OPEN-FILE REPORT 02-13

History, Geology, And Environmental Setting of Selected Mines Near Ophir, Uncompahgre National Forest, San Miguel County, Colorado

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FOREWORD

Open-File Report 02-13 describes the history, geology, and environmental setting of several mines in San Miguel County near Ophir. The mines described in this report are located on private land and on U.S. Forest Service administered land. Effluent from some of these mines flows onto National Forest System land and into Howard Fork of the San Miguel River. The U.S. Forest Service selected some of these sites for detailed investigation because of the results of an abandoned mine inventory recently completed by the Colorado Geological Survey. State and Federal agencies and private owners can use this study for developing realistic and cost-effective reclamation plans for these mines.

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ABBREVIATIONS AND SYMBOLS

bgs	below ground surface
bk.	book
cm	centimeter
CBM	Colorado Bureau of Mines (now Colorado Division of Minerals and Geology)
CDPHE	Colorado Department of Public Health and Environment
CDMG	Colorado Division of Minerals and Geology
CGS	Colorado Geological Survey
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cps	counts per second
°	degree
EE/CA	Engineering Evaluation/Cost Analysis
EDR	Environmental Degradation Rating
EPA	United States Environmental Protection Agency
=	equals
4WD	four-wheel drive
gpm	gallons per minute
<	less than
µg/L	micrograms per liter
µ	microns
µS	microSiemens
mg/L	milligrams per liter
>	more than
NFS	National Forest System
NPL	National Priorities List
n/a	not applicable
no.	number
#	number
p.	page(s)
ppm	parts per million
%	percent
PHR	Physical Hazard Rating
pCi	picoCuries
lb(s)	pound(s)
PBS	Primary Base Series
SH	State Highway
x	times (when factoring ion concentrations or radioactivity)
trec	total recoverable
oz(s)	troy ounce(s)
U.S.	United States
USFS	United States Department of Agriculture - Forest Service
BLM	United States Department of Interior - Bureau of Land Management
v.	volume

INTRODUCTION

During the summer of 1996 the Colorado Geological Survey (CGS) inventoried mines in the Ophir (Iron Springs) mining district in the Howard Fork of the San Miguel River drainage basin (fig. 1) as part of a Statewide inventory of abandoned mines on or affecting U.S. Forest Service-administered lands in Colorado. In 2000 the U.S. Forest Service requested more detailed information regarding selected inventoried mine features, the Carribeau Mine, and the Carbonero tailings. The Carribeau Mine and Carbonero tailings were not included in the 1996 inventory because U.S. Forest Service Primary Base Series (PBS) maps suggested that these sites were on private land (figs. 2, 3). However, a survey in 2000 showed that the draining adit at the Carribeau was on National Forest System (NFS) land. Although not surveyed, a small portion of the Carbonero tailings pile probably extends onto NFS land, too.

In addition to the Carribeau Mine and Carbonero tailings, selected mine features in the North Chapman Gulch (254/4194-1), Chapman Gulch (253/4194-1), Drill Hole-Chapman Gulch (253/4194-3), Carbonero Area (252/4194-1), and New Dominion (251/4193-1) inventory areas are described. CGS assigned Environmental Degradation Ratings (EDRs) of 3 (potentially significant) or worse to some of the mine features in those inventory areas. The following report describes sites beginning upstream in Chapman Gulch and progressing downstream to the Carribeau Mine.

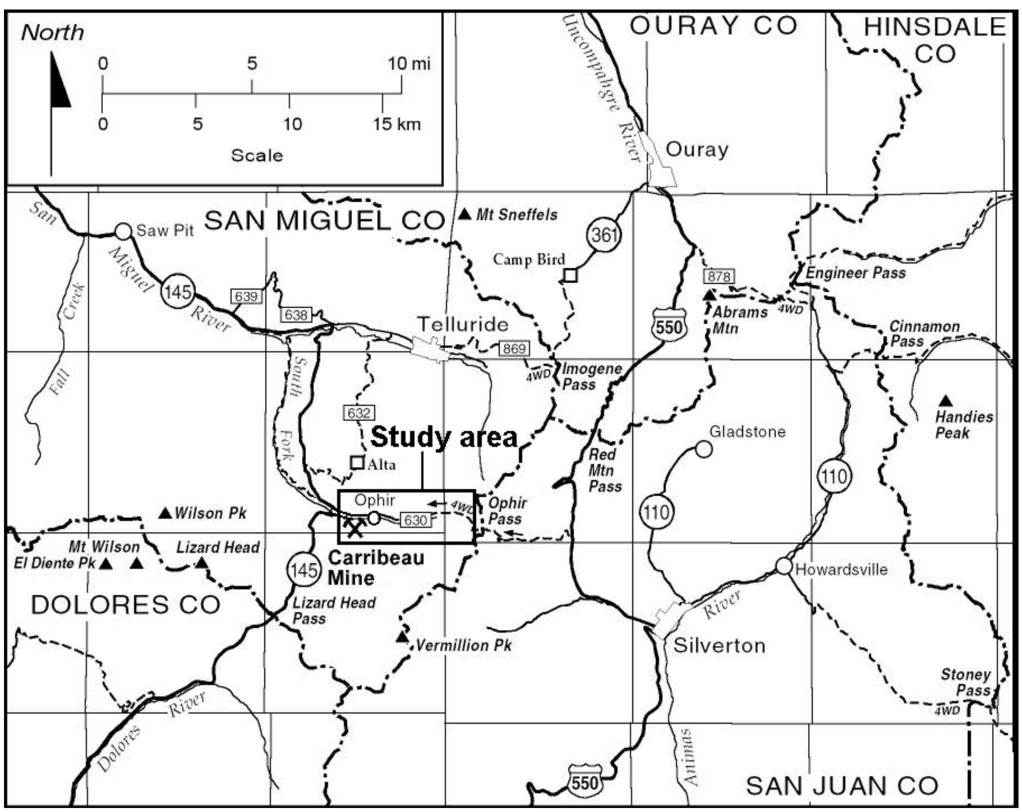

Figure 1. Location map of Ophir mining district (scale is approximate).

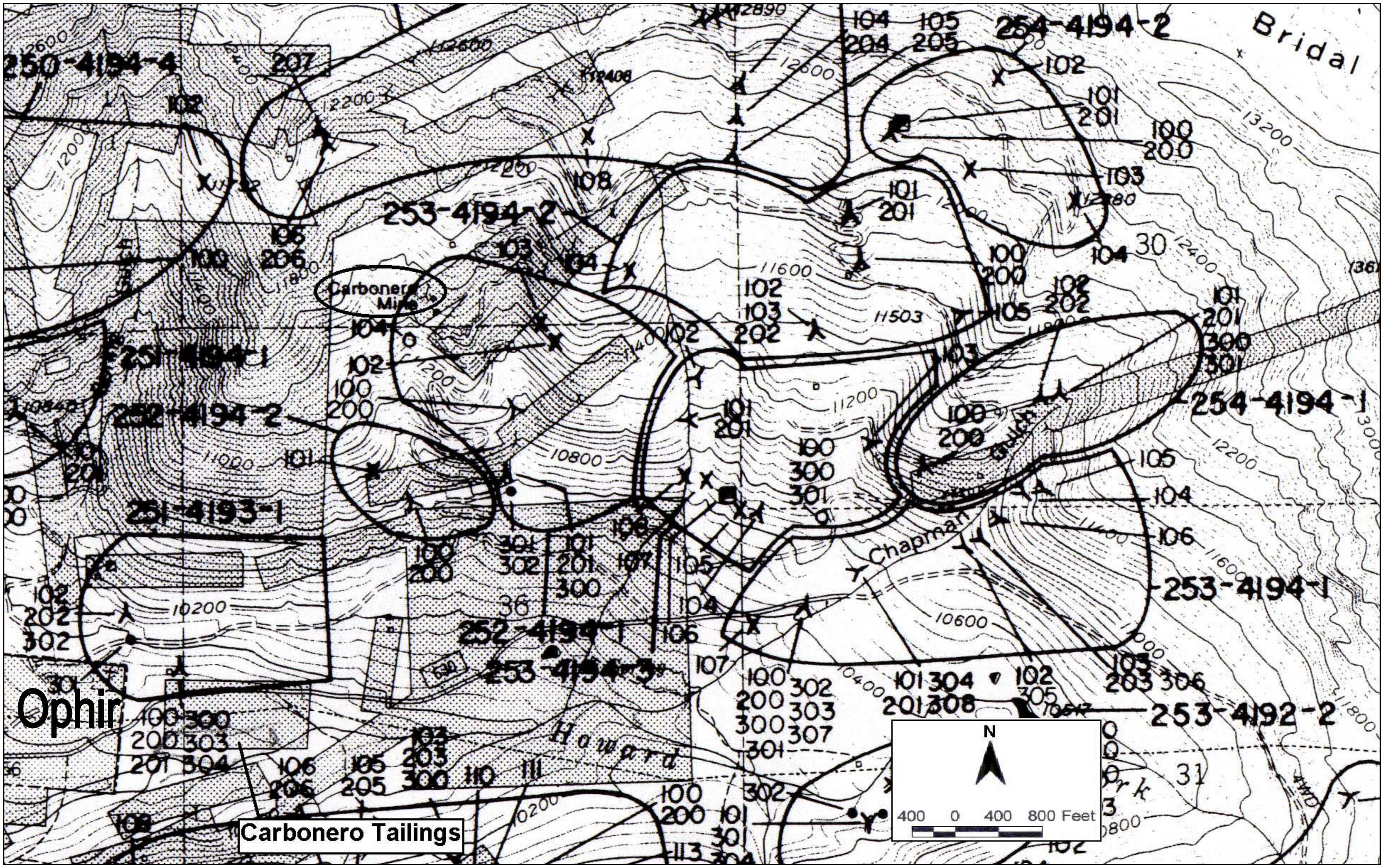

Figure 2. PBS map showing inventoried features in the upper Howard Fork drainage basin and the Carbonero Mine and tailings (scale is approximate).

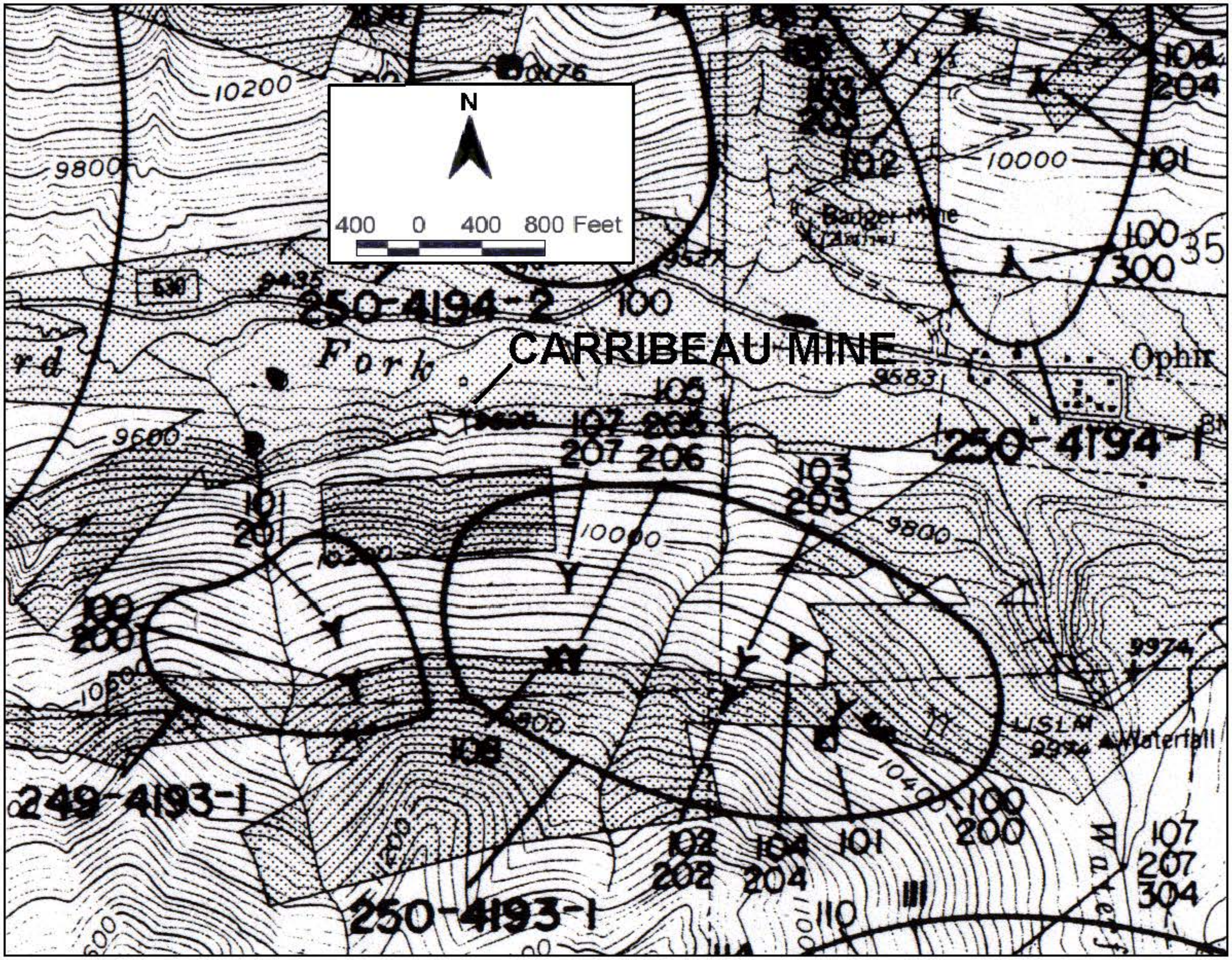

Figure 3. PBS map showing the Carribeau Mine and nearby inventoried mine features (scale is approximate).

LOCATION

The mines described in this report are in San Miguel County near Ophir, in the San Juan Mountains of southwestern Colorado. Topography is steep in this narrow glaciated valley that is drained by Howard Fork of the San Miguel River. Elevations of the sites range from about 9,500 to 11,500 feet. Forest Road 630 (Ophir Pass Road) parallels Howard Fork and provides general access to the Ophir mining district. Old mine roads branching from Forest Road 630 allow vehicular access close to most of the sites.

