## CONTENTS

<table>
<thead>
<tr>
<th>Abstract</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Purpose and scope</td>
<td>1</td>
</tr>
<tr>
<td>Fieldwork</td>
<td>1</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>1</td>
</tr>
<tr>
<td>Previous geologic work</td>
<td>2</td>
</tr>
<tr>
<td>Geography</td>
<td>2</td>
</tr>
<tr>
<td>Location and accessibility</td>
<td>2</td>
</tr>
<tr>
<td>Surface features</td>
<td>2</td>
</tr>
<tr>
<td>Climate and vegetation</td>
<td>2</td>
</tr>
<tr>
<td>Geology</td>
<td>2</td>
</tr>
<tr>
<td>General features</td>
<td>2</td>
</tr>
<tr>
<td>Stratigraphy</td>
<td>3</td>
</tr>
<tr>
<td>Cambrian (?) rocks</td>
<td>3</td>
</tr>
<tr>
<td>Garden Creek Phyllite</td>
<td>3</td>
</tr>
<tr>
<td>Bayhorse dolomite</td>
<td>3</td>
</tr>
<tr>
<td>Ordovician rocks</td>
<td>3</td>
</tr>
<tr>
<td>Ramshorn conglomerate</td>
<td>3</td>
</tr>
<tr>
<td>Ramshorn slate</td>
<td>4</td>
</tr>
<tr>
<td>Kinnikinic quartzite</td>
<td>4</td>
</tr>
<tr>
<td>Tertiary rocks</td>
<td>4</td>
</tr>
<tr>
<td>Challis volcanics</td>
<td>4</td>
</tr>
<tr>
<td>Quaternary rocks</td>
<td>4</td>
</tr>
<tr>
<td>Slope wash</td>
<td>4</td>
</tr>
<tr>
<td>Alluvium</td>
<td>5</td>
</tr>
<tr>
<td>Structure</td>
<td>5</td>
</tr>
<tr>
<td>Folds</td>
<td>5</td>
</tr>
<tr>
<td>Bayhorse anticline</td>
<td>5</td>
</tr>
<tr>
<td>Chalihar syncline</td>
<td>5</td>
</tr>
<tr>
<td>Faults</td>
<td>5</td>
</tr>
<tr>
<td>Longitudinal faults</td>
<td>5</td>
</tr>
<tr>
<td>Transverse faults</td>
<td>6</td>
</tr>
<tr>
<td>Other faults</td>
<td>6</td>
</tr>
<tr>
<td>Mineralized faults</td>
<td>6</td>
</tr>
<tr>
<td>Fluorspar deposits</td>
<td>6</td>
</tr>
<tr>
<td>History and production</td>
<td>6</td>
</tr>
<tr>
<td>Character of the deposits</td>
<td>7</td>
</tr>
<tr>
<td>Geologic and geographic distribution</td>
<td>7</td>
</tr>
<tr>
<td>Structural relations</td>
<td>7</td>
</tr>
<tr>
<td>Mineralogy</td>
<td>8</td>
</tr>
<tr>
<td>General features</td>
<td>8</td>
</tr>
<tr>
<td>Minerals associated with the fluorspar</td>
<td>8</td>
</tr>
<tr>
<td>Quartz</td>
<td>8</td>
</tr>
<tr>
<td>Fluorite</td>
<td>8</td>
</tr>
</tbody>
</table>
ILLUSTRATIONS

Following Page

Plate 1. A, Daughterty Gulch; B, Bayhorse dolomite ............... 2
2. A, Crystal fluorspar; B, Boxwork fluorspar .................. 8

Figure 1. Index map showing location of fluorspar area
near Challis, Idaho .................................................. 2
2. Geologic map of the fluorspar area near Challis, Idaho .... Pocket
3. Topographic and geologic map of the
Chalspar No. 1 area .................................................. 8
4. Plan and sections of the West and Past Up veins
on Chalspar No. 1 ..................................................... Pocket
5. Underground workings on the Past Up vein ................. 10
6. Map of the Chalspar No. 2 vein .............................. 12
A Preliminary Report on the Fluorspar Mineralization Near Challis, Custer County, Idaho

by

Alfred L. Anderson

ABSTRACT

The fluorspar deposits near Challis, Custer County, Idaho, are in the northern part of the Bayhorse district, mostly on Keystone mountain, in and near Daughtersy Gulch, and in several of the mines near the old town of Bayhorse. The presence of fluorspar at these places became known only recently and exploration so far has not extended much below the surface.

The deposits occur as fissure and breccia fillings in the fractured and faulted Bayhorse dolomite along the crest and flanks and in faulted offsets of the Bayhorse anticline. The deposits are fairly numerous and many of them are relatively large. The surface exposures show exceptional promise and suggest that the district may contain one of the most important concentrations, if not the most important concentration of fluorspar within the State. More exact evaluation of the district and appraisal of its deposits must await more extensive underground exploration, for the downward extent of the fluorspar deposits is still largely unknown. However, the outlook for a substantial reserve of fluorspar is bright.

INTRODUCTION

PURPOSE AND SCOPE

The purpose of this preliminary report is to direct attention to the recent fluorspar discoveries in the region near Challis in Custer County, Idaho, and to encourage more active exploration and development in what appears to be one of the most promising centers of fluorspar mineralization within the State. Because of the potential importance of these discoveries, it was decided to issue a preliminary report before completion of the field study in order that the present available information on the fluorspar mineralization might be made to serve an immediate need. This is in accordance with the policy of the Idaho Bureau of Mines and Geology to lend support to the development and utilization of the State's mineral resources for the benefit of the State and its people.

The present report deals largely with the geologic occurrence and geographic and geologic distribution of the fluorspar deposits and delineates the area in which the fluorspar may be expected. So far most of the deposits have received a rather cursory examination, with detailed mapping and study confined to a small area readily accessible from Challis. Some of the deposits had just been discovered and were being explored by the bulldogger while the writer was in the district. Very few of the deposits are exposed underground. Although the general region had long been known for its base-metal deposits, the presence of fluorspar was not generally known and apparently attracted little, if any attention until the late forties.

FIELDWORK

Several hours were spent at the fluorspar deposits on Keystone Mountain in the summer of 1951 and several brief visits were made to the deposits bordering Daughtersy Gulch in 1952 and in the early summer of 1953, but actual fieldwork did not get underway until August 4, 1953. This work continued for little more than three weeks. During this time the writer prepared a fairly detailed geologic map of a part of the area and examined some of the deposits in as much detail as the surface exposures would permit, giving other deposits a most cursory examination. The more detailed study and mapping of some of the deposits was left to Mr. James A. Humphreys for use as a thesis problem. Except for a one-day visit to the Bayhorse area and another to Keystone Mountain, the entire time was spent in or near Daughtersy Gulch from Garden Creek north to Mill Creek.

ACKNOWLEDGEMENTS

The writer wishes to acknowledge his deep gratitude to Messrs. Keith Madill, Don Ferguson, and Arthur Chambers for their helpful assistance in the field. Mr. Madill personally escorted the writer to many of the deposits in the Daughtersy Gulch area and accompanied him on his one-day trip to the fluorspar deposits near Bayhorse. Mr. Ferguson also drove the writer to some of the deposits in and bordering Daughtersy Gulch accessible only by jeep and accompanied him on several of his all-day traverses on the high ridges. Both Messrs. Madill and Ferguson also provided jeep transportation for Messrs. James Humphreys and Clayton Reynolds to the Chalnaph No. 2 area on the high ridge north of Daughtersy Gulch and otherwise assisted them with the mapping and study of the deposits reserved for the thesis project. Mr. Chambers in 1951 and again in 1953 drove the writer to the top of Keystone Mountain, accessible only by jeep, and escorted him personally to the various fluorspar deposits on the mountain, giving freely of his knowledge of the occurrence of the fluorspar and of the general features of the geology.

The writer also wishes to express his appreciation to Mr. James A. Humphreys for the use of his maps and the data collected for his thesis study. Mr. Humphreys assisted by Mr. Clayton Reynolds (the writer's personal field assistant loaned to Mr. Humphreys)
Highway 93 and is about 60 miles from Mackay, the nearest railroad and terminus of a branch line of the Union Pacific Railroad. The highway to Mackay (U. S. 93-A) is hard surfaced, but the highway up the Salmon River (U. S. 93) to Clayton and Stanley has only a gravel surface.

SURFACE FEATURES

The area of fluor spar mineralization is near the southeastern edge of the Salmon River Mountains, a complex of deeply dissected uplands, incised locally by Garden, Mill, and Bayhorse Creeks, all tributaries of the Salmon River. Each of these streams in turn has its system of tributaries, some of which occupy valleys or gulches of pertinent geographic interest, among them Daugherty and Whetstone Gulches (tributaries to Garden Creek), Big Hill Gulch (tributary to Mill Creek), and Beardsley Gulch (tributary to Bayhorse Creek). These gulches are shown in Figures 1 and 2.

