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Vein and fault systems of the western San Juan Mountains mineral belt, Colorado

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component of shifting, and by downward slipping of the hanging wall before and during mineralization, forming gouge planes which acted like baffles. These gouge seams divided the open zones into a series of channelways of comparatively low dip, which had a greater horizontal than vertical extent. At places where the vertical zones were not tightly sealed by the limiting gouge planes or baffles, the channels are vertically elongated, and allowed the ore-depositing solutions to rise directly toward the surface.

Under the conditions existing along dike walls and other surfaces of discontinuity that were refissured, the nature and physical properties of the wall rocks had a minimum effect on the fracture systems formed and on the nature of open spaces.

VEIN AND FAULT SYSTEMS OF THE WESTERN SAN JUAN MOUNTAINS MINERAL BELT, COLORADO

By
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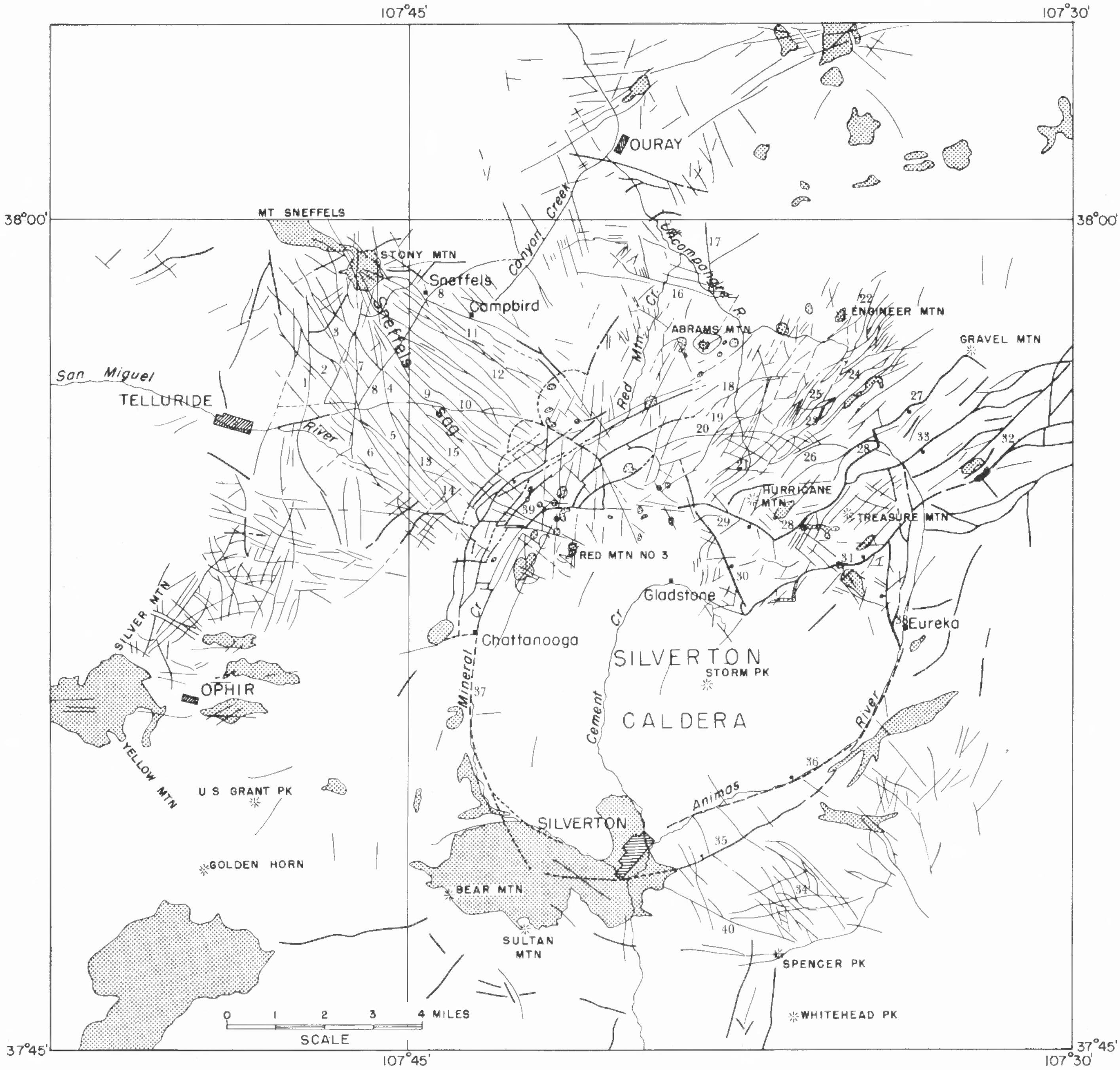
The accompanying Figure 1 shows the principal fracture systems of the central part of the western San Juan Mountains. This is of course, only a partial pattern,owing not only to the scale of the map but also to the fact that some parts of the region have not been mapped as much as others. Nevertheless, the figure does give a fairly complete picture of the trends and types of the principal fractures. Faults, veins, and dikes are shown together with the principal stocks and plugs. Joints or sheeting are exceedingly abundant. Many fractures occupied by dikes or veins are small faults and the principal faults commonly are mineralized at least locally. Most of the faults have no more than a few hundred feet of throw, although one or two may exceed 1,000 feet (Burbank, 1951, p. 291). Most of the veins, dikes, and faults are steeper than 70 degrees, but some, including the so-called "flat" veins dip as low as 45 degrees. The dikes are usually only a few feet thick but in some places may be more than a hundred feet thick. They are 5-6 miles in length in some cases. They are mostly rhyolitic to andesitic in composition and of several ages, although almost always older than the veins. Some of the dikes are breccia injections. Many of the fissure veins are occupied by narrow dikes, but these are commonly much sheared and altered. The early workers in the region either did not notice or paid little attention to these dikes. Burbank (1930, p. 195-200, 206-208; 1933, p. 152-154; and 1941, p. 212-214), however, has mapped and described numerous dikes both in and out of the fissure veins and paid particular attention to the possible relationship between ore, dikes, and structure in several of the mining districts.

