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PAMPHLET

# MINERAL RESOURCE POTENTIAL OF THE OH-BE-JOYFUL WILDERNESS STUDY AREA, GUNNISON COUNTY, COLORADO

By

**Steve Ludington, U. S. Geological Survey,**

**and**

**Clarence E. Ellis, U. S. Bureau of Mines**

## STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, the U. S. Geological Survey and the U. S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness", "wild", or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report presents the results of a geological and mineral survey of the Oh-Be-Joyful Wilderness Study Area in the Gunnison National Forest, Gunnison County, Colorado. The Oh-Be Joyful Wilderness Study Area was established by Public Law 96-560, December 22, 1980; the area had been classified as non-wilderness by the Second Roadless Area Review and Evaluation (RARE II) by the U. S. Forest Service, January 1979.

## MINERAL RESOURCE POTENTIAL SUMMARY

Two areas immediately southeast of the Oh-Be-Joyful Wilderness Study Area contain resources of molybdenum. Another locality, partly within the study area along the eastern boundary, contains molybdenum mineralization of unknown extent at depth. These three areas have high mineral resource potential for molybdenum in stockwork deposits. In addition, the northwestern part and most of the eastern half of the study area have moderate mineral resource potential for molybdenum in stockwork deposits. Three areas that are entirely or partly within the study area, two of which contain resources of silver, zinc, and lead, have high mineral resource potential for those commodities. Also, the western part and a small area in the southern part of the study area have moderate mineral resource potential for silver, zinc, and lead. More than half the study area contains inferred coal resources and has high mineral resource potential for coal.

