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FLUORSPAR IN CALIFORNIA

By James W. Crosby III * and Samuel R. Hoffman *

OUTLINE OF REPORT

ABSTRACT

Fluorspar (fluorite) is a nonmetallic industrial mineral of importance as a flux in the open-hearth process of manufacturing steel, in making hydrofluoric acid, and in the ceramic industry. A relatively new use of hydrofluoric acid is in the alkylation process for the manufacture of 100-octane gasoline. The small amount of fluorspar intermittently produced in California has fallen far short of meeting the increasing demand.

In the present study 19 deposits were investigated and 13 are described as having some possibility of development; none were producing in early 1951. Deposits in which some development work has been done include Warm Spring Canyon, Fluorspar Group, Red Bluff, Afton Canyon, Green Hornet, Primer, Providence Mountain, and Clark Mountain.

Geologic study and mapping of the Clark Mountain deposit, which was being developed in late 1950, shows that fluorspar occurs with sericite in replacement veins of variable thickness along discontinuous shear zones in dolomite. The friable fluorspar-sericite ore at this locality has some commercial possibility, particularly if the sericite proves to be a satisfactory substitute for ground mica.

INTRODUCTION

Pure fluorspar (fluorite) is calcium fluoride (CaF_2) which consists of 51.1 percent calcium and 48.9 percent fluorine. Rarely, however, does a body of fluorspar analyze more than 99 percent CaF_2. Because most commercial fluorspar deposits contain varying amounts of impurities such as silica, calcite, alumina, and oxides of iron, and are commonly associated with barite, galena and sphalerite, the ore from the deposits must be concentrated before shipping.

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Mineralogy. Fluorite crystallizes in the isometric system, usually in the form of cubes, but some fluorite crystals are octahedrons or dodecahedrons. Perfect octahedral (111) cleavage is characteristic of crystalline varieties. The mineral is number four on Mohs scale of hardness and has a specific gravity of 3.01 to 3.25. Compact varieties of fluorspar have a splintery fracture. The mineral displays a wide range of colors, even within a single crystal. The most common colors displayed are purple, white, green, and blue; but yellow, rose-red, crimson red, violet-blue, sky-blue, brown, wine-yellow, and greenish-blue varieties are occasionally found. Red fluorite is rare. The cause of the color in fluorite has not been determined, but it is known that the color may be modified by various means, such as heat, X-rays, gamma rays, ultra-violet light, and pressure. The color of fluorspar ordinarily is not an indication of its purity, but in certain places color is used as a guide in hand sorting ore from a picking belt. Some specimens exhibit a blue fluorescence in ultra-violet light.

The name fluorite is the one commonly found in works on mineralogy and apparently is more or less confined by common usage to the nearly pure mineral. Fluorspar, on the other hand, is the term used almost

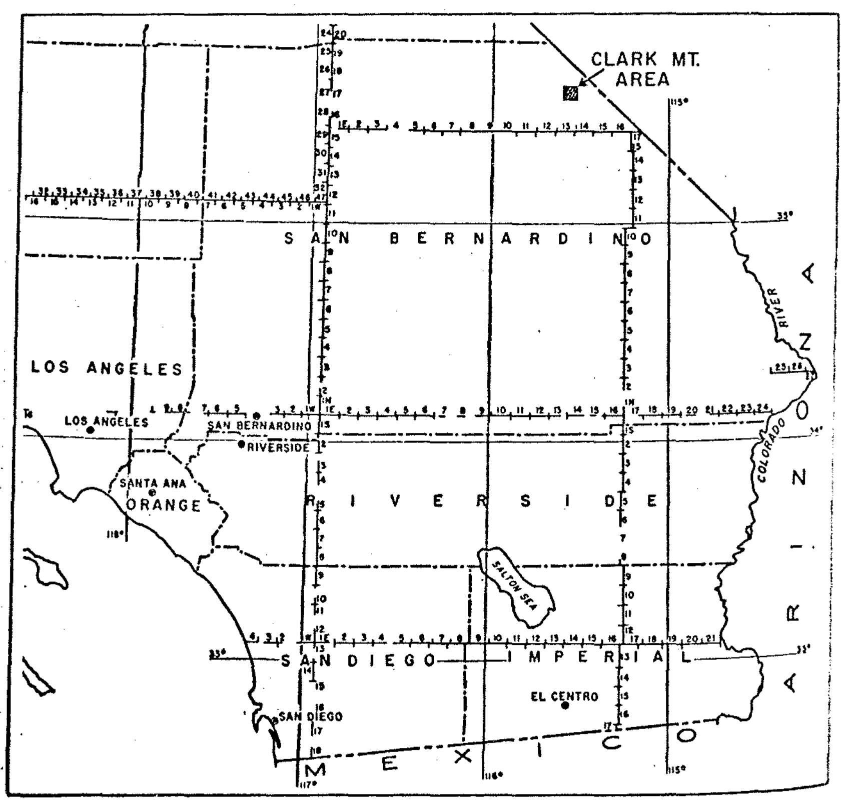

FIGURE 1. Index map of part of southern California showing location of the Clark Mountain area, San Bernardino County, California.

...clusively in commercial practice. ...he literature designated it "fluate ... many districts is to call fluorite ... may also apply to barite (heavy ... gypsum, and even quartz, the term ... be avoided.

Occurrence. Fluorspar is one ... rine-bearing minerals; the other is ... (Na_3AlF_6), which contains 54.4 per... at Ivigtut, Greenland, is the only ... produced on a commercial basis.

Almost without exception, com... ciated with faults or fault zones. ... simple filling of the fault zone, as ... near faults, as a filling of any solution ... deposit resulting from the weather... Of the above mentioned types, th... accounts for the majority of all lar... of fluorspar deposits developed in ... as limestone, calcareous shale, and ... strata are especially susceptible to ... in the Illinois-Kentucky fluorspar ... beds consisting of shales, sandston... number of places by faults mineral... cut limestone or calcareous beds, th... the replacement that has taken pl... beds of sandstone or shale, many ... entirely.

Uses.[1] Fluorspar has a wide ... ones every year. The largest consum... try in which the mineral is necess... basic open-hearth process. The sec... turing hydrofluoric acid, and the th... These three industries annually co... produced. Additional quantities a... ferro-alloys, primary aluminum ... coatings, and chemicals. One of th... hexafluoride, used for the gaseous ... topes U_{235} and U_{238} in the develop... uses not listed above require small ... expected that the number of use... within the next few years and th... facture of hydrofluoric acid will ... many new processes being develo...

The use of fluorspar in the ... lurgical processes depends upon it... upon its low viscosity when molte... so as to flux silica, calcium and ... terials which are highly refract...

[1] Ladoo, R. B., Fluorspar; its ... cryolite: U. S. Bur. Mines Bull. 244, ...

exclusively in commercial practice. Early references to the mineral in the literature designated it "fluate of lime." Common practice of miners in many districts is to call fluorite "spar." However, because this term may also apply to barite (heavy spar), feldspar, calcite (calc-spar), gypsum, and even quartz, the term "spar" in reference to fluorspar is to be avoided.

Occurrence. Fluorspar is one of two commercially important fluorine-bearing minerals; the other is cryolite, a sodium aluminum fluoride (Na_3AlF_6), which contains 54.4 percent fluorine. The deposit of cryolite at Ivigtut, Greenland, is the only one in the world where the mineral is produced on a commercial basis.

Almost without exception, commercial fluorspar deposits are associated with faults or fault zones. The fluorspar may be present as a simple filling of the fault zone, as a replacement of sedimentary strata near faults, as a filling of any solution cavities near faults, or as a residual deposit resulting from the weathering of one of the first three types. Of the above mentioned types, the replacement of sedimentary strata accounts for the majority of all large deposits. This is particularly true of fluorspar deposits developed in sedimentary beds rich in calcite, such as limestone, calcareous shale, and calcareous sandstone. That calcareous strata are especially susceptible to replacement by fluorspar is shown in the Illinois-Kentucky fluorspar district, where a series of sedimentary beds consisting of shales, sandstones, and limestones are broken in a number of places by faults mineralized with fluorspar. Where the fissures cut limestone or calcareous beds, the veins generally are wide because of the replacement that has taken place. However, where the fissures cut beds of sandstone or shale, many of the veins are narrow or pinch out entirely.

Uses.[1] Fluorspar has a wide variety of uses and is assuming new ones every year. The largest consumption of fluorspar is by the steel industry in which the mineral is necessary for the production of steel by the basic open-hearth process. The second most important use is in manufacturing hydrofluoric acid, and the third is its use by the ceramic industry. These three industries annually consume about 90 percent of all fluorspar produced. Additional quantities are consumed in making enamel, iron, ferro-alloys, primary aluminum and magnesium, cement, welding-rod coatings, and chemicals. One of the more important chemicals is uranium hexafluoride, used for the gaseous diffusion separation of the uranium isotopes U_{235} and U_{238} in the development of atomic energy. Miscellaneous uses not listed above require small percentages of the mineral. It is to be expected that the number of uses for fluorspar will increase rapidly within the next few years and that the quantity consumed by the manufacture of hydrofluoric acid will become much greater because of the many new processes being developed which require the use of the acid.