PREVIOUS INVESTIGATIONS

Beginning in 1976, several environmental studies were done in the Ophir mining district in the Howard Fork drainage basin (McLaughlin, 1981, p. III-14-15, V-14, 80, 90-92). A study by Woodling in 1976 reported limited populations of benthic fauna and fish because of water chemistry. In 1980, Kepler found natural and mine-related sources for metals, but at its mouth, Howard Fork only slightly exceeded aquatic-life standards. An aquatic-life study completed at about the same time reported low numbers of species and population. Only pollution-tolerant species existed in Howard Fork. In McLaughlin's aquatic-life study, the furthest upstream sample point was upstream of the largest mines, and the entire Howard Fork was deemed a "degradation zone." The researchers asserted that even if metal concentrations were reduced in Howard Fork, the stream would only support a relatively low mass of 35 lb of fish per surface acre because of degraded physical habitat, low flows, and easy accessibility. Howard Fork was ranked as a low priority for reclamation because of its low potential productivity and small size compared to other stream reaches in need of reclamation work.

Colorado Division of Minerals and Geology (CDMG) conducted an inventory of abandoned mines in 1980. As part of their inventory, selected draining mines were sampled and analyzed for total metals (not dissolved). In 1994 CDMG conducted a high flow (June) and low flow (November) sampling program in Howard Fork (Appendix). Cadmium, copper, iron, lead, manganese, and zinc were analyzed for total recoverable and dissolved concentrations. Results suggested that in the main stem of Howard Fork metal concentrations increase as flow rate decreases. Despite the lower concentrations, metal loads in June were significantly higher because flow rates were 4 to 6 times greater than in November. Samples of mine effluent were not as easily generalized. Some samples showed great variability in flow rates and/or in metal concentrations, while others remained relatively constant. At least as far downstream as the site 27, immediately downstream from the Carribeau tailings (Appendix), Howard Fork was within State surface water standards for all of the metals analyzed, however iron, copper, and zinc concentrations were elevated and approached standards. Surface-water standards refer to State of Colorado, Water Quality Control Commission Regulation 31. Total recoverable lead concentration was elevated during low flow. (Jim Herron, CDMG, unpublished data.)

In the mid-1990's, Colorado Department of Public Health and Environment (CDPHE) began a series of environmental studies focusing on Howard Fork. These studies culminated in a Site Investigation conducted in 1998. CDPHE concluded that the major sources of metals in Howard

Fork above Ophir Loop were the Carbonero Mine, Carbonero tailings, and the Carribeau Mine, although the naturally occurring Iron Springs and other diffuse sources were also significant metal contributors (CDPHE, 1999, p. 17-19).

Unfortunately, major discrepancies between total and dissolved metals in water samples became obvious in the analytical results of the CDPHE Site Investigation and CDPHE did not make a distinction between “total” and “total recoverable” metal content. Lead and copper values were the most problematic, and laboratory errors were blamed for the erratic data. Although EPA chemists concluded that the data “may not be usable” and that “lead and copper data should only be used as estimates”, CDPHE contended that the total metal concentrations for lead and copper were probably valid, and that the dissolved data for these elements may be misleading (CDPHE, 1999, p. 6-7). Because most aquatic-life stream standards are based on dissolved concentrations, samples collected in 2000 by CGS during the present investigation were not analyzed for total copper or lead, making comparison of sample results difficult. With a few exceptions, dissolved lead and copper were not detected in the CGS water samples.

GEOLOGIC SETTING

In the Ophir mining district, the Ophir stock and several smaller felsic to intermediate composition stocks and plugs intruded late Paleozoic, Mesozoic, and Tertiary sedimentary rocks and Tertiary volcanic rocks of the San Juan Formation and Silverton Volcanic Group (fig. 4). Large areas have been intensely hydrothermally altered, probably during or shortly after the emplacement of the intrusive rocks (Varnes, 1947, p. 425-426; Vhay, 1947, plate 16; Luedke, 1996).

Most of the larger mines developed east- to northeast-trending, silver-rich, base-metal veins containing one, and usually more, of the following metallic minerals in varying proportions: galena, sphalerite, pyrite, chalcopyrite, and tetrahedrite. Low-grade gold was usually present. Gangue was dominated by quartz; but calcite, barite, ankerite, rhodochrosite, hematite, magnetite, anhydrite, manganiferous iron carbonate, fluorite, and gypsum occurred in lesser quantities. Many of the most productive veins were in an east-trending belt that straddles Howard Fork and extends eastward to Chapman Gulch (Vhay, 1962, p. 286; Varnes, 1947, p. 426-427). These types of veins were mined at the Carribeau, Carbonero, New Dominion, Marie Antoinette (adit #101 of the Carbonero Area inventory area), and Slide Mines (adit #101 of the Chapman Gulch inventory area).

Smaller mines were developed near Chapman Gulch on west- to northwest-trending, gold-bearing quartz-pyrite veins. These veins also contained clay and sparse base-metal sulfides. The Wealth of Ophir Mine (adit #100 of the Chapman Gulch inventory area) may have been driven on one of these types of veins. A large, intensely altered area west of Chapman Gulch contains abundant disseminated pyrite accompanied by low-grade base-metal sulfides. The Calumet Mine (adit #101 of the North Chapman Gulch inventory area) was driven along a vein hosted by this iron-stained, pyrite-rich, hydrothermally altered volcanic rock.(Vhay, 1962, p. 287-288).

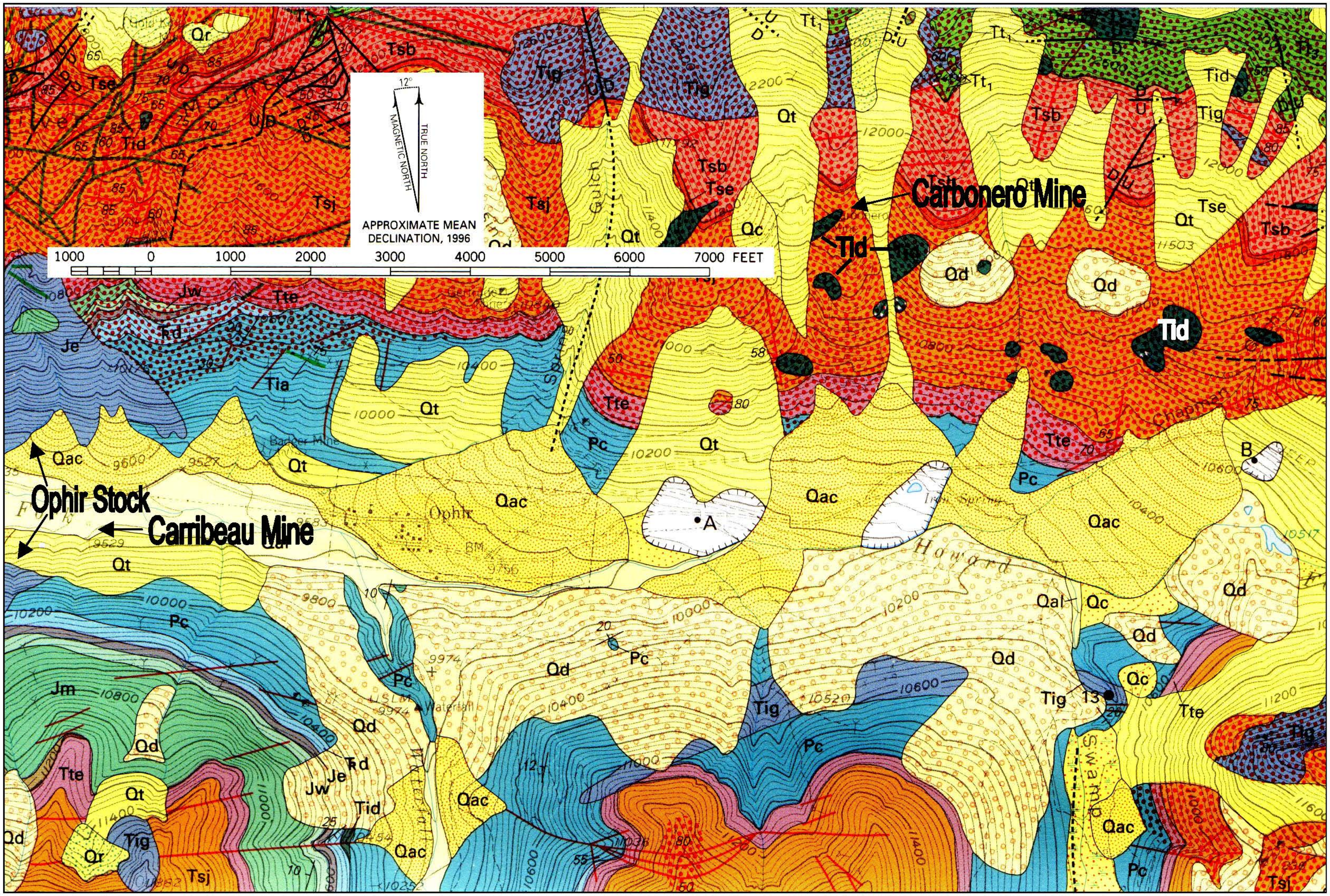

Figure 4. Geologic map of the Ophir mining district (modified from Luedke, 1996).

Explanation of geologic map symbols on Figure 4 (Luedke, 1996).

Qal=Quaternary alluvium	Tsp=Tertiary Picayune megabreccia
Qac=Quaternary alluvial cones	Tsj=Tertiary San Juan Formation
Qc=Quaternary colluvium	Tig=Tertiary granodiorite
Qt=Quaternary talus	Tid=Tertiary dacite
Qr=Quaternary rock glaciers	Tte=Tertiary Telluride Conglomerate
Qls=Quaternary landslide deposits	Jm=Jurassic Morrison Formation
Qd=Quaternary glacial drift	Jw=Jurassic Wanakah Formation
Tt_{1-7}=Tertiary ash-flow tuff	Je=Jurassic Entrada Sandstone
Tsb=Tertiary Burns Member of Silverton Volcanics	Trd=Triassic Dolores Formation
Tse=Tertiary Eureka Member of Silverton Volcanics	Pc=Permian Cutler Formation
Red stippled areas=hydrothermally altered rocks	Red lines=vein or mineralized fault
White areas=bog-iron (ferricrete/ferrosinter) deposits	Green lines=Tertiary andesite dikes.

HISTORICAL OVERVIEW

Prospectors began working in the upper reaches of the San Miguel drainage basin in the mid-1870's, and by 1878 a small tonnage of ore produced from the Ophir mining district was hauled over Ophir Pass to a smelter in Silverton. In 1879 miners in the Ophir mining district were the first in present-day San Miguel County to attempt milling their silver ore in two arrastras prior to shipping. A smelter operated at Ames, near the confluence of Howard Fork and Lake Fork, for about a year in 1883. A hydroelectric plant was built at Ames in 1890, and mines, mills, homes, and businesses in the Telluride and Ophir areas used the electricity. Although several veins were prospected near Ophir, and annual production was generally increasing, no mines were large producers until the railroad reached the Ophir area about 1890 (Henderson, 1926, p. 53-54, 216-223; Vhay, 1962, p. 270).

During its heyday in the 1880's and 1890's, Ophir had up to 1,000 residents, but by the early 1920's the town had declined. Most of the mines were operated only intermittently, in part because of difficulty in processing the unoxidized ore deeper in the vein systems. A local miner, Jimmy Noyes, began purchasing property from discouraged miners and acquired several claims, but was not a large producer. By 1947 many of the largest mines and mills in the district had fallen into disrepair. After purchasing Noyes' property in 1951, Silver Bell Mines Company expanded mining operations and rebuilt and modernized the town (*Denver Post*, December 9, 1962, p. 8; Vhay, 1962, p. 270). Despite their efforts, the district was not a major producer after the early 1900's.

NORTH CHAPMAN GULCH

The North Chapman Gulch inventory area (254/4194-1, fig. 2) is about 2 miles east of Ophir and north of Forest Road 630. Chapman Gulch is the furthest upstream tributary to Howard Fork that enters from the north. CGS assigned an EDR of 3 to open adit #101. This adit was draining a large volume of water that formed the headwaters of surface flow in Chapman Gulch.

On the Ophir PBS map, adit #101 was plotted on NFS land on the north side of the patented Prospector Lode. However, mineral surveys suggest that this adit probably lies within the claim.

MINING HISTORY

Adit #101, which is probably on the Prospector Lode, is part of the Calumet Mine. Patented claims adjoining the ends of the Prospector Lode to the northeast and southwest are the Black Diamond No. 4 and Black Cloud Lodes, respectively. Numerous unpatented claims were originally associated with the Prospector and Black Diamond group. More recent unpatented claims include the Chapman Gulch group.

Calumet Mine

1895. Will J. Scoutt, A.P. Murray, S.E. Gleason, and Frank Delgard located the Black Cloud Lode (Mineral Survey No. 10181). The Black Cloud adjoins the southwest side of the Prospector Lode (fig. 5).

1898. The Black Cloud Lode was patented (USFS records).

1899. Justin McCarthy located the Prospector Lode (Mineral Survey No. 18062).

1904. John Waisanen located the Black Diamond No. 3 and No. 4 Lodes (Mineral Survey No. 18062). The Black Diamond No. 4 Lode adjoins the northeast side of the Prospector Lode.

1906. Waisanen transferred his interest in the Black Diamond No. 2, No. 3 and No. 4 claims to Calumet-Telluride Gold Mining Company (Charles Wickstrom-President) in January (bk. 95, p. 237). In August, J.H. and Anna Martin deeded the Prospector Lode to Calumet-Telluride Gold Mining Company (bk. 95, p. 254). The company amended the location certificate for the Black Diamond No. 4 Lode in November, and Mineral Survey No. 18062 was conducted on the Black Diamond No.3, Black Diamond No.4, and Prospector Lodes in December. Calumet-Telluride Gold Mining Company owned these claims and a block of 20 contiguous claims nearby. Workings surveyed on the Prospector Lode included a 300-foot-long, northeast-trending adit and a 70-foot-long, north-trending crosscut (adit #101, fig. 5). The survey notes reported that the crosscut adit was intended to develop the three surveyed claims and the Gold Star No. 3 and Helsinky No. 2-6 lodes (not surveyed) (Mineral Survey No. 18062). The 300-foot adit is probably caved adit #102 of this inventory area (fig. 2).