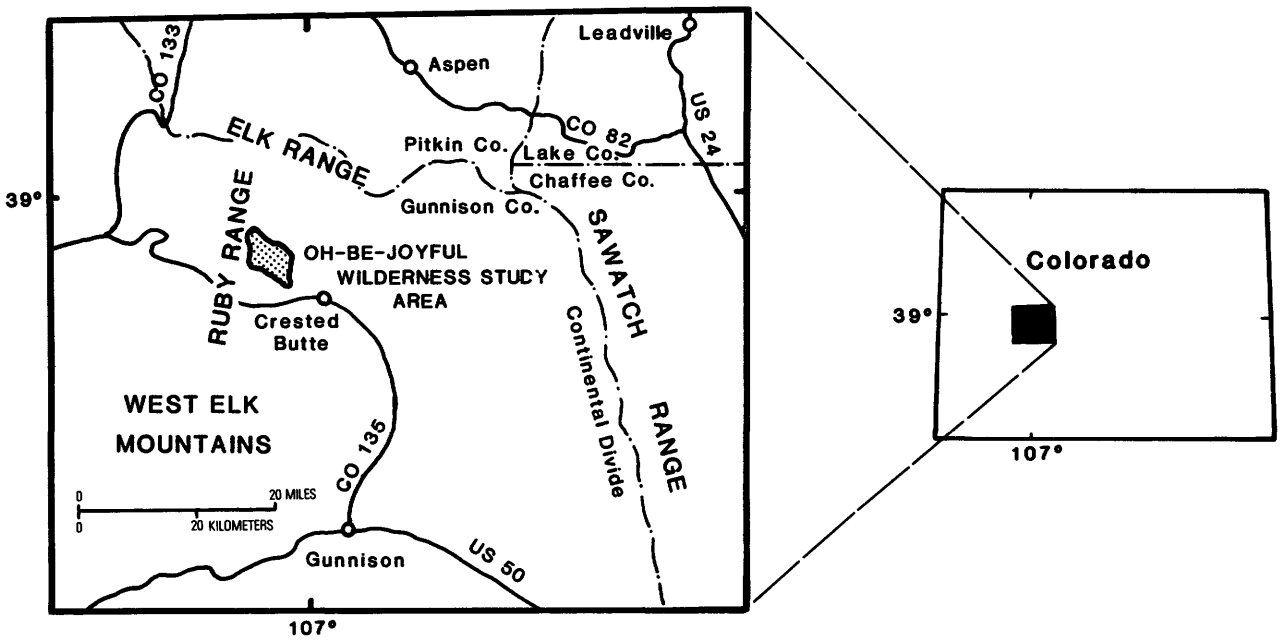
## LOCATION AND ACCESS

The Oh-Be-Joyful Wilderness Study Area, located in central Colorado, covers about 5,500 acres (22 $km^2$) of the Gunnison National Forest in Gunnison County, Colorado. The center of the area is about 4 mi (6 km) northwest of Crested Butte and about 25 mi (40 km) north-northwest of Gunnison. This mountainous area is drained by the upper part of Oh-Be-Joyful Creek and its tributaries, and is bounded on the west by the crest of the Ruby Range, the highest point of which is Afley Peak, 12,646 ft (3855 m). The lowest point in the study area is about 9700 ft (2960 m), where Oh-Be-Joyful Creek emerges from it. Access can be made via good jeep roads on the south from Lake Irwin and on the north from Poverty Gulch, as well as via a jeep road up Oh-Be-Joyful Creek that traverses most of the study area.

## GEOLOGIC SETTING

The study area lies on the east flank of the Ruby Range, a high, north-south-trending ridge that connects the Elk Range and the West Elk Mountains (index map). It is separated on the east from the Sawatch Range by Taylor Park, a large intermontane basin. The west flank of the Ruby Range adjoins the Colorado Plateau.

The study area is underlain primarily by Cretaceous and Tertiary sedimentary rocks that are cut by a complex series of Oligocene and Miocene intrusive rocks, ranging in composition from diorite to granite. The oldest exposed rocks are the upper part




INDEX MAP SHOWING LOCATION OF STUDY AREA

of the Mancos Shale. This is overlain by the Mesaverde Formation, a series of alternating sandstones, shales, and conglomerates. The shaly portion of the Mesaverde contains six known coal beds up to 3 ft (1 m) thick in the study area (Gaskill and others, 1967). The overlying lower Tertiary Wasatch Formation consists of shales, marine and continental sandstones, and conglomerates. The units above the Mancos, possibly because they are more brittle and will support open fractures, have been host to most of the epithermal sulfide veins in the area.

The Tertiary intrusive rocks are of two distinct suites. The older, of Oligocene age, is primarily of intermediate composition, ranging in silica content from 64 to 68 percent (Mutschler and others, 1981). These rocks generally have fine-grained, hypabyssal textures and occur chiefly as a group of stocks and dikes that form the core of the Ruby Range. They also form a volumetrically less important series of sills that crop out throughout the study area.

The younger suite of rocks is expressed at the surface only by a felsite plug and associated dikes in Redwell Basin, immediately southeast of the study area, and at depth by a series of granites and granite porphyries (Dowsett and others, 1981; Thomas and Galey, 1982). The granites contain more than 70 percent silica (Mutschler and others, 1981) and are the source of the Redwell Basin and Mt. Emmons stockwork molybdenite deposits (fig. 1. on accompanying map).

Compilation of a structure contour map of the base of the Mesaverde Formation in the central part of the study area reveals a dome with about 200 ft (61 m) of closure (fig. 1 on accompanying map). Similar doming is present, though more difficult to demonstrate at the map scale, over the Mt. Emmons and Redwell Basin molybdenite deposits (Dowsett and others, 1981). The dome in the central part of the study area may lie above another concealed granitic intrusion.

The study area is broken by numerous normal faults that trend primarily northeast and northwest. Some of the faults are mineralized and contain epithermal vein deposits, and some contain intermediate-composition dikes; the faults are generally of small displacement.

## MINES AND PROSPECTS

### Mining Activity

The Oh-Be-Joyful Wilderness Study Area adjoins the northern edge of the Crested Butte coal mining district and is entirely within the Ruby mining district. A subdistrict of the Ruby, the Irwin silver district, is centered about 1 mi (1.6 km) southwest of the study area. Mining began in the region in 1874 in the Irwin district, when it was still part of the Ute Indian Reservation. The Ruby Chief and Bullion King mines, followed by the Forest Queen and Ruby King mines, were the district's principal early producers. In 1882 a snowslide shut down the Ruby Chief mine and another slide in 1884 wiped out the Bullion King, which was never reopened. By 1890, the silver-mining era of the Irwin district had ended: low silver prices, snowslides, underground flooding, and, in some mines, ore depletion, were the causes. The Forest Queen mine continued to operate sporadically, reaching $1 million in production by 1915 (Socolow, 1955). Other production figures for the early period are unavailable or incomplete.