The use of fluorspar in the production of steel or in other metallurgical processes depends upon its low melting point (1270° to 1387° C), upon its low viscosity when molten, and upon its ability to form eutectics so as to flux silica, calcium and barium sulfates, alumina, and other materials which are highly refractory. The formation of these eutectics re-

[1] Ladoo, R. B., Fluorspar; its mining, milling, and utilization with a chapter on cryolite: U. S. Bur. Mines Bull. 244, 1927.

sults in an easily fusible and very fluid slag, which of course, is desirable. Fluorspar also tends to volatilize or to form a slag with phosphorus, sulfur, and other unwanted impurities in iron and other metals.

The amount of fluorspar used in each heat of the basic open-hearth furnace depends entirely upon the type of ore and contained impurities making up the charge. If the percentage of silica, alumina, and sulfur contained in the ore is high, a large amount of fluorspar is necessary to lower the melting point sufficiently to give fluidity to the slag. The average quantity of fluorspar consumed per long ton of basic open-hearth steel produced was 5.86 pounds in 1948, 5.54 pounds in 1947, and 5.39 pounds in 1946. In 1949 the figure decreased slightly from the 1948 level and was 5.85 pounds per tons. The general trend upward in the quantity of fluorspar used per ton of steel during the past few years may be indicative of a lower grade of ore being used by the steel foundries. With the depletion of the higher-grade Lake Superior iron ores this figure may continue its upward trend.

Large quantities of fluorspar are consumed annually in the production of hydrofluoric acid (HF). In this process the finely ground mineral (80 to 100 mesh) is treated with sulfuric acid producing a reaction which is essentially:

CaF_2	+	H_2SO_4	=	$2HF$	+	$CaSO_4$
(fluorite)		(sulfuric acid)		(hydrofluoric acid)		(calcium sulfate)

This reaction will take place at ordinary temperatures, but complete dissociation takes place only at temperatures above 130° C. The operation is carried on in platinum or cast-iron retorts and the hydrofluoric acid produced is distilled and collected in lead-lined containers filled with water.

Hydrofluoric acid is used for etching glass and in manufacturing fluorine chemicals, hydrofluosilicic acid (H_2SiFO_6), which is used in making fluosilicates such as magnesium silicofluoride ($MgSiF_6$), an ingredient of concrete hardeners. Additional uses of hydrofluoric and hydrofluosilicic acid are in making sodium fluoride (NaF), which is used in ceramics, as a food preservative, as an antiseptic, as an antifermentative in alcohol distilleries, and as a wood preservative; sodium silicofluoride (Na_2SiF_6), which is used in ceramics and in medicine, and is a substitute for oxalic acid for certain bleaching purposes; calcium silicofluoride ($CaSiF_6$), used principally in ceramics; barium fluoride (BaF_2), used in enamels, in embalming fluids, and as an antiseptic; and potassium fluoride (KF), used in etching glass and as a wood preservative. A newly developed use for hydrofluoric acid is in the production of synthetic organic compounds of fluorine and chlorine sold under the trade name of "Freon." These gases are used as refrigerants in household and commercial refrigerating systems, in air-conditioning units, and as solvents and propellants for insecticides. Another new use for hydrofluoric acid is the alkylation process for manufacturing 100-octane gasoline. This process opens up a very large field which is dependent upon a large and steady production of fluorspar. Because fluorine will substitute freely with many of the elements in organic compounds, many new and startling developments may be expected in the next few years; although substitutes may be found for fluorspar in some of its present uses, the outlook for the

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future is exceedingly bright and the annual consumption may be expected to increase considerably.

The glass industry, which annually consumes the third greatest amount of fluorspar, requires it in manufacturing opal or opaque white glass and colored or cathedral glass. Light opal glass is used for vases, bowls, and other ornamental glassware. A denser variety of opal glass is used for making so-called ointment pots, such as cosmetic and food jars and bottles. The dense opal glass is also used for electric light shades and globes and architectural panels and slabs. Cathedral glass, as its name would suggest, is commonly used for church windows and other decorative panels. Small quantities of fluorspar are consumed in the production of enamels; the mineral serves as a flux and as a secondary opacifying agent. The value of fluorspar in the manufacturing of glass products depends upon the crystallization of fluorides in the glass, giving a milky or opalescent effect.

Mining Methods.[2] Because the geological occurrence of fluorspar is little different from the occurrence of any of the metallic ores, the methods of mining are essentially the same. The operating mines in the United States may be divided into three main types depending on the mining methods employed. These are: (1) open-cut mining, (2) drift and tunnel mining, and (3) shaft mining. Of the three, the last, or mines opened by shafts, is by far the most important.

Mining fluorspar in open cuts is feasible only where the ore consists of residual gravel and lump fluorspar in a matrix of loose sand and clay. Deposits of this nature must be of wide areal extent because operations usually cannot be carried on successfully at depths much greater than 50 feet. Such mining practice must be carried out with extreme care, as it may become necessary later to sink a shaft, and careless open-cut mining could easily make future shaft sinking impossible, or possible only at great expense.

Bedded fluorspar deposits which lie at a greater elevation than the surrounding country can be exploited advantageously by drifting. This type of mining has many advantages, the principal ones being that no hoisting is required, and often no pumping is necessary. Fluorspar veins that dip at a steep angle and are in a region of rugged topography are also amenable to mining by drifts. Bedded fluorspar deposits are generally mined by a modified room-and-pillar system, such as is sometimes used in coal mining.

Deposits which are opened by shafts constitute the majority of the mines in the United States. The mines differ greatly in size, production, working methods, efficiency of operation, and in other ways. Once the shaft is sunk, drifts are driven and the ore is removed by one of the common methods of stoping.

Milling.[3] The methods employed in the concentration or milling of fluorspar depend on the nature and quantity of the impurities present in the ore and on the type of ore being treated. The impurities which may be present in any given ore may be classified as either diluents or harmful impurities. Diluents constitute minerals present in the ore which have no harmful effects in the process for which the flurospar is to be utilized; harmful impurities have an injurious effect in the process for which the

[2] Ladoo, R. B., op. cit.
[3] Ladoo, R. B., op. cit.

fluorspar is to be used and should be removed entirely or reduced to a very low percentage.

The common diluents are calcite or any form of calcium carbonate, silica in any form, silicates and alumina-silicates (particularly feldspar, granite, slate, shale, sandstone, sand, clay, and other types of wall rock). Although these materials do not have harmful effects in the uses to which the fluorspar is put, they nevertheless require fluxing. Therefore, penalties are imposed for their presence in the fluorspar concentrate. The penalty for the common impurity, silica, is calculated on the following basis: percentage fluorspar minus 2.5 times the percentage silica = the effective fluorspar content. For example, a concentrate containing 97 percent fluorspar and 3 percent silica would have an effective fluorspar content of 89.5 percent ($97\% - 2.5 \times 3\% = 89.5\%$). All fluorspar is purchased on the basis of effective fluorspar content.

The harmful impurities are generally considered to be barite, galena, sphalerite, pyrite, all other sulfides and sulfates, all other lead and zinc minerals, and all iron compounds (iron produces an undesirable color in glass and enamel).

The methods used in concentrating fluorspar ores are dependent upon the type and physical characteristics of the impurities. The ores may be classified in three broad groups which cover the great majority of deposits. The groups are arbitrary and are based on the type of gangue associated with the fluorspar. They are: (1) residual and/or disintegrated ores in which the adulterants are chifly sand and clay; (2) massive crystalline ores in which the gangue may be separated easily from the fluorspar; and (3) mixed ores in which the fluorspar is intimately associated with other vein materials or with the country rock.

Ores belonging to the first group are concentrated without much difficulty by washing away the admixed sand and clay. A low grade ore of this type may generally be concentrated to a high-grade product at a minimum cost. The ores in the second group are more difficult to concentrate, but a high-grade product may sometimes be obtained by hand-sorting. If additional or different treatment is required, good results are obtained by jigging. By this process, ores containing as little as 50 percent fluorspar may be concentrated into a product of good grade without employing flotation if the principal gangue mineral is calcite. If the principal gangue mineral is quartz, however, a higher percentage of fluorspar is required to meet specifications.

Ores in the third group are usually difficult to concentrate. They consist of intimate mixtures of fluorspar and silica, silicates, galena, barite, sphalerite, and other minerals, and require flotation to accomplish a satisfactory separation. The concentration of these ores has been economically feasible for only a few years, but an ore containing high percentages of galena, sphalerite, and fluorite may now be treated so that the concentrates of each of the three minerals will meet the minimum requirements of most buyers. The use of flotation methods to concentrate fluorspar ores may allow the profitable mining of deposits which were previously considered to be too low grade. To illustrate, ores containing as little as 50 percent fluorspar and as much as 50 percent silica may now be concentrated to produce fluorspar of acid grade (97% effective CaF_2). The discovery of better flotation reagents will undoubtedly result in the ity to handle ores with smaller percentages of fluorspar and higher entages of impurities.

