in the northern half of the Star Range, a few miles directly west of Milford (figure 1). The district was organized in 1871, and the main production occurred from 1872 to 1875. The principal metals recovered were lead, copper, silver, and gold. A few important mines were the Harrington-Hickory, Copper King, Rebel, Wild Bill, and Cedar Talisman. The district is mentioned briefly by Butler and others (1920, p. 504-505); the structure and stratigraphy of the Star Range is described by Baer (1973, p. 33-38). Small quantities of fluorite occur in a tactite zone at the Wild Bill mine.

Wild Bill Mine

The Wild Bill mine is about 10 miles west by road from Milford on the northwest side of the Star Range. The property lies at an elevation of 6,350 feet in the NW¼ sec. 13, T. 28 S., R. 12 W., North Star mining district, Beaver County (figure 1). The Wild Bill claim was located in 1871 by David Anderson and patented in 1911 by Matthew Cullen. The present ownership is vested in Robert S. Pollack, Edward Galloway, and others of Salt Lake City. The property was active in the early days of mining in the district. Workings consist of an inclined shaft extending to a depth of 470 feet with four levels of drifts and crosscuts totaling about 1,400 feet. The mine is described by Butler (1913, p. 196-197); the mine is mentioned briefly by Buranek (1948, p. 16), Thurston and others (1954, p. 22), Bullock (1967, p. 19, 119), and Elevatorski (1974, p. 80).

The Wild Bill mine is on the Mississippian Redwall Limestone, which consists of a dark gray to black thick-bedded to massive limestone. The strata contain abundant bedded and nodular chert. The rocks strike north-south and dip about 35° E. Immediately to the east of the mine the limestone is intruded by a small stock of quartz monzonite and associated aplite dikes. The limestone adjacent to the intrusive has been recrystallized and replaced by silicates and other minerals. A tactite zone has developed along the contact zone.

The most abundant mineral in the zone of alteration is garnet and lesser amounts of tremolite, diopside, wollastonite, magnetite, specularite, quartz, fluorite, siderite, and secondary metallic ores. No primary sulfides are present, but rather all have altered to secondary minerals. The principal ore mineral is cerussite. Other ore minerals are anglesite, jarosite, plumbojarosite, corkite, azurite, malachite, chrysocolla, and limonite.

Fluorite gangue fills small fractures in the Redwall Limestone and replaces the limestone near but not at the contact with the quartz monzonite. The fluorite is colorless to pale green. Fluorite is not an abundant gangue mineral but is present as a minor occurrence at the Wild Bill mine.

Pine Grove District

The Pine Grove district covers the southern end of the Wah Wah Mountains and lies about 18 miles directly north-northwest of Lund (figure 1). Small amounts of lead, zinc, copper, silver, and iron were produced during the early years after the district was organized in 1873. Production of fluorspar and uranium was important during the 1940's and 1950's. During the 1960's the alunite potential of the district was recognized and investigated. The geology of the southern Wah Wah Mountains is described by Butler and others (1920, p. 528-529), Taylor and Powers (1953), Whelan (1965, 31 p.), and Miller (1966, p. 858-900). Over 5,000 tons of fluorspar ore has been produced in the Pine Grove district, the major production coming from the Staats mine.

Daisy Mine

The Daisy mine is at an elevation of 7,230 feet in Sawmill Canyon on the southern end of the Wah Wah Mountains. The mine is intersected by the section line between the SW¼ sec. 31, T. 29 S., R. 15 W., and the SE¼ sec. 36, T. 29 S., R. 16 W., Pine Grove mining district, Beaver County (figure 1). The Daisy claim was originally staked in 1940 by Fred Staats. Presently, the property is owned by Frank B. Lowder of Delta and Angus I. and Carol S. Nicholson of Salt Lake City. In 1974 the property was leased to Western Nuclear, a subsidiary of Phelps Dodge Corporation. The property has been developed by a 280-foot adit, two winzes 55 and 70 feet deep, and a raise to the surface. An alteration and mineralization study of the Staats mine area, which includes the Daisy mine, is described by Whelan (1965, p. 1-18).

The Daisy mine lies about ½ mile directly south of the Staats mine. The geology and mineralogy is similar for the Daisy, Producer, and Staats mines; more detail will be given under the heading of the Staats mine. The Daisy mine is along a contact zone between Silurian-Devonian carbonate rocks and a Tertiary rhyolite porphyry intrusion. Sedimentary rocks exposed

west of the mine comprise undifferentiated Silurian Laketown Dolomite and Devonian Sevy Dolomite. The dolomites are massive, fractured, and generally light to medium gray, but they are buff colored near the Daisy mine. The rhyolite porphyry weathers to a purplish cast and is fine grained with quartz phenocrysts up to about 4 mm in size. Sanidine and biotite form smaller phenocrysts. The contact between the dolomite and rhyolite porphyry consists of about 100 feet of argillized igneous breccia. The Daisy mine adit and workings lie within the altered brecciated contact zone.

Mineralization at the Daisy mine consists of fluorite and uranium ores. Fluorite is typically crystalline and ranges from colorless to pale green to purple hues. Fluorspar occurs in pods and lenses a few feet wide and several feet long. In 1944 about 200 tons of fluorspar was mined from a winze 6 feet wide, 10 feet long, and 55 feet deep. A second winze in the adit was larger and extended to a depth of 70 feet. This winze produced about 700 tons of metallurgical fluorspar up to 1948, when fluorspar operations ceased. Between the two winzes in the adit, uranium mineralization was more intense and commercial in grade. About 100 tons of uraninite ore was produced in the early 1950's. The Daisy mine produced about 900 tons of fluorspar and 100 tons of uranium ore. The fluorspar potential for further production from this mine is not apparent from present workings or development work.

Iron Queen Mine

The Iron Queen mine is on the crest of Blawn Mountain in the southern Wah Wah Mountains. The mine lies at an elevation of 3,100 feet in the SW¼ sec. 30, T. 29 S., R. 15 W., Pine Grove mining district, Beaver County (figure 1). The property has been developed by prospect holes, glory holes, and a 500-foot adit and stope. Seven Iron Queen claims were staked in 1941 by Maggie E. Carter, W. R. Lay, and Erwin C. Lay; however, the mine had been active under other ownership before the turn of the century. In 1950 the claims were relocated by LeRoy Wilson. Present ownership is vested in Mickey Robis of Milford and Murray and in W. L. Rasmussen of Veyo. The Iron Queen mine has been described by Crawford and Buranek (1943, p. 13-14), Whelan (1965, p. 27), and Bullock (1970, p. 11-12).

Blawn Mountain consists of Ordovician-Devonian quartzite and dolomite that have been intruded by Tertiary rhyolite and rhyolite porphyry, which lie mainly on the north side of Blawn Mountain. Iron mineralization occurs along the contact zone between the rhyolite porphyry and dolomite and has replaced the dolomite. Iron ore occurs in ten small lenticular replacements, which align themselves in a west-northwest direction for 4,200 feet. The chief iron ore is hematite, containing varying amounts of magnetite and goethite. Much of the ore is dense with a dark brown to black color; some masses contain voids partly filled with limonite and goethite. Some samples are iridescent and others are slightly magnetic. The largest iron occurrence is the Iron Queen mine. Mineralization on this outcrop extends for 250 feet with a maximum width of 60 feet. Several hundred tons of iron ore was shipped from this mine to the San Francisco mining district to be used as a fluxing ore. An adit driven about 150 feet below the surface outcrops exposes a replacement body of iron ore 7 feet thick.

Hydrothermal activity has produced extensive argillic and alunitic alteration and silicification. The argillic alteration produced extensive kaolinite deposits of potential economic value. The kaolinite is massive, remarkably pure, and tan to white. Some dickite and montmorillonite are present. Extensive alunite mineralization, also of potential economic value, is present on the north and east sides of Blawn Mountain. The crest of Blawn Mountain consists of white, silicified rhyolite porphyry that forms a hard porcelainlike rock.

Small quantities of purple fluorite occur in the iron mineralization at the Iron Queen mine. Fluorite occurs as disseminations and as small veinlets in the ore. Fluorite does not occur in commercial quantities suitable for exploitation but rather as a minor occurrence.

Producer Mine

The Producer mine lies at an elevation of 7,400 feet in Sawmill Canyon at the southern end of the Wah Wah Mountains. The mine is intersected by the section line between SW¼ sec. 31, T. 29 S., R. 15 W., and NE¼ sec. 6, T. 30 S., R. 15 W., Pine Grove mining district, Beaver County (figure 1). The mine lies about ¾ of a mile south-southeast of the Staats mine. The original Producer claim was staked in 1940 by Fred Staats and Frank Staats. The present owners are Frank B. Lowder of Delta and Angus I. and Carol S. Nicholson of Salt Lake City. The mine was leased in 1974 to Western Nuclear, a subsidiary of Phelps Dodge Corporation. Development work consists of two adits extending to the southwest. The east adit is 75 feet long; the west adit is about 50 feet long with a winze that continues for another 50 feet. An alteration and mineralogy study of the Staats mine area, which includes the Producer mine, is described by Whelan (1965, p. 1-18). The mine is mentioned briefly by Elevatorski (1974, p. 80).

The Producer mine is in a brecciated and altered contact zone. A Tertiary rhyolite porphyry has intruded undifferentiated Silurian and Devonian

dolomites. The sedimentary strata include the Silurian Laketown Dolomite and the Devonian Sevy Dolomite. The mine is developed in a brecciated area that lies between the rhyolite and dolomite and measures about 150 feet wide at the mine site. The breccia is argillized and mineralized with uranium and fluorite. More detail is given under the discussion of the Staats mine.

In the early 1950's the Producer mine yielded about 750 tons of commercial uranium ore. The primary uranium mineral was uraninite, which occurred as impregnations in the argillized breccia. Autunite and uranophane occurred in minor quantities as local coatings on fluorite. Purple crystalline fluorite was scattered as small lenses and pods in the breccia. No attempt was made to recover the fluorspar from the Producer mine. Its presence is regarded as a minor occurrence of fluorite.

Staats (Monarch) Mine

The Staats (Monarch) mine lies at an elevation of 7,375 feet in Sawmill Canyon at the southern end of the Wah Wah Mountains. The mine lies in the NE¼ sec. 36, T. 29 S., R. 16 W., Pine Grove mining district, Beaver County (figure 1). Five Monarch claims were staked in 1931 by Fred Staats and Horace Skougard. The present owners are Angus I. Nicholson and Carol S. Nicholson of Salt Lake City. The property was leased in 1974 to Western Nuclear, a subsidiary of Phelps Dodge Corporation. The main workings of the Staats mine are an 85-foot shaft, an opencut, and an adit. The deposit was first explored by an opencut within which the shaft was sunk. Several levels and stopes, totaling about 800 feet of drifting, were driven from the shaft; but most workings are now inaccessible. A short adit lies immediately to the east of the main shaft. Some pits and trenches are cut to the north along a contact zone. A shallow shaft lies 600 feet directly north of the main shaft. The mine is described by Thurston and others (1954, p. 16-19) and Chojnacki (1964, p. 180-182). An alteration and mineralization study of the Staats mine area was made by Whelan (1965, p. 1-18). The mine is mentioned briefly by Buranek (1948, p. 17), Dasch (1964, p. 167), Bullock (1967, p. 15, 119), Elevatorski (1974, p. 80), and Worl and others (1974, p. 10).

The Staats mine workings are along a faulted and brecciated igneous-sedimentary contact zone between a Tertiary rhyolite-porphyry plug and Silurian-Devonian dolomites. The Silurian Laketown Dolomite consists of about 1,200 feet of light- to medium-gray dolomite. Both the top and bottom of the formation are gradational. The Devonian Sevy Dolomite, ranging from 150 to 300 feet thick, is lithologically similar to the underlying dolomite. The basal Sevy Dolomite is dense, light-colored dolomite, whereas the upper member is medium- to coarse-grained, friable dolomite. The contact between the Laketown and Sevy Dolomite is mostly indefinite, obscured, or altered, and the two formations have been mapped in part as undifferentiated in the southern Wah Wah Mountains. Near the Staats mine the dolomites are massive. They are generally gray but locally buff near the mineralized contact zone. The mine area is cut by a rhyolite porphyry plug slightly over 1 mile long and nearly ½ mile wide. The main body forms an elongate north-south hill. The Staats mine lies on the northwestern side of the intrusion. The northern half of the plug is generally purplish, whereas the southern part is buff. The intrusive rock has a porphyritic texture. The ground mass is fine grained and contains phenocrysts of quartz up to 1 mm long; sanidine crystals measure up to 2 mm, and biotite up to ½ mm in diameter. The igneous-sedimentary contact is sharp along the eastern side of the rhyolite porphyry plug; but on most of the northern, western, and southern sides a faulted and brecciated zone occurs along the contact.

The structure of the southern Wah Wah Mountains is complex. Two large thrust faults are present. The strata near the Staats mine are associated with the lower or Blue Mountain thrust plate that brings a sequence of rocks ranging from Middle Cambrian through Early Pennsylvanian over the Mesozoic strata exposed as windows at Blue Mountain farther east. The thrust has a minimum horizontal displacement of 9 miles. Two to 3 miles northwest of the Staats mine the upper or Wah Wah thrust has brought a sequence of rocks that range in age from Upper Precambrian to Late Cambrian over the Paleozoic strata of the Blue Mountain thrust. Immediately to the west of the Staats mine Ordovician-Devonian strata are arched into a gentle, northeast-trending anticline. The mine lies on the east limb of this structure, although it is complicated by faulting along the igneous-sedimentary contact zone. Near the shaft the strata strike nearly north-south and dip 48° E., but the strike and dip change rapidly along the contact.

The Staats mine has been the source of commercial production for both fluorspar and uranium ores. Mineralization is along the faulted contact between dolomite and rhyolite porphyry. The zone consists of mylonized and argillized breccia. The zone is as much as 400 feet wide. Rock fragments include dolomite, rhyolite, and other volcanic and sedimentary debris. The varied mineral composition includes feldspar, quartz, calcite, dolomite, clays, fluorspar, uranium minerals, sericite, pyrite, and hematite. Montmorillonite, nontronite, sericite, kaolinite, and chlorite are products of argillic alteration resulting from hydrothermal solutions.

Purple, massive, and crystalline fluorspar occurs in the altered brecciated zone as lenticular shoots

within large podlike ore zones. The ore shoots are composed primarily of fluorite with little or no vein quartz or calcite, but they do contain relatively small amounts of dolomite and rhyolite breccia fragments. The fluorspar ore was selectively mined, containing from 80 to 91 percent fluorite and averaging over 85 percent fluorite. Waste rock between the fluorspar ore shoots consists mainly of brecciated dolomite and rhyolite porphyry. The ore shoots range from 2 to 6 feet in width, from 5 to 10 feet in length, and to more than 25 feet in depth. The shoots are oriented roughly parallel with the north-trending contact zone. The contact is intricately faulted with considerable variations in strike and dip. Fluorspar was mined from 1935 through 1945 with a reported production of 3,500 tons. Some additional fluorspar was mined from 1948 to 1951. Total fluorspar ore shipped was about 4,855 tons.

In the early 1950's uranium mineralization was recognized at the Staats mine. Uranium minerals occur as coatings on fluorite and as impregnations in the argillized breccia. After uranium ore was discovered with fluorite, the property was mined for uranium and the fluorspar was ignored. The ore was shipped to Vitro Corporation of Murray. The primary uranium mineral is uraninite, and the secondary minerals include autunite, uranophane, and metatorbernite. The mine produced about 1,900 tons of uranium ore during the 1950's. The Staats mine is currently under lease to Western Nuclear for uranium exploration. The future commercial potential of the Staats mine for fluorspar ore appears to be negligible.

San Francisco District

The San Francisco district covers the southern half of the San Francisco Mountains and lies about 16 miles west-northwest of Milford (figure 1). The district, organized in 1871, was an important producer of lead, silver, gold, copper, zinc, and iron ores. The ore occurs in veins and as replacements in limestone tactite zones associated with a quartz monzonite intrusive. The major producer was the Horn Silver mine discovered in 1875, which yielded over $20,000,000 worth of metals. Other mines with some production include the Cactus, Beaver Carbonate, Imperial, Washington, Cupric, and King David. The district is described by Butler (1913, 212 p.), Butler and others (1920, p. 503-504, 510-527), and East (1966, p. 901-920). Fluorite is associated with low-grade tungsten ore bodies at the Cupric mine.

Cupric Mine

The Cupric mine lies on the southwestern side of the San Francisco Mountains. The mine lies in the SW¼ sec. 15, T. 27 S., R. 13 W., San Francisco mining district, Beaver County, with additional properties in the SE¼ sec. 21 and the NW¼ sec. 22 (figure 1). The Cupric claims were staked in 1896 by R. Farnsworth, O. S. Carver, and P. L. Bentz. The mine was originally operated for iron ore that was used as a flux in the local smelters of Newhouse and Frisco. The old workings consist of several shallow shafts and inclines from which drifts were run. In 1909 a shaft was sunk to a depth of about 325 feet. Tungsten ore was discovered on the property in 1941. Early in 1942 the U. S. Vanadium Corporation and Homestake Mining Company explored the property by drilling three holes and excavating several trenches. The prospect was explored further in the winter of 1942 and 1943. The U. S. Bureau of Mines drove an adit to the east at an elevation of 6,123 feet for a distance of 282 feet and four crosscuts from the adit for a total of 100 feet. At the same time Desert Silver Mining Company drove an adit at an elevation of 6,183 feet to the north for 145 feet and added 100 feet of drifting and raising from the adit. The property consists of 19 patented claims owned by Tintic Mineral Resources of Salt Lake City. The property has been mentioned briefly or described by Butler (1913, p. 184), Hobbs (1945, p. 87-94), King and Wilson (1949, 9 p.), Thurston and others (1954, p. 50), Everett (1961, p. 39), and Bullock (1967, p. 16, 119).

The San Francisco Mountains comprise Precambrian and Paleozoic strata that have been folded, faulted, and later subjected to large-scale overthrusting. During Tertiary time the strata were intruded by the Cactus quartz monzonite stock. The Cupric mine workings are at the igneous-metamorphic contact along the southwestern edge of the stock and undifferentiated Cambrian-Ordovician sedimentary strata. The quartz monzonite is dark gray, medium-grained, and holocrystalline rock. The Cambrian-Ordovician strata consist of two limestone members. The lower member is a thick-bedded limestone, mostly dark gray, but it includes some light layers. Overlying the gray limestone is a very massive, white to light buff-colored limestone. The strata strike N. 10°-40° E. and dip 30°-60° NW.

The quartz monzonite stock has produced extensive contact metasomatism, especially in the lower limestone member. The contact is irregular and the sedimentary strata strike into the stock. A tactite zone has developed in the limestone that adjoins the quartz monzonite. Tactite containing scheelite is concentrated in three main areas at the Cupric mine. The largest ore body measures about 550 feet long and 400 feet wide and averages about 0.34 percent WO_3. Away from the tactite zone the intensity of metamorphism gradually decreases and passes into recrystallized limestone, which grades into unaltered limestone.

The most abundant minerals in the tactite zone are garnet, wollastonite, diopside, quartz, and calcite. Less important minerals are epidote, fluorite, muscovite, chlorite, idocrase, scheelite, pyrite, chalcopyrite, and molybdenite. Fluorite appears to be more abundant in the areas containing scheelite, but it is present only as a minor occurrence at the Cupric mine.

Star District

The Star district covers the southern half of the Star Range, a few miles southwest of Milford (figure 1). The district was organized in 1870. Lead, silver, zinc, copper, and gold were mined in small quantities from replacement bodies and pipes along faults in limestone. Tungsten has been mined from limestone tactite zones associated with quartz monzonite. The district is described by Butler and others (1920, p. 504-505); the structure and stratigraphy are given by Baer (1973, p. 33-38). Fluorite occurrences of the district are mentioned briefly by Worl and others (1974, p. 10). In the 1940's a few hundred tons of fluorspar was mined from fissure fillings and replacements in limestone tactite zones and from fissure fillings in a quartz monzonite intrusive.

Black Bart Prospect

The Black Bart prospect lies on the southwestern end of the Star Range at an elevation of about 6,050 feet and 9 miles directly southwest of Milford. The property lies in the SE¼ sec. 35, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). The Black Bart No. 1 claim was staked in 1972 and the Black Bart No. 2 claim in 1974. The two mining claims are held by Louis Lessing of Beaver. Development work consists of a road to the claims, bulldozer cuts, and shallow prospect pits. Assessment work is current.

Mineralization is along an igneous-sedimentary contact zone of a small roof pendant of limestone. The Shauntie quartz monzonite stock lies to the north and northwest and intrudes Devonian and Mississippian sedimentary rocks in the southwestern part of the Star Range. These sedimentary strata are well exposed on the east side of the stock and strike N. 15° E. and dip 40°-45° E. The Black Bart prospect is along the southeastern end of the Shauntie stock, where a small roof pendant of Mississippian Redwall Limestone is exposed. The limestone is altered to varying degrees by argillization, silicification, and pyritization along the contact zone.

Colorless, gray, white, and pale green fluorite replaces Redwall Limestone at one prospect pit, which measures about 8 feet in diameter. The limestone rock has been slightly replaced along stringers and by small pockets or bunches of fluorite. The fluorite is coarsely crystalline and breaks easily into cleavable masses. Small clusters of coarsely crystalline fluorite can occasionally be found in limestone by breaking bedrock or loose limestone blocks scattered near the prospect pit. The limestone is partly silicified where fluorite is better exposed. Immediately below the prospect pit, the limestone is argillized and pyritized. The pyrite is oxidized to a spongy limonite gossan. About 100 feet southeast along the ridge is a 12-foot inclined shaft in gossan and limestone. It contains no fluorspar but does show a few specks of galena scattered through the rock. The limestone rock is strongly argillized between the fluorspar occurrence and the inclined shaft. Bart No. 2 claim has an outcrop of copper mineralization that contains small showings of malachite, azurite, and bornite. The Black Bart prospect has no commercial potential because it is only a minor occurrence of fluorspar.

Fluorine Ledge Prospect

The Fluorine Ledge prospect lies about 8 miles directly southwest of Milford and about 13 miles by road. The claim is at an elevation of about 6,480 feet in the NW¼ sec 25, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). The claim was staked in 1940 by W. O. Thompson and Theodore E. Stevens. The property was leased for a short time to the Western Fluorite Company. A few tons of fluorspar ore was produced from a pit 15 feet long and about 4 feet deep. Assessment work was maintained by the owners until 1947. Actually, the Fluorine Ledge claim was in part staked over two patented claims, the Triumph and Old Crow mine claims. The Fluorine Ledge prospect is described by Thurston and others (1954, p. 22) and Chojnacki (1964, p. 129). The prospect is mentioned briefly by Dasch (1964, p. 167), Bullock (1967, p. 16, 119), and Elevatorski (1974, p. 80).

Fluorite mineralization is probably in the basal part of the Guilmette Formation, which is Devonian in age. This formation, approximately 400 feet thick, consists of dark gray, sugary-textured dolomite. The lower contact is not well defined with the underlying Sevy Dolomite, owing to alteration from nearby and likely underlying intrusive rocks. The Guilmette Formation strikes N. 20° E. and dips 30° E.

Fluorite and quartz occur in small irregular fissures and as small replacements along bedding planes of the dolomite. The fluorite is colorless to pale green and coarsely crystalline. A few tons of ore came from a replacement of fluorite and quartz in dolomite. The outcrop measured up to 5 feet wide at the surface and pinched out or ranged up to 18 inches wide at the bottom of a 4-foot pit. At present only small patches

of fluorite and quartz are exposed at the north end of the pit. The Fluorine Ledge prospect, a minor occurrence of fluorite, has no future potential for commercial production of fluorspar.

Fluorite (Virginia) Prospect

The Fluorite (Virginia) prospect is on the southwestern end of the Star Range at an elevation of about 5,880 feet. The property lies in the E½ sec. 35, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). This property was originally located in 1936 as the Virginia claims by Thomas E. Gillins. The property was restaked in 1957 as the Fluorite Nos. 1-8 claims by Gerold J. Gillins of Milford. The property has been developed by a road to the claims, a shallow inclined shaft, prospect pits, and bulldozer cuts. The assessment work on the claims is current. About 100 tons of fluorspar was shipped from this property in the early 1940's. The Virginia claims are described by Thurston and others (1954, p. 23-24) and Chojnacki (1964, p. 129). The prospect is mentioned briefly by Buranek (1948, p. 16), Dasch (1964, p. 162), Bullock (1967, p. 16, 119), and Elevatorski (1974, p. 17).

Fluorspar mineralization is associated with bull quartz veins that cut quartz monzonite intrusive rock. The Tertiary Shauntie stock, measuring 1¾ miles long and ¾ mile wide, has intruded Devonian and Mississippian sedimentary strata on the southwestern end of the Star Range. The medium-gray quartz monzonite weathers to brownish hues. The fine- to medium-grained rock forms smooth rolling slopes in contrast to the angular topography developed by Paleozoic sedimentary rocks. A large Tertiary volcanic field covering many square miles lies to the west of the Shauntie stock.

A few quartz veins ranging from less than 1 inch to 6 feet in width cut the southern end of the Shauntie quartz monzonite. They strike generally N. 30° W. and dip from 20°-40° SW. The veins can be traced from a few feet to as much as 200 feet in length. The quartz is massive and white with comb structure development in the center of some veins. Locally, late fluorite and some calcite has filled the central part of the quartz veins. Fluorite is coarsely crystalline and typically pale green, but some white and colorless fluorite is present. Only remnants of larger quantities of fluorspar remain. About 50 tons of fluorspar was mined from a 15-foot inclined shaft. A pod or lens of fluorspar ranged from 2 to 4 feet in width but pinched out at the bottom of the shaft. A second productive vein striking east was developed by a shallow open pit about 40 feet long. A lens of quartz, fluorite, and calcite had a maximum width of 6 feet but pinched out at a 5-foot depth. This lens contained 60 to 70 percent fluorite and produced approximately 50 tons of fluorspar.

There appears to be no further commercial potential for the Fluorite prospect. Mine workings have obscured several outcroppings of quartz veins, and only remnant blocks of quartz and fluorite and tiny veinlets of fluorite are now observed. There are a few thin quartz and fluorite veinlets scattered at other points on the property, but none appear to warrant further development work.

Hub Mine

The Hub mine is about 8 miles directly southwest of Milford on the south side of Picacho Peak on the southwestern part of the Star Range. The mine lies at an elevation of 6,610 feet in the SW¼ sec. 25, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). The Hub mine is on the Dan claim that was located in 1905 by Danford Ferguson. The claim was patented in 1908 by the Utah Mining, Milling, and Transportation Company. Current ownership is vested in North Star Silver Mines; Val J. Lund of Sandy is president. The Hub mine produced a small quantity of lead-silver ore when first discovered. The mine workings include a vertical shaft 200 feet deep, a short adit, a winze that connects with the shaft on the 200-foot level, and drifting along the contact zone. The Hub mine is described by Butler (1913, p. 202-203). The mine is mentioned briefly by Buranek (1948, p. 16), Thurston and others (1954, p. 22), and Bullock (1967, p. 16, 119).

The Hub mine is along an igneous-metamorphic contact zone. The mine lies on the Devonian Guilmette Formation, which consists of dark gray, sugary-textured dolomite. Immediately to the west of the mine lies a large quartz monzonite stock that intrudes the dolomite. The quartz monzonite is light colored and more acidic than the main body of the stock, approaching a granite in composition. The dolomite is thick bedded and has been recrystallized near the intrusive body. Near the contact the dolomite is fissured to some extent. Contact silicates, sulfides, and other minerals have developed along the contact zone. The principal contact minerals are chlorite, fluorite, serpentine, and magnetite. There has been some movement along the contact subsequent to mineralization, since a talcose gouge containing mainly chlorite and fluorite has developed.

Most of the metallic ores have been found along the contact zone, although some have been found as replacements of dolomite along small fissures cutting the bedding. The metallic sulfide ores include galena, sphalerite, pyrite, and chalcopyrite. The ore occurrences are found mainly where the dolomite is the hanging wall along the contact. The ores have been oxidized. Cerussite carrying silver was the most valuable ore mineral. The oxidized ores include

anglesite, smithsonite, plumbojarosite, and abundant limonite.

Fluorite occurs along the igneous-metamorphic contact associated with chlorite and sulfides. Colorless to pale green fluorite is locally an abundant gangue, but it is not present in commercial quantities along the narrow contact zone. Fluorite at the Hub mine represents a minor occurrence of this mineral.

Ladie (Lady) Bryan Mine

The Ladie (Lady) Bryan mine is about 8½ miles directly southwest of Milford on the southwest side of the Star Range. The mine lies on the west side of Topache Peak at an elevation of 6,620 feet in the NW¼ sec. 36, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). The Ladie Bryan claim was staked in 1896 by Matthew Cullen and A. G. Campbell. The claim was patented in 1903 by Matthew Cullen. Some ore was shipped from this property soon after its discovery, but the main production began in 1910. The mine was operated by the Utah Mining, Milling, and Transportation Company. The present owners are Dr. Russell Miller, A. Harris, and Tessie B. Hansen of Las Vegas, Nevada. The mine is developed by a shaft about 400 feet deep and by a series of drifts and crosscuts. The mine is described by Butler (1913, p. 203-204). It is mentioned briefly by Thurston and others (1954, p. 22), Bullock (1967, p. 16, 119), and Elevatorski (1974, p. 80).

The Ladie Bryan mine is in the Devonian Guilmette Formation, which consists of dark gray, sugary-textured dolomite. The strata strike north-south and dip about 60° E. Immediately to the west and north of the mine lies a huge stock of quartz monzonite. The dolomite has been recrystallized, and near the contact a narrow tactite zone has developed. The dolomite is cut by a series of small east-west fissures that dip steeply to the north. Metallic mineralization has developed in dolomite near but not in the contact zone. The mine workings are along one of the fissures that dips 70° N. The ore body occurs as fissure fillings and replacements. The main ore body forms an ore shoot pitching to the northeast and follows the intersection of readily replaced beds and the fissure. The mineralized dolomite is recrystallized and slightly silicified, but contact silicates are absent from the main deposits. The metallic ores, oxidized from primary sulfides, consist mainly of cerussite, anglesite, azurite, malachite, and abundant limonite.

Silicates and other minerals have developed along a tactite zone adjacent to the quartz monzonite intrusion. Garnet, chlorite, epidote, diopside, fluorite, and some tremolite are present. With these are varying amounts of magnetite, pyrite, and chalcopyrite. Fluorite was locally abundant with chlorite in the tactite zone, but commercial quantities of fluorspar are lacking. Fluorite is present as a minor occurrence at this mine.

Luckie (Lucky) Boy Prospect

The Luckie (Lucky) Boy prospect lies about 14 miles southwest of Milford. Two claims positioned end-to-end lie immediately east of the western section line of the W½ sec. 25, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). Two Luckie Boy claims were staked in 1940 by Marion Tassell and James Baudino. The property was leased to Western Fluorite Company for a short time. The owners performed assessment labor until 1947. Several shallow pits were dug to explore the property; a few tons of ore was shipped from the southern end of Luckie Boy No. 2 claim at an elevation of approximately 6,400 feet. The two Luckie Boy claims actually were staked in large part across three patented claims: the Old Crow mine, Silver King, and Atlas No. 1 claims. The Luckie Boy prospect is described by Thurston and others (1954, p. 22) and Chojnacki (1964, p. 129). The prospect is mentioned briefly by Bullock (1967, p. 16, 119) and Elevatorski (1974, p. 80).

The Luckie Boy claims straddle more or less the Devonian Sevy Dolomite and Guilmette Formation contact. The sedimentary strata strike N. 15° E and dip 40° E. The sedimentary contact of these two formations is obscured owing to alteration of nearby and underlying intrusive igneous rocks. The southern end of the Luckie Boy No. 2 claim lapped onto the large Shauntie stock that lies to the south and covers about 1½ square miles. It consists of medium-grained quartz monzonite.

The mineralized area occurs along the igneous-sedimentary contact. Mineralization is in the basal part of the Guilmette Formation. A shallow pit exposed an east-west trending fluorspar vein. It is irregular, vertical, and 2 feet wide at maximum. The vein, which lies 30 feet north of the igneous contact, is traceable only for about 20 feet. The vein consists of fluorite and quartz; no metallic ore minerals were observed. The fluorite is colorless to pale green and coarsely crystalline. Cleavage fragments of fluorite as much as 2½ inches across can be obtained. A few tons of fluorspar ore was shipped from this outcrop. Other smaller veins of fluorspar are exposed in a few shallow pits. The Luckie Boy prospect has no further commercial potential for fluorspar production and represents a minor occurrence of fluorite.

Manassas Mine

The Manassas mine lies about 8 miles directly southwest of Milford on the north side of Picacho

Peak along the southwestern side of the Star Range. The mine lies immediately west of the Moscow mine at an elevation of 6,400 feet in the SW¼ sec. 25, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). The Manassas claim was located in 1892 by Mattie Barrett, and it was patented in 1908 by the Jim Barrett Mining Company. Present ownership is vested in the North Star Silver Mines; Val J. Lund of Sandy is president. The property has been developed by a 200-foot adit. The Manassas mine is mentioned by Thurston and others (1954, p. 22-23), Chojnacki (1964, p. 120), Dasch (1964, p. 167), Bullock (1967, p. 16, 119), and Elevatorski (1974, p. 80).

The Manassas mine is on the Devonian Guilmette Formation, which is well exposed in sec. 25, north of the mine. Here dark gray, sugary-textured dolomite overlies altered Devonian Sevy Dolomite. The lower contact of the Guilmette Formation is not well defined because of alteration from contact metamorphism. The upper contact is conformable with the overlying Devonian Pilot Shale. Approximately 400 feet of Guilmette Formation is exposed in this area. A large quartz monzonite stock lies immediately to the south of the Manassas mine. The north end of the stock is cut by a normal fault that trends east-west and dips toward the north. The mine is on the downthrown block, where the Guilmette Formation is in fault contact with the quartz monzonite stock.

Primary minerals fill fissures in dolomite and replace dolomite near but not at the contact with the stock. Medium-grained, colorless to pale green fluorspar occurs with garnet and tremolite. Sparse fluorite is exposed at the surface, but a zone 2 to 3 feet wide at the end of the adit contains about 20 percent fluorite. The extent of the fissure is not exposed by the workings, but mineralization appears to be a minor occurrence at the Manassas mine.

Monte Christo Mine

The Monte Christo mine is about 8½ miles directly southwest of Milford on the west side of Picacho Peak along the southwest side of the Star Range. The mine lies at an elevation of 6,200 feet in the SE¼ sec. 26, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). The Monte Christo claim was staked in 1906 by Hans Miller; it was patented in 1920 by the Bon Soldat Mining Company. The current ownership is vested in the Silver Cedar Mining Company, in care of Richard Draney of North Hollywood, California. The property has been developed by a shallow inclined shaft. The mine is mentioned briefly by Thurston and others (1954, p. 23), Chojnacki (1964, p. 130), Bullock (1967, p. 16, 119), and Elevatorski (1974, p. 80).

A large quartz monzonite stock intrudes middle Paleozoic strata in the southwestern part of the Star Range. The Monte Christo claim is along the northwestern margin of the stock, along an igneous-metamorphic contact zone. Thick Quaternary alluvium covers nearly all the Paleozoic strata along the western margin of the stock. Devonian Sevy Dolomite, however, is well exposed a few hundred feet north of the claim. The formation, about 500 feet thick, consists of recrystallized dolomite, mostly light gray. Dolomite is exposed at the Monte Christo mine shaft. The shaft follows an eastward dipping fault between quartz monzonite on the east and dolomite on the west. Fluorspar veinlets in dolomite are exposed near the collar of the inclined shaft and about 100 feet north of it. Fluorite is a minor gangue mineral associated with garnet, chlorite, epidote, tremolite, diopside, and small quantities of galena, pyrite, and chalcopyrite. No commercial fluorspar is exposed at the mine, but rather fluorite is a minor occurrence.

Moscow Mine

The Moscow mine lies about 8 miles directly southwest of Milford in Moscow Canyon on the southwest side of the Star Range. The mine is at an elevation of 6,520 feet in the SW¼ sec. 25, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). The Local and Burning Moscow Extension claims were located in 1900 by P. B. McKeon and were patented in 1908 by the Moscow Mining and Milling Company. Present ownership is vested in the Moscow Silver Mines Company, in care of R. S. Johnson of Salt Lake City. Shipments of lead-silver-zinc-copper ore began in 1905 and continued for nearly a decade; activity was renewed in the 1940's. Workings consist of a main 450-foot shaft with five levels, the old Moscow shaft, small adits, inclines, and open cuts. Drifts, crosscuts, and stopes in the underground workings total about 5,000 feet. The Moscow mine is described by Butler (1913, p. 201-202). It is mentioned briefly by Buranek (1948, p. 16), Thurston and others (1954, p. 22), Chojnacki (1964, p. 130), Bullock (1967, p. 16, 119), and Elevatorski (1974, p. 80).

The ore deposits at the Moscow mine occur in massive blue and gray dolomite of the Devonian Guilmette Formation. The strata strike N. 15° E. and dip 45°-50° E. They are overlain by the Devonian Pilot Shale. Less than ¼ mile to the southwest is a stock of quartz monzonite that forms a large part of the range south of the Moscow mine. The Guilmette Formation is cut by east-west trending dikes that are highly altered at the mine site. The formation is also cut by east-west trending fissures that dip steeply to the north.

The main ore deposits are replacements of dolomite, which form irregular chimneys along the

intersection of certain carbonate beds and the east-west trending fissures. The chimneys pitch toward the northeast with the intersection. The main production has come from one carbonate bed, but there has been some replacement of other layers. The replacements lie below the Pilot Shale, which likely localized the ore solutions along favorable beds of the Guilmette Formation. The primary sulfides in the mine are galena, sphalerite, pyrite, chalcopyrite, and a little greenockite. Gangue minerals include muscovite, fluorite, and rhodochrosite. Most of the ore was oxidized, consisting of cerussite, anglesite, plumbojarosite, jarosite, limonite, smithsonite, azurite, malachite, and manganese oxides.

Fluorite at the Moscow mine is colorless to pale green and medium grained. It occurs as a gangue with rhodochrosite and chlorite in sulfide ores or oxidized ores. Fluorite gangue comprises about 20 percent of the ore mined from the Moscow mine. Fluorite also occurs in limited amounts in the altered quartz monzonite dikes. Commercial quantities at the mine are lacking. Fluorite is present as a minor occurrence.

State Land Prospects

Two State Land prospects lie on the southern end of the Star Range. One prospect lies at an elevation of 6,160 feet in the NE¼NE¼ sec. 2, T. 29 S., R. 12 W., Star mining district, Beaver County. The second prospect lies about 1,000 feet to the northeast at an elevation of 6,320 feet in the SW¼SW¼ sec. 36, T. 28 S., R. 12 W. (figure 1). The property was originally staked in 1951 as the Sleepy Hollow claim by Isadore Lessing. In 1968 five more claims, the Sleepy Hollow Nos. 1-5, were staked by Louis Lessing of Beaver. The property was later sold to V. Lee Oertle of Beaver, who restaked the six Sleepy Hollow claims in 1974. The two prospects, however, lie on state-owned land, not federal land. Melvin Bradshaw of Milford has a fluorspar lease from the state on the larger prospect which lies in sec. 36. The Sleepy Hollow claims are not valid in the state-owned secs. 2 and 36. These claims, however, extend into secs. 1 and 35 where they are valid, but no fluorspar was observed in these two sections. The property has been developed by a road built up a steep slope, bulldozer cuts, prospect pits, and two shallow exploratory pits.

The State Land prospects are on a steep rugged mountain topography of abundant bedrock outcrops. The prospects are small fluorspar replacements in the Mississippian Redwall Limestone, which strikes N. 25° E. and dips 35°-40° E. The Redwall Limestone consists of dark gray to black, thick-bedded to massive limestone and dolomite. The strata contain abundant dark-bedded and nodular chert. Nearly 1,540 feet of Redwall Limestone is exposed in the Star Range. The abundant Mississippian fossils appear in the strata as white outlines against a darker carbonate rock. The Shauntie quartz monzonite stock lies approximately 1,000 feet to the northwest.

Colorless, white, gray, and pale green fluorite occurs as replacements in the Redwall Limestone parallel to the bedding. The coarsely crystalline fluorite breaks easily into cleavable masses. The fluorspar outcrop in sec. 2 measures only about 1 foot in width and 6 feet in length. The outcrop exposed in sec. 35 measures about 5 feet in diameter on the southwest end, and mineralization extends along the bedding to the northeast for 20 feet at a maximum thickness of 1 foot. The two State Land prospects appear to be only minor occurrences of fluorite and have little or no commercial ore potential for fluorspar.

Sullivan Group Prospects

The Sullivan group of claims lies about 8 miles directly southwest of Milford on the west side of the Star Range. The property lies in the E½ sec. 26, T. 28 S., R. 12 W., Star mining district, Beaver County (figure 1). The main prospect lies at an elevation of approximately 6,200 feet. Eight claims, named the Sullivan, Sullivan Nos. 1-3, Spar, Kathy, Carol, and K. J. constitute the Sullivan group. The claims were staked in 1952 by John C. Hanley, Jr., of Milford, who has performed annual assessment labor to date. The Sullivan claim covers the old Paloma mine that was operated during World War I. The mine workings consist of a 300-foot inclined shaft, which extends eastward at about 40°, and two mine levels. The 150-foot level is caved in but is reported to be several hundred feet long with stopes. Some lead-silver-copper-zinc ores were shipped from this level. The 300-foot level has two drifts, each about 500 feet long, that extend northeast and southeast into barren rock. The northern end of the Sullivan group of claims was originally staked in 1942 as the Brown Thrush claim by A. C. Wynaught and Theodore E. Stevens. This claim was leased to the Western Fluorite Company for a short time; the last assessment work on the Brown Thrush claim was performed in 1947. The claim was developed by a few surface pits and a 40-foot shaft. The Brown Thrush claim is now part of the K. J. and Carol claims. Numerous prospect pits, bulldozer cuts, and shallow shafts are scattered over the Sullivan group of claims. The Brown Thrush claim has been described by Thurston and others (1954, p. 21) and Chojnacki (1964, p. 128). The property is mentioned briefly by Buranek (1948, p. 16), Dasch (1964, p. 167), and Bullock (1967, p. 16, 119).

The Sullivan group of claims is along the contact zone of altered Sevy Dolomite, Devonian in age. The formation is cut by at least three small

Tertiary quartz monzonite cupolas in the claims area. One-half mile to the south of the claims is the large Shauntie quartz monzonite stock, and to the west of the property is an extensive Tertiary volcanic field. The Sevy Dolomite is recrystallized, and in places argillized, near the intrusive contacts. About 500 feet in thickness, it strikes north-south, and dips 40° E.

Sparse fluorite mineralization is along the contact zone of the Sevy Dolomite and the quartz monzonite cupolas and for several hundred feet east of the contact in the dolomite. On the old Brown Thrush claim colorless to pale green fluorspar occurs with quartz in a shear zone in the Sevy Dolomite. The shear zone varies from 15 to 20 feet wide, strikes N. 20° W., and is traceable for about 100 feet. Coarsely crystalline fluorite occurs in small pockets a few inches across along the shear zone. A fissure trending N. 60° W. cuts this shear and contains malachite, azurite, cerussite, anglesite, and smithsonite. The dump from the 40-foot shaft contains small amounts of the primary ores of galena, chalcopyrite, and sphalerite. The large dump at the Paloma mine contains the same primary and secondary metallic ores with small amounts of quartz and fluorspar gangue. Several prospect pits and bulldozer cuts were made in the Sevy Dolomite away from the contact zone. These excavations occur where pale green fluorspar was found as pockets a few inches wide or on stringers several feet long. It is likely the intrusive underlies the dolomite at a shallow depth. These occurrences are devoid of metallic ore minerals.

The largest fluorspar prospect on the Sullivan group of claims lies several hundred feet south of the Paloma mine on the Spar claim. It lies near the contact of the Sevy Dolomite and a small quartz monzonite cupola. An argillized dolomite zone measuring about 30 feet in diameter contains pockets and chunks of colorless and pale green fluorspar. Small pieces and chunks of fluorite measuring several inches across are scattered throughout the clay. The fluorite is coarsely crystalline and relatively pure. A few feet east in recrystallized dolomite is a 20-foot shaft excavated in a chimney of limonite gossan. The two deposits are likely related to the same period of mineralization during Tertiary intrusive activity. The clay also contains limonite staining and chunks of gossan. The Spar claim apparently was mineralized by fluorite and oxidized to limonite gossan. Fluorite was unaffected by alteration and occurs as small scattered masses in the clay.

Minor fluorspar mineralization is widely scattered on the Sullivan group of claims. There are, however, no apparent commercial fluorspar deposits exposed in the present development work or from surface exposures. Perhaps, shallow drilling during assessment work might reveal larger or even commercial deposits of fluorspar. The Sullivan group of claims is regarded as a minor occurrence of the mineral fluorite.

Washington District

The Washington district covers much of the Indian Peak Range in southwestern Beaver County (figure 1). It was organized in 1879 with the discovery of silver, copper, lead, and zinc ores in veins within Tertiary volcanic rocks. Production has been small. From 1941 to 1946 the New Arrowhead mine yielded 2,357 tons of oxidized lead-zinc ores. The district is described by Everett and Wilson (1950, p. 2; 1951, p. 2) and Grant and Nackowski (1968, 12 p.). The district is mentioned briefly by Worl and others (1974, p. 10). Fluorspar was discovered in 1937. The principal production was made during the 1940's, but some additional ore was shipped during the early 1970's. Total fluorspar production from the district is approximately 20,000 tons of metallurgical grade ore.

Blue Bell Mine

The Blue Bell mine lies on the eastern slope of the Indian Peak Range near the summit at an elevation of 8,500 feet (figure 2). The mine workings are in the SE¼ sec. 4, T. 30 S., R. 18 W., Washington mining district, western Beaver County (figure 1). In 1937 a total of 24 Blue Bell mining claims were staked by J. H. Holt, Joe L. Banta, and others. The present owner is Bekins Metal Resources, in care of Floyd R. Bekins of North Hollywood, California. In 1974 the mine was leased to Allied Chemical Corporation of Boulder, Colorado. The U. S. Bureau of Mines investigated the property and performed development work from February 1945 to June 1946, which is reported by Frey (1947, 11 p.). The mine is described by Cochran (1952, p. 70-72), Thurston and others (1954, p. 11-12), Chojnacki (1964, p. 166-170), and Grant and Nackowski (1968, p. 11-12). It is mentioned briefly by Buranek (1948, p. 16), Dasch (1964, p. 167), Bullock (1967, p. 15, 119), and Elevatorski (1974, p. 80).