In the Ruby district just north of the Oh-Be-Joyful Wilderness Study Area, the Augusta mine and smaller properties in Baxter Basin (Ellis, in press) operated from 1883 into the 1910s before losing the battle with snowslides. During the early 1900s, attempts were made to work the silver-rich base-metal veins of the region, but little was accomplished until 1950 when the Keystone, Micawber (Standard), and Daisy mines began operations near the southeast corner of the study area (Ellis, in press). These base-metal veins were mined until 1969, after which molybdenum exploration became the main activity. Since 1965, two molybdenite deposits, one underlying Redwell Basin and the other beneath Red Lady Basin, have been discovered. The Red Lady Basin deposit--AMAX's Mt. Emmons deposit--has been delineated, and a mine was planned to start operation in the mid-1980s. The Redwell Basin deposit has not been fully delineated by drilling (W. White, Climax Molybdenum Co., oral commun., 1981).

Within the study area, silver production was small from Democrat Basin in the 1930s; silver production was also small from Peeler Basin during an unknown period.

Coal was mined from the northern part of the Crested Butte district--from the Smith Hill (Anthracite Mesa) mine about 1.5 mi (2.4 km) east of the study area, south to the village of Crested Butte--from 1884 to 1954.

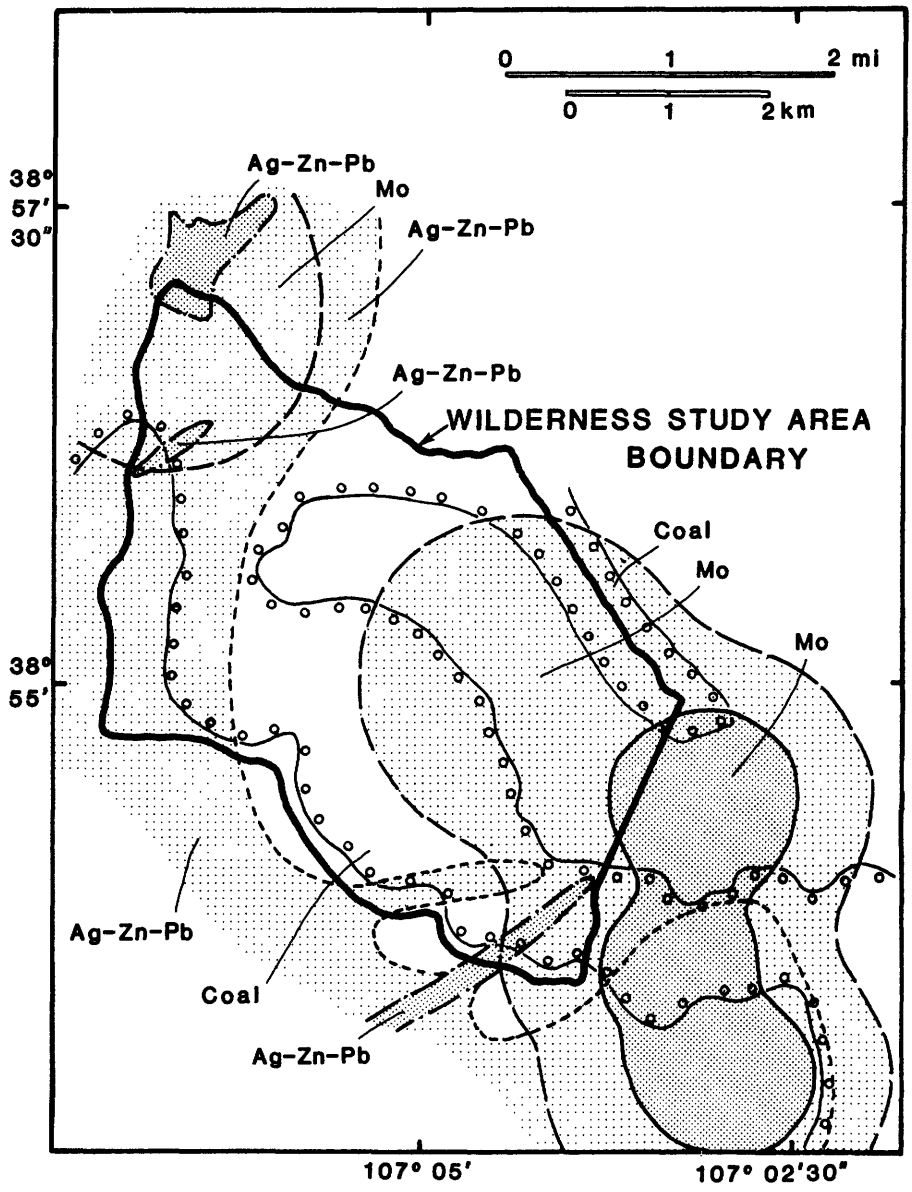
The study area had five patented mining claims and about 4,800 acres (19 $km^2$) of unpatented claims as of March 1982. Oil and gas leases covered about 4,700 acres (19 $km^2$) as of January 1979. No drilling for oil or gas had been conducted as of September 1981.