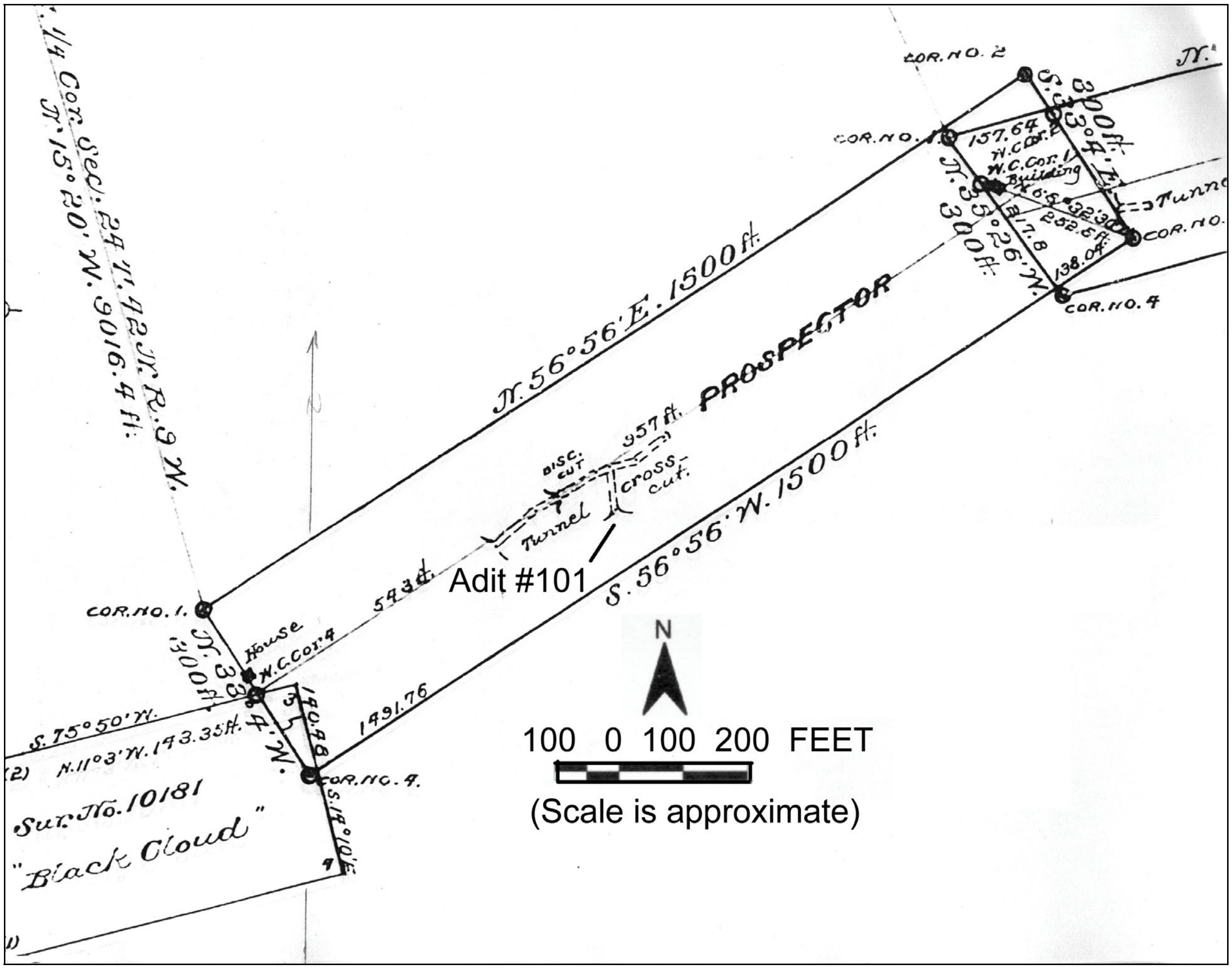

Figure 5. Prospector Lode portion of Mineral Survey No. 18062 (modified).

1907. Calumet-Telluride Gold Mining Company (John Waisanen-president/manager; Oscar Keckonen-secretary) owned a large claim block including the Prospector Lode. An average of 18 workers continued the project, which started in 1904. Development included a 950-foot-long adit driven on the vein. Ore was processed at the Calumet-Telluride mill. Between 70 and 100 tons per day were processed at the 20-stamp mill. Tables were used to concentrate the ore (1907 Mine managers report-Prospector, p. 158, CBM). The location of the Calumet-Telluride mill is not certain, but at least two ruined buildings large enough to house a mill remain on the northwest side of Chapman Gulch in this general area. No associated tailings piles were found, however.

1908. The Black Diamond No. 3 and No. 4, and Prospector Lodes were patented (USFS records).

1909. Calumet-Telluride Gold Mining Company (John Kiiskila-president; John Waisanen-manager; Joseph Gabesson-secretary) owned and operated a large claim block that included the Prospector, Calumet, and Black Cloud Lodes. A workforce of 8 to 10 workers produced silver, lead, and minor gold. Improvements included the 80 ton/day Calumet-Telluride 20-stamp mill, electric power plant, transformer house, blacksmith shop, boarding house, and bunkhouse. The combined workings of the Prospector and Calumet tunnels totaled 6,000 feet. Both adits were driven for development (1909 Mine managers report-Black Cloud, p. 117, CBM).

1913. Lake Superior-Ophir Mining Company (John Kiiskila-president; John P. Nelson-secretary) owned and operated a large claim block including the Prospector, Calumet, and Black Diamond No. 2 and 3 Lodes. Between 10 and 20 workers were employed. New development on the claim block included 815 feet of drifts and 40 feet of crosscuts. The ore was mostly zinc and lead sulfides and was processed at the Lake Superior-Ophir mill, which was built in Chapman Gulch in 1906. The mill had a daily capacity of 60 to 80 tons and was equipped with 20-stamps, four copper amalgamating tables, and four Wilfley concentrators (1913 Mine managers report-Black Cloud, p. 454, CBM). The Lake Superior-Ophir mill is probably another name for the Calumet-Telluride mill described in 1907.

1915. A "small" quantity of ore was shipped from the Calumet Mine (Henderson, 1917, p. 471-472). William Parsons, John Nelson, and J.H. Jasberg (trustees for creditors) acquired the Black Diamond No. 3 and No. 4 and Prospector Lodes and the associated mill from Calumet Telluride Gold Mining Company and Lake Superior Ophir Mining Company (bk. 116, p. 436).

1947. The portion of the Calumet adit northeast of the junction with crosscut tunnel #101 had been extended at least 300 feet from when Mineral Survey No. 18062 was conducted. The adit was caved about 400 feet from the portal of adit #101 and possibly undercut the Black Diamond No. 4 Lode. The west portal (adit #102) was caved, and underground workings were accessed through adit #101 (Vhay, 1962, plate 21-C). The mine was not operating, and no production is known after 1915.

2001. Fleet Resources was the listed owner of the Propector and Black Diamond Lodes as of May (courthouse records). It is not clear when or how Fleet acquired the claims.

Claim Blocks

1906. Calumet-Telluride Gold Mining Company owned a large block of 20 contiguous unpatented claims (Helsinky No. 1-7, Good Luck No.1, Black Diamond No. 1-2, Neglected, Silver Pick, Lake View, Gold Star No. 3, Riiski Hill No. 1-3, Jumper No. 1, Alma, and Alma No. 2) near the Prospector Lode (Mineral Survey No. 18062).

1971. A claim map of the Ophir area showed the Chapman G. No. 13 and No. 15 lodes northwest of the Prospector Lode, and probably overlying part of adit #101 (USFS files). Silver Bell Industries, Inc. owned these claims and other nearby patented and unpatented claims Silver Bell Industries, Inc., 1971).

GEOLOGY

Adit #101 was driven to explore one of a series of east-northeast-trending veins in this highly altered portion of Chapman Gulch. Pyrite-rich San Juan Formation volcanic rocks are exposed at the portal of adit #101. The intensely altered area that includes Chapman Gulch is rich in disseminated pyrite, accompanied by low-grade base-metal sulfides (Vhay, 1962, p. 287-288). An aerial photograph of this area shows the extent of the pyritic alteration (figs. 4, 6).

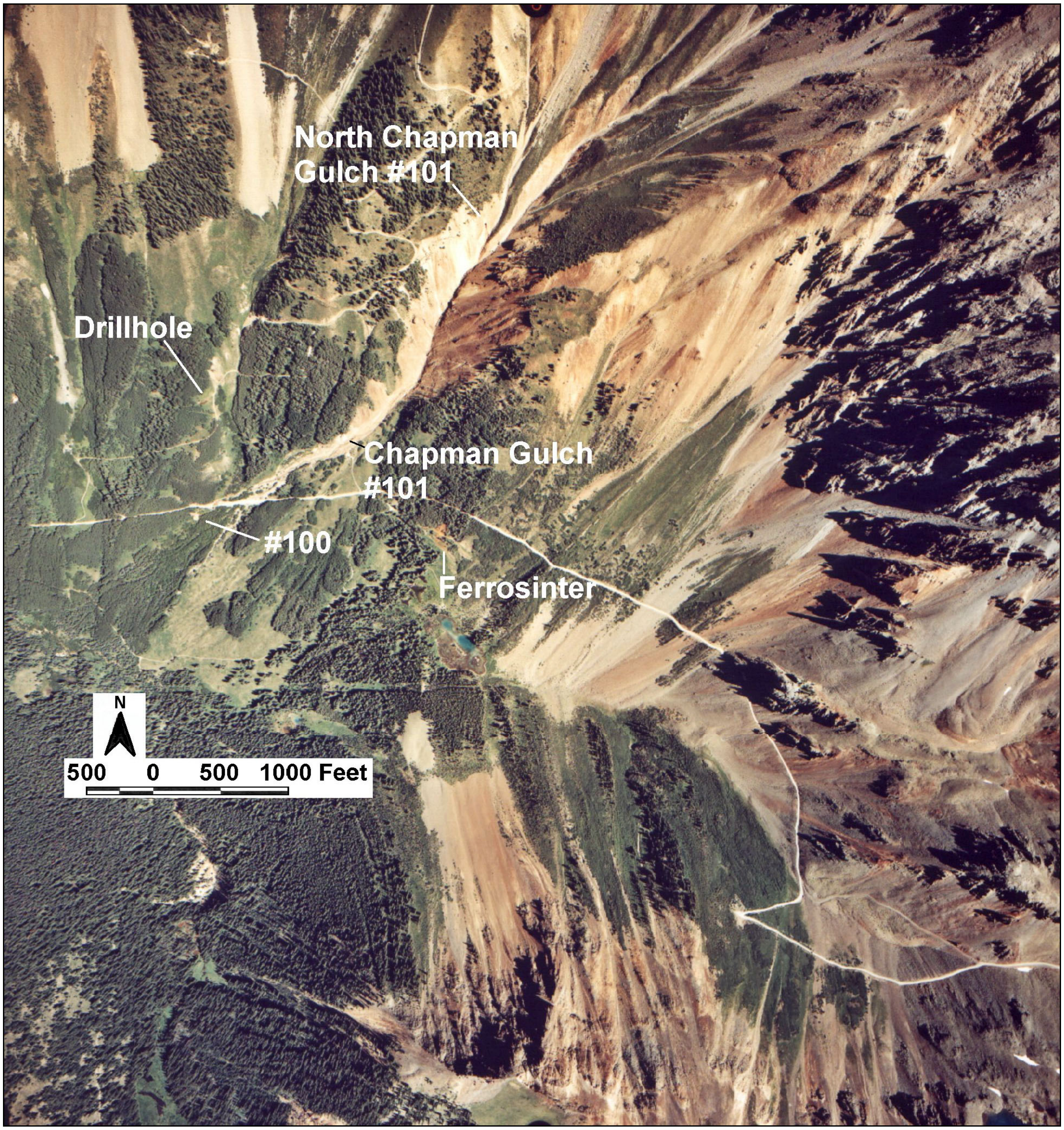

Figure 6. Aerial photograph of upper Howard Fork drainage basin.

SITE DESCRIPTION

Open adit #101 is reached by a 4WD road that accesses the west and northwest sides of Chapman Gulch, north of the Ophir Pass Road (fig. 7). In October 2000, adit #101 was discharging a large volume of water (302 gpm) that formed the headwaters for surface flow in Chapman Gulch (fig. 8). Effluent from the adit flowed along the east side of dump #201 and down a steep slope into Chapman Gulch, which was dry above this feature. The effluent deposited abundant orange precipitate, especially at the adit level, and to a lesser extent, in Chapman Gulch. At the adit level the precipitate was forming terracettes of ferrosinter (fig. 9). Dump #201 was severely eroded in the past, but did not appear to be actively eroding during the inventory or during this investigation.

WASTE AND HAZARD CHARACTERISTICS

CDMG sampled effluent at adit #101 in June and November of 1994 (site 7, Appendix). Flow was measured at about 680 gpm in June and about 121 gpm in November. Total recoverable and dissolved iron concentrations were 3,300 and 1,500 µg/L, respectively in June, and 2,200 and 1,600 µg/L, respectively in November. Manganese concentrations remained relatively constant during high flow and low flow. The concentrations were elevated but barely within the State standard of 1,000 µg/L. Zinc was slightly elevated, and the concentration dropped by about 50% from high flow to low flow. (Jim Herron, CDMG, unpublished data.)

In August of 1996, pH averaged 6.85 and conductivity averaged 1,270 µS/cm on two tests of the 520 gpm discharge from adit #101. A sample of the effluent contained high concentrations of iron (2,700 µg/L, total recoverable; 1,500 µg/L, dissolved), manganese (2,200 µg/L), and sulfate (620 mg/L) (Neubert and Harris, 1996, p. 27-28).

Sample MH-2000-47 was collected from the portal in the autumn of 2000 (fig. 7). Flow was 302 gpm, pH was 6.71, and conductivity was 1,301 µS/cm. Most of the analyzed parameters were similar to the 1996 sample. Iron and sulfate concentrations exceeded State water-quality standards; manganese in this stream segment was elevated, but slightly below the standard (Table 1).

DRILL HOLE - CHAPMAN GULCH

The Drill Hole - Chapman Gulch inventory area (253/4194-3) is about 1½ miles east of Ophir, west of Chapman Gulch (fig. 2). Access is via a 4WD road off of Forest Road 630. During the inventory in 1996, CGS assigned an EDR of 3 to a drill hole (feature #100) with an artesian flow of degraded water. Unpatented claims associated with the drill hole are the Iron No. 3, Ruth No. 7, Chapman Gulch No. 7, and possibly the Chapman Gulch No. 9 lodes. It is not clear which claim holder drilled the exploration hole, however.