The Blue Bell mine has been developed by vertical and inclined shafts, two adits, associated drifts, stopes, crosscuts, extensive surface pits, trenches, and bulldozer cuts. In 1941 about 35 tons of ore was shipped from surface workings; in 1942, 180 tons was hauled to and concentrated by the Western Fluorite Company's mill near Milford. The original open cut measured 60 feet long, 10 feet wide, and 12 feet deep. In 1943 a Reconstruction Finance Company loan was granted to the owner for installing equipment and sinking the Blue Bell shaft. This shaft is vertical, 50 feet deep, and in ore all the way. At the bottom of the shaft are irregular drifts and stopes. About 300 tons of ore, assaying 65 percent fluorite, was mined

Figure 2. Blue Bell mine, Indian Peak Range, Beaver County.

and sold to Western Fluorite Company. In 1944 an inclined shaft was sunk southeast of the original open cut and about 45 feet north of the Blue Bell shaft. This shaft was inclined 65 degrees north-northwest for 30 feet. At the bottom a drift extended 80 feet along the strike of the fluorite mineralization, where it is terminated by a transverse fault. A 50-foot crosscut to the west exposed the faulted segment. An additional 55 feet of drifting was made on this vein. The inclined shaft and the two drifts along the vein segments produced 486 tons of fluorspar, which was processed at the Tintic Standard Mining Company's mill at the nearby Cougar Spar mine. Of this ore about 200 tons averaged 60 percent fluorite, and the balance 49 percent.

A 40-foot crosscut adit trending westerly was made by the owners to explore the faulted north segment of the mineralized shear zone. This adit lies 165 feet north-northwest of the Blue Bell shaft. A zone of mineralization ranging from 15 to 20 feet was cut by this adit; 70 feet of drifting and stoping were made along the zone. Approximately 300 tons of fluorspar, which assayed 46 percent fluorite, was taken from this operation. Part of this production was hauled to the Cougar Spar mine for milling, and part was left at the Blue Bell mine. Apparently none of this ore was sold commercially.

In 1945 and 1946 the U. S. Bureau of Mines performed exploratory work on the Blue Bell property by cutting a 492-foot crosscut adit, whose portal is 415 feet east and 150 feet below the collar of the original Blue Bell shaft. Additional work within the adit consisted of a 130-foot northerly drift, a 98-foot southerly drift, and 42 feet of excavation in a mineralized area of the southerly drift. A total of 762 feet of drifting and crosscutting was done.

The Blue Bell mine was idle until 1969 when the Willden Fluorspar Mining Company began extensive surface mining. Outcrops for nearly 200 feet were excavated by expanding and destroying older surface workings and then breaking into some of the older underground near-surface workings. Approximately 720 tons of fluorspar was mined and sold to Kaiser Steel Corporation of California. The shipments averaged about 70 percent fluorite and 15 percent silica. No further production has been made from the Blue Bell mine. In July 1975 Allied Chemical Corporation drilled

three exploratory drill holes in the mineralized zone to depths over 150 feet but found only narrow stringers of fluorite. Allied Chemical has abandoned the project.

Fluorspar at the Blue Bell mine occurs in Tertiary volcanic rocks of the Needles Range Formation. Mineralization is associated with fissure veins in a red to greenish gray porphyritic ignimbrite. Fluorite, quartz, and calcite occur as near vertical lenses and pods striking N. 35° W. in a shear zone. The shear zone is up to 40 feet in width and traceable for approximately 260 feet at the surface. The workings have been along the fluorspar-rich parts of the shear zone measuring 12 feet wide. The 492-foot adit driven by the U. S. Bureau of Mines lies 150 feet below the surface workings. Fluorspar mineralization in the adit consists of small noncommercial veinlets in a shear zone nearly 40 feet wide.

Postmineral faults have displaced the ore body transverse to its strike. The largest of these is found at the north end of the deposit. Here a fault striking N. 50° E. and dipping 70° SE. displaces the northern 65 feet of the deposit about 20 feet to the west, both at the surface and in the inclined adit.

Fluorite at the Blue Bell mine is massive and crystalline. It is typically light green to milky white, but some purple fluorite is present. The ore is siliceous and requires milling. Total production is slightly over 2,000 tons. The future of the Blue Bell mine is questionable, especially since negative results were determined by the drilling program of Allied Chemical Corporation. It appears that the larger lenses and pods of fluorite were confined to the near surface outcroppings, which are about depleted.

Cougar Spar Mine

The open pit of the Cougar Spar mine lies at an elevation of 7,685 feet on the eastern slope of the Indian Peak Range (figure 3). The mine property lies in the E½ sec. 10, T. 30 S., R. 18 W., Washington mining district, western Beaver County (figure 1). A single claim was originally staked on the deposit in 1937 by W. C. Dalton and S. M. Dalton of Parowan. In 1941 Hubert C. Eyre of Minersville relocated the claim, staked an additional claim on each side, and named the claims the Spar, Spar No. 1, and Spar No. 2. The property was leased in 1941 and 1942 to E. A. McKenzie of Minersville, and Fred Morrman and B. M.

Figure 3. Core drilling by Allied Chemical Corporation, Cougar Spar mine, Indian Peak Range, Beaver County.

Anderson of Los Angeles, California. In the fall of 1942 Tintic Standard Mining Company of Salt Lake City leased the three Spar claims. The claims were surveyed for patent. Three additional claims were located, and two 40-acre parcels of ground adjoining the mining claims were acquired by the mining company. The Spar claims were patented in 1956 to H. C. Eyre, who sold them to Tintic Standard Mining Company. In 1974 the Cougar Spar mine merged with Amax Copper Mines of Tucson, Arizona. In late 1974 the Cougar Spar mine was leased to Allied Chemical Corporation of Boulder, Colorado. The property is described by Everett and Wilson (1951, 12 p.), Cochran (1952, p. 63-69), Thurston and others (1954, p. 8-10), Chojnacki (1964, p. 170-177), and Grant and Nackowski (1968, p. 11). The property is mentioned briefly by Buranek (1948, p. 16), Dasch (1964, p. 167), Bullock (1967, p. 15, 119), and Elevatorski (1974, p. 80).

The mine workings at the Cougar Spar mine consist of both surface and underground operations. In 1937 the Dalton brothers sank an inclined shaft to the 40-foot level. During the period of the McKenzie lease in 1941 and 1942 about 600 tons of fluorspar that averaged 40 percent fluorite was produced. This ore came from open-pit workings along the outcrop of the vein and from underground workings of 150 feet of drifts and crosscuts on the 40-foot level. In the fall of 1942 the U. S. Bureau of Mines began exploration and development work on the property by trenching, sampling, and drifting. The first work of the Bureau of Mines consisted of hand-cutting and sampling the surface outcrops. A crosscut on the 100-foot level was driven through the vein to the hanging wall. Drifting began on the footwall and followed the vein 400 feet to the southeast. Crosscuts were driven at intervals to determine the width of the vein. Development work consisted of 440 linear feet of trenching and 560 feet of underground work. In the fall of 1943 after the Bureau of Mines completed underground operations, the Tintic Standard Mining Company began development of the 200-foot level. They drove a crosscutting adit from its portal at the mill site for 710 feet southwest to intersect the vein. An additional 900 feet of drifts, stopes, and crosscuts extend from the adit. A mine plant and 150-ton gravity mill were constructed. Operations began in May 1944 and ceased in September 1945, when the fluorspar contract with Metals Reserve Company was terminated. A total of 17,037 tons of ore was milled, largely from the production of the Cougar Spar mine. Subsequently, the company started the 300-foot level adit to explore the vein deeper and to provide drainage for the mine. The portal is 1,000 feet northeast of the portal at the 200-foot level. The company ceased this development work before the adit had reached 700 feet, some 700 feet short of the Cougar Spar vein at this level. Work was discontinued in 1948 when the camp and facilities were dismantled. Renewed interest in the mine began during June and July 1975, when Allied Chemical Corporation drilled two 300-foot holes into the mineralized zone. The hole on the northwest end found no fluorspar. The hole on the southeast end penetrated 5 feet of mineralized rock of which about 2 feet contained possible ore. Allied Chemical Corporation abandoned the project in late July 1975.

The Cougar Spar mine is on the northeastern side of the Indian Peak stock. The deposit lies along a faulted and instrusive contact of Tertiary quartz diorite porphyry and volcanic rocks of the Tertiary Needles Range Formation. The quartz diorite porphyry is fine- to medium-grained and greenish gray; it contains phenocrysts of andesine, biotite, and quartz. The quartz diorite porphyry and tuff is irregular and complicated by extensive faulting at the mine site.

Fluorspar mineralization, traceable for over 1 mile north and 1 mile south of the mine, lies along a major fault zone that strikes N. 15° W. The fault dips steeply to the east. South of the mine the stock is in fault contact with various members, chiefly pyroclastics, of the Needles Range Formation. North of the mine the fault zone continues within various latite flows and pyroclastic rocks. Within the mine the fault zone is more than 200 feet wide on the 200-foot level. Here the zone strikes N. 30° W. and dips steeply east. The trace of the fault is marked by quartz veins and quartz-filled breccia; in places lamellar calcite may be found. At the Cougar Spar mine the surface of the fault zone was marked originally by a broad belt of overburden, containing vein quartz and quartz-filled breccia. A ledge of quartz-cemented breccia measuring 2 to 4 feet wide stood as much as 5 feet above the ground on the west side of the fault zone. The ledge was traceable for about 200 feet.

Fluorite mineralization occurs within the northwest-trending fault zone. At the Cougar Spar mine the fault zone contains both quartz diorite porphyry and tuff fragments. Quartz diorite porphyry appears to be more abundant. A strong gouge zone is developed near the hanging wall, which dams ground water. The fault zone is up to 200 feet wide. Mineralized parts of this fault zone have widths up to 40 feet, and minable concentrations of fluorspar have widths to 20 feet but average less than 10 feet. The deposit is developed for a strike length of nearly 500 feet on surface and underground workings.

Fluorite occurs with quartz and calcite as fillings along fissures and brecciated host rock. Several post-mineral north- and northwest-trending faults cut the fluorspar deposit, resulting in displacements of 5 to 30 feet. Offsets of the deposit on the 40-foot and

100-foot levels are greater than those on the 200-foot level. Owing to fault displacement the segments vary greatly in strike. On the 40-foot level three mine segments strike between N. 30° and 60° W. Numerous segments are exposed on the 100-foot level with strikes generally between N. 25° and 48° W., but east-west and north-south segments are present at the southeast end of the deposit. On the 200-foot level three main segments strike between N. 37° and 60° W. Dips of the veins range from 65 degrees to vertical; however, near vertical and vertical attitudes are typical.

The fluorspar ore consists primarily of massive, crystalline fluorite associated with quartz and calcite. The fluorite is pale green to milky white with small quantities of brown and purple colors. The crystalline fluorite typically contains thin silica separations along cleavage planes that are only partially removed by milling. Quartz and calcite are present in smaller quantities with calcite in lesser abundance.

During 1944 and 1945 the Cougar Spar mine produced 15,955 tons of fluorspar. This ore was beneficiated at the Cougar Spar mill into 3,663 tons of finished product, which was sold to Metals Reserve Corporation. The average grade of the mine ore during the two years of production was about 42 percent fluorite, whereas the finished product averaged approximately 87 percent fluorite. The Cougar Spar fluorspar contains a high silica content and requires milling. A large sample of better grade ore from one of the ore bodies averaged 55.4 percent fluorite, 38.7 percent silica, and 1.7 percent calcite.

Ore reserves at the Cougar Spar mine have been evaluated by Cochran (1952, p. 65-69) and Chojnacki (1964, p. 175-177) of the Union Pacific Railroad Company. A review of the data presented by Cochran (1952, plate XXXI) indicates that his values are too large by a factor of 2. Surface trenching under the direction of Everett and Wilson (1951, figure 12) for the U. S. Bureau of Mines exposed about 235 feet of outcroppings. Although in segmented blocks, the total length of ore exposures on the map prepared by Thurston and others (1954, plate 2) of the U. S. Geological Survey is 320 feet on the 100-foot level and 225 feet on the 200-foot level. The average strike length of the surface outcroppings and the 100-foot and 200-foot levels is 260 feet. The average width is about 8 feet. This volume of ore is equivalent to 26,000 tons above the 200-foot level. The Cougar Spar mine produced 16,595 tons of ore from the surface and the 40-foot, 100-foot, and 200-foot levels; all production was above the lower level. One diamond drill hole cut at the 300-foot level by Allied Chemical Corporation exposed a mineralized zone of 5 feet wide, but typical Cougar Spar ore measured only about 2 feet thick. The ore body pinches out at depth. Assuming that the ore exposed on strike for 225 feet on the 200-foot level continues for 50 feet below this level and that it averages 8 feet thick, an additional 5,000 tons of ore is indicated. It is likely that Tintic Standard Mining Company removed only the most favorable ore bodies and that some of the remaining smaller segmented ore bodies cannot be mined economically. The total reserves of the Cougar Spar mine probably do not exceed 10,000 tons of fluorspar at an average of 42 percent fluorite; recoverable ore may be considerably less.

Doughout (Dugout) Prospect

The Doughout (Dugout) prospect lies on the Indian Peak Range. The prospect lies at an elevation of 8,075 feet on the section line separating secs. 9 and 16, T. 30 S., R. 18 W., Washington mining district, western Beaver County (figure 1). Four Doughout claims were staked in 1942 by James H. Haslam and Dick Jones. The property was leased to H. A. McKenzie from 1944 to 1946. No assessment work has been done since 1946. Development work consists of a small open pit and a shallow shaft. The property has been mentioned briefly by Thurston and others (1954, p. 16), Chojnacki (1964, p. 180), Bullock (1967, p. 15, 119), and Grant and Nackowski (1968, p. 12).

The Indian Peak Range consists mainly of Tertiary ash-flow tuffs and lava flows, which are intruded by a mid-Tertiary stock. The stock, a granodiorite porphyry, occupies the west-central part of the Indian Peak Range. The Doughout claims are on the granodiorite porphyry stock. The rock is greenish gray and contains abundant plagioclase phenocrysts.

A few veinlets of fluorite occur in two quartz veins that measure less than 4 feet wide and are traceable only a short distance. Veinlets of fluorite about 3 inches in width are exposed in a pit near the entrance road and in an outcrop about 1,000 feet southeast. A shallow shaft 15 feet southeast of the pit has no fluorite exposed. Quartz is the predominant vein material, and fluorite is in minor quantities. Some azurite is associated with the quartz-fluorite veins. Fluorite is a minor occurrence on the Doughout claims; the property has no commercial fluorspar potential.

J. B. Mine

The J. B. mine lies at an elevation of 7,130 feet in the eastern foothills of the Indian Peak Range (figure 4). The property is in the N½ sec. 30, T. 30 S., R. 17 W., Washington mining district, western Beaver County (figure 1). Three claims, the J. B. Nos. 1, 2, and 3, were located in 1942 by Bart W. Mortensen and Vera R. Mortensen of Parowan. The property was

Figure 4. J. B. mine and tailings pile, Indian Peak Range, Beaver County.

subsequently leased to Theodore B. Stevens of Milford. Between July 1942 and June 1943 about 30 tons of fluorspar was mined from surface trenches and shipped to the Western Fluorite Company mill at Milford. From October 1943 to October 1944 the U. S. Bureau of Mines explored the deposit by surface trenching and underground workings. The mine lay idle until 1972, when the property was leased to Dale Aslett of Twin Falls, Idaho. Fluorspar was mined from a large open pit during 1972 and 1973 and was milled at the mine site. Approximately 1,280 tons of finished ore was shipped from this operation. The mine has been idle since the summer of 1973.

Development work at the J. B. mine consists of surface and underground workings. During 1942 and 1943 Stevens mined fluorspar from shallow surface trenches cut along the strike of the fluorspar veins. At this time the U. S. Bureau of Mines made a thorough investigation of the property. The first work consisted of bulldozing five long trenches, which ranged from 140 to 290 feet long, across the strike of the mineralized zone. The trenches were deepened later by hand methods, and several shorter hand trenches were excavated across the fluorspar veins. A total of 1,800 linear feet of trenching was completed during the project. An inclined shaft was sunk into the mineralized zone at the hanging wall contact and about midpoint along the strike length of the zone. The shaft was sunk to a depth of 105 feet. A total of 577 feet of drifting and crosscutting was conducted on the 93-foot level. Mining by Aslett in 1972 and 1973 was confined to a large open pit, which measured nearly 400 feet long, 50 feet wide, and 30 feet deep. The J. B. mine is described by Everett and Wilson (1950, 11 p.), Cochran (1952, p. 73-74), Thurston and others (1954, p. 13-14), Chojnacki (1964, p. 177-179), and Grant and Nackowski (1968, p. 11). The mine is mentioned briefly by Buranek (1948, p. 16), Dasch (1964, p. 167), Bullock (1967, p. 15, 119), and Elevatorski (1974, p. 80).

The J. B. mine is along a broad fault zone between red dacite on the northwest side and green andesite on the southeast side. These volcanic rocks belong to the Tertiary Needles Range Volcanic Series. The fault zone consists of a fissured and brecciated belt at least 250 feet wide that strikes N. 60° E. and extends to the northeast several hundred feet and to the southwest 3,200 feet to the Utah mine. At the J. B. mine mineralization has been traced for 400 feet along the trend of the fault zone. At least six larger

fluorspar veins are present. They strike from N. 10° W. to N. 50° E. and dip steeply to the north and northwest from 65 degrees to near vertical attitudes. The veins are discontinuous and subparallel, and they pinch and swell within short distances. The veins range from 40 feet to 218 feet long and from 4 feet to 11 feet wide. The largest vein measures 218 feet long with a maximum width of 11 feet. Mineralization varies in intensity within each vein, so that the boundaries of the ore bodies are gradational and vaguely defined.

The ore consists of fluorite, quartz, calcite, and brecciated volcanic rocks. Fluorite occurs as breccia and fissure fillings. The fluorite is crystalline, forming cleavable masses over ½ inch across a face. Much of the fluorite is colorless to pale green, but milky white and purple varieties are present. The surface workings show a high proportion of fluorite in relation to the amount of quartz, calcite, and breccia. The underground workings exposed fewer fluorspar-rich parts and a much higher proportion of breccia and gangue minerals.

Massive quartz veins are common in the mine area. One quartz vein marks the southeastern wall of the mineralized zone at the J. B. mine. It is traced for over 1,000 feet at an average width of 10 feet. Over much of its length it forms a ridge as much as 10 feet high. A smaller quartz vein lies 300 feet southeast of the mine. It measures 200 feet in length, 16 feet in width on one end, and 2 feet on the opposite end.

Representative ore samples from the mineralized zones averaged 24.1 percent fluorite, 46.8 percent silica, and 11.4 percent calcite. After milling operations by Aslett in 1972 and 1973 the finished ore ran about 77.9 percent fluorite, 13.2 percent silica, and 5.25 percent calcite. The fluorspar was beneficiated by crushing, followed by heavy liquid separation of ore ranging in size between 1/8 and 1¼ inches. Ore recovery amounted to only 15 to 18 percent of the fluorspar present. About 5,000 tons of tailings is stockpiled at the J. B. mine from the Aslett operations. This product consists of minus 1/8 inch fines, which average 38.5 percent fluorite, 45.1 percent silica, and 10.75 percent calcite. The remaining in-place ore is low grade and likewise requires beneficiation. The ore potential is difficult to assess because of the spotty mineralization and vagueness of the vein boundaries. No production came from the underground development work of the U. S. Bureau of Mines, and at the present these workings are caved in. The potential probably does not exceed 20,000 tons of low-grade ore, which averages only about 10 percent fluorite due to admixtures of wall rock. There is about 5,000 tons of tailings at the mine that averages 38.5 percent fluorite.

Lost Sheep Prospect

The Lost Sheep prospect is along Atchison Creek on the west slope of Indian Peak Range. The prospect lies at an elevation of 7,380 feet in the NW¼ sec. 20, T. 30 S., R. 18 W., Washington mining district, western Beaver County (figure 1). Four Lost Sheep claims were staked in 1942 by J. H. Haslam and E. Haslam of Cedar City. In 1943 the property was leased to H. A. McKenzie of Minersville. The property was explored by a short adit and was only active until 1946. The Lost Sheep prospect is described by Thurston and others (1954, p. 16) and Chojnacki (1964, p. 179-180). It is mentioned briefly by Bullock (1967, p. 15, 119) and Grant and Nackowski (1968, p. 12).

The Indian Peak Range consists of Tertiary ash-flow tuffs and lava flows that have been intruded by a Tertiary granodiorite porphyry stock. The Lost Sheep prospect lies on the undifferentiated Tertiary volcanic rocks of andesite composition. The granodiorite porphyry stock lies a few hundred feet east of the Lost Sheep workings. A wide vein zone containing calcite and quartz cuts the volcanic rocks on the claims. An outcrop of massive calcite occurs near the eastern margin of the vein zone. Small veinlets of fluorite are exposed in two outcrops, one 200 feet west and the other 500 feet west of the calcite mass. Colorless to pale green fluorite veinlets occur in quartz and range from 1 to 6 inches in width. No commercial fluorspar is exposed; rather fluorite is present as a minor occurrence on the Lost Sheep property.

Noonday Prospect

The Noonday prospect is on the east slope of the Indian Peak Range, about halfway between the Blue Bell and Cougar Spar mines. The prospect lies at an elevation of 7,800 feet in the NW¼ sec. 10, T. 30 S., R. 18 W., Washington mining district, western Beaver County (figure 1). Two Noonday claims were located in 1941 by H. C. Eyre of Minersville. The property was leased to H. A. McKenzie of Minersville for a short time and then leased to Tintic Standard Mining Company. Assessment work was continued until 1948. The prospect has been developed by a shallow trench, bulldozer cuts, and a 30-foot inclined shaft. The property is described by Thurston and others (1954, p. 12-13) and Chojnacki (1964, p. 182-184). The prospect is mentioned briefly by Bullock (1967, p. 15, 119), Grant and Nackowski (1968, p. 12), and Elevatorski (1974, p. 80).

The Noonday prospect is on the Oligocene Wah Wah Springs tuff member of the Needles Range Formation. The rock is a greenish gray, welded tuff of dacite composition. A 2-foot vein of quartz and fluorite occurs in a shear zone in the dacite. The vein strikes

N. 10° W. and dips 45° W. It is traceable for about 40 feet and has been explored to a depth of 30 feet. The vein does not extend beyond the workings. Colorless to pale green fluorite is present only as a minor occurrence at the Noonday prospect.

Utah Mine

The Utah mine lies at an elevation of 7,280 feet in the eastern foothills of the Indian Peak Range. The mine workings lie in the NE¼ sec. 25, T. 30 S., R. 18 W., Washington mining district, western Beaver County (figure 1). The Utah mine was located originally on the Crystal claims that were staked in 1936 by Utah Fluorspar Corporation in which Bart W. Mortensen was the principal owner. In the late 1930's the claims were under lease to Theodore E. Stevens and R. H. Alsop of Milford. The mine was first developed by an open pit 110 feet long and then followed by a 90-foot vertical shaft and a 50-foot adit into the shaft. The old shaft caved in, and in 1942 a new shaft was sunk to 110 feet at a point 45 feet northwest of the caved in shaft. A 40-foot drift was driven on the 90-foot level to the old workings. In 1950 the property was relocated as the Utah Nos. 1-3 claims by Bart W. Mortensen and his wife, Vera Mortensen. The Utah mine is currently under lease to Dale Aslett of Twin Falls, Idaho, Chad Spor of Delta, and Melvin Bradshaw of Milford. The Utah mine is described by Thurston and others (1954, p. 14-16) and Chojnacki (1964, p. 184-185). It is mentioned briefly by Buranek (1948, p. 16), Dasch (1964, p. 167), Bullock (1967, p. 15, 119), Grant and Nackowski (1968, p. 11), and Elevatorski (1974, p. 80).

The Utah mine cuts a volcanic series belonging to the Tertiary Needles Range Formation on a vertical fault zone that strikes N. 45° E. Andesite porphyry lies to the southeast and rhyolite porphyry to the northwest. The fault zone measures about 80 feet wide. The greater part of this width consists of fault breccia and altered rock that contain veins and fillings of quartz and calcite. Quartz and calcite can be traced for about 500 feet in both directions along the strike. On the northwest margin of the fault zone fluorspar is present as seams and lenses up to 2 feet wide. The mineralized zone was about 20 feet wide in the older workings. Near the center a section 12 feet wide contained fluorspar lenses so closely spaced as to make the entire width minable. The mineralized zone in the second shaft was about 8 feet wide, about one-half of which was fluorspar in 1-foot lenses that were selectively mined.

Before 1940, about 720 tons of metallurgical fluorspar was mined by a glory hole from the old shaft, which subsequently caved in. In 1942 an additional 330 tons was mined from the second shaft and drift. The mine has been inactive since 1942. The reserves at the Utah mine are difficult to assess; however, a 2-foot fluorite vein is exposed at the surface in an open pit. The vein consists of friable granules of crystalline fluorite up to ¼ inch in diameter. The fluorite is colorless, white, or pale green. A channel sample from this vein assayed 68.6 percent fluorite, 19.6 percent silica, and 1.4 percent calcite. Perhaps several hundred tons of ore that would require selective mining and milling remains at the Utah mine.

GRAND COUNTY

Miners Basin District

Miners Basin district is on the north stock of the La Sal Mountains (figure 5). The district was organized in 1898, following the discovery of gold ores. The principal mines are the Dillon, M. I. F., High Ore, Dewey, and McCoy adits. Their chief value is in the content of gold that occurs in pyrite and in the small amounts of silver and copper ores. Mineralization is associated with vertically sheeted joints that radiate from the north La Sal stock. Production of ore has been small. The geology of the district is described by Hill (1913, p. 99-118) and Hunt (1958, 60 p.). Fluorite is present as a minor occurrence in two of the mines.

Dewey Mine

The Dewey mine is on the west side of Green Mountain, north La Sal Mountains, at an elevation of 11,400 feet. The mine lies in the northern part of NE¼ sec. 23, T. 26 S., R. 24 E., Miners Basin mining district, Grand County (figure 5). The mine consists of an adit, which extends eastward for 500 feet, along the bottom of Golden Sceptre Gulch. The property was located in 1898. The mine is described by Hill (1913, p. 113) and Hunt (1958, p. 357). The mine is mentioned briefly by Bullock (1967, p. 32, 119).

The Dewey mine is on the north La Sal stock. The adit follows a vertical-fissured zone that cuts across a dike-swarm complex. The adit is mostly in crushed and fissured Tertiary soda syenite porphyry, but it exposes some Tertiary metadiorite. The fissured zone extends N. 85° E. and is crossed by a set of joints that trend mainly north and dip to the west. These joints occur singly at widely spaced intervals, and only a few are mineralized. For the first 350 feet from the portal, quartz veins are relatively common along the joints. They crosscut the main fissured zone, trending N. 10° E. and dipping 45°-70° W. Two veins average about 7 inches in width, but the veins are mostly less than 1 inch in width.

The principal minerals present in the veins include quartz, chalcedony, calcite, siderite, fluorite,

LOCATIONS

MINERS BASIN DISTRICT

1. **Dewey mine**
2. **High Ore mine**

RYAN CREEK DISTRICT

3. **Blue Spar mine**
4. **Prince Albert prospect**
5. **Ryan Creek prospect**

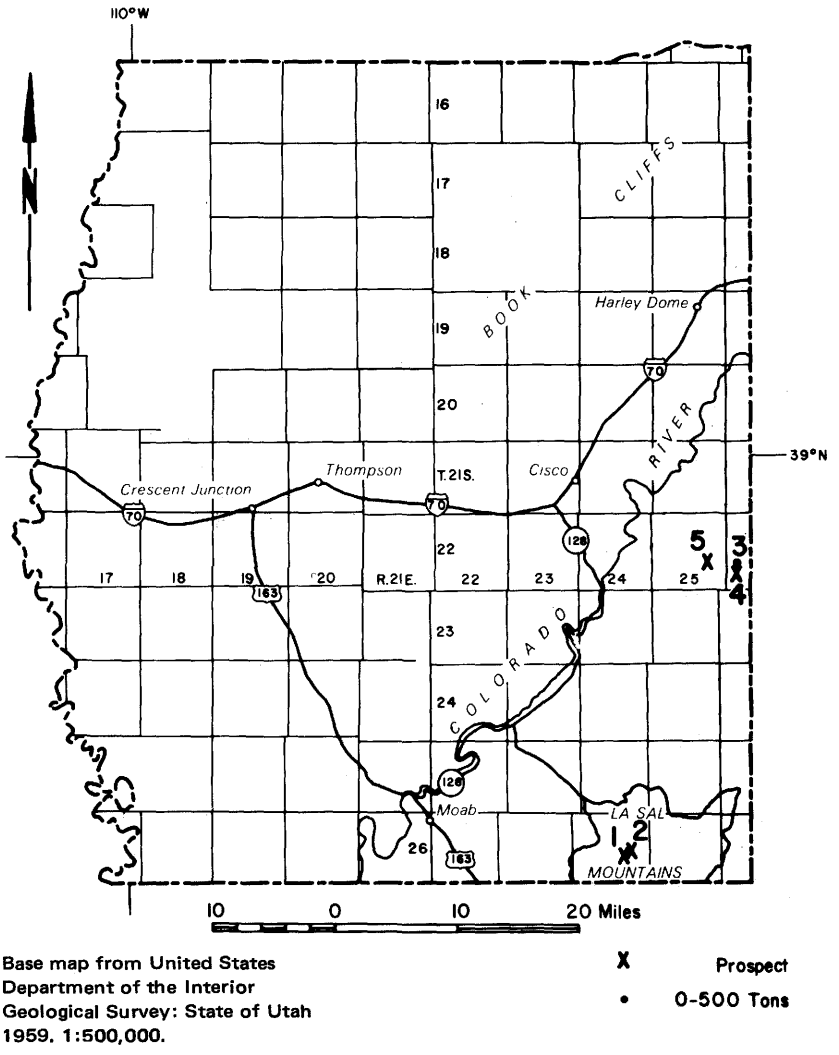

Figure 5. Grand County fluorite occurrences.

pyrite, limonite, chalcopyrite, malachite, and chrysocolla. Fluorite occurs in part as tiny individual crystals or as a powdery mass interstitial in calcite. Traces of fluorite occur in several veins in the central and eastern parts of the north La Sal stock. Fluorite appears later than calcite or quartz, since it coats vugs in quartz or calcite veins or occurs interstitially in the calcite. Fluorite is not abundant, representing only a minor occurrence.

High Ore Mine

The High Ore mine lies on the east side of Mineral Mountain, north La Sal Mountains, at an altitude of 10,900 feet. It is in the SW¼ sec. 14, T. 26 S., R. 24 E., Miners Basin mining district, Grand County (figure 5). It is accessible from Miners Basin. The property was first located in 1896. The mine workings consist of two principal adits. The south or main adit extends to the west for 140 feet and includes a southwest branch drift near the portal that extends for 180 feet. The north adit is about 150 feet in length. The mine is described by Hill (1913, p. 113) and Hunt (1958, p. 357). It is mentioned briefly by Bullock (1967, p. 32, 119).

The High Ore mine is on the north La Sal stock. Mineralization occurs along fissure veins that include mainly quartz, pyrite, and copper carbonates which cut Tertiary metadiorite. The north adit is developed along the footwall of a fissure that strikes westerly and dips 70°-90° N. The footwall is cut by three sets of fractures that strike N. 40° E., N. 10° E., and N. 50° W. The veins are all less than 1 inch in width. All production of copper, silver, and gold came from the south or main adit. At the portal the main fissure strikes east-west and dips 80° N. The mineralized vein is 2 to 3 feet wide and extends for 130 feet west. About 30 feet from the portal the ore zone splits and extends to the southwest for about 85 feet along a second fissure

vein. This fissure strikes N. 32° E. and dips 80° NW. Mineralization ceases where the vein crosses a contact from metadiorite into soda syenite porphyry. The ore zone averages about 3 feet along each fissure in the south adit. Both drifts in the south adit are cut by numerous fissures, but only the two described are mineralized.

The minerals observed in the main adit include quartz, chalcedony, calcite, fluorite, pyrite, limonite, hematite, chalcopyrite, malachite, azurite, and chrysocolla. Fluorite is principally earthy and light purple. It also occurs as tiny euhedral crystals. Although fluorite is present as a gangue mineral, it represents only a minor occurence at the High Ore mine.

Ryan Creek District

Ryan Creek lies in northeastern Grand County near the Colorado-Utah state line (figure 5). The area is accessible from Fruita, Colorado, southward through the Colorado National Monument to Glade Park, then westward to the state line, and southwestward in Utah 10 miles to Ryan Creek. The oldest rocks exposed belong to the Precambrian granite complex, consisting of coarsely crystalline biotite granite porphyry and associated pegmatitic phases. The complex is overlain unconformably by about 135 feet of Triassic Chinle Formation and about 300 feet of Jurassic Wingate Sandstone. The overlying Jurassic Kayenta Formation, exposed to the west and southwest of Ryan Creek, ranges from 200 to 320 feet in thickness.

Running parallel to Ryan Creek for several miles is the Ryan Creek fault zone that strikes N. 75°-80° W. Slightly to the south a second fault more or less parallels the Ryan Creek fault for 3 miles. The two faults form a narrow graben block on the south side of Ryan Creek with a displacement of 250 to 300 feet. Minor fluorite occurs as fissure fillings in the faults and associated shears in the Precambrian granite complex and in the overlying Chinle Formation and Wingate Sandstone. Fluorite also occurs as disseminations in the two sedimentary formations near shear zones.

Blue Spar Mine

The Blue Spar mine lies at an elevation of 5,800 feet on the south side of Ryan Creek. The property is about 2 miles west of the Utah-Colorado state line in the SW¼ sec. 19, T. 22 S., R. 26 E. and in the SE¼ sec. 24, T. 22 S., R. 25 E., in eastern Grand County (figure 5). The Blue Spar claims were located in 1943 by Nate B. Knight, Sr., and Nate B. Knight, Jr., of Moab. The property was held by assessment work until 1967. Workings consist of an open cut for 50 feet along the vein, which lies 60 feet above the stream bed. A 100-foot adit was cut southward just above the stream bed to intersect the vein. Drifting for about 15 feet northeast and 10 feet southwest was made on the vein at the end of the adit. The property was restaked in 1972 as the Florine No. 54 claim by Gilbert Daily, Harold Kramer, and Gerald Laughter of Moab. It is held currently by performance of annual assessment labor. The Blue Spar property is mentioned briefly by Davis (1950, p. 589), Thurston and others (1954, p. 50), Bullock (1967, p. 30, 119), Elevatorski (1974, p. 88), and Worl and others (1974, p. 10).

Fluorspar at the Blue Spar mine occurs along a fissure vein that cuts Precambrian biotite granite porphyry. The vein strikes N. 68° E. and dips 70° NW., and it can be traced about 50 feet on the surface. The vein measured from 5 to 30 inches wide and averaged about 15 inches in the open pit. The bottom part of the vein exposed in the adit measured about 25 feet long, less than 1 foot wide, and pinched out at the ends and bottom of the drift.

The principal mineral in the Blue Spar vein was coarsely crystalline fluorite with colorless, pale yellow, and pale green hues. Other gangue minerals include quartz, calcite, and barite rosettes. Fluorspar samples from the adit were high in quartz. A small amount of galena as well as minor amounts of sphalerite were present in the vein.

Six tons of hand-sorted fluorspar was shipped in 1948 to the U. S. Steel Corporation at the Provo Geneva Works for testing. The ore averaged 84.1 percent fluorite and 6.9 percent lead and was rejected because of the high lead content. About 50 tons of fluorspar was sold to Atlas Minerals at Moab during the fall and winter of 1966 and 1967. The ore averaged 70 percent fluorite, 15 percent silica, and an undetermined amount of calcite, barite, and galena. The ore was unsuccessfully used to separate uranium and vanadium ores. Three samples of ore remaining in the Blue Spar vein averaged 82.86 percent fluorite, 5.20 percent silica, 2.8 percent barite, and 2.48 percent calcite. The vein has been mined out and now possesses no commercial fluorspar.

Prince Albert Prospect

The Prince Albert prospect occurs on the south side of Ryan Creek about ¼ mile southeast of the Blue Spar mine and only 1½ miles west of the Utah-Colorado state line. The prospect lies in an unsurveyed area that would fall in the NW¼ sec. 30, T. 22 S., R. 26 E., eastern Grand County (figure 5). The prospect was originally staked on a small copper seam as the Prince Albert No. 4 claim. The old copper workings consist of a 40-foot inclined shaft; some drifting was completed to the southwest along the vein. A 1-foot by 2-foot glory hole lies 12 feet west of the shaft on

the vein. This property was staked as a fluorspar prospect, the Blue Spar No. 5 claim, in 1943 by Nate B. Knight, Sr., and Nate B. Knight, Jr., of Moab. Assessment work was maintained only until 1967. The property was restaked for fluorspar as the Florine No. 66 and 67 claims in 1972 by Gilbert Daily, Harold Kramer, and Gerald Laughter of Moab. The property is currently held by annual assessment labor, but no recent development work has been performed on this vein. The prospect is described by Dane (1935, p. 179) and is mentioned briefly by Elevatorski (1974, p. 88).

Dane (1935) considered the copper mineralization on this prospect to be associated with a small pegmatite dike, but actually it is a small fissure vein of fluorite and calcite in Precambrian biotite granite porphyry. The vein, lenticular with a maximum width of 2 feet, is exposed for a distance of about 30 feet on the surface. It has a strike of N. 68° E. and dips 65° NW. Metallic ore minerals include small amounts of chalcopyrite, malachite, azurite, galena, and sphalerite. Gangue minerals include calcite, fluorite, and quartz.

Fluorite is crystalline and ranges from colorless to pale yellow to pale green. Calcite is the next most abundant gangue mineral. Quartz is present in lesser amounts. An analysis from this old copper working averaged 70.01 percent fluorite, 18.95 percent calcite, and 4.4 percent quartz. The vein has been completely mined out. The Prince Albert prospect has no commercial fluorspar and represents only a minor occurrence of fluorite.

Ryan Creek Prospect

The Ryan Creek prospect lies at an elevation of about 5,180 feet along the bottom of Ryan Creek, approximately 1 mile east of the junction of Ryan Creek and Cow Creek. The prospect lies 3½ miles west of the Utah-Colorado state line in the S½ sec. 23, T. 22 S., R. 25 E., in eastern Grand County (figure 5). This property was staked in 1939 by the late Joseph Quinn of Grand Junction, Colorado, as the Grover Cleveland and Thomas J. Black lode claims. The prospect was examined for scheelite by Tweto and Burbank (1941) and is mentioned briefly by Thurston and others (1954, p. 50), Bullock (1967, p. 32, 119), Elevatorski (1974, p. 88), and Worl and others (1974, p. 10). In 1972 the mineral occurrence was restaked for fluorspar as the Floride Nos. 5 and 8 claims by Gilbert Daily, Harold Kramer, and Gerald Laughter of Moab. The claims are currently held by annual assessment labor, although no development work has been performed.

Fluorspar mineralization occurs along the main Ryan Creek fault, which strikes N. 75°-80° W. and dips 70°-75° S. This fault brings the Precambrian biotite granite porphyry, which lies immediately to the north, in fault contact with Jurassic Wingate Sandstone. A brecciated and granulated fault zone measures from a few feet to over 50 feet wide along the East Ryan Creek fault. Fluorspar mineralization is largely near the footwall of the fault in brecciated Wingate Sandstone.

The main vein of fluorspar mineralization strikes N. 75° W. and dips about 70° S. It measures from a few inches to about 4 feet in width. It is easily traced, although not continuously, for about 375 feet. In addition, a few tiny veins ½ to 6 inches wide and a few feet long lie parallel to the main vein in the Wingate Sandstone. Pale green fluorite and white to pink calcite occur as breccia fillings and as banded open space fillings. Bands of alternating fluorite and calcite range from a fraction of an inch to about 1 inch in width. Barite and quartz are present as minor or major constituents of the mineralized zones. Small disseminated grains of galena and sphalerite are typical of the banded ore. No scheelite was found; apparently the prospectors thought the mineral barite was tungsten ore.

The main fluorspar occurrence is traversed by veinlets of late mineralization of fluorite and calcite. Veinlets also cut the hanging wall block of Wingate Sandstone where it is shattered by faulting or along joint planes. In places the biotite granite porphyry footwall is also brecciated, granulated, and cemented by veinlets of fluorite and calcite. Four chip samples, which averaged 50.1 percent fluorite, 5.0 percent silica, and 40.8 percent calcite, were taken across the main vein. The Ryan Creek prospect has no commercial potential as a source of fluorspar, since the tonnage is small and the ore is high in silica and also contains lead and zinc. The prospect is only a minor occurrence of fluorite.

JUAB COUNTY

Fish Springs District

The Fish Springs district is on the northwestern end of the Fish Springs Range in western Juab County (figure 6). The district was organized in 1891 and has yielded more than $2.5 million worth of silver-lead ore carrying a small amount of gold. Most of the ore came from the Utah and Galena mines prior to 1917. Reconnaissance geology of the district is described by Butler and others (1920, p. 465-469), and a detailed study is given by Oliveira (1975, p. 69-104). Fluorite in the district is mentioned briefly by Bullock (1967, p. 35, 119) and Elevatorski (1974, p. 92). Less than 1 mile north of the mines is an occurrence of magnesite on Magnesite Hill. A small fluorite fissure cuts the Silurian Bell Hill Dolomite a few feet east of the magnesite deposit.

LOCATIONS

FISH SPRINGS DISTRICT

1. Magnesite Hill prospect

JOHNSON PEAK (TROUT CREEK) DISTRICT

2. Trout Creek mine

THOMAS RANGE (SPOR MOUNTAIN) DISTRICT

3. Bell Hill mine
4. Blowout mine
5. Blue Queen prospect
6. Dell mine
7. Dell No. 5 claim
8. Eagle Rock prospect
9. Evening Star prospect
10. Floride mine
11. Floride No. 1 mine
12. Floride No. 5 mine
13. Floride No. 13 mine
14. Floride No. 18 mine
15. Fluorine Queen mine
16. Fluorine Queen No. 1 mine
17. Fluorine Queen No. 2 mine
18. Fluorine Queen No. 4 mine
19. Green Crystal mine
20. Harrisite mine
21. Hilltop mine
22. Lost Sheep mine
23. Lost Soul prospect
24. Lucky Louie mine
25. Non Ella prospect
26. Oversight mine
27. Prospector prospect
28. Thursday mine
29. Beryllium bearing tuffs

URANIUM MINES AND PROSPECTS

30. Yellow Chief mine
31. Buena No. 1 prospect

BERYLLIUM MINES AND PROSPECTS

32. Blue Chalk mine
33. Claybank prospect
34. Fluro mine
35. Hogsback prospect
36. North End prospect
37. Rainbow prospect
38. Roadside mine
39. Tarus prospect

WEST TINTIC DISTRICT

40. "88" mine

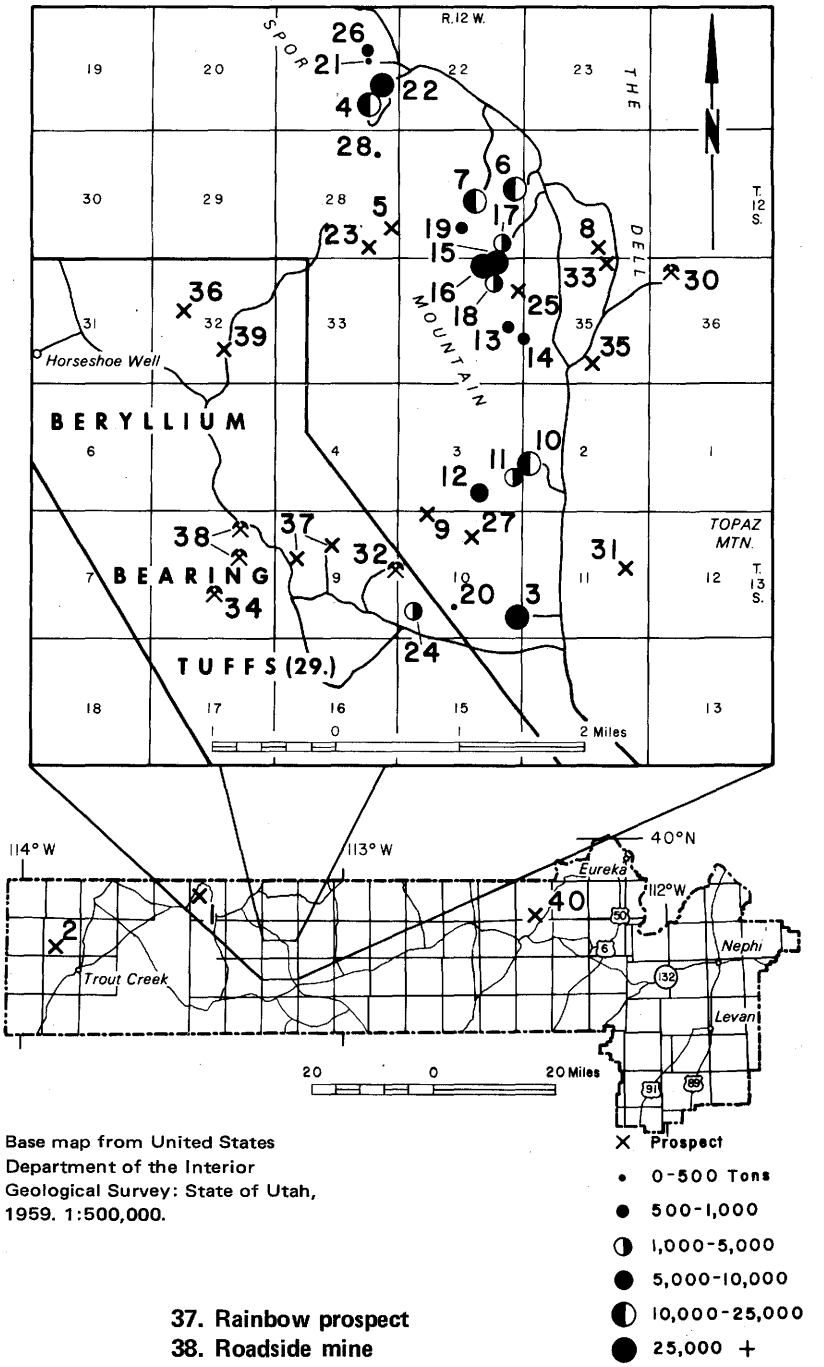

Figure 6. Juab County fluorite occurrences.

Magnesite Hill Prospect

Magnesite Hill lies on the northwest end of the Fish Springs Range. The prospect lies in an unsurveyed area that would fall in the NE¼ sec. 18, T. 11 S., R. 14 W., Fish Springs mining district, Juab County (figure 6). The occurrence lies about ¾ mile northeast of Joseph adit. Six claims were staked in 1941 on Magnesite Hill by the Silver Shield Mining and Milling Company of Salt Lake City and have been held by annual assessment labor. The property is presently held by Utah International of Reno, Nevada. A description of the magnesite deposit is given by Crawford and Buranek (1942, 13 p.). The fluorite outcrop is reported by Buranek (1948, p. 14); the occurrence is mentioned briefly by Thurston and others (1954, p. 50).

Sedimentary rocks of the northern Fish Springs Range are of Upper Cambrian through Middle Devonian ages, whereas the southern part of the range is Cambrian strata. The anticlinal structure of the northern range has been cut by thrust, tear, and high-angle normal faults of large magnitude. In the Fish Springs district, which lies on the northwest side of the range, the strata strike north-south. Dips are as high as 35° W. but generally more gentle.