The mountains are relatively high and possess considerable local relief. The highest ridges rise to nearly 10,000 feet above sea level or nearly 3,000 feet above the lower valley bottoms. Keystone Mountain reaches 9,464 feet; Ramshorn Mountain, 9,906 feet; and the peak at the head of Daugherty Gulch, 9,840 feet. Cirques nestle against some of the higher peaks and a double cirque occurs at the head of Daugherty Gulch (Pl. 1A). From this compound cirque the glacial ice drained to the mouth of Daugherty Gulch and reshaped the stream-carved valley into a relatively broad-bottomed glacial trough. Except in Big Hill, slopes are steep, in places even precipitous.

CLIMATE AND VEGETATION

Because of the high altitude, much of the area has a rigorous climate, with short cool summers and long cold winters with much snow on upper slopes. The snow constitutes somewhat of a handicap to winter-time operation of deposits on the higher ridges. In places the snow may linger well into June and even into July.

Except on the lower slopes, the area is fairly heavily timbered, especially on the north sides of the ridges (Pl. 1A). Much of the timber is second growth and consists largely of fir and spruce, suitable for mine timbers. Open country and lower slopes are covered by sage brush and various grasses.

GEOLoGY

GENERAL FEATURES

Except for local overlies of Challis volcanic (Tertiary) and Quaternary slope wash and alluvium, the area of fluor spar mineralization is underlain throughout by sedimentary rocks of lower Paleozoic age; namely, the Garden Creek phyllite and Bayhorse dolomite of Cambrian (?) and the Ramshorn slate and conglomerate and the Kimnukic quartzite of Ordovician age. These sedimentary strata have been rather strongly folded and faulted and locally form the complexly faulted Bayhorse anticline, the dominant structural feature of the region.

GEOGRAPHY

LOCATION AND ACCESSIBILITY

The fluor spar deposits are in the northern part of the Bayhorse district with the fluor spar mineralization known to extend at present from the Pacific mine near the old town of Bayhorse to Mill Creek some 7 1/4 miles to the north. The town of Challis is 9 1/2 miles north of the Pacific mine and 2 3/8 miles west-southwest of the town of Mill Creek. The southwestern edge of the fluor spar mineralization (Fig. 2) covers the northern end of the zone of fluor spar mineralization from Garden Creek to Mill Creek, by eastern edge about 4 miles southwest of Challis (Fig. 1). This area is at about 44° 30' N. latitude and 114° 20' W. longitude. It lies mostly within the Challis National Forest, much of it in unsurveyed T. 13 N., R. 18 E., Boise meridian.

The area of fluor spar mineralization is fairly accessible. A gravelled, well-graiedd and maintained road extends from Challis into the mapped area (Fig. 2), with one fork continuing up Garden Creek and the other across a relatively low divide to Mill Creek and thence over to Bonanza on Yankee Fork. The fluor spar deposits below the mouth of Daugherty Gulch (Challis No. 1 and Holterman) are reached by a short branch road accessible by car but the deposits in Daugherty Gulch and on the ridges bordering the Gulch are accessible only on foot or by jeep. The Pacific mine has road connection with Bayhorse and is within easy reach by car. The deposits on Keystone Mountain are approached from Garden Creek over a steep road with many switchbacks (road not shown in Figure 2).

Challis, the county seat of Custer County, is on U.S. 

Figure 1. Index map showing location of fusc spar area near Challis, Idaho.
A. DAUGHERTY GULCH

Shows the cirques at the head and the high ridges bordering Daugherity Gulch and the location of the Westpar on the south ridge, the Chalspar No. 5 on the end of the ridge between the cirques, and the Chalspar No. 2 on the north ridge. The picture also shows the area of Bayhorse dolomite (foreground) faulted against the flank of the Bayhorse anticline and the location of the Holterman and the Chalspar No. 1 properties. The prominent ridges at the end of the north ridge are composed of silicified dolomite. Photograph by James Humphreville.

B. BAYHORSE DOLOMITE

Exposure of the Bayhorse dolomite on the locally overturned east limb of the Bayhorse anticline north of Garden Creek. The smooth slope on the left is underlain by the Garden Creek phyllite and the prominent ledges in the extreme upper right are composed of Ramsbom conglomerate.
STRATIGRAPHY
Cambrian (7) Rocks
Garden Creek Phyllite

The Garden Creek phyllite forms the core of the Bayhorse anticline and is exposed in the valley walls on both sides of Garden Creek, reaching well up on Key- stone Mountain on the south and over the ridge into Daugherty Gulch on the north (Fig. 2). From Daugherty Gulch the phyllite extends northward through the ridge under a cap of Bayhorse dolomite and appears as a small window on the other side. It bears no resemblance to dolomite. Its only other occurrence elsewhere is along Bayhorse Creek near the town of Bayhorse.

As pointed out by Ross, the formation is composed entirely of dark-gray to black, in part somewhat calcareous phyllite with silvery sericite abundantly displaced on sides of the antiformal structure, but may be recognized on close observation as thin crenulated bands. The phyllite is soft and weathers readily to smooth slopes (Pl. 1-B), breaking up into small fragments or flakes that make masses of mobile talus. The only rock observed in place was along the inner gorge of Garden Creek and in some low cliffs on the slope to the south.

The base of the phyllitic formation has not been exposed and the thickness is indeterminate, but from map interpolation the thickness must aggregate some hundreds of feet. The formation appears to underlie the Bayhorse dolomite with little, if any, discordance.

The Garden Creek phyllite has no counterpart anywhere in the region. Because of its apparent conformance with the Bayhorse dolomite and the lack of formance of the dolomite with the overlying Rams horn slates of undisputed Ordovician age, the phyllite is regarded as Cambrian. It bears no resemblance to any of the formations of pre-Cambrian age exposed elsewhere in the region.

Bayhorse Dolomite

The Bayhorse dolomite occurs on the flanks and in places along the crest of the Bayhorse anticline and at several other localities. The most extensive exposures are in the vicinity of Daugherty Gulch and Garden Creek where it overlies and otherwise completely encircles the Garden Valley phyllite (Fig. 2). Its outcrop pattern is that of an elongated, more or less ellipsoidal-like ring, encircled in turn by Rams horn slate and conglomerate. Off the antiformal structure, it is exposed along the relatively low ridge north of the mouth of Daugherty Gulch and again near the mouth of Big Hill Gulch and on Mill Creek. Another small isolated block occurs about midway along the northern edge of Big Hill Gulch (Fig. 2).

The greater part of the formation is composed of thick-bedded dolomite with cliff or ledge-forming tendencies, very well exposed along Mill Creek and other exposures off and along the anticline (Pl. 1-B). The beds are mostly light gray in color, but outcrops are usually weathered a rusty buff. A part of the dolomite is cherty and some near the top of the formation contains interbedded lenses of slate. According to Ross some of the dolomite on the west flank of the anticline on Garden Creek is a breccia or poorly rounded conglomerate and some on the east flank has interbedded quartzite containing fragments of dolomite. These quartzite beds measure as much as 100 feet thick. The dolomite generally shows much evidence of local fracturing and brecciation, a feature of considerable economic importance from the standpoint of occurrence and distribution of fluor spar.

Because the dolomite was extensively eroded prior to deposition of the overlying beds of the Rams horn formation, its original thickness is not known. Only a few hundred feet are exposed along the east flank of the anticline in Daugherty Gulch and in the valley of Garden Creek whereas as much as 1,000 feet and perhaps more remain along the eastern flank of the anticline in the Broadhead area. The broader areas of the dolomite shown on the geologic map (Fig. 2) reflect duplication of the beds by faulting.

The dolomite appears to be non-fossiliferous, but because of its unconformable relationship to the overlying slates of Lower Ordovician age and its lack of lithologic resemblance to any of the known members of the pre-Cambrian Belt series it is tentatively assigned to the Cambrian.

Ordovician Rocks

Rams horn Conglomerate

The Rams horn conglomerate is strictly local and is exposed only around the northern end of the Bayhorse anticline. It is a prominent feature in the vicinity of Daugherty Gulch and Garden Creek (Pl. 1-A) and in the upper reaches of Big Hill Gulch and Mill Creek, where it wraps around the sharply plunging nose of the anticline (Fig. 2). The conglomerate may be traced southward along the west flank of the anticline, but not beyond. Garden Creek is a few feet east exposed, and a long east flank for a somewhat greater distance, actually across Garden Creek and for about 3/4 of a mile up Whetstone Gulch. It is not known to occur elsewhere along the anticline, except on upper Rattlesnake Creek, a short distance east of Big Hill Gulch, and 7 miles to the south and does not overlie or occur with any of the isolated exposures of Bayhorse dolomite east of the anticline.