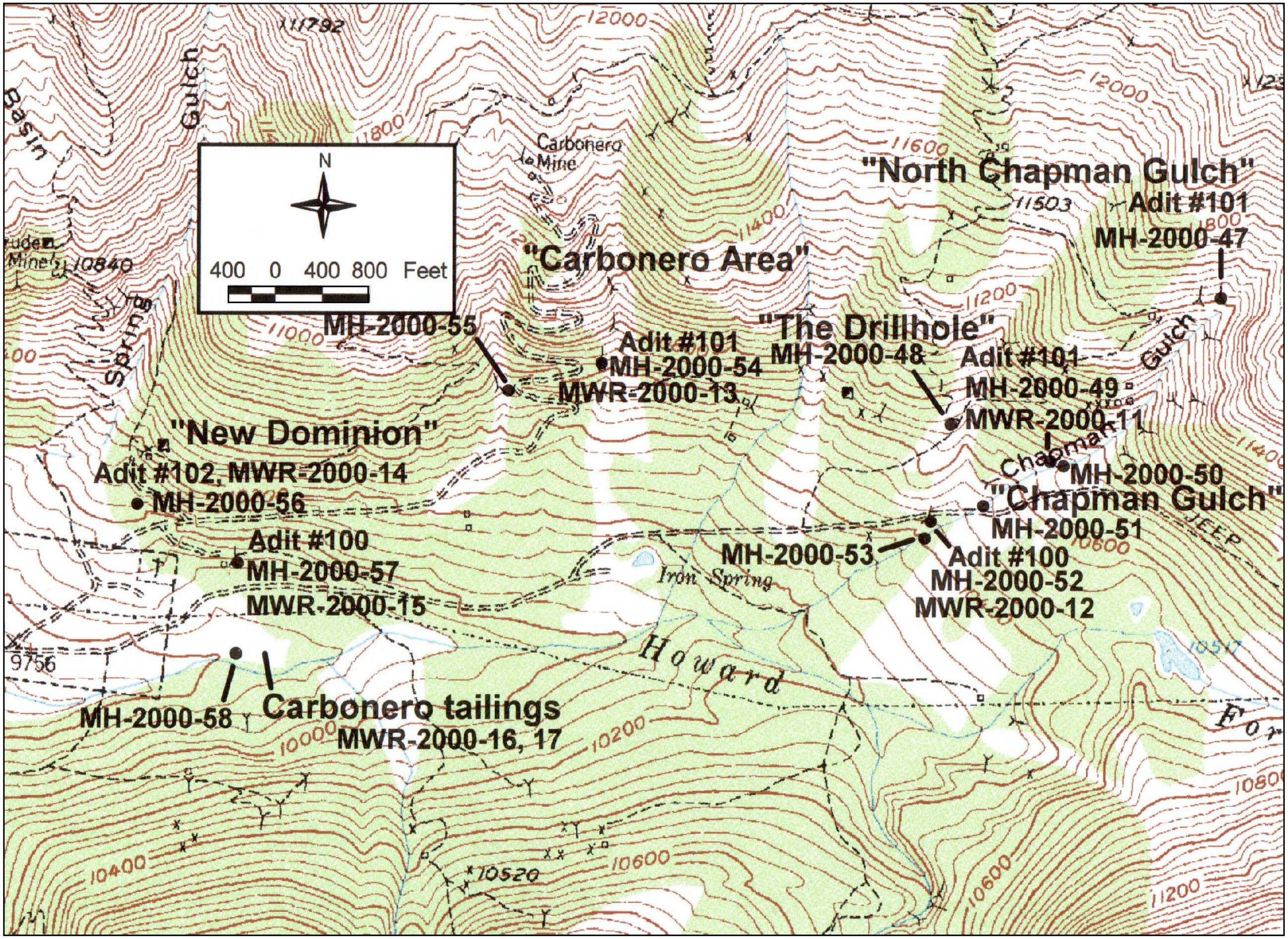

Figure 7. Map showing sample locations in the upper Howard Fork drainage basin.

Figure 8. Effluent from adit #101 forms the headwaters of Chapman Gulch.

A claim map indicates that the drill hole probably lies within the Iron No. 3 Lode. The Iron No. 3 Lode was originally located in 1956 (BLM files). Theresa Robinson relocated the claim in 1986. This claim remained active in 2000, the most recent year for which assessment work was filed (BLM lead file 217590). Robinson mined brown iron ore (ferrosinter) between 1962 and 1965 and sold the material for use as a soil amendment.

In 1969, F.W. Baumgartner relocated the Ruth No. 7 Lode, which was originally located in 1966 (bk. 317, p. 534; bk. 330, p. 132; bk. 336, p. 905). Drill hole #100 lies within this claim. Duval Corporation drilled exploration holes during the summer and fall of 1969 on claims controlled by Baumgartner Oil Company. “A few years(?)” after the Duval exploration, Prospectors Inc. of Peoria, Illinois, drilled 6 shallow holes near Chapman Gulch. Baumgartner Oil reportedly controlled Prospectors Inc. (unpublished report by Gumble and Koestal for Minerals Exploration Company, 1979, p. 11, BLM lead file 130726). No map was available showing the locations of all of the Duval Corporation holes or any of the Prospectors Inc. drill holes.

A 1971 claim map of the Ophir area showed the Chapman G. No. 7 Lode on or very close to drill hole #100. Silver Bell Industries Inc. owned the claim, as well as the surrounding patented and unpatented claims (Silver Bell Industries Inc., 1971).

A map of the Iron Springs district (Cox, 1978) showed the Duval 1 and Risser drill holes close to drill hole #100 of this inventory area (fig. 10). If the drill holes were slightly misplotted by Cox (1978), drill hole #100 may be one of these labeled features.

Figure 9. Portal, effluent, and terracettes of precipitate at adit #101.

GEOLOGY

Altered San Juan Formation volcanic rocks crop out near the collar of the drill hole. A nearby north-trending mineralized vein is shown on the geologic map, but the vein was not observed during this study. The drill hole may extend to the Telluride Conglomerate, which presumably lies about 200 feet below the surface in this area (fig. 4). A well indurated ferricrete deposit is exposed on the gulch wall about 200 feet east of the drill hole.

Table 1. Analytical data for water samples collected in the Ophir mining district.

Sample	MH-2000-1, CARRIBEAU PORTAL (6/14/00)			
Parameter	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)
Flow (gpm)	760			
pH (standard units)	6.61			
Conductivity (µS/cm)	1,039			
Alkalinity (mg/L CaCO3)	85			
Hardness (mg/L CaCO3)	660	None	N/A	
Aluminum (trec) (µg/L)	< 500	None	N/A	N/A
Antimony (trec) (µg/L)	< 1	6.0	Below standard	N/A
Arsenic (trec) (µg/L)	8	50.0	Below standard	33
Iron (trec) (µg/L)	8,400	1,000.0	8.4	34,900
Thallium (µg/L)	< 1	0.5	Not detected	N/A
Zinc (trec) (µg/L)	280	2,000.0	Below standard	1,200
Aluminum (µg/L)	< 500	87.0	Not detected	N/A
Cadmium (µg/L)	0.7	5.0	Below standard	2.9
Calcium (mg/L CaCO3)	620	None	N/A	2,500,000
Chloride (mg/L)	< 10	250.0	Below standard	N/A
Chromium (µg/L)	< 200	11.0	Not detected	N/A
Copper (µg/L)	< 40	59.3	Below standard	N/A
Fluoride (mg/L)	0.98	2.0	Below standard	4,100
Iron (µg/L)	4,500	None	N/A	18,700
Lead (µg/L)	< 1	56.4	Below standard	N/A
Magnesium (mg/L)	9.8	None	N/A	40,700
Manganese (µg/L)	1,800	1,000	1.8	7,500
Nickel (µg/L)	< 200	401.1	Below standard	N/A
Potassium (mg/L)	< 10	None	N/A	N/A
Silicon (mg/L)	8.3	None	N/A	34,500
Silver (µg/L)	< 0.2	1.9	Below standard	N/A
Sodium (mg/L)	4.2	None	N/A	17,400
Sulfate (mg/L)	440	250.0	1.8	1,800,000
Zinc (µg/L)	270	524.5	Below standard	1,100

Table 1. Analytical data for water samples collected in the Ophir mining district--continued.

Sample	MH-2000-2, CARRIBEAU EAST (6/14/00)				MH-2000-3, CARRIBEAU WEST (6/14/00)			
Parameter	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)
Flow (gpm)	100				570			
pH (standard units)	6.96				6.86			
Conductivity (µS/cm)	1,025				1,034			
Alkalinity (mg/L CaCO3)	100				85			
Hardness (mg/L CaCO3)	650	None	N/A		650	None	N/A	
Aluminum (trec) (µg/L)	< 500	None	N/A	N/A	< 500	None	N/A	N/A
Antimony (trec) (µg/L)	< 1	6.0	Below standard	N/A	< 1	6.0	Below standard	N/A
Arsenic (trec) (µg/L)	11	50.0	Below standard	6	9	50.0	Below standard	28
Iron (trec) (µg/L)	12,000	1,000.0	12.0	6,400	8,900	1,000.0	8.9	27,800
Thallium (µg/L)	< 1	0.5	Not detected	N/A	< 1	0.5	Not detected	N/A
Zinc (trec) (µg/L)	310	2,000.0	Below standard	165	310	2,000.0	Below standard	970
Aluminum (µg/L)	< 500	87.0	Not detected	N/A	< 500	87.0	Not detected	N/A
Cadmium (µg/L)	0.6	4.9	Below standard	0.3	0.7	4.9	Below standard	2.2
Calcium (mg/L CaCO3)	610	None	N/A	325,800	610	None	N/A	1,908,600
Chloride (mg/L)	< 10	250.0	Below standard	N/A	< 10	250.0	Below standard	N/A
Chromium (µg/L)	< 200	11.0	Not detected	N/A	< 200	11.0	Not detected	N/A
Copper (µg/L)	< 40	58.5	Below standard	N/A	40	58.5	Below standard	125
Fluoride (mg/L)	0.96	2.0	Below standard	500	0.98	2.0	Below standard	3,100
Iron (µg/L)	2,700	None	N/A	1,400	3,700	None	N/A	11,600
Lead (µg/L)	< 1	55.1	Below standard	N/A	< 1	55.1	Below standard	N/A
Magnesium (mg/L)	9.6	None	N/A	5,100	9.6	None	N/A	30,000
Manganese (µg/L)	1,800	1,000	1.8	960	1,800	1,000	1.8	5,600
Nickel (µg/L)	< 200	396.1	Below standard	N/A	< 200	396.1	Below standard	N/A
Potassium (mg/L)	< 10	None	N/A	N/A	< 10	None	N/A	N/A
Silicon (mg/L)	7.9	None	N/A	4,200	8.0	None	N/A	25,000
Silver (µg/L)	< 0.2	1.9	Below standard	N/A	< 0.2	1.9	Below standard	N/A
Sodium (mg/L)	4.2	None	N/A	2,200	4.0	None	N/A	12,500
Sulfate (mg/L)	500	250.0	2.0	267,100	490	250.0	2.0	1,500,000
Zinc (µg/L)	250	517.2	Below standard	134	260	517.2	Below standard	800

Table 1. Analytical data for water samples collected in the Ophir mining district--continued.

Sample	MH-2000-4, BELOW CARRIBEAU (6/14/00)				MH-2000-5, ABOVE CARRIBEAU (6/14/00)			
Parameter	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)
Flow (gpm)	18,000				18,000			
pH (standard units)	7.43				7.47			
Conductivity (µS/cm)	373				351			
Alkalinity (mg/L CaCO3)	32				35			
Hardness (mg/L CaCO3)	195	None	N/A		184	None	N/A	
Aluminum (trec) (µg/L)	380	None	N/A	37,300	480	None	N/A	47,100
Antimony (trec) (µg/L)	< 1	6.0	Below standard	N/A	< 1	6.0	Below standard	N/A
Arsenic (trec) (µg/L)	< 1	50.0	Below standard	N/A	< 1	50.0	Below standard	N/A
Iron (trec) (µg/L)	290	1,000.0	Below standard	28,500	380	1,000.0	Below standard	37,300
Thallium (µg/L)	< 1	0.5	Not detected	N/A	< 1	0.5	Not detected	N/A
Zinc (trec) (µg/L)	210	2,000.0	Below standard	20,600	210	2,000.0	Below standard	20,600
Aluminum (µg/L)	< 50	87.0	Below standard	N/A	< 50	87.0	Below standard	N/A
Cadmium (µg/L)	0.7	1.9	Below standard	69	0.7	1.8	Below standard	68.7
Calcium (mg/L CaCO3)	180	None	N/A	17,700,000	170	None	N/A	16,700,000
Chloride (mg/L)	< 10	250.0	Below standard	N/A	< 10	250.0	Below standard	N/A
Chromium (µg/L)	< 20	11.0	Not detected	N/A	< 20	11.0	Not detected	N/A
Copper (µg/L)	< 4	20.9	Below standard	N/A	< 4	19.9	Below standard	N/A
Fluoride (mg/L)	0.29	2.0	Below standard	28,000	0.24	2.0	Below standard	23,500
Iron (µg/L)	< 10	None	N/A	N/A	< 10	None	N/A	N/A
Lead (µg/L)	< 1	10.0	Below standard	N/A	< 1.0	9.2	Below standard	N/A
Magnesium (mg/L)	3.6	None	N/A	353,000	3.3	None	N/A	323,800
Manganese (µg/L)	190	1,000	Below standard	18,600	190	1,000	Below standard	18,600
Nickel (µg/L)	< 20	158.6	Below standard	N/A	< 20	151.6	Below standard	N/A
Potassium (mg/L)	< 1	None	N/A	N/A	< 1	None	N/A	N/A
Silicon (mg/L)	4.7	None	N/A	460,000	4.4	None	N/A	431,700
Silver (µg/L)	< 0.2	0.2	Below standard	N/A	< 0.2	0.2	Below standard	N/A
Sodium (mg/L)	2.2	None	N/A	216,000	2.00	None	N/A	196,200
Sulfate (mg/L)	140	250.0	Below standard	13,700,000	140	250.0	Below standard	13,700,000
Zinc (µg/L)	180	186.5	Below standard	17,700	180	177.3	1.0	17,700

Table 1. Analytical data for water samples collected in the Ophir mining district--continued.