In the foothills immediately north of the mining camp lies a low hill called Magnesite Hill. Bedrock exposures consist of Silurian Bell Hill Dolomite. The rock is fine- to medium-grained, blue-gray dolomite that grades into white, crystalline, dolomitic marble. About ½ mile farther south in the mining camp, rhyolite porphyry dikes cut the sedimentary strata.

Magnesite Hill is cut by magnesite fissure veins that strike north-south and are nearly vertical. These lenticular veins are several feet long and a few inches to several feet wide. The largest vein, 8 feet wide and 35 feet long, has been explored to a depth of 40 feet. The magnesite is dense, snow-white, and porcelainlike in appearance.

Small veinlets of coarse-grained calcite are found in the marginal phases of the dense magnesite. Immediately east of the prominent magnesite outcroppings a crystalline, green-colored vein of fluorite cuts the Bell Hill Dolomite. The fluorite vein is only about 8 inches wide and 12 feet long. No other occurrences were observed on Magnesite Hill. There is no commercial potential for fluorspar on this property; fluorite is present only as a minor occurrence.

Johnson Peak (Trout Creek) District

The Johnson Peak (Trout Creek) district lies on the southeastern end of the Deep Creek Mountains (figure 6). The range is a west-dipping fault block mountain. Precambrian rocks occur on the southeast side, and Paleozoic rocks occur on the west side. About 8,000 feet of Precambrian schist, quartzite, dolomite, and tillite are exposed at Trout Creek. These rocks are overlain and in thrust contact with 4,000 feet of schist, quartzite, and shale of Upper Precambrian and Lower Cambrian ages. The geology of the range is reported by Bick (1966, 120 p.). The structure and stratigraphy of Trout Creek is described by Misch and Hazzard (1962, p. 321-327). Fluorite associated with sphalerite and scheelite ore occurs in minor amounts at the Trout Creek mine.

Trout Creek Mine

The Trout Creek mine is near the mouth of Trout Creek on the southeast side of the Deep Creek Mountains. The mine lies about 1 mile northwest of the Bobcat Ranch in the W½ sec. 28, T. 12 S., R. 18 W., Johnson Peak (Trout Creek) mining district, Juab County (figure 6). The property consists of six claims patented in 1912 by H. F. Robinson. The mine is presently owned by Trout Creek Mining Company of Salt Lake City. The workings are on the Shilo claim consisting of a 450-foot inclined shaft with the main, 60, 120, 180, and 415-foot levels. The total length of drifts, crosscuts, and stopes is about 750 feet. The Trout Creek mine is described by Everett (1961, p. 29-30) and Thomson (1973, p. 51). The fluorite occurrence is mentioned briefly by Buranek (1948, p. 14), Thurston and others (1954, p. 50), Bullock (1967, p. 39, 119), and Elevatorski (1974, p. 92).

The country rock near the mine site consists of Precambrian Trout Creek Formation, which is composed of muscovite biotite schist and white to dark gray dolomitic marble. These strata have been domed by the Tertiary Trout Creek alaskite intrusive, which is exposed prominently in the east half of sec. 28. Trout Creek mine is on dolomitic marble, which strikes north-south and dips about 25°-30° W. On the east side of the property a thrust fault occurs with dolomitic marble thrust eastward over muscovite biotite schist.

In 1912 an inclined shaft was started, and it followed a fissure vein that contained sphalerite mineralization. Scheelite was recognized in the mine in 1916. The only known shipments of ore from the Trout Creek mine were 125 tons in 1955 by S. F. Falkenburg. Production came from erratic pockets along a fissure vein, which strikes N. 60° W. and dips 60° SW. The vein measured from a mere fracture to 4 feet wide and was followed for 180 feet on the main level. Production came chiefly from the 60-foot level. The ore minerals include dark sphalerite and scheelite; the gangue minerals are fluorite, siderite, gypsum, dolomite, limonite, and garnet.

Fluorite is present as an important gangue mineral along the fissure vein, but no commercial fluorspar is available. Fluorite is a minor occurrence at the Trout Creek mine.

Thomas Range
(Spor Mountain) District

Spor Mountain is 45 miles northwest of Delta on the west side of the Thomas Range in west-central Juab County (figure 6). Mineralization of fluorite, uranium, and beryllium occur within and surrounding Spor Mountain. In 1943 fluorite was discovered by George Spor and his sons, Chad and Ray, on the southeast side of Spor Mountain, where production began in 1944 and has continued to the present. In 1953 uranium was discovered in The Dell on the east side of the mountain, where production commenced in 1956 and continued through 1962. In 1959 beryllium was detected in rhyolite tuff on the southwest side of Spor Mountain, where production by Brush Wellman began in 1971 and will continue for some time. The geology of the district has been described by Bauer (1952, 47 p.), Thurston and others (1954, p. 25-45), Staatz and Osterwald (1959, 97 p.), Griffitts and Rader (1963, 2 p.), Sharp and Williams (1963, 59 p.), Staatz (1963, 36 p.), Staatz and Carr (1964, 188 p.), Shawe (1968, p. 1148-1161), and Lindsey and others (1973, 20 p.).

Paleozoic rocks of Ordovician, Silurian, and Devonian ages make up most of Spor Mountain. The Lower Ordovician Garden City Formation, which is chiefly limestone, is the oldest rock exposed. The overlying Ordovician Swan Peak Formation consists of a lower shale member and an upper quartzite member. The Upper Ordovician is composed of the Fish Haven Dolomite. The overlying Laketown Dolomite of Middle Silurian age is divided into five formations: Floride Dolomite, Bell Hill Dolomite, Harrisite Dolomite, Lost Sheep Dolomite, and Thursday Dolomite. The Devonian strata include the Sevy Dolomite, Simonson Dolomite, and Guilmette Formation. Fluorspar occurrences at Spor Mountain are known only in the Upper Ordovician Swan Peak Formation and in the Middle Silurian dolomites.

A thick sequence of rhyodacite and rhyolitic volcanic rocks of Tertiary age surround Spor Mountain. Dikes and intrusive plugs are common. The volcanic rocks are divided into an older and a younger group, which are separated by an unconformity. The older group of probable Miocene age is divided into six units. These include a dark labradorite rhyodacite, quartz-sanidine crystal tuff, vitric tuff, porphyritic rhyolite, and an overlying tuffaceous sandstone and conglomerate. These rocks are poorly exposed on small hills and along the sides of The Dell on the eastern side of Spor Mountain. The greater part of the exposed volcanic rocks belong to the younger volcanic group of probable Pliocene age. This group consists of five main subgroups, each of which began with explosive eruptions of pyroclastic rocks and ended with extrusions of lavas. Each subgroup consists of vitric tuff, volcanic breccia, and rhyolite. All are rhyolitic in composition, and the rhyolite flows are by far the most abundant rock type.

Intrusive breccia is abundantly exposed along the eastern side of the northern half of Spor Mountain and in the northern part of The Dell, with smaller exposures scattered throughout the mountain. Intrusive breccia includes various kinds of rock that were shattered and partially blown out by volcanic explosion. Pieces of rock were later surrounded by rising lava or red secondary dolomite. The matrix is easily weathered, and the breccia forms smooth slopes and brick-red soil. Some intrusive breccia consists of blocks of dolomite in red secondary dolomite matrix; some breccia consists of a mixture of blocks of volcanic rock with dolomite; some bodies are almost entirely porphyritic rhyolite with red dolomite matrix; and a few small bodies consist of volcanic blocks in a glassy volcanic matrix. The age of the intrusive breccia is questionable. It has been considered as the youngest unit of the older volcanics and as the youngest unit of the younger volcanics. The writer favors the latter age assignment, assuming a related genetic origin for the uranium, beryllium, topaz, fluorspar deposits, and the ore mineralization associated with the intrusive breccia.

Paleozoic sedimentary rocks at Spor Mountain and the older volcanic group have a northeast strike and moderate northwest dip. The attitude of the younger volcanic rocks conforms largely to their initial dip. The mountain is cut by numerous faults of five differing ages. The older are small northeast-trending thrust faults. Two of these thrusts are found on the northeastern side of Spor Mountain and on the west side of Eagle Rock Ridge. Most of the faults on Spor Mountain belong to northeast-trending normal and reverse faults that repeat the stratigraphic section many times. Most of these faults dip between 35° and 65° SE. A series of northwest-trending faults intersect and commonly offset the northeast faults. These three sets of faults are prevolcanic and locally intruded by igneous rocks. A few large north-trending faults typical of the Basin and Range system have produced the present topographic relief of Spor Mountain and brought Tertiary volcanic rocks against Paleozoic sedimentary rocks. A few faults of moderate displacement trend east-west across Spor Mountain and offset the north-trending faults. These faults cut Paleozoic sedimentary rocks and Tertiary volcanic rocks and are postvolcanic in age.

Uraniferous fluorspar deposits are found on Spor Mountain, where they occur as pipes, veins, and

disseminated deposits. More than 99 percent of the ore has been produced from brecciated pipes. Commercial production has largely come from pipes and along veins in dolomite, with rare exceptions of production in intrusive breccia. Breccia pipes occur in or adjacent to faults and intrusive breccia bodies. The fluorspar pipes, generally circular or oval in plan, range from less than a foot in diameter to 155 feet long and 105 feet wide. They plunge vertically or steeply to the east. The deepest pipe mined in the district extends to 425 feet at the Purple pit of the Lost Sheep mine. The pipes narrow with depth, sometimes forming two or more extensions. The bases of several large ore pipes are terminated at rather shallow depths by faults. The walls of the fluorspar pipes are nearly vertical, smooth, and divided from the fluorspar ore by thin clay separations.

The shipped fluorspar ore consists of 60 to 95 percent fluorite, which is intermixed with variable amounts of montmorillonite, quartz, chalcedony, calcite, and dolomite. The ore may be white, bluish, purple, green, or reddish brown. The purple coloration is closely related to the uranium content of the ore. The fluorspar deposits comprise three types of ore: (1) fine-grained, friable fluorite; (2) coarsely crystalline and banded crystalline fluorite; and (3) hard, dense, boxwork fluorite. The fine-grained, friable ore is a common type in the fluorspar pipes (figure 7). The ore may range from white, bluish, purple, to reddish brown hues. Coarsely crystalline or banded crystalline fluorite or both are associated with a few veins such as those at the Hilltop, Dell No. 5, Fissure pit of the Fluorine Queen No. 2, and Bell Hill mines (figure 8). The ores range from white to pale green to purple. Only a few thousand tons of this type of ore has been produced from Spor Mountain.

The hard, dense, boxwork ore is abundant in most fluorspar pipes. The ore is typically purple or

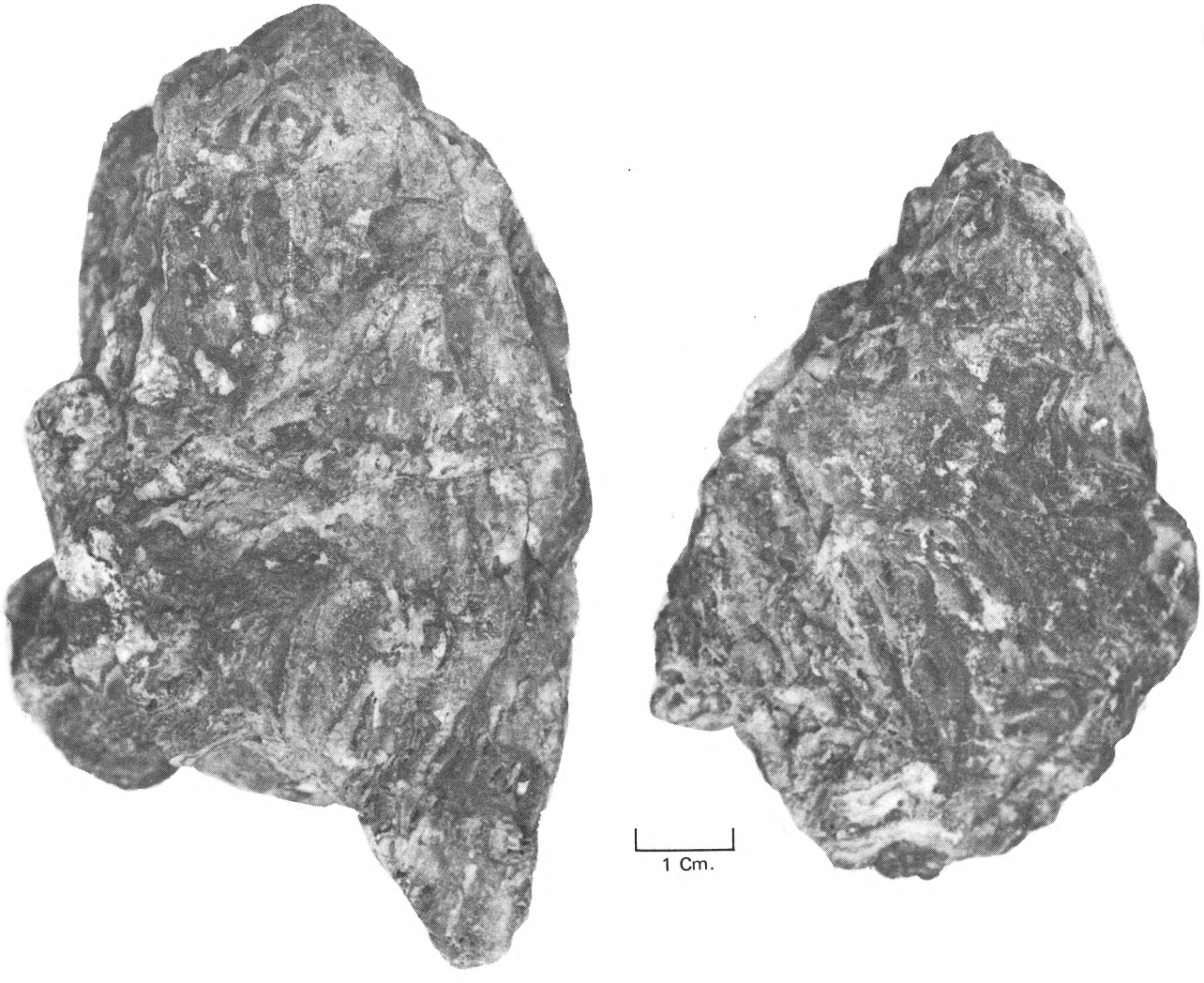

Figure 7. Fine-grained, friable, purple fluorite. Bell Hill mine, Spor Mountain, Juab County.

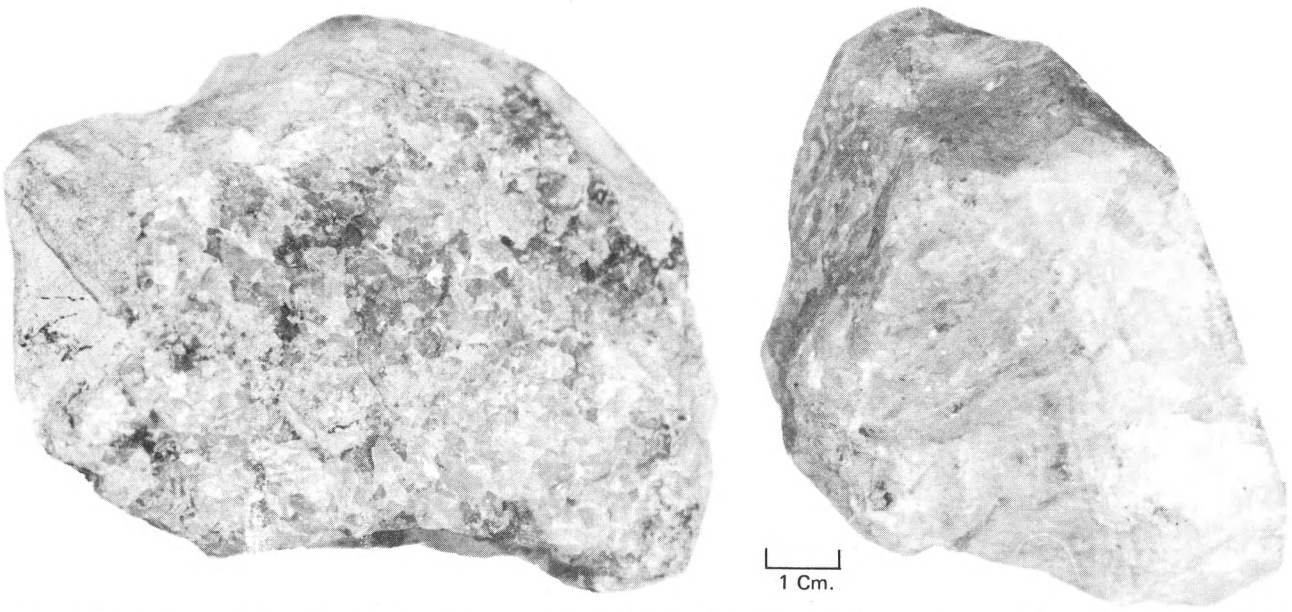

Figure 8. Coarsely crystalline and banded fluorite, colorless to pale green. Fissure pit, Fluorine Queen No. 2 claims, Spor Mountain, Juab County.

reddish brown. The boxworks represent a network of fluorite veinlets around dolomite fragments within breccia pipes. Hydrothermal solutions subsequently dissolved the dolomite fragments and left open vuggy spaces. At the same time or shortly afterwards many voids have been partly or completely filled with younger generation minerals. The character of the boxworks varies considerably. Thin-walled and thick-walled boxworks are shown in figures 9 and 10. Large boxworks and miniature boxworks are shown in figures 11 and 12. Angular and a rare tubular boxwork are contrasted in figures 13 and 14. The boxworks may be void, or they may be partly or completely filled with fluorite, calcite, dolomite, or montmorillonite. Partial fillings of boxworks by fluorite are shown in figure 15; complete fillings of boxworks by fluorite are shown in figure 16. Partial to complete fillings of boxworks by calcite are shown in figure 17; partial to complete fillings by montmorillonite are given in figure 18. The ore pipes generally increase in quartz and chalcedony content with depth of the pipe.

Production from Spor Mountain from its beginnings in 1944 through 1975 was slightly over 225,000 tons. The Lost Sheep mine was the largest producer with 90,000 tons. Other producers in order of magnitude are the Fluorine Queen, Bell Hill, Florine Queen No. 1, Floride, Dell, Dell No. 5, and Blowout mines.

Bell Hill Mine

The Bell Hill mine is on a group of low hills 80 to 160 feet high on the extreme southeast end of Spor Mountain. The main workings are at an elevation of 5,250 feet and lie in the SE¼ sec. 10, T. 13 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Bell Hill claims, Nos. 1-7, were staked in 1949 by C. Delbert Searle, Donald W. Searle, T. E. Searle, Harold J. Rutherford, and Harold L. Rutherford of Delta. The property was leased to George Spor in 1950, who mined fluorspar by open pit methods from the two largest ore bodies, Pit 1 and 2. By October 1950 George Spor had produced a total of 3,385 tons of fluorspar. From October 1950 to August 1951 the property was under control of the E. D. Harris family. They drove a 230-foot adit from the east side of the hill to the largest ore body. Sixty feet from the main deposit the adit struck a smaller ore pipe, which was covered by alluvium at the surface. This small ore body was stoped to the surface, and some ore was mined from the surface of Pit 2. They shipped a total of 1,530 tons. From September 1951 through 1952 the property was leased to Les Price and Earl Dalton of Delta. They mined the large ore body by stoping ore from the adit level, from three levels above the adit level, and from four sublevels below. They produced 7,031 tons of fluorspar.

No production of fluorspar was reported from the Bell Hill mine in 1953. From 1953 through 1956 the Searles mined the property and shipped 5,362 tons of ore. In 1956 Quo Vadis leased the property. They shipped one carload, about 50 tons of ore, in 1957 and none in 1958. In 1958 the Searles sold the property to Quo Vadis. In 1959 United Technical Industries purchased the Bell Hill mine. In 1960 and 1961 Larsen Industries operated the mine and

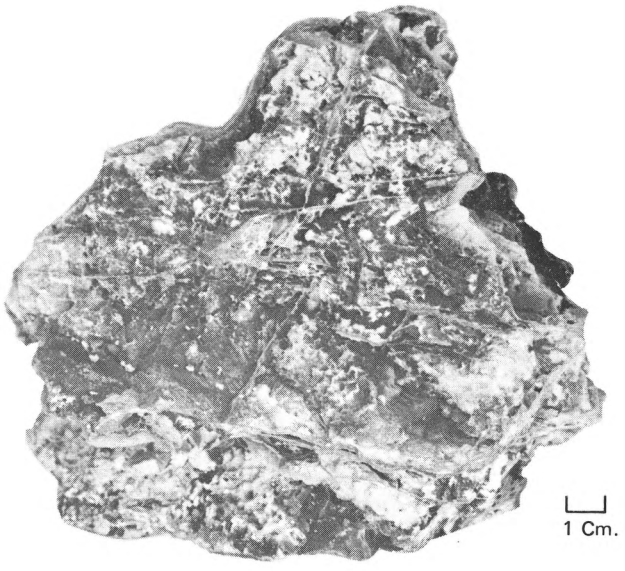

Figure 9. Thin-walled, purple fluorite boxworks. Middle pit, Fluorine Queen No. 1 claim, Spor Mountain, Juab County.

produced about 1,270 tons of ore. Production from 1953 to 1961 was 6,682 tons. Total production through 1961 was 18,628 tons. In 1964 the mine was purchased by Delea Mining Company, in care of Richard Moody of Delta and Salt Lake City. In 1968 and 1969 the Delea Mining Company shipped about 3,439 tons of fluorspar from the Bell Hill mine. In 1973 the company produced 3,711 tons of ore from the two inclined shafts and 416 tons in 1974. The total production from the Bell Hill mine from 1950 through 1974 was 26,194 tons. The Bell Hill mine has been described by Cochran (1952, p. 22-24), Thurston and others (1954, p. 29-30), Staatz and Osterwald (1959, p. 62-70), and Chojnacki (1964, p. 155-159). The mine is mentioned briefly by Dasch (1964, p. 164), Bullock (1967, p. 37, 119), and Elevatorski (1974, p. 93).

The Silurian Bell Hill Dolomite surrounds all the fluorspar bodies at the surface of the Bell Hill mine. The strata strike N. 15°-55° E. and dip 25°-45° NW. At the mine the bedrock exposures are poor and partly covered by a thin veneer of Pleistocene Lake Bonneville gravels. The type section of the Bell Hill Dolomite is about 2 miles north of the mine, although the formation was named from the Bell Hill mine. The Bell Hill Dolomite is the thickest of the Silurian formations on Spor Mountain, ranging from 395 to 430 feet. The dolomite is resistant to weathering and forms steep hills with prominent outcrops, especially in the central and southern part of Spor Mountain. The Bell Hill Dolomite is a dark gray, coarse-grained, clastic dolomite, except for the upper 45 feet which is light gray, fine-grained dolomite. The mine property is cut by numerous branching faults. Since no distinctive marker beds exist, except in the upper part of the formation, the faults are difficult to trace unless they contain breccia. One of the largest faults has a displacement of 175 feet.

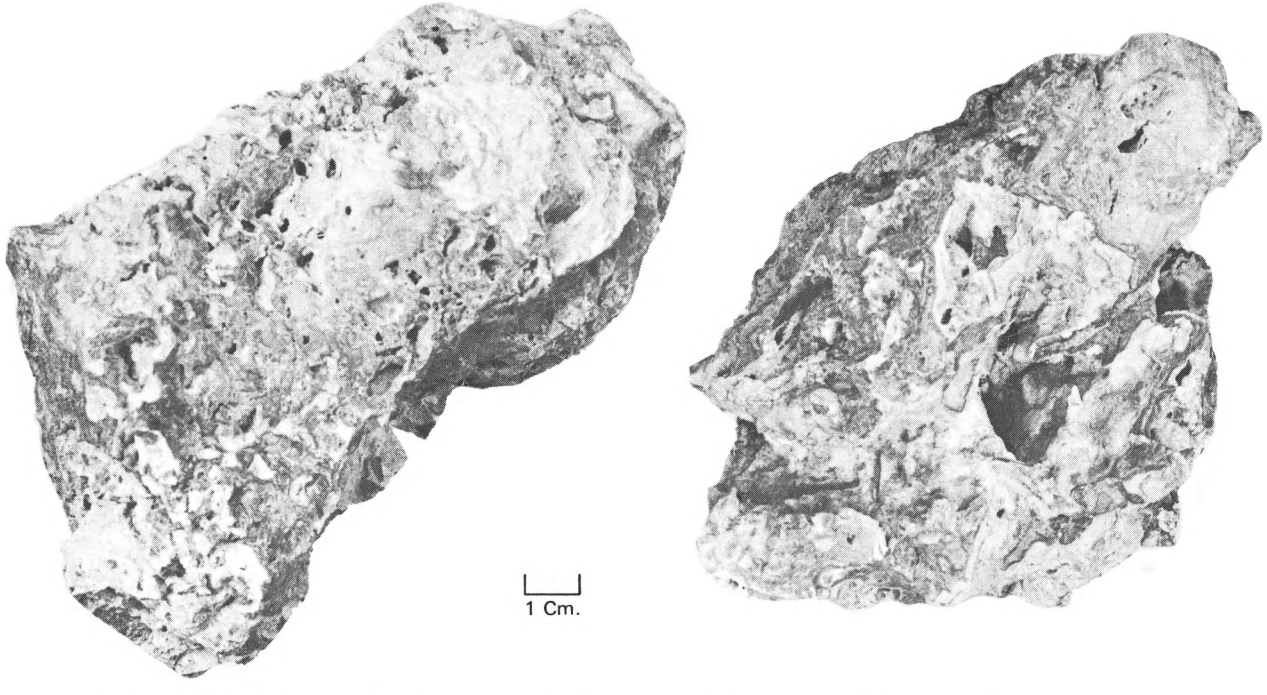

Figure 10. Thick-walled, reddish brown fluorite boxworks. Purple pit, Lost Sheep mine, Spor Mountain, Juab County.

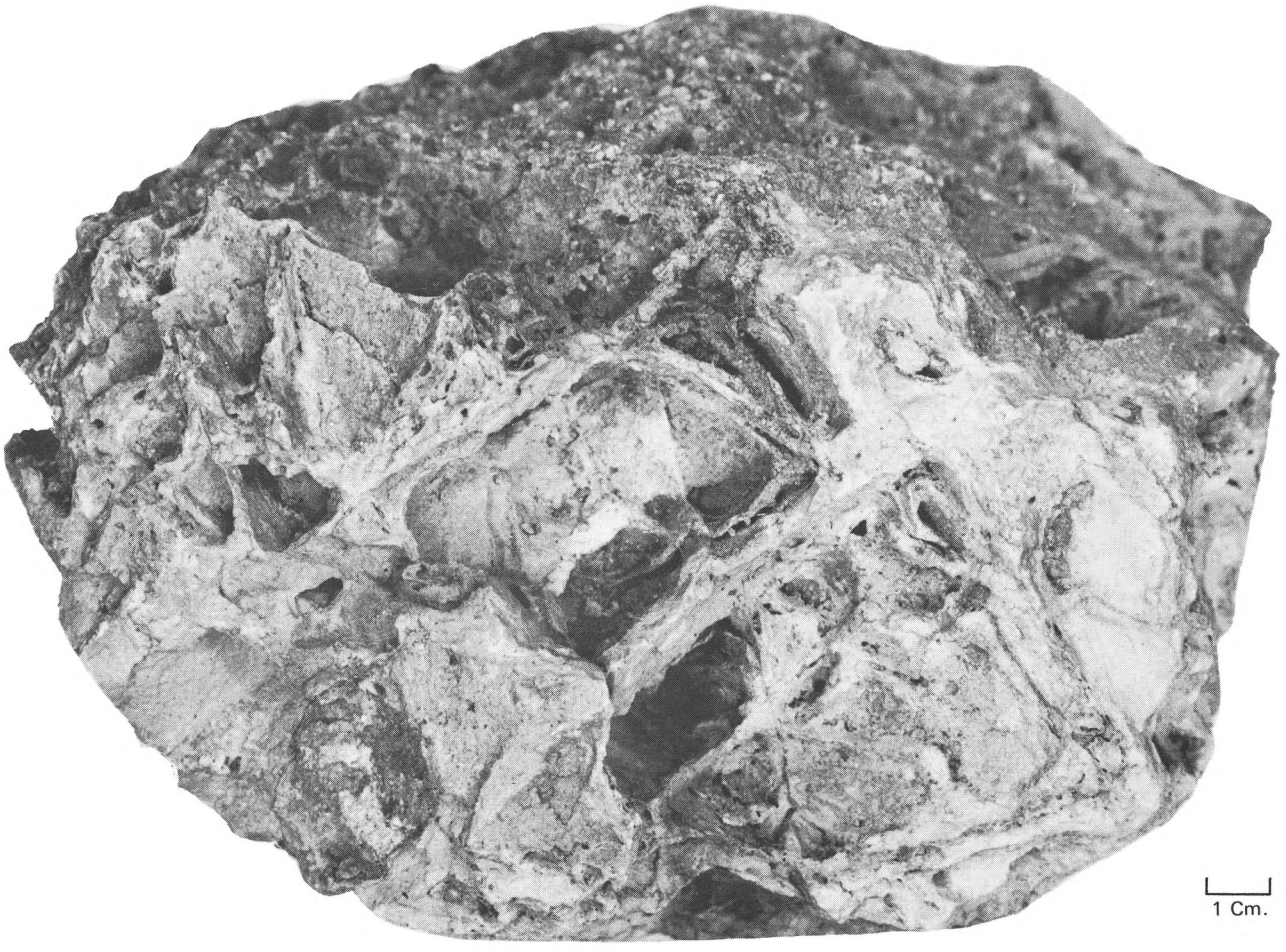

Figure 11. Large boxworks in reddish brown fluorite. Green Crystal mine, Spor Mountain, Juab County.

Fluorspar at the Bell Hill mine is in pipes and veins. The largest deposit is a pipe that is H-shaped in outline on the surface, lying along two parallel faults of unknown displacement. The faults have a strike of N. 60° E. and dip steeply to the northwest. The maximum length of this pipe on the surface was 130 feet, and the width at the junction of the H-shaped pipe was 50 feet. The average plunge of the pipe at the surface is 52° N. 62° E; the average plunge from the 87-foot level to the 168-foot level is 70° S. 81° E. This change in plunge gives the pipe a hooklike shape. On the 69-foot level the ore body formed a single lense; the two branches coalesced between the surface and this level. At depth this lenticular pipe pinches in the center. On the 168-foot level two separate ore bodies were found. On this level the largest pipe measured 55 feet long and 30 feet wide; the smaller pipe was 40 feet long and 27 feet wide. The ore on this level on the top of the Silurian Fluoride Dolomite is siliceous and cherty. The ore pipe was first mined at the surface of Pit 1 to a depth of 10 to 35 feet. An adit driven for 230 feet from the east cut the pipe and continued in ore for 110 feet. The adit entered the ore body on the 87-foot level. A raise with three levels was developed above the adit level. A winze, inclined 54 degrees, was sunk from the 87-foot or adit level. Several sublevels were developed from the winze on the 108, 129, 150, 168, 200, 230, 260, and 280-foot levels. Fluorspar was mined from the 108, 129, 150, 168, and 200-foot levels. Pillars of ore were left to support the walls and levels above. Later these supporting blocks of ore were mined out, leaving an open pit about 200 feet deep. Exploratory mining was accomplished on the 230, 260, and 280-foot levels. Production of ore was limited, owing to an increase in silica and a decrease in fluorite content. The walls of the pit overhang, and one wall caved in during the last mining operation. The lower exploratory levels are not accessible at the present, and the mine is considered to be extremely dangerous.

A small oval fluorspar pipe was discovered 60 feet northeast of the main pipe when the adit was driven. The pipe extends 80 feet to the surface but originally was covered by alluvium. At the outcrop this pipe was 20 feet long and 14 feet wide. At the adit

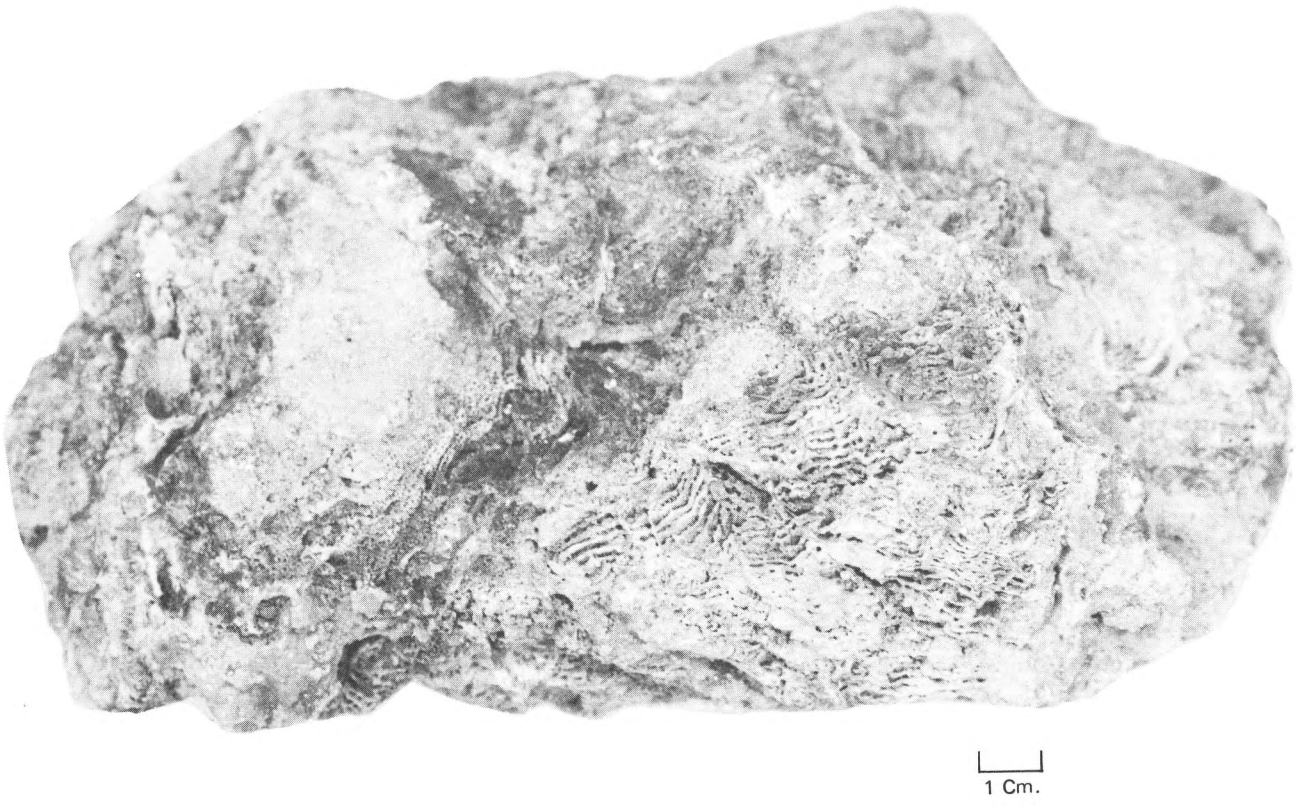

Figure 12. Miniature boxworks in purple fluorite. Purple pit, Lost Sheep mine, Spor Mountain, Juab County.

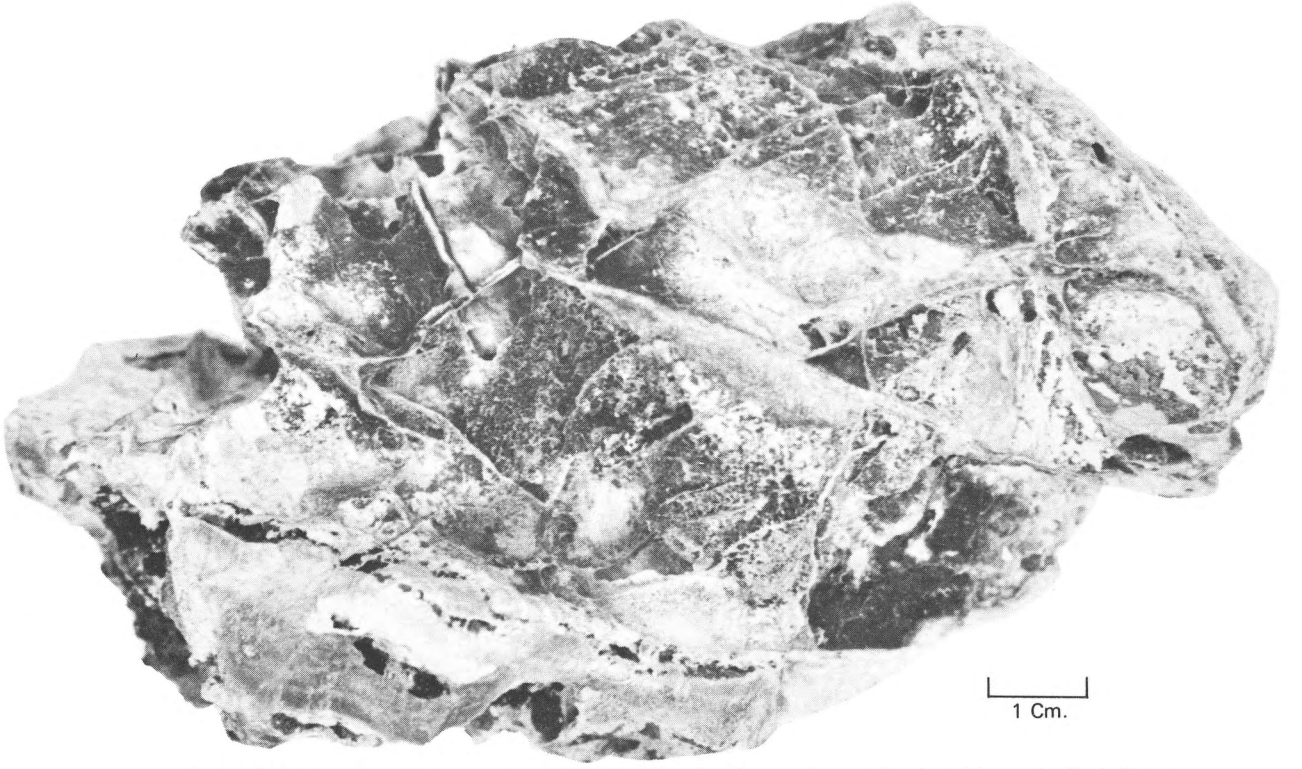

Figure 13. Purple, angular fluorite boxworks. Middle pit, Fluorine Queen No. 1 claim, Spor Mountain, Juab County.

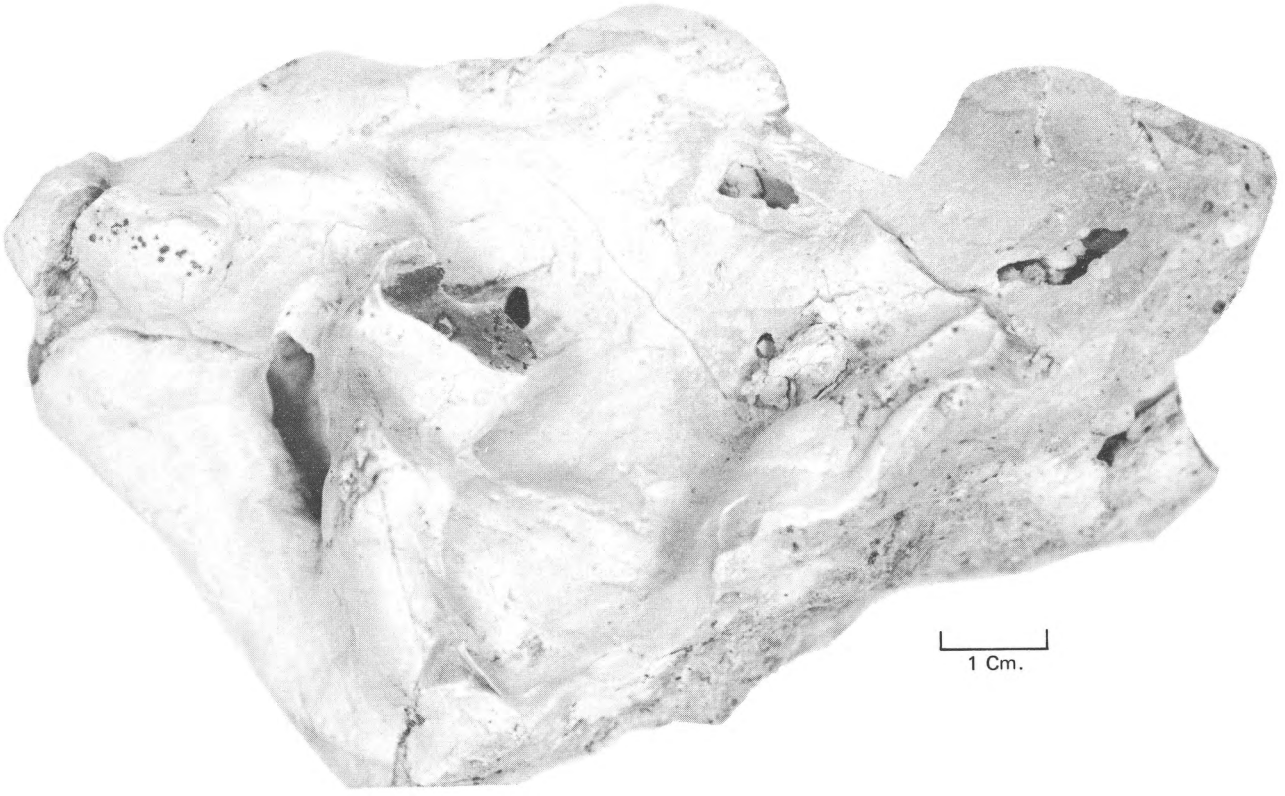

Figure 14. Reddish brown, tubular fluorite boxworks. Green Crystal mine, Spor Mountain, Juab County.

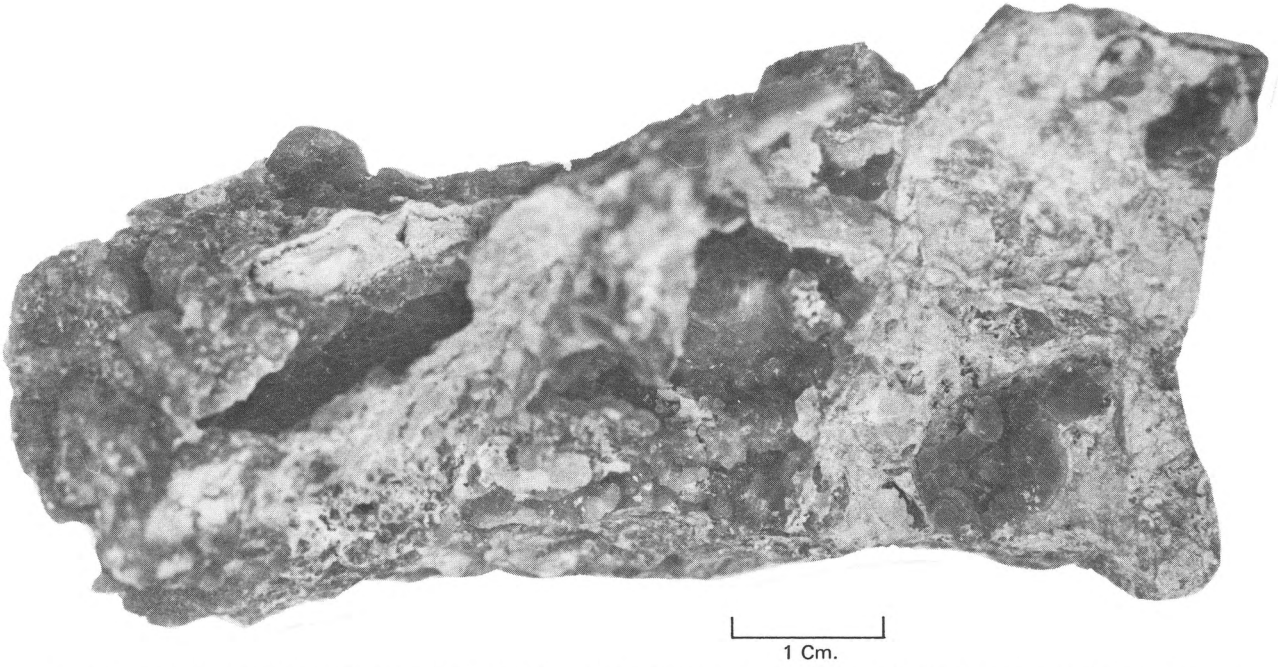

Figure 15. Reddish brown fluorite boxworks lined with green fluorite crystals. Green Crystal mine, Spor Mountain, Juab County.

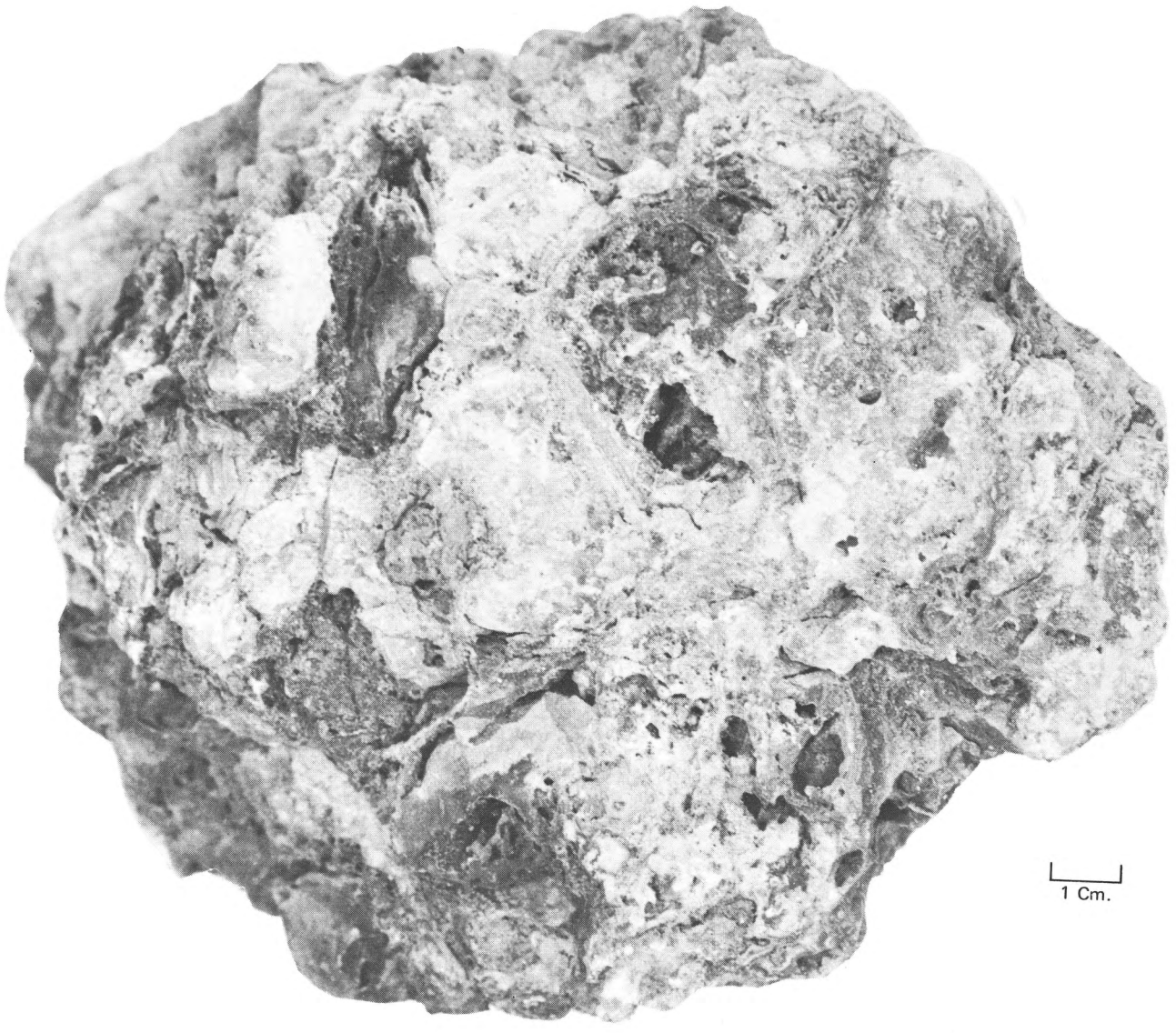

Figure 16. Purple fluorite boxworks filled with green massive and crystalline fluorite. Purple pit, Lost Sheep mine, Spor Mountain, Juab County.

level it was 15 feet long and 8 feet wide. The pipe plunges 75° N. 74° E. The pipe was only stoped upward from the adit level to the surface.