This conglomerate occurs at the base of the Rams horn slate and is composed almost entirely of fairly well rounded pebbles of vein quartz and quartzite with most of the pebbles less than an inch in diameter but with some as large as 3 inches. These pebbles are generally securely held in a siliceous matrix, locally somewhat sandy. In places the conglomerate contains interbedded quartzite or thin lenses of slate.

The conglomerate shows considerable variation in thickness, from 0 up to 600 feet, reaching its maximum thickness in the upper part of Daugherty Gulch. In most places the conglomerate rests directly on the Bay horse dolomite, but at some places it is separated from the dolomite by a small thickness of slate. It is conformable with the slate and locally contains thin lenses of interbedded slate. Both slate and conglomerate rest unconformably on the eroded surface of the dolomite. Variation in thickness of the conglomerate may reflect the depth of erosion of the dolomite, for there appears to be less dolomite where the conglomerate is thick than where it is thin.

As the conglomerate forms the basal part of the Rams horn slate, its age is tied up with that of the

\[ \text{Ross, C. P., U.S. Geol. Survey Bull. 877, op. cit. p. 12.} \]
\[ \text{Ross, C. P., U.S. Geol. Survey Bull. 877, op. cit. p. 12.} \]
\[ \text{U.S. Geol. Survey Bull. 877, op. cit. p. 13.} \]
slate, which on fossil evidence is known to be of Lower Ordovician age.  

Ramshorn Slate  

Like the other Paleozoic formations, the Ramshorn slate forms a part of the Bayhorse anticline and in the map-area (Fig. 2) completely envelopes the dolomitic and phyllitic core of the anticline. It is exposed over a greater area than any of the other Paleozoic units and extends far out on the flanks of the anticline, with much of the rock on the east side concealed beneath a cover of slope wash and Tertiary volcanics. It is particularly widespread near Mill Creek at the north end of the anticline and along the south edge of the map across the top of Keystone Mountain (Fig. 2).

Except for the basal conglomerate, the Ramshorn is composed almost entirely of thin-banded argillaceous rock, some beds consisting of siltstones while others are a mixture of siltstone and sandstone. Beds containing siltstone are somewhat more calcareous than the average. The rock possesses a prominent slaty cleavage which invariably cuts the banding at high angles. Most of the slate is dark green to purplish, but some locally has been lightened by calcareous material or darkened by carbonaceous matter. According to Ross, most of the slate consists largely of quartz, in grains rarely more than a few hundredths of a millimeter in diameter, and fine aggregates of chlorite, serpentine, biotite, and other micaceous minerals. The slate is generally somewhat contorted, but not as much so as the Garden Creek phyllite.

The Ramshorn slate is the thickest of the Paleozoic formations, locally with at least 3,000 feet and possibly 3,000 feet of beds exposed in or near the area. Absence of easily recognizable horizon markers within the mass of the formations makes it difficult to eliminate the effects of repetition or omission of beds by faulting.

The age of the Ramshorn slate from fossil evidence is known to be Lower Ordovician.  

Kimniknic Quartzite  

The Kimniknic quartzite, which flanks and crowns the Bayhorse anticline at intervals along its course, has locally been lost by erosion, except for a cap on the high ridge at the head of Daugherty Gulch. A part of the cap extends into the map-area (Fig. 2).

The Kimniknic quartzite is conspicuously well-bedded and consists largely of rather pure quartzite strata with some shaly partings and some minor intercalations of somewhat shaly quartzite. The rock is generally white, but in some exposures it has a distinctive lavender cast. It is composed essentially of detrital grains of quartz 0.1 to 0.5 millimeter in diameter in a silicious cement containing sericite.

The exposure at the head of Daugherty Gulch is perhaps 500 feet or more thick, but the bulk of the rock there represents only the lower part of the formation which elsewhere is known to be at least 3,500 feet thick.

As the formation lies above the Ramshorn slate (Lower Ordovician) and below the Saturday Mountain formation (Upper Ordovician), its age is definitely Ordovician and probably Lower or Middle Ordovician.

Tertiary Rocks  

Challis Volcanics  

Most of the cover of Challis volcanics has been stripped from the Bayhorse anticline, but otherwise the cover is continuous for miles to the north and east and forms most of the exposed rock in the eastern and northern part of the map-area (Fig. 2). The stripping of the volcanic blanket from the anticline was not quite complete in the map area and many thin patches or caps remain, some large enough to show on the map (Fig. 2), others much too small.

The volcanics comprise a thick accumulation of flows and tuffs of varied character and composition which Ross has subdivided locally into flows of basalt and andesite, the Germer tuffaceous member, and flows and pyroclastics of mainly intermediate composition, the latite-andesite member. The basalt and andesite drainage basin where it covers the slopes crosses into Big Hill Gulch from Garden Creek, and the light-colored bedded Germer tuffs occur just beyond the basaltic and andesitic flows on both sides of the road as it descends to the mouth of Big Hill Gulch. The latite-andesite member is much more widespread than the others and extends over much of the country along the east and north side of the map-area (Fig 2). As the volcanic rocks appear to have escaped the fluor spar mineralization, they received little attention in the present study and the several members were not differentiated in mapping.

After consideration of all aspects of the problem, Ross has concluded, largely on the basis of fossil evidence, that the Challis volcanics are possibly, if not probably, of Oligocene age and that they can hardly be younger than early Miocene.

Quaternary Rocks  

Slope wash  

Slope wash is rather widespread and has been mapped wherever there is uncertainty as to the structural and stratigraphic relations of the underlying rock (Fig. 2). The largest area of slope wash is in the Big Hill Gulch drainage basin where it covers the slopes of a somewhat basin-like area and effectively conceals all the underlying bedrock. This wash extends far up the slope on the south and joins with another wash that stretches down the slope in a more easterly direction and around a projecting spur of Paleozoic rocks on which the Chalspar No. 1 and Holteman properties are located. Another body of slope wash occurs in and below the floor of the cirque at the head of Daugherty Gulch and another larger mass, at the mouth of Daugherty Gulch. Other areas of slope wash lie to the south of Daugherty Gulch on both sides of Garden Creek.

The slope wash consists largely of blocks and boulders of the more resistant members of the Paleozoic formations, carried down the slopes from the higher ridges under gravity. In the Big Hill area the wash contains a notable abundance of material from the Ramshorn conglomerate and from masses of silified dolomite. Such materials are also abundant in the wash that encircles the outlier of dolomite in which the Chalspar No. 1 is located. The same materials are
also abundant in the wash that extends from the mouth of Daugherty Gulch, but included also are notable amounts of the Kinnikinic quartzite. The wash at the head of Daugherty Gulch is composed largely, if not entirely, of materials derived from the Kinnikinic quartzite. The wash on the slope between lower Daugherty Gulch and Garden Creek is derived largely from the Ramshorn conglomerate, but that on the east side of Garden Creek is composed of volcanic rocks. The deposits everywhere show little sorting and contain notable admixtures of coarse materials, including blocks of rock several feet in diameter. Much of the debris at the mouth of Daugherty Gulch appears to be of morainal origin, but glacial ice apparently has had little to do in forming the deposits elsewhere.

The slope wash has probably been accumulating since early glacial times and apparently still continues to accumulate. Its age, therefore, may range from Pleistocene to Recent.

Alluvium

The alluvium is restricted to the lower valley bottoms and has been mapped along Garden Creek, lower Daugherty Gulch, and locally along Mill Creek (Fig. 2). As mapped, it may include also some lower terrace deposits.

The alluvium is composed largely of coarse gravel with a generous admixture of cobbles and boulders. Most of it is made up of the more resistant members of the Paleozoic formations and of flows in the Challis volcanics. Some of it is reworked glacial outwash. Much of it is of Recent age.

STRUCTURE

The most pertinent structural features are those which involve the Paleozoic rocks, for to date all the fluor spar has been found in structural openings in the Bayhorse dolomite and nowhere else. Although the fluor spar mineralization may post-date the extrusion of the Challis volcanics, the fluor spar apparently did not enter the volcanics and, therefore, the structural relations of the volcanics have little present interest. Most of the folding and faulting in the Paleozoic rocks preceded the extrusion of the volcanics and deformation since has merely caused some tilting of the volcanic strata, chiefly as a result of rather minor faulting.

Folds

As mentioned earlier, the dominant structural feature of the area is the Bayhorse anticline, but there is also another fold of local significance, composed of a faulted syncline, which lies against the east flank of the anticline. This second fold is referred to herein as the Chalpsar syncline.