Sample	MH-2000-47, NORTH CHAPMAN GULCH #101 (10/3/00)				MH-2000-48, DRILL HOLE - CHAPMAN GULCH (10/3/00)			
Parameter	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)
Flow (gpm)	302				33			
pH (standard units)	6.71				6.68			
Conductivity (µS/cm)	1,301				2,210			
Alkalinity (mg/L CaCO3)	105				78			
Hardness (mg/L CaCO3)	727	None	N/A		1,339	None	N/A	
Aluminum (trec) (µg/L)	< 250	None	N/A	N/A	< 500	None	N/A	N/A
Antimony (trec) (µg/L)	< 1	6.0	Below standard	N/A	< 1	6.0	Below standard	N/A
Arsenic (trec) (µg/L)	3	50.0	Below standard	4.9	2	50.0	Below standard	0.4
Iron (trec) (µg/L)	2,000	1,000.0	2.0	3,300	8,900	1,000.0	8.9	1,600
Thallium (µg/L)	< 1	0.5	Not detected	N/A	< 1	0.5	Not detected	N/A
Zinc (trec) (µg/L)	140	2,000.0	Below standard	230	250	2,000.0	Below standard	45
Aluminum (µg/L)	< 250	87.0	Not detected	N/A	< 500	87.0	Not detected	N/A
Cadmium (µg/L)	< 0.3	5.4	Below standard	N/A	< 0.3	8.7	Below standard	N/A
Calcium (mg/L CaCO3)	670	None	N/A	1,103,000	1,300	None	N/A	234,000
Chloride (mg/L)	3	250.0	Below standard	4,9000	12	250.0	Below standard	2,200
Chromium (µg/L)	< 100	11.0	Not detected	N/A	< 200	11.0	Not detected	N/A
Copper (µg/L)	< 20	64.4	Below standard	N/A	< 40	108.5	Below standard	N/A
Fluoride (mg/L)	0.57	2.0	Below standard	940	2.1	2.0	1.1	380
Iron (µg/L)	1,600	None	N/A	2,600	8,900	None	N/A	1,600
Lead (µg/L)	< 1	64.7	Below standard	N/A	< 1	153.6	Below standard	N/A
Magnesium (mg/L)	14.0	None	N/A	23,000	9.4	None	N/A	1,700
Manganese (µg/L)	950	1,000	Below standard	1,600	800	1,000	Below standard	144
Nickel (µg/L)	< 100	431.8	Below standard	N/A	< 200	686.4	Below standard	N/A
Potassium (mg/L)	< 5	None	N/A	N/A	< 10	None	N/A	N/A
Silicon (mg/L)	6.6	None	N/A	10,9000	6.9	None	N/A	1,200
Silver (µg/L)	< 0.2	2.3	Below standard	N/A	< 0.2	6.5	Below standard	N/A
Sodium (mg/L)	4.1	None	N/A	6,700	6.1	None	N/A	1,100
Sulfate (mg/L)	550	250.0	2.2	905,400	1,200	250.0	4.8	215,900
Zinc (µg/L)	140	569.4	Below standard	230	240	954.7	Below standard	43

Table 1. Analytical data for water samples collected in the Ophir mining district--continued.

Sample	MH-2000-49, CHAPMAN GULCH #101 (10/3/00)				MH-2000-50, CHAPMAN GULCH ABOVE #101 (10/3/00)			
Parameter	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)
Flow (gpm)	16				376			
pH (standard units)	6.89				7.24			
Conductivity (µS/cm)	967				1,229			
Alkalinity (mg/L CaCO3)	70				73			
Hardness (mg/L CaCO3)	514	None	N/A		683	None	N/A	
Aluminum (trec) (µg/L)	< 100	None	N/A	N/A	400	None	N/A	800
Antimony (trec) (µg/L)	< 1	6.0	Below standard	N/A	<	6.0	Below standard	N/A
Arsenic (trec) (µg/L)	3	50.0	Below standard	0.3	1	50.0	Below standard	2
Iron (trec) (µg/L)	4,000	1,000.0	4.0	350	990	1,000.0	Below standard	2,000
Thallium (µg/L)	< 1	0.5	Not detected	N/A	< 1	0.5	Not detected	N/A
Zinc (trec) (µg/L)	83	2,000.0	Below standard	7.2	130	2,000.0	Below standard	266
Aluminum (µg/L)	< 100	87.0	Not detected	N/A	< 250	87.0	Not detected	N/A
Cadmium (µg/L)	< 0.3	4.1	Below standard	N/A	< 0.3	5.1	Below standard	N/A
Calcium (mg/L CaCO3)	480	None	N/A	41,900	630	None	N/A	1,300,000
Chloride (mg/L)	1	250.0	Below standard	87	4	250.0	Below standard	8,000
Chromium (µg/L)	< 40	11.0	Not detected	N/A	< 100	11.0	Not detected	N/A
Copper (µg/L)	< 8	47.9	Below standard	N/A	< 20	61.1	Below standard	N/A
Fluoride (mg/L)	1.42	2.0	Below standard	120	0.77	2.0	Below standard	1,600
Iron (µg/L)	2,100	None	N/A	180	< 50	None	N/A	N/A
Lead (µg/L)	< 1	39.5	Below standard	N/A	< 1	59.2	Below standard	N/A
Magnesium (mg/L)	8.2	None	N/A	700	13.0	None	N/A	26,600
Manganese (µg/L)	800	1,000	Below standard	70	320	1,000	Below standard	655
Nickel (µg/L)	< 40	331.5	Below standard	N/A	< 100	411.8	Below standard	N/A
Potassium (mg/L)	< 2	None	N/A	N/A	< 5	None	N/A	N/A
Silicon (mg/L)	11	None	N/A	960	6.6	None	N/A	13,500
Silver (µg/L)	< 0.2	1.3	Below standard	N/A	< 0.2	2.0	Below standard	N/A
Sodium (mg/L)	5.3	None	N/A	460	4.6	None	N/A	9,00
Sulfate (mg/L)	400	250.0	1.6	35,000	540	250.0	2.2	1,100,000
Zinc (µg/L)	82	424.0	Below standard	7.2	110	540.1	Below standard	200

Table 1. Analytical data for water samples collected in the Ophir mining district--continued.

Sample	MH-2000-51, CHAPMAN GULCH ABOVE ROAD (10/3/00)				MH-2000-52, CHAPMAN GULCH #100 (10/3/00)			
Parameter	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)
Flow (gpm)	314				110			
pH (standard units)	7.39				6.77			
Conductivity (µS/cm)	1,222				1,261			
Alkalinity (mg/L CaCO3)	78				28			
Hardness (mg/L CaCO3)	683	None	N/A		690	None	N/A	
Aluminum (trec) (µg/L)	470	None	N/A	800	< 250	None	N/A	N/A
Antimony (trec) (µg/L)	< 1	6.0	Below standard	N/A	< 1	6.0	Below standard	N/A
Arsenic (trec) (µg/L)	1	50.0	Below standard	1.7	< 1	50.0	Below standard	N/A
Iron (trec) (µg/L)	1,100	1,000.0	1.1	1,900	7,600	1,000.0	7.6	4,600
Thallium (µg/L)	< 1	0.5	Not detected	N/A	< 1	0.5	Not detected	N/A
Zinc (trec) (µg/L)	120	2,000.0	Below standard	200	470	2,000.0	Below standard	280
Aluminum (µg/L)	< 250	87.0	Not detected	N/A	< 250	87.0	Not detected	N/A
Cadmium (µg/L)	< 0.3	5.1	Below standard	N/A	0.8	5.2	Below standard	0.5
Calcium (mg/L CaCO3)	630	None	N/A	1,100,000	660	None	N/A	395,700
Chloride (mg/L)	< 1	250.0	Below standard	N/A	4	250.0	Below standard	2,400
Chromium (µg/L)	< 100	11.0	Not detected	N/A	< 100	11.0	Not detected	N/A
Copper (µg/L)	< 20	61.1	Below standard	N/A	< 20	61.6	Below standard	N/A
Fluoride (mg/L)	0.75	2.0	Below standard	1,200	1.14	2.0	Below standard	680
Iron (µg/L)	< 50	None	N/A	N/A	6,900	None	N/A	4,100
Lead (µg/L)	< 1	59.2	Below standard	N/A	1	60.0	Below standard	0.6
Magnesium (mg/L)	13.0	None	N/A	22,000	7.2	None	N/A	4,300
Manganese (µg/L)	290	1,000	Below standard	500	970	1,000	Below standard	580
Nickel (µg/L)	< 100	411.8	Below standard	N/A	< 100	414.6	Below standard	N/A
Potassium (mg/L)	< 5	None	N/A	N/A	< 5	None	N/A	N/A
Silicon (mg/L)	6.4	None	N/A	11,000	12.0	None	N/A	7,200
Silver (µg/L)	< 0.2	2.0	Below standard	N/A	< 0.2	2.1	Below standard	N/A
Sodium (mg/L)	4.4	None	N/A	7,500	5.1	None	N/A	3,100
Sulfate (mg/L)	570	250.0	2.3	976,000	570	250.0	2.3	342,00
Zinc (µg/L)	110	540.1	Below standard	188.3	480	544.2	Below standard	290

Table 1. Analytical data for water samples collected in the Ophir mining district--continued.

Sample	MH-2000-53, CHAPMAN GULCH LOW (10/3/00)				MH-2000-54, "CABLE" ADIT (10/3/00)			
Parameter	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)
Flow (gpm)	477				87			
pH (standard units)	7.06				6.37			
Conductivity (µS/cm)	1,267				938			
Alkalinity (mg/L CaCO3)	77				16			
Hardness (mg/L CaCO3)	719	None	N/A		416	None	N/A	
Aluminum (trec) (µg/L)	310	None	N/A	800	570	None	N/A	270
Antimony (trec) (µg/L)	< 1	6.0	Below standard	N/A	< 1	6.0	Below standard	N/A
Arsenic (trec) (µg/L)	1	50.0	Below standard	2.6	< 1	50.0	Below standard	N/A
Iron (trec) (µg/L)	2,600	1,000.0	2.6	6,800	27,000	1,000.0	27.0	12,800
Thallium (µg/L)	< 1	0.5	Not detected	N/A	< 1	0.5	Not detected	N/A
Zinc (trec) (µg/L)	190	2,000.0	Below standard	490	400	2,000.0	Below standard	190
Aluminum (µg/L)	< 250	87.0	Not detected	N/A	570	87.0	6.6	270
Cadmium (µg/L)	0.3	5.3	Below standard	0.8	0.8	3.5	Below standard	0.4
Calcium (mg/L CaCO3)	670	None	N/A	1,742,000	380	None	N/A	180,200
Chloride (mg/L)	4	250.0	Below standard	10,400	2	250.0	Below standard	950
Chromium (µg/L)	< 100	11.0	Not detected	N/A	< 40	11.0	Not detected	N/A
Copper (µg/L)	< 20	63.8	Below standard	N/A	43	39.9	1.1	20
Fluoride (mg/L)	0.88	2.0	Below standard	2,300	1.44	2.0	Below standard	680
Iron (µg/L)	750	None	N/A	1,900	27,000	None	N/A	12,800
Lead (µg/L)	< 1	63.7	Below standard	N/A	3	29.3	Below standard	1.4
Magnesium (mg/L)	12	None	N/A	31,2000	8.7	None	N/A	4,000
Manganese (µg/L)	400	1,000	Below standard	1,000	2,100	1,000	2.1	1.000
Nickel (µg/L)	< 100	428.1	Below standard	N/A	< 40	282.2	Below standard	N/A
Potassium (mg/L)	< 5	None	N/A	N/A	< 5	None	N/A	N/A
Silicon (mg/L)	7.7	None	N/A	20,000	13	None	N/A	6,200
Silver (µg/L)	< 0.2	2.2	Below standard	N/A	< 0.2	0.9	Below standard	N/A
Sodium (mg/L)	4.8	None	N/A	12,000	6.6	None	N/A	3,100
Sulfate (mg/L)	610	250.0	2.4	1,600,000	440	250.0	1.8	209,000
Zinc (µg/L)	160	564.0	Below standard	400	400	354.4	1.1	190

Table 1. Analytical data for water samples collected in the Ophir mining district--continued.

Sample	MH-2000-55, CARBONERO EFFLUENT DOWNSTREAM (10/3/00)				MH-2000-56, NEW DOMINION #102 (10/4/00)			
Parameter	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)
Flow (gpm)	423				90			
pH (standard units)	6.83				6.38			
Conductivity (µS/cm)	1,321				565			
Alkalinity (mg/L CaCO3)	35.00				26			
Hardness (mg/L CaCO3)	743	None	N/A		246	None	N/A	
Aluminum (trec) (µg/L)	950	None	N/A	2,200	970	None	N/A	475
Antimony (trec) (µg/L)	< 1	6.0	Below standard	N/A	< 1	6.0	Below standard	N/A
Arsenic (trec) (µg/L)	< 1	50.0	Below standard	N/A	< 1	50.0	Below standard	N/A
Iron (trec) (µg/L)	1,600	1,000.0	1.6	3,700	2,600	1,000.0	2.6	1,300
Thallium (µg/L)	< 1	0.5	Not detected	N/A	< 1	0.5	Not detected	N/A
Zinc (trec) (µg/L)	630	2,000.0	Below standard	1,500	520	2,000.0	Below standard	255
Aluminum (µg/L)	< 250	87.0	Not detected	N/A	430	87.0	4.9	200
Cadmium (µg/L)	1.3	5.5	Below standard	3.0	2.1	2.3	Below standard	1
Calcium (mg/L CaCO3)	710	None	N/A	1,637,000	220	None	N/A	108,000
Chloride (mg/L)	4	250.0	Below standard	9,200	< 2	250.0	Below standard	N/A
Chromium (µg/L)	< 100	11.0	Not detected	N/A	< 20	11.0	Not detected	N/A
Copper (µg/L)	< 20	65.6	Below standard	N/A	41	25.5	1.6	20
Fluoride (mg/L)	1.06	2.0	Below standard	2,400	0.99	2.0	Below standard	485
Iron (µg/L)	< 50	None	N/A	N/A	2,000	None	N/A	980
Lead (µg/L)	< 1	66.7	Below standard	N/A	< 1	13.9	Below standard	N/A
Magnesium (mg/L)	8.0	None	N/A	18,400	6.3	None	N/A	3,100
Manganese (µg/L)	570	1,000	Below standard	1,300	1,800	1,000	1.8	880
Nickel (µg/L)	< 100	438.7	Below standard	N/A	< 20	189.3	Below standard	N/A
Potassium (mg/L)	< 5	None	N/A	N/A	1.1	None	N/A	540
Silicon (mg/L)	6.9	None	N/A	15,900	14	None	N/A	6,900
Silver (µg/L)	< 0.2	2.4	Below standard	N/A	< 0.2	0.4	Below standard	N/A
Sodium (mg/L)	5.0	None	N/A	11,500	5.7	None	N/A	2,800
Sulfate (mg/L)	650	250.0	2.6	1,500,000	220	250.0	Below standard	108,000
Zinc (µg/L)	470	579.6	Below standard	1,100	520	227.1	2.3	255

Table 1. Analytical data for water samples collected in the Ophir mining district--continued.