Surface workings consisted of four bulldozer trenches and two open pits. Pit 1 was excavated at the top of the large H-shaped pipe. About 300 feet to the northwest other occurrences of fluorspar were mined along a large fault, which parallels the two northeast-trending faults of the main pipe. Pit 2 on the north side of this fault was the second largest ore body on the Bell Hill property. This pipe was roughly oval in outline, measuring 50 feet long and 30 feet wide. Some fluorspar extended along the fault plane. Pit 2 was mined out from the surface to a depth of 90 feet, where mineralization pinched out. The ore body plunged 65° S. 58° E.

In bulldozer trench 1 two bands of fluorspar with a maximum width of 6 feet and one 6-inch stringer were found cutting dolomite. Mineralization could be traced for 60 feet. No further mining was performed on this outcrop. In trench 2 an ore body was uncovered that measured 70 feet long and 12 feet wide at the widest. From this deposit Delea Mining Company mined 4,127 tons of ore from two inclined shafts, a 150-foot shaft, and a shallow shaft 50 feet to the southwest. The ore pipe diminished to a diameter of only 3 feet at the bottom of the main shaft. A small ore pipe in trench 3 was mined from the surface

Figure 17. Purple fluorite boxworks with partial fillings of colorless to white calcite. Middle pit, Fluorine Queen No. 1 claim, Spor Mountain, Juab County.

to a depth of 20 feet. Although the original outcrop was about 34 feet long and 26 feet wide, it pinched out at a depth of 20 feet. A small irregular vein was uncovered in trench 4, but no further development work has been warranted. Diamond drilling during assessment work by Delea Mining Company has failed to expose any new ore bodies on the Bell Hill mining claims.

The fluorspar deposits at Bell Hill mine replaced dolomite along faults and fractured zones, especially brecciated zones adjacent to the faults. The ore bodies were mainly pipelike in form with irregular outlines and minor veins. The fluorspar was soft, pulverant, and white to dark purple. The chief impurities were montmorillonite, dolomite, and quartz. At the 87-foot level and lower the main pipe was cut by irregular bands of fine-grained, dark brown rhyolite tuff, which ranged in thickness from a fraction of an inch to several feet. Uranium is present in each individual occurrence but varies considerably, ranging from 0.008 to 0.33 percent. The fluorspar mined was metallurgical

Figure 18. Purple fluorite boxworks with partial fillings of white montmorillonite clay. Middle pit, Fluorine Queen No. 1 claim, Spor Mountain, Juab County.

grade. The first 5,991 tons of ore averaged 78.8 percent fluorite and 0.89 percent silica. Over two-thirds of the fluorspar ore from the Bell Hill mine came from the large H-shaped ore pipe. A total of 38 samples taken from this pipe in the surface pit and from the 69, 87, 108, 129, 150, and 168-foot levels averaged 80.3 percent fluorite.

The future of the Bell Hill mine is questionable since the ore below the 200-foot level is siliceous and cherty and since the fluorite content of the ore decreases. Four samples from the 260-foot level averaged only 40.7 percent fluorite, 13.7 percent silica, and 0.124 percent uranium. Two samples from the deepest level, the 280-foot level, averaged 67.9 percent fluorite, 17.8 percent silica, and 0.19 percent uranium. If the two pipes exposed on the 168-foot level continue to the 280-foot level and diminish by one-half in size, it is estimated that about 10,000 tons of inferred ore may yet remain in the main fluorspar pipe. The ore would require milling to meet metallurgical requirements. Perhaps uranium may be profitably recovered from the ore since it appears to increase with depth.

Blowout Mine

The Blowout mine is on the north end of Spor Mountain near its crest at an elevation of 5,700 feet (figure 19). The property adjoins the Lost Sheep mine on the south-southwest and lies in an unsurveyed area in the SE¼ sec. 21, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). Three claims, the Blowout and Blowout Nos. 1 and 2, were located in 1948 by Tass A. Claridge and Rex Claridge of Overton and Elko, Nevada. The claims were named "Blowout" because fluorspar veins were first discovered in an intrusive plug next to a fluorspar pipe. The deposit has been mined from an open pit and from two adit levels, 100 and 217 feet below the surface pit. Mining began at the surface in the open pit, which now measures 175 feet long and nearly 60 feet wide. Mining from the open pit ceased in the fall of 1950 when large dolomite blocks caved into the cut. Mining had extended to a depth of about 60 feet. The lower adit, known as the Willden-Claridge tunnel, was driven in 1950 by the owners of both the Blowout and Lost Sheep properties. The portal is on the Lost Sheep No. 1 claim, and the adit extends southward for 505 feet where it has intersected a second ore pipe. This pipe was mined to the surface and outcropped in the northeast part of the surface pit. In 1953 the middle adit, or 100-foot level, was driven to the north for 293 feet where it intersected a third ore pipe, which was mined upward toward the surface; but the ore terminated shortly before reaching the surface. Other workings from the 100-foot level were extended to the bottom of the surface pit.

Figure 19. Blowout mine, Spor Mountain, Juab County.

Ore shipped from the open pit at the Blowout mine was approximately 3,000 tons, and production from the ore pipe exposed on the 217-foot level was about 7,200 tons. The total of shipped ore from the mine from 1950-1958 was 10,200 tons. The mine was idle during the years 1954-1956 and from 1959-1969. In 1970 the property was leased and operated by Harold Spencer of Ely, Nevada. He mined the ore pipe, which was exposed on the 100-foot level and which terminated before reaching the surface. Shipped fluorspar amounted to 205 tons in 1970, 433 tons in 1971, 506 tons in 1972, and 306 tons in 1973, totaling 1,460 tons. The total of shipped ore from the Blowout mine from 1950 through 1974 was 11,660 tons. In 1974 the Blowout mine was optioned for purchase by Bailey Fluorspar Company of Marfa, Texas. This company operated an ore-buying station at Delta. The Blowout mine is described by Bauer (1952, p. 28-31), Cochran (1952, p. 20-22), Thurston and others (1954, p. 30-32), Staatz and Osterwald (1959, p. 70-72), and Chojnacki (1964, p. 145-147). The mine is mentioned briefly by Dasch (1964, p. 164), Bullock (1967, p. 37, 119), and Elevatorski (1974, p. 92).

The Blowout mine is on the Silurian Lost Sheep Dolomite. The lower and middle members of this

formation consist of light gray and medium gray, sandy-textured dolomite; the upper member is dark gray dolomite with pink and gray chert bands. The formation is about 220 feet thick at the Blowout property. The strata strike N. 40°-45° E. and dip 35°-40° NW. The dip on the haulage levels ranges from 40°-50° NW. The surface ore body and the ore pipe on the 100-foot level are in the Lost Sheep Dolomite. The ore pipe exposed on the 217-foot level begins in the Upper Harrisite Dolomite and extends to the surface in the Lost Sheep Dolomite. An oval-shaped Tertiary rhyolite intrusive plug, measuring 65 feet long and 55 feet wide, adjoins the fluorspar ore pipes at the surface. The plug was also found on the 100-foot level. The plug consists of rhyolite breccia and small pieces of chert. The hematite-stained rhyolite contains small smoky quartz crystals and residuals of feldspar crystals.

The Blowout mine consisted of three main ore pipes. The pipe forming most of the large open pit measured about 110 feet long and from 15 to 30 feet wide. The long axis of this pipe trended N. 68° W. The surface and underground workings below the pit are now caved in, but the ore pipe apparently terminated near the 100-foot level in a series of narrow downward projections. The second ore pipe, exposed on the 217-foot level, measured about 400 feet long and 300 feet wide. It was mined to the surface, where it outcropped in the spurlike projection in the northeast part of the pit. This pipe measured about 40 by 12 feet on the surface, but the surface and 100-foot levels are now caved in. A third and smaller ore pipe, exposed on the 100-foot adit level, measured about 20 by 15 feet. It was mined upward but terminated before reaching the surface.

The fluorspar ore varies from white to lavender to dark purple. It ranges from soft and friable ore to hard, well-defined boxwork varieties. The spaces in the boxworks are angular and measure up to 1½ inches across. Some of the open spaces contain small colorless crystals of fluorite. The ore has replaced brecciated dolomite in the pipes. The ore ranges from 72 to 94 percent fluorite and from 0.8 to 7.4 percent silica. The silica content increases with depth. The first 3,000 tons of ore shipped from the mine averaged 75 percent effective fluorite and from 2 to 4 percent silica. A recent sampling of some ore remaining in the pipe on the 217-foot adit level averaged 79.16 percent fluorite, 7.4 percent silica, and 4.3 percent calcite. All the ore from the mine shows traces of uranium ranging from 0.004 to 0.013 percent.

The ore potential of the Blowout mine is difficult to assess. Some ore remains in two of the three pipes exposed by mining. The large surface pipe terminated in a series of downward projections on the 100-foot level and was mined out. The ore pipe on the 100-foot level measured about 20 by 15 feet. It was mined upward until it terminated but was not mined below this level. If these same dimensions persist in depth to the 217-foot level, approximately 2,000 tons of inferred ore remains in this pipe. The ore pipe on the 217-foot level measured about 40 by 30 feet. It was mined to the surface and is reported to have been mined about 50 feet below the adit level. This pipe contains about 3,000 tons of inferred ore. Any future mining would require a vertical shaft or a winze to recover the ore. Since the silica content is high on the 217-foot level, any ore mined below this depth would require milling to meet metallurgical requirements. The ore potential of the Blowout mine is between 4,000 and 5,000 tons of inferred ore.

Blue Queen Prospect

The Blue Queen prospect is at an elevation of 5,600 feet on the west side of Spor Mountain. The property lies in an unsurveyed area that would fall in the SE¼ sec. 28, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). Seven Blue Queen claims were staked in 1952 by Wesley Sampson, Harold Goodwin, and Archie A. Searle of Delta. The property was deeded in 1961 to Russell Knight and Elwin Pace of Delta, who did assessment work until 1967. The workings consist of an inclined shaft, an adit, and several pits and trenches. The workings lie on the south slope of a steep canyon. The property is described by Staatz and Osterwald (1959, p. 72-73).

The Blue Queen prospect workings are mainly on the Silurian Lost Sheep Dolomite. These strata strike N. 40° E. and dip 30° NW. Two shallow trenches are also cut in Tertiary intrusive breccia about 400 feet to the east of the main workings. The mine adit is driven 25 feet to the south in dolomite. The workings show a few fine-grained masses of purple fluorite in the dolomite along the west wall near the portal. Fluorite has filled fractures in the dolomite and lined small vugs. The adit crosses a fault that strikes N. 22° E. and dips 47° E. No fluorite is found beyond the fault. The drift is abandoned.

The inclined shaft, only about 12 feet deep, plunges steeply to the south. Irregular masses of fine-grained purple fluorite have replaced dolomite and some chert nodules in the Lost Sheep Dolomite. Fluorite was found along a narrow zone that has a strike and dip similar to the fault exposed in the adit. A few tons of fluorspar that averages about 25 percent fluorite has been stockpiled near the workings. A few pieces of green crystalline fluorite are scattered on the dump, but none were found in place in the workings. The property is slightly radioactive. No shipments of fluorspar have been made from the property. The Blue Queen prospect is apparently only a minor occurrence of fluorite on Spor Mountain.

Dell Mine

The Dell mine is on the east slope of Spor Mountain at an elevation of 5,650 feet. The property lies in an unsurveyed area that would fall in the E½ sec. 27, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). Five claims called the Dell, Dell Nos. 1-3, and Red Hill were located in 1947 by Lafe Morley, Tass A. Claridge, Albert Willden, and Earl Willden of Delta. They drove an adit about 100 feet long toward a small ore body on the Red Hill claim at the northern end of the property. The claims were sold in 1948 to the Ward Leasing Company, who continued this adit about 15 feet to a small deposit. This company drove a haulage adit toward the west to intersect a larger fluorspar body exposed at the surface on the Dell claims. A smaller ore pipe, called the Rattlesnake, was cut 40 feet from the portal. The Dell adit was continued westward for a total of 933 feet and ended in quartzite. A 50-foot raise from the adit opened into the bottom of the western or Dell ore pipe. The Ward Leasing Company shipped ore totaling 15,800 tons from 1948 to 1953. The mine has been idle since 1954. The property currently consists of four main claims, named the Dell, Red Hill, Big Boy, and Oversight. The claims are held by annual assessment labor by the M and M Mining Company. The principal owners are Lafe Morley and Paul McFarland of Salt Lake City. The property is described by Thurston and others (1954, p. 32), and mentioned briefly by Dasch (1964, p. 164), Bullock (1967, p. 37, 119), and Elevatorski (1974, p. 93).

The country rocks exposed on the Dell mine property include the Ordovician Swan Peak Formation and Fish Haven Dolomite, the Silurian Floride, Bell Hill and Harrisite Dolomites, and Tertiary plugs of intrusive breccia. The area has been broken by numerous faults of varying magnitudes that have formed complicated structures and cut out various parts of the stratigraphic section. The area is cut by masses of intrusive breccia that range from small dikes an inch or two in thickness to large masses several hundred feet across. The intrusive breccia weathers to a pale reddish soil and forms smooth slopes, such as those exposed on Red Hill and immediately to the south. One outcrop of intrusive breccia runs as much as 40 percent fluorite.

The small Red Hill fluorspar body occurred in the Bell Hill Dolomite and measured only 8 by 10 feet. The mine portal to this ore body was cut in an intrusive breccia plug. At 115 feet the adit intersected the Red Hill ore pipe 35 feet below the surface. The pipe, stoped for 25 feet above and 25 feet below the adit level, has pinched out in quartzite in the lower workings. Only about 400 tons of fluorspar was mined from the Red Hill ore pipe. An unmined, siliceous fluorspar vein occurs in the intrusive breccia plug near the portal of the 115-foot adit. The vein is 40 feet long and 1½ feet thick.

The Rattlesnake fluorspar pipe was intersected when the Dell haulage adit was driven. This pipe, cut 40 feet from the Dell portal, measured 32 feet in diameter. It was stoped to the surface and for 20 feet below the adit level, where the ore bottomed out. About 1,400 tons of ore was shipped. This pipe was in the Silurian Lost Sheep Dolomite.

The Dell adit was driven westward a total of 933 feet and ended in the quartzite member of the Swan Peak Formation. A 50-foot raise from the adit opened into the bottom of the Dell ore pipe, which extended 220 feet to the surface. The bottom of this pipe is in the Ordovician Fish Haven Dolomite, although the surface exposures are in the Silurian Bell Hill Dolomite. An intrusive breccia plug and the complicated structure apparently have contributed to the faulting out of the Silurian Floride Dolomite and part of the Ordovician Fish Haven Dolomite. The Dell pipe, remarkably uniform in diameter, measured about 45 by 40 feet. The relatively smooth walls formed sharp contacts with the fluorspar ore. The pipe bottomed against massive quartzite, although miners reported fluorspar veins up to 6 inches wide extended into the quartzite. The Dell pipe produced about 14,000 tons of fluorspar ore.

Fluorspar ore from the Dell mine ranged from soft and friable to hard boxworks of fluorite. Colors varied from white to lavender to dark purple. The ore was slightly radioactive. The shipped ore contained 80 percent fluorite, 3 to 4 percent silica, and 1 to 2 percent calcite. There are several small surface showings of fluorspar on the Dell property, especially near the Dell ore pipe. A sample from a prospect pit west of the pipe averages 93.37 percent fluorite, 0.73 percent calcite, and 0.60 percent silica. Banded dolomite, which occurs in the Dell adit about 400 feet from the portal, may indicate an alteration zone near a hidden ore pipe. Little measurable ore is in sight on the property, yet the writer is impressed with its good potential for future production. Some areas warrant further exploration by a drilling program.

Dell No. 5 Claim

The Dell No. 5 claim lies in the central part of Spor Mountain, astride a pass at an elevation of 6,100 feet (figure 20). The claim is in an unsurveyed area that would fall in the S½ sec. 27, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The workings can be reached from the main haulage road along the east side of Spor

Figure 20. Red pit, Dell No. 5 claim, Spor Mountain, Juab County.

Mountain by a steep private road a little over 1 mile long. The Dell No. 5 claim was staked in 1948 by Earl Willden, Albert Willden, Tass A. Claridge, and Lafe Morley of Delta. The present owner is the Willden Fluorspar Company of Delta. Three occurrences of fluorspar are known on the Dell No. 5 claim. The workings consist of bulldozer cuts, adits, and open pits. The property has been described by Cochran (1952, p. 28-30), Thurston and others (1954, p. 33), Staatz and Carr (1964, p. 144-148), and Chojnacki (1964, p. 162-164). The claim is mentioned briefly by Buranek (1948, p. 10), Dasch (1964, p. 164), and Bullock (1967, p. 37, 119).

Two small fluorspar pipes, known as Spors lease, were exposed on the east end of the claim: one near the low point of the saddle of the ridge, and the other 250 feet northwest and 140 feet higher in elevation. The Spor brothers leased this property in 1948 and drove an adit 48 feet northwest to the lower ore body. Later they extended the adit for 272 feet toward the upper ore body but did not intersect it. The lower pipe, cut at about 25 feet below the surface, was stoped for 15 feet above and 27 feet below the adit level. About 420 tons of fluorspar was shipped from this pipe. The pipe is in the Ordovician Fish Haven Dolomite. It measures 15 feet in diameter and contains friable white to purple fluorspar. The upper pipe, partly exposed by bulldozer workings, is prospected by a 15-foot adit. No ore production has come from this ore body. The pipe is in the Silurian Bell Hill Dolomite. It measures 15 by 20 feet. The ore is in part powdery but contains many hard ribs of siliceous material. It is not of metallurgical grade. A rhyolite porphyry plug cuts the dolomite immediately east of the lower fluorspar pipe. The Spors lease contains little ore potential.

In 1954 when bulldozing a road on the Dell No. 5 claim, a large fluorspar pipe was uncovered under 6 to 15 feet of overburden. This discovery, known as the Red pit deposit, was near the center of the southeast sideline. This occurrence consists of at least three pipes on a line that trends N. 70° E. The westernmost and largest pipe has been mined to a depth of about 80 feet. It has an irregular shape with dimensions of 140 by 150 feet. The middle pipe to the east is separated by a limestone rib about 20 feet wide. It is oval shaped with dimensions of about 30 by 40 feet. The third and easternmost pipe is separated by a 20- to 25-foot limestone rib. This pipe measures about 20 by 40 feet. A short 35-foot adit was driven into this pipe.

The three ore pipes have nearly vertical walls and extend down to the Swan Peak Quartzite. The ore pipes terminate between 25 and 100 feet below the original surface. Mineralization is in the lower half of the Ordovician Fish Haven Dolomite. The strata underlain by the Ordovician Swan Peak Quartzite, strike northeast and dip 30° NW. The three fluorspar pipes lie between two intersecting faults. The western fault forms the southwest wall of the large pipe. It is not readily apparent in the pit area because it is mostly concealed by debris and talus. The fault is well exposed on the road leading to the mine, about 200 feet southeast of the pit, where it has displaced the Swan Peak Quartzite. The average strike of the western fault is N. 65° W. The second fault lies about 50 feet east of the easternmost pipe. It has a strike of N. 15° W. and dips 45° NE. Displacement along this fault has placed the top of the Swan Peak Quartzite against the middle of Fish Haven Dolomite. Fluorspar mineralization occurs along brecciated zones between these two bordering faults. Most of the ore is light reddish brown. It is a fine-grained boxwork ore. Some of the fluorspar is dark purple and grades into white hues. Some is hard and compact. White montmorillonite clay is found in scattered pockets throughout the ore. Although some siliceous ore remains in the Red pit deposit, the main pit floor is virtually down to the top of the Swan Peak Quartzite and, therefore, does not extend in depth. Approximately 12,000 tons of fluorite was mined from the Red pit deposits. The ore was high in silica and required blending with higher grade ore from the Lost Sheep mine to meet minimum metallurgical requirements. The ore ranges from 43 to 80 percent fluorite, 4.4 to 32 percent silica, and 1.1 to 8 percent calcite. The potential of the Red pit does not exceed 500 tons of highly siliceous ore.

About 400 feet west of the Red pit near the southwest end of the Dell No. 5 claim, a trench has exposed 30 feet of fluorspar mineralization. This occurrence is known as the Rattlesnake prospect. The ore is mixed with dolomite and not a commercial grade. The outcrop lies near the top of the Ordovician or Silurian Floride Dolomite. It is bounded on the northeast side by two closely spaced faults, which strike N. 75° W. and dip vertically. The same fault that bounds the west side of the Red pit displaces the Bell Hill Dolomite-Floride Dolomite contact about 40 feet downward on the northeast side of the fault. No production has come from the Rattlesnake prospect, and the ore grade is poor.

Eagle Rock Prospect

The Eagle Rock prospect lies in a small hollow on the northeast side of Eagle Rock Ridge, a low range of hills about 300 feet high on the east side of Spor Mountain. The property lies in an unsurveyed area that would lie in the SE¼ sec. 26, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). Three claims, the Eagle Rock and Eagle Rock Nos. 1 and 2, were staked in 1948 by Albert Willden, Earl Willden, Tass A. Claridge, and Rex Claridge of Delta. The property is currently held by annual assessment work by the Hilltop Mining Company; the principal owners are Alfred Willden, Darrell Willden, Carl Willden, and N. S. Bassett of Delta. Mine workings consist of a discovery trench that was excavated on a small fluorspar vein, pits, bulldozer cuts, an adit, and a churn drill hole. The trench is 30 feet long, 4 feet wide, and 12 feet deep. The adit lies at an elevation of 5,710 feet and is driven S. 83° W. for 170 feet toward the discovery trench. The property is described by Cochran (1952, p. 32), Thurston and others (1954, p. 33-34), and Staatz and Carr (1964, p. 144-146). The prospect is mentioned briefly by Elevatorski (1974, p. 92).

The Silurian Bell Hill, Harrisite, and Lost Sheep Dolomite crop out on the Eagle Rock claims. The strata strike N. 45° E. and dip 30° NW. Development work on the property, however, is confined largely to the Bell Hill Dolomite. The dolomite, containing a fine network of chert, is gray, fine grained, and dense. Several small depressions, covered by slopewash, occur on the property. The largest one is near the central part of the area. The dolomite near the edges of these depressions is typically brecciated, and the fractures are filled with cryptocrystalline quartz. The rocks exposed by bulldozing in the large depressions are highly altered, consisting of buff to red calcareous clay that is siliceous and has a boxwork structure. A churn drill hole was cut at the south end of this depression, exposing an underlying volcanic intrusive body.

Nearly all the fluorspar exposed on the Eagle Rock prospect is in a small vein in the discovery trench, which lies on the southeast side of the large depression. The fluorspar vein, about 40 feet long and vertical, ranges in thickness from less than 1 inch to 4 feet. The fluorspar consists of a dark purple siliceous boxwork that is rather hard. Quartz makes up at least 50 percent of this vein, and fluorite averages about 35 percent. Some calcite is present. This property is unusual in that visible bright yellow, powdery carnotite coats the fluorspar in some places. Small masses of fluorspar measuring up to 1 foot in diameter are exposed in a siliceous boxwork at the end of the adit at the contact of the dolomite and red calcareous clay. Minor amounts of fluorspar have been exposed in other workings. Although considerable development work has been expended on the Eagle Rock prospect, no shipments of ore have been made. The property is regarded as a minor occurrence of fluorite at Spor Mountain.

Evening Star Prospect

The Evening Star prospect is on the northwest side of a low hill on the southwestern end of Spor Mountain. The property, a little over ½ mile north of the Lucky Louie mine, lies in the northern part of the NW¼ sec. 10, T. 13 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Evening Star and Evening Star Nos. 1 and 2 claims were staked in 1953 by Glen Bunker and Sydney Searle of Delta. The property is held by annual assessment labor. The workings consist of a bulldozer trench approximately 80 feet long and about 6 feet deep. In the center of the trench a pit about 8 feet deep has been sunk. The property is described by Staatz and Carr (1964, p. 146). The prospect is mentioned briefly by Bullock (1967, p. 37, 119) and Elevatorski (1974, p. 93).

A porphyritic rhyolite intrusion surrounded by dolomite forms the central part of the low hill. Rubble from the rhyolite and Lake Bonneville gravels obscures the contact between the rhyolite intrusion and dolomite. The only exposure of this contact is in the bulldozer trench at an elevation of about 5,180 feet, where rhyolite overlies the lower part of the Lost Sheep Dolomite. Along the contact is a zone of alteration about 15 feet wide, which consists of light-gray clayey material. Fluorspar is sparsely distributed in the contact zone as irregular masses surrounded by clay. Fluorspar is exposed along this zone of alteration for a distance of about 72 feet. The fluorite is fine grained, massive, and dark purple. Several small veins also occur in the contact zone; the largest observed was about 8 inches wide. The prospect is radioactive, but no uranium mineralization has been observed. The Evening Star prospect has produced no fluorspar and is regarded as a minor occurrence of fluorite at Spor Mountain.

Floride Mine

The Floride mine was the first fluorspar property operated in Spor Mountain (figure 21). It is on the southeastern slope of the mountain at an elevation of 5,525 feet. The mine workings are in the SW¼ sec. 2 and SE¼ sec. 3, T. 13 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Floride claim was staked in 1941 by George P. Spor and his sons, Chad and Ray, of Delta. They actively operated the mine for over a decade and intermittently mined ore to the present. Chad and Ray

Figure 21. Floride mine on the right, Floride No. 1 mine on the left, Spor Mountain, Juab County.

Spor of Delta are the present owners. The property has been described by Cochran (1952, p. 14-16), Thurston and others (1954, p. 34-36), and Chojnacki (1964, p. 151-152). The mine is mentioned briefly by Buranek (1948, p. 10), Dasch (1964, p. 164), Bullock (1967, p. 37, 119), and Elevatorski (1974, p. 93).

The Floride mine has been developed by a large open pit, an inclined shaft, a vertical shaft, and two haulage adits. The 130-foot long upper adit intersects the ore pipe about 40 feet below the surface. The lower adit, about 275 feet long, cuts the deposit approximately 80 feet below the surface. Two crosscuts were made on the lower level. One crosscut extends west of the fluorspar pipe about 30 feet to a highly fractured zone near the footwall quartzite. The second crosscut originally extended 70 feet south of the pipe; recently an additional crosscut extends about 60 feet to the west to the fractured and mineralized dolomite that plunges down the dip of the fault. A shaft inclined 60 degrees was sunk from the surface to the lower adit level. The deposit, mined by shrinkage methods from the surface to a depth of 20 feet below the lower adit level, formed a large glory hole over 100 feet deep. A vertical shaft now inaccessible was sunk from the bottom of the glory hole about 40 feet to the footwall quartzite. The bottom of the pit is now covered by backfill from recent operations on the lower adit level.

The Floride mine deposit consists of a fluorspar pipe replacement in the Ordovician or Silurian Floride Dolomite, the formation being named after the Floride mine. The dolomite is dense, thick bedded, and dark gray to black. The strata strike N. 32°-38° E. and dip 26°-32° NW. The lower half of the pipe is a replacement in the upper part of the Ordovician Fish Haven Dolomite. The major structure of the mine is a normal fault, which is exposed just 60 feet north of the northern edge of the fluorspar pipe. The fault strikes N. 85° E. and dips 60° S. at the surface and 73° S. in the lower workings of the mine. The fault truncates the Floride pipe. The ore pipe is developed in the hanging wall of the Floride Dolomite and Fish Haven Dolomite; the Swan Peak Quartzite forms the footwall block and underlies the fluorspar pipe. The Swan Peak Quartzite is exposed at the surface on the north side of the normal fault. The quartzite strikes N. 30° E. and dips about 29° NW.

The fluorspar pipe is oval shaped and elongated to the northwest, measuring 100 feet long and 40 feet wide. Two projections of this ore pipe extend to the southwest, one for 30 feet and the other for 45 feet, parallel to the strike of the bedding. The dolomite walls of the pipe are near vertical to vertical, and the bottom of the pipe is fashioned by footwall quartzite. A considerable amount of waste and low-grade ore, which had to be sorted before shipment, was included within the pipe. The low-grade ore was later milled to an acceptable product. The ore ranged from a dark purple, highly siliceous material to a soft-white powdery ore that was 95 percent fluorite. Much of the ore was fine grained and white to lavender. The ore averaged about 85 percent fluorite and 2 percent silica. Over 20,000 tons of fluorspar ore was mined from the Floride mine. Recently, a little production has come from operations in the lower adit, which is developed along the fault contact of the dolomite hanging wall and the quartzite footwall. Future reserves are difficult to assess but are less than 1,000 tons of inferred ore.

Floride No. 1 Mine

The Floride No. 1 mine lies just 350 feet south of the Floride mine at an elevation of 5,520 feet on the southeastern side of Spor Mountain. The mine lies in the SE¼ sec. 3, T. 13 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Floride No. 1 claim was staked in 1941 by George P. Spor and his sons, Chad and Ray. The present owners are Chad and Ray Spor of Delta. The mine has been developed by an adit approximately 150 feet long and 30 feet below the surface outcrop. A small fluorspar pipe was mined by a raise from the adit level to the surface. A winze was sunk from the adit level to a depth of 35 feet.

The Floride No. 1 pipe crops out in the top of the Ordovician Fish Haven Dolomite. The strata strike N. 30° NE. and dip about 33° NW. The pipe lies near the center of a large triangular fault block; the nearest fault, however, lies about 400 feet to the north. The original exposures of ore consisted of a fluorspar-cemented breccia zone about 30 feet long. The ore pipe, quite irregular in outline, measures up to 30 feet in diameter and narrows to 8 feet. The pipe plunges steeply to the northwest. Approximately 2,000 tons of ore was mined from the Floride No. 1 pipe. The ore ranged from soft-white powder to dark purple boxwork. The ore averaged from 65 to 70 percent effective fluorite. Ore is present in the bottom of the pipe. The potential of the remaining inferred ore is less than 500 tons.

Floride No. 5 Mine

The Floride No. 5 mine lies on the south side of a steep ridge in the southern part of Spor Mountain. The mine property is in the SE¼ sec. 3, T. 13 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The property is reached by a road on the southwest end of the mountain. The Floride No. 5 claim was staked in 1944 by George P. Spor and his sons, Chad and Ray. The present owners

are Chad and Ray Spor of Delta. The fluorspar crops out near the crest of a ridge at an elevation of 5,470 feet. Because of the steep terrain the property was developed by an adit driven at an elevation of 5,340 feet. The adit enters the hill from the south and extends N. 27° E. about 250 feet; then it turns 30 feet east to intersect the ore pipe. At 205 feet from the portal a raise was extended to the surface to an elevation of 5,430 feet. A 50-foot trench was cut from the top of the raise to the ore pipe. The deposit was then mined from an open pit. The ore was trammed to the raise and dropped down to the adit level. The first ore was shipped in 1954. After the ore was mined down to the trench level, a second raise was constructed off the main raise. It intersected the ore pipe about 50 feet below the bottom of the open pit. Ore was dropped down the raise and removed from the mine. A third raise extended from the adit level upward in the ore pipe. A glory hole now extends 130 feet down from the surface to the adit level. Approximately 6,500 tons of fluorspar ore has been shipped from the Floride No. 5 pipe. The property is described by Staatz and Carr (1964, p. 146-148) and Chojnacki (1964, p. 152-154). The mine is mentioned briefly by Bullock (1967, p. 37, 119).

The Floride No. 5 mine occurs in the lower half of the Silurian Bell Hill Dolomite. The ore body is oval shaped, measuring 27 feet long and 20 feet wide. The pipe has smooth walls and plunges 61° SE. On the adit level the pipe is circular and about 5 feet in diameter. The fluorspar varies from soft and friable varieties to hard boxwork ore. In places the boxwork is coated with tiny white crystals of calcite. A small quantity of white montmorillonite clay accompanies the ore. The ore ranges from light to dark purple and averages about 70 percent fluorite. The ore is slightly radioactive, averaging about 0.03 percent uranium. The ore pipe plunges to the southeast below the adit level. The better inferred ore potential is less than 500 tons.

Floride No. 13 Mine

The Floride No. 13 mine lies at an elevation of 6,080 feet in the south-central part of Spor Mountain. It is on the summit about 1 mile north of the Floride mine. The property lies in an unsurveyed area that would fall in the SE¼ sec. 34, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The property was located in 1953 by George P. Spor and his sons, Chad and Ray. The present owners are Chad and Ray Spor of Delta. The mine has been developed by a south trending, 40-foot trench cut about 20 feet deep and by a 30-foot near vertical shaft in the trench floor and on the north side of the ore pipe.

The Floride No. 13 deposit crops out in the Silurian Bell Hill Dolomite. The ore pipe is slightly oval shaped, measuring about 25 by 30 feet in diameter. The pipe is vertical and uniform in diameter and has steep smooth walls. The pipe was mined to a depth of 20 feet by an open cut from the trench; then it was deepened an additional 30 feet by an 80 degree inclined shaft. Approximately 2,000 tons of ore was shipped from this ore pipe. The ore ranged from soft friable materials to hard boxwork. The ore varied from white to lavender to dark purple and averaged about 80 percent effective fluorspar. The Floride No. 13 pipe continues in depth and has a better inferred-ore potential of less than 1,000 tons.

Floride No. 18 Mine

The Floride No. 18 mine lies at an elevation of 5,780 feet on the eastern side of Spor Mountain. The mine is 1 mile north of the Floride mine. The Floride No. 18 claim lies in an unsurveyed area that falls in the SE¼ sec. 34 and the SW¼ sec. 35, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The claim was staked in 1953 by George P. Spor and his sons, Chad and Ray. The present owners are Chad and Ray Spor of Delta. The mine is developed by a 70-foot adit, two raises, and a winze. The mine is described by Chojnacki (1964, p. 149-151).

Two vertical fluorspar pipes occur on the Floride No. 18 claim, which replace Ordovician Fish Haven Dolomite. The strata strike N. 35° E. and dip 34° NW. On the northeast side of the mine the Ordovician Swan Peak Quartzite is in fault contact with the Fish Haven Dolomite. The quartzite crops out just 20 feet northeast of the adit portal. The fault strikes N. 45°-55° W. and dips 72° SW. toward the ore pipes.

The main fluorspar pipe crops out at the surface and is oval shaped. The long axis trends slightly northwest and measures 30 feet long and about 20 feet wide. The ore was mined from an adit 40 feet below the surface outcrop. The pipe was almost circular in shape on the adit level, measuring 10 by 12 feet. A raise was extended from the adit level to the surface and was mined by a winze to a depth of 35 feet below the adit level. At the bottom of the workings the pipe measured only about 8 feet long and 4 to 6 feet wide.

The second fluorspar pipe does not outcrop at the surface. It was discovered in the adit about 20 feet northwest of the main pipe. This pipe, about 10 feet in diameter, was stoped from the adit level to about 32 feet above the floor. The stope does not continue to the surface. Directly above the stope the ore pipe is only 3 feet in diameter. No ore was mined below the adit level.

The fluorspar from the Floride No. 18 mine ranged from white to dark purple and varied from soft earthy materials to hard boxwork ore. A total of approximately 1,000 tons of ore was shipped from the mine. The ore potential is small, perhaps less than 200 tons of highly siliceous fluorspar.

Fluorine Queen Mine

The Fluorine Queen mine property straddles the central ridge of Spor Mountain (figure 22). The mine lies on the eastern side of the ridge on a steep mountain slope. The lower or eastern edge of the open pit is at an elevation of approximately 6,140 feet and 600 feet above the valley floor to the east. A steep mountain road, about 1 mile long, connects the mine with the haulage road along the east side of Spor Mountain. The mine is in an unsurveyed area that would fall into the NE¼ sec. 34, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Fluorine Queen claim was staked in 1948 by Francis B. (Scott) Chesley and William E. Black of Delta, who have maintained ownership to the present. The property is currently leased to U. S. Energy Corporation of Riverton, Wyoming. The mine is described by Cochran (1952, p. 18-20), Thurston and others (1954, p. 37-38), Staatz and Osterwald (1959, p. 72-75), and Chojnacki (1964, p. 141-142). The mine is mentioned briefly by Buranek (1948, p. 10), Dasch (1964, p. 164), Bullock (1967, p. 37, 119), and Elevatorski (1974, p. 92).

The Fluorine Queen mine, known as the East pit deposit, is developed in a large fluorspar pipe in the Silurian Bell Hill Dolomite. Most of the production has come from an elliptical-shaped open pit, which measures in a northeast direction 190 feet long and 110 feet wide. The main pit extended to a depth of about 80 feet on the western side and about 20 feet on the eastern side. The western edge of the open pit lies at an elevation of about 6,200 feet, and the eastern edge is about 60 feet lower. The main pit eventually extended about 20 feet lower than the eastern edge of the pit, but it is now backfilled with waste rock.

In 1951 a 95-foot inclined adit, known as Adit No. 1, was driven from the road westward into the lower part of the East pit deposit. The portal is at an elevation of approximately 6,110 feet; in the ore body the adit is 15 feet lower. A sublevel 25 feet higher was developed from which raises extended to the bottom

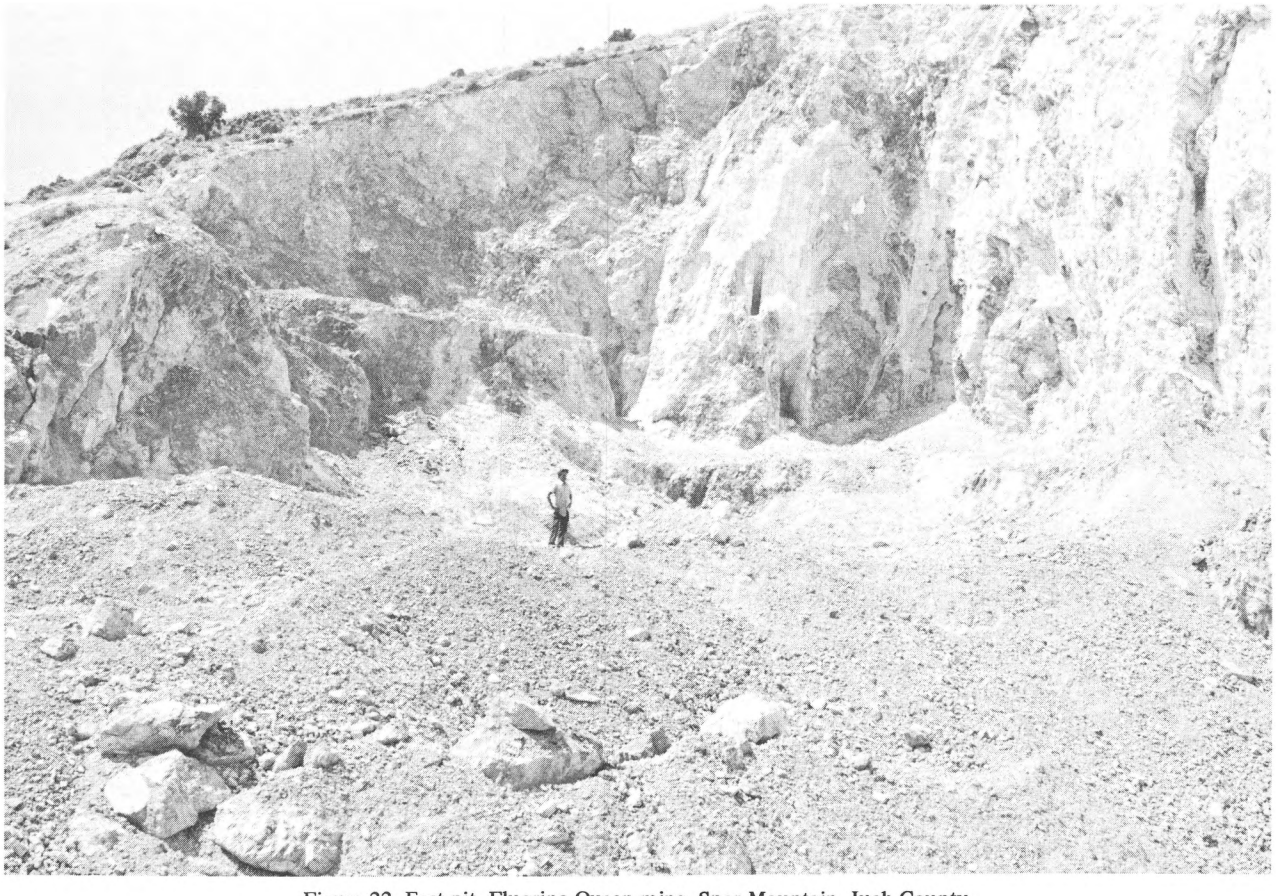

Figure 22. East pit, Fluorine Queen mine, Spor Mountain, Juab County.

of the open pit and from which ore was withdrawn. At an elevation of about 6,052 feet a second inclined adit was cut into the Fluorine Queen pipe. This adit, known as Adit No. 2, measures 205 feet long and levels off 21 feet lower in dolomite. At least 280 feet of crosscuts were made, but only small exposures of fluorspar were found. Later a 500-foot adit at an elevation of 5,967 feet was driven S. 75° W. below the ore body. No ore was found. In 1970 the U. S. Energy Corporation extended the adit 190 feet farther to the southwest; at 470 feet from the portal a 110-foot arcuate crosscut was driven to the northwest and north beneath the ore body. Only a small ore body containing siliceous fluorspar was found. Several 70-foot drill holes from the adit and crosscut probed for ore.

The Fluorine Queen mine lies in a highly faulted area. The largest fault lies 300 feet to the southeast of the mine with several hundred feet of displacement. Several smaller faults cut the open pipe and nearby dolomite. In fact, the area appears to be a zone of shattering with many small faults and shears.

The Fluorine Queen ore pipe consisted of a major elliptical-shaped pipe, measuring about 155 feet long and 105 feet wide at the surface, that extended from 6,200 to about 6,120 feet. A large north-south trending dolomite mass, found in Adit No. 1 at an elevation of 6,092 feet, extended upward to the sublevel at 6,117 feet. The ore diminishes rapidly below this sublevel. The western ore pipe measures only 6 feet by 30 feet on the sublevel. The eastern ore body consisted of two connected stopes measuring 30 feet by 65 feet and 50 feet by 55 feet on the sublevel. On the Adit No. 1 level the western ore body is absent, and the eastern pipe measures only 19 feet by 40 feet. In Adit No. 2, at the elevation of 6,031 feet, the eastern pipe has reduced to a veinlike occurrence measuring 7 feet wide and 40 feet long. The lowest adit, known as the Main Lower Tunnel, lies at an elevation of 5,967 feet. Here a small ore body of silicified fluorspar yielded about one carload of ore.

The main mineralization is restricted to the Bell Hill Dolomite, and it diminishes rapidly at the Bell Hill-Floride Dolomite contact. The eastern pipe, however, extends downward into the Ordovician-Silurian Floride Dolomite. The fluorspar varies from soft and friable to hard boxwork ore. Much of the boxwork is thin walled and filled with fine fluorite or impurities. The chief impurity is white montmorillonite clay. Quartz stringers and crystals are found in places. Calcite lines and nearly fills some boxworks. The ore ranges from white to dark purple. The ore deeper in the mine is reddish brown and siliceous. The ore has ranged from 61 to 82.5 percent fluorite, 3 to 6 percent silica, and up to 12 percent calcite. The ore contains from 0.01 to 0.02 percent uranium.

The Fluorine Queen pipe, known as the East pit, is the second largest fluorspar producer in Spor Mountain. It yielded about 36,000 tons of ore from 1948 to 1975. If the remaining ore in place and ore from caved in parts of the pipe can be successfully extracted, an additional 4,000 tons of fluorspar may be produced from the mine.

Fluorine Queen No. 1 Mine

The Fluorine Queen No. 1 mine adjoins on the south of the Fluorine Queen claim. The property straddles the central ridge of Spor Mountain. The workings, known as the Middle pit deposit, lie near the summit on the western side of the ridge at an elevation of 6,145 feet. The claim lies in an unsurveyed area that falls into the NE¼ sec. 34, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Fluorine Queen No. 1 claim was staked in 1948 by Francis B. (Scott) Chesley and William E. Black of Delta. Currently, the claim is leased to U. S. Energy Corporation of Riverton, Wyoming. The claim has been described by Thurston and others (1954, p. 37-38), Staatz and Osterwald (1959, p. 72-75), and Chojnacki (1964, p. 134-141).

The shape of the fluorspar pipe at the Middle pit deposit is irregular and elongated in a northeast direction. It measures 105 feet long and up to 40 feet wide at the surface. The ore crops out in the Bell Hill Dolomite, but at depth the ore also occurs in the underlying Floride Dolomite. The original operations consisted of a 35- to 40-foot trench cut into the mountainside from which the upper part of the pipe was mined. A backhoe was used to remove ore to about 20 feet below the trench level. The north side of the open pit measured about 80 feet high, and the south wall had a minimum height of about 35 feet. These mining operations were conducted mainly from 1949 to 1956. Approximately 15,000 tons of ore was removed during this time.

In 1974 the U. S. Energy Corporation drove a northwest-trending, 220-foot adit and intersected the western edge of this ore pipe 83 feet below the surface workings. From December 1974 through December 1975 about 12,000 tons of ore was removed from these underground operations. A series of samples of this ore averaged 72.4 percent fluorite, 2.6 percent silica, and 5.6 percent calcite. Washed fines of this ore taken at the Bailey Fluorspar mill in Delta, averaged 82.8 percent fluorite, 0.60 percent silica, and 3.78 percent calcite. Washed coarse ore averaged 91.8 percent fluorite, 0.40 percent silica, and 1.0 percent calcite. An additional 161-foot block of ore below the present underground workings has been outlined. A 400-foot drift, at a 15 percent grade downward, is proposed to mine this block of ore. The drift would

extend southwest from the lowermost adit of the Fluorine Queen East pit deposit. The drift would lie at the bottom of the ore block at an elevation of about 5,905 feet.