The improvements which have been made in the treatment of fluor-ar ores are indeed comforting to producers in California; although the te has several deposits which show promise, all of them are relatively grade ores containing high percentages of silica. The inability to entrate these ores economically has hindered possible development the fluorspar industry in the state.

MINES AND PROSPECTS

Clark Mountain Deposits

The Clark Mountain fluorspar area is on the north side of Clark untain, about 35 miles northeast of the town of Baker, San Bernardino unty, California. The Ivanpah quadrangle, scale 1/250,000, is the only ographic map available for the area at the present time.

The Clark Mountain fluorspar area is easily accessible by unimproved ads which join U. S. Highway 466 near Valley Wells Station. Except light winter snows and occasional heavy rains, which, at times, leave roads in poor condition for a few hours or days, the area is accessible roughout the year.

Clark Mountain, one of the highest peaks in the Ivanpah quadrangle, s an elevation of 7,903 feet. The fluorspar-bearing area, however, is a lower elevation on the north side of the mountain. The vegetation the area is sparse and characteristic of arid regions; there are numerous all stands of scrub pine and a few willows. Rains and snow are com-on during the winter months, but few are of long duration. Cloudbursts re especially common to the area during the summer months, and it is ely that much of the present topography has been carved by these rrential rains.

The only streams in the area are intermittent, resulting from melting ows or heavy rains, and none flows for more than a few days at a time. everal small springs in the top parts of the mountain flow continually at quickly pass into the valley wash.

Persons living in the area are dependent upon a well at the site of e old Colluseum mine camp for their water supply, and according to heir report all of their needs have been supplied without lowering the ater level. Some of the residents believe the well could supply sufficient ater to operate a small mill.

Dr. D. F. Hewett of the United States Geological Survey kindly out-ined the regional geology for the writers before the field work was begun. Dr. Adolph Pabst of the University of California generously donated his ime to the preparation of X-ray diffraction patterns. Discussions with im regarding the mineralogy of the ores were very helpful. To the wners of the fluorspar claims in the Clark Mountain area who were xtremely helpful and cooperative, the authors express their gratitude.

Five weeks were spent in the field studying the areal geology and uorspar deposits. Two weeks in March 1950 were spent studying the real geology and preparing a plane table map of part of the area. An dditional 3 weeks were spent in the field in May and June 1950, during hich time the mineralized area was studied in detail. Considerable time

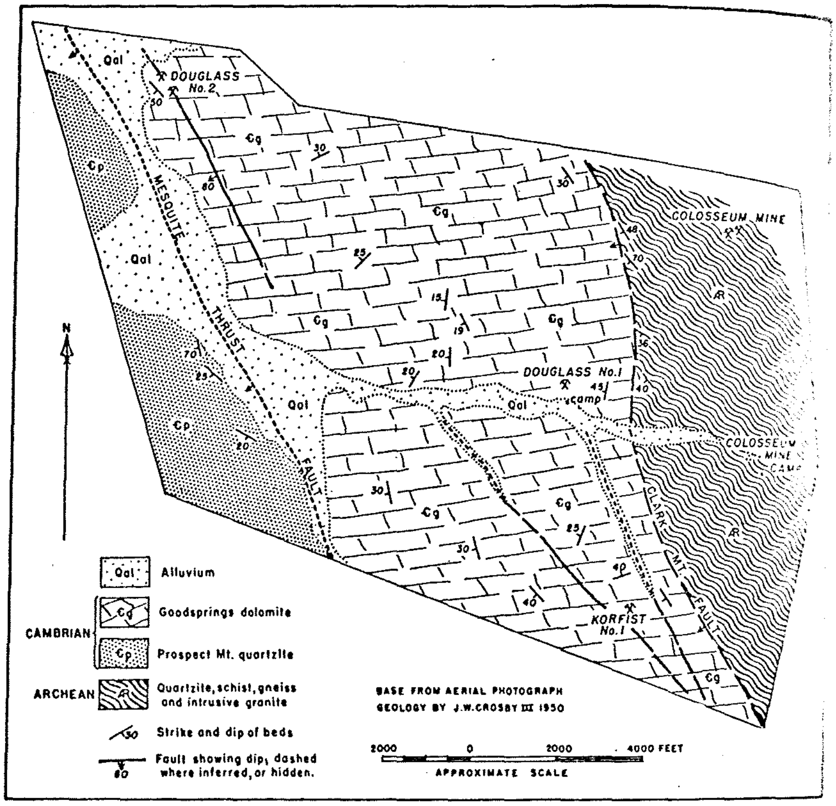

FIGURE 2. Areal geologic map of Clark Mountain fluorspar area.

was devoted to laboratory work, and numerous samples of ore and country rock were examined by means of the petrographic microscope.

Geology

Three stratigraphic units were recognized and mapped in the course of this study. They are (1) the Archean complex which is composed largely of granitic rocks, quartzite, gneiss, and schist; (2) the Goodsprings dolomite of Cambrian age which is composed of magnesian limestones and dolomites; and (3) the Prospect Mountain quartzite of Cambrian age which, in this area, is predominantly a medium-grained quartzite.

Two major faults traverse the area and account for the intense brecciation and minor faulting which is prevalent in the rocks of the locality. One fault, the westward-dipping Clark Mountain normal fault, places Archean rocks in contact with the Goodsprings dolomite. The fault trends through the area in a direction about 20° west of north. The other major fault, about 2 miles to the west, is the Mesquite thrust, the trace of which nearly parallels the trace of the Clark Mountain fault. The Prospect Mountain quartzite has been thrust over the Goodsprings dolomite along the westward-dipping plane of the Mesquite thrust. Because of minor faulting and extreme brecciation accompanying these

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Archean Rocks. The Archean r... ...ea. On the west they are limited by ...ng which they have been brought ...lomite. The only recognizable sedi... ...e quartzites which are most commo... ...ark Mountain fault. The quartzites ...rfaces and on weathered surfaces ... many places bedding is well defin... other places. The grain size rang... ...illimeters, but in many places the ...merates in which individual pebbl... ...artzite is composed almost entirely ...mount of feldspar and magnetite a... ...agnetite has been altered in large ...

Bedding-plane joints are comm... ...ith numerous other fractures in the ...f massive, blocky outcrops.

The bulk of the Archean is c... ...hiefly granitic in composition—and ...epresentative of more than one geol... ...aving a well defined gneissic or schi... ...he older group, whereas the rocks ...would be assigned a younger age and ...

One of the more noticeable feat... ...n this area is the predominance of ...f rock a characteristic pink color. ...lbite, muscovite, and biotite. The ...ominantly biotite-quartz-plagiocl... ...s intruded in many places by small ...ition. These intermediate and basic ...esistant to erosion than the rest ...stically mark the presence of saddl...

Goodsprings Dolomite. The ...scribed in detail by Hewett[4] in ...Ivanpah quadrangles.

The Goodsprings formation ex... ...sists of a northwest-trending belt ...tain fault, and on the west by the ...faulting have brecciated and deform... ...has produced a mass of small and ...formation in general which consti... ...ther oblique to the Clark Mount... ...re to be found all through the ...early all mineralized portions of ...faulting suggests selective repla...

[4] Hewett, D. F., Geology and ore d... U. S. Geol. Survey Prof. Paper 162, 19... and Nevada (in preparation).

major faults, the stratigraphic relationships are confused and no attempt was made to subdivide the major stratigraphic units.

Archean Rocks. The Archean rocks are in the eastern part of the area. On the west they are limited by the Clark Mountain normal fault, along which they have been brought into contact with the Goodsprings dolomite. The only recognizable sedimentary units of the Archean rocks are quartzites which are most commonly exposed along the trace of the Clark Mountain fault. The quartzites are white to light brown on fresh surfaces and on weathered surfaces are generally light to dark brown. In many places bedding is well defined, and cross-bedding is prominent in other places. The grain size ranges from about ¼ millimeter to 2 millimeters, but in many places the quartzite grades into pebble conglomerates in which individual pebbles may reach ¾ inch in diameter. The quartzite is composed almost entirely of quartz and chert grains. A small amount of feldspar and magnetite are present in the quartzite and the magnetite has been altered in large part to limonite.

Bedding-plane joints are common in the quartzites, and coupled with numerous other fractures in the rock, tend to promote the formation of massive, blocky outcrops.

The bulk of the Archean is composed of an intrusive complex—chiefly granitic in composition—and schists and gneisses, which may be representative of more than one geologic period. If this is true, the rocks having a well defined gneissic or schistose structure would be assigned to the older group, whereas the rocks devoid of obvious linear elements would be assigned a younger age and may not be Archean.