Sample	MH-2000-57, NEW DOMINION #100 (10/4/00)				MH-2000-58, CARBONERO TAILS WEST (10/4/00)			
Parameter	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)	Concentration/ measurement	Standard	Factor above standard	Load (grams/day)
Flow (gpm)	269				18			
pH (standard units)	6.86				7.05			
Conductivity (µS/cm)	1,540				1,491			
Alkalinity (mg/L CaCO3)	77				33			
Hardness (mg/L CaCO3)	895	None	N/A		845	None	N/A	
Aluminum (trec) (µg/L)	< 250	None	N/A	N/A	330	None	N/A	32
Antimony (trec) (µg/L)	< 1	6.0	Below standard	N/A	< 1	6.0	Below standard	N/A
Arsenic (trec) (µg/L)	3	50.0	Below standard	4.4	< 1	50.0	Below standard	N/A
Iron (trec) (µg/L)	7,200	1,000.0	7.2	10,600	1,400	1,000.0	1.4	140
Thallium (µg/L)	< 1	0.5	Not detected	N/A	< 1	0.5	Not detected	N/A
Zinc (trec) (µg/L)	140	2,000.0	Below standard	200	650	2,000.0	Below standard	64
Aluminum (µg/L)	< 250	87.0	Not detected	N/A	< 250	87.0	Not detected	N/A
Cadmium (µg/L)	< 0.3	6.3	Below standard	N/A	1.4	6.1	Below standard	0.1
Calcium (mg/L CaCO3)	850	None	N/A	1,200,000	800	None	N/A	78,00
Chloride (mg/L)	3	250.0	Below standard	4,400	4	250.0	Below standard	390
Chromium (µg/L)	< 100	11.0	Not detected	N/A	< 100	11.0	Not detected	N/A
Copper (µg/L)	< 20	76.9	Below standard	N/A	< 20	73.2	Below standard	N/A
Fluoride (mg/L)	1.48	2.0	Below standard	2,200	1.34	2.0	Below standard	130
Iron (µg/L)	7,200	None	N/A	10,600	860	None	N/A	84
Lead (µg/L)	< 1	86.9	Below standard	N/A	< 1	80.1	Below standard	N/A
Magnesium (mg/L)	11	None	N/A	16,100	11	None	N/A	1,100
Manganese (µg/L)	1,400	1,000	1.4	2,100	510	1,000	Below standard	50
Nickel (µg/L)	< 100	505.6	Below standard	N/A	< 100	484.0	Below standard	N/A
Potassium (mg/L)	< 5	None	N/A	N/A	< 5	None	N/A	N/A
Silicon (mg/L)	14	None	N/A	20,500	1	None	N/A	1,100
Silver (µg/L)	< 0.2	3.3	Below standard	N/A	< 0.2	3.0	Below standard	N/A
Sodium (mg/L)	7.9	None	N/A	11,600	7.7	None	N/A	755
Sulfate (mg/L)	780	250.0	3.1	1,100,000	760	250.0	3.0	75,000
Zinc (µg/L)	140	678.9	Below standard	200	640	646.6	Below standard	62

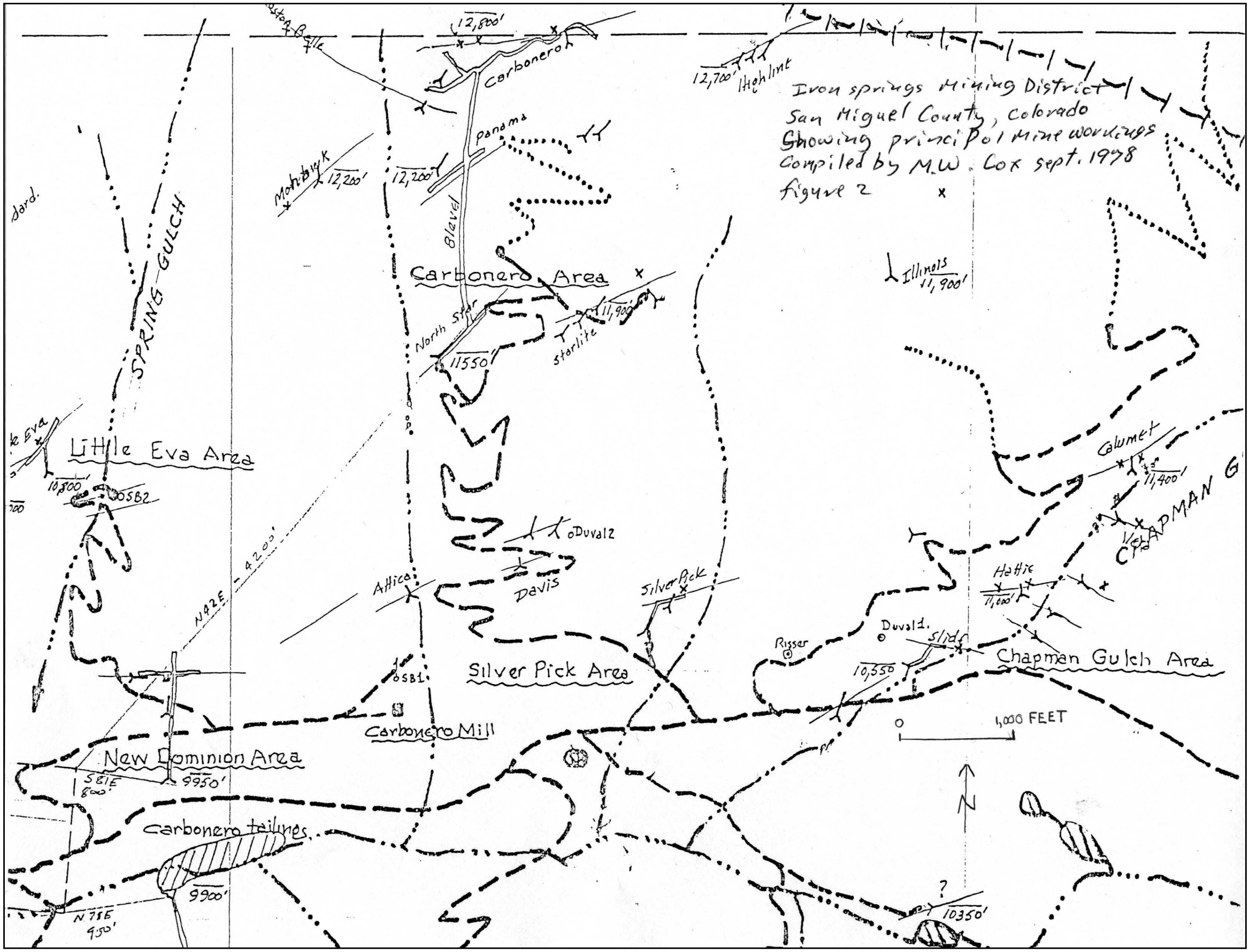

Figure 10. Sketch map showing some of the mines and drill holes in the Ophir mining district (modified from Cox, 1978, fig. 2).

SITE DESCRIPTION

This site is on the west side of a 4WD road that accesses the west side of Chapman Gulch, north of the Ophir Pass Road (fig. 7). Feature #100 is a drill hole spewing water up to 1 foot above the top of the pipe (figs. 11, 12). The water has no true channel, but ponds around the drill pipe and on nearby old roads and drilling pads, then seeps into the ground. Light red/orange precipitate is deposited near the hole. The color of the precipitate grades to reddish brown further from the source. Surface flow does not reach any streams.

Figure 11. Discharging drill hole in June 1996.

Figure 12. Discharging drill hole in October 2000.

WASTE AND HAZARD CHARACTERISTICS

The Duval No. 1 drill hole was almost 1,500 feet deep and cuts Cenozoic sedimentary rock. It is described as being a "short distance northeast of the adit of the Slide claim." This location description does not match the Cox (1978) map (fig. 10) (unpublished report by Gumble and Koestal for Minerals Exploration Company, 1979, p. 11, BLM lead file 130726). No map was available showing the locations of the Prospectors Inc. drill holes.

The average of two water tests conducted in 1996 showed pH was 6.62 and conductivity was 2,170 µS/cm. Flow decreased from 100 gpm in June to 30 gpm when it was sampled in August 1996. Drill hole effluent exceeded State standards in concentrations of iron (9,400 µg/L, total and dissolved), sulfate (1,300 mg/L), and fluoride (2.4 mg/L). Calcium (1,400 mg/L as $CaCO_3$) and hardness were significantly elevated (Neubert and Harris, 1996, p. 23-24).

Sample MH-2000-48 was collected in October 2000. Flow was 33 gpm and the discharge rose an inch or two above the collar of the hole (fig. 12). Conductivity was 2,200 µS/cm and pH was 6.68. Concentrations of most of the analyzed parameters were similar to the 1996 sample. Iron, sulfate, and fluoride exceeded standards (Table 1). Manganese in the 1996 and 2000 samples was elevated but within the standards for this stream segment. Silver was at the detection limit in the 1996 sample but was not detected in 2000.

An older, dry and hardened ferricrete deposit is exposed in the bank of a ravine about 200 feet upstream of this drill hole. The presence of this ferricrete deposit suggests a long history of degraded water in this area. Most likely the drill hole provided an outlet for some of the degraded ground water in this part of the Howard Fork drainage basin.

CHAPMAN GULCH

The Chapman Gulch inventory area (253/4194-1) is about 1½ miles east of Ophir, both north and south of where Chapman Gulch crosses Forest Road 630. During the abandoned mine inventory in 1996, CGS assigned EDRs of 3 to adits #100 and #101 in this inventory area. Both adits were discharging effluent and are on NFS land.

Adit #100 is on the north side of Chapman Gulch, south of and undercutting Forest Road 630. Adit #101 is on the north side of Chapman Gulch, north of Forest Road 630. An adit shown on the topographic base map was incorrectly labeled adit #101 during the inventory in 1996 (fig. 2). Another field visit and examination of air photos in 2000 revealed that no adit exists at the location shown on the topographic base map. Adit #101 is further upstream along Chapman Gulch and is not shown on the topographic map (figs. 6, 7).

MINING HISTORY

Little historical information was available regarding the adits in this inventory area. Recorded production from them amounted to a few tons of ore.

McLaughlin Engineers (1981, fig. VI-O) labeled adit #100 as the Wealth of Ophir Mine. A "small" quantity of ore was shipped from the Wealth of Ophir Mine in 1933 (Henderson, 1934b, p. 183). No other information was found regarding the Wealth of Ophir. A 1971 claim map showed that the unpatented Dorothy B. Lode covered adit #100 (Silver Bell Industries, Inc., 1971). However, the excavation of adit #100 probably predates any activity related to the Dorothy B. lode claim.

Adit #101 is probably No. 3 level of the Slide Mine, on the Slide unpatented mining claim. Cox (1978) showed the Slide adit at the approximate location of adit #101, at an elevation of 10,550 feet (fig. 10).

Slide Mine

1946-1947. The Belisle Brothers owned the Slide, Dorothy B., Defense, and Vera claim block and operated the Slide Mine intermittently from late 1946 until July 1947, when they moved their operation to the New Dominion Mine. Three men worked a total of 160 shifts. No. 1 Level was a 45-foot-long crosscut adit with 50 feet of east and west drifts on a quartz vein. No. 2 Level was a 30-foot-long crosscut adit connected to Level No. 1 by a 30-foot raise dug on the vein. Eight tons of ore containing gold (3 oz) and some silver and zinc were shipped. Four tons, worth $35/ton (0.88 oz/ton gold, 5 oz/ton silver, 2% lead, 3% zinc), were processed at the New Dominion mill, and 26 oz of gold were shipped to the mint (D.C. McNaughtam, Inspector report-Slide Mine, July 23, 1947; 1947 Mine manager report-Slide Mine, CBM). The Belisle Brothers shipped a "small" quantity of ore from the Slide Mine (Martin, 1949, p. 1372).

1959. Randy Belisle worked 130 shifts on the Slide group (Slide, Dorothy B., Defense, and Vera claims). Work included drifting to intersect the vein 100 feet from the portal. No ore was shipped (J.H. Pakka, Information report-Slide, July 24, 1959; 1959 Mine manager report-Slide Mine, CBM).

1963. R. Belisle worked 30 shifts on the Slide group. Work included cleaning out an old stope 60 feet from the portal. No ore was shipped (J.H. Pakka, Information report-Slide, July 25, 1963; 1963 Mine manager report-Slide Mine, CBM).

1964. R. Belisle cleaned out and timbered the Vera tunnel on the Slide group (E. Ray, Information report-Slide, September 16, 1964, CBM.)

1966. R. Belisle performed development work in the Slide group along a 40-foot drift reached by a 180-foot-long crosscut adit**.** No ore was shipped (J.H. Pakka, Information report-Slide, September 22, 1966; 1966 Mine manager report-Slide Mine, CBM).

1967. R. Belisle drifted a short distance east on a vein developed by a 175-foot-long crosscut adit and 40 feet of drift. The Boyles brothers performed some surface drilling for Belisle on the Slide group. About 5 tons of quartz vein material was stockpiled, but no ore was shipped (T. High, Information report-Slide, September 19, October 7, 1967; 1967 Mine manager report-Slide Mine, CBM).

1969. R. Belisle owned the Slide group and had 1,000 feet of exploratory core drilling done (1969 Mine manager report-Slide Group, CBM.)

1970. R. Belisle drifted for 20 feet along the vein on the west side of Chapman Gulch (H. Loue, Information report-Slide Group, October 6, 1970, CBM).

1971. Two employees of Silver Bell Industries operated the Slide group, which was still owned by R. Belisle, for 40 days. No ore was shipped (1971 Mine Managers report-Slide Group, CBM).

1974. R. Belisle operated for 20 days, but shipped no ore. Three adits were on the claim block. No. 1 bears north for 100 feet, then east for 300 feet to the surface. No. 2 bears north for 125 feet, then east for 350 feet connecting to No. 1 adit. About 50 feet below No. 1 and No. 2 adits, No. 3 bears north for 180 feet, then drifts for 75 feet along a vertical vein. It was anticipated that adit No. 3 would intersect the main vein and connect with No. 2 adit in 25 feet. No. 3 adit was discharging water into Chapman Gulch (H. Loue, Information report-Slide Group, October 3, 1974; 1974 Mine Managers report-Slide Group, CBM). Level No. 3 is probably adit #101 of the Chapman Gulch inventory area.

1976. R. Belisle operated with one employee for 40 days. Assessment work was completed, but no ore was shipped (T. Hisk, Information report-Slide Group, July 14, 1976; 1976 Mine Managers report-Slide Group, CBM).

1977. R. Belisle operated with one employee for 16 days. No ore was shipped although a drift was extended (C. Warniu(?) Information report-Slide Group, November 18, 1977; 1977 Mine Managers report-Slide Group, CBM).

1978-1979. R. Belisle performed assessment work on the Slide Group (F. Yates, Information report-Slide Group, August 8, 1978, July 18, 1979, CBM).

1998. R. Belisle quitclaimed the Slide Lode to Vera Belisle (reception no. 319886).

Claim Blocks

A 1971 claim map of the Ophir area showed the Dorothy B. unpatented claim overlying adit #100 and the Slide claim covering adit #101 (Silver Bell Industries, Inc., 1971). These lode claims were originally located in May 1946 (BLM files). By 1971, Silver Bell Industries, Inc. owned or had a significant interest in the Dorothy B. and surrounding claims. R. Belisle amended the location certificate for the Dorothy B. and Slide lodes in October 1979 (BLM files).