### Crested Butte Coal Mining District

Within 4 mi (6 km) of the study area, the Smith Hill (Anthracite Mesa) and Silver Brook (Peanut) mines, as well as three mines not shown on plate 1 of Ellis (in press) (K&K, Horace, and Elk Mountain), produced coal from two or more beds 2 to 5 ft (0.6 to 1.5 m) thick. The coal ranks between high volatile B bituminous and anthracite (Gaskill and others, 1967). Six beds are in a 250-ft (76-m) sedimentary sequence above the second sandstone unit above the base of the Mesaverde Formation. Some of these beds have been mapped in the head of Oh-Be-Joyful valley and along Schuylkill Mountain within the study area. In general, the beds in the study area are thin, ranging from 0.5 to 3 ft (0.15 to 0.9 m) thick (Gaskill and others, 1967).

### Ruby Mining District

For the purpose of this report, the Oh-Be-Joyful Wilderness Study Area is considered to be part of the Ruby mining district, although some claim notices refer to the district as the Elk Mountain or Rock Creek district; both are north of the study area.




## EXPLANATION

High mineral resource potential for molybdenum

Moderate mineral resource potential for molybdenum

High mineral resource potential for silver, zinc, and lead

Moderate mineral resource potential for silver, zinc, and lead

High mineral resource potential for coal

# MAP SHOWING MINERAL RESOURCE POTENTIAL OF THE OH-BE-JOYFUL WILDERNESS STUDY AREA

Although almost the entire study area is mineralized, it is here divided into centers of mineralization referred to as : Mt. Emmons-Keystone, Redwell Basin-Micawber, Independence, Scarp, Richmond Mountain, Augusta, and Oh-Be-Joyful Headwaters. The Mt. Emmons-Keystone and Redwell Basin-Micawber centers of mineralization each consist of a stockwork molybdenum deposit and associated base-metal and silver veins. Both centers are less than 1 mi (1.6 km) southeast of the wilderness study area. The molybdenum deposits in both have been explored by extensive core drilling. The other centers have been explored by prospect and mine workings.

### Mt. Emmons-Keystone

In 1978, AMAX announced the discovery of the Mt. Emmons stockwork molybdenite deposit. Located beneath Red Lady Basin about 0.75 mi (1.2 km) southeast of the study area, the deposit contains reserves of 165 million tons (150 million metric tons [t]) of 0.43 percent molybdenite ($MoS_2$). The Keystone Mine, farther southeast (fig. 2 on accompanying map), produced silver, gold, and base metals from two parallel, northwest-trending veins that intersect the Mt. Emmons deposit and cut the earlier of two known stages of molybdenite veinlets. The base-metal vein is composed of iron-rich sphalerite, pyrite, galena, chalcopyrite, banded and vuggy quartz, rhodochrosite, and rhodonite. The vein generally fills open spaces along a normal fault that shows small left-lateral displacement. This lateral movement caused the vein to pinch where it trends north-northwest and to swell where it trends northwest.