The fluorspar ore ranges from white to lavender to dark purple. Samples obtained from a drill hole in the deeper block of ore are reddish brown and high in silica. The ore varies from soft and friable to hard boxwork. The boxworks are typically thin walled and filled or partly filled with fluorite or impurities. White, waxy montmorillonite clay is the chief impurity. Calcite lines and partly fills some boxworks; quartz stringers and crystals are found in places. The ore is slightly radioactive, ranging from about 0.02 to 0.04 percent uranium. Potentially, the Middle pit fluorspar pipe could produce an additional 20,000 tons of ore, but this will be siliceous and will require some beneficiation to be metallurgical quality.

Fluorine Queen No. 2 Mine

The Fluorine Queen No. 2 mine property straddles the summit ridge of Spor Mountain. The claim adjoins immediately to the north of the Fluorine Queen claim; it is in an unsurveyed area that would fall into the SE¼ sec. 27, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The deposit is known as the Fissure pit and lies about 300 feet northwest of the East pit of the Fluorine Queen claims. The deposit cropped out at an elevation of about 6,280 feet near the summit on the east side of the ridge. The claim was staked in 1948 by Francis B. (Scott) Chesley and William E. Black of Delta. The claim is presently leased to U. S. Energy Corporation of Riverton, Wyoming. The mine has been described by Chojnacki (1964, p. 142-143).

The fluorspar deposit is along a fault in the Silurian Bell Hill Dolomite. The fault strikes northeast and dips steeply to the southeast. The Fissure pit deposit is small. On the surface the deposit measured about 60 feet long and was 8 to 15 feet wide. The ore was mined from the surface to a depth of 40 feet and from an upper adit known as the North Tunnel No. 1. This adit is 70 feet below the outcrop at an elevation of about 6,210 feet. It was driven 110 feet in a N. 80° W. direction. A stope at the end of the adit measures 12 feet by 25 feet. A raise was extended to the surface. Approximately 3,000 tons of ore was removed from the Fissure pit deposit in the early 1950's. A fault at the end of the drift strikes N. 48° E. and dips 73° SE.

In 1972 the U. S. Energy Corporation drove the lower adit, known as the North Tunnel No. 2, which lies at an elevation of about 6,135 feet. The 128-foot long adit was driven N. 70° W. Forty feet from the portal the adit cuts a rhyolite porphyry plug that measures 20 feet along the adit. Only minor mineralization was found on this level.

Fluorspar from the Fissure pit deposit differed from most of the ore in Spor Mountain in two ways: the occurrence is a fissure deposit; and the fluorite is dense, coarsely crystalline, and banded. The ore averaged 90 percent fluorite and 5 to 6 percent silica. The ore was slightly radioactive. The Fissure pit deposit on the Fluorine Queen No. 2 claim produced about 3,000 tons of ore, but the deposit is now depleted.

Fluorine Queen No. 4 Mine

The Fluorine Queen No. 4 mine lies about 1,000 feet southwest of the Fluorine Queen East pit deposit. The occurrence lies on a southeast facing slope at an elevation of 6,120 feet in the upper westward drainage of Spor Mountain. The mine lies in an unsurveyed area that would fall in the NE¼ sec. 34, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Fluorine Queen No. 4 claim was staked in 1948 by Francis B. (Scott) Chesley and William E. Black of Delta. The mining operations are on the Fluorine Queen No. 4 and No. 1 claims, but the deposit is actually on the Fluorine Queen No. 1 claim. The property is presently under lease to U. S. Energy Corporation of Riverton, Wyoming. The property is described by Thurston and others (1954, p. 38), Staatz and Osterwald (1959, p. 76), and Chojnacki (1964, p. 138-140). The mine is mentioned briefly by Dasch (1964, p. 164) and Bullock (1967, p. 37, 119).

The fluorspar deposit consists of low-grade fluorite mineralization in a Tertiary porphyritic rhyolite plug, which cuts the Silurian Bell Hill Dolomite. The dolomite crops out in a prominent cliff; it strikes N. 36° E. and dips 35° NW. The intrusive plug is L-shaped, extending to the northwest about 130 feet long by 40 feet wide with a projection to the east-northeast about 80 feet long and 15 feet wide. The porphyritic rhyolite, gray and fine grained, contains scattered phenocrysts of smoky quartz. The rock is iron stained, and montmorillonite clay coats some of the fractures. In the center of the northwest-trending plug was a somewhat circular mass about 40 feet in diameter of red dolomitized breccia, which contained low-grade fluorspar.

The deposit was mined from a trench cut into the intrusive plug to the fluorspar pipe. The floor of the open pit now lies up to 55 feet below the surface. As the pipe was mined the grade gradually improved, but the diameter of the pipe decreased to about 30 feet. Approximately 1,000 tons of fluorspar ore, which

averaged 60 percent fluorite and up to 12 percent silica, was mined from this pit in the early 1950's. The ore was blended with higher grade materials from nearby ore pipes. The fluorspar is white to lavender, and the matrix contains abundant limy material. The ore is slightly radioactive, ranging from 0.01 to 0.02 percent uranium.

In 1953 three drill holes south and one drill hole north of the fluorspar pipe gave negative results to depths of about 75 feet. A 172-foot drill hole in the center of the ore pipe gave a favorable test. From the surface down to 80 feet the ore averaged 65.5 percent fluorite, and from 81 to 111 feet the ore averaged 88.7 percent fluorite. From 111 to 163 feet circulation was lost in the hole, and from 163 to 172 feet dolomite was found. The deposit remained idle until 1972 when the U. S. Energy Corporation mined about 800 tons of fluorspar from the open pit and lowered the floor level to about 35 feet. The deposit has an ore potential of about 4,000 tons of low-grade and siliceous fluorspar that would require beneficiation to meet metallurgical requirements for industry.

Green Crystal Mine

The Green Crystal mine is in the central part of Spor Mountain on the west side of the main divide at an elevation of 5,830 feet. The mine lies in an unsurveyed area that would fall in the SW¼ sec. 27, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Green Crystal mine on the south slope of a prominent southwest-trending ridge adjoins the Dell No. 5 claim on the southwest. The fluorspar deposit occurs about 700 feet west of the Red pit on the Dell No. 5 claim. The Green Crystal claim was staked in 1952 by Albert Willden, Earl Willden, and Tass A. Claridge of Delta. The present owner is Willden Fluorspar Company, in care of Darrell Willden of Delta. The property has been described by Chojnacki (1964, p. 164-165) and Staatz and Carr (1964, p. 148). The mine is mentioned briefly by Bullock (1967, p. 37, 119).

In 1954 the road to the Dell No. 5 property was extended southwest to the Green Crystal pipe. The first ore was produced in 1956, when about 500 tons of fluorspar was shipped. The original workings consisted of a deep cut 60 feet long and 20 feet wide. The ore was mined at the end of the cut from an open pit that measured 40 feet long, 30 feet wide, and 50 feet deep. The mine remained inactive until the summer of 1975, when the pit was deepened and 300 tons of ore was mined.

The Green Crystal ore body comprises an oval-shaped pipe about 18 feet wide by 43 feet long. It plunges steeply to the southeast. The ore crops out in the lower part of the Silurian Floride Dolomite and extends downward into the Ordovician Floride Dolomite and the Ordovician Fish Haven Dolomite. The strata strike N. 40° E. and dip 30° NW. The south side of the deposit is bounded by a 20-foot zone of sheared and brecciated dolomite. The fluorspar pipe occurs within the zone along multiple shear planes. Undisturbed dolomite just a few inches away is not replaced.

The fluorspar ore at the surface was pale to dark purple but with depth was light reddish brown. Pistachio green fluorite lines some of the boxworks, hence the name–Green Crystal mine. Most of the ore is boxwork and fine grained. White and brown montmorillonite clay is the principal impurity, but some chalcedony is present. The ore averages about 67.9 percent fluorite, 18.4 percent silica, and 1.69 percent calcite. After crushing and screening, the coarse ore averages about 78.8 percent fluorite, 10.6 percent silica, and 1.07 percent calcite. During the summer of 1975 the ore was mined to 30 feet below the entrance to the trench level. If the ore continues another 100 feet in depth, the potential of the Green Crystal mine is about 3,500 to 4,000 tons. The ore is high in silica and requires beneficiation to meet metallurgical requirements.

Harrisite Mine

The Harrisite mine on the southern end of Spor Mountain adjoins the Lucky Louie mine on the west and the Bell Hill mine on the east. It is in the S½ sec. 10, T. 13 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The main workings are in a small dry stream bed. The claim was located in 1949 by E. D. Harris, E. T. Harris, Rex Harris, John Harris, and Mark Harris of Delta. The property is inactive but was held by assessment work until 1971 by John Harris of Hinckley. The Harrisite mine has been described by Cochran (1952, p. 26-27), Thurston and others (1954, p. 38-40), Staatz and Osterwald (1959, p. 76-80), and Chojnacki (1964, p. 148-149). The mine is mentioned briefly by Bullock (1967, p. 37, 119) and Elevatorski (1974, p. 93).

Early trenching and several test pits exposed small fluorspar veins and pipes. During June 1951 the Harrises sank two small shafts on two of the pipes. One was 10 feet in diameter, and the other was 4 feet by 6 feet at the surface. One carload of ore was shipped, containing 78 percent fluorite and 4 percent silica. In November 1951, the property was leased to Ray and Harold Davis, who made two bulldozer trenches. A flat thrust fault, exposed in a 15-foot trench in the central part of the wash, revealed small fluorspar masses which at points extended to the surface. Below this fault only small stringers of fluor-

spar were observed. An inclined shaft, 64 feet deep, was sunk from the bottom of this excavation beneath the thrust fault and under the largest of the two small pipes. No additional ore was found at depth. The Davises obtained about 65 tons of fluorspar ore.

Dolomite sedimentary strata of Silurian age are exposed at the Harrisite property. In the southern part of the claim latite porphyry of Tertiary age is intruded into the dolomite. The intrusive contact between the dolomite and latite porphyry cross the Harrisite claim. These rocks are in part overlain by Lake Bonneville sands and gravels. Owing to considerable faulting, the Silurian Harrisite, Lost Sheep, and Thursday Dolomites are all present on the Harrisite claim. The beds strike N. 6° W. to N. 29° E. and dip 25°-42° NW. The dolomite is cut by numerous northeast trending faults that dip 60°-75° SE.; the largest fault has a displacement of at least 250 feet. The flat thrust fault was exposed during mining operations in the wash.

Fluorspar occurs as small veins and disseminations in the latite porphyry. The grade is low and does not exceed 30 percent fluorite. Samples contain from 0.039 to 0.094 percent uranium. Fluorspar also occurs along the contact of the latite porphyry and the dolomite. A series of small veins cut the dolomite. The veins are small, irregular, and up to 3½ feet wide. A small amount of fluorspar came from these veins. Most came from the two small pipes in dolomite. Both pipes and veins were irregular and contained abundant horses of dolomite. The larger pipe, 10 feet in diameter, extended only to a depth of 8 feet. The second productive pipe measured 4 feet wide by 6 feet long and bottomed at 23 feet. The productive pipes and veins do not extend below the flat thrust fault. This fault is older than the fluorspar bodies and has served as a passageway for fluorine-bearing solutions.

The fluorspar ore of the Harrisite mine is soft and friable and ranges from dark purple to white. The chief impurity is montmorillonite clay. The ores were radioactive and ranged from 0.073 to 0.17 percent uranium. Total recorded production of fluorspar from this mine is 102 tons of ore averaging 81 percent fluorite and 4 percent silica. The deposit has no future potential for fluorspar production.

Hilltop Mine

The Hilltop mine is near the top of a steep ridge at an elevation of 5,570 feet on the north end of Spor Mountain. The mine lies 1,300 feet northwest of the Lost Sheep mine in an unsurveyed area that would fall in the NE¼ sec. 21, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The property was located in 1948 as the Hilltop and Hilltop Nos. 1-8 claims by P. W. Watts, E. J. Hamblin, W. B. Hamblin, and Lee McCallister of Delta. In 1951 a bulldozer cut exposed several small veins of fluorspar. Two small fluorspar pipes were discovered on the hillside above the bulldozer cuts. The pipes, mined by open pits in 1952 and 1953, produced 316 tons of ore. Presently the property is covered by two claims, the Hilltop and Hilltop No. 1, and is held by the Hilltop Mining Company. The principal owners are Albert Willden, Darrell Willden, Carl Willden, and N. S. Bassett of Delta. The mine is described by Staatz and Osterwald (1959, p. 80-81) and is mentioned briefly by Bullock (1967, p. 37, 119).

The fluorspar mineralization crops out in the Silurian Harrisite Dolomite, which is a massive dark gray to black dolomite that contains nodules and bands of black chert. Southwest of the two ore pipes is a small fault with a 50-foot displacement. To the north and east is a small irregular intrusive breccia pipe. The breccia consists of angular fragments of white porphyritic rhyolite.

The smaller of the two fluorspar pipes is irregular in outline and has a maximum diameter of 5 feet. The larger rectangular pipe measures 16 feet long by 5 feet wide. The ore is chiefly a brown fluorspar boxwork. The voids in the boxwork were formed by a leaching of the dolomite fragments. A few small quartz crystals were observed in the boxwork. The 316 tons of ore shipped from the Hilltop mine was metallurgical grade. The ore was slightly radioactive. The deposit appears to have been mined out, and it has no future potential for commercial production of fluorspar.

Lost Sheep Mine

The Lost Sheep mine, the largest fluorspar producer in Utah, is at the extreme northeastern end of Spor Mountain at an elevation of 5,350 feet (figure 23). The property lies in an unsurveyed area that would fall into the SE¼ sec. 21, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The mine lies on the east side of a hill and is reached by a ¼ mile private road from the haulage road on the east side of the mountain. The Lost Sheep claims Nos. 1-4 were staked in 1948 by Albert Willden and Earl Willden of Delta. The claims adjoin the east side line of the Blowout mine property. The Lost Sheep mine is owned by Willden Fluorspar Company, in care of Darrell Willden of Delta. Two fluorspar pipes crop out on the Lost Sheep No. 1 claim; the most productive is called the Purple pit deposit, and a smaller pipe that lies 700 feet to the south is called the Badger Hole pit deposit. The pipes have been developed by open cuts, an inclined shaft, a vertical shaft, adits, crosscuts, and raises. The Lost Sheep mine is described by Bauer (1952, p. 31-35), Cochran (1952, p. 16-18), Thurston and others (1954,

Figure 23. Purple pit and Willden campsite, Lost Sheep mine, Spor Mountain, Juab County.

p. 40-42), Staatz and Osterwald (1959, p. 81-84), and Chojnacki (1964, p. 159-162). The mine is mentioned briefly by Buranek (1948, p. 10), Dasch (1964, p. 164), Bullock (1967, p. 38, 119), and Elevatorski (1974, p. 92).

The main or Purple pit pipe crops out in the Silurian Lost Sheep Dolomite, the formation being named after the Lost Sheep mine. The pipe extends downward over 400 feet through the Lost Sheep Dolomite and the Silurian Harrisite Dolomite, and terminates in the Silurian Bell Hill Dolomite. The strata near the pipe strike N. 40°-45° E. and dip 37°-42° NW. The Purple pit lies along the western edge of an intrusive rhyolite breccia plug measuring 1,150 feet long and 400 feet wide. A normal fault crops out on the west side of the hill about 600 feet west of the Purple pit pipe. The fault strikes N. 55° E., dips 38° SE., and projects to a point about 400 feet below the original surface of the Purple pit. Movement along this fault has placed Bell Hill Dolomite in the hanging wall against the top of the Swan Peak Quartzite in the footwall. Thus, the Purple pit pipe is not expected to project much below the 400-foot level.

At the surface the Purple pit, crescent shaped with a somewhat irregular outline, trends east-west. It measures about 185 feet long across the arms of the crescent with a maximum width of about 75 feet. Fluorspar ore was mined by open pit operations to approximately the 110-foot level. The surface workings were mined from benches with dolomite forming the smooth vertical walls of the open pit. An inclined shaft was sunk to the 200-foot level. A vertical shaft was sunk to the east of the pit. By the summer of 1975 the shaft had been deepened to the 400-foot level. Crosscuts from the shaft were developed on the 150, 250, 325, and 400-foot levels. The ore was mined by a series of raises and has been removed above the 325-foot level, forming a huge glory hole with vertical to near vertical walls. Production from the Purple pit has been approximately 90,000 tons of ore from 1948 through 1975.

The Purple pit fluorspar pipe has a toothlike form. From the surface to a depth of nearly 150 feet the deposit formed a continuous crescent-shaped ore body, roughly 160 feet long and 60 feet wide. At about the 150-foot level the main pipe began to split; and at the 250-foot level three smaller pipes were present, measuring about 30 by 30 feet, 30 by 40 feet, and 30 by 20 feet from west to east. At the 325-foot level the two large pipes were about the same size, but the eastern pipe was veinlike, measuring only 4 feet

wide and 20 feet long. At the 400-foot level only the central pipe was present, measuring about 25 feet in diameter. The western pipe is apparently terminated by the normal fault that dips beneath the Purple pit pipe, whereas the eastern pipe wedges out. Reserves in the central pipe are estimated at about 4,000 tons of siliceous ore.

The fluorspar ore is white to deep purple, except on the lower levels where it is reddish and high in silica. Much of the ore near the surface was soft and friable, but most has been hard with nearly filled boxwork structures. Ore ranges from about 78 to 95 percent fluorite. Much of the ore has averaged about 85.4 percent fluorite and 2.6 percent silica. Some selected carloads of ore averaged about 95 percent fluorite. A typical high grade ore averaged 91.3 percent fluorite, 2.7 percent silica, and 1.6 percent calcite. Uranium content is low, ranging from 0.009 to 0.029 percent.

The second pipe near the southern end of the Lost Sheep No. 1 claim, 700 feet south of the Purple pit and 300 feet east of the Blowout mine pit, is referred to as the Badger Hole pit. This fluorspar pipe marks the original discovery site on the Lost Sheep claims. Ore was discovered when the Willden brothers, who were following stray sheep at the time, found fluorspar at the entrance of a badger hole. The Badger Hole pipe is oval shaped and measures 28 feet long and 16 feet wide at the surface. The ore crops out in the Silurian Harrisite Dolomite at an elevation of 5,595 feet. This deposit was mined from a 110-foot adit, which enters the hill from the east and bears N. 75° W. The adit was cut on the 50-foot level, where the pipe measured only 13 feet in diameter. Approximately 600 tons of ore was mined from the Badger Hole pipe from the 50-foot level to the surface. A lower level, which is the 110-foot level of the Badger Hole pipe, was developed by extending a crosscut eastward from the Claridge-Willden adit that served the Blowout mine. The workings lie directly below the pipe on the 50-foot level, but no ore was found. Ore from the Badger Hole pipe is similar to the nearby Blowout pit and the Purple pit. Ore ranged from 66 to 83 percent fluorite and contained small quantities of uranium.

Lost Soul Prospect

The Lost Soul prospect lies at an elevation of 5,340 feet on the western side of Spor Mountain. The property lies in an unsurveyed area that would fall in the SE½ sec. 28, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). Two Lost Soul claims were staked in 1950 by Sherman Perkins and Wesley Sampson of Delta. Assessment work was maintained until 1958. Mine workings consist of a bulldozer cut, an adit 40 feet long, and a shorter adit 7 feet long. The property is described by Staatz and Osterwald (1959, p. 73, 84) and is mentioned briefly by Bullock (1967, p. 38, 119).

The adit portals and bulldozer cuts are in the upper gray member of the Silurian Bell Hill Dolomite. The strata strike N. 30° E. and dip 40° NW. The 40-foot adit trends to the west, and at 8 to 15 feet from the portal the adit passes through a 7-foot zone of fracturing. At 25 feet from the portal the adit crosses into the overlying Silurian Harrisite Dolomite. At the contact the adit forms two branches. The northern branch trends to the northwest for about 15 feet more. Near the face the adit passes through a zone almost 2 feet wide that contains 10 to 50 percent fluorite. Most of the material is a boxwork of dark purple, fine-grained fluorite and white dolomite. The adjacent rock contains irregular masses of purple fluorite. The southern branch trends to the southwest for about 10 feet and cuts a 8-inch fracture zone of dolomite. It contains about 10 percent of fine-grained purple fluorite as coatings along the fractures and as irregular masses.

The fluorite occurrences in the main adit are restricted to the Harrisite Dolomite near the Bell Hill contact. On the surface fluorite also fills tiny fractures near the base of the Harrisite Dolomite. The ore is slightly radioactive. A small stockpile of hand-picked fluorite lies near the adit portal. No shipments of fluorspar have been made from this prospect, which apparently has no commercial potential. The Lost Soul prospect is a minor occurrence of fluorite on Spor Mountain.

Lucky Louie Mine

The Lucky Louie mine is on some low hills on the southern end of Spor Mountain at an elevation of 5,120 feet. It lies in the W½SW¼ sec. 10, T. 13 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Lucky Louie mine was located in 1948 by James Quigley, Ehard Snell, H. E. Carlson, and Hyrum Schmidt of Eureka. Several trenches cut by bulldozers exposed an area of the property about 8 feet wide that contained some fluorspar. Several large boulders of fluorspar were also found about 700 feet east in Lake Bonneville sediments. Only assessment work was attempted until the fall of 1951, when mining began by James Quigley and H. E. Carlson. During exploratory work an oval pipe 35 feet long and 14 feet wide was uncovered below the surface outcrop found in 1948. The first ore was shipped in January 1952. The pipe was mined to a depth of 120 feet, where it became uneconomical to operate. The Lucky Louie claim was sold in 1952 to Chief Consolidated Mining Company and patented in

1955. In 1971 the mine was sold to Centennial Development Company of Salt Lake City. This was the only fluorspar mining claim patented on Spor Mountain in 1975. The mine has been described by Cochran (1952, p. 27-28), Thurston and others (1954, p. 42), Staatz and Osterwald (1959, p. 84-85), and Chojnacki (1964, p. 143-145). The mine is mentioned briefly by Bullock (1967, p. 38, 119) and Elevatorski (1974, p. 93).

The Lucky Louie mine lies in a strongly faulted area, although the mineralized fluorspar pipe itself is about 90 feet from the nearest fault. The pipe crops out in the gray cherty member of the Lost Sheep Dolomite, Silurian in age. It plunges about 60° N. 89° E. The ore body decreases in size with depth, and at the bottom of the workings it measures only 10 feet by 7 feet. The ore in the upper part of the pipe was soft white to purple fluorite with small quantities of residual chert derived from the host rock. At about 90 feet in depth from the surface large pieces of black chalcedony appeared in the ore. At 120 feet at the bottom of the workings chalcedony made up the entire central part of the pipe, with a narrow 18 inch zone of banded fluorspar on the periphery.

A composite assay compiled from carload lots of shipped ore showed that the ore contained 81.6 percent fluorite and 5.2 percent silica. Total production from the pipe amounted to 1,178 tons. The ore deposit is depleted in this pipe, and no further fluorspar potential is known for this property. The ore contained 0.078 to 0.149 percent uranium.

Non Ella Prospect

The Non Ella prospect is at an elevation of about 6,000 feet on the eastern flank of Spor Mountain. The property lies in an unsurveyed area that would fall in the NE¼ sec. 34, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). Two claims, the Non Ella and Non Ella No. 1, were staked in 1948 by Nona Chesley and Ella Black. Assessment work was maintained until 1951, when the claims were restaked as part of the Fluorine Queen group of claims. Present ownership is vested in Chesley and Black in care of Francis B. (Scott) Chesley of Delta. Development work is limited and consists of an open pit that measures 15 feet long, 8 feet wide, and 10 feet deep. The property is described by Thurston and others (1954, p. 42-43) and Chojnacki (1964, p. 143). The prospect is mentioned briefly by Bullock (1967, p. 38, 119).

The Non Ella prospect is on the Silurian Fluoride Dolomite. It consists of thin-bedded, fine-grained, smooth-weathering gray dolomite and calcareous dolomite. The strata strike N. 35° E. and dip 34° NW. The fluorspar occurrence is nearly covered with talus of dolomite and chert boulders. The fluorspar body appears to be a small pipelike structure and contains limited amounts of white to pale purple, fine-grained fluorite and many stringers of silica. Small quantities of rhyolite porphyry are found on the dump. The prospect is regarded as a minor occurrence of fluorite on Spor Mountain.

Oversight Mine

The Oversight mine is the northernmost deposit in Spor Mountain on the top of a steep ridge at an elevation of 5,600 feet. The mine lies in an unsurveyed area that would fall in the NE¼ sec. 21, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Oversight mine adjoins the Hilltop mine that lies immediately to the south. The Oversight claims were staked in 1948 by Frank Lowder, Fred Staats, and Harold A. Stephensen. The present owners are Frank Lowder of Delta and Carol S. Nicholson of Salt Lake City. The property is described by Bauer (1952, p. 35-37), Cochran (1952, p. 25-26), Thurston and others (1954, p. 43), Staatz and Osterwald (1959, p. 85-88), and Chojnacki (1964, p. 154-155). The mine is mentioned briefly by Bullock (1967, p. 38, 119) and Elevatorski (1974, p. 92).

Development work consists of bulldozer trenches along the top of the ridge, several prospect pits, and an original cut that is 4 feet deep and 20 feet long. In the face of the cut the main fluorspar pipe was exposed. The pipe was mined in 1951 and 1952 by sinking a circular winze 15 feet in diameter. The winze was sunk on a 79 degree angle to a depth of 80 feet, where the ore shoots were too small to mine. Three short crosscuts along the winze were driven to explore outward from the main ore pipe. A smaller fluorspar pipe was exposed about 10 feet southeast of the main pipe. This pipe was mined by driving a short crosscut 24 feet below the surface and raising on the ore to the surface. From these two pipes about 600 tons of fluorspar ore was mined that ranged from 82.3 to 89.8 percent fluorite and from 2.2 to 4.2 percent silica. On the north side of the ridge, approximately 150 feet lower in elevation, a 261-foot adit was driven southward under the main ore pipe. Several small stringers and a small boxwork of fluorspar were found in the adit, but no ore was mined. The property has been idle since 1952, except for limited assessment work.

The fluorspar mineralization on the Oversight property occurs in the middle gray member of the Silurian Lost Sheep Dolomite. The strata strike N. 34° E. and dip 32° NW. The mine is in the central part of a fault block in a strongly faulted area. The main ore body lies 65 feet north of the nearest fault. An intrusive rhyolite breccia plug crops out 150 feet

southeast of the main ore pipe on the Hilltop property, and several small intrusive plugs occur about 250 feet to the northwest.

The main fluorspar pipe and several smaller pipes crop out on top of the ridge. The main pipe was 15 feet in diameter and plunged 79 degrees to the southeast. A vein extended for a few feet to the north at the surface. Approximately 60 feet below the surface the main pipe splits into two smaller shoots. At 80 feet the ore pipes are too small to be mined economically. The second largest pipe was just 10 feet southeast of the main pipe. It was oval shaped and measured 12 feet long and 6 feet wide. This pipe plunged 70 degrees to the east and was mined to a depth of 24 feet. Several smaller pipes measuring 1 to 5 feet in diameter lie west and south of the main ore body. These pipes are irregular in outline and have been prospected only a few feet in depth.

The fluorspar ore at the Oversight mine showed a well-developed boxwork structure, which measured from 1/8 to 3 inches across the boxwork. The ore was gray to brown and pale purple. Fluorite and small quartz crystals lined the cavities of the boxwork. Occassionally, small white dolomite crystals could be found. The ore contained small quantities of uranium, ranging from 0.003 to 0.007 percent uranium. Future commercial production from the Oversight mine will be limited. During recent assessment work a pit measuring 20 feet long and 10 feet wide exposed a mineralized area about 10 feet in diameter.

Prospector Prospect

The Prospector prospect lies on a low hill at an elevation of 5,200 feet near the southern end of Spor Mountain. The property is in the N½ sec. 10, T. 13 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The Prospector claim was staked in 1948 by Ray Spor and Lawrence Spor of Delta. Assessment work is current and the property is held by Spor Corporation. Mine workings are limited, consisting of a trench and bulldozer cuts. The property is mentioned briefly by Staatz (1963, p. M33).

A lima bean-shaped plug of porphyritic rhyolite has intruded dolomite of Silurian and Devonian ages. The main workings are cut in the Silurian Lost Sheep Dolomite. The elongated east-west intrusive measures 1,700 feet in length with a maximum north-south width of 800 feet. In places the porphyritic rhyolite plug is marked by a chilled glass border. Surrounding much of the plug is a calcareous clay zone of alteration about 20 feet thick, which has formed by the reaction of the hot rhyolite with dolomite. Within the alteration zone are small quantities of fluorspar and the beryllium mineral, bertrandite. Small purple fluorite veins are found in the zone of argillic alteration. A surface outcrop of unaltered dolomite is cut by veinlets containing cryptocrystalline quartz and some purple fluorite. The veins are irregular and range in thickness from a fraction of an inch to about 1 inch. The Prospector prospect is only a minor occurrence of fluorite on Spor Mountain.

Thursday Mine

The Thursday mine is on the northwestern side of Spor Mountain at an elevation of 5,520 feet. The mine lies in an unsurveyed area that would fall in the NE¼ sec. 28, T. 12 S., R. 12 W., Thomas Range (Spor Mountain) mining district, Juab County (figure 6). The mine, about 2,000 feet south of the Blowout mine, can be reached by a road from that property. The Thursday claim was located in 1949 by William C. Hamblin, G. Donald Hamblin, and Arden W. Hamblin of Kaysville. The property is currently owned by the Willden Fluorspar Company, in care of Darrell Willden of Delta. The property is described by Bauer (1952, p. 38-39), Cochran (1952, p. 30-31), Thurston and others (1954, p. 43-45), and Chojnacki (1964, p. 147-148). The property is mentioned briefly by Bullock (1967, p. 38, 119) and Elevatorski (1974, p. 93).

Mine workings consist of two adits, a few open cuts, and several prospect pits. The deposit was first developed by a large open cut. Production records are incomplete, but about 100 tons of ore was mined. The main mine adit was driven S. 43° E. along a fault for a distance of 175 feet. Ore averaging 5 feet wide was exposed along the entire length of the adit. A second adit was driven N. 80° W. for 300 feet from the eastern side of the hill and 150 feet below the main adit level. In the lower adit level the vein narrows to less than 1 foot, but other small veins and low-grade replacements occur along the entire length of the adit. No production has come from either adit at the present time.

Fluorspar mineralization occurs in the Silurian Thursday Dolomite. Near the mine the strata strike N. 42° E. and dip 30° NW. Ore is found as thin tabular veins and as replacements of dolomite. On the northeast side of the Thursday mine the dolomite is intruded by a dike of highly altered, reddish brown rhyolite porphyry. The northeast-trending dike is traced for nearly 400 feet. The dike occurs along a major unmineralized fault that can be traced 1½ miles completely across Spor Mountain. Near the mine the fault strikes N. 30° E. and dips 44° SE. Intrusive breccia occurs intermittently along the entire length of this fault.

Two fluorspar bodies are exposed at the Thursday mine workings. The largest deposit occurs

along the footwall of a fault that strikes N. 43°-60° W. and dips from 70°-82° NE. The fault is exposed throughout the mine adit and in the large open pits at the surface. This deposit has a maximum thickness of 14 feet in the surface workings and 6 feet in the main adit level, 65 feet below the surface. This body is exposed on the surface for 240 feet and in the adit for 175 feet. All fluorspar production, however, came from the surface workings mainly on this vein. The second deposit is a small chimney or pipe of fluorspar that is exposed in a prospect pit about 50 feet east of the large open cut. It has a maximum length of 60 feet and a maximum width of 10 feet. Only a few tons of ore came from this pipe. The fluorspar in both bodies is white to pale purple. The ore is fine grained and sugary in texture, and locally it contains small pockets of coarsely crystalline fluorite. Narrow veins of white crystalline calcite are abundant at the contact of the dolomite and the fluorspar. Because the Thursday mine ore was highly siliceous, it was mixed with 20 tons of higher grade ore from the Lost Sheep mine to bring this product up to metallurgical grade. The Thursday mine has an ore potential of up to 1,000 tons of highly siliceous ore that will require beneficiation.

Beryllium-Bearing Tuffs

Large beryllium-bearing deposits occur in water-laid volcanic tuffs on the flats surrounding Spor Mountain. Fluorite, which is closely associated with the beryllium mineralization, represents a large tonnage of low-grade fluorspar. The principal deposits lie in an area about 2 miles wide by 4 miles long in secs. 31 and 32, T. 12 S., R. 12 W. and secs. 4, 5, 6, 7, 8, 9, 10, 15, 16, and 17, T. 13 S., R. 12 W., Thomas Range (Spor Mountain) mining district, western Juab County (figure 6). Fluorspar, uranium, and beryllium ore have been produced commercially from this area. Beginning in 1944 and continuing to the present, fluorspar has been produced from about 20 pipes or chimneys and from a few veins in Ordovician and Silurian strata on Spor Mountain. Uranium ore was discovered in 1953, and mining started on the Yellow Canary property in the fall of 1956. The ore occurred in a small body of lacustrine sandstone interbedded in Tertiary volcanic rocks on the east side of Spor Mountain. The first beryllium deposits were found in 1959, and others in 1960 and 1961. The deposits contain large reserves of ore averaging less than one percent BeO. Brush Wellman began production in 1971 at their mill northeast of Delta; these deposits can be expected to provide a major source of beryllium in the future. Most of the property is owned or controlled by Brush Wellman and Anaconda Company, both with offices in Salt Lake City. The beryllium occurrences at Spor Mountain have been described by Staatz and Osterwald (1959, p. 89-91), Montoya and others (1962, 15 p.), Griffitts and Rader (1963, p. 16-17), Staatz (1963, 36 p.), Williams (1963, p. 36-59), Park (1968, p. 9-50), Shawe (1968, p. 1148-1161), and Lindsey and others (1973, 20 p.).

The rocks in the Spor Mountain area range from Ordovician to Pleistocene in age. Sedimentary rocks constitute the main mountain mass and range from early Ordovician to late Devonian in age. They have a northeast strike and dip gently to the northwest. They are cut by small northeast-trending thrust faults and by moderate, normal, and reverse faults. The mountain is bounded by large Basin and Range normal faults. The flats surrounding Spor Mountain are made up mainly of two groups of Tertiary volcanic rocks in which beryllium and accompanying fluorite are found. The attitude of the older volcanic group results from initial dip and some tilting of the Paleozoic rocks. The attitude of the younger volcanic rocks conforms to the original dip. In most places the valley flats are thinly to thickly mantled by gravels and marls of Pleistocene Lake Bonneville sedimentation.

Beryllium is present as the mineral bertrandite and is found chiefly in water-laid tuffs with varying amounts of accompanying fluorite. The flats surrounding Spor Mountain consist of an older and a younger group of volcanic rocks that are separated by an angular unconformity. Rocks of the older group are found on the east and south side of Spor Mountain. They have been divided into six units, which include dark labradorite rhyodacite, rhyodacite, porphyritic rhyolite, quartz-sanidine crystal tuff, vitric tuff, and intrusive breccia. Interbedded with these units on the east side of Spor Mountain is a water-laid sandstone and thin limestone pebble conglomerate that contains uranium mineralization. The greater part of the exposed volcanic rocks, however, belong to the younger group, which comprises five overlapping, identical sequences of volcanic rocks. Each sequence consists, in ascending order, of vitric tuff, volcanic breccia, and topaz rhyolite. The tuffs characteristically contain dolomite pebbles and clasts, in which both beryllium and fluorite mineralization is concentrated. The largest deposits are on the southwest and west sides of Spor Mountain.

The beryllium deposits occur mostly in water-laid vitric tuffs of the younger group, although at least one deposit, the Claybank, is known in the older group. The vitric tuff of the younger volcanic group exceeds 300 feet in thickness. The tuff is referred to as water-laid because of stratification and sorting of dolomite pebbles and clasts that characterize most outcrops. The tuff consists mostly of volcanic debris or its alteration products. In the area of beryllium mineralization, abundant dolomite pebbles and clasts are commonly altered to calcite, silica minerals, clay, fluorite, and manganese oxides. The tuff is divided into three

members. The lower member, characterized by dolomite pebbles and clasts, includes two-thirds of the total thickness. The middle member is present locally, forming a welded tuff. The upper member, marked by altered carbonate clasts and pebbles and volcanic rock fragments in greater abundance than in the lower member, makes up one-third of the total thickness.

Bertrandite and fluorite are found in altered tuff of the mineralized areas, and both minerals show high concentrations in the altered dolomite pebbles and clasts. Argillic and feldspathic alteration characterize the mineralized volcanic tuffs, the latter representing the most advanced stage. The argillic tuff is characterized by as much as 80 percent montmorillonite clay, less than 20 percent potash feldspar, and 1 to 5 percent fluorite. Dolomite pebbles and clasts range from white calcite to complete replacement by quartz, opal, purple fluorite, clay, and manganese oxides. Feldspathic tuff consists of over 20 percent feldspar, up to 30 percent cristobalite, as much as 40 percent montmorillonite clay, and 1 to 8 percent fluorite. Dolomite pebbles and clasts are replaced by quartz, opal, and purple fluorite, or by clay, fluorite, and manganese oxides. The maximum beryllium content of any ore specimen might be between 7 and 10 percent, associated with a fluorite content of about 30 percent. Mining operations indicate that the beryllium-bearing tuff deposits normally range between 3 percent and 15 percent fluorite for an average of 8 percent. An analysis of a large ore sample from the Blue Chalk stockpile averaged 12.67 percent fluorite, 64.0 percent silica, and 1.91 percent calcite.

Beryllium ore production to date at Spor Mountain has been restricted to operations by Brush Wellman, which operates three large open pits. The Roadside pit, which was first in operation, measures 50 to 125 feet deep and 3,800 feet long. The Blue Chalk pit is 100 feet deep and 1,400 feet long (figure 24). Ore has been removed from the present Roadside and Blue Chalk pits. In 1974 the Fluro pit was developed, measuring 150 feet deep and 1,700 feet long (figure 25). Removal of the beryllium ore was scheduled to begin late in 1975. As of August 1976, Brush Wellman has not attempted to recover fluorite in their processing plant northeast of Delta. The tailings pile from this operation averages 8 percent fluorite and constitutes a large potential source of low-grade fluorspar ore.

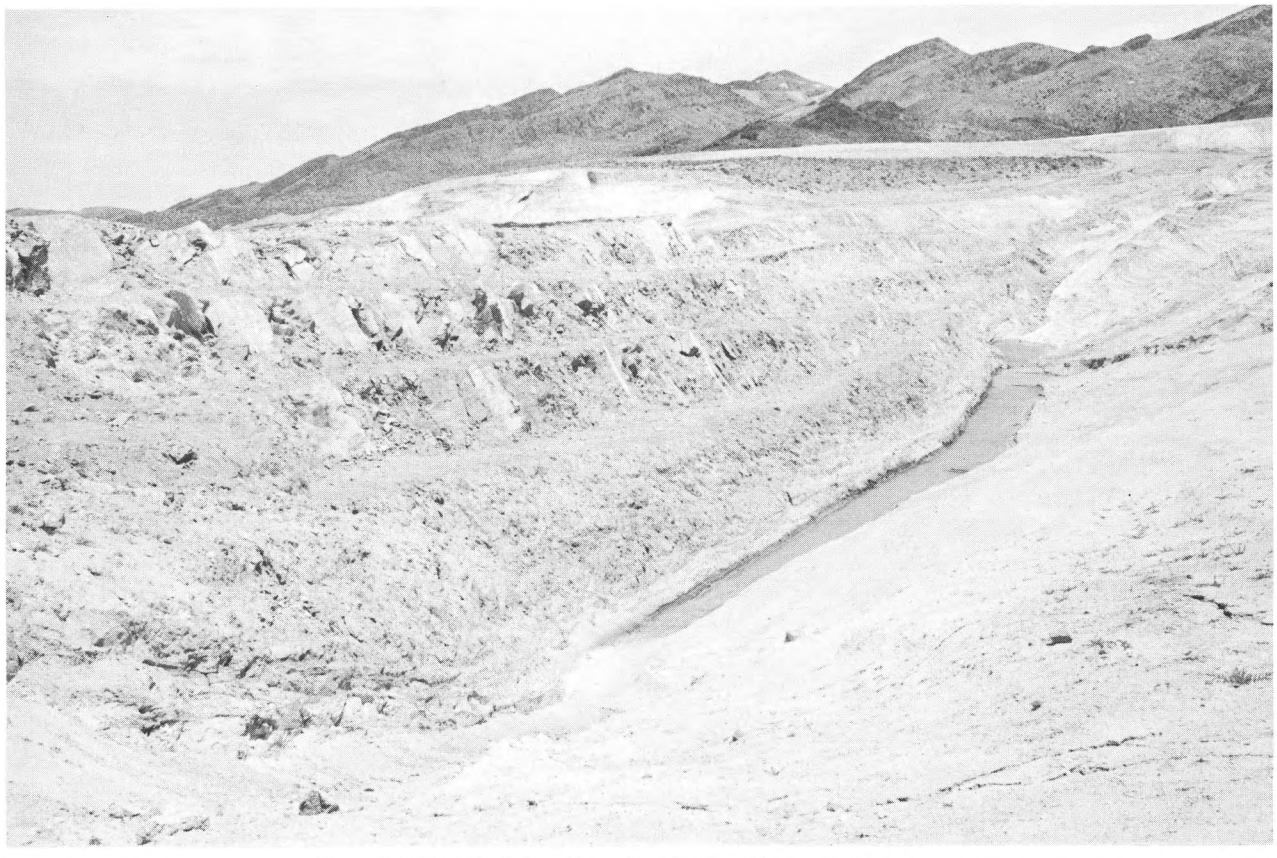

Figure 24. Blue Chalk beryllium deposit, Spor Mountain, Juab County.

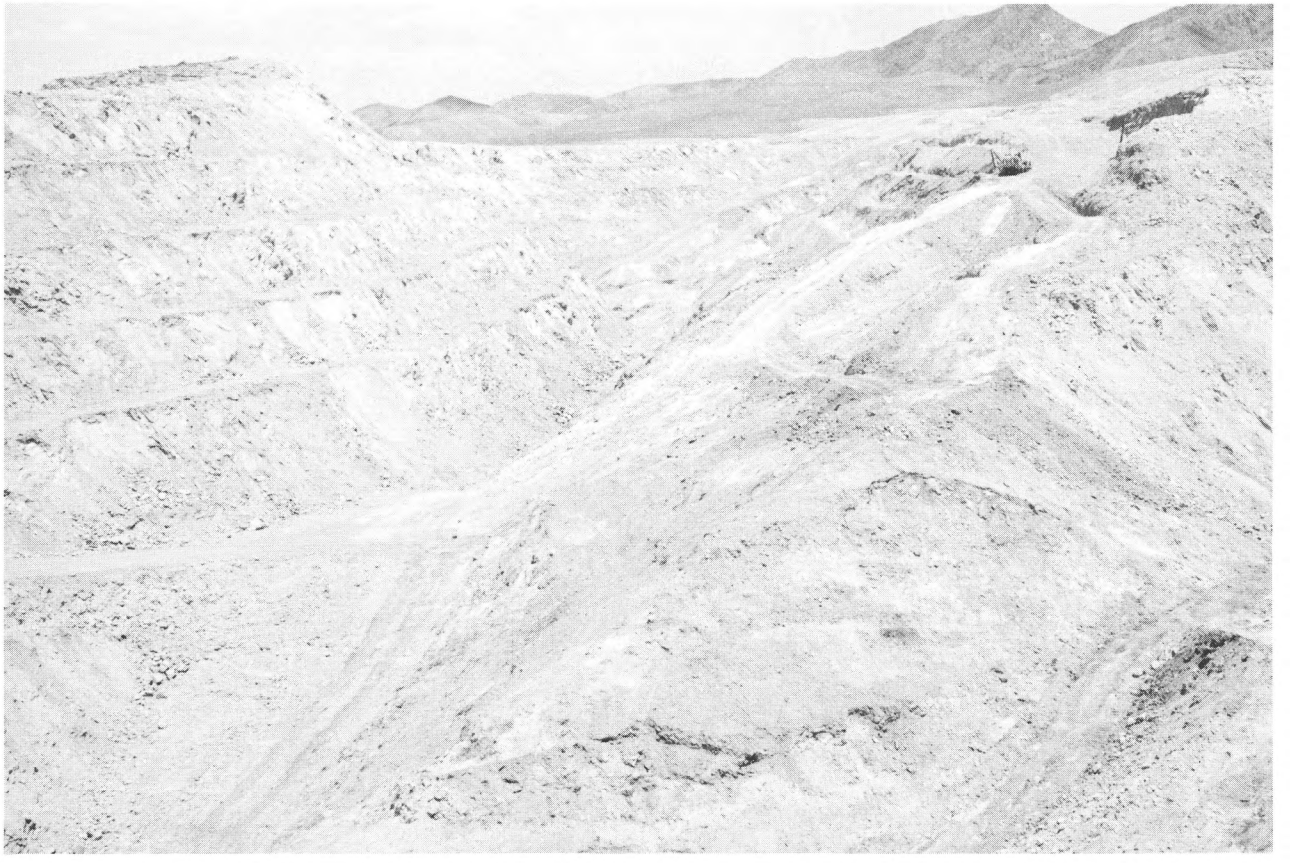

Figure 25. Fluro pit beryllium deposit, Spor Mountain, Juab County.

West Tintic District

The West Tintic district lies at the southern end of the Sheeprock Mountains (figure 6). The district, organized in 1870, has had sporadic production of gold, silver, lead, copper, tungsten, and iron ores. Most of the production came from the Scotia mine. Other mines with a little production include the Iron King, "88", and War Eagle. The geology of the district is described by Butler and others (1920, p. 432-444), Gardner (1954, 43 p.), and Groff (1959, 183 p.). Fluorite and quartz occur as abundant gangue minerals in a fissure vein of galena ore at the "88" mine.

"88" Mine

The "88" mine is in the southern Sheeprock Mountains in the West Tintic mining district, Juab County. The mine lies at the southern end of Browns Ridge between Bates Gulch and Scotia Gulch in the NW¼ sec. 34, T. 11 S., R. 5 W. (figure 6). The "88" mine was discovered in 1888 by Mark E. Howard, William Smith, and Orren P. Rockwell; it was held by assessment work until 1892 when it was sold to John McChrystal. The property was restaked as the Cedar claims and later patented in 1931. Currently, the property is held by Mary S. Gardner of Scottsdale, Arizona. The "88" mine has been developed by an inclined shaft to the south to a depth of 140 feet, by a 150-foot drift on the 45-foot level to the east, and by a 50-foot drift and stope to the north. The mine is described by Butler and others (1920, p. 441-442) and Stringham (1942, p. 285). The mine is mentioned briefly by Buranek (1948, p. 15) and Bullock (1967, p. 39, 119).