Adit #100 is alongside the southeastern boundary and presumably undercuts the unpatented Howard Placer claim. This claim was located over bog-iron (ferrosinter) deposits in 1960 and relocated by Theresa B. Robinson in 1986 (BLM files). Despite its proximity, adit #100 is probably not related to the Howard Placer.

The Ophir No. 6, Ruth No. 3, and Ruth No. 5 Lodes were originally located in 1966. F.W. Baumgartner relocated them in 1969 (bk. 317, p. 241, 530, 532; bk. 330, p. 132; bk. 336, p. 901, 903; bk. 338, p. 110). Adit #100 is on the Ophir No. 6, near the boundary between the two Ruth claims. Adit #101 is probably on the Ophir No. 6 and Ruth No. 5 Lodes. It is doubtful that Baumgartner did any work related to adit #100 or adit #101, because Belisle was working the Slide Mine during this time. Baumgartner probably staked some claims on top of claims owned by Belisle.

GEOLOGY

From North Chapman Gulch adit #101 (described previously) downstream to adit #101 of this inventory area, Chapman Gulch exposes highly altered volcanic rocks with variable amounts of disseminated pyrite and isolated remnants of ancient ferricrete deposits (fig. 6). Adit #101 was driven in altered San Juan Formation volcanic rocks (fig. 4) with varying amounts of disseminated fine-grained pyrite. The adit probably intersected an unmapped vein or mineralized fault zone, because dump #201 contained quartz-pyrite vein fragments and yellow and gray clay. Vhay's (1962) geologic map shows an east-trending, steeply north-dipping vein in the approximate location of adit #101.

Although adit #100 is hosted by Telluride Conglomerate according to the geologic map (fig. 4), abundant porphyritic volcanic rock was on dump #200. The same north-trending mineralized vein associated with the Drill Hole inventory area (described previously) extends southward to adit #100, but it was not observed in the field. Perhaps the porphyritic rock originated from this vein. Moderate amounts of disseminate pyrite and minor amounts of epidote and fluorite were identified on dump #200.

SITE DESCRIPTION

Adit #101 is on the northwest side of Chapman Gulch and north of the Ophir Pass Road. In October 2000, the portal was posted with "No Trespassing" and Colorado Division of Mines warning signs. Effluent depositing minor amounts of red-brown precipitate flowed from the portal onto dump #201. Grass was growing in the muddy effluent channel, which split on the bench of dump #201. Much of the effluent soaked into the dump. Most of the remaining surface flow ran down the west side of dump #201, but some flowed between its two lobes. No effluent reached the Chapman Gulch stream at the surface (figs. 13-15).

Below adit #101 and above adit #100, and just upstream of the Ophir Pass Road, a spring emerges from the bank of Chapman Gulch (fig. 16). This spring or seep deposits abundant red precipitate before it merges with surface flow in Chapman Gulch.

Caved adit #100 is south of and about 20 feet below the Ophir Pass Road. The exact location of the adit could not be determined because of dense vegetation and debris moved during road construction. Water depositing abundant orange-red precipitate emerged from the slope about halfway between dump #200 and the road (fig. 17). This effluent flowed down the east side of dump #200 and into the Chapman Gulch stream (fig. 18). Upstream of its confluence with effluent, Chapman Gulch was slightly turbid. Rocks within the steep stream channel and in pools have a slight red staining. Downstream of its confluence with the mine water, abundant light red-brown precipitate lined Chapman Gulch (figs. 18, 19). The volume of precipitate diminished rapidly downstream.

Figure 13. Adit #101 and dump #201 of the Chapman Gulch area.

Figure 14. Effluent braiding on bench of dump #201.

Figure 15. Adit #101 and effluent.

Figure 16. Seep adjacent to Chapman Gulch, just upstream of the Ophir Pass Road.

Figure 17. Effluent emerging from caved adit #100.

Figure 18. Mixing of effluent from adit #100 (right) with Chapman Gulch.

Figure 19. Chapman Gulch downstream of features #100/200.

Although a moderate volume of effluent flowed adjacent to the east side of dump #200, evidence of active erosion was absent. A small amount of water was seeping from the toe of the waste-rock pile, however (fig. 20).

Figure 20. Seep below dump #200.

WASTE AND HAZARD CHARACTERISTICS

In August 1996, adit #101 was draining 10 gpm with pH of 6.90 and conductivity of 934 µS/cm. A water sample collected at the portal exceeded State standards in iron (4,400 µg/L total recoverable; 2,900 µg/L dissolved) and sulfate (480 mg/L) concentrations. The effluent also contained abundant manganese (800 µg/L) and calcium (460 mg/L) (Neubert and Harris, 1996, p. 22-23).

In October 2000, effluent flowed from the portal of adit #101 at a measured rate of 16 gpm and had 6.89 pH and 967 µS/cm conductivity (sample MH-2000-49). The water was slightly turbid, and red-brown precipitate lined the channel. Minor amounts of algae were growing. This sample was similar to the 1996 sample, exceeding standards in iron and sulfate (Table 1). Manganese and calcium also had significant concentrations.

Samples collected from adit #101 in 1994 (site 9, Appendix) had similar metal concentrations as those collected in 2000, although the total iron in November 1994 (7,200 µg/L) was markedly higher than in October 2000 (4,000 µg/L). (Jim Herron, CDMG, unpublished data.)

Dump #201 contained about 200 cubic yards of red-brown stained, fine-grained volcanic rock with varying amounts of disseminated pyrite. Some quartz-pyrite vein material, and gray and yellow clay also was evident (fig. 13). Evidence of sheet wash erosion was observed, but the toe of the pile is about 50 feet away from the surface water flowing within Chapman Gulch. Sample MWR-2000-11 was a composite sample collected from dump #201 in October 2000. Most metal concentrations were low, although gold concentration was unusually high at 0.149 oz/ton. The sample had extremely low paste pH of 2.79, almost no neutralization potential, and high potential acidity of -23.1 tons $CaCO_3$/1,000 tons (Table 2). Most of the effluent from adit #101 infiltrated into dump #201, presumably entering the alluvial aquifer of Chapman Gulch. This degraded mine water is probably further degraded as it seeps through the acid-generating material of dump #201.

In October 2000, water samples collected from the Chapman Gulch stream above and below the influence of features #101/201 contained similar metal concentrations (fig. 7, Table 1). Upstream of this mine, Chapman Gulch was flowing at 376 gpm and had 7.24 pH and 1,229 µS/cm conductivity (sample MH-2000-50). The water was slightly turbid and minor iron stain and light red precipitate was present in the channel. Iron concentration (990 µg/L) was within standards; sulfate concentration (540 mg/L) exceeded State standards. Below adit #101 and upstream of the iron-rich spring in Chapman Gulch (figs. 7, 16), flow was measured at 314 gpm, pH was 7.39 pH, and conductivity was 1,222 µS/cm (sample MH-2000-51, Table 1). The channel contained slightly more light red precipitate and algae than at the upstream sample site. Sulfate concentration (570 mg/L) remained above State standards, and iron concentration (1,100 µg/L) increased slightly and exceeded standards.

In June 1996 water with pH of 5.80 and conductivity of 1,215 µS/cm emerged from caved adit #100. In August this effluent was sampled where it emerged at a measured rate of 100 gpm. Concentrations of iron (7,200 µg/L trec), sulfate (680 mg/L), and zinc (390 µg/L) exceeded standards, and manganese (970 µg/L) was elevated. The sample contained abundant calcium carbonate (640 mg/L) that contributed to the relatively neutral pH and high conductivity (Neubert and Harris, 1996, p. 21-22).

Adit #100 effluent was sampled again in October 2000. Flow rate was 110 gpm, pH was 6.77, and conductivity was 1,261 µS/cm (sample MH-2000-52). The water was slightly turbid and was depositing abundant red-orange precipitate. The sample contained similar metal concentrations as the 1996 sample, exceeding standards in iron (7,600 µg/L trec) and sulfate (570 mg/L). Concentrations of zinc (470 µg/L) and manganese (970 µg/L) approached standards. Calcium concentration (660 mg/L as CaCO3) was significantly elevated, contributing to a high hardness value.

Water samples collected from adit #100 during low flow and high flow conditions in 1994 remained relatively constant in metal concentrations (site 10, Appendix) and were quite similar to the sample collected in 2000. The flow rate also remained relatively stable. (Jim Herron, CDMG, unpublished data.) The consistent flow and metal concentrations may be indicative of a deep source of ground water, relatively unaffected by meteoric waters.

Dump #200 contained about 450 cubic yards of brown, oxidized, mostly sand-size material.

Disseminated pyrite was common, and minor epidote and fluorite were present. Composite sample MWR-2000-12 was collected from this waste-rock pile. Metal concentrations were generally low. Paste pH was slightly acidic at 5.02, but net acid-base potential was slightly alkaline at 0.8 tons $CaCO_3$/1,000 tons (Table 2).

About 2 gpm of water was seeping from the toe of dump #200 in October 2000, with pH of 7.09 and conductivity of 1,112 µS/cm. No precipitate was associated with this water, which dispersed into some willows before entering the Chapman Gulch stream.

Downstream of the influence of features #100/200, Chapman Gulch flowed at 477 gpm, and the turbid water had 7.06 pH and 1,267 µS/cm conductivity (sample MH-2000-53). Upstream of its confluence with effluent from adit #100, Chapman Gulch had minor amounts of red staining in some of the pools within the stream channel. Immediately downstream of its confluence with the mine water, abundant light red-brown precipitate lined Chapman Gulch. The volume of precipitate diminished rapidly downstream.

The iron-stained spring above adit #100 and near the Ophir Pass Road (fig. 16) discharged water with 7.30 pH and 1,946 µS/cm conductivity. No sample was collected. The proximity of this spring to adit #100, and the similarity in the color of the associated precipitate, suggests that this "spring" may actually be mine water from adit #100. The underground workings of that caved adit are entirely filled with water, and perhaps some of that water escapes through vertical fractures and emerges in Chapman Gulch.

A comparison of surface water from the headwaters of Chapman Gulch (adit #101, North Chapman Gulch inventory area MH-2000-47), to sample site MH-2000-53 below all of the sites in the Chapman Gulch sampled in October 2000, showed only minor changes. Flow increased from 302 to 477 gpm; pH increased slightly from 6.71 to 7.06; and conductivity decreased slightly from 1,301 to 1,267 µS/cm. Total recoverable iron concentration increased by about 30%, and the load nearly doubled to about 15 lb/day. Interestingly, dissolved iron concentration decreased at the downstream site, suggesting that much iron was carried as suspended solids. Zinc concentration increased slightly, but the zinc load nearly doubled to about 1 lb/day. A minor increase in sulfate concentration resulted in a greater than 50% increase in the load at the downstream site. Manganese concentration below all of the sites in Chapman Gulch was cut in half, and the load was reduced to about 2 lb/day at the lower site. Although other mines and natural sources of metals occur higher in Chapman Gulch, most of the increased metal loads are probably related to effluent from adit #100 of the Chapman Gulch inventory area.

In 1994, little change in water chemistry was revealed from adit #101 of the North Chapman Gulch inventory area (site 7, Appendix) to site 11 below adit #100 of the Chapman Gulch inventory area. Most metals decreased slightly in concentration at the downstream site. Because of higher flow at the downstream site, loads remained approximately the same for most metals. Samples from Howard Fork above and below its confluence with Chapman Gulch (Appendix) showed a slight increase in total recoverable concentrations of manganese, zinc, and iron below Chapman Gulch, but remained within standards. (Jim Herron, CDMG, unpublished data.)

Table 2. Analytical data for waste rock and tailings samples collected in the Ophir mining district. [Negative numbers for net acid-base potential indicate acid-generating material. Parameters below the bold line were analyzed by x-ray fluorescence.]

Parameter	Carribeau-composite (MWR-2000-1)	Carribeau-channel (MWR-2000-2)	Chapman Gulch #201 254/4194-1.201 (MWR-2000-11)	Chapman Gulch #200 254/4194-1.200 (MWR-2000-12)	Carbonero area #201 252/4194-1.201 (MWR-2000-13)	New Dominion #202 251/4193-1.202 (MWR-2000-14)	New Dominion #200 251/4193-1.200 (MWR-2000-15)	Carbonero tailings west (MWR-2000-16)	Carbonero tailings east (MWR-2000-17)
pH	5.50	4.43	2.79	5.02	4.63	5.75	6.13	2.93	3.97
Neutralization potential (tons CaCO3/1,000 tons)	5.6	0.4	0.1	5.7	4.6	10.5	30.8	<0.1	0.8
Potential acidity (tons CaCO3/1,000 tons)	14.3	7.7	23.1	4.9	10.5	8.6	11.2	6.0	2.8
Net acid-base potential (tons CaCO3/1,000 tons)	-8.8	-7.4	-23.0	0.8	-5.9	1.9	19.6	-6.0	-2.0
Gold (oz/ton)	0.007	0.15	0.149	0.007	<0.002	0.015	0.026	0.011	0.010
Silver (oz/ton)	0.34	1.24	0.21	0.06	0.06	0.30	0.86	2.24	2.36
Mercury (ppm)	0.1	0.2	<0.1	0.2	<0.1	<0.1	0.1	2.1	2.0
Al2O3 (%)	15.5	15.8	17.6	12.5	17.8	14.3	14.1	14.6	15.4
BaO (%)	0.26	0.28	0.23	0.11	0.09	0.09	0.13	0.38	0.31
CaO (%)	0.78	0.23	0.76	3.84	1.13	0.37	2.10	1.17	1.41
Chlorine (%)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fe2O3 (%)	6.51	4.06	4.81	5.26	6.30	4.54	6.17	5.46	6.75
K2O (%)	4.28	4.47	4.20	4.54	3.62	4.03	4.19	3.72	4.01
MgO (%)	1.05	0.69	1.92	2.13	2.75	1.32	2.47	0.75	0.77
MnO (%)	0.27	0.02	0.02	0.09	0.03	0.20	0.26	0.08	0.03
Na2O (%)	0.56	0.22	0.53	1.81	1.12	0.28	0.59	<0.05	<0.05
P2O5 (%)	0.14	0.07	0.17	0.28	0.27	0.07	0.14	0.22	0.29
SiO2 (%)	64.8	70.2	63.8	66.0	60.2	70.1	65.0	57.8	57.5
Sulfur (%)	1.13	1.10	1.24	0.26	0.64	0.96	1.17	2.73	2.37
TiO2 (%)	0.63	0.53	0.64	0.47	0.77	0.39	0.52	0.79	0.84
Arsenic (ppm)	64	71	90	<20	<20	59	81	59	91
Chromium (ppm)	94	65	35	41	35	63	86	<10	<10
Cobalt (ppm)	11	<10	<10	<10	<10	<10	<10	<10	<10
Copper (ppm)	322	96	141	118	142	552	483	359	267
Lead (ppm)	1,044	6,102	423	282	41	5,393	5,729	12,352	14,517
Molybdenum (ppm)	<10	<10	13	<20	78	25	<10	<10	<10
Nickel (ppm)	14	<10	<10	<10	<10	<10	15	<10	<10
Niobium (ppm)	17	12	<10	<10	<10	<10	11	10	12
Rubidium (ppm)	130	148	197	118	155	187	194	162	185
Strontium (ppm)	161	170	169	296	269	61	175	234	255
Thorium (ppm)	36	171	22	27	29	76	67	123	147
Tin (ppm)	110	130	94	93	111	125	129	176	207
Tungsten (ppm)	<10	10	<10	<10	<10	<10	<10	<10	<10
Uranium (ppm)	14	15	13	24	<10	15	28	29	19
Vanadium (ppm)	85	94	108	75	141	63	66	134	149
Yttrium (ppm)	50	55	58	41	39	73	78	82	93
Zinc (ppm)	249	263	125	118	42	1,789	888	7,115	4,132
Zirconium (ppm)	220	189	177	146	188	153	201	164	177

CARBONERO AREA

The Carbonero Area inventory area (252/4194-1, fig. 2) is northeast of Ophir. Access is via a winding and steep 4WD road off of Forest Road 630. During the inventory in 1996, CGS assigned an EDR of 2 to a large ravine eroded by mine water from the Carbonero Mine (feature #104), and EDRs of 3 to adit #101 and associated dump #201 in this inventory area.