One of the more noticeable features of the non-linear intrusive rocks in this area is the predominance of microcline which gives to large areas of rock a characteristic pink color. Other minerals in the rock are quartz, albite, muscovite, and biotite. The rocks considered Archean are predominantly biotite-quartz-plagioclase schists and gneisses. The complex is intruded in many places by small dikes of dioritic and basaltic composition. These intermediate and basic dikes have evidently been much less resistant to erosion than the rest of the series because they characteristically mark the presence of saddles and small gullies.

Goodsprings Dolomite. The Goodsprings dolomite has been described in detail by Hewett [4] in his reports on the Goodsprings and Ivanpah quadrangles.

The Goodsprings formation exposed in the Clark Mountain area consists of a northwest-trending belt bounded on the east by the Clark Mountain fault, and on the west by the Mesquite thrust. The stresses during faulting have brecciated and deformed the formation. The shearing action has produced a mass of small and medium-sized faults in the Goodsprings formation in general which constitute two systems, one parallel and the other oblique to the Clark Mountain fault. Large zones of brecciation are to be found all through the formation in this area. The tendency for nearly all mineralized portions of shears to be sharply delimited by cross faulting suggests selective replacement of dolomite within the confines

[4] Hewett, D. F., Geology and ore deposits of the Goodsprings quadrangle, Nevada: U. S. Geol. Survey Prof. Paper 162, 1931. Geology of the Ivanpah quadrangle, California and Nevada (in preparation).

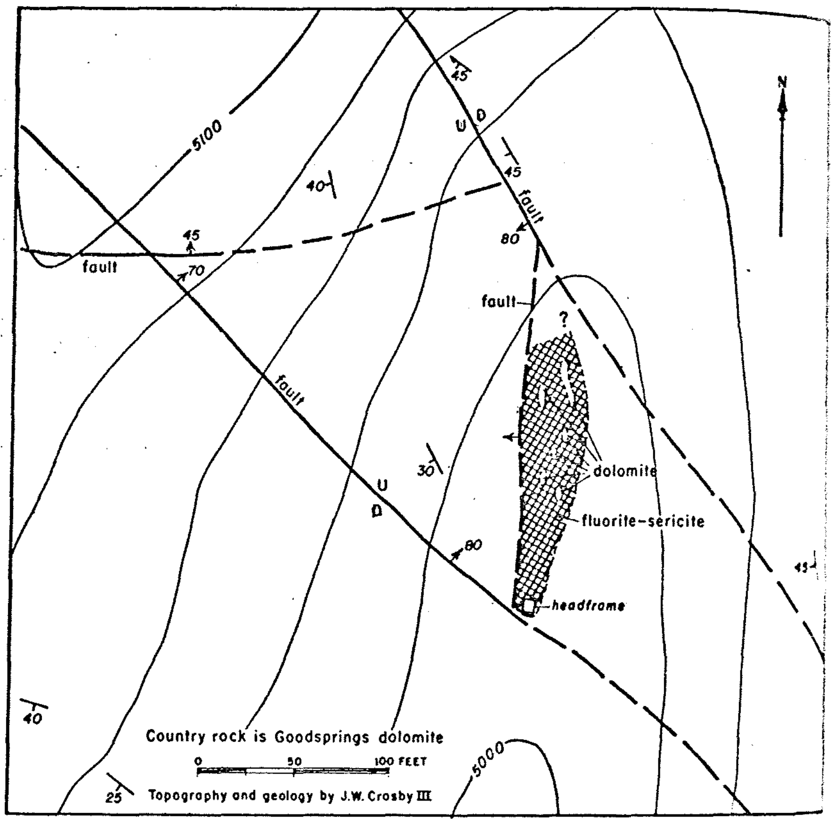

FIGURE 3. Geologic sketch map of Douglass No. 1 fluorspar prospect, Clark Mountain, San Bernardino County, California.

of the cross faults, especially because offset segments of the veins cann be traced.

Both field and laboratory tests have shown that the Goodsprin formation in this area is composed almost entirely of dolomite and hi magnesian limestone. Most of the formation is fine- to medium-grain but along some shear zones sufficient recrystallization has taken place produce a very coarse-grained rock. The color ranges from nearly wh to dark smoky gray; most of the formation is medium-gray.

At only one place in the area was anything found that could identified as organic remains, and preservation was so poor that they we of no assistance in age determination.

Prospect Mountain Quartzite. The Prospect Mountain quartzi is exposed in the western part of the area. On the east it is limited by t Mesquite thrust fault along which the formation has been thrust ov the Goodsprings dolomite.

The quartzite in this locality is typically medium- to coarse-graine A dark brown color on weathered surfaces is caused by iron oxides. Son

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Many of the beds contain a high pe
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Mineralogy and Description of the Ores

The fluorspar ores of the Clark Mo
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Dr. Adolph Pabst of the University of C
patterns of the sericite. He states: "Th
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conclusions as to the chemical compos
identification, except that the composit
patible with a muscovite structure." Sp
ative chemical tests made in the Divisi
with Dr. Pabst's conclusions.

Some of the Clark Mountain ores
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The ore has been arbitrarily class
schistose, and friable. A subtype, mass
are intermediate between the massive an

The massive type is a tough, compa
almost entirely of sericite and fluorite.
low; the mineral occurs as veinlets and
It is probably a replacement of the ser
and the difficulty of breaking the fluorsp
do not make these ores amenable to bene

The schistose ores are typified by
property, which averages between 40 an
foliation that parallels the trend of the
post-mineral movement along the fault
ores also, unlike massive ores, have a
are stained brown by alteration of pyrit
massive ores, the intimate associatio
schistose ores presents problems of ben
ores could be successfully treated by fl
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feasible for such treatment than w

The friable ores, exposed in D
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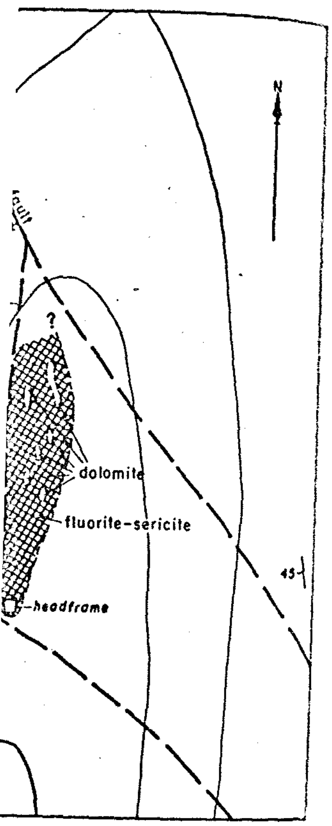

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beds are stained so heavily they have a color approaching black, whereas others which are nearly iron-free approach a creamy or whitish color.

Many of the beds contain a high percentage of magnetite which, in part, may have been altered to limonite. With the exception of magnetite the quartzite is composed almost entirely of quartz grains.

Mineralogy and Description of the Ores

The fluorspar ores of the Clark Mountain area are unique in that they are composed predominantly of two minerals: fluorite and sericite. Dr. Adolph Pabst of the University of California made X-ray diffraction patterns of the sericite. He states: "The material is definitely a mica close to muscovite. It is not talc, pyrophyllite, or a related material. No conclusions as to the chemical composition can be drawn from this identification, except that the composition must be such as to be compatible with a muscovite structure." Spectrographic analyses and qualitative chemical tests made in the Division of Mines laboratory conform with Dr. Pabst's conclusions.

Some of the Clark Mountain ores contain pyrite, which alters to brown limonite. The only other minerals in the ore are quartz—much of it in small veinlets—and blue and green copper carbonates.

The ore has been arbitrarily classified into three types—massive, schistose, and friable. A subtype, massive-friable, is used for ores that are intermediate between the massive and friable types.

The massive type is a tough, compact, grayish-purple ore composed almost entirely of sericite and fluorite. The fluorite content is generally low; the mineral occurs as veinlets and blebs within the sericite gangue. It is probably a replacement of the sericite. The low fluorspar content and the difficulty of breaking the fluorspar away from the sericite gangue do not make these ores amenable to beneficiation except at excessive cost.

The schistose ores are typified by the ore at the Korfist Number 1 property, which averages between 40 and 60 percent fluorite. A distinct foliation that parallels the trend of the vein—apparently indicative of post-mineral movement along the fault—is characteristic of them. These ores also, unlike massive ores, have a greater percentage of pyrite and are stained brown by alteration of pyrite to limonite. Although, like the massive ores, the intimate association of fluorite and sericite in the schistose ores presents problems of beneficiation, it is probable that the ores could be successfully treated by fine grinding followed by flotation. The increased tenor of the schistose ores would make them much more feasible for such treatment than would the massive ores.

The friable ores, exposed in Douglass' Number 2 claim, contain little in the way of minerals other than fluorspar and sericite. The ores are composed of a very white, friable sericite in which are veins and pods of light purple fluorite, with which is associated the massive type of sericite. The ore may contain as much as 50 to 60 percent fluorspar and will disintegrate in water, the sericite forming a suspension the fluorspar settling to the bottom. The fluorspar which settles to the bottom contains a higher percentage of fluorite than massive ore, probably averaging more than 90 percent. These ores would be amenable to the production of metallurgical-grade fluorspar by a very simple beneficiation process. However, the quantity of ore available is probably too small to warrant installation of the necessary equipment.