Ordovician, Silurian, and Devonian strata have been folded into an overturned anticline and synclinal structure in the West Tintic mining district. They consist of a series of mineralized Paleozoic rocks exposed below the West Tintic thrust that lies immediately to the north. The Paleozoic strata have been overthrust by the Precambrian Sheeprock series consisting of quartzite and argillite. A Tertiary monzonite stock about ½ mile west of the "88" mine cuts both the Precambrian and Paleozoic strata. The gray to gray-green monzonite weathers to tan and light gray. It is even grained, with pink orthoclase and white laths of plagioclase visible in hand specimens. The "88" mine is in the Silurian Laketown dolomite, which consists of about 950 feet of medium to dark gray dolomite that weathers to light gray. The dolomite contains scattered tremolite and wollastonite aggregates. Chert and jasper occur at random intervals in

bands parallel to the bedding, and a chert bed lies at its base.

The main metallic ore deposit consisted of a quartz-barite-galena fissure vein, which trends N. 15° E. and dips eastward parallel to the bedding. The principal metallic production came from an ore shoot of heavy galena on the east or hanging wall side of the main vein. The ore body was exposed on the 45-foot level about 30 feet north of the shaft. The ore body was between two bands of chert-tremolite rock. The walls of the stope are low grade fluorite-galena ore and quartz. The vein minerals exposed in the stope and in a shallow trench 200 feet north of the shaft consist mainly of quartz, barite, and galena, with minor amounts of pyrite, sphalerite, cerussite, anglesite, chrysocolla, malachite, calamine, and limonite.

The main fissure vein is intersected at the shaft by an east-west trending fissure vein that dips steeply to the south. This cross-fissure was followed by the inclined shaft to a depth of 140 feet. At the 45-foot level a drift was extended eastward along the fissure for 150 feet. The ore cut in the shaft and along the drift to the east in the fissure vein ranged from 1 to 4 feet wide. The vein material is mainly quartz-fluorite-galena ore accompanied by chalcopyrite. The fine-grained quartz resembles quartzite and chert. The chalcopyrite forms relatively pure large grains or masses up to 2 inches across. The galena forms fine-grained aggregates that enclose small grains of chalcopyrite.

Considerable amounts of coarse-grained, colorless to purple fluorite accompanies galena and quartz in the fissure vein. The vein contained about 22 percent lead with a comparable amount of fluorite. Fluorite has not been observed in any other mines in the West Tintic district, although it may be present. The "88" mine has no commercial fluorspar ore potential, and fluorite is regarded only as a minor occurrence.

MILLARD COUNTY

Gordon District

The Gordon district lies on the southwest side of the Pavant Range and the northwest side of the Tushar Mountains in Millard and Beaver Counties (figure 26). The district was organized in 1872. Over 30,000 tons of sulfur has been produced from solfataric deposits in Tertiary rhyolite tuffs, in Cretaceous Price River conglomerate, and from siliceous sinter in recent alluvium. The geology of the area is described by Crosby (1959, 50 p.), Welsh (1972, p. 13-20), and Callaghan (1973, p. 120-125). A study of the sulfur deposits is given by Rodriquez (1960, 74 p.). Fluorite occurs with sulfur as open space fillings and partial replacements of limestone breccia along the major fault that bounds the west side of the Pavant Range.

Rain Bow (Forminco) Mine

The Rain Bow (Forminco) mine is 2½ miles north of Cove Fort in the Gordon mining district, Millard County. The mine lies in the NW¼ sec. 19, T. 25 S., R. 6 W., on the southwest end of the Pavant Range (figure 26). Other mining claims in secs. 17 and 18 contain minor amounts of fluorspar in sulfur mineralization. The Rain Bow mine was originally developed in 1946 by a 15-foot adit and a 40-foot inclined shaft by the late Brice Prisby of Joseph. In 1959 the property was relocated as the Neale fluorspar claims, Nos. 1-10, and is held by annual assessment work. The main fluorspar deposit lies on the Neale F-1 claim. The property is owned and operated by Forminco. Gordon H. Ford of Sulphurdale is president and manager of the corporation. Recently, Forminco explored the property by 17 air-drilled holes, each hole having a diameter of 4¾ inches. A total of 16 holes were drilled on Neale F-1 claim and one hole on Neale F-9 claim. The holes ranged from 30 to 200 feet deep and totalled 1,350 feet of drilling. The sulfur operation at Sulphurdale and the fluorspar mine are part of Forminco's holdings. The mine is mentioned briefly by Davis (1954, p. 510), Thurston and others (1954, p. 50), Bullock (1967, p. 41, 119), Elevatorski (1974, p. 93), and Worl and others (1974, p. 10). A private report on the drilling of the Forminco fluorspar deposit is given by Podesta (1974, 83 p.).

Sedimentary strata at the Forminco fluorspar mine consist of Pennsylvanian Callville Limestone. These strata measure about 1,000 feet thick in the southwest Pavant Range and consist largely of limestone and some interbedded dolomite and quartzite. The strata strike N. 35° E. and dip 15° SE. Thrust faulting is present farther north in the Pavant Range. A major normal fault occurs along the west side of the range, along which the fluorspar is deposited. The fault strikes N. 50°-65° E. and dips 45°-60° NW. Normal faulting is associated with Basin and Range faulting that is expressed in several step-faults in the Pavant Range. Total displacement is several thousand feet and forms the Pavant graben. A faultline scarp developed along the mountain front, and later the area was overlain by Tertiary Mt. Belknap volcanic rocks. The fault is well exposed ½ mile north of the mine site, where volcanic rocks are absent. At the mine the fault is actually concealed by alluvium and volcanic rocks. Brecciated limestone and mineralized fault breccia mark the position of the main fault at the mine.

Mineralization containing fluorite and some native sulfur ascended along the normal fault at the mine site. Fluorspar filled the open spaces in limestone

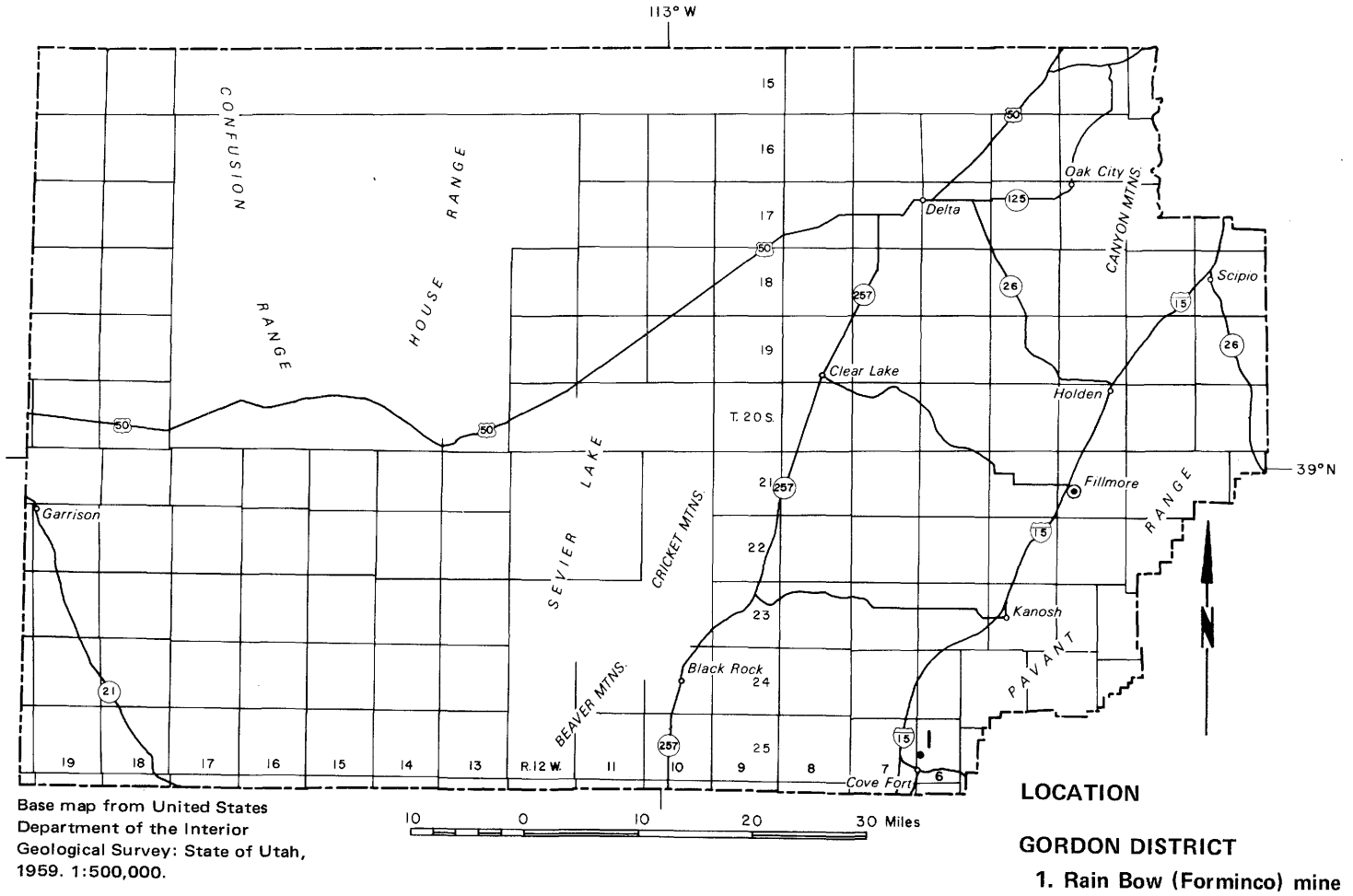

Figure 26. Millard County fluorite occurrence.

breccia and partly replaced it. Fluorspar also occurs in argillized volcanic rocks of the Mt. Belknap series. Sulfur encrustations are common in the mineralized zone. From 1947 to 1950 Brice Prisby shipped a total of 210 tons of fluorspar to the Geneva Steel Works at Geneva. Forminco drilled and outlined the fluorspar body at the Rain Bow mine site, which measured 32 feet wide, 80 feet long, and 100 feet down the dip of the fault. The deposit is cut off by a transverse northwest-trending fault on the southern end and is displaced to the southeast. To the northeast, the deposit steepens to 75°-85° NW. and narrows to about 5 feet wide. The ore body outlined by drilling contains about 20,000 tons of ore. Forminco estimates an ore potential of 40,000 tons. An experimental mill was operated at Sulphurdale by Forminco to process the fluorspar and to demonstrate that a commercial product is possible. The average grade of mill-tested ore ran 30.8 percent fluorite. High grade samples taken by the writer from the mine and from a stockpile of ore at the mill averaged 65.15 percent fluorite, 28.4 percent silica, and 2.59 percent calcite. A sizable tonnage of mill ore is available on the property; however, it is low grade, high in silica content, and variable in amounts of sulfur.

PIUTE COUNTY

Durkee District

The Marysvale uranium area lies from 4 to 4½ miles north of Marysvale in the southwestern part of Antelope Range, in the Durkee mining district, northern Piute County (figure 27). The mineralized "central" area (Taylor and others, 1951, p. 5), about 3,000 feet long and 1,500 feet wide, surrounds the two common corners of secs. 4 and 5, T. 27 S., R. 3 W., and secs. 26 and 27, T. 26 S., R. 4 W. (nonstandard plat). The primary uranium minerals are extremely fine crystalline pitchblende and umohoite associated with dark fluorite and fine pyrite. Major production was confined to a group of veins in quartz monzonite and associated granite. Minor production came from rhyolite dikes and volcanic rocks. Secondary uranium ores found in the same rock types in altered near-surface occurrences include: autunite, torbernite, schroeckingerite, uranophane, zippeite, uranopilite, johannite, and others. The Marysvale area is described by Taylor and others (1951) and Kerr and others (1957, 212 p.). Fluorite occurrences are mentioned briefly by Worl and others (1974, p. 10).

LOCATIONS

DURKEE DISTRICT

1. Buddy mine
2. Bullion Monarch (Farmer John) mine
3. Fluorite mine
4. Freedom No. 1, Etta, and Sunnyside mines
5. Freedom No. 2 mine
6. Prospector mine
7. Scorpion Fault area
8. Yellow Canary prospect

GOLD MOUNTAIN DISTRICT

9. Annie Laurie mine
10. Beaver Creek prospects
11. Keystone mine
12. Sevier mine

MT. BALDY DISTRICT

13. Deer Trail mine

OHIO DISTRICT

14. Bully Boy mine
15. Great Western mine
16. Shamrock mine

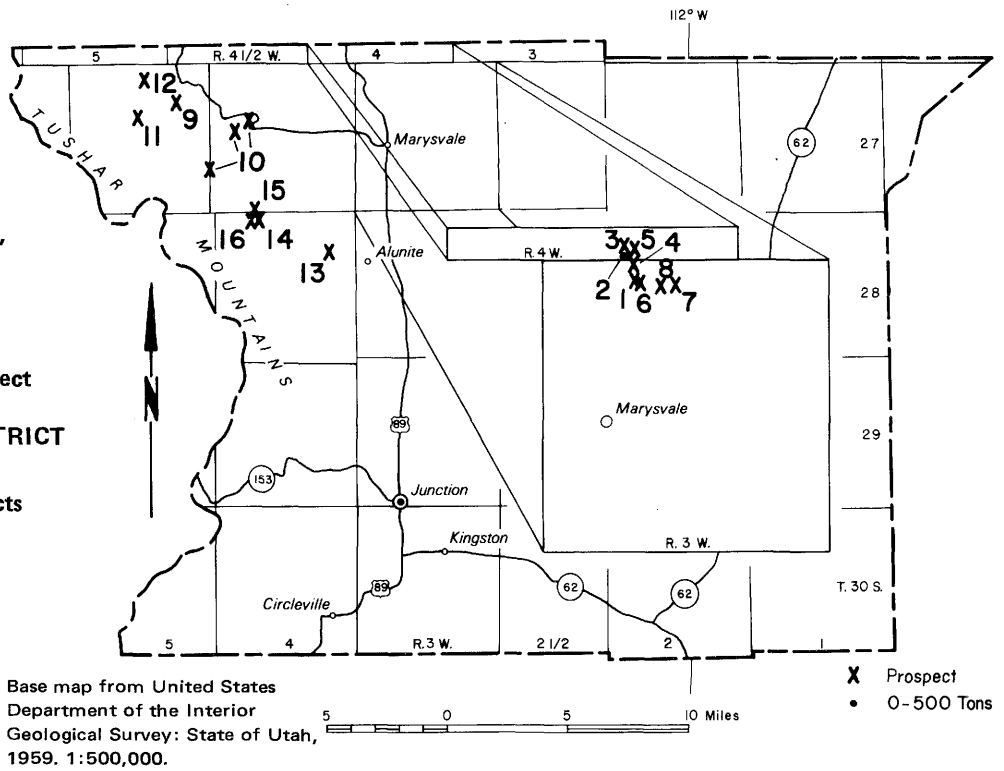

Figure 27. Piute County fluorite occurrences.

Dark purple and purple-black fluorite accompanies primary pitchblende. Its purple color appears to be a function of the intensity of radioactivity. Light purple, green, and colorless fluorite occurs where uranium mineralization is poor or lacking. Fluorite is found in veins normally 2 to 3 inches wide and occassionally up to 1 foot or more wide. It also occurs in disseminations of small crystals and fine-grained powdery masses. Fluorite is universally present in ores of the central area. Small quartz-pyrite-adularia-fluorite veins are also present in granite. The principal mines of the central area that contain fluorite are described.

Buddy Mine

The Buddy mine is about 4 miles north of Marysvale in the southwestern part of Antelope Range, in the Durkee mining district, northern Piute County. The property lies in the NW¼ sec. 4 and the NE¼ sec. 5, T. 27 S., R. 3 W. (figure 27). The property consists of two unpatented claims called the Buddy and Buddy No. 1. The claims are held by Pratt Seegmiller of Marysvale, and Foote Minerals of Naturita, Colorado. In the fall of 1974 the part held by Seegmiller was optioned to Anaconda Company, and the part held by Foote Minerals was leased to Verde Nuclear, a subsidiary of Phelps Dodge Corporation. Development work began in 1950 on a surface outcrop. The workings consist of two inclines totaling 400 feet and of 800 feet of levels. The property is described by Taylor and others (1951, p. 26-27) and Kerr and others (1957, p. 143-144).

The Buddy mine lies on the contact zone of the Tertiary Mt. Belknap rhyolite and Tertiary quartz monzonite of the central uranium area. Slight mineralization of autunite was found along the contact zone. The only productive uraniferous vein in the mine is the Buddy winze vein. The 1½- to 3-foot wide vein strikes N. 70° W. and dips 85° SW. It was followed for 100 feet in the upper level workings and for 175 feet on the lower level.

Minerals found along the fissure vein include quartz, purple fluorite, gypsum, autunite, jordisite, and a little pitchblende. The Buddy mine has no commercial potential for fluorspar production. Fluorite is present only as a minor occurrence.

Bullion Monarch (Farmer John) Mine

The Bullion Monarch mine, more recently called the Farmer John mine, lies about 4½ miles north of Marysvale in the Antelope Range. The uranium production came from two patented claims, Farmer John and Farmer John No. 1, that lie in the SE¼ sec. 27, T. 26 S., R. 4 W., Durkee mining district, northern Piute County (figure 27). A third patented claim, the Farmer John No. 3 in the northwest corner of NW¼ sec. 4 and the northeast corner of NE¼ sec. 5, T. 27 S., R. 3 W., produced one carload of fluorspar. The property was staked in 1949, and in 1954 it was leased by Vanadium Corporation of America. The ownership was vested in Bullion Monarch Company until the fall of 1974, when it was sold to Verde Nuclear. The mine is described by Taylor and others (1951, p. 24-26) and Kerr and others (1957, p. 140). The property is mentioned briefly by Davis (1954, p. 524), Thurston and others (1954, p. 51), Bullock (1967, p. 43, 119), and Elevatorski (1974, p. 100).

Both primary and secondary uranium minerals are found in three different rock types at the Bullion Monarch mine. These are Tertiary quartz monzonite, granite, and red rhyolite vitrophyre. Quartz monzonite forms the oldest rock mass and a stock, which has been intruded by granite. Rhyolite dikes cut both the other rock types. All rocks have undergone intense argillic alteration. Ore minerals occur in mineralized fissure veins and in rhyolite dikes.

A considerable amount of secondary uranium ore was produced from pits on the Bullion Monarch property. Ore minerals include autunite, torbernite, schroeckingerite, and uranophane. Primary minerals include quartz, fluorite, and small amounts of pitchblende. The host rock in the upper pits is quartz monzonite; in the lower pits the minerals occur in both quartz monzonite and granite. Most of the ore was mined from adits beneath the surface pits.

Three veins were mined from underground workings at the Bullion Monarch mine. Vein No. 1 strikes N. 60°-65° W. and dips 45°-55° SW. It is a fault breccia that has been cemented and partly replaced by mineralizing solutions. The fracture zone ranges from 3 to 4 feet in maximum width. Quartz and fluorite occur disseminated in small veinlets in the fissure zone. Pyrite is disseminated throughout the fissure. The most abundant minerals are jordisite and ilsemannite. Gypsum and halloysite are present. The main uranium minerals are autunite and torbernite. Vein No. 2 strikes N. 40° W. and dips 65° SW. The vein is in quartz monzonite that is altered. The mineralized zone is characterized by an abundance of quartz and fluorite. Limonite, hematite, and small amounts of autunite and torbernite are present in a few places. The vein, displaced by several northeast faults, consists of small parallel veinlets of black fluorite and dusty pitchblende. Vein No. 3 strikes N. 70° E. and dips 80° NW. to vertical. Extensive faulting has complicated mining activities. The vein is associated with a red rhyolite dike. Argillic alteration is intense. Pitchblende and dark fluorite occur in very small veinlets in the altered rhyolite dike.

In 1949 a 45-ton carload of fluorspar was shipped from the Farmer John No. 3 claim of the Bullion Monarch mine. Many fluorite veinlets cut the fissure zones in quartz monzonite, granite, and rhyolite dikes, but at present they are uneconomical to mine. The fluorspar potential of the mine is small, since the veins are narrow and will require high costs for mining and milling of the ore.

Fluorite Mine

The Fluorite mine lies just 500 feet north of the Bullion Monarch mine, about 4½ miles north of Marysvale, Durkee mining district. The property lies in the southwestern part of Antelope Range, northern Piute County, in SE¼ sec. 27, T. 26 S., R. 4 W. (figure 27). The property is on unpatented land held by Verde Nuclear. The occurrence is mentioned briefly by Kerr and others (1957, p. 147) and Elevatorski (1974, p. 100).

The Fluorite mine is in light gray granite of the central uranium area. An adit has been driven in a near vertical fissure that strikes N. 55° E. and measures about 400 feet in length on the surface. A solid vein filling of light to moderately purple fluorite occurs with quartz and adularia along a fissure vein. The fluorite has a reniform or a columnar structure. A trace of uranium is present (Taylor and others, 1951, p. 12). The fluorite vein is a simple fissure filling with a maximum width of 2 feet where exposed. No known production has come from the Fluorite mine. The vein has a potential of several thousand tons but would require hand sorting or milling of the ore.

Freedom No. 1, Etta, and Sunnyside Mines

The Freedom No. 1, Etta, and Sunnyside mines lie about 4 miles north of Marysvale in the Durkee district, which lies in the southwestern part of Antelope Range, northern Piute County. Freedom No. 1 is associated with a group of 8 patented claims. The mine is on the Freedom claim, which lies in the NW¼ sec. 4, T. 27 S., R. 3 W. (figure 27). This group of claims is owned by Pratt Seegmiller. In the fall of 1974 he optioned the claims to Anaconda Company. The Etta and Sunnyside mines, in the NE¼ sec. 5, T. 27 S., R. 3 W., are on unpatented land and are held by assessment work. The properties, held by Foote Minerals, were leased to Verde Nuclear in the fall of 1974.

These three mines are considered together since they are all on the Seegmiller vein, which is traced for 850 feet on the surface. The geology of the mines and the mineralogy of the ores are similar. The mines are described by Taylor and others (1951, p. 22-24) and Kerr and others (1957, p. 143). The mines are mentioned briefly by Bullock (1967, p. 43, 119) and Elevatorski (1974, p. 100).

Development work began on the Freedom No. 1 mine with the sinking of an inclined shaft to a depth of 100 feet. Subsequent workings include drifts on two levels above the bottom of the shaft and on a third level reached by a winze. A crosscut was started towards the Freedom No. 2 mine but was discontinued at 200 feet. The Sunnyside mine is developed by a vertical shaft and drifts. A crosscut from the Sunnyside shaft on the 250-foot level intersects the Seegmiller vein, which extends northeast for a horizontal distance of 310 feet to the other two properties. The Freedom No. 1 and Etta workings explored this vein for a horizontal distance of 350 feet and for a depth of approximately 200 feet.

Tertiary quartz monzonite is the predominant rock type at the mines, but a few granite dikes have been cut on the lower levels. The principal structure of the mines is the Seegmiller fissure vein. It has a strike of N. 53° E. and a near vertical dip. The shear zone averages 5 to 6 feet wide in the upper levels and 2 to 3 feet wide in the lower levels. Where the fissure was cut in drill holes below the bottom level, the fissure divides into small veinlets. The rocks show strong argillic alteration adjacent to the Seegmiller vein.

Uranium mineralization along the shear zone is erratic, and it has consisted mainly of autunite, some torbernite and schroeckingerite, and a trace of pitchblende. Uranium mineralization proved disappointing in these mines. Gangue minerals consist of quartz veins and disseminations of fluorite, quartz, pyrite, calcite, hematite, limonite, and montmorillonite clay. Fluorite is less abundant in these mines than in others in the central uranium area. The properties have no ore potential for fluorspar production. Fluorite is present only as a minor occurrence at this mine.

Freedom No. 2 Mine

The Freedom No. 2 mine lies about 4½ miles north of Marysvale in the southwestern part of Antelope Range. The mine shaft is on Freedom No. 1 claim. The property consists of eight patented Freedom and Cloys claims, which lie in the SW¼ sec. 26, T. 26 S., R. 4 W., and the NW¼ sec. 4, T. 27 S., R. 3 W., in the Durkee mining district, northern Piute County (figure 27). The property was owned by Pratt Seegmiller, who leased it to Vanadium Corporation of America during the uranium boom. In the fall of 1974 Seegmiller optioned the property to Anaconda Company.

The mine is on the west slope of a rhyolite-capped mountain locally known as Pratts Ridge. The

collar of the Freedom No. 2 shaft is at an elevation of 6,880 feet. The shaft was started in March 1950, and the mine is developed to a depth of 300 feet on six levels. The mine is described by Taylor and others (1951, p. 20-22) and Kerr and others (1957, p. 147-151). The property is mentioned briefly by Thurston and others (1954, p. 51), Bullock (1967, p. 43, 119), and Elevatorski (1974, p. 100).

Uranium mining at the Freedom No. 2 mine was along two principal veins, No. 1 and No. 2, that intersect at angles of 28 degrees to 31 degrees. The No. 1 vein, over 800 feet long and slightly curved, trends N. 73° E. in the western half and almost east-west along the eastern half. The No. 2 vein, about 650 feet long, strikes N. 54° E. Both veins are near vertical from the surface to the 160-foot level, and at the 300-foot level the dip flattens to 55 degrees to 65 degrees. The veins are breccia-filled open fractures, which range from 1 inch to 2½ feet in width. The veins split, horsetail, and pinch and swell.

The main rock type cut in underground mining was quartz monzonite. Granite dikes are present in several places in the mine. Secondary uranium minerals were important in the upper levels of the mine. They are, in order of importance, autunite, uranophane, schroeckingerite, and torbernite. In the lower levels the veins contain pitchblende. The important gangue minerals are quartz, fluorite, hematite, pyrite, alunite, and clay and some calcite, chlorite, magnetite, and limonite. Traces of gypsum, jordisite, and ilsemannite are found.

The contact of the vein with altered wall rock is sharp and bounded by one or more bands of dark purple fluorite that has a cockscomb structure. There are two generations of fluorite on the 160-foot level of the mine. In a few places quartz has been brecciated and cemented later by quartz, fluorite, and possibly pitchblende. Quartz and fluorite persist in discontinuous veins with an average thickness of 4 inches through the ore shoots and in barren zones. Darker fluorite bands are highly radioactive, whereas the lighter bands are not.

The veins in Freedom No. 2 mine contain less pyrite but more fluorite at depth than other uranium mines in the central area. An argillic alteration zone extends a few feet away from the veins. Fluorite is disseminated as minute subhedral crystals in the altered wall rock. Away from the vein the amount of fluorite decreases rapidly and becomes either pale green or colorless.

The fluorspar potential of the Freedom No. 2 mine is limited. Bands of fluorite range from less than 1 inch to 4 inches in thickness. Fluorite is also intimately associated with other gangue minerals as disseminations in the fissure veins and in the altered wall rock. Mining for fluorspar would not be feasible at this mine, although fluorite forms an important mineral occurrence.

Prospector Mine

The Prospector mine lies about 4 miles north of Marysvale in the southwestern part of the Antelope Range. The claims are in the southern part of N½ sec. 4, T. 27 S., R. 3 W., in the Durkee mining district, northern Piute County (figure 27). The property, discovered in 1949, was owned principally by Vanadium Corporation of America during the uranium boom of the 1950's. Presently, the property is owned by Foote Minerals who leased the property in the fall of 1974 to Verde Nuclear.

The Prospector mine was one of the more important mines of the Marysvale central uranium area. Development has taken place on five levels for a vertical distance of 425 feet. A main incline, a subsidiary incline, and three winzes total over 1,800 feet in length. The mine is described by Taylor and others (1951, p. 18-19) and Kerr and others (1957, p. 144-147). The mine is mentioned briefly by Thurston and others (1954, p. 51) and Bullock (1967, p. 46, 119).

Mine workings are mainly in a Tertiary quartz monzonite stock. Granite occurs at the bottom of the main incline and along part of the 425-foot level. Uranium mineralization was prominent along two intersecting veins, Vein No. 1 and Vein No. 3. Vein No. 1 is traced for about 1,000 feet on the surface. It strikes N. 60°-70° E. and dips 80°-90° SE. Vein No. 3 strikes N. 55° W. and dips 45°-60° SW. The intersection of the two veins was a site of an excellent ore shoot. Displacement along the veins is marked by slickensides and fault breccia, but the movement ranges only a few inches to several feet. Fissure veins range in thickness from less than 1 inch up to minable zones in ore shoots 6 feet wide.

Veins No. 1 and No. 3 vary from simple fissures to sheet structures. Uranium ore occurred mainly as pods along the plane of the vein and was concentrated in ore shoots. Pitchblende was the main ore mineral, occurring as black sooty and massive varieties. Secondary uranium ores near the surface were autunite, torbernite, and uranophane. Gangue minerals include fluorite, pyrite, quartz, adularia, magnetite, hematite, limonite, calcite, marcasite, siderite, gypsum, jordisite, ilsemannite, and alunite. Ore shoots contain an abundance of pyrite. Fluorite is also present in nonradioactive veinlets of jordisite and ilsemannite. When fluorite is intimately associated with pitchblende, it is

dark purple to black. When no significant pitchblende occurs, the fluorite is either colorless, pale green, blue, or pale purple. Where banding occurs, the usual association is quartz or calcite, which is bordered by fluorite.

Fluorite in the Prospector mine is a common gangue mineral in intimate association with several other minerals. Ore potential for fluorspar production from this property is limited owing to its complex mineral association, low grade, and milling requirements.

Scorpion Fault Area

The Scorpion fault area marks the southern end of the central intrusive stock in the Marysvale uranium area. It lies about 3½ miles northeast of Marysvale mainly in the E½ sec. 4, T. 27 S., R. 3 W., in the Durkee mining district, Piute County (figure 27). The Scorpion fault crosses several mining properties. The area is described by Kerr and others (1957, p. 189-191).

The Scorpion fault is traced for 3,600 feet on the surface. It strikes N. 60° E. and dips from 62° S. to vertical positions. The central intrusive, consisting mainly of Tertiary quartz monzonite, lies on the north side of the fault. Tertiary Bullion Canyon, Dry Hollow, and Mt. Belknap Volcanic series lie to the south. Radioactive highs occur along the Scorpion and nearby J. D. G. faults.

The quartz monzonite is moderately radioactive near the Scorpion fault, whereas latite on the opposite side of the fault is weakly radioactive. Both rock types are altered, containing purple fluorite and pyrite. Fluorite occurs as disseminations and as small stringers and veinlets in both rock types. No commercial fluorspar is present. Fluorite, although widespread, represents only a minor occurrence of this mineral.

Yellow Canary Prospect

The Yellow Canary prospect lies about 3½ miles north of Marysvale in the Durkee mining district, Piute County. The property lies near the center of sec. 4, T. 27 S., R. 3 W., at the southern margin of the central uranium area (figure 27). Development work includes a shaft, which is inclined 82° S. and sunk to a depth of 235 feet. Approximately 140 feet of drifting was completed on the 50-foot level, and over 600 feet of drifting and crosscuts were made on the 235-foot level. A group of four unpatented claims were originally held by Howell Mining Company; presently, the property is held by Pratt Seegmiller as the Uranium claims and was optioned to Anaconda Company in the fall of 1974. The property is described by Taylor and others (1951, p. 27-28) and Kerr and others (1957, p. 140-142).

The country rock on the Yellow Canary prospect is weathered Tertiary quartz monzonite, which forms the extreme southwestern side of the central intrusive stock. All underground workings are in quartz monzonite. Tertiary Mt. Belknap rhyolite lies on the west side of the property. Two fracture zones are exposed on the surface near the Yellow Canary shaft. The main vein, along which the shaft was sunk, strikes east-west for 400 feet and dips from 85° S. to a vertical position. A vein, cutting the west end of the main fracture, can be traced for 300 feet on the surface. Its strike ranges from N. 50°-70° W. and dips about 77° SW. Three slightly mineralized fissures were explored by underground workings. A zone of argillic alteration extends from 5 to 10 feet on each side of the fractures.

Slight uranium mineralization occurs with quartz veins along the fracture zones. Autunite and uranophane are the main radioactive minerals observed. Other minerals present include varicolored fluorite, pyrite, hematite, limonite, and jarosite. Fluorite mineralization is slight, representing a minor occurrence of this material.

Gold Mountain (Kimberly) District

The Gold Mountain (Kimberly) district lies in the northern part of the Delano Peak Quadrangle near the crest of the Tushar Mountains (figure 27). The district, organized in 1889, lies about 9 miles directly west-northwest of Marysvale. The principal mines are the Annie Laurie and Sevier. The district is described by Butler and others (1920, p. 554-555), Callaghan and Parker (1962), and Callaghan (1973, p. 24-29).

Gold and silver ores occur in quartz veins that contain considerable calcite and siderite and minor adularia. Some veins also contain fluorite gangue. Precious metals came from the upper parts of oxidized veins, where leaching of calcite concentrated the gold and silver in an insoluble residue composed of manganese oxide and quartz. These veins, ranging in width from 3 to 20 feet, cut the Tertiary Bullion Canyon Volcanics. A second type of fluorite occurrence was noted along the Beaver Creek drainage in the eastern part of the Gold Mountain (Kimberly) district. Fluorite is found in less conspicuous fissures and veinlets and as small replacements of the Bullion Canyon Volcanics. Quartz and calcite are of lesser importance, and some of the occurrences are radioactive.

Annie Laurie Mine

The Annie Laurie mine lies in the northwest part of the Delano Peak Quadrangle on the north slope of the Tushar Mountains at an elevation between 8,600 and 9,700 feet. The mine lies about 10 miles directly west of Marysvale in the Gold Mountain mining district, Piute County. The property is on patented land mainly in sec. 11, T. 27 S., R. 5 W. (figure 27). The area is accessible either from Marysvale via Beaver Creek or from Utah Highway 4 and U. S. I-70 in Clear Creek.

The Annie Laurie mine was the major producer of the Gold Mountain district, yielding over $3,000,000 in gold and silver during the early 1900's. The property is owned by the Annie Laurie Consolidated Gold Mines of Salt Lake City. The mine is leased to Kimberly Gold Limited; the president is J. H. Burns of Cedar City. The property is described by Lindgren (1906, p. 87-90), Butler and others (1920, p. 554-555), and Callaghan (1973, p. 21-28).

The Annie Laurie mine was developed along a well-defined quartz vein cutting Tertiary Bullion Canyon Volcanics. The main country rock exposed is latite. The northern part of the quartz vein is known as the Annie Laurie vein which strikes N. 5°-10° W. and dips 60° W. The southern part of this vein is called the Blue Bird vein which strikes N. 20° W. and dips 60° W. Old stopes extend for 2,000 feet along the Annie Laurie-Blue Bird vein. Mining proceeded from three main levels and other sublevels, and ore was stoped vertically for about 500 feet along the vein.

Mining was confined to the weathered zone of the Annie Laurie-Blue Bird vein. The vein consisted of white quartz and lamellar calcite. Adularia and pyrite are sparse. Colorless and pale purple fluorite occurs mainly as a coating along open fractures in the vein; apparently it was the latest mineral to form. Ground water moving down through the vein has removed the calcite and pyrite, leaving quartz and fluorite with cavities filled with manganese and iron oxides. Neither gold nor silver is visible in the ore. Fluorite, present as a gangue mineral, is a minor occurrence.

Beaver Creek Prospects

Beaver Creek lies to the northwest of Marysvale in the northeast part of the Tushar Mountains, Piute County. Beaver Creek forms the eastern part of the Gold Mountain mining district. A number of old and more recent claims have been staked along the Beaver Creek drainage, primarily because of a low radioactivity and the presence of fluorite (figure 27). The main Gold Mountain district and the adjoining Ohio district are characterized by large quartz veins that contain considerable calcite and siderite and some adularia and fluorite gangue. Many veins consist of quartz and lamellar calcite and fluorite. These veins are often 10 to 20 feet wide and more than a thousand feet long. In contrast, fluorite occurrences along Beaver Creek are typically associated with less conspicuous fissures and veinlets and as small replacements of volcanic rocks. Quartz and calcite are less important. Some fluorite occurrences are radioactive. Two Beaver Creek deposits are described by Callaghan (1973, p. 125), and the prospects are mentioned briefly by Elevatorski (1974, p. 100).

Three Beaver Creek prospects are on unpatented lands in T. 27 S., R. 4 W. The Beaver claims, Nos. 1-5 in the E½ sec. 18, are held by Clinton Colby of Spanish Fork. The Jolly Green Giant claims, Nos. 1-14 in the N½ sec. 17 and the S½ sec. 8, are held by Arnold Tate of Marysvale. The Come Back claims, Nos. 1-6 in the S½ sec. 17 and the S½ sec. 18, are owned by Joel Johnson of Marysvale. These claims are leased to Verde Nuclear. A fourth property, the Mary Ellen adit in the NE¼ sec. 25, T. 27 S., R. 5 W., lies near Snowslide Gulch tributary. It was held by the late Jim Bolitho of Marysvale.

Development work on the claims along Beaver Creek is minimal. Beaver claims, Nos. 1-5, have been prospected by shallow drill holes and bulldozer cuts. At present no development work has been completed at the Come Back and Jolly Green Giant claims. The Mary Ellen property is cut by a 355-foot adit. The principal rock exposed in the drift is fractured and silicified latite. The adit shows mainly shattered latite cut with veinlets of quartz for 140 feet. Fluorite accompanied by adularia occurs in fractures in quartz up to the face of the drift.

The Beaver Creek prospects are all staked on Tertiary Bullion Canyon Volcanics, which consist of both pyroclastic and lava flow rocks. The rocks are mainly latite in composition. Quartz monzonite intrudes the volcanic rocks to the north. Near the fluorite occurrences, the volcanic rocks are commonly altered to chlorite, sericite, and calcite along a group of intersecting fractures. Silicification of volcanic rocks and the presence of small quartz veins are typical of some outcrops.

Fluorite occurs along narrow fractures and as thin lenses in altered latite. The lenses may be 1 foot or more wide and 10 feet long but are generally smaller. They may be traced intermittently for 50 feet or more. Fluorite, the abundant mineral in the lenses, is accompanied mostly by quartz and calcite. Most of the lenses show lamellar banding. Some irregular fluorite replacements measure several feet across. The fluorite may be colorless, green, or purple. Most of it

occurs in subhedral crystals measuring up to 1 inch in diameter. Chemical analyses from chip samples of the Beaver claims averaged 81.33 percent fluorite, 5.20 percent silica, and 6.01 percent calcite. Samples from the Jolly Green Giant claims averaged 67.93 percent fluorite, 20.0 percent silica, and 2.53 percent calcite. Although the fluorite is widely scattered along Beaver Creek, no commercial deposits have been exposed.

Keystone Mine

The Keystone mine lies in the Gold Mountain mining district, about 11 miles directly west of Marysvale near the crest of the Tushar Mountains. The mine lies on the east side of Fish Creek in the NE¼ sec. 16, T. 27 S., R. 5 W., in the northeast part of the Delano Peak Quadrangle, Piute County (figure 27). The area is accessible either from Marysvale via Beaver Creek or from Utah Highway 4 and U. S. I-70 in Clear Creek. The Keystone property consists of four patented claims, owned by Richard R. Schaar of Salt Lake City. The property has been developed by two shallow shafts and two short adits in search of gold. A similar type of fluorspar occurs to the north in the adjoining SE¼ sec. 9. It has been developed by one adit cut along a fissure vein. No recent development work has been done.

Gold Mountain ore deposits are characterized by quartz veins that contain considerable calcite and a little adularia. Gold and silver were concentrated in the oxidized parts of some of these veins. Fissure veins on the Keystone property and in sec. 9 also contain fluorite. The veins cut Tertiary Bullion Canyon Volcanics. These rocks, consisting of pyroclastics and lava flows, are mainly latite and andesite in composition. The volcanics have been faulted and brecciated. Fissure veins, developed along these faulted areas, contain quartz, calcite, fluorite, and adularia. Quartz and calcite are predominant minerals, but the veins have obvious amounts of white and green fluorite. These properties contain no commercial fluorspar but rather represent a minor occurrence of fluorite.

Sevier Mine

The Sevier mine lies on the north end of the Tushar Mountains in the northwestern part of Piute County. The property is about 1 mile west of the old Kimberly mining camp and 1½ miles northwest of the Annie Laurie mine. The mine is in the W½ sec. 3, T. 27 S., R. 5 W., Gold Mountain district (figure 27). The area is accessible from Clear Creek, 8 miles to the north, and from Marysvale via Beaver Creek. The property lies on patented land owned by the Annie Laurie Consolidated Gold Mines of Salt Lake City; it is leased to Kimberly Gold Limited. The property produced $434,000 in gold and silver immediately before and after the turn of the century. The Sevier mine is described by Lindgren (1906, p. 89-90), Butler and others (1920, p. 555), and Callaghan (1973, p. 28-29).

The country rock at the Sevier mine consists mainly of latite of the Tertiary Bullion Canyon Volcanics. The latite is intruded in places by dikes and small intrusive bodies of monzonite porphyry. The mine is on a vein system about 3,000 feet long that strikes N. 10°-20° W. and dips from 54°-75° E. The mine lies at an elevation of 9,100 feet. The workings extend for a distance of about 1,165 feet. A vein zone up to 70 feet wide consists of 8 quartz veins ranging from a few inches to 17 feet in width. The original veins also contained lamellar calcite, adularia, fluorite, and some sulfides. Mining has been confined to the oxidized zone of the vein from which calcite is now leached. The principal ore products tend to be banded and consist mainly of quartz that is mostly porous, iron oxides, small quantities of adularia and fluorite, and finely disseminated gold and silver.

Fluorite is colorless to pale purple. It commonly occurs on open fractures along the vein system. Fluorite is not abundant and present only as a minor constituent at the Sevier mine.

Mt. Baldy District

The Mt. Baldy district lies on the east side of the Tushar Mountains a few miles south of Marysvale (figure 27). The district, organized in 1878, has had sporadic production of gold, lead, zinc, copper, mercury, and alunite. The principal productive mine is the Deer Trail, which is noted for its lead-zinc replacement deposits. Other metal mines include the Lucky Boy, Pluto, Clyde, Crystal, Park, and Monte del Rey. Alunite mineralization is extensive in the Mt. Baldy district. The area is described by Butler and others (1920, p. 542-543) and Callaghan (1973, p. 30, 44-47, 66-81, 86). Fluorite occurs in the upper Talisman Quartzite immediately below the limestone replacement deposits in the Deer Trail mine.

Deer Trail Mine

The Deer Trail mine lies about 6 miles south of Marysvale along the east base of the Tushar Mountains. The property lies mainly in the E½ sec. 11, T. 28 S., R. 4 W., Mt. Baldy district, Piute County (figure 27). Discovered in 1878 the ore body has been explored and mined at intervals during the past century, producing about $6,500,000 in silver-zinc-lead-copper-gold ores. The property is patented and owned by the Deer Trail Development Company of Salt Lake City. The property is described by Callaghan (1973, p. 45-47); the mine is mentioned briefly by Bullock (1967, p. 46, 119).

The mine has been developed some 4,000 feet in bedded replacement deposits in limestone. Stopes form an almost continuous ribbon for the full length of the mine, averaging about 100 feet wide but expanding in places to 200 feet and in one area to 400 feet. The ore trend is mainly N. 45° W. In 1945 the Arundel Mining Company cut a long adit 600 feet lower in quartzite and raised to the ore.

The ore body is a replacement deposit at the base of the Permian Toroweap Formation immediately above the upper surface of the Permian Talisman Quartzite. The ore followed the crest of a small northwest plunging anticline and replaced three thin beds of limestone. The deposit ranged from 2 to 40 feet thick and on the main level consisted of weathered products of sulfide. On the lower level the ore is principally sphalerite and galena containing silver and some gold. The ore body is confined to a narrow ribbon less than 50 feet wide, which departs from the crest of the fold and turns down the west limb of the anticline. The ore mineralization raises from the upper surface of the Talisman Quartzite and climbs stratigraphically a succession of thick limestone beds of the Toroweap Formation as the mine deepens.

Fluorite occurs in shattered and brecciated Talisman Quartzite immediately below the limestone replacements. Fluorite consists of pale green, subhedral and euhedral cubic crystals that measure up to 1 inch along a face of a cube. Fluorite is mainly confined to open spaces in quartzite. The Talisman Quartzite is mineralized in places by sulfides, but commercial ores are confined to the overlying Toroweap Formation. On the other hand fluorite appears to be confined to the shattered Talisman Quartzite. No commercial quantities of fluorspar are exposed in the Deer Trail mine, but rather fluorite mineralization is a minor occurrence.

Ohio District

The Ohio district is in Bullion Canyon about 6 to 10 miles west of Marysvale in the Pine Creek drainage basin (figure 27). The district was organized in 1868. The principal mines include the Bully Boy, Great Western, Cascade, Dalton, Iris (Deseret), Shamrock, and Wedge. Lead-silver-gold-copper ores occurred in fissure veins that contained a gangue of quartz and lamellar calcite and fluorite. Many of these veins were 10 to 20 feet in width and more than a thousand feet in length and vertical extent. The veins cut mainly the Tertiary Bullion Canyon Volcanics and the underlying Jurassic Navajo Sandstone. The district is described by Butler and others (1920, p. 540-542) and Callaghan (1973, p. 29-44). The veins exhibit a wide occurrence of fluorite gangue in the district. The more important fluorite occurrences are given.

Bully Boy Mine

The Bully Boy or Bully Boy and Webster mine is on the east side of the Tushar Mountains about 6 miles southwest of Marysvale, Piute County. The portal of the lower level is at an altitude of 7,900 feet. The mine is on a claim that was patented in 1899 in the NE¼ sec. 5, T. 28 S., R. 4 W., Ohio mining district, Piute County (figure 27). The property is owned by Deer Trail Development Corporation of Salt Lake City. The mine is described by Proctor (1943, 26 p.) and Callaghan (1973, p. 31-35). The mine is mentioned briefly by Butler and others (1920, p. 556), Thurston and others (1954, p. 50), Bullock (1967, p. 46, 119), and Elevatorski (1974, p. 100).

The Bully Boy mine was the largest producer of metallic ores in the Ohio district. The principal workings are along two veins. The Bully Boy vein strikes north-south for most of its length, but near the north portal it curves to N. 15° W. Its dip is about 60° W., and normal displacement is about 200 feet. A second vein known as the East or Webster vein strikes N. 15° W. and dips 72° W. The workings are on two principal levels that extend about 6,000 feet in length and include adits, drifts, crosscuts, winzes, and raises. Fissure veins have developed along faults that have brought Tertiary Bullion Canyon Volcanics and the underlying Jurassic Navajo Sandstone into fault contact. The Navajo Sandstone is about 2,000 feet thick in this district and sufficiently cemented to be considered a quartzite. The Bully Boy vein near the mine portal is enclosed in volcanic rocks and at the southern end of the drift is wholly in quartzite. All the upper workings are in volcanic tuff. The Bully Boy vein has been traced underground for 2,000 feet and on the surface for 3,200 feet.