Bayhorse Anticline

The Bayhorse anticline is one of the largest and longest in the region. Its total length is unknown. In the map area (Fig. 2) it plunges sharply to the northwest and within a short distance disappears beneath a cover of Challis volcanics, but southward it extends past Bayhorse and Clayton and, after an interruption by thrust faulting near Clayton, appears to continue across the East Fork of the Salmon River and thence southeastward across the Halley quadrangle.

The anticline is especially well-developed within the map-area (Fig. 2) and is ideally exposed along Garden Creek and in Daugherty Gulch. This part of the anticline has apparently been lifted higher by the orogenic forces than elsewhere, since the oldest rocks in the region are exposed in it. The anticline is comparatively wide with a nearly flat top, but the immediate flanks are steep and locally even overturned (Pl. 1-B). It apparently reaches its greatest height in Daugherty Gulch and from there plunges rather steeply northwest and less steeply south, thus forming a local, somewhat elongated dome (Fig. 2).

The anticline is asymmetric with the easterly limb as a whole more steeply dipping than the westerly. In places, as along Garden Creek, the resistant Bayhorse dolomite and overlying conglomerate are overturned (Pl. 1-B). The anticline has been complexly faulted, but the faults have not produced any major offsets in the structure.

Chalpsar Syncline

The Chalpsar syncline lies against the east flank of the Bayhorse anticline, but its exposures are small and restricted chiefly to the area of Bayhorse dolomite on the lower east slope of the mountain, identified locally as the site of the Chalpsar No. 1 group of claims, and to the area of dolomite at and near Mill Creek (Fig. 2). In the Chalpsar No. 1 area the beds are nearly flat and apparently represent the bottom of the syncline, but near Mill Creek the exposed beds are those of the east flank. The syncline has apparently been brought up to its present position along side the anticline by faulting with the anticline on the downthrown side. The syncline shows some minor undulations, apparently induced by faults of relatively minor magnitude.

Faults

The Bayhorse anticline and bordering Chalpsar syncline have been cut by many faults, some of comparatively large size but most of rather small. Some of the larger faults have been mapped (Fig. 2), but mapping of the smaller ones must await detailed studies. These faults may be conveniently classed as longitudinal faults (those that tend to parallel the long dimension of the anticline and syncline), transverse faults (those that extend at about right angles to the trend of the folds), other faults (those which are neither longitudinal or transverse to the folds), and mineralized faults (those faults and fault zones of minor magnitude which have localized fluor spar mineralization).

Longitudinal Faults

The longitudinal faults comprise some of the largest and most impressive faults in the district, among them the fault that has brought the Bayhorse anticline against the Chalpsar syncline. The trace of the fault is mostly concealed beneath the cover of Challis volcanics and slope wash, but may be followed through the low saddle of bench just west of the exposure of Bayhorse dolomite of the Chalpsar No. 1 area and again across the ridge between Big Hill Gulch and Mill Creek. At both places beds of Ramshorn slate occur on both sides of the fault, but the Bayhorse dolomite immediately underlies the slate east of the fault. The fault strikes about N.30° W. and apparently dips steeply southwest. It is a normal fault with down-

throw on the southwest side. Its throw must be at least 1,000 feet.

Other longitudinal faults extend into the map-area from the south (Fig. 2). One of these lies along Whetstone Gulch on the east side of the anticline and several occur on the west side, but only one of the latter has been mapped. The one in Whetstone Gulch strikes about N.30°W. and apparently dips northeast. The ones to the west have more northerly trends and apparently dip west. These several faults appear to terminate against transverse faults.

Longitudinal faults also interrupted by transverse faults are present farther north, one near the west edge of the map-area, two others in Big Hill Gulch. The two in Big Hill Gulch form the northeast and southwest boundaries of a small block of Bayhorse dolomite.

Transverse Faults
The transverse faults are roughly paralleled and extend across the anticline structure in a north-northeast-erly directions. Those in the northern part of the area are outlined by prominent gulches and saddles. Of the three shown on the map (Fig. 2), two dip south and the third north. The more southerly of these faults has caused a local extension of the Rasmhorn conglomerate. The position of the faulted conglomerate north of the fault suggests that the fault had considerable rotational movement.

The transverse faults in the southern part of the area have caused some minor offsets of the limbs of the anticline. The course of Garden Creek is apparently controlled by one of the faults which on crossing the anticline from west to east swerves from an east-northeast to a more northeasterly direction. Its downthrow is to the south. The second fault closely parallels to one along the creek, but its throw appears to be to the north. This fault loses its identity on approaching Whetstone Gulch.

Other Faults
There are many other faults worthy of mapping and would have been mapped had time permitted. Some of these faults have caused local thickening or repetition of beds, particularly of the dolomite along the east flank of the anticline near Garden Creek. Chambers\(^2\) reports several rotational faults south of Garden Creek, which are believed to have caused the thinning and expance of dolomite on the north side of Keystone Mountain. The faulting is especially complex along or near lower Whetstone Gulch and may not be exactly as represented (Fig. 2).

Mineralized Faults
Because of the relatively small size of the mineralized faults, they are not shown in Figure 2, but some of them are shown on the larger scale maps of the Chalrper No. 1 and 2 areas. These minor faults, actually the most important economically, do not seem to have the structural relations of the longitudinal and transverse faults. At least one of those at the Chalrper No. 1 has a prominent strike-slip relationship and locally has placed volcanic rocks against the Paleozoic. The relations of the mineralized faults elsewhere are less clearly defined, but they appear to dif-

\(^2\) Chambers, A. E., Personal communication.

FER in kind and age. These various faults will be described in some detail in the part of the report dealing with the structural relations of the fluor spar deposits.

The faults have produced fissures as well as zones of brecciated rock. Some of the zones of brecciated rock seem related to the folding and may have been formed as a result of differential movement or shearing between the beds during the folding, especially along or near the dolomite-slate contact. Other breccias seem to be related to tectonic faults.

**FLUORSPAR DEPOSITS**

**HISTORY AND PRODUCTION**

The history of the Bayhorse district dates back to 1877 to the discovery of the base-metal lodes, but the fluor spar did not become associated with the history until about 70 years later. During the intervening years the presence of fluor spar must have been known to the prospectors who combed the area and to the miners who worked some of the silver and base-metal lodes in which the fluor spar is now known to occur. But they may not have recognized the fluor spar for what it is and, even if they had, they may have realized its then lack of economic value. That the presence of the fluor spar was not generally known is indicated by the fact that no mention is made of it in any of the reports on the area.

It was not until the days of World War 2 when fluor spar was added to the critical list of strategic minerals that the local deposits received any recognition. The mineral was then reworked at some of the old silver-bearing veins on Keystone Mountain and at the Pacific mine above Bayhorse. Near the end of the War or shortly thereafter the fluor spar on Keystone Mountain attracted the attention of Arthur Chambers, who in the next year or so began an intensive investigation of the fluor spar mineralization. This investigation carried through from 1947 to 1949 during which time Mr. Chambers studied and mapped the geology of the area from Bayhorse north to Daugherty Gulch and by bond and lease and location acquired possession of the fluor spar deposits on Keystone Mountain. He noted but did not locate or acquire any of the deposits since prospected in and near Daugherty Gulch.

The history since has been largely one of discovery and exploration. During the early fifties some development was carried on at the Holterman property below the mouth of Daugherty Gulch. The nearby Past Up vein on the Chalrper No. 1 was actively developed during 1952 and 1953 both on and below the surface, the final work by the diamond drill in August and September of 1953. During the summer of 1953 active search for fluor spar was carried on in other parts of the Daugherty Gulch area with important discoveries made in and on the ridges bordering the gulch. Except for the Holterman, all the deposits in the Daugherty Gulch area were located or acquired and prospected or developed by the J. R. Simplot Company.

To date the only production of fluor spar has come from the Past Up vein on the Chalrper No. 1. From this vein were shipped 475 tons of metallurgical spar containing 88 percent CaF\(_2\) and 245 tons of milling spar with 55 percent CaF\(_2\).
CHARACTER OF THE DEPOSITS

The fluor spar deposits may be classed as fissure and breccia deposits. Some of them are simple fissure veins, but most of the veins also contain some breccia material either within or alongside the fissure filling and show transition into deposits more aptly described as breccia veins and lodes. There are also breccia deposits which lack the thin tabular characteristics of the breccia veining and contain only thick blunted bodies. In many of these thicker and shorter bodies the fluor spar shows a striking "boxwork" structure and this feature has prompted the use of the term "boxwork" in referring to the deposits. The boxwork deposits are particularly well developed on Keystone Mountain.

The fluor spar is everywhere a filling of open spaces and shows little, if any evidence of replacement of the rock in which it occurs. The filling is generally somewhat incomplete and for that reason the deposits, except for a few of the filled fissures, abound in openings lined with small fluorite crystals.