The veins of the district are dominated by those of great length, commonly referred to as "persistent" veins. They occur in great numbers and although many are of remarkably uniform strike, others are broadly or locally curved. Local jogging, splitting, and complex echelon linkage are common, but complicated faulting and offsetting of the veins are uncommon. The veins range in width from an inch or so up to 50 feet, and in zones of closely spaced veins may be as much as 150 feet wide. A few veins are nearly 6 miles in length, and single ore shoots along them have in a few places been followed for nearly two miles. Probably the average width of all the veins might be 3-4 feet. Owing to the great relief of the region the veins may be observed to have a vertical range of at least 3-4 thousand feet, and even though some veins have been observed to bottom at the the Precambrian basement, others persist downward and the vertical range of the main veins may be at least as great as their lengths. The large veins are commonly compound and may locally possess complex local breccia structures and ore shoots. Several stages of opening and mineralization may be observed in many veins,and banded and coxcomb structures within them are common. Elsewhere cementation of fault breccia and much replacement of wall rock and early vein matter are present.

The major faulting in the area is marginal to the Silverton caldera and in a zone about three miles wide extending northeastward out of the caldera toward the Lake City "caldera" (see Kelley, fig. 1, in this guidebook). The triangular system of faults bounding the Silverton caldera structure, which is about 8 miles in diameter, has dropped the block 1,500-2,000 feet (fig. 2). The fault system extending northeastward out of the Silverton caldera structure is dominated by the Treasure Mountain graben, which is bounded on the north by the Sunnyside-Cinnamon faults and on the south by the Toltec fault. The volcanic formation are tilted away from the graben on both sides suggesting an arching along the line of the graben before its collapse (Burbank, 1951, p. 295). On the northwest side of the caldera, along Red Mountain Valley, there is a belt of faulting along which grabening (Red Mountain sag) occurred, as well as lowering of the Silverton caldera with respect to the area northwest of the fault



LIST OF PRINCIPAL VEINS AND FAULTS

1. Alleghany vein
2. Dynamo vein
3. Smuggler vein
4. Montana vein
5. Argentine vein
6. Ajax vein
7. Ansborough vein
8. Wheel of Fortune vein
9. Hidden Treasure vein
10. Camp Bird vein
11. Highland Chief vein
12. Yellow Rose vein
13. Tomboy vein
14. Black Bear vein
15. St. Paul vein
16. Dunmore vein
17. Silver Link vein
18. Sylvanite - Forrest vein
19. Alabama vein
20. Silver Star vein
21. Bonanza vein
22. Miner's Bank vein
23. Vermilion vein
24. Ben Butler vein
25. Rip Van Winkle vein
26. Mountain Queen vein
27. Wood Mountain fault
28. Sunnyside vein and fault
29. Ross Basin fault
30. Bonita fault
31. Toltec fault
32. Anaconda fault
33. Cinnamon fault
34. Shenandoah - Dives vein
35. Animas fault
36. Animas River fault
37. Mineral Creek fault?
38. Eureka fault
39. Red Mountain fault belt and sag
40. Silverton Gulch vein

Generalized geology from Silverton, Ouray, and Telluride folios and from local surveys by Burbank, Kelley, Vhay, and others.