Vein fillings are mainly quartz, barite, and some apatite in the deeper parts of the mine. The Bully Boy veins range from 20 to 50 feet in width, and the Webster vein from 6 to 12 feet in width. Much of the quartz is fine grained, chalcedonic in part, and colorless to white. The quartz veins are cut by subordinate amounts of fluorite, calcite, and iron-manganese carbonate. In places the veins are banded with lamellar calcite and fluorite. A third stage of mineralization consists of pyrite, galena, tetrahedrite, chalcopyrite, and a little sphalerite. These sulfides are deposited as fracture fillings and replacements of earlier vein minerals. The veins range from less than 2 percent to more than 50 percent sulfides. The upper levels of both veins yielded very rich gold-silver ores that were associated with oxidized ores, whereas the lower levels contained primary sulfide ores. The visible oxidized ores were malachite, azurite, chrysocolla, anglesite, cerussite, limonite, and manganese oxides.

Fluorite and calcite represent a second stage of mineralization and occur in veinlets and fractures that cut the quartz and barite veins. Fluorite at the Bully Boy mine is not abundant but conspicuous along the main level of the mine. It is recognized by its octahedral cleaveage and white to greenish hues. Some crystals are up to 2 cm long. It commonly occurs as small veinlets cutting the early quartz. Fluorite at the Bully Boy mine represents only a minor occurrence with no economic potential for fluorspar production. Future exploration and development work may lead to a discovery of commercial fluorspar in this district.

Great Western Mine

The Great Western mine is about 7 miles southwest of Marysvale in the Ohio mining district, Tushar Mountains, Piute County. The mine lies on a patented claim measuring only 200 feet wide and 3,000 feet long and trending northeasterly up the north side of Bullion Canyon. The claim is in the SE¼ sec. 32, T. 27 S., R. 4 W., on the east side of a tributary called Warnick Gulch (figure 27). The property is owned by Russell K. Woodruff, Jr., and Susan W. Emery of Salt Lake City. The mine is described by Evans (1953, p. 102-108) and Callaghan (1973, p. 40-43).

The Great Western mine, on a rugged slope at an elevation of 8,377 feet, can be reached by a jeep road. The mine workings include the Great Western adit that measures 220 feet long, an additional 200 feet of crosscuts and drifts on this level, a 35-foot winze, two inclined stopes, and an upper level 33 feet vertically above the main level. The upper level has 150 feet of drifts, stopes, and crosscuts. Two parallel fissure veins striking northerly were exposed in the main workings. The east vein dips 50°-80° W., and the west vein dips 40°-50° W.; both are separated about 90 feet horizontally. Each vein was stoped upward along an ore shoot and connected by the upper level workings. The ore shoots on each vein are about 50 feet long, 3 to 6 feet wide, and stoped upward about 60 and 70 feet.

The structure at the Great Western mine consists of a succession of fault blocks, which are composed of quartzite and overriding bedded tuff, that are tilted eastward. The well-cemented quartzite belongs to the Jurassic Navajo Sandstone. The bedded tuff is part of the thick overlying Tertiary Bullion Canyon Volcanics. In places the two rock types are in fault contact. Mineralization has developed along two of these fissure zones at the Great Western mine.

Lead, silver, and minor zinc and copper are largely confined to the two stopes in the Great Western mine. Galena was the most abundant sulfide, followed by pyrite and tetrahedrite. Sphalerite and chalcopyrite are sparse. Weathering in the oxidized zone has converted much of the chalcopyrite to azurite, malachite, chrysocolla, and chalcocite. The hypogene gangue minerals include quartz, siderite, fluorite, and calcite.

Fluorite is conspicuous in the ore occurrences at the Great Western mine. The large stope on the main level shows fluorite occurring as veinlets within the fissure vein. Fluorite is colorless to pale-pink and waxy in luster. Although fluorite is relatively abundant, it is not present in commercial quantities at this mine.

Shamrock Mine

The Shamrock mine lies on the south slopes of Bullion Canyon on the east side of the Tushar Mountains. The mine is about 7 miles southwest of Marysvale in the Ohio mining district, Piute County. The mine is on the east side of the tributary, Cascade Creek, in the N½ sec. 5, T. 28 S., R. 4 W. (figure 27). The mine is on patented claims high on the canyon walls at an elevation of 8,350 feet. The property is owned by Deer Trail Development Corporation of Salt Lake City. The mine is described by Butler and others (1920, p. 556) and Callaghan (1973, p. 39-40).

The mine adit penetrates Jurassic Navajo Sandstone for a distance of 1,680 feet. The sandstone has been tightly cemented into a quartzite. A thin capping of Tertiary Bullion Canyon Volcanics overlies the Navajo Sandstone. The adit explores a system of small veins in quartzite, rather than a single vein. A considerable amount of the workings are crosscuts in search of minable veins. The veins strike from N. 23° W. to true north and dip from 55° W. to vertical positions. Maximum vein width is 3 feet. The vein filling is mainly quartz that contains some calcite, fluorite, and siderite. Narrow streaks of sulfides, that contain chalcopyrite, sphalerite, galena, and tetrahedrite, cut the veins. The sulfides are partly oxidized. Some ore is found in irregular shoots along the veins. Fluorite is somewhat inconspicuous in this mine and present only as a minor occurrence.

SEVIER COUNTY

Henry District

The Henry district lies in the southern part of Sevier County (figure 28). The district was organized in 1883. Small amounts of gold and silver ores were shipped between 1902 and 1911. About the same time iron ores were shipped from the Krotki mine to the Salt Lake City smelters to be used as a flux. The district is described by Butler and others (1920, p. 543) and by Callaghan (1973, p. 52-56). Uranium was discovered on the La Veta prospect in 1941. The ore is accompanied by fluorite and other gangue minerals.

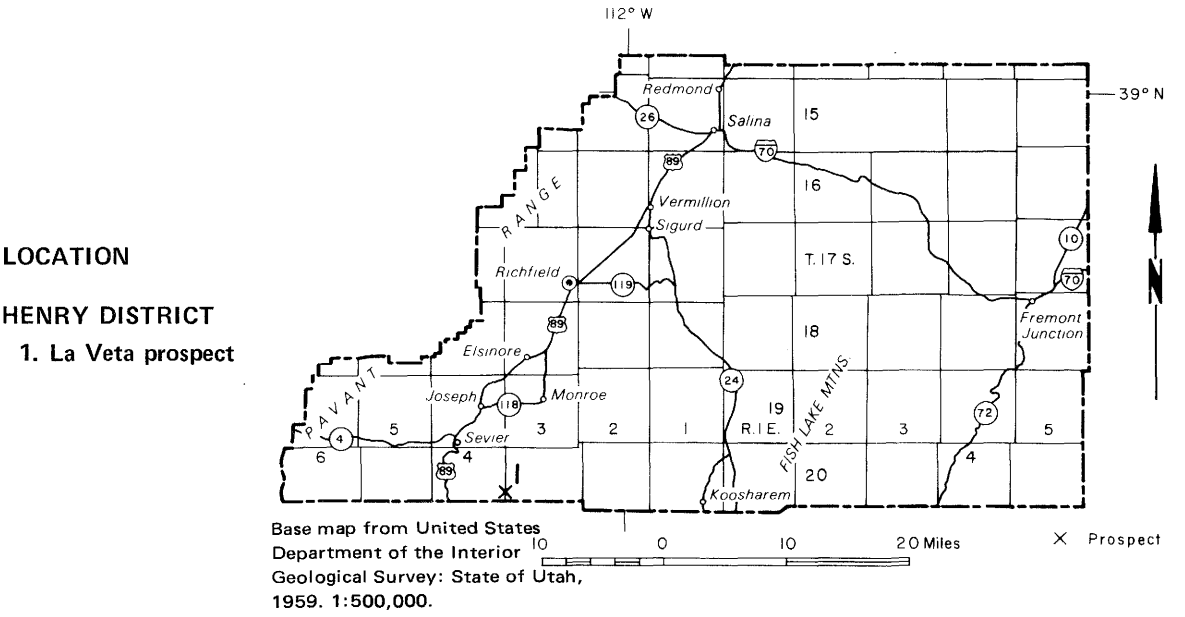

Figure 28. Sevier County fluorite occurrence.

La Veta Prospect

The La Veta prospect lies to the northeast of the Marysvale central uranium area in Sevier County. The property is about 9 miles southwest of Monroe in the W½ sec. 19, T. 26 S., R. 3 W., and the E½ sec. 24, T. 26 S., R. 4 W., Henry mining district (figure 28). The holdings consisted of eight unpatented mining claims. The workings include several bulldozer cuts, a 112-foot shaft, and 340 feet of drifts and crosscuts on the 56-foot and 112-foot levels. The prospect was originally staked in 1941 by W. H. Coleman, Dean U. Leavitt, and Denton B. Chamberlain of Marysvale. It was operated by Uranium Exploration Company of Salt Lake City; the owners did assessment work until 1961. The property is described by Kerr and others (1957, p. 181-185); the prospect is mentioned briefly by Bullock (1967, p. 47, 119).

Uranium mineralization is associated with an intrusive plug of Tertiary quartz monzonite porphyry, which intrudes older Tertiary Bullion Canyon tuffs and andesites. The outcrops of the quartz monzonite porphyry are limited, owing to the heavy talus of volcanic rocks. The shaft is bordered on the south by a breccia pipe 20 feet thick as exposed on the lower level. An intrusive plug of younger Mt. Belknap rhyolite is exposed to the south of the property. Most of the rocks show hydrothermal alteration. Clay and silicification predominate, but a considerable amount of alunite is found to the north of the property.

Uranium minerals occur in altered quartz monzonite porphyry. These include tyuyamunite, rauvite, meta-autunite, and metatorbernite. Mineralization was found at 17 feet in the shaft and on the 56-foot and 112-foot levels. Associated gangue minerals include pyrite, fluorite, molybdenite, hematite, goethite, jarosite, and wad. Purple fluorite is present only as a minor occurrence on the La Veta prospect.

SUMMIT COUNTY

Park City District

The Park City district lies at the junction of the Wasatch and Uinta Mountains (figure 29). The district, organized in 1869; is the second largest producing mining camp in Utah. Lead, silver, zinc, copper, and gold ores occur in fissures and replacements of calcareous beds, mainly in the Humbug, Park City, and Thaynes Formations, and in veins in the Weber Quartzite and diorite porphyry intrusions. The district is described by Boutwell (1912, 231 p.), Butler and others (1920, p. 285-319), and Barnes and Simos (1968, p. 1102-1126). Fluorite gangue occurs with the metallic ores in the Silver King and Woodside mines.

Silver King Mine

The Silver King mine is in Woodside Gulch, 1 mile southwest of Park City, Summit County. The property lies in the E½ sec. 20, T. 2 S., R. 4 E., Park City mining district (figure 29). The Silver King claims were located in 1889 by Martin McGrath and W. H. Dodge. In the summer of 1892 some lessors purchased the property and organized the Silver King Mining Company. In 1953 the mine was consolidated as part

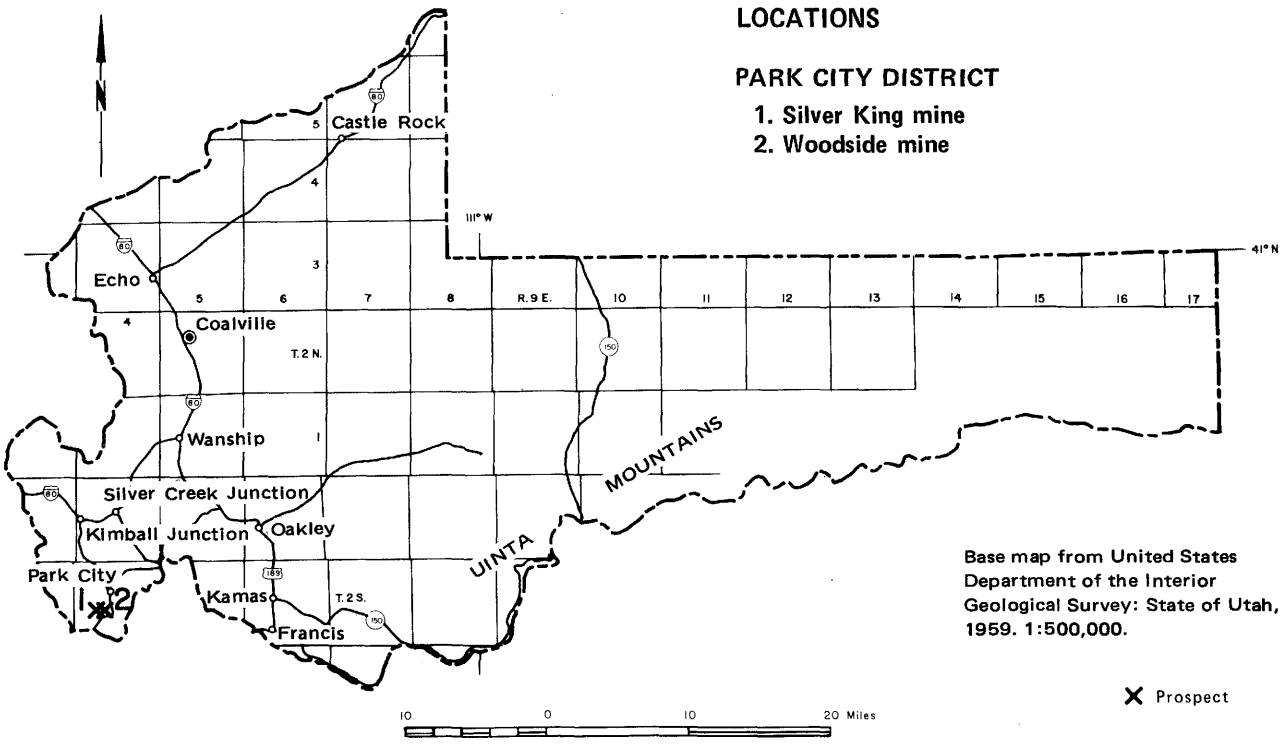

Figure 29. Summit County fluorite occurrences.

of the United Park City Mines Company. At present the Silver King mine property is leased to Park City Ventures. The property has been developed by a 1,325-foot shaft and an extensive system of drifts, crosscuts, and stopes. Production from lead-silver-gold ore is valued over $20,000,000. The mine is described by Boutwell (1912, p. 178-188). The mine is mentioned briefly by Buranek (1948, p. 13-14), Thurston and others (1954, p. 51), and Bullock (1967, p. 60, 119).

The Silver King property lies on the western flank of the Park City anticline. Surface exposures of sedimentary rocks from east to west include the Pennsylvanian Weber Quartzite, Permian Park City Formation, and the Triassic Woodside Shale. The sedimentary rocks strike northeast and dip 22°-30° NW. The strata are deformed by extensive faulting that has served as channelways for ore solutions. Replacement bodies of lead-silver ores are confined largely to the basal part of the Park City Formation in certain limestone members, especially the Jenny bed.

Fluorite was found in the Clover Leaf stope about 60 feet above the 900-foot level. Fluorite occurs as lenses and bunches in oxidized bedded ore. Pale green and purple varieties are present, but most was mined with the sulfide ores. Fluorite is present at the Silver King mine only as a minor occurrence.

Woodside Mine

The Woodside mine is in Woodside Gulch on the south slope of Treasure Hill, about ½ mile southwest of Park City, Summit County. The property lies in the W½ sec. 21, T. 2 S., R. 4 E., Park City mining district (figure 29). The ground was located by John A. Nelson in 1873 and purchased by E. P. Perry in 1874. The mine was active until the turn of the century, producing about $1,000,000 of lead and silver. In 1906 the mine was purchased by Silver King Mining Company. In 1953 the property was consolidated and is now owned by the United Park City Mines Company. Currently it is leased to Park City Ventures. The mine is developed by a shaft and an adit 138 feet lower on Treasure Hill near the bottom of the gulch. These openings connect about a dozen sublevels. The workings extend westward toward the Silver King mine. The Woodside mine is described by Boutwell (1912, p. 188-190). The mine is mentioned briefly by Buranek (1948, p. 13-14), Thurston and others (1954, p. 51), and Bullock (1967, p. 60, 119).

Lead-silver ores mineralized the lower 20 to 70 feet of the Permian Park City Formation. The main ore body was a pod-shaped shoot. At the foot of the Carey incline near the Silver King property line, fluorite occurs in lenses and bunches in bedded lead-silver ore and in the adjoining limestone of the Park City Formation. The lenses are accordant with the

bedding and the ore. Pale green and purple fluorite occurs in massive layers, and like the enclosing ore, it is shattered. Fluorspar gangue was mined with the lead-silver ores. There are no commercial deposits at the Woodside mine but only a minor occurrence of the mineral fluorite.

TOOELE COUNTY

Clifton (Gold Hill) District

The Clifton (Gold Hill) district lies at the northern end of the Deep Creek Mountains near the Nevada border (figure 30). The district, organized in 1869, has produced substantial amounts of zinc, lead, copper, silver, gold, arsenic, and tungsten ores. Lead, zinc, copper, and silver are mainly in replacement bodies in the Pennsylvanian Oquirrh Formation. Copper occurs in veins in quartz monzonite. Gold is found in veins in limestone beds near quartz monzonite contacts. Arsenic occurs in replacement bodies in the Mississippian Ochre Mountain Limestone. Tungsten is in tactite zones in limestone near quartz monzonite intrusives. The district is described by Butler and others (1920, p. 475-484) and Nolan (1935, 175 p.). Fluorite is associated with danburite and calcite in veins at the Gold Bond mine.

Gold Bond Mine

The Gold Bond mine is in Lucy L Gulch, Clifton mining district, western Tooele County. The mine lies about 2½ miles south of Gold Hill in the unsurveyed NW¼ sec. 13, T. 8 S., R. 18 W. (figure 30). The Gold Bond claim was patented in 1906 by the New York Giant Mining Company. The property is currently held by M. B. Johnson of Salt Lake City. The Gold Bond mine is described by Nolan (1935, p. 125-127) and mentioned briefly by Buranek (1948, p. 14), Thurston and others (1954, p. 50), and Bullock (1967, p. 63, 119).

The Gold Bond mine lies near the eastern edge of a small irregular cupola of Tertiary quartz monzonite. This body of intrusive rock is separated from the main quartz monzonite stock to the east by a roof pendant of Mississippian Ochre Mountain Limestone. The mine workings are in altered quartz monzonite, and the Ochre Mountain Limestone underlies the eastern part of the property.

Four veins are present on the Gold Bond claim. The largest vein is exposed in the adit. It strikes N. 50° W. and dips 45° SW. Although the vein zone is only 5 feet wide, nearly 1 foot of epidote and smaller amounts of silicate minerals are on each side. In the central part of the vein black tourmaline and altered specularite are the most abundant minerals. Other minerals include coarsely crystalline quartz, danburite, calcite, fluorite, diopside, amphibole, biotite, and white scapolite. Copper ore minerals make up 2 to 4 percent of the vein and include chalcopyrite, chalcocite, chrysocolla, and malachite.

Salmon-colored massive danburite is abundant on the Gold Bond claim. It is found in veins and as irregular or lenticular masses that are more than 1 foot wide. Calcite and white to purple fluorite have replaced danburite in part. Fluorite is not abundant but present only as a minor occurrence at the Gold Bond mine.

Dugway (Dugway Range) District

The Dugway (Dugway Range) district lies at the northern end of the Dugway Range in western Utah (figure 30). The district, organized in 1872, has yielded small quantities of lead, silver, copper, and zinc ores. Metallic production has been sporadic with less than 10,000 tons in the past 100 years. The ores occur principally as fissure veins in quartzite and as fissure veins and replacements in limestone and dolomite. The district is described by Butler and others (1920, p. 458-463) and Staatz and Carr (1964, 188 p.).

Fluorite with galena or cerussite and limited amounts of other metallic elements are found along fissures in Cambrian Prospect Mountain Quartzite. Fluorite is the most common vein material in the deposits, and quartz is next in abundance. Other gangue minerals include calcite, siderite, aragonite, and barite. Fluorite makes up a good proportion of the vein material of the Bryan, Lauris (Louis), Rattler, and Black Maria claims; it forms fairly important gangue in the Confidence and Dugway claims and is of lesser importance on the Golconda, Eureka, Rainbow, and Julia Ann claims. The first six claims are described in this report. Colorless or pale green fluorite crystals are associated with comb quartz and a little galena in the Cambrian Fandangle Limestone at the Great Eastern, Pride of the West, and Nautilus claims.

Fluorite occurs either as massive or columnar banded veins from less than 1 inch to more than 12 feet wide, or as colorless to pale green octahedra and cubes up to ½ inch in size. The massive or columnar fluorite, commonly pale apple-green or occassionally pale purple or brownish orange, occurs only in veins in the Prospect Mountain Quartzite. Fluorite cubes and octahedra occur both in quartzite and carbonate rocks. The Lauris (Louis) and Bryan claims on the same faulted structure that cuts quartzite have the greatest potential for fluorspar production from the Dugway district. The deposits of the Dugway Range are all high in silica and would require beneficiation by milling.

LOCATIONS

CLIFTON DISTRICT

1. Gold Bond mine

DUGWAY (DUGWAY RANGE) DISTRICT

2. Black Maria claim
3. Bryan claim
4. Confidence claim
5. Dugway prospect
6. Lauris (Louis) claim
7. Rattler claim

DUGWAY (GRANITE PEAK) DISTRICT

8. Blue Bell prospect
9. Cannon Tank Canyon
10. Desert Queen prospect
11. El Dorado mine
12. Mountain Queen prospect

DUGWAY (WILDCAT MOUNTAIN) DISTRICT

13. Silver Queen mine

ERICKSON DISTRICT

14. Copper Jack mine
15. Flying Dutchman mine
16. Silver King mine

OPHIR DISTRICT

17. Buffalo mine
18. Ophir mine

RUSH VALLEY DISTRICT

19. Honerine mine

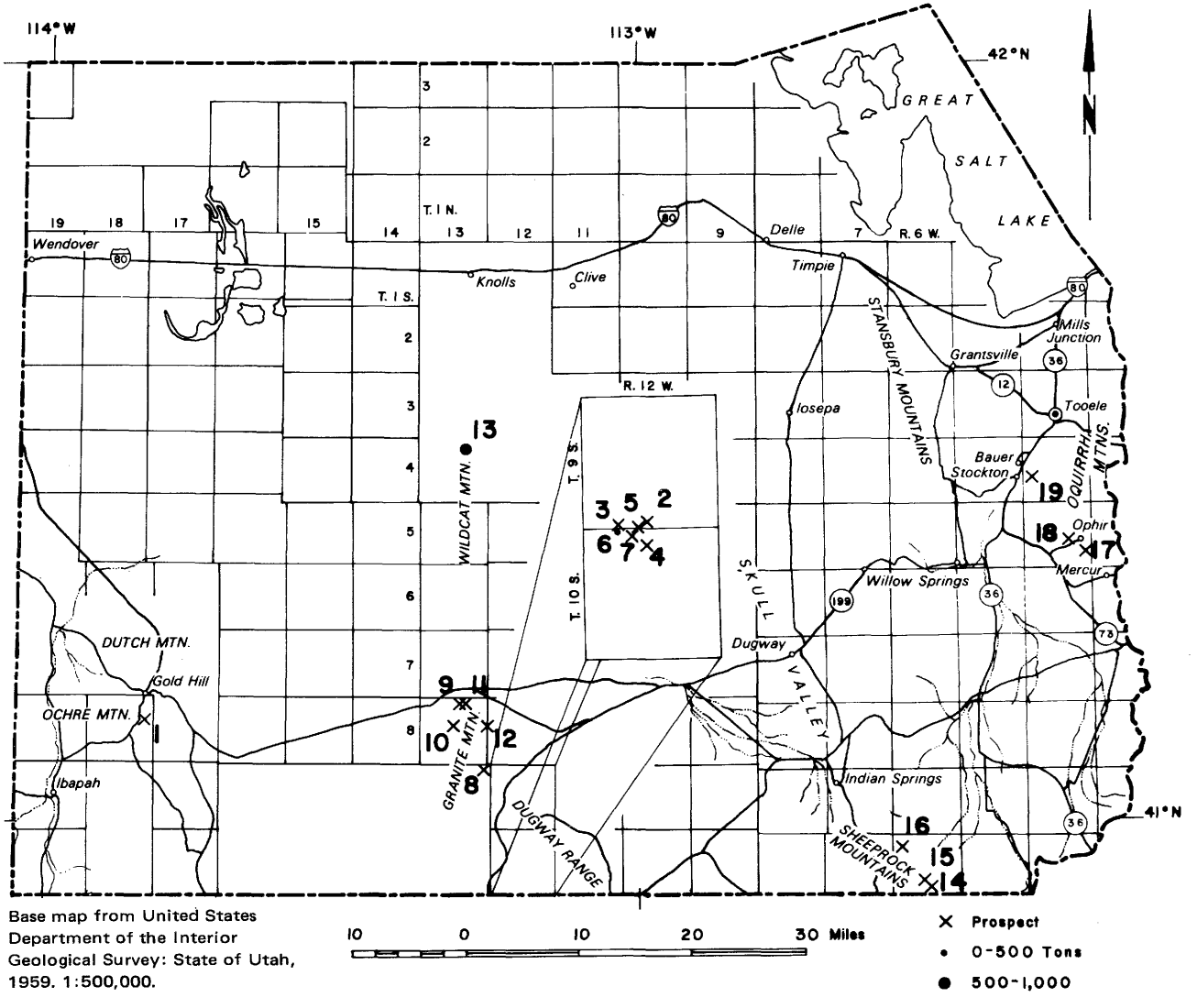

Figure 30. Tooele County fluorite occurrences.

Black Maria Claim

The Black Maria claim is on the northwest end of Dugway Range. The property lies in an unsurveyed area in the SE¼ sec. 33, T. 9 S., R. 12 W., Dugway (Dugway Range) mining district, Tooele County (figure 30). The property has been developed by a 30-foot shaft and a short adit, which has explored the mineralized vein. The Black Maria claim was patented in 1897 by Angus M. Cannon and is currently owned by Dr. J. Floyd Cannon of Salt Lake City. Experiments in concentrating fluorspar ores from this claim were made by the U. S. Bureau of Mines and reported by Snedden and others (1947, p. 21, 25-26). The mine is mentioned briefly by Buranek (1948, p. 15), Dasch (1964, p. 168), Bullock (1967, p. 62, 119), and Elevatorski (1974, p. 110).

The Black Maria claim is on a long narrow northwest-trending ridge of Cambrian Prospect Mountain Quartzite. The strata strike N. 12° W., dip 37° W., and consist of white and tan massive quartzite. As much as 12,000 feet of Prospect Mountain Quartzite is exposed in the Dugway Range. A narrow mineralized fissure vein on the Black Maria claim is parallel to a major fault that cuts across the quartzite ridge and can be traced for nearly 2,000 feet. The main fault strikes N. 18° E. and dips steeply to the east. A branch fault 200 feet south of the shaft extends southwesterly for about 600 feet and strikes N. 55° E. and dips steeply southeast.

Metallic ores from the Black Maria claim consist of a complex intergrowth of galena, cerussite, chalcopyrite, chalcocite, covellite, malachite, azurite, and smithsonite. Malachite and azurite are relatively abundant. Malachite is more common than azurite, and both are associated with chrysocolla. Chrysocolla is abundant locally along or adjacent to fault intersections. In addition to small amounts of hematite, barite, and calcite, quartz and colorless or pale green fluorite are the principal gangue minerals.

Chemical analyses of the ores from the Black Maria fissure vein by the U. S. Bureau of Mines averaged 24.75 percent fluorite, 35.5 percent silica, 0.4 percent calcite, 9.15 percent iron, 6.6 percent lead, and 4.20 percent copper. Sulfidization and selective flotation of the Black Maria ore by the Bureau of Mines recovered 82 percent of the lead, 67 percent of the copper, 93 percent of the gold, and 91 percent of the silver in a marketable concentrate. Approximately 65 percent of the fluorite was recovered that assayed 93 percent fluorite.

The Black Maria fissure vein contains about 25 percent fluorite that is high in silica and would require beneficiation to produce a commercial product. The ore potential of fluorspar on this claim is limited since the vein measures less than 1 foot wide.

Bryan Claim

The Bryan claim is on a north-facing slope of a steep quartzite ridge at the northwest end of the Dugway Range. The property lies in an unsurveyed area in the S½ sec. 32, T. 9 S., R. 12 W., and extends in the N½ sec. 5, T. 10 S., R. 12 W., Dugway (Dugway Range) mining district, Tooele County (figure 30). Sec. 32 is owned by the state of Utah, except for active mining claims staked prior to acquisition of this section of land by the state. The Bryan claim is unpatented and was first located in the late 1880's. It was relocated several times, but most recently in 1955 by George Willis Smith of Stockton. The property is held by annual assessment work and currently under lease to Dr. J. Floyd Cannon of Salt Lake City. Two groups of workings lie in a ravine on the Bryan claim. The lower group, called the Cross Bow mine, lies at an elevation of 4,720 feet at the north end of the claim; the portal is actually on the adjoining Harding claim to the north. These workings consist of an adit driven southward about 300 feet with short crosscuts. The upper group of workings lie at an elevation of 5,100 feet and consist of two small adits 15 feet apart vertically. The portal of the uppermost adit is caved in. The main upper adit, called the Glory tunnel in which fluorspar is well exposed, is about 108 feet long. The claim is described by Staatz and Carr (1964, p. 168-170) and Doelling (1972, 12 p.). The property is mentioned briefly by Dasch (1964, p. 168), Bullock (1967, p. 62, 119), and Elevatorski (1974, p. 110).

The Bryan claim lies entirely on white to tan massive Prospect Mountain Quartzite, Cambrian in age. The claim is on the northern half of a conspicuous fault known as the Laurel fault, which is nearly 3,000 feet long. On the Bryan claim the fault strikes north-northeast and dips up to 65° E. The property was originally mined for lead-silver-copper ores. At the southern end of the adit of the Glory tunnel a 6-inch lead-silver vein occurs on the footwall side of the fluorspar deposit. The vein contains visible galena, cerussite, sphalerite, hemimorphite, calcite, a little quartz, and abundant fluorite. A sample taken by the U. S. Geological Survey across the lead-silver vein assayed 5 ounces of silver per ton, 6.83 percent lead, 0.41 percent zinc, and 46.5 percent fluorite. Apparently a small tonnage of hand-sorted lead-silver ore was shipped from this claim in the latter part of the nineteenth century.

The vein material of the Glory tunnel consists primarily of pale green fluorspar in colloform layers ¾ to 3 inches thick. The vein material, strongly banded with iron-stained silica separations, is cemented with

calcite. The fluorspar has been brecciated by renewed movement on the fault after the main period of mineralization. The vein measures from 8 to 14 feet across the fissure and is well exposed for 40 feet in the adit. A chip sample across the vein contains 73.4 percent fluorite, 14.24 percent calcite, and 9.0 percent silica. A stockpile containing perhaps 25 tons of fluorspar is near the mine portal.

The lower group of workings of the Cross Bow mine has exposed up to 7 feet of fluorspar near the mine portal. The adit, however, does not follow the fluorspar fissure but rather a trace of lead, silver, and copper mineralization. Nodules of chrysocolla ranging up to 4 inches in diameter were mined along the metallized fissure. The fluorspar exposed in the Cross Bow mine is similar in appearance to that in the Glory tunnel, although a crosscut exposes some coarsely crystalline fluorite and some quartz.

No shipments of fluorspar have been made from the Bryan claim, although this property appears to have the greatest potential for commercial production in the Dugway district. The indicated ore is at least 2,000 tons and the ore potential considerably more. The property would require drilling along the Laurel vein and possible associated veins to determine the size of the fluorspar deposits. The fluorspar has a high silica content and may contain some metallic ore that would require milling operations.

Confidence Claim

The Confidence claim is on the southwest side of Kellys Hole at the northwest end of Dugway Range, Tooele County. The property lies in the Dugway (Dugway Range) mining district in an unsurveyed area in the SE¼ sec. 4, T. 10 S., R. 12 W. (figure 30). The Confidence claim was patented in 1905 by Metallic Hill Mining Company, and currently it is owned by J. Floyd Cannon of Salt Lake City. The property is described by Staatz and Carr (1964, p. 170). The claim is mentioned briefly by Bullock (1967, p. 62, 119) and Elevatorski (1974, p. 110).

Two northeast-trending veins, approximately 250 feet apart on this claim, lie in massive Prospect Mountain Quartzite, Cambrian in age. These mineralized faults trend nearly at right angles to the main major fault outlining the west side of Kellys Hole. The south vein, cut by a short open crosscut, is explored by a 60-foot trench about 2½ feet wide and 12 feet deep. The vein ranges from 6 inches to 2½ feet thick, strikes N. 19° E., and dips 82° SE. Vein material is quartz, hematite, barite, jarosite, and calcite. Malachite and azurite are present as coatings, and fluorite is absent.

The north vein strikes N. 73° E. and dips 65° NW. Two adits separated 50 feet vertically are developed on the north vein. The lower adit is 125 feet long, and the upper one is about 100 feet long. The vein is best exposed in the adits, where it has been explored along strike for 100 feet and down dip for 60 feet. The vein ranges from 1 inch to 1½ feet wide. The vein walls consist of about ½ inch octahedra of colorless fluorite. The chief ore mineral in the central part of the vein is cerussite, which occurs in irregular masses several inches across. Cerussite is white to gray and either earthy or compact. Gangue minerals are fluorite, quartz, calcite, hematite, and limonite.

Two channel samples, which averaged 21.6 and 39.6 percent lead, 1.1 and 8.94 ounces of silver per ton, and 14.6 and 1.7 percent fluorite, were taken across the north vein by Staatz and Carr. The Confidence claim is only a minor occurrence of fluorite, and its ore potential for fluorspar ore production is negligible.

Dugway Prospect

The Dugway prospect lies near the central part of Kellys Hole at the northwestern end of the Dugway Range. The property is in an unsurveyed area that lies in the N½ sec. 4, T. 10 S., R. 12 W., Dugway (Dugway Range) mining district, Tooele County (figure 30). The Dugway prospect consists of six claims patented in 1905 by the Dugway Copper Mining and Smelting Company and includes the Anaconda, Contact, Surplus, and York lodes. The property is currently held by the Dugway Mining Company in care of Romaine Peterson of Laguna Hills, California. The property has been developed by an inclined shaft and adit on the Contact claim. The shaft is about 200 feet deep with a 40-foot drift on the 100-foot level and a 30-foot drift at the bottom of the shaft. An adit north of the shaft is advanced about 15 feet along a fault contact. Ore from the Dugway prospect was analyzed and concentrated by the U. S. Bureau of Mines and also reported by Snedden and others (1947, p. 20-21, 23-24).

The Dugway shaft started in alluvium but soon cut bedrock and followed downward a major fault contact that outlines the east side of Kellys Hole. Complicated thrust faulting, transverse faulting, and finally normal faulting have brought the Cambrian Prospect Mountain Quartzite in fault contact with the Upper Mississippian Ochre Mountain Limestone. The Prospect Mountain Quartzite consists of about 12,000 feet of light gray to tan quartzite in the Dugway Range. The exposed Ochre Mountain Limestone, only 470 feet thick in Kellys Hole, consists largely of medium-gray limestone with interbeds of dark gray dolomite. The inclined shaft follows downward the fault contact between these two formations. The fault strikes N. 38° W. and dips 57° SW. The mineralized

part of the fault ranges from less than 1 inch to about 1 foot in thickness.

The Dugway ore, primarily an oxidized copper-silver ore, comprises chalcopyrite, chalcocite, covellite, malachite, and azurite. The main gangue minerals are quartz and fluorite and some orthoclase, chlorite, calcite, and barite. An analysis of the ores by the U. S. Bureau of Mines ran 50.7 percent silica, 17.1 percent fluorite, 8.15 percent iron, 0.45 percent calcite, 3.82 percent copper, and 1.6 ounces of silver per ton. The ore was ground to a minus 100 mesh, and the copper minerals were floated after sulfidization. The tailing product was deslimed, and selective flotation recovered nearly 90 percent of the fluorite.

The fluorspar potential of the Dugway prospect is limited. The mineralized zone is narrow and contains excessive amounts of quartz and metallic ores.

Lauris (Louis) Claim

The Lauris (Louis) claim lies on a south-facing slope of a steep quartzite ridge on the northwest end of the Dugway Range. The claim lies in an unsurveyed area that lies in the N½ sec. 5, T. 10 S., R. 12 W., Dugway (Dugway Range) mining district, Tooele County (figure 30). The claim adjoins the south end of the Bryan claim; the two properties lie on the same faulted zone. The Lauris (Louis) claim was first located in 1880. It has been relocated several times but most recently as the Louis claim in 1955 by George Willis Smith of Stockton. The claim has been developed by two separate workings. An upper adit at an elevation of 4,912 feet is about 100 feet long. It has stopes that extend upward about 25 feet to the surface and downward about 55 feet. This adit produced about a carload of lead-silver ore each year during 1921 and 1922. The lower adit or Cannon mine lies at an elevation of 4,760 feet. It is 430 feet long with a few small overhead stopes. The mine is described by Staatz and Carr (1964, p. 175-176) and Doelling (1972, 12 p.). The property is mentioned briefly by Heikes (1921, p. 200; 1922, p. 477), Bullock (1967, p. 62, 119), and Elevatorski (1974, p. 110).

The Lauris (Louis) claim lies along the Laurel fault, a north-trending fissure in the Prospect Mountain Quartzite, Cambrian in age. The Laurel fault is about 3,000 feet long. The Lauris (Louis) claim covers the southern half, whereas the Bryan claim covers the northern half of the fissure. The fault zone in which the vein occurs strikes north to north-northwest on the Lauris (Louis) claim and dips from 60° to 84° E. The vein is entirely within the Prospect Mountain Quartzite.

A lead-silver ore body exposed in the upper workings was almost completely mined out in 1921 and 1922. The ore body was between two faults that dip eastward 68 degrees and 69 degrees at the adit level. The dimension of the stope suggests that the ore body was about 60 feet long by 5 feet wide, extending downward from the surface for about 80 feet. A remaining pillar containing 2.7 feet of ore consisted of bands of galena, cerussite, and 1-inch bands of fluorite. Cerussite is particularly abundant, occurring as irregular masses several inches across. It is white to gray and either earthy or compact. Veins of fluorite a few inches to 1½ feet wide can be seen along faults at the south end of the ore body and in the bottom of the stope.

No sulfide ore is visible in the Cannon mine or lower adit or on the dump, whereas numerous veins of light green massive and banded fluorspar are present. These veins of fluorite are from ½ inch to 6 feet wide. The largest vein exposed in the Cannon mine adit is about 60 feet from the portal. The vein is 6 feet wide in a stope above the adit, but it pinches downward to less than 1 foot wide at the adit level. It is from this stope that 300 tons of fluorspar was mined in 1949 and shipped by George Willis Smith to Geneva Works. The ore averaged 70.0 percent fluorite. A chip sample across a 3-foot vein in a stope of the Cannon mine ran 74.24 percent fluorite, 16.2 percent silica, and 2.59 percent calcite.

The Lauris (Louis) claim has good ore potential as a fluorspar producer, especially in conjunction with the Bryan claim that lies immediately to the north. The fissure vein has only been partly explored by the two adits on the Lauris (Louis) claim. Diamond drilling is recommended at strategic points along the Laurel fault. The potential at present appears to be about a thousand tons of inferred ore, although additional drilling could greatly increase this tonnage. The chief disadvantage of this property is the high silica content of the ore, which would require milling operations.

Rattler Claim

The Rattler claim lies in Cannon Canyon that drains Kellys Hole, at the northwest end of the Dugway Range, Tooele County. The property lies in the Dugway (Dugway Range) mining district in an unsurveyed area that falls in the NW¼ sec. 4, T. 10 S., R. 12 W. (figure 30). The claim is staked on a steep south-facing mountain slope. The Rattler claim, first patented in 1892, is now owned by Dr. J. Floyd Cannon of Salt Lake City. The claim is mentioned briefly by Buranek (1948, p. 15), Thurston and others (1954, p. 51), Dasch (1964, p. 168), Bullock (1967, p. 62, 119), and Elevatorski (1974, p. 110).

The Rattler claim has been explored by shafts and adits at two different levels. The lower workings

consist of the Lower Rattler tunnel (adit), which lies at an elevation of 4,800 feet and extends to the northwest for 490 feet. A drift 45 feet from the portal extends to the northeast for 285 feet along a slightly mineralized copper-lead-silver vein. Only a trace of fluorspar is found along this drift in the lower workings.

The upper workings consist of two shafts and the Upper Rattler tunnel (adit). Shaft No. 1, on the ridge at an elevation of 5,600 feet, is sunk on a copper-lead-silver vein. Shaft No. 2 at an elevation of 5,440 feet is inclined 49 degrees along a fissure vein that contains fluorspar. The shaft is sunk to about 40 feet, the lower part being caved in. At the 30-foot level a drift extends for about 32 feet to the northeast along the vein. The Upper Rattler adit begins at the same elevation, just 20 feet north of Shaft No. 2, and extends for 110 feet to the northeast along the same fluorspar fissure vein. The Upper Rattler adit also contains a winze and a short sublevel.

The Rattler claim is staked on Cambrian Prospect Mountain Quartzite, which consists of several thousand feet of light gray to tan quartzite in the Dugway Range. The claim is on a northwest-trending ridge that is cut by a north to northeast-trending fault, which dips 50° E. The fault extends to the north in a curving pattern for 2,300 feet from the bottom of Cannon Canyon over the quartzite ridge into Kellys Hole. Small mineralized fissure veins parallel this fault. Fluorspar mineralization is along the major fault. Galena and cerussite are the principal metallic ore minerals, occurring as irregular veinlets and as small individual crystals scattered through a gangue of quartz and fluorite.

In the Upper Rattler tunnel (adit) colorless and pale green fluorite occurs in a vein up to 6½ feet wide. Quartz and fluorite constitute a good proportion of the vein material. The fissure vein averages about 4 feet in width, and contains about 27.7 percent fluorite. Small quantities of galena, cerussite, malachite, and azurite are present in the vein.

Fluorspar potential on the exposed parts of the Rattler is probably less than 2,000 tons. The ore is high in silica and would require milling operations to produce a commercial product.

Dugway (Granite Peak) District

Dugway (Granite Peak) mining district includes all of Granite Peak, which is now part of the U. S. Army Dugway Proving Grounds military reservation in western Tooele County (figure 30). Ownership is now vested in the federal government, and no public access is allowed in the area. Small, scattered fluorite occurrences are found in lead-copper fissure veins in leucogranite and in some pegmatite dikes associated with gneissic biotite granite. The district is mentioned briefly by Butler and others (1920, p. 462), Buranek (1948, p. 15), and Thurston and others (1954, p. 51); the district is described by Ives (1946, p. 339-344) and Hanley (1950, p. 121-122); and a detailed study of the pegmatites is given by Fowkes (1964, p. 97-125). The southern two-thirds of Granite Peak consists of Precambrian gneissic biotite granite. Indistinctly foliated to the northeast, it has a medium-grained to porphyritic texture. The rock contains from 15 to 40 percent mafic minerals, principally biotite, but locally contains hornblende. The gneissic biotite granite is cut by numerous branching pegmatites. At the extreme southern end of the mountain a small outcrop of Precambrian schist and phyllite overlies the gneissic biotite granite. The northern one-third of Granite Peak consists of a Tertiary leucogranite, which intrudes the gneissic biotite granite. It is light gray, medium grained, and nearly equigranular in texture.

Pegmatite dikes are extremely numerous throughout the 7 mile length of Granite Peak. They make up approximately 20 percent of the gneissic biotite granite and are common in the leucogranite. They range in width from less than 1 inch to about 100 feet and in length from several feet to over 5,000 feet. Most pegmatites strike about N. 35° E. and dip 55°-70° W. Many of the dikes are branching and some are zoned. An age determination by Park (1970, p. 21) from a beryl-bearing pegmatite that intruded the gneissic biotite granite gave an age of 30 ± 2 million years.

Immediately south of Granite Peak is a small elongate hill, having a local relief of about 400 feet, called Sapphire Mountain. It consists of Tertiary porphyritic rhyolite. It is a gray to purplish gray lava containing phenocrysts of quartz and sanidine and locally a little biotite. Flow breccia is found in a few places.

Blue Bell Prospect

Several old prospect pits are found at the southern end of Granite Peak. They lie mainly in sec. 1, T. 9 S., R. 13 W., Dugway (Granite Peak) mining district, Tooele County (figure 30). The Blue Bell prospect was located in 1899 by L. J. Larson, but assessment work was discontinued. There were no valid mining claims in the area in 1955 when the federal government purchased all mineral lands within the military reservation. Development work consists of shallow pits. There has been no production of ore from the area.

The Precambrian gneissic biotite granite is cut by pegmatite dikes and small mineralized fissures. The

principal minerals in the pegmatites include quartz, muscovite, microcline, perthite, and plagioclase. Accessory minerals include tourmaline, beryl, amethyst quartz, fluorite, garnet, zircon, apatite, and samarskite. Metallic ore minerals are galena, chalcopyrite, hematite, limonite, and some malachite and azurite. Fluorite is found in pegmatites that have been fractured and with amethyst in the quartz core. Fluorite is present only as a minor occurrence at the southern end of Granite Peak.

Cannon Tank Canyon

Cannon Tank Canyon lies directly south of the GPI-2 military installation at the north end of Granite Peak. The canyon lies in an unsurveyed area in sec. 3, T. 8 S., R. 13 W., Dugway (Granite Peak) mining district, Tooele County (figure 30). Small pits and minor openings have been made in the canyon by prospectors and mineral collectors.

Cannon Tank Canyon is eroded in Tertiary leucogranite. The main rock type is gray, medium grained, and nearly equigranular granite. Weathered surfaces exhibit a mottled-brown desert varnish and some pitting. Numerous aplite and pegmatite dikes cut the leucogranite. Small fissure veins cut the leucogranite and dike rocks. The principal minerals are quartz, fluorite, amethyst quartz, and hematite. Locally, small quantities of galena, pyrite, chalcopyrite, malachite, azurite, and limonite are present. Fluorite is present only as a minor occurrence in small fissure veins.

Desert Queen Prospect

The Desert Queen prospect is on the west side of Granite Peak. It lies in an unsurveyed area that would fall in the W½ sec. 15 and the E½ sec. 16, T. 8 S., R. 13 W., Dugway (Granite Peak) mining district, Tooele County (figure 30). The property, consisting of eight unpatented claims located in 1940 by James M. Sargent, was incorporated in 1942 as the Mica Corporation of America. In 1955, the property was sold to the federal government. The claim is mentioned briefly by Bullock (1967, p. 64, 119) and Elevatorski (1974, p. 110).

Bedrock outcrops consist of Precambrian gneissic biotite granite that is cut by numerous pegmatite dikes. An attempt was made to mine muscovite by the Mica Corporation of America. Mica occurs in bands of indistinctly zoned pegmatite dikes, some mica books measuring up to 6 inches across. Commercial production proved to be uneconomic.