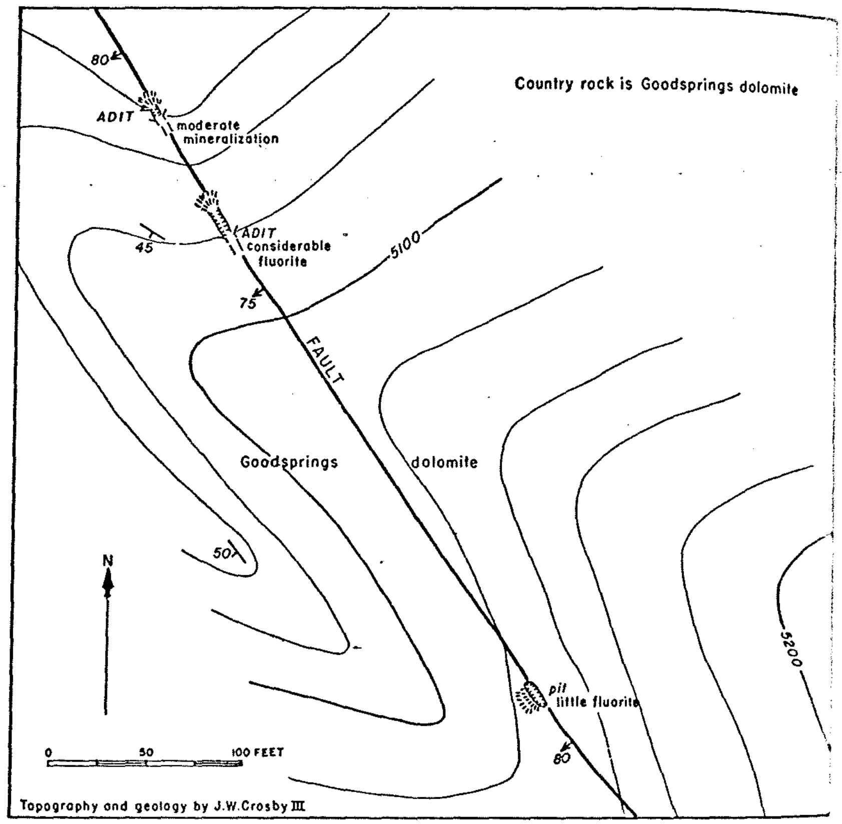


FIGURE 4. Geologic sketch map of Douglass No. 2 fluorspar prospect, Clark Mountain, San Bernardino County, California.

The subtype of ore—massive-friable—is characterized by that at th Douglass' Number 1 property. This type of ore is composed of bodies massive fluorspar-sericite. Much of this material will disintegrate water, but not sufficiently for beneficiation. The average tenor of the o is 50 to 60 percent fluorite, and like the schistose ore, it is probably ame able to treatment by fine grinding and flotation, providing sufficient r serves could be established to warrant the expense of installing th necessary equipment.

Ore Deposits. The fluorspar deposits of the Clark Mountain are represent local replacement bodies along fissures in the Goodsprings dolomite. Many of the fissures are mineralized to some extent as show on the map (fig. 4), but very few warrant exploratory work.

At the Korfist Number 1 property an 85-foot shaft facing sou at a 60° incline has been completed. The top 50 feet is in fluorspar. T drifts, one 40 feet due west and the other 30 feet due south, were driv at the 50-foot level. Fluorspar was encountered in both drifts and the s south drift was halted with dolomite on the footwall. Approximately 1

feet east of the shaft are five pits, from spar. The vein is about 40 feet wide Korfist ore body apparently is limited both directions along the strike (pl. 17 extensions of the ore by searching for It would therefore appear that the fluo area, but additional development work dictions can be made.

The ore body at the Douglass' Num of the dolomite underlying a small thr gouge zone composed of brecciated and the gouge is friable and can be dug eas apparently been an impervious barrie because the fluorspar is confined to th to the underlying dolomite. Associated of dolomite which have recrystallized t

The Douglass' Number 1 ore body feet along the strike and is faulted off impossible to trace extensions because north, however, the thrust fault is agai ment, but no ore was seen. The maxim bearing zone is about 10 feet, but its lim not allow much hope for the developme

The Douglass' Number 2 ore body the area. The ore has been exposed by cu vertical fault. In one adit the ore appa fluorspar, but in the other exposures the vein, where it is exposed, ranges betwe contains small horses of dolomite and do have not been replaced by the minerali and swells along the strike. The shear zo can be traced for nearly a mile, but thu the northwestern end of the fault. It is p will be found with more extensive devel

Conclusions. Fluorspar deposits widely separated and appear to be limited amount of fluorspar can be obtained hand-sorting. However, insufficient warrant the installation of a plant to

The abundance of sericite in the area may warrant further investigation may be a satisfactory substitute for pared by the grinding of scrap mus able fluorspar-sericite ore would be would prove to be a satisfactory sub could be obtained as a by-product at v

Other De

Warm Spring Canyon Deposit. deposit, comprising four claims, is Mountains, 48 miles by road from Sh feet east of the shaft are five pits, from 5 to 10 feet deep, exposing fluorspar. The vein is about 40 feet wide on the surface at this point. The Korfist ore body apparently is limited by faults within short distances in both directions along the strike (pl. 47). Attempts have been made to trace extensions of the ore by searching for float, but none has been found. It would therefore appear that the fluorspar ore is restricted to a small area, but additional development work is necessary before accurate predictions can be made.

The ore body at the Douglass' Number 1 property is a replacement of the dolomite underlying a small thrust fault. The ore is capped by a gouge zone composed of brecciated and sugary dolomite. Where exposed, the gouge is friable and can be dug easily with a pick. However, it has apparently been an impervious barrier to the mineralizing solutions because the fluorspar is confined to the lower few inches of the gouge and to the underlying dolomite. Associated with the ore are numerous horses of dolomite which have recrystallized to coarse-grained marble.

The Douglass' Number 1 ore body is exposed for approximately 200 feet along the strike and is faulted off on both ends. To the south it is impossible to trace extensions because of the thick valley wash. To the north, however, the thrust fault is again exposed in an upthrown segment, but no ore was seen. The maximum thickness of the fluorspar-bearing zone is about 10 feet, but its limits, extending along the strike, do not allow much hope for the development of reserves.

The Douglass' Number 2 ore body is perhaps the most promising of the area. The ore has been exposed by cuts at several places along a nearly vertical fault. In one adit the ore apparently contains 50 or 60 percent fluorspar, but in the other exposures the fluorite content is much less. The vein, where it is exposed, ranges between 4 and 5 feet in thickness, and contains small horses of dolomite and dolomitic breccia fragments which have not been replaced by the mineralizing solutions. The vein pinches and swells along the strike. The shear zone in which the ore bodies occur can be traced for nearly a mile, but thus far ore has only been found at the northwestern end of the fault. It is possible that additional ore shoots will be found with more extensive development.

Conclusions. Fluorspar deposits in the Clark Mountain area are widely separated and appear to be limited in size. It is likely that a small amount of fluorspar can be obtained by selective mining followed by hand-sorting. However, insufficient fluorspar is in sight at present to warrant the installation of a plant to concentrate the ore.

The abundance of sericite in the ore bodies of the Clark Mountain area may warrant further investigation. It is possible that this material may be a satisfactory substitute for finely ground mica which now is prepared by the grinding of scrap muscovite at considerable cost. The friable fluorspar-sericite ore would be especially suitable and if the material would prove to be a satisfactory substitute for ground mica, fluorspar could be obtained as a by-product at very little additional cost.

Other Deposits

Warm Spring Canyon Deposit. The Warm Spring Canyon deposit, comprising four claims, is on the east slope of the Panamint Mountains, 48 miles by road from Shoshone. A dirt road turns off from the Death Valley west road and runs up Warm Spring Canyon to lower adit of the mine. The owner of the claims is Owen Montgom... Death Valley, California.

Fluorite veins ranging in width from 1 foot to 10 feet are associ... with quartz in pre-Cambrian (?) quartz-muscovite gneiss. The flu... is apparently associated with shears trending in the same direction as vein system (strike N. 40° E., dip 40°-60° NW.). Minor cross-shears also present. One vein is exposed for more than 400 feet on the surfa... Three adits have been driven for a total length of about 700 feet.

White Mountain Deposit. This deposit is about 14 miles ... northwest of Bishop in sec. 33, T. 6 S., R. 35 E., M. D. It is owned George A. McAfee and Louie Stewart of Bigpine. Two claims, Fluorite Number 1 and the Fluorite Number 2 have been filed. The flu... spar occurs in small fissures in limestone and as disseminated crystals several dikelike epidote tactite bodies present in the area. The str... of the fissures ranges from N. 10° E., to N. 40° E., the dip is usua... vertical or nearly so.