At the Carbonero Mine, the portal and waste-rock pile lie on the privately owned North Star Lode and were not included in the inventory. Erosional feature #104 associated with mine water from the Carbonero extends onto NFS land however. Underground workings of the Carbonero Mine extended to the north from the North Star Lode and undercut private land (West Panama, East Panama, Carbonero, Carbonado, Carbon, and Boston Belle Lodes) and NFS land that included the unpatented Vindicator, Vindicator No.1, Columbine No. 3, and Vista lodes (as of 1971).

The Carbonero Mine's associated mill is located on private land on the North Star Millsite, but the large tailings pile from the Carbonero mill lies partly on NFS land. The environmental setting of that site is described later in this report (see **Carbonero Tailings** section). Historical information regarding the mill is included in this segment because of its close association with the mining history.

Mine features #101/201 of the Carbonero Area inventory area are a caved adit and waste-rock pile within or near the patented Marie Antoinette Lode. Names that have been used for adit #101 include the Marie Antoinette, Perry Davis Tunnel, Davis, and Cable Adit. This area should be surveyed to determine property ownership.

MINING HISTORY

The Carbonero Mine was one of the largest and most consistent producers in the Ophir (Iron Springs) mining district (Table 3). The Marie Antoinette Mine produced insignificant quantities of ore.

Carbonero Mine

Operations began at the Carbonero Mine in about 1885. Production was almost continuous from the 1890's until the early 1940's (Table 3). Peak production was probably during the 1920's, when various individuals and companies leased the property from Carbonero Mines and Reduction Company. From 1907 to1941, Vhay (1962, p. 287) cited production figures of 101,662 tons of ore containing 0.024 oz/ton gold, 8.7 oz/ton silver, 6.99% lead, 4.7% zinc, and 0.16% copper. These figures were based on written communication with W.B. Meek. Additional production by Silver Bell Mines Company occurred in the early 1950's. Activity at the site continued until the 1970's.

Table 3. Production from the Carbonero Mine. (From various sources, see following text for details; X refers to production of an unknown quantity; ? refers to probable production.)

YEAR	PRODUCTION (tons unless noted)	Au (oz)	Ag (oz)	Cu (lb)	Pb (lb)	Zn (lb)	Operator
1899	?						Pickett
1900	?						
1901	?						
1902	X ($75/ton)	X	X		X		Pickett
1904	Regular shipments	?	?		?		
1905	X	?	X		X		
1906	X		X		X		Carbonero Gold Mining
1907	X		X		X		
1908	250 tons/month		X		X		Carbonero Mines & Reduction
1909	X		?		X		
1910	X ($40/ton)		X		X		Carbonero Mines & Reduction
1911	X ($40/ton)		?		?		Pickett
1912	X				X		Pickett
1913	X	X	X		X		Pickett
1914	X	?	X		X		Pickett
1917	Several cars	?	X		?		Carbonero Leasing
1918	204	26	5,916	9,751	97,920	16,320	Carbonero Leasing
1919	"Several hundred"	?	X		X		Ruuttilla, Brown, & Co.
1920	490	33	22,932	14,700	255,780	88,200	Ruuttilla-Brown Leasing
1921	340	21	18,190	10,200	180,880	61,200	Ruuttilla-Brown Leasing
1922	183	7	7,075	5,124	101,748	29,280	Ruuttilla-Brown Leasing; Basil, Ferguson, & Divan
1923	926	43	32,780	27,780	431,516	150,012	Ruuttilla-Brown Leasing; Basil & Ferguson
1924	71 crude 137 concentrate	1,795	5,169	9,563	109,052	27,904	Ophir-Colorado Mines
1925	652 crude 1,306 concentrate	161	53,292	72,713	1,315,931	297,492	Ophir-Colorado Mines
1926	451 crude 1,697 concentrate	161	76,447	66,588	201,611	?	Girardi & Downs
1927	492 crude; 2,774 concentrate	163	111,044	101,246	3,168,020	?	Girardi & Anderson
1928	600 crude 14,500 concentrate	314	151,500	18,000	3,440,000	1,081,000	Girardi & Anderson
1929	154 crude 1,970 concentrate	88	94,810	56,160	2,305,600	156,380	Girardi
1930	40 tons/day	?	?	?	?	?	Girardi
1931	X	?	?	?	?	?	
1934	X	?	?	?	?	?	
1936	4,000 crude 180 middlings	200	40,000	32,000	360,000	600,000	Harrison
1938	157.5 crude 2,500 middlings	X	4,410	?	6,300	?	Ophir-Telluride Exp.; Harrison
1939	Small amount						
1940	Small amount						
1941	Small amount						
1951	275 tons ($7,165)	?	?	?	?	?	Silver Bell Mines
1952	5,756 tons ($119,733)	X	X	X	X	X	Silver Bell Mines
1953	14,196 tons ($221,712)	X	X	X	X	X	Silver Bell Mines
1954	X	?	?	?	?	?	Silver Bell Mines

The original Carbonero Mine was high on the slopes, about 1,800 feet north and 700 feet higher than the Carbonero Mine labeled on the PBS and topographic maps. These early, upper levels of the mine were driven on the Carbon and/or Carbonero patented claims. Most production, however, came through a newer portal on the North Star patented claim, and this is the Carbonero Mine labeled on maps. This lower and most important level was probably started between 1898 and 1901 and had several different names during the long production history of the mine. Initially it was the North Star, then it became the No. 4 level, the No. 8 level, and in the 1950's it was called the 600 level. Several operators called it the Shoofly level.

Production from this main level was trammed to a mill that was built in 1924. Mill tailings were deposited below the mill, with the largest accumulation placed near Howard Fork (figs. 10, 21).

1885. John Leslie, Albert Carpenter, and Jeremiah Cole located the Carbonero and Carbonado Lodes in October. "Lessees of the Carbon mine, at Ophir, have begun work on a 700 foot cross cut tunnel, which will tap the vein at a depth of 500 feet" (*Rocky Mountain News*, October 22, 1885, p. 6). This may refer to the Carbon Lode, which adjoins the west side of the Carbonero Lode.

1886. The Carbonero was owned by Leslie, Everett, and Donnenlan and was "worked during the summer with good results" (*San Juan Herald*, November 4, 1886, p. 3).

1887-1888. No production was reported from the Carbonero Mine (Munson, 1888, p. 184; Munson, 1889, p. 124).

1897. The Carbonero Lode was located in August (Mineral Survey No. 16906).

1898. George B. Pickett, G. Anderson, and J. Williamson located the North Star Lode in May. At the time, an abandoned adit of unknown length already existed on the claim (bk. 73, p. 382; Mineral Survey No.16905). The draining portal associated with erosional feature #104 of the inventory area labeled "Carbonero Mine" on the PBS and topographic map, lies on the North Star Lode (figs. 2, 7). Pickett, Frank L. Rouse, W.W. Stevens, and William Strieby amended the location certificate for the Carbonero Lode in August (Mineral Survey No. 16906).

1899. Pickett operated the Carbonero properties and expected to ship ore soon (*Denver Times*, June 24, 1899, p. 3). A rich vein was exposed, and an investor from Colorado Springs purchased one-fourth interest in the mine (*Mining Reporter*, December, 28, 1899, v. 40, p. 390).

1901. Ore was exposed in the 200-foot-long upper adit and the 150-foot-long lower adit at the Carbonero. A 6-inch-thick ore zone was exposed along the 350-foot-long drift off a crosscut tunnel at the North Star (*Mining Reporter*, February 7, 1901, v. 43, p. 88). The crosscut and drift at the North Star are probably the adit labeled as the "Carbonero Mine" on the topographic map. Gust Anderson located the Vindicator and Vindicator No.1 lodes in January (BLM files). These claims lie along the north side of the North Star, but were never patented.

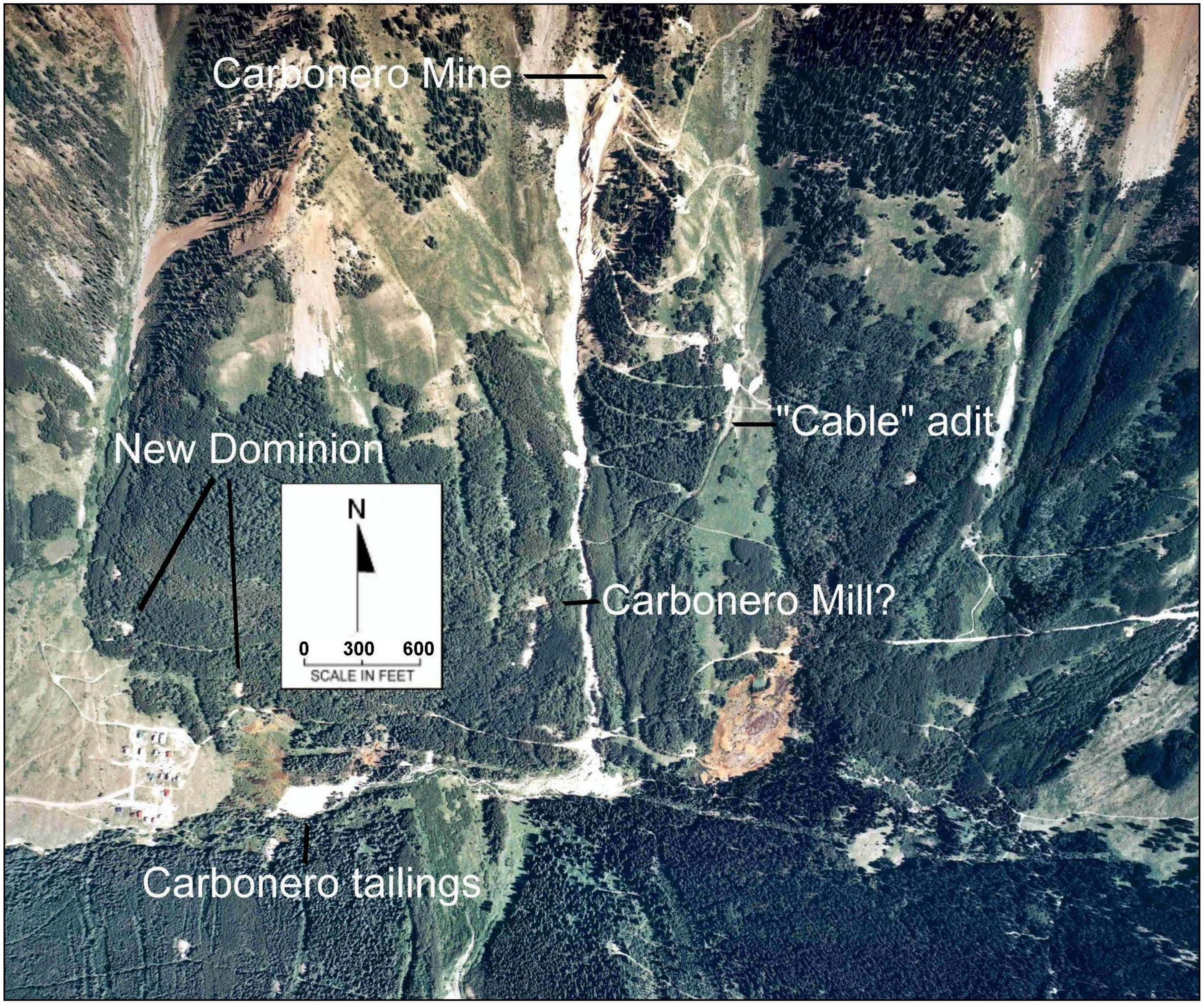

Figure 21. Aerial photograph of the middle portion of Howard Fork drainage basin.

1902. An 8-inch-wide vein of "high-grade galena ore" was exposed in a crosscut at the Carbonero property late in the year. Averaging $75/ton, the ore consisted of galena and lead carbonate with gold and silver values. Pickett was the manager. Reportedly, regular shipments were made from the property nearly from its discovery (*Denver Times*, December 3, 1902, p. 12). No record of major or consistent production was found in other literature however. Perhaps the shipments were small, or were combined with production from other mines.

1903. Owners of the Carbonero group (Pickett, Rouse, Stevens, and Strieby) purchased the North Star group (*Mining Reporter*, November 12, 1903, v. 48, p. 471). Mineral Survey No. 16905 was conducted on the North Star Lode in November, and Mineral Survey No. 16906 was conducted on the Carbonero, Carbonado, Carbon, and Boston Belle Lodes in December. Pickett and others were listed as owners on both surveys.

Development on the North Star Lode (fig. 22) included a 32-foot-long discovery adit and 570-foot-long adit with a 240-foot-long, north-trending crosscut (810 total feet). About 150 feet of the crosscut extended north of the North Star Lode. An unknown individual had excavated the first 20 feet of the discovery adit. Pickett and others developed the remainder of the workings on the claim. The first 49 feet of the longer adit and 12 feet of the discovery adit were used toward the $500 worth of improvements required for patent (Mineral Survey