Quartz, muscovite, microcline, perthite, and plagioclase form the essential minerals composing the pegmatites. Accessory minerals include garnet, tourmaline, beryl, samarskite, hematite, pyrite, fluorite, zircon, and apatite. Small quantities of fluorite are found in some pegmatites where late fracturing has occurred. Fluorite is also associated with amethyst quartz in the quartz core of zoned pegmatites of the area. Fluorite is present only as a minor occurrence at the Desert Queen prospect.

El Dorado Mine

The El Dorado mine is in a canyon that lies nearly 1 mile east of GPI-2 military installation at the north end of Granite Peak. The mine lies in an unsurveyed area in the W½ sec. 2, T. 8 S., R. 13 W., Dugway (Granite Peak) mining district, Tooele County (figure 30). The property was located in 1913 by W. H. Clover and Robert N. Clover under the title of National Copper Mines Company. The property consisted of ten El Dorado claims and two Ella claims, all patented in 1922. Nine El Dorado claims are positioned end to end in a north-south direction through the W½ sec. 2 and W½ sec. 11. Development work includes several hundred feet of drifting in the two adits, the El Dorado tunnel and Ella tunnel. The El Dorado mine produced only about 22 tons of lead-copper-silver ore. In 1955 the El Dorado and Ella claims were sold to the federal government. The mine is mentioned briefly by Bullock (1967, p. 64, 119).

The El Dorado mine is on the Tertiary leucogranite that forms the northern one-third of Granite Peak. It is cut by numerous aplite and pegmatite dikes. Mineralization has developed along a fissure vein that parallels and cuts a dike in the leucogranite. The vein strikes nearly north-south and dips steeply to the east. It varies in width from mere stringers to several feet. It shows strong banding. The principal minerals in the fissure vein are quartz, fluorite, and hematite. Locally a little galena, pyrite, chalcopyrite, malachite, azurite, and limonite are present. Fluorite mineralization is only a minor occurrence at the El Dorado mine.

Mountain Queen Prospect

The Mountain Queen prospect lies on the east side of Granite Peak. It lies in an unsurveyed area in the E½ sec. 13, T. 8 S., R. 13 W., Dugway (Granite Peak) mining district, Tooele County (figure 30). The property, consisting originally of three unpatented claims staked in 1937 by John A. Perkins, was sold in 1955 to the federal government. Development work is limited to a few prospect holes, and no production is known. The prospect is mentioned briefly by Bullock (1967, p. 64, 119).

The Mountain Queen prospect is near the Tertiary leucogranite and Precambrian gneissic biotite

granite contact. Small fissure veins occur within the leucogranite. They consist mostly of quartz, fluorite, and hematite along with minor amounts of galena, pyrite, chalcopyrite, malachite, azurite, and limonite. Fluorite is present only as a minor occurrence at this prospect.

Dugway (Wildcat Mountain) District

Dugway (Wildcat Mountain) district includes all of Wildcat Mountain, which is now part of the U. S. Air Force Wendover Bombing and Gunnery Range (figure 30). Ownership is now vested in the federal government, and no public access is allowed in the area. Wildcat Mountain lies in the Great Salt Lake desert and consists of somewhat subdued topographic features with a local relief of about 1,000 feet. Bedrock consists of sedimentary rocks of the Oquirrh Formation, Desmoinesian series, Pennsylvanian in age. The strata strike generally north and northeast and dip from 20°-50° W. The mountain is blanketed with beach deposits of Quaternary Lake Bonneville sediments. Fluorite mineralization occurs at the extreme north end of the Wildcat Mountain.

Silver Queen Mine

The Silver Queen mine, also known as the Wildcat mine, lies on two subdued hills on the extreme northern end of Wildcat Mountain, Tooele County (figure 31). The property is 18 miles southwest of Clive, a station on the Western Pacific railroad, which is about 48 miles east of Wendover. The property is accessible from U. S. Highway I-80. The mine lies in an unsurveyed area that is in the SW¼ sec. 2 and SE¼ sec. 3, T. 4 S., R. 13 W., Dugway (Wildcat Mountain) district (figure 30). The property was located in 1898 by Charles W. Coe and John R. Mellen. The claims were patented in 1912 as the Crazy Aaron, First Chance, My Annie, and North Star by the Silver Queen Mining Company of Salt Lake City. The property has been developed by a series of trenches, shafts, and adits. A total of 904 tons of hand-picked fluorspar was mined from 1918 through 1924 by the Silver Queen Mining Company. In 1940, the Silver Queen mine was included within the Wendover Bombing and Gunnery Range, and the title of ownership was transferred to the federal government. Government restrictions do not permit access or claim staking of any mineral resources within the area. The deposit is described by Heikes (1924, p. 48-49), Buranek (1945, p. 20-28; 1948, p. 12), and Smith and Wadsworth (1954, p. 45-48). Chemical analyses and flotation experiments were conducted by the U. S. Bureau of Mines and reported by Snedden and others (1947, p. 20-27). The mine is mentioned briefly by Burchard (1933, p. 21), Dasch (1964, p. 167), Bullock (1967, p. 67, 119), Elevatorski (1974, p. 110), and Worl and others (1974, p. 10).

Fluorite occurs as fissure fillings and fissure replacements in limestone members of the Pennsylvanian Oquirrh Formation. At the mine the strata comprise thin to thick-bedded blue limestone traversed by scattered veinlets of calcite and interstratified with a few thin beds of shale. At the crest of the western ridge is a thick quartzite member of the Oquirrh Formation. The only faulting observed near the deposit is along the fissures that contain fluorite. In places the walls of the fissures have slickensides, are polished, and contain little or no gouge or fault breccia. The displacement along the faults is slight. A few small lamprophyre dikes ranging from a few inches to 4 feet in width run more or less parallel with the fluorspar fissures. The dikes are exposed only for short distances and well exposed at the western deposit.

Two occurrences of fluorspar are found at the Silver Queen mine. The western deposit is on a limestone hogback about 200 feet high that trends north-south. The eastern deposit is on a low, flat limestone hill about 800 feet east of the hogback. The two hills are separated by lacustrine deposits of the former Lake Bonneville. On the hogback the limestone beds strike north-south and dip 20°-50° W. Limestone beds on the low hill to the east strike nearly east-west and dip 30° S. The differences in strike and dip on the two hills are not apparent but likely due to faulting.

Fluorspar fissure veins trend in two general directions, N. 75°-80° E. and N. 5°-35° E. Along these fissures fluorspar occurs as fillings and vein replacements in pockets 5 to 15 feet long and 2 inches to 5 feet wide. The eastern occurrence has one north-trending and two east-trending fissures. The southernmost vein is about 350 feet long and trends N. 80° E. and dips 50° N. North about 225 feet is a second east-trending fissure of similar strike and dip that measures 250 feet long. Fifty feet northward is a north-trending fissure traceable for 150 feet. Most of the fluorspar production from the eastern deposit has been by a series of trenches and short adits developed along these three fissure veins. An 80-foot shaft and drifts were used to explore the southern vein. The shaft occurs at the east end of the vein. A drift at a depth of 40 feet in the shaft was driven S. 35° W. along a vein of fluorite 2 feet in width. The vein is traceable for about 100 feet, although it is pockety in places, ranging from a few inches to 2 feet wide. At the same depth a short drift trending S. 80° W. has cut a few small pockets of fluorspar. At the bottom of the shaft, about 80 feet deep, small pockets of fluorspar occur along a fault striking N. 45° E. and dipping 55° NW. A short stope has been worked along this mineralized zone.

Fluorspar is found in two fissures on the western hogback at the Silver Queen mine. The largest is a

Figure 31. Silver Queen mine, Wildcat Mountains, Tooele County.

north-trending vein that is traceable for over 700 feet. This vein, parallel with the hogback, has variable strike and dip. Surface outcrops of fluorspar range from 2 inches to 2 feet, but the fissure is not continuously mineralized. A second fissure 250 feet long strikes N. 80° E. and dips 65° N. This east-trending fissure cuts and displaces the large fissure. Both fissures are mineralized and have been partly developed by trenching. A caved-in shaft about 10 feet deep and 200 feet east of the east-trending fissure was excavated in Lake Bonneville sediments. This shaft is in alignment with the east-trending fissures on the hogback and the eastern outcrops. These veins are separated by 800 feet, and the intervening area is covered by Lake Bonneville sediments. There is no evidence that the 10-foot shaft was deep enough to intersect the fissure. Two inclined shafts were used to explore the hogback deposits. The northernmost inclined shaft is near the north end of the 700-foot fissure. The shaft cuts the vein at the opening but follows the bedding of the Oquirrh Formation downward. The latter vein carries mostly calcite and barite. A second inclined shaft lies 200 feet to the southeast at a lower elevation, but development work did not extend deep enough to intersect the fissure vein.

Ore deposits consist of fissure fillings and vein replacements in limestone members of the Oquirrh Formation. The veins carry fluorspar, silver-copper ores, and in places calcite, barite, siderite, and quartz. Generally the limestone near the ore is bleached and dolomitized. The strongest alteration occurs alongside the lamprophyre dikes, the best developed on the western hogback. Limestone for several feet away is dolomitized, and it carries finely disseminated pyrite and chalcopyrite and tiny veinlets of fluorite and barite.

Fluorite forms the principal mineral in the veins. It generally occurs as well-formed cubes and crystalline masses that range from almost colorless to yellow, blue, and green. Calcite, siderite, barite, and quartz occur in lesser amounts. Silver-copper ore, distributed through the fluorspar as veinlets and as interstitial fillings, constitutes about one-fifth of the total material mined. The copper minerals are principally malachite and azurite along with a little chalcopyrite, chalcocite, chrysocolla, and cuprite. The silver occurs with the copper as native silver and cerargyrite. These products were separated by hand sorting and screening. Three samples taken by the writer from two veins and a

small stockpile of fluorspar averaged 65.82 percent fluorite, 21.46 percent quartz, and 5.76 percent calcite. Samples collected by the U. S. Bureau of Mines averaged 58.3 percent fluorite, 12.6 percent silica, 20.7 percent calcite, 0.75 percent copper, and 4.1 ounces of silver per ton. Chemical analyses of ten carload lots of hand-sorted fluorspar shipped from the Silver Queen mine to Salt Lake City and to San Francisco averaged 88.9 percent fluorite, 6.7 percent calcite, and 3.1 percent quartz.

The potential for additional production of fluorspar from the Silver Queen mine is good, but the ore would require milling. Production would likely not be large, but it might be several times the original production. Development work on the property is limited, and underground mining is poorly engineered. Exposed veins on the eastern deposit have been extensively trenched, but only one vein on the eastern deposit was partly tested by underground mining. The alignment of the veins on the two hills suggests that the mineralization may continue across the intervening 800 feet covered by Lake Bonneville sediments. Trenching may be feasible for prospecting between the exposed hills. The known veins on both deposits could be explored by diamond drilling; and if the Lake Bonneville deposits are excessively thick, drilling of this area is recommended. Further work on this property is restricted until the federal government abandons the Wendover Bombing and Gunnery Range or grants public access to the property.

Erickson District

The Erickson district includes all the Simpson Mountains and the western side of the Sheeprock Mountains (figure 30). The district, organized in 1894, has produced small quantities of lead, copper, and zinc ores. The main deposits are fissure veins in granite or quartzite. The ore occurrences in the Sheeprock Mountains are in granite; they include pegmatite deposits, copper-fluorite, lead-zinc, manganese-fluorite-uranium, and wolframite-quartz veins. The principal mines are the Copper Jack, Flying Dutchman, Silver King, Silver Queen, Tintic-Delaware, Dutch Peak, and Indianapolis. The district is described by Butler and others (1920, p. 425-429), Harris (1958, 82 p.), and Cohenour (1959, p. 117-120). Fluorite occurrences of this district in the Sheeprock Mountains are associated with copper-fluorite veins in the Copper Jack and Flying Dutchman mines and with manganese-fluorite-uranium veins at the Silver King mine.

Copper Jack Mine

The Copper Jack mine lies along the southwestern side of the Sheeprock Mountains. The property lies at the mouth on the north side of Burned Canyon. The mine shaft is in the northeast part of the SW¼ sec. 34, T. 10 S., R. 6 W., Erickson mining district, Tooele County (figure 30). The property consists of two Copper Jack claims located in 1908 and patented in 1912 and eight additional adjoining patented claims, including the Flying Dutchman claims (see p. 81). The claims are held by the Ekker family, in care of John Gary Ekker, Jr., of Springville. The Copper Jack mine, developed by a shaft 140 feet deep, follows a 3-foot vein that has averaged 6 percent copper. The mine shaft struck water at 80 feet and is presently flooded. The Copper Jack mine is described by Butler (1920, p. 427-428), Harris (1958, p. 14), and Cohenour (1959, p. 117). The mine is mentioned briefly by Buranek (1948, p. 14), Thurston and others (1954, p. 51), Bullock (1967, p. 62, 119), and Elevatorski (1974, p. 111).

In the early 1900's prospectors in the Dutch Peak area discovered copper-bearing fissure veins in the Tertiary Sheeprock granite stock. The Copper Jack mine lies on the southwestern side of the stock. The main granite rock is iron stained, white to light gray, and medium to coarse grained. Much of the rock is porphyritic. Weathering has reduced much of the granite to rounded, crumbly masses. The granite is cut by numerous sets of joints, which control the weathered landforms.

Quartz-fluorite fissure veins with pyrite and chalcopyrite cut the granite along the western margin of the stock near the base of granite cliffs. The veins strike N. 25°-45° W. and dip about 50° SW. Four discontinuous fissure veins cut through the Copper Jack and nearby Flying Dutchman claims. Two fissures form a sheeted structure with mineralization along the fractures. Surface expressions of these fissures range in width from a mere fracture up to 4 feet. The Copper Jack vein followed in mining was up to 3 feet wide and averaged 6 percent copper. One 100-foot portion of the Copper Jack vein averaged 7 to 8 percent copper and included considerable high-grade ore running 20 to 30 percent copper. The silver content ranged from 1 to 7 ounces per ton. The fissure vein contacts are sharp and curved.

The primary vein minerals consist chiefly of quartz, fluorite, chalcopyrite, pyrite, and minor specularite. Secondary minerals include malachite, chrysocolla, turquoise, limonite, and manganese oxides. Fluorite forms single crystals or coarse-grained aggregates of colorless, green, and purple hues. Much of the fluorite is dark purple and radioactive, containing small quantities of uraninite.

Since the mine is flooded, no underground workings were observed, but the fluorspar ore potential of the mine is regarded as small. Any fluorspar ore

removed would require milling to remove granite rock, chalcopyrite, pyrite, quartz, and other impurities. The Copper Jack mine is regarded as a minor occurrence of fluorite.

Flying Dutchman Mine

The Flying Dutchman mine is along the southwestern side of the Sheeprock Mountains. The mine lies on the west side near the mouth of Hard-to-Beat Canyon at an elevation of 6,335 feet. The mine lies in the southeast part of SE¼ sec. 28, T. 10 S., R. 6 W., Erickson mining district, Tooele County (figure 30). The property consists of two Flying Dutchman claims, located in 1908 and patented in 1912, and eight additional patented claims, including the Copper Jack claims. The claims are owned by the Ekker family, in care of John Gary Ekker, Jr., of Springville. The Flying Dutchman mine has been developed by two inclined shafts. The main shaft, 240 feet long with a slope of about 40 degrees, follows a copper-bearing fissure vein for 900 feet. The mine is inaccessible, because it is flooded. The property has been described by Butler and others (1920, p. 428-429), Harris (1958, p. 75-78), and Cohenour (1959, p. 117). The mine is mentioned briefly by Buranek (1948, p. 14) and Elevatorski (1974, p. 111).

The geology of the Flying Dutchman mine is similar to the Copper Jack mine. Both properties are on the southwestern side of the Tertiary Sheeprock granite stock and mineralized along northwest-trending fissure veins. Mineralization can be traced for 1½ miles from near the mouth of Burned Canyon northwestward to the Flying Dutchman mine. The veins are discontinuous, and many are covered by alluvium in places. They range from mere fractures to several feet wide on the surface. The veins more or less parallel the trend of the nearby South Flank fault that outlines the western side of the Sheeprock Mountains and were probably developed by the same tectonic forces. Several fissure veins extend through the granite. Four main fissure veins are recognized on the Copper Jack and Flying Dutchman claims, and strike N. 30° W. and dip about 50° SW. The fissure vein followed in the Flying Dutchman inclined shaft ranged from 3 to 15 feet in width along a sheeted structure. The average copper content was 3 to 5 percent.

Chalcopyrite, fluorite, manganese oxides, and pyrite constitute the principal vein minerals in a quartz matrix. Fluorite occurs as single crystals and coarsely grained aggregates, either pure or mixed with other minerals. Fluorite varies from colorless, to green, to dark purple. Much of the fluorite is dark purple, radioactive, and contains small quantities of uraninite. Pyrite and chalcopyrite tend to form in separate aggregates. Some specimens consist of irregular masses almost wholly of chalcopyrite and fluorite, or of pyrite and fluorite. Quartz forms a matrix for the other primary vein minerals. The order of crystallization appears to be pyrite, fluorite, chalcopyrite, and quartz.

The underground mine workings are flooded and not accessible to observation, but the fluorspar ore potential of the Flying Dutchman mine is limited. Milling operations would be required to remove granite rock, quartz, chalcopyrite, pyrite, and other impurities. The fluorspar present at this mine is regarded as a minor occurrence of fluorite.

Silver King Mine

The Silver King mine is on the west side of the Sheeprock Mountains, north of South Oak Brush Canyon. The Silver King No. 1 tunnel lies at an elevation of 6,630 feet in a partly surveyed area that lies in the SE¼ sec. 7, T. 10 S., R. 6 W., Erickson mining district, Tooele County (figure 30). The property consists of four Silver King mining claims patented in 1900 that lie in sec. 6 and 69 IXL unpatented claims that lie in sec. 7 and adjoining sections. The mine is controlled by the IXL Mining Corporation. The principal owners are Mrs. Earl J. (Gladys) Clinger of Hurricane and Patrick Holden of Murray. The mine is described by Hillier (1956) and Cohenour (1959, p. 118) and is mentioned briefly by Thurston and others (1954, p. 51), Bullock (1967, p. 62, 119), and Elevatorski (1974, p. 111).

The older Silver King mine workings consist of three shallow shafts and one adit, developed along copper-silver veins in granite. A vertical shaft is 65 feet deep, and two inclined shafts are 30 and 50 feet in length. The Porcupine adit extends 200 feet to the southeast along a fissure vein in granite. In 1953, uranium was discovered on the Silver King claims. The U. S. Atomic Energy Commission conducted exploratory work in the area by bulldozing, diamond drilling, and underground drifting. Bulldozing consisted of nearly parallel cuts at 200-foot intervals, which totaled 4,350 feet. Four drill holes were completed, ranging in depths from 165 feet to 367 feet and totaling 1,062 feet. The holes were inclined and designed to intercept veins at depths from 100 to 245 feet below the surface. Underground drifting in the Silver King No. 1 tunnel was driven to crosscut a series of nearly parallel fissures at depth. The crosscut was advanced N. 72° E. for 420 feet and then was turned to N. 55° E. for 336 feet. It started in quartzite but entered granite after penetrating a fault zone at 42 feet from the portal. In 1967 and 1968 this adit was advanced to 1,400 feet in length by the owner, Mrs. Earl J. Clinger, and two shallow vertical drill holes were cut.

The Silver King mine lies along the western margin of the Tertiary Sheeprock granite stock, which is in the west-central part of the Sheeprock Mountains. Mineralization occurs in granite near the contact between Paleozoic sedimentary rocks and granite. The contact represents the westernmost exposures of granite in the Sheeprock area. The oldest sedimentary rock in the immediate area of the mine is the Ordovician Swan Peak Quartzite, which forms the contact with the granite. The Swan Peak Quartzite is up to 462 feet thick in the Sheeprock Mountains, forming an excellent marker bed and consisting of well-sorted, well-rounded, pure quartzite. It is medium grained, occassionally cross-bedded, and white, pink, and tan. The overlying Ordovician Fish Haven Dolomite consists of light to dark gray dolomite. The Sheeprock granite stock is iron-stained, white to light gray rock with a medium- to coarse-grained texture. Much of the rock is porphyritic. Pegmatite and aplite dikes are common in the granite stock to the south of the Silver King mine.

The major structural feature is a fault at the contact of the Sheeprock granite and the Swan Peak Quartzite. This fault, related to the West flank zone of the Sheeprock Mountains, strikes N. 25° W., dips 50° SW., and is 15 feet wide in the mine adit. The granite is cut by numerous sets of joints. The strongest set strikes northeast and dips nearly vertical. A minor set trends northwest and dips at a shallow angle. The joints contain limonite and hematite, which locally gives the granite a reddish-brown tint.

Eight mineralized fissure veins, ranging from 200 to 900 feet in length, are exposed on the surface in the granite. They also show a northwest trend, striking N. 11°-40° W. and dipping from 56°-88° W. Most of the fissure veins are thin, ranging from 1 to 6 inches in width. A few fissure veins up to 6 feet wide contain manganese oxides, hematite, or uranium mineralization. Uranium occurs as uraninite in a few places underground, but no commercial ore has been found. Manganese coatings along a network of fine fractures stain the granite black. Colorful disklike crystals of specularite occur in great abundance in many of the joints and fissure veins. Soft red earthy hematite is present in veins that are a few inches to about 5 feet in width in the adit.

Specular hematite, earthy hematite, manganese oxides, chalcopyrite, pyrite, uraninite, and possibly an unidentified silver mineral form the ore minerals. Fluorite and quartz are the main gangue minerals. Pale purple to dark purple fluorite occurs in several small stringers in the adit or the Silver King No. 1 tunnel. Fluorite cuts and replaces parts of the mineralized fissure veins. Fluorite crystals were observed in the drill cores. No commercial fluorspar is present at the Silver King mine, and its presence is considered only a minor occurrence.

Ophir District

The Ophir district lies on the southwest side of the Oquirrh Mountains (figure 30). The district, organized in 1870, has produced substantial amounts of lead, silver, zinc, copper, and gold ores. Production has come from fissure veins, pipes, and bedded replacements in Paleozoic limestones and hornfels. The district is described by Butler and others (1920, p. 374-382) and Gilluly (1932, p. 139-156). Fluorite forms a minor gangue mineral at the Buffalo mine, but it is an abundant gangue mineral in the primary sulfides at the Ophir mine.

Buffalo Mine

The Buffalo mine lies about 2 miles by road up Long Trail Gulch from Ophir, Tooele County. It is on the east side of Silveropolis Hill near the center of sec. 25, T. 5 S., R. 4 W., Ophir mining district (figure 30). The mine is developed on two levels that are about 280 feet vertically apart, the lower level being at an elevation of 8,047 feet. The total workings are probably over 6,000 feet in length, and most of the older workings are now caved in and inaccessible. The property lies principally on the Baltimore and Fair Day claims, and it is held by F. and S. Company of Tooele. The mine is described by Gilluly (1932, p. 139-140) and is mentioned briefly by Thurston and others (1954, p. 51), Bullock (1967, p. 65, 119), and Elevatorski (1974, p. 110).

The Buffalo mine is in the lower part of the Upper Mississippian Great Blue Limestone, below the Long Trail Shale member. Two sills of altered monzonite porphyry were cut in the lower adit, but the ore seems to have little relationship to them. The Great Blue Limestone strikes N. 25° E. and dips 25° SE. Lead-silver ores occurred in fissures and replacements in pipes and limestone beds. The fissures strike N. 65° W. and N. 70° E. Jasperoid alteration was common in large stopes in the upper levels. On the lower levels the ore consisted of primary sulfides, mainly galena, chalcopyrite, and pyrite. Gangue minerals were calcite, fluorite, and some quartz. On the upper levels of the mine the ore was oxidized to cerussite, cerargyrite, jarosite, plumbojarosite, malachite, and limonite.

Fluorite is present only as a minor gangue mineral at the Buffalo mine. No commerical fluorspar is known at this mine or in the Ophir district.

Ophir Mine

The Ophir mine is about ¼ mile northwest of Ophir, Tooele County. The working adit and drain tunnel are in the north wall of Ophir Canyon just west

of town. The mine lies in unsurveyed W½ sec. 23, T. 5 S., R. 4 W., Ophir mining district (figure 30). The property, formerly called the Ophir Hill Consolidated mine, consists of several patented claims. The history of mining activities began in 1964 with the discovery of lead-silver ores. Production started in 1870. The mine was idle from 1880 until 1897 when W. A. Clark resumed work until 1926. The property was acquired by Donald Gilbert who operated the mine until the 1940's, when the mine was purchased by U. S. Smelting, Refining, and Mining Company. The mine was leased to McFarland and Hullinger of Tooele until it was closed in 1972. In 1972 the U. S. Smelting, Refining, and Mining Company was incorporated as UV Industries of Salt Lake City. Underground workings consist of several thousand feet of levels, drifts, crosscuts, stopes, and raises. The entrance to the mine is on the 1,000 foot level at an elevation of 6,620 feet. A drain tunnel 2,400 feet long lies at an elevation of 5,502 feet at the portal. The mine is not accessible at the present time owing to flooding. The property has been described by Gilluly (1932, p. 148-151) and Weintraub (1957, 44 p.). The mine is mentioned briefly by Bullock (1967, p. 66, 119) and Elevatorski (1974, p. 110).

Ore at the Ophir mine is in the Cambrian Ophir Formation, which consists of shale and interbedded limestone members. Ore occurs as bedded replacements in the limestone members and along fissures that cut the Cambrian strata. Almost all of the early workings occurred in a block of ground between the Cliff and Canyon faults. In this wedge-shaped block the strata strike N. 60°-75° W. and dip 15°-25° NE, forming part of the northeast limb of the Ophir anticline.

Cambrian strata are cut by monzonite porphyry dikes that have contributed to premineral silication of the sedimentary beds. Epidote, garnet, diopside, and tremolite are the main minerals developed from contact metamorphism. During the following period of ore mineralization pyrite, scheelite, galena, chalcopyrite, sphalerite, and pyrrhotite were formed. Postmineral gangue consist of fluorite, calcite, and dolomite, forming late hypogene veins and replacements in the mineralized zones.

Fluorite is common in all primary sulfide ores. It forms fillings and replacement veins that cut all previous minerals indiscriminately. Fluorite is closely associated with a monzonite porphyry dike that measures 10 to 15 feet thick and cuts much of the Ophir mine property. Although fluorite is present in all primary sulfides, it is especially closely associated with pyrite and the richer copper ores near the dike. No commercial fluorspar is available from the Ophir mine, and its presence must be regarded as a minor occurrence.

Rush Valley (Stockton) District

The Rush Valley (Stockton) district lies on the west side of the Oquirrh Mountains east of the city of Stockton (figure 30). The district, organized in 1864, has produced over one-half million tons of lead, silver, copper, zinc, and gold ores. The mineralization is concentrated in fissure veins and bedded replacements in the Pennsylvanian Oquirrh Formation. The district is described by Butler and others (1920, p. 362-374) and Gilluly (1932, p. 117-122). Fluorite is present as a minor gangue mineral at the Honerine mine.

Honerine Mine

The Honerine mine lies in the western foothills of the Oquirrh Mountains about 1 mile northeast of Stockton, Tooele County. The Honerine claim lies in the SE¼ sec. 19, T. 4 S., R. 4 W., Rush Valley mining district (figure 30). The Honerine claim was staked in 1865 and patented in 1881. Consolidation of mining claims of this area into larger units has gone on for many years. In 1924, this and adjoining claims, consisting of 77 patented claims, were acquired by Combined Metals. At the present time, the claim is held by Combined Metals Reduction Company of Reno, Nevada. The Honerine claim and adjacent properties aggregate over 10 miles of underground development work. Production in the mine has been high in lead, silver, zinc, copper, and gold. The mine is described by Gilluly (1932, p. 160-162) and mentioned briefly by Bullock (1967, p. 66, 119).

The workings of the Honerine mine are in the Pennsylvanian Oquirrh Formation, which consists of a great series of interbedded limestone and quartzite. The mine is about 5,000 feet stratigraphically above the base of the formation. The strata strike N. 70°-75° W. and dip 60°-75° NE. They are cut by numerous fissures that strike N. 10°-30° E. and dip 60°-75° W. In addition, several monzonite porphyry dikes cut the strata. They range in width from 1 foot to over 300 feet.

The ore bodies of the Honerine mine are typically pipelike or tabular replacement deposits in limestone. They lie at intersections of limestone beds and fissures. As a rule the ore bodies are the full thickness of the interbedded limestone. They range from 10 to 100 feet in width, and up to 1,800 feet in pitch length. The largest ore bodies have been developed in the Honerine Limestone member. The hypogene ore consists of mixed sulfides including pyrite, galena, sphalerite, and some chalcopyrite and arsenopyrite. Oxidation in the higher parts of the mine has altered the sulfides to cerussite, plumbojarosite, jarosite, malachite, smithsonite, aurichalcite, pyromorphite, and limonite. Gangue minerals include abundant quartz,

fluorite, calcite, epidote, dolomite, wollastonite, diopside, and chlorite.

Fluorite is a later hypogene mineral cutting the ores. It is widespread in the Honerine mine, but is a minor occurrence. It also is found in small quantities in some of the contact zones in Soldier and Settlement Canyons.

UTAH COUNTY

Santaquin District

The Santaquin district lies on the west side of the southern Wasatch Mountains east of the city of Santaquin (figure 32). The district was organized in 1871. Minor lead and zinc mineralization is found in fissure veins and bedded replacements in Cambrian limestone. Small copper deposits are present as thin veins and stringers of chalcopyrite in the Precambrian Farmington Canyon Complex. The district is described by Butler and others (1920, p. 322-334). On the Black Balsam claims fluorite is associated with a copper vein as a subordinate gangue mineral.

Black Balsam Prospect

The Black Balsam prospect is about 2 miles southeast of Santaquin on the west side of Dry Mountain in the southern Wasatch Mountains. The prospect is in SE¼ sec. 7, T. 10 S., R. 2 E., Santaquin mining district, Utah County (figure 32). The claim was located in 1903 on the north side of Green Canyon near the crest of a mountain spur at an elevation of about 6,600 feet. The property consists of two unpatented claims, Black Balsam No. 1 and No. 2. The property is developed by two adits. The upper adit on the Black Balsam No. 1 claim is 251 feet long; the

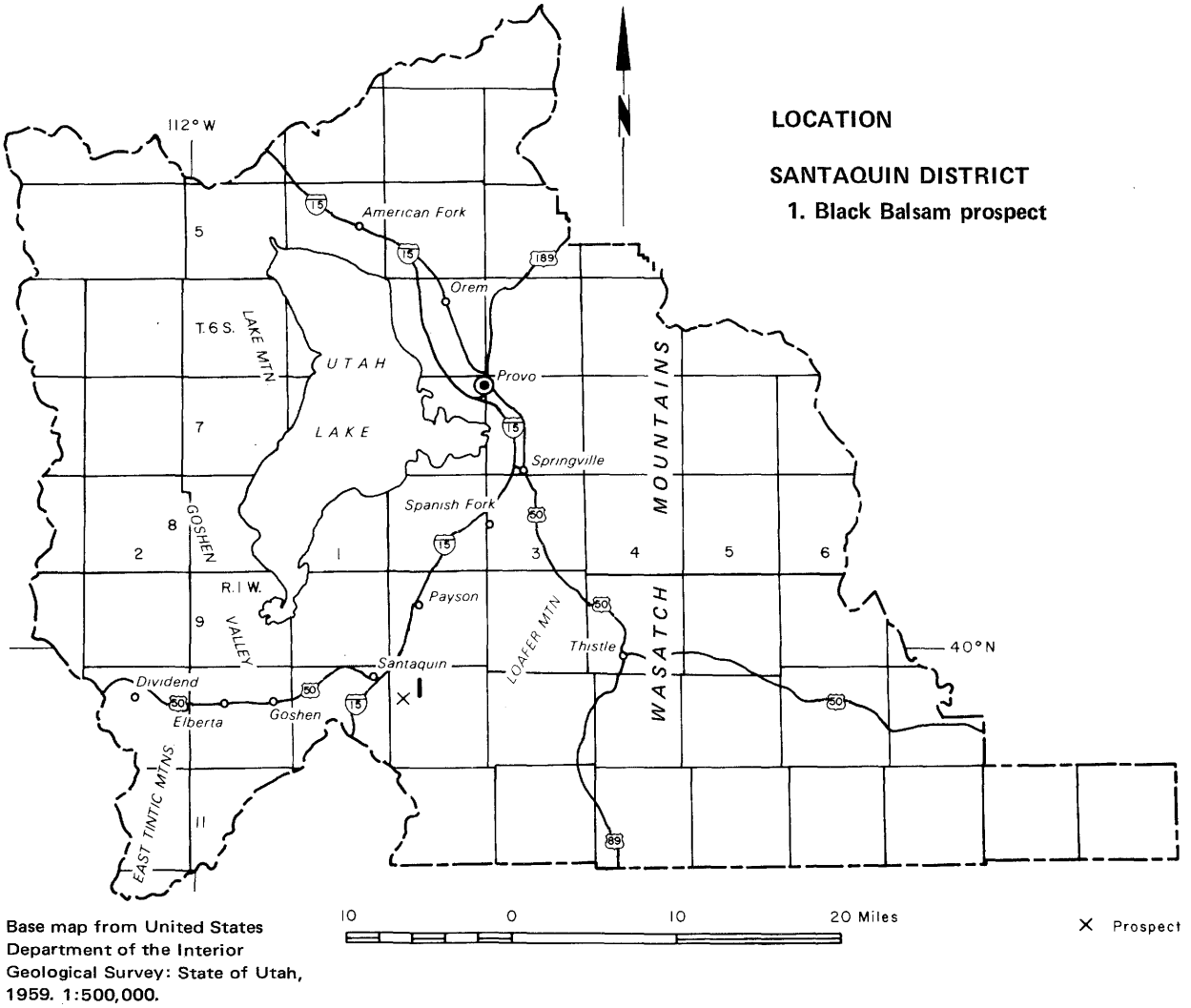

Figure 32. Utah County fluorite occurrence.

lower adit on the Black Balsam No. 2 claim is 312 feet long. The property is owned by Lentz Greenhalgh of Salt Lake City and held by annual assessment work. The Black Balsam prospect is described by Butler and others (1920, p. 330) and mentioned briefly by Loughlin (1919, p. 101) and Bullock (1967, p. 72, 120).

A belt of Precambrian rocks measuring about 3 miles long and 1 mile wide crop out east and southeast of Santaquin. They comprise two units. The older rocks are part of the Precambrian Farmington Canyon Complex, consisting of crystalline gneiss, schist, granite, and pegmatite of unknown thickness. They are overlain unconformably by the younger Precambrian Big Cottonwood Formation, which consists of quartzite, slate, phyllite, shale, and graywacke conglomerate, slightly more than 3,000 feet thick.

The Black Balsam prospect is on a vein that cuts the Precambrian Farmington Canyon Complex. The vein is in shattered granite gneiss. It trends N. 50° E. and dips 70° SE. Near the vein is a lamprophyre dike 3 feet thick that has parallel strike and dip. The vein lies close to the dike but apparently not in contact with it. The vein is traceable for over 150 feet along branching veinlets that contain copper and other minerals. The principal fissure vein minerals are coarse-grained white calcite, and a considerable, though subordinate, amount of pale green fluorite. The vein also contains a little chalcopyrite, pyrite, and galena. The chalcopyrite is oxidized in part to malachite. No commercial fluorspar is present on the Black Balsam property, since fluorite is a minor occurrence along a small fissure vein.

WEBER COUNTY

Weber District

The Weber district lies on the west side of the Wasatch Mountains, immediately east and northeast of Ogden (figure 33). The district was organized in 1878. Several prospects were established, but only one serious attempt at mining was made by Ogden Buckhorn Mining Company. The district is described by Butler and others (1920, p. 233), and the geology of the area is discussed by Eardley (1944, p. 819-894). Narrow fissure veins of fluorite outcrop at the Norman mine in the Precambrian Farmington Canyon Complex.

Norman Mine

The Norman mine is immediately east of Ogden on the steep Wasatch Mountain front. The property lies in the SW¼ sec. 14 and SE¼ sec. 15, T. 6 N., R. 1 W., Weber mining district, Weber County (figure 33). The property was located in 1953 by Dale H. Norman and Arden Norman as All Minerals claims, Nos. 1-6, and relocated in 1954 as All New Minerals claims, Nos. 1-4. During a period of federal government stockpiling of fluorspar in 1957, the property was mined by the Normans. One carload, 47 tons of ore, was sold to General Administration Services at Ogden. Present

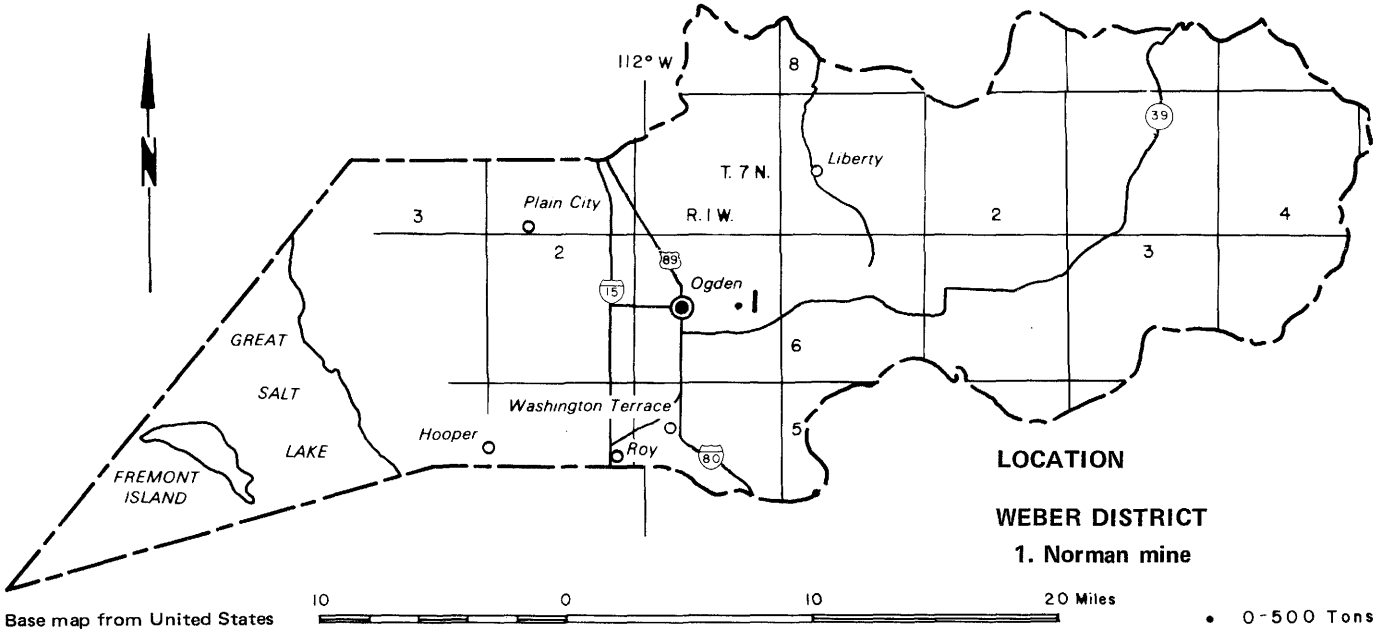

Figure 33. Weber County fluorite occurrence.

ownership of the property is held by Norman Mining; Dale H. Norman of Ogden is vice president. There are 15 unpatented claims that lie in a strip along a mineralized zone that trends northeast. The claims begin about 1 mile east of the Ben Lomond High School, at the upper level of ancient Lake Bonneville, elevation 5,200 feet, and to the northeast along the Wasatch Mountain front to approximately 6,500 feet in elevation. The property is developed by a 250-foot open cut, a small open pit, bulldozer cuts, and a 240-foot adit. The Norman mine is described by Chojnacki (1964, p. 123-126) and Perry (1973, 8 p.). The property is mentioned briefly by Burchard (1933, p. 21), Thurston and others (1954, p. 51), Bullock (1967, p. 76, 120), and Elevatorski (1974, p. 120).

Fluorite mineralization occurs along fissures that cut the Precambrian Farmington Canyon Complex, which consists of granite gneiss, injection gneiss, schist, metaquartzite, metagraywacke, and other crystalline metamorphic types. This complex is overlain unconformably by several thousand feet of Precambrian Big Cottonwood Series, which consists of quartzite, phyllite, tillite, and arkosite. Paleozoic strata overlie both types of Precambrian rocks unconformably, or they are in thrust fault contact with them. The structure is complicated and involves three thrustsheets of major proportions that make up the Wasatch Mountains immediately north and south of Ogden Canyon. The west side of the Wasatch Mountains is outlined and bounded by normal faulting along the Wasatch fault.

Fluorite occurs along a mineralized zone that can be traced for about 1,500 feet, which strikes N. 40° E. and dips 55°-75° NW. Fluorite is found as fissure fillings along fractures and open spaces in breccia and gouge. The veins are lenticular and discontinuous; they undulate and bifurcate, and range from less than 1 inch up to 2 feet in width. The fluorite, containing thin bands of silica, is massive and crystalline. Colorless and pale green hues are typical of the ore.

The main open cut at the Norman mine lies at an elevation of 5,660 feet. Bulldozer cuts and hand workings have exposed a mineralized zone about 250 feet in length. The fissure, which contains at least two veins of fluorite, strikes N. 48° E. and dips from 70°-75° NW. A more prominent vein occurs on the hanging wall of the fissure zone; a smaller one is on the footwall. At the north end of the open cut the hanging wall vein is 4 inches wide, and at the south end the same vein contains 10 inches of fluorite. Near the midpoint of the fissure zone the Normans made a hand excavation 50 feet long, 10 feet wide, and 15 feet deep. The fissure zone is 9 feet wide, containing a 2-foot vein of fluorite on the hanging wall and 6 to 18 inches on the footwall. The mineralization on the footwall bifurcates and dies out a short distance in each direction. The Normans mined 47 tons of hand-sorted fluorspar from this open cut in 1957 and shipped it to General Administration Services for stockpiling by the government. No ore was sold commercially. The ore averaged 88 percent fluorite and 12 percent silica. A sample taken from the 2-foot vein in the hanging wall averaged 89 percent fluorite and 5.2 percent silica. A sample from a small stockpile at the open cut averaged 79.7 percent fluorite and 12.3 percent silica.

A bulldozer cut and a small trench are approximately 200 feet lower than the upper pit. This cut, exposing a zone about 20 feet wide and containing stringers of fluorite 1 to 2 inches in width, is across the strike of the fissure. The trench, which measures about 30 inches wide, is cut in a fluorite-rich part of the fissure. No fluorspar has been shipped, but a small quantity of ore is stockpiled at the pit.

The mine adit predates the work of the Norman's and lies at an elevation of 5,330 feet. The portal is cut in a mylonite zone of schist. Small stringers of fluorite, ¼ to ½ inch wide, occur near the portal. Within the adit, the workings cut three separate veins of fluorite. The first, which lies 162 feet from the mine portal, is 6 inches thick, strikes N. 35° E., and dips 76° NW. The second, which lies 175 feet from the portal, is 6 inches to 2 feet thick, striking N. 40° E. and dipping 65° NW. A 30-foot drift driven along this vein to the northeast exposed a 6-inch fluorite vein, which branches from the main vein with a subparallel strike and a dip only 33° NW. A third vein lies 223 feet from the portal and is 6 to 12 inches wide, striking N. 35° E. and dipping 85° SE. The second or largest vein apparently correlates with the vein exposed on the surface in the large open cut.

The ore potential at the Norman mine can be inferred from surface and underground workings. If the vein averages 1 foot wide for the 250-foot length of the open cut and extends down dip about 300 feet to the adit level, the inferred fluorspar ore potential of this vein could be over 4,000 tons. The main vein and associated fluorspar veins are likely too narrow to be mined under present economic conditions. However, a drilling program is warranted to test the main fissure and others that may be present. The ore would require milling.

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CONVERSION TABLE FOR ENGLISH AND METRIC UNITS

Acre	0.4047 hectare
Acre-foot	1233.49 cubic meters
BTU	0.252 kilogram-calorie
Centimeter	0.3937 inch
Cubic meter	264.2 gallons
Foot	30.48 centimeters
Gallon	3.785 liters
Gram	0.03527 ounce
Gram	0.03215 ounce (troy)
Hectare	2.471 acres
Inch	2.540 centimeters
Kilogram	2.205 pounds
Kilogram-calorie	3.968 BTU
Kilometer	3,281 feet
Kilometer	0.6214 mile
Liter	0.2642 gallon
Meter	3.281 feet
Meter	39.37 inches
Mile	1.609 kilometers
Ounce	28.349527 grams
Ounce (troy)	31.103481 grams
Pound	453.5924 grams
Ton (short)	0.907 metric ton
Ton (long)	1.016 metric tons
Ton (metric)	1.1025 short tons
Yard	0.9144 meter

UTAH GEOLOGICAL AND MINERAL SURVEY

606 Black Hawk Way
Salt Lake City, Utah 84108

THE UTAH GEOLOGICAL AND MINERAL SURVEY, a Division of the Utah Department of Natural Resources, operates with a professional staff under the guidance of a policy-making Board appointed by the Governor of Utah from various representatives of industry and the public as specified by law.

The Survey is instructed to investigate areas of geologic and topographic hazards, to survey the geology and mineral occurrences, and to collect and distribute reliable information concerning the mineral industry and mineral resources, topography and geology of the state so as to contribute to the effective and beneficial development of all resources. The *Utah Code, Annotated, 1953 Replacement Volume 5, Chapter 36, 53-36-1 through 12,* describes the Survey's functions.

The Survey issues several series of publications and maps, *Survey Notes*—a quarterly newsletter, and *Utah Geology*—a biannual volume containing short papers on the geology of the state. It has also reprinted significant articles pertaining to Utah geology from other publications. (Write to the above address for the latest list of publications available.)

The Survey also sells the colored geologic map of Utah (Army Map Service base, 1:250,000, in four quarters), a project of the College of Mines and Mineral Industries from 1961 through 1964. It acts as sales agent for publications of the Utah Geological Association and its predecessor organizations, the Utah Geological Society, the Intermountain Association of Geologists, and the Intermountain Association of Petroleum Geologists.

THE SAMPLE LIBRARY is maintained to preserve well cuttings, drill cores, stratigraphic sections and other geological samples. Files of lithologic logs, electrical and other mechanical logs of oil and gas wells drilled in the state are also maintained. The Library's collections have been obtained by voluntary donation and are open to public use, free of charge.

THE SURVEY'S BASIC PHILOSOPHY is that of the U. S. Geological Survey, *i. e.,* our employees shall have no interest in lands within Utah where there is a conflict of interest deleterious to the goals and objectives of the Survey; nor shall they obtain financial gain by reason of information obtained through their work as an employee of the Survey. For permanent employees this restriction is lifted after a two-year absence; for consultants employed on special problems, there is a similar time period which can be modified only after publication of the data or after the data have been acted upon. For consultants, there are no restrictions beyond the field of the problem, except where they are working on a broad area of the state and, here, as for all employees, we rely on their inherent integrity.

Directors:
Donald T. McMillan, 1974-
William P. Hewitt, 1961-1974
Arthur L. Crawford, 1949-1961