The mineralized zones along the fissures are unusual and appear to ... the result of pegmatitic emanations reacting with limestone. The ve... are banded. Near the wall rock there is a zone consisting of a fine-grain... mixture of quartz and fluorite. Next is a well-defined zone of coars... crystalline muscovite, composed of individual cleavage plates as mu... as 1½ inches in diameter, averaging about ¾ inch. Occupying the cent... portion of the vein is very pure, dark purple fluorite. The maximum wid... of the fluorite in the center of the vein is seldom more than 3 inches. T... border zones of quartz and fluorite are as much as 8 or 10 inches wi...

The largest vein in the area strikes N. 30° E. and dips 75° W. I... maximum width is about 2 feet, but it can not be traced for more th... 20 feet on the surface. The veins have been explored by a series of sm... trenches.

Although some high grade fluorspar has been uncovered in t... area, the small size of the veins will probably prohibit development ... the property.

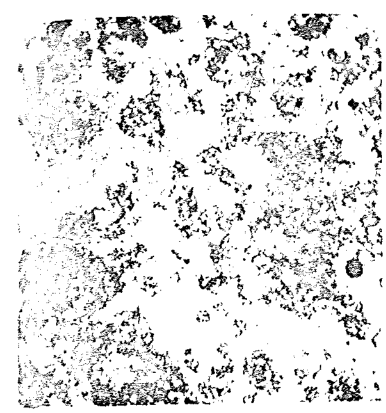
Last Chance Canyon Deposit. This deposit is located in the El Pa... Mountains, in sec. 12 (approximately), T. 29 S., R. 38 E., M. D. T... owners are Della Gerbracht and R. L. Meur who live near the depo...

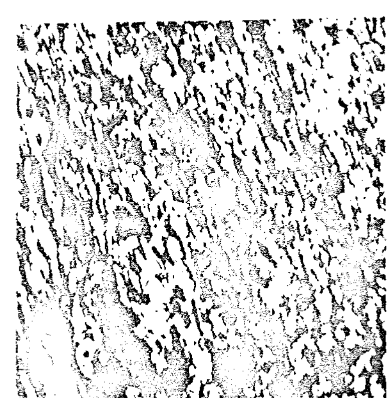
Several veinlets are present in a shear zone about 8 inches wi... The shear zone strikes N. 55° E. and dips vertically. Country rock ... the immediate area is a meta-rhyolite; adjacent to the deposit, the count... rock has been hydrothermally altered producing a talcose and serici... rock. The fluorspar is multi-colored, red, green and white.

No production is foreseen from this deposit.

Fluorspar Group Deposit. The Fluorspar Group comprises fi... claims situated on the north end of the Palen Mountains, 1 mile sou... west of Packard's Well, in sec. 4, T. 3 S., R. 18 E., S. B., 18 miles nor... west of Midland. Owners are Louis Favret and L. H. Raines, Blyt... California, and N. A. Anderson, Pasadena, California.

The country rock is monzonite. The fluorite-bearing vein, 5 feet ... width, strikes N. 65°E. and dips 45°N. White, green, and purple fluorsp...





A. PHOTOMICROGRAPH OF ORE FRO... SHAFT. Photo shows fluorite (black) ... B. PHOTOMICROGRAPH OF ORE FR... SHAFT. Photo shows fluorite (black) ... Crossed nicols. C. PHOTOMICROGRAPH ... LINE. Photo shows fluorite (black) ... ...on in the ore. Crossed nicols. D. PH... DOUGLASS NO. 1 PROPERTY. Photo ... (white). Cr...

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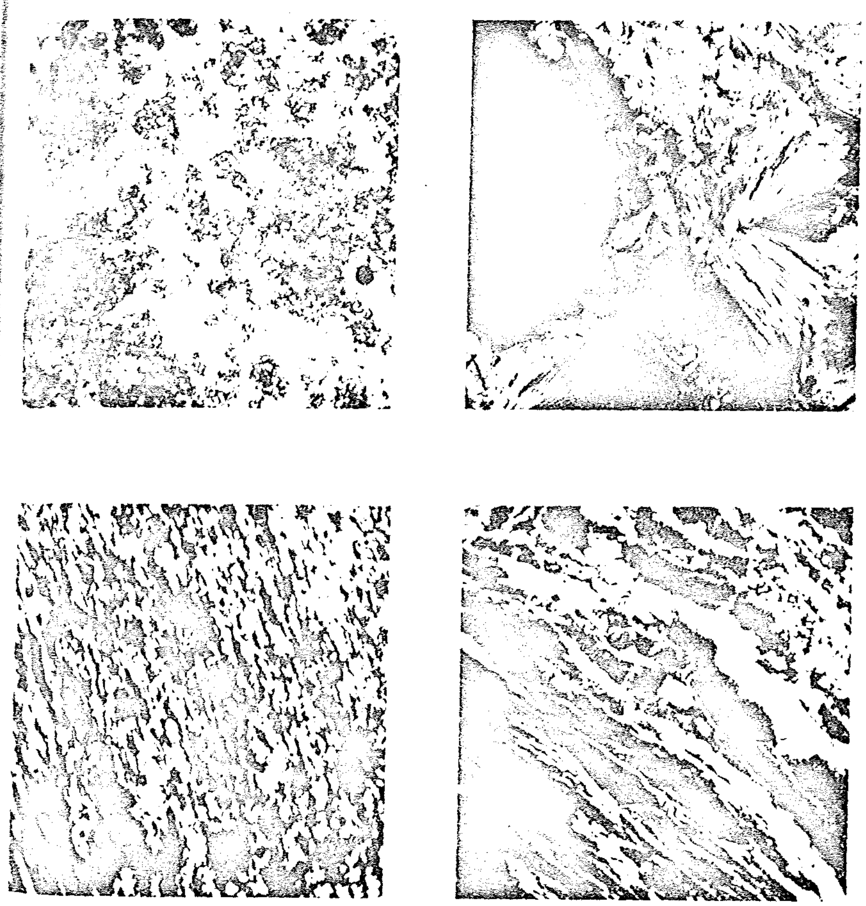
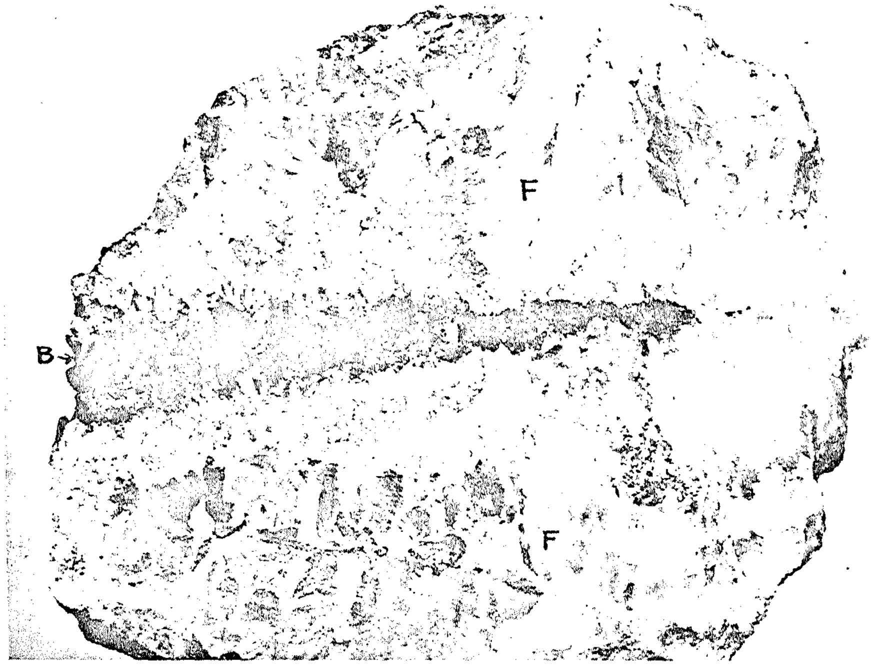
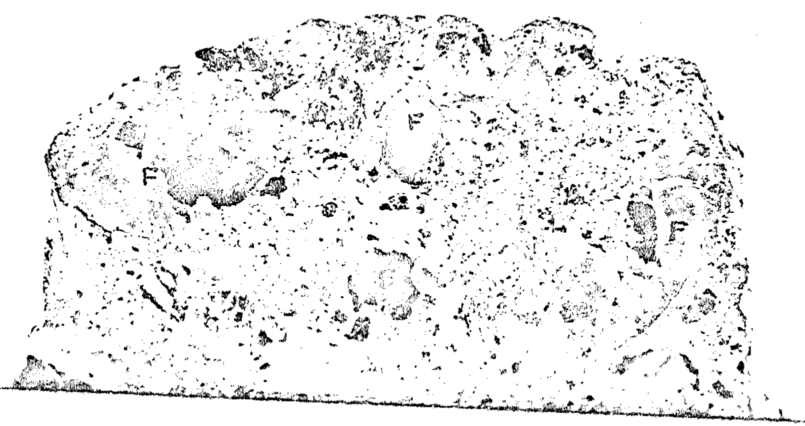


A, PHOTOMICROGRAPH OF ORE FROM AREA NORTHWEST OF KORFIST SHAFT. Photo shows fluorite (black) blebs in gangue of sericite (white). Crossed nicols. B, PHOTOMICROGRAPH OF ORE FROM AREA NORTHWEST OF KORFIST SHAFT. Photo shows fluorite (black) bounded by recrystallized sericite (white). Crossed nicols. C, PHOTOMICROGRAPH OF ORE FROM KORFIST'S MAIN INCLINE. Photo shows fluorite (black) associated with sericite (white). Note the lineation in the ore. Crossed nicols. D, PHOTOMICROGRAPH OF ORE FROM THE DOUGLASS NO. 1 PROPERTY. Photo shows fluorite (black) associated with sericite (white). Crossed nicols.