### Redwell Basin-Micawber

Exploration of the Redwell Basin stockwork molybdenum deposit, just north of the summit of Mount Emmons, has been conducted from 1968 to the present. No grade and tonnage figures have been announced, but the deposit is of comparable size to the Mt. Emmons deposit, though of lower grade.

The Micawber mine, southwest of Redwell Basin (fig. 2 on accompanying map), produced silver, gold, and base metals from a vein that intersects the Redwell Basin deposit. Mine workings do not expose molybdenite mineralization. Mineralogically similar to the Keystone vein, the Micawber vein strikes northeast and the major swell on the vein was caused by a few hundred feet of right-lateral movement. Projection of the trace of the Micawber vein to the southwest indicates it could be on the same structure as the vein at the Forest Queen mine. The Forest Queen ore contains native and ruby silver in a quartz and arsenopyrite gangue; galena and sphalerite are present, but only in small quantities (Socolow, 1955). If the correlation of the Forest Queen and Micawber is valid, the vein is clearly mineralogically zoned away from a source within the Redwell Basin molybdenite deposit.

The Daisy mine, just southeast of the Redwell Basin deposit (fig. 2 on accompanying map), is in an arcuate vein containing the same minerals as the Keystone and Micawber veins. The vein is traceable for about 1000 ft (305 m) along strike and dips into the Redwell Basin intrusive. Sharp (1978) interpreted the Daisy vein as a shovel (listric) fault that formed at an early intrusive stage and was mineralized between stages of molybdenite mineralization. An extension of the Daisy vein was discovered during exploration drilling in the Redwell Basin deposit. The vein has a true thickness of 41 ft (12 m) where it was intersected (W. White, Climax Molybdenum Co., oral commun., 1981).

### Independence Vein

Extending from Independence Basin south of the study area to Peeler Basin within the study area, the Independence vein (fig. 2 on accompanying map) has been prospected and mined intermittently since about 1890. Where mined in the southwest side of Independence Basin, the vein is primarily quartz with sparse sulfides (mostly pyrite) and a moderate silver content. Drill-core intercepts in the upper part of the basin have similar mineralogy and grade (E. Perussic, U. S. Energy Co., oral commun., 1976). Workings on the vein in Peeler Basin, within the study area, show iron-rich sphalerite, pyrite, and galena in quartz and calcite gangue, with significant silver concentrations (Ellis, in press). Prospects on the vein at Peeler Falls expose pyrite cubes in gouge, but little obvious sphalerite or galena; samples assay high in silver, lead, and zinc, and the gouge is obviously metal-rich. The fault which the vein follows has had both dip-slip (northwest side up) and strike-slip movement (right-lateral). Pinching and swelling are well displayed at Peeler Falls.

From Peeler Falls, the fault projects northeastward to the bottom of the valley of Oh-Be-Joyful Creek at the eastern edge of the study area, where the rocks are brecciated, hornfelsed, and cut by quartz veinlets. Climax Molybdenum Co. drilled two holes into this area just outside the eastern boundary of the study area and found granites that are chemically and mineralogically similar to the ones at Mt. Emmons and Redwell Basin, as well as some molybdenite mineralization (W. White, Climax Molybdenum Co., oral commun., 1981).

A small identified silver and base-metal resource exists in the Independence vein at the workings in Peeler Basin within the study area (Ellis, in press).

### Scarp Vein

South of Scarp Ridge, in Justice Basin, extensive workings on the Scarp vein (fig. 2 on accompanying map) expose only a narrow quartz vein (or veins) that have minor pyrite and silver. To the west and at a lower altitude, in Robinson Basin, abundant sulfides---sphalerite, galena, and pyrite---are on dumps of caved workings beside the creek draining the basin. Though geologic mapping (Gaskill and others, 1967) shows the Scarp fault terminating just north of Scarp Ridge in Peeler Basin, projection of the structure east-northeast would result in an intersection with the altered area drilled by Climax in the valley of Oh-Be-Joyful Creek. The lack of mineralization in Justice Basin may be due to pinching

of the vein in this area. Conversely, the mineralogy of the vein in Justice and Robinson Basins could indicate zoning away from a mineralization center somewhere to the south-southeast.