The fluor spar mineralization is younger than and apparently entirely independent of the base-metal mineralization. In general the fluor spar forms separate bodies remote from the base-metal deposits, but some do occur along side the base-metal lodes and some have incorporated small amounts of the base-metal ores.

GEologic AND GEOGRAPHIC DISTRIBUTION

The fluor spar deposits that have been found so far have been entirely within the Bayhorse dolomite. It is doubtful that significant amounts will be found in any of the other formations, for unlike the dolomite, the Garden Creek phylite and Ramphorn slates are not proper host rocks for the development of breccia or open space and hence are not hospitable hosts for the open-space seeking fluorite. Search for fluor spar is, therefore, most likely to be rewarded if confined to the Bayhorse dolomite. Not all parts of the dolomite, however, appear to be equally favorable for the occurrence of the fluor spar. Whereas the fissure veins may apparently appear in any part of the formation, the boxwork breccia deposits show a marked preference for the upper beds of dolomite, more particularly for the beds just below the Ramphorn slate or just above a parting slate in the dolomite about 120 feet below the Ramphorn contact. No fluor spar has yet been found entirely within the volcanic rocks, but does occur in a fissure with a footwall of dolomite and hanging wall of altered volcanic rock.

The fluor spar is widely distributed in the dolomitic rocks along the Bayhorse anticline and in the areas of dolomite adjacent to the anticline, with concentrations appearing sporadically all the way from the old town of Bayhorse to the last exposure of dolomite on Mill Creek nearly 8 miles to the north. The most notable concentration of fluor spar deposits appears to be on Keystone Mountain with the deposits there larger and more numerous than elsewhere; but other important concentrations also occur in and on the ridges bordering Daugherty Gulch, in the dolomite faulted against the Bayhorse anticline just north of the mouth of Daugherty Gulch, and at the Pacific and some of the adjoining mines near the town of Bayhorse. Weak fluor spar mineralization is also expressed in the dolomitic rocks elsewhere along the anticline, in the small block of faulted dolomite in Big Hill Gulch, and in the dolomitic rocks at and near Mill Creek. The fluor spar appears to occur sparingly in almost every exposure of dolomite, but at and near the lodes in garnet dolomite only where the dolomite has been appreciably brecciated or fissured.

STRUCTURAL RELATIONS

The fluor spar deposits have varied structural relations and are in part fault controlled and in part controlled by the structure which may in part have formed concomitantly with the folding. The fissure veins and breccia lodes are all fault controlled and are localized along faults and fault zones of relatively minor magnitude, contained wholly within the dolomite and bearing in general northerly directions. These mineralized faults and fault zones are too few as yet to establish a definite pattern, but most of them trend N.15°-20°W., and N. 90°E., with some trending N.30°-40°E. Except for some relatively flat bedding faults, they all dip steeply, most of them 70°-80°E., some steeply west. Except for the Past Up vein at the Chalspar No. 1, the direction and amount of displacement on the faults still remains to be determined. The fault that controls the Past Up vein shows considerable curvature with the strike changing from N.30°W. to N.15°W. and the dip from steeply southwest to steeply northeast. Slickenlines present along the faults show essentially horizontal grooves and afford evidence of marked horizontal displacement, but no clue has yet been found as to the amount of movement. The displacement may be considerable, for volcanic rocks have locally been brought against the Bayhorse dolomite and the dolomite against a slice of Ramphorn slate. Along some of the faults just simple fissures were produced, but along others the breccia shows also considerably brecciated, forming in places very porous breccias. Such breccias all were highly favorable to fluor spar deposition.

The boxwork deposits appear to be controlled by zones of brecciation which may in part represent structural adjustments to folding. These deposits tend to keep close to the contact of the Ramphorn, generally within a hundred feet or so of the top of the dolomite or in close proximity of a thin slate member (parting slate) some 100 to 200 feet below the contact. These mineralized breccias tend to parallel the contact and their localization appears to be more or less definitely controlled by the contact. The individual breccia zones may be several tens of feet wide and up to several hundred feet long, but the depth to which they extend can be learned only from underground exploration. The breccias show evidence of no great movement, but do show much cracking of the rock and an apparent independence of major fissuring. Probably the greater competency of the dolomite as compared with the slate was instrumental in causing the brecciation with the contact between the two formations tending to localize the structural deformation and failure. In any event the dolomite brecciated when subjected to deformation, whatever may have been the nature of the deforming stresses.

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* A little fluorite is reported in the phylite at the Hoosier mine near Bayhorse.
MINERALOGY

General Features

The fluor spar deposits contain few minerals other than fluorite and these few are represented in places by only trivial amounts of quartz and calcite. Some of the deposits do contain some grains and small masses of sulfides and quartz as fragmental inclusions incorporated from earlier base-metal or quartz fillings, but these inclusions are foreign to the fluor spar mineralization. The chief gangue of the fluor spar deposits is the fragmented dolomite contained as breccia fragments in the fluor spar fillings.

Although quartz is conspicuous in the vicinity of some of the fluor spar deposits, in places forming huge ledges of silicified dolomite, it appears to be more closely associated with the base-metal rather than with the fluor spar mineralization and composes the chief gangue of some of the base-metal lodes. Such quartz is milky white and occurs as a replacement of the fractured dolomite, and locally the bordering phyllite or slate. The fluor spar may occur in the fractured dolomite along side the bodies of quartz but never in the quartz itself. Such quartz forms an enormous body on Keystone Mountain adjacent to the area of fluor spar mineralization and forms very prominent ledges on the east end of the high ridge north of Daugherty Gulch (Pl. 1-A).

Minerals Associated With The Fluorspar

Quartz

The quartz deposited with the fluor spar is very sporadic in its distribution and in most deposits is present very sparingly. It was rarely observed along the fissure and breccia veins and lodes, although in places it forms a thin inconspicuous layer beneath the fluorite. Its presence is more evident in the boxwork breccias where it forms very thin partitions between boxwork cells, always with a coating of small fluorite crystals.

Fluorite

The fluorite seems to occur wherever the dolomite has been fractured and is to be found more or less sparingly through almost every outcrop, but the important concentrations are in the structurally favorable areas of more extensively fissured and brecciated rock.

The fluorite shows some variation in its textural and structural characteristics, depending largely on the completeness of the fissure and breccia filling. In the filled fissures and breccias the fluorite is quite massive and rather coarsely grained. Any unfilled openings, however, are generally lined with small cubic crystals. The fluorite filling may show inconspicuous banding and in some of the smaller fissures crystalization parallel to the walls. It may also form poorly defined concentric bands around breccia fragments. Some of the fluorite has itself been brecciated and cemented by more fluorite. As filling is generally incomplete, the fluorite shows a marked tendency to develop crystal form and much of the filling, especially of the open breccias, consists of crystals and crystal aggregates coating the surface of the breccia fragments and the fracture walls (Pl. 2-A). In the boxwork deposits the small crystals occur as coatings on the walls of the paper-thin partitions of silica which in general are joined in such a way as to affect a striking celadon-like structure (Pl. 2-B).

The fluorite has some fairly distinctive characteristics. Its crystals are invariably small with none more than 0.8 inch square and with few more than 0.4 inch. On the boxwork partitions the crystals rarely exceed 0.1 inch. In most of the breccias the range is between 0.1 and 0.4 inch. The crystals are always cubic with no modifications and are invariably white or colorless. Some of the crystals are actually transparent. Even the massive fluorite is dominantly white or colorless, but it does in places show rather inconspicuous tints of gray, rose, purple, and green.

Calcite

Calcite was noted only at the West vein on the Chal spar No. 1 where it formed small flat crystal rhombs on the surface of some of the fluorite crystals. It was not observed elsewhere, but because of the ease with which it disappears in the zone of weathering, it could be present in other deposits and could be more abundant than the present exposed outcrops seem to indicate.

Paragenesis

The paragenesis of the fluor spar deposits is quite simple. Disregarding the minerals inherited from the earlier base-metal fillings, the mineral succession appears to be quartz, fluorite, and calcite. In many of the deposits, however, the quartz and calcite seem to be lacking and the succession consists of fluorite alone.

DISTRIBUTION OF THE FLUORSPAR

From what little is known of the fluor spar mineralization, the fluor spar may be expected to have a rather erratic and sporadic distribution along the fissure and breccia zones. This bunchy distribution has been partly verified underground at the Past Up vein, where the filling swells and pinches quite abruptly on strike and dip with the mineable shoots confined to lengths of a few tens of feet. On the other hand, the vein at the Chal spar No. 2 appears to be persistently and quite uniformly mineralized for some hundreds of feet. The breccia deposits show some irregularity in the distribution of the fluor spar, but this irregularity should not greatly affect the overall tenor of the deposits. Such irregularity as may appear along the outcrop may also be expected to characterize the deposits with depth. The distribution of the fluorite is dependent largely, if not entirely on favorable structural openings, the extent of which is as yet unpredictable.