VEIN FLUORSPAR FROM THE BIG HORN NUMBER 9 CLAIM
Afton Canyon area, San Bernardino County. Fluorite (F) is coarsely crystalline, green in color and includes a narrow breccia zone of calcite and colorless fluorite. Scale is full size.



VEIN FLUORSPAR FROM THE BIG HORN NUMBER 9 CLAIM
Afton Canyon area, San Bernardino County. Fluorite (F) is coarsely crystalline, green in color and includes a narrow breccia zone of calcite and colorless fluorite. Scale is full size.

FLUORSPAR (F) IN ANDESITE BRECCIA
From Afton Canyon area, San Bernardino County. Scale is full size.

FLUORSPAR FROM THE WHITE MOUNTAINS DEPOSIT, INYO COUNTY

Fluorite (F) is pale to dark purple in color and occurs as veins with coarse muscovite (M) and also as fine-grained replacement in limestone wallrock (RL). Scale is three-fourths size.

rs in bunches and is disseminated
d with malachite, azurite, calcite, a
Development consists of an open c
5 feet wide.

Red Bluff Deposit. This deposit
f No. 1 to No. 7, and Lucky Day,
le Maria Mountains, in sec. 27, T. 3
heast of Midland.

A series of roughly parallel veins
mica schist. The veins strike N. 50°
18 inches to 3 feet. Development
t sunk to a depth of 30 feet. This s
t 40 feet in length and 2 to 4 feet i
xings there is a trench 50 feet in le
luorspar. At a higher elevation, a
feet on a vein which strikes N. 30°
is 2 to 4 feet. Here there is also a
One hundred and thirty tons of
ped to Torrance. Analysis showed
percent CaO, 2.25 percent Al_2O_3.

Afton Canyon Deposit. The Aft
and 7, T. 10 N., R. 6 E., and sec. 3,
s south of Afton, a station on the
Two fluorspar-bearing zones are
other by about 1½ miles. The first
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mber 9. It is likely that other claims
arently long since been destroyed.
The fluorspar occurs in veins a
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y strike N. 70° E. and dip vertical
hes in width. Quartz, calcite, and
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ge-scale stripping operation, and
would support such an enterprise
Fluorspar has been produced a
the above area. A shaft was sunk to
hich strikes S. 80° E., dips vertical
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not known. Fluorite is in a gangu
tion of the mineralized fissure has
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FLUORSPAR FROM THE WHITE MOUNTAINS DEPOSIT, INYO COUNTY
Fluorite (F) is pale to dark purple in color and occurs as veins with coarse muscovite (M) and also as fine-grained replacement in limestone wallrock (RL). Scale is three-fourths size.

...rs in bunches and is disseminated in the gangue, intimately asso-...ed with malachite, azurite, calcite, and quartz.

Development consists of an open cut 100 feet in length, 5 feet deep, ...5 feet wide.

Red Bluff Deposit. This deposit comprises 8 claims located as Red ...f No. 1 to No. 7, and Lucky Day, situated on the east slope of the ...le Maria Mountains, in sec. 27, T. 3 S., R. 20 E., S. B., about 3½ miles ...heast of Midland.

A series of roughly parallel veins of fluorspar occurs in quartzite ...mica schist. The veins strike N. 50° W., dip 75° N., and range in width ...m 18 inches to 3 feet. Development on the Red Bluff vein consists of a ...ft sunk to a depth of 30 feet. This shaft developed a lens of fluorspar ...ut 40 feet in length and 2 to 4 feet in width. To the northwest of these ...kings there is a trench 50 feet in length which exposes 12 to 18 inches ...luorspar. At a higher elevation, a shaft has been sunk to a depth of ...feet on a vein which strikes N. 30° W. and dips 70° E. Width of the ...n is 2 to 4 feet. Here there is also a vein that strikes N. 50° W.

One hundred and thirty tons of fluorspar was mined in 1944 and ...pped to Torrance. Analysis showed 87 percent CaF_2, 4 percent SiO_2, ...7 percent CaO, 2.25 percent Al_2O_3, and 0.15 percent Fe_2O_3.

Afton Canyon Deposit. The Afton Canyon fluorspar area is in secs. ...1 and 7, T. 10 N., R. 6 E., and sec. 3, T. 11 N., R. 6 E., S. B. It is about 3 ...es south of Afton, a station on the Union Pacific Railroad.

Two fluorspar-bearing zones are present in the area, separated from ...h other by about 1½ miles. The first of these zones has been staked in ...rt by Ora E. Whitlock, the name of the claim being the Big Horn ...mber 9. It is likely that other claims are present, but the markers have ...parently long since been destroyed.

The fluorspar occurs in veins and breccia zones in andesite and ...salt. The attitude of the veins is somewhat variable, but in general ...y strike N. 70° E. and dip vertically. The veins range from ½ inch to 8 ...ches in width. Quartz, calcite, and siderite are the associated gangue ...nerals. Apparently the fluorspar was the last mineral to be introduced ...it characteristically occupies the center portion of the veins. The fluor-...ar occurs in a zone about ⅛ mile wide and approximately 1 mile long. ...single vein is extensive over any great distance, but there is a ten-...ncy for the veins to form en echelon making the fluorspar more or less ...ntinuous throughout the zone. If commercial production were to be ...dertaken in this area, it is likely that the operation would have to be a ...rge-scale stripping operation, and it is doubtful that the tenor of the ...e would support such an enterprise.

Fluorspar has been produced about 1½ miles to the west-southwest ...f the above area. A shaft was sunk to a depth of about 150 feet on a vein ...hich strikes S. 80° E., dips vertically, and has a maximum width of 4 ...et. The tonnage of fluorspar produced and the ownership of the property ...e not known. Fluorite is in a gangue of quartz and calcite. The western ...rtion of the mineralized fissure has an andesite foot and hanging wall, ...hereas the eastern portion has a hanging wall of granite and a footwall ...f andesite. The writers were not able to go down in the shaft to learn

Tabulated list of fluorspar properties in California.

Claim	Last known owner	Sec.	T.	R.	B&M	Remarks and references
			Inyo County			
Fluorite #1 & #2 (White Mountain)	George A. McAfee and Louie Stewart, Bigpine	33	6S	35E	M.D.	
Warm Spring	General Chemical Division, Allied Chemical and Dye Corp., 40 Rector St., N.Y., N.Y.	—	22N	1E	S.B. proj.†	R34:483-484; herein
Wine Fluorspar	Wade H. Wine, 2165 Plumas St., Reno, Nevada	13?	19S	44E	M.D. proj.†	Fluorspar in dolomite (?); worked by shallow inclined shaft
			Kern County			
Last Chance Canyon	Della Gerbracht, R. L. Meuer	12?	29S	38E	M.D.	Herein
			Riverside County			
Fluorspar Group	Louis Favret, L. H. Raines, Blythe, and N. A. Anderson, Pasadena	4	3S	18E	S.B.	R25:470; B50:343; herein
Afton Canyon	Essential Mineral Co., 617 Black Bldg., Los Angeles	4, 5, 7, and 3	10N 11N	6E 6E	S.B. S.B.	Burchard, E. F., A.I.M.E. Trans., vol. 109, pp. 373-374; herein
Big Horn #9 (Afton Canyon)	Ora E. Whitlock	------	10N	6E	S.B.	Herein
Free Thinker or Magna #1	H. C. Moore, 1958½ Rodney Dr., Los Angeles	------	28S	16E	S.B.	R27:376; herein
A.L.French (Ivanpah Mountains)	A. L. French	------	14N	14E	S.B.	Herein
Green Hornet	Mrs. L. B. Garvell, 2580 Lincoln Blvd., San Bernardino	7, 8	6N	1W	S.B.	Herein
[illegible] (Clark Mt.)	[illegible], Baker	------	17N	[illegible]	S.B.	Herein
[illegible]	[illegible] and Lola May Adams	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
McKinney	C. J. McKinney, F. C. Snyder, and D. R. Brown, Victorville	1	6N	1W	S.B.	Herein
Philadelphia (Providence Mountain)	Oscar L. Hoerner, Newberry	------	9N	13E	S.B.	R27:376; herein
Primer	George B. Primer, Lancaster	26	7N	6W	S.B.	Herein
War Eagle (Clark Mt.)	Gilbert W. Douglass	------	17N	13E	S.B.	Herein
			Tulare County			
Annie J. Nash, Camp Nelson, and V. K. Porterville		34	20S	31E	M.D.	R26:439

† Public land survey lines are not complete on the base map.