Figure 1. Index map of the mineral belt of the western San Juan Mountains showing the fracture systems, veins, dikes (thin), and faults (thick), and principal stocks and plugs. Modified from Burbank (1930, 1941, 1951), Cross, et al. (1907), and Kelley (1946).

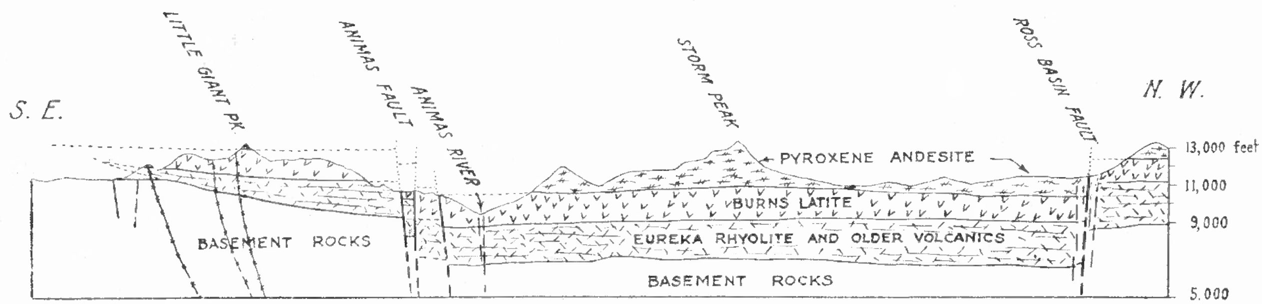


Figure 2. Structure section across the Silverton caldera (From Burbank, 1933).

belt possibly as much as 2,000 feet (Burbank, 1941, p. 162; pl. 2). In addition to the original faulting, however, Burbank (1941, p. 164-166) has postulated that much sagging along Red Mountain Valley, south of Ironton Flats, is the result of rock alteration by igneous emanations, and consequent shearing and slump that were subsequent to the main period of step-faulting into the caldera.

The early work in the region (Ransome, 1901, p. 63-66) emphasized the dominance of northwesterly and northeasterly trending faults and veins, and concluded that the "effective stress producing the principal fissuring", at least in the Silverton quadrangle, was oriented north-south but this stress was chiefly generated "by slight vertical movements following the enormous transfer, in Tertiary time, of volcanic material" from depth. Burbank (1933, p. 174-181), on the other hand, after deciphering the Silverton caldera structure, concluded that the fracture system outside the caldera consisted of two significant types: (1) radial to the caldera structure, and (2) concentric to it. Both types he believed showed close genetic relationships to the caldera. He ventured that the remarkable symmetry of the structural pattern was the result of some comparatively simple and systematic failure of the crust "probably generated by the upthrusting of igneous bodies and by gravitative adjustments that followed their upward surge". Since the radial fractures are followed by dikes that are truncated by the concentric bounding faults of the Silverton caldera center, they were formed prior to the collapse. In addition to the bounding faults about the Silverton center there are other concentric fractures some distance away which dip steeply toward the caldera, such as the Wheel of Fortune to the northwest, the Silver Star to the north, and near Spencer Peak to the south. A dike, presumably younger, occurs in the Wheel of Fortune fissure. Later Burbank (1941, p. 157-161), in an analysis of the structure northwest of the caldera between Red Mountain and Mount Sneffels, noted a similar but smaller scale arrangement of fracture systems about the Stony Mountain stock. In addition to the radial and concentric fractures there was noted a spiral cone-sheet type of fracture branching from the Stony stock. The Camp Bird vein bears a similar relation to the Silverton center. Between Stony Mountain and the Silverton center lie the greatest veins of the San Juan region and the interplay of the stresses attendant upon these two centers of igneous actions undoubtedly contributed to the persistence and abundance of the fault fissures and the veins. Figure 1 shows the interpenetration of the system south of the Stony center. Burbank (1941, p. 217-220) also called attention to the presence of an incipient sag nearly parallel to the great radial veins and termed this the Sneffels axis of sagging. The total depth of the sag is 200-500 feet in a width of about six miles. Curiously the fissure veins crossed by the sag (Burbank, 1941, fig. 8) dip outward on either side of the axis and since the fissures are small normal faults their geometric effect is to diminish the depth of the sag. Burbank presented a rather astute analysis of the mechanics of the sag formation involving evidence from several veins and other fracture sets, but the situation is not without other interpretations.