SIZE

The fluor spar deposits show a considerable range in size. The fissure veins and lodes may range from those but a few inches thick and a few tens of feet long to those which are several feet thick and several hundred feet long. The only productive vein to date, the Past Up on the Chal spar No. 1, has been exposed for about 200 feet and has been mined on the surface for about 100 feet. For much of its length the vein is a few inches to several feet thick but, where stoped, is 3 to 4 feet and in places as much as 7 feet thick. The West vein nearby may be traced for about 300 feet and shows a thickness ranging from 1 to 5 feet. The long-
A. CRYSTAL FLUORSPAR
Crystal coatings are typical of much of the fluor spar in the breccia deposits and occur as druses in all deposits where filling has been incomplete.

B. BOXWORK FLUORSPAR
Typical "Boxwork" structure found in many of the breccia deposits. After fragments of the brecciated dolomite had received a thin coating of silica, the dolomite was dissolved, leaving the silica partitions which were then coated by small crystals of fluorite.
Figure 3. Topographic and geologic map of the Chalspar No. 1 area.

August 1923.
est and most persistently mineralized vein is the one on the Chalspar No. 2 group. This fissure-breccia vein has been exploited for about 100 feet and for much of its length is 12 to 18 feet thick.

The breccia deposits are quite variable as to size. Those on Keystone Mountain measure from a few feet up to 30 feet across with most of them between 20 and 30 feet. Those that outcrop boldly on the surface may be traced for a hundred feet or more. The breccia deposit in Daugherty Gulch has been exposed for about 200 feet. This deposit is about 30 feet across with some 5 feet composed essentially of massive fluor spar. The dolomite above the breccia deposit also contains appreciable quantities of fluorite through a zone at least 100 feet thick. Although surface exposures of many deposits seem adequately large for commercial exploitation, the depth to which the deposits extend will not be known until some work is carried on underground.

TENOR

Data on the tenor of the deposits are scanty. The fluor spar shipped as metallurgical spar from the Past Up vein on the Chalpar No. 1 contained 88 percent CaF₂ and that sent to the mill contained 55 percent CaF₂. Samples across the vein on the Chalspar No. 2 showed 13 feet of 61.1 percent CaF₂ on the crest of the ridge and 14 feet of 57.1 percent CaF₂ in a channel on the hanging wall side. A 12-foot sample in a cut about 200 feet slope distance down the south side of the ridge contained 69.7 percent CaF₂. The high tenor of this outcrop material may reflect in part surface enrichment through solution-weathering of some of the incorporated breccia fragments of dolomite. On the Chalspar No. 6 a 17-foot channel showed 40 percent CaF₂ and an 8-foot channel, 44 percent CaF₂.

According to Chambers¹¹ some of the exposed boxwork deposits on Keystone Mountain contain from 30 to 60 percent CaF₂ across sample widths of 18 to 30 feet, with the average between 40 and 50 percent CaF₂. On Keystone Mountain and elsewhere in the vast tonnage of fluor spar in deposits which probably carry 20 to 30 percent CaF₂. On Mill Creek there is a huge tonnage of rock that may carry 10 to 20 percent CaF₂.

GENESIS

The fluorite must have been introduced into the fissured and brecciated dolomite by solutions which probably originated in some deep magmatic source, perhaps the source that supplied the materials of the Challis volcanics. This source may have been a fairly basic magma, generated perhaps in the basic subcrust, and the lime-fluorine-bearing fluids may have escaped after prolonged magmatic differentiation had affected their concentration within the magma. The fluids probably escaped at a high temperature; but deposition of fluorite did not take place until the fluids reached the abundant openings high in the crust and not until they had become comparatively cool, reduced perhaps to warm aqueous solutions.

The fluorite-bearing solutions spread widely through the fractured dolomite and in places of exceptional fissuring and brecciation left considerable concentrations of fluorite, deposited largely as a filling of the fissuring and partial filling of the breccia openings. Because of general incomplete filling, the deposits show unusual crystal development with abundant crystal crusts and druses. The deposits also show interesting textural and structural features, among them the boxwork structures. These boxwork structures are developed only in the brecciated dolomite and only where the breccia fragments received a thin coating of quartz. Apparently before the fluorite was introduced, the dolomite was removed in solution leaving the quartz behind as a cast of the dolomite fragments. These thin partitions of quartz were then coated by small crystals of fluorite, thus preserving the cellular or boxwork structure produced by leaching of the brecciated dolomite.

The channels for the circulation of the fluorite-bearing solutions were largely independent of those which directed the earlier quartz-sulfide mineralization. Some of the channels were along side the older ones, but many were some distance away. In a few places the latter did invade the earlier base-metal fillings. The relations are such as to suggest that structural movements that preceded the introduction of the fluorite-bearing solutions found the earlier lines and zones of weakness too strongly reinforced by the earlier quartz and could not in general reopen the channels that had accommodated the base-metal mineralization. As the quartz-reinforced rock tended to resist refracting, the fluorite-bearing fluids were forced to take up the deformation and failed by fissuring and brecciation.

As fluorite was introduced into a fissure with Challis volcanics as a part of the hanging wall (Past Up vein), the age of the fluorite is post-Challis and hence probably the same age as the fluorite at Meyers Cove where some of the deposits are entirely within the Challis volcanics. As at Meyers Cove, the fluorite mineralization is apparently of Miocene age.

OUTLOOK

The district appears to have an exceptional concentration of fluorite and may indeed have one of the most important, if not the most important, concentrations of its kind within the State. The surface exposures show unusual promise, but it will take underground exploration to determine whether the deposits will measure up to present expectations. The exploration has been too limited as yet to reveal the behavior of the fluorite mineralization with depth.

The distribution of the fluorite appears entirely dependent on the location of structurally favorable fissures and breccia zones within the Bayhorse dolomite. The much fractured and faulted Bayhorse anticline apparently provided an ideal structural setting for the fluorite deposits, with especially favorable sites on Keystone Mountain and in and near Daugherty Gulch. The mineralization is not restricted to these sites, however, and fluorite deposits occur elsewhere along the anticline and in faulted segments of dolomite off the anticline. Such deposits are known near Bayhorse and in the faulted dolomite north of the mouth of Daugherty Gulch. The district appears to offer a fruitful field for search and exploration.
MINES AND PROSPECTS
CHALSPAR PROPERTY

The Chalspar property comprises holdings of J. R. Simplot Company in and near Daugherty Gulch. These holdings consist of two groups of claims, a lower group of 9 claims on the dolomite below the mouth of Daugherty Gulch and an upper group of 20 claims in and on both sides of Daugherty Gulch. The first holdings were acquired in 1952 and then added to by discovery and staking during the late spring and summer of 1953. The exploratory and development work to date has been centered on the Chalspar No. 1, Chalspar No. 2, Chalspar No. 5, Westpar, and Troxpar claims (Fig. 2).

Chalspar No. 1

History and Development

The Chalspar No. 1 is in the lower group of claims which covers the dolomite exposure north of the mouth of Daugherty Gulch (Fig. 2). The location was made in the early fifties and acquired by J. R. Simplot Company in 1952. The holdings contain two veins, one known as the Past Up and the other as the West main (Fig. 3). The first work was on the Past Up and consisted of extensive bulldozer stripping, followed by open cutting, and then underground by shaft and drifts, with most of the surface work in 1952 and the underground work in 1953. Work was also carried on in 1953 with the diamond drill. Exclusive of the surface work, the total development on the Past Up vein consists of a 65-foot shaft with a short drift on the 50-foot level, some stopes to the surface, and 1232 feet of core drilling in six holes, all driven into the hanging wall of the vein from the surface (Figs. 4 and 5). The West vein received some attention in 1952, but most of the work, chiefly stripping with the bulldozer and trenching along the outcrop with a sluisher, was done in 1953. The only production to date has been from the Past Up and includes 475 tons of metallurgical-grade spar (88 percent CaF₂), shipped as mined, and 245 tons of milling spar (55 percent CaF₂).

Geologic Features

The Chalspar No. 1 is in the synclinal block of Bayhorse dolomite faulted against the east flank of the Bayhorse anticline (Figs. 2 and 3). The dolomite has barely lost its cover of Challis volcanics and in places still retains thin patches of the volcanic rocks, mainly where infaulted in the dolomite. The patches are mainly covered by wash and have in part been revealed by surface stripping. The volcanics locally apparently accumulated on an uneven surface much like the present with the remnants in part marking the lower spots on the pre-volcanic erosion surface. The beds of dolomite dip gently west and have not been seriously displaced by a series of northerly trending faults, mainly of rather minor magnitude. A thin cover of Ramshorn slate overlies the uppermost exposure of dolomite and some infaulted slate also occurs in the dolomite lower on the ridge. The Ramshorn conglomerate is missing.