			Riverside County			
Fluorspar Group	Louis Favret, L. H. Raines, Blythe, and N. A. Anderson, Pasadena	4	3S	18E	S.B.	R25:470; B50:343; herein
Afton Canyon	Essential Mineral Co., 617 Black Bldg., Los Angeles	4, 5, 7, and 3	10N 11N	6E 6E	S.B. S.B.	Burchard, E. F., A.I.M.E. Trans., vol. 109, pp. 373-374; herein
Big Horn #9 (Afton Canyon)	Ora E. Whitlock	------	10N	6E	S.B.	Herein
Free Thinker or Magna #1	H. C. Moore, 1958½ Rodney Dr., Los Angeles	------	28S	16E	S.B.	R27:376; herein
A. L. French (Ivanpah Mountains)	A. L. French	------	14N	14E	S.B.	Herein
Green Hornet	Mrs. L. B. Garvell, 2580 Lincoln Blvd., San Bernardino	7, 8	6N	1W	S.B.	Herein
Korfist (Clark Mt.)	Jerry Korfist, Baker	------	17N	13E	S.B.	Herein
Live Oak	Emily R. Hall and heirs of [illegible] and Lola May Adams	------	[illegible]	[illegible]	[illegible]	[illegible]
McKinney	C. J. McKinney, F. C. Snyder, and D. R. Brown, Victorville	1	6N	1W	S.B.	Herein
Philadelphia (Providence Mountain)	Oscar L. Hoerner, Newberry	------	9N	13E	S.B.	R27:376; herein
Primer	George B. Primer, Lancaster	26	7N	6W	S.B.	Herein
War Eagle (Clark Mt.)	Gilbert W. Douglass	------	17N	13E	S.B.	Herein
			Tulare County			
Annie J. Nash, Camp Nelson, and V. K. Porterville		34	20S	31E	M.D.	R26:439

† Public land survey lines are not complete on the base map.
* The following abbreviations for Division of Mines publications in this column: R—Report of the State Mineralogist; B—Bulletin. The number following the colon in such references is the page number.

whether or not there had been any drifting on the vein. A short distance to the west of the shaft the fault is mineralized entirely by calcite, in places being as much as 15 feet wide. To the east of the shaft the fluorite-bearing zone appears to pinch out entirely.

The vesicles of some of the basalt exposed at the surface near the shaft are filled with fluorspar.

Ivanpah Mountains Deposit. The A. L. French fluorspar deposit is in the Ivanpah Mountains in sec. 8 (approximately), T. 14 N., R. 14 E., S. B. The prospect is not likely to develop into a commercial ore body.

The fluorspar is present in minute shears in a partly sericitized quartz monzonite porphyry, and wholly or partly replaces many of the phenocrysts of the rock. The fluorite is dark purple and is in sharp contrast to the more subdued color of the country rock.

The mineralized area is irregular in shape, and is about 75 feet across in its greatest dimension. The deposit has been explored by a small trench and a discovery hole.

Because the fluorite content of the rock is low and the extent of the deposit small, little development work is likely to be undertaken.

Green Hornet Deposit. The Green Hornet deposit comprises claims situated in secs. 7 and 8, T. 6 N., R. 1 W., 16 miles northeast of Lucerne P.O. and 30 miles by road northeast of Victorville. Mrs. L. Garvell, 2580 Lincoln Boulevard, San Bernardino, California, is the owner.

Five parallel quartz veins 4 to 6 feet wide occur in granite. The veins strike east and dip 80° S. Fluorite occupies irregular lenses in the quartz veins.

Development is confined to quartz veins about 40 feet apart. A shaft has been sunk on one of the parallel veins to a depth of 80 feet. On the 80-foot level a drift has been driven east 125 feet. About 100 feet along the drift a crosscut has been driven 40 feet north to intersect a parallel vein. In the east drift several small lenses of fluorspar about 10 feet in length were mined. It is estimated that there is on the dump about 30 tons of ore reported to carry 40 percent CaF_2. Ten tons of sorted ore is reported to carry 85 percent CaF_2 and 12 percent silica.

Live Oak Mine. The Live Oak Mine is in the New York Mountains in T. 14 N., R. 16 E., S. B. It is about 14 miles southeast of Ivanpah. The mine is owned by Emily R. Ball and the heirs of E. H. Hunting and L. May Adams.

The vein has a strike of N. 20° W. and dips 75° S. The footwall is granite of Jurassic (?) age and the hanging wall is an alaskite dike which has intruded the granite and Cambrian (?) limestone. Several small tactite bodies have been formed between the limestone and alaskite dike.

Fluorspar is associated with quartz, pyrrhotite, pyrite, chalcopyrite, covellite, calcite, sphalerite, galena, and the secondary minerals malachite and limonite. Some fluorite and sulfides are disseminated in the alaskite hanging wall and the granite footwall. Several smaller fissures striking N. 10° E. and dipping 75° E. are also mineralized.

The maximum width of the vein is about 12 feet. Zoning is prominent. Fluorite and sulfides are concentrated near the vein walls, and quartz, or quartz and fluorite, fill the central portion of the vein.

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McKinney Deposit. This d
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Nipton Deposit. The Free
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Primer Deposit. The Prime
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Providence Mountain Depos
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Oscar L. Hoerner of Newberr
The deposit consists of a sir
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The fluorite content of the ores at this property probably averages about 40 percent. It is impossible to estimate ore reserves as only several hundred feet of development work has been done. It is likely, however, that acid-grade fluorite could be produced as a by-product of a flotation mill providing the sulfides in the ore would warrant the necessary installation costs.

McKinney Deposit. This deposit comprises two claims on a low range of hills a mile south of the Gold Belt mine, in sec. 1, T. 6 N., R. 1 W., S. B., 27 miles by road east of Victorville, California.

A quartz vein 6 feet wide occurs in granite. The vein strikes east and dips vertically. A 6-inch streak of purple and green fluorspar occurs on the wall of the vein, in 4 feet of quartz mixed with fluorspar. About a quarter of a mile south is a parellel vein of quartz containing fluorspar. Development consists of a 10-foot shaft and an incline shaft 55 feet in depth.

Nipton Deposit. The Free Thinker, or Magna Number 1, fluorite claim is in T. 28 S., R. 16 E., S. B., about 3½ miles west of Nipton. It is owned by H. C. Moore of 1958½ Rodney Drive, Los Angeles.

Country rock in the area is predominantly Archean augen gneiss, but some Archean quartzite is also exposed. Several small veins have been explored by cuts and adits, and a small amount of fluorite from these excavations has been stock piled.

The largest of the exposed veins has a maximum width of about 18 inches and was traced for about 40 feet along its strike. Most veins pinch out a short distance along the strike, and it is likely that they behave similarly in the direction of dip. The strike and dip of the veins vary widely and do not appear to represent any clearly defined system.

Fluorite is associated with quartz, iron oxides, and carbonates of copper. Much of the ore would meet metallurgical-grade specifications if it were hand-sorted.

It is unlikely that any large tonnage of fluorspar could be developed at this property. However, a small amount of shipping-grade material could undoubtedly be obtained by selective mining and hand-sorting.

Primer Deposit. The Primer deposit comprises three claims on the northeast slope of Shadow Mountain in the Silver Mountain mining district, 8 miles northwest of Adelanto in sec. 26, T. 7 N., R. 6 W., S. B. George B. Primer, Lancaster, California, is the owner.

Discontinuous stringers and pockets of light green fluorite are associated with white, transparent calcite crystals in hydrothermal fissure veins in gray limestone. Some limonite and a small amount of quartz are present. The veins strike N. 5°-20° E., dip 45°-60° W., and range in size from several inches to 4 feet in width.

A shaft has been sunk on a fissure to a depth of 15 feet. A 30-foot open cut and two trenches about 45 feet long complete the development work.

Providence Mountain Deposit. The Philadelphia fluorspar claim is in the Providence Mountains, in T. 9 N., R. 13 E., S. B. It is owned by Mr. Oscar L. Hoerner of Newberry, California.

The deposit consists of a single vein having a maximum width of about 6 feet and an exposure of about 50 feet along the strike. There is

some reason to believe that it may be terminated by a fault and that
tensions may be found.

The only fluorite observed outside the limits of the main vein
a small gully just north of the end of the main mineralized zone. In
gully a few small veinlets containing fluorite were found.

With the exception of a small amount of quartz gangue, the
composed of nearly solid fluorite. The mineralized fissure is locali
a fine-grained granite which makes up part of an extensive gra
complex.

About 20 tons of 50 percent fluorite was on the dump early in
The fluorspar is of good grade and, if a sufficient tonnage of ore co
developed, the property might produce on a commercial basis.

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