The Silverton caldera structure appears without much doubt to have exerted the dominant control upon the fracture pattern of the area, but outlying igneous centers such as the Cow Creek center northeast of Ouray, the Mount Wilson center west of Ophir, and the Stony Mountain center have exerted additional, although more local, effects. Future detailed mapping in the southern part of the Silverton caldera and in the southwestern sector outside the Silverton structure will add much to the final interpretation of the fracture systems. In conclusion it may be pointed out that, although igneous actions and induced stresses from the Silverton center may have produced roughly radial and concentric fractures of principal importance, the overall structure is far from symmetrical. Among the asymmetrical features are the structure of the basement, the distribution of plugs and stocks, and the distribution of the volcanic and sedimentary rocks around the Silverton structure. Also the throw along the bounding faults differs considerably from place to place. All this of necessity most likely resulted in the observed variations of the fracture systems within the caldera structure and in the several surrounding sectors.

THE IDARADO MINE

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INTRODUCTION

The Idarado mine lies beneath the high ridge between Red Mountain Valley and Telluride, and is in both San Miguel and Ouray Counties, Colorado. The mine contains more than 80 miles of interconnected drifts or crosscuts on or connecting the Ajax-Smuggler, Tomboy, Liberty Bell, Alamo, Virginius, Pandora, Flat, Japan, Flora, Cross, Ansborough, Handicap, Barstow, Montana-Argentine, and Black Bear veins. Approximately 100,000 feet of drifts and 37,000 feet of crosscuts are accessible, and are mostly on the Montana-Argentine and Black Bear veins and Ajax section of the Ajax-Smuggler vein. Present operations are confined to the Black Bear and Montana-Argentine veins; therefore the description is limited to them.

Access to the mine (fig. 1) is through either the Treasury tunnel, whose portal is below Red Mountain Pass on U. S. Highway 550 at an altitude of 10,600 feet, or the Mill Level tunnel entrance 2 miles east of Telluride, Colorado, at an altitude of 9,060 feet. The Treasury tunnel intersects the Black Bear vein 8,670 feet from the portal, and the Mill Level tunnel intersects the Argentine vein 7,150 feet from the portal. Mining is by shrinkage stoping from slusher sublevels. The size of the stope blocks varies somewhat, but the standard size is 220-250 feet long and 200-250 feet high. The mine ranks either first or second in Colorado in yearly production of gold, silver, copper, lead, and zinc.

It is 6 miles from the Red Mountain plant to the Pandora plant, via interconnecting drifts and raises. There are engineering offices at both plants as a matter of convenience. The Red Mountain plant includes the company general offices, warehouse, carpenter and machine shops, and mine change-room. The Pandora plant consists of the mill and assay office, machine shops, and mine change-room. The flotation mill has a capacity of 1,800 tons perday, making a bullion product and separate concentrates of lead, copper, and zinc.

History of the Mine

The Montana-Argentine vein was first extensively worked by the Tomboy Gold Mines Co., Ltd, a British concern. This company mined the stoped areas above the Ophir level between 1910 and the late 1920's and most of the stoped areas above the 2,100 level between 1900 and the late 1920's. Gold was the principal ore metal mined.

The area between the Revenue and Ophir levels was mined chiefly by the Revenue Mines Co. between 1900 and 1910. The ore was worked from the Revenue tunnel, which portals in Canyon Creek. Gold and silver were the chief metals recovered.

The stopes between the 1,700 and Revenue levels, as well as some higher stopes, were mined by Telluride Mines Inc. during the 1940's. The Mill Level tunnel was driven by that company in 1945-1948. Lead and zinc then became economically more important than the precious metals. In 1953, Idarado purchased Telluride Mines, which was merged with the parent company in 1956.

The Black Bear vein was first extensively worked by the Black Bear Mining Co. in the 1900's and by the Colorado Superior Mining Co. from about 1914 until snowslides at the mine camp (altitude 12,300 feet) terminated the company's operations in 1924. Leasers operated at intervals until 1934. The Treasury tunnel, formerly the Hammond tunnel, had been started before 1900 and reached the 5,400-foot mark early in the 1900's, at which time activity lagged until the late 1930's. In the early 1940's, Idarado extended the Treasury tunnel (from its heading at 5,400 feet) to the Black Bear vein and established a raise connection with the 600 level, the lowest level in the old mine.

Since completion of initial work in the mid-1940's, systematic development of the mine, both in the driving of new headings and the utilization of older openings, has resulted in the present extensive network of workings.

Acknowledgments

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