The two veins occupy fault fissures of somewhat dissimilar structural characteristics. The Past Up vein strikes in a northwesterly direction along a course that changes from N.30°W. to N.10°W. and with a dip that changes from steeply southwest to about 80°NE. The Past Up vein apparently occupies a fault fissure of strike-slip origin, for grooves on slickensided surfaces along the south end of the vein dip 20°SE. and along the north end, about 10°E. This fault was active after as well as before mineralization.

The West vein on the other hand strikes N.30°E. and dips 65°SE. The nature of the faulting that controls the West vein is not clear. There appears to have been little movement along the fault after mineralization.

Past Up vein—The Past Up vein has been exposed on the surface for about 200 feet and below the surface for a much shorter distance. It shows a range of thickness from a few inches up to a maximum of 7 feet, averaging 3 to 4 feet in the stopes. The vein filling has been considerably shattered by post mineral-faulting and in places has been reduced to a granular sand. As revealed by the underground work, the fault which produces the fissure carried volcanics against dolomite and dolomite against slate, so that the hanging wall is in part altered volcanics and the football in part slate (Fig. 5). Holes Nos. 1, 2, and 3 drilled to intersect the vein at points 30 feet and 180 feet north of the shaft passed through an appreciable thickness of volcanics before entering the dolomite (Fig. 4). South of the shaft the hanging wall is wholly dolomite, but the footwall is slate, apparently an infaulted block of the Ramshorn (Fig. 5). The vein is not so wide against the slate as it is when entirely within the dolomite.

The fluor spar appears to have a rather sporadic distribution along the fault and forms bodies which may pinch and swell quite abruptly. Although the north end of the vein shows considerable promise on the surface, no significant mineralization was uncovered in Hole 1 drilled to intersect the vein 30 feet north of the shaft nor in Holes 2 and 3 drilled at 180 feet. On the other hand, Hole 5 encountered a highly mineralized zone with fluor spar exposed for 40 feet and estimated to contain about 70 percent CaF₂ for a length of 30 feet. But Hole No. 6, drilled from the same station as the No. 5 and at such an angle as to intersect the fluor spar zone 40 feet above the No. 5, penetrated only a foot of massive fluorite together with an indeterminate amount of gouge. Apparently Hole No. 5 either penetrated a large bunch or pocket of fluor spar which terminated upward short of the No. 6 hole or was driven along a vein of mineralized zone of about the same dip as the drill hole. Hole No. 4 which lies to the south of Holes 5 and 6, exposes fluor spar only on the projected dip of the vein (Fig. 4). Apparently commercial fluor spar would have to occur within a strike distance of less than 90 feet (the distance between Holes 1 and 5).

The fluor spar in the Past Up vein is mainly coarse, massive, but some does occur as crystals in small scattered druses. A very little of the fluorite occurs in the cryptocrystalline form, but some is interbanded with the more coarsely crystalline variety. Most of the fluorite in the vein is white, but in places it does show a faint coloring, mainly in pale shades of green and purple. The fluor spar filling holds some scattered breccia fragments of the dolomite. Some of the fluorite has itself been brecciated and cemented by more fluorite.
Figure 5. Underground workings on the Past Up vein.
West vein.—The West vein has been uncovered almost continuously for about 500 feet. It is mostly 12 to 18 inches thick near the top of the ridge but thickens down slope and is about 3 feet thick in the face of the cut made along the outcrop (Fig. 4). In places its thickness increases to 5 feet. The vein has been little disturbed by post-mineral movement and the filling, therefore, has not been broken up as it has in the Past Up vein. Both walls are in dolomite. The fluor spar resembles that in the Past Up vein. The filling of the fissure has been nearly complete and few drussy openings remain. The filling has incorporated some fragments of the brecciated dolomite.

The economic merit of the West as well as of the Past Up vein can be determined only by underground exploration. The long cut on the West vein appears to have uncovered a sizable body of fluor spar of considerable size more than 80 feet long, perhaps equal in size to the one in the Past Up.

Chalcopyrite No. 2

The Chalcopyrite No. 2 straddles the high ridge north of Daughtery Gulch far up the west flank of the Bayhorse anticline (Fig. 2). The location was made in the late Spring of 1955 and was subsequently explored by stripping the crest of the ridge and by bulldozer trenching on the slopes below (Fig. 6).

The site of fluor spar mineralization is a hundred feet or so from the dolomite-conglomerate contact and equally as far from some of the heavily silicified ledges of dolomite farther east on the ridge. The fluor spar exposed by the stripping and trenching operations is along a well-defined zone of fissuring and breccia which has been bared here and there for about 1,000 feet. This zone strikes about N.20°W. and from the relationship to the topography must dip steeply southwest. The zone is fairly broad and for much of the distance measures up to 18 or 20 feet across. The fluor spar seems to be well distributed along the fissure-breccia zone, and, except for a relatively narrow parting of breccia, is quite continuous. Samples taken across the zone in the stripped and trench areas commonly show more than 60 percent CaF₂. As pointed out elsewhere, a 13-foot channel on the crest of the ridge actually showed 67.1 percent CaF₂ and a 14-foot channel on the hanging wall side showed 67.1 percent CaF₂. A sample across 12 feet of the vein along a cut 200 feet slope distance on the south side of the ridge contained 65.7 percent CaF₂.

The filling along the fissure-breccia zone seems quite complete and the fluorite shows only minor druse development. The fluorite surrounds fragments of dolomite, some of which are more than a foot in diameter, and otherwise fills most of the fracture and breccia openings. The fluorite is accompanied by a minor amount of fine-grained quartz, which lies under the fluorite filling.

The trenching has exposed the fluor spar over a vertical range of about 250 feet. Should the deposit maintain its present steep dip, it should come against the phyllite not far below the present lowest fluorite exposure. Contact with the phyllite would probably mark the bottom of economic mineralization. The deposit appears to be one of the largest in the district and seems to be much more uniformly mineralized than most. It is worthy of exploration by adit drifts from the south slope.

Chalcopyrite No. 5

The Chalcopyrite No. 5 is on the lower end of the ridge that separates the two cirques (Pl. 1-A) at the head of Daughtery Gulch about midway between the Chalcopyrite No. 2 on the ordering ridge to the north and the Westarp on the ordering ridge to the south (Fig. 2). It lies only a short distance from the floor of the gulch and at a considerably lower level than the deposits on the ordering ridges. Like most of the other locations made in 1955, the development work has been done by the bulldozer and consists of two broad and rather long cuts across the lower nurse of the ridge, one cut just above the other.

The Chalcopyrite No. 5 is also in the dolomite rocks on the west flank of the Bayhorse anticline with the most extensive and intensive mineralization well down in the dolomite, apparently not far above the phyllite. The dolomite and the rocks above stand out in bold relief along the end of the ridge, the dolomite particularly so because of some local silicification. Some 200 feet of slate lie between the dolomite and the conglomerate.

The upper part of the dolomite has been more or less extensively fractured and silicified and has had numerous fracture surfaces coated by small crystals of fluorite. Some of these fractures show preferred orientation, the more pronounced ones striking about due north and showing slickensided surfaces with grooves and striations dipping 25°N. These fractures are fairly persistent on the strike and one of them is paralleled by an 8-foot zone of rather abundant fluor spar mineralization with the fluorite as crystals and crystalline crusts on fracture walls. There appears to be some fluorite throughout a hundred feet or more of ledgy matter, but not in commercial concentrations.

The main fluor spar mineralization is in the dolomite below the ledges and has been uncovered by the bulldozer. The fluorite appears to be localized along a broad zone of brecciation and fissuring which has been uncovered along the strike for about 215 feet. This zone trends about N.15°W. and contains fluorite over a width of 30 feet with some lenses of massive fluorite up to 5 feet wide. Samples along a 17-foot channel across the exposure contained 40 percent CaF₂, and a second along an 8-foot channel contained 44 percent CaF₂. The whole zone of mineralization may be mineable selectively, with bodies of high-grade fluor spar occurring at various places. Much of the fluorite is white and in part fairly coarsely crystalline. The dip of the fluor spar body has not been learned. If steep, the body is limited at depth by the phyllite, which is known to be not far below. But if the dip of the body is no steeper than the contact of the dolomite and phyllite, then the body may persist to considerable depth. The deposit has possibilities and is worthy of some underground exploration.

Westarp

The Westarp is on the high ridge south of Daughtery Gulch on the upper west flank of the Bayhorse anti-
cline (Fig. 2). The location was made during the summer of 1983 and was followed by some bulldozing on and below the outcrop.