No resources related to the Scarp vein can be identified within the study area.

### Richmond Mountain Veins

Five base-metal veins appear to intersect under Richmond Mountain, at the northwest corner of the study area. These veins are herein referred to as Big, Excelsior, Jacob Straeder, Domingo, and Richmond (fig. 2 on accompanying map).

The Big and Excelsior base-metal veins were mined in the 1880s in Baxter Basin. Both veins consist primarily of sulfides in quartz and calcite gangue. As in other veins in this region, iron-rich sphalerite is more plentiful than pyrite, which is more plentiful than galena. Chalcopyrite is present only in small quantities. Sphalerite has been left on the dumps. Commonly, only hand-sorted lead-silver ore was shipped in the 1880s because zinc was penalized at most smelters. The Big and Excelsior veins probably intersect under the rock glacier in Baxter Basin.

Workings on the Jacob Straeder vein under the east face of Richmond Mountain are flooded, but the vein is exposed in the cliff above. Where accessible, the vein is composed of sandy gouge with quartz and pyrite. Both vein and dump contain more than 2 oz/ton (69 g/t) silver (Ellis, in press).

The Domingo vein was mined at the base of cliffs high on the north face of Richmond Mountain. The mine portal and dump are covered by talus funneled through a deep gully in which the vein crops out. The vein is composed of quartz, sphalerite, and pyrite, and contains considerable silver (Ellis, in press). This mineralization is also present 20 ft (6 m) from the buried portal at what may have been a shallow powder-storage adit.

The Richmond vein, farther northwest, is exposed along a 360-ft (110-m) drift (Ellis, in press), as well as 200 ft (61 m ) above it at the collar of a raise to the surface. The vein is brecciated quartz, with only traces of sulfides and small to moderate amounts of silver.

Workings on the southeast side of Richmond Mountain, inside the study area, are caved, but the dump contains the same minerals as the Big, Excelsior, Jacob Straeder, Domingo, and Richmond veins. A probable source for these veins is under Richmond Mountain, and could be partly within the study area. Small identified silver-zinc-lead resources are in these veins, and could extend into the study area.

### Augusta Vein

The Augusta mine, about 1 mi (1.6 km) north of the study area (fig. 2 on accompanying map) is largely inaccessible because of bad air and caved portals. Surface workings expose a base-metal vein near the top of Augusta Mountain. Compared to the veins previously described, the Augusta vein contains more galena and less sphalerite, more gold, and possibly more silver. The northeastward projection of the vein, in Poverty Gulch, appears to be several thin veins containing silver, quartz, arsenopyrite, and minor galena and sphalerite. The precious- and base-metal resource in the Augusta vein does not appear to extend into the study area.

### Oh-Be-Joyful Headwaters

The crest of the Ruby Range, from Ruby Peak (just off the map south of Mt. Owen) to Augusta Mountain, is weakly mineralized along the entire 5-mi (8-km) distance. The best-exposed vein, the Ruby No. 1 (fig. 2 on accompanying map), is a sulfide vein in Democrat Basin that was followed 420 ft (128 m) southwestward in an adit (Ellis, in press). The vein crops out about 400 ft (122 m) southwest of the face of the adit, about 400 ft (122 m) above the adit. The vein is narrow and locally pinches out, but sparse metal concentrations are in the wall rock adjacent to the vein. The mineralogy is similar to the other sulfide veins described. A small identified silver-zinc-lead resource exists in the Ruby No. 1 vein entirely within the study area.

Dippold and Little Silver Basins, near the crest of the Ruby Range, contain a number of shallow prospects. Prospects in Dippold Basin have neither gold nor silver, but a few tens of parts per million molybdenum is present (Ellis, in press). Similar prospects in Little Silver Basin, just to the south, contain gold and silver, but no molybdenum. The mineralization described at the Ruby No. 1 vein, and in Dippold and Little Silver Basins, could indicate zoning over and around a center of mineralization below Dippold Basin.

The evidence from mines and prospects (Ellis, in press) is insufficient, by itself, to identify any resource in the Oh-Be-Joyful headwaters part of the study area, other than the small resource in the Ruby No. 1 vein.

### Production Data

Most of the recorded production from the Ruby district occurred after 1901 and before 1969. Total recorded production for that part of the district discussed in this report was about 24,000 oz (746,000 g) of gold, 5.2 million oz (162 million g) of silver, 6.6 million lb (3.0 million kg) of copper, 30.9 million lb (14.0 million kg) of lead, 55.2 million lb (25.0 million kg) of zinc, and a few pounds of cadmium.

Between 1884 and 1954, the coal mines within 4 mi (6 km) of the study area produced about 3 million tons (2.7 million t) of coal (Gaskill and others, 1967).

### Resources

Inferred coal resources within the study area, in beds 1 to 3 ft (0.3 to 0.9 m) thick, are 12 million tons (10.9 million t). Less than half of this coal resource is recoverable by current technology.

The indicated silver-zinc-lead resource within the study area is about 10,000 tons (9,070 t), averaging about 0.6 oz/ton (21 g/t) silver, 1.4 percent zinc, and 1.0 percent lead. The inferred silver-zinc-lead resource is about 400,000 tons (363,000 t) of a similar grade.

## ASSESSMENT OF MINERAL RESOURCE POTENTIAL

### Molybdenum

Two stockwork molybdenum deposits, Mt. Emmons and Redwell Basin, occur immediately southeast of the Oh-Be-Joyful Wilderness Study Area (fig. 1 on accompanying map). A third deposit, north of these areas, is likely to occur in the subsurface, beneath the valley of Oh-Be-Joyful Creek near the eastern boundary of the study area, and the potential for a stockwork molybdenum deposit there is high. Mineral zoning in associated base-metal veins and the distribution of hornfels, minor veining, and hydrothermal alteration are consistent with the model presented by the occurrence of the Mt. Emmons and Redwell Basin deposits. Also, appropriate high-silica intrusions and molybdenite mineralization are known to occur at depth (W. White, Climax Molybdenum Co., oral commun., 1981).

A fourth deposit may occur in the subsurface beneath the structural dome (fig. 1 on accompanying map) in the overlying sediments, just upstream from the potential deposit described above. The potential here is moderate. Some hornfels and minor veining is present in the valley of Oh-Be-Joyful Creek in this area. Because of lack of drilling, the presence of a concealed silicic intrusive body remains hypothetical. Another area, near Richmond Mountain, in the northwest corner of the study area, has moderate potential, largely on the basis of a radial pattern of silver and base-metal veins. Known intrusive rocks in the area are of the older, less-silicic suite. Alteration and mineralization associated with those rocks makes discernment of possible later effects problematical.

The entire study area is on the southwest margin of the central Colorado gravity low (Isaacson and Smithson, 1976), to which many Colorado stockwork molybdenum deposits and prospects seem related.

### Silver-Zinc-Lead

Indicated resources of silver, zinc, and lead are present within the study area in the Independence and Ruby No. 1 veins, and these areas have high potential for the occurrence of silver-bearing base-metal vein deposits. High potential is also present under Richmond Mountain, based on the large number of possibly intersecting veins, past production, and scattered high silver assays. Elsewhere in the study area, mineralized structures have moderate potential for silver, zinc, and lead in an elongate band flanking the Ruby Range intrusives and on the margins of the Irwin district.

### Coal

Coal is found in the study area in beds 0.5 to 3 ft (0.15 to 0.9 m) thick in the Mesaverde Formation. Most coal beds are in the stratigraphic sequence above the second sandstone unit above the base. The area that is stratigraphically above the second sandstone unit and not deeply buried by overlying formations has high potential for coal resources. This includes nearly two-thirds of the study area.

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