On this part of the anticline the Bayhorse dolomite, which dips west at a moderate angle, is only about 200 feet thick. The Garden Valley phyllite immediately below has been extensively silicified and rises boldly above the saddle carved in the unaltered phyllite. Silification has also spread from the phyllite into the dolomite and has produced some prominent ledges along the crest of the ridge, especially near the contact of the overlying Ramshorn conglomerate.

The fluor spar is contained in brecciated dolomite near or along side the silicified rock not far under the conglomerate. The fluor spar is in considerable part the boxwork type and is developed along fairly well-defined zones of brecciation. These zones appear to trend N.10°E. and N.40°E., dip steeply northwest, and contain up to 8 feet of high-grade spar, mostly as crustiform crystals (Pl. 2). The boxwork zone may be traced in the outcrop for about 60 feet. Bulldozing on the south side of the ridge just under the fluor spar outcrop has uncovered large blocks or boulders of high-grade fluor spar material weighing perhaps as much as a ton. These boulders are composed largely of crustiform and druse fluorite (Pl. 2).

The fluor spar has apparently been concentrated into rather short but relatively thick bodies. These bodies contain much high-grade material and are worthy of exploration.

Troxspar

The Troxspar is on the same ridge as the Westspar but at the east end of the ridge and on the east flank of the anticline (Fig. 2). Except for a small amount of bulldozing, very little work has been done to uncover the fluor spar, discovered during the summer of 1983.

The fluor spar mineralization is exposed just over the crest of the anticline. Near the phyllite the beds of dolomite dip 35°NE., but the dip steepens on approaching the conglomerate and near the fluor spar deposits is about 55°NE.

Some quartz-sulfide mineralization is exposed around on the south side of the ridge, apparently entirely independent of any fluor spar mineralization. Spars fluor spar float occurs nearby and small seams of fluor spar a few inches thick occur in minor fissures in the dolomite not far away. The main body of fluor spar is apparently on the northeast slope where chunks of fluor spar up to 12 inches thick have been piled below several shallow hand-dug trenches. These chunks consist of float and the source has not been uncovered. The character of the float, however, suggests fissure deposition with crustification parallel to the walls. The fluorite is coarsely crystalline and is rose to pink. It shows greater resemblance to the fluor spar in the Meyers Cove area than does any other of the fluor spar in the district.

HOLTHERMAN PROPERTY

The Holttherman property on the nose of the ridge of faulted dolomite just below the Chalaspar No. 1 (Fig. 2) was located May 4, 1951. The development since has comprised several cuts and a shaft (Fig. 3).

Several small veins are exposed on the property, including a bedded vein in the face of the dolomite cliff and two steeply dipping fissure veins on the ridge just back of the cliffs. The largest vein has been uncovered by cuts and a shaft for a length of 210 feet. This vein strikes N.10°E. and dips 78°-80°SE. It contains up to 12 inches of massive fluor spar at the top of the shaft but the vein pinches with depth and is little more than a narrow stringer in the bottom of the shaft.

The second fissure vein lies a short distance west of the first within and about 65 feet west of the road turn. This vein also strikes N.10°E., but dips 70°W. It measures up to 8 inches thick along its exposed length of 20 feet.

The bedded vein exposed in the face of the cliffs east of the fissure veins is a composite of several thin veins or seams spaced through a zone about 5 feet thick. This zone contains thin seams or lenses of fluorite about an inch thick, exceptionally 4 inches thick, with enlargements at or along cross fractures. This composite vein is about 70 feet long and dips gently with the bedding into the cliff. The filling shows crustification with some crystals an inch square. The fluorite apparently occurs along a local zone of bedding plane slits and cross fractures. The fluorspar seams and thin lenses are too widely separated to have much economic interest at the present time.

KEYSTONE PROPERTY

The Keytone property, held by Arthur Chambers, is on the upper north and east slope of Keytone Mountain at the southern edge of the map-area (Fig. 2). It is in part an old property developed and worked for silver in the eighties and intermittently since. Fluorspar was uncovered during the early operations but received no attention until the late forties, when the property was acquired by Mr. Chambers.

The property now consists of 14 unpatented claims located by Mr. Chambers and 4 patented claims held under lease and bond. The development comprises several short adits and stopes along a silver-bearing vein on the northeast side of the mountain, a short adit in fluor spar on the north side of the mountain, and a number of bulldozed excavations made at various other places, primarily to explore the fluor spar deposits. All the working are well up the mountain slope at altitudes of from 7,500 to nearly 9,500 feet and are reached by a steep road with many sharp switchbacks.

The fluor spar deposits are on the gentle, southerly plunging nose of the Bayhorse anticline south of Garden Creek, entirely within the Bayhorse dolomite (Fig. 2). The contact of the dolomite with the overlying Ramshorn slate is arcuate in outline and describes a broad curve across the north slope of the mountain. As the bodies of fluor spar tend to follow the contact, they, too, lie along or describe an arcuate belt.

The fluor spar deposits are distributed along the belt for about 6,000 feet either close to the Ramshorn contact or to a parting slate in the dolomite about 125 feet below the contact. Except along the silver lodes, the fluor spar is contained in breccias and occurs for the most part as breccia lodes. The exposures are scattered but appear to be more or less closely connected by float. Continuity of deposits, however, cannot
be definitely established without drilling or other underground work. The exposed bodies contain from 18 to 30 feet of crystalline and boxwork fluorite composed of 30 to 60 percent CaF₂, mostly as small crystals averaging about 0.25 inch. At one point the fluor spar is along a north-south fault, which also contains a quartz-silver vein. A huge mass of white quartz outcrops on the upper slope of the mountain near the fluor spar deposits; but, although somewhat fractured in places, it contains no fluor spar.

The deposits along with their geologic setting are described in detail in an unpublished report by Arthur Chambers. Suffice to say that the fluor spar deposits are exceptionally numerous on Keystone Mountain and are among the largest and most promising in the district. As elsewhere, underground exploration must be carried on before the deposits can be properly evaluated and estimates made of reserves. Should the breccias continue to parallel the Ramshorn contact along the flanks of the anticline, the fluor spar should have an impressive vertical range; otherwise, the bottom of fluor spar mineralization may be expected against the underlying Garden Valley phyllite.

PACIFIC MINE

The Pacific mine is near the top of the high ridge between Beardsley Gulch and Bayhorse Creek little less than a mile north of the old town of Bayhorse. The mine is an old silver-lead producer and was probably active in the eighties with considerable production during the first decade of the present century and during the years of World War 2 to the present. Fluorspar was not mentioned in the earlier reports and its presence may not have been known until the late war.

The base-metal ore occurs as a replacement of the Bayhorse dolomite and forms podlike bodies along certain beds of the gently rolling, almost horizontal formation. The replaced material is in part a dolomite breccia recemented by quartz with galena occurring here and there as bunches and stringers in the cemented breccia and in silicified dolomite. The fluor spar mineralization appears to be limited to the walls of the quartz-sulfide bodies and rarely penetrates those bodies.

The fluor spar is known in several parts of the mine with one showing in adit 4A just in from the portal, where the walls are composed of fluor spar material reported to contain about 30 percent CaF₂. The fluorite appears to be along fractures under a quartz-sulfide body. The extent of the fluor spar mineralization is not revealed by the limited work in the adit.

Some fluor spar also appears in Adit 6, but the most impressive body is below the level in the Blaine stope about 25 feet above the Blaine 7 level. This body of fluor spar lies under the sulfide ore and is exposed over a height of more than 8 feet. The dimensions of the fluor spar body are not fully known, but the showing is attractive and contains fluorite reported to carry 60 percent CaF₂. The fluor spar is composed largely of small crystal aggregates and probably occurs largely as a filling of an open breccia. Apparently openings for the fluorite were produced by structural movements which found the dolomite beneath the quartz bodies more favorable to breakage than the overlying quartz-sulfide filling.

The deposits appear to be controlled stratigraphically and perhaps structurally by an intercalated slate member about 120 feet below the top of the dolomite. The fluor spar, as well as the quartz-sulfide ore, occurs 30 to 40 feet above the parting slate.

The fluor spar showing at the Pacific mine is worthy of more thorough investigation than it has received.

OTHER DEPOSITS NEAR BAYHORSE

Fluorspar also occurs along the crest of the ridge some distance west of the Pacific and north of the Forest Rose. This fluor spar is exposed along a shallow adit just under a knoll on the crest of the ridge near the contact of the dolomite with the Ramshorn slate. The rock shows rather extensive brecciation and contains much fluor spar of the boxwork type.
Figure 3. Geologic map of the fluor spar area near Challis, Idaho.
Adapted from map by James Humphreys and Clayton Reynolds
Drill data from Company records, 1982

Figure 4. Plan and sections of the West and Post Up veins on Claim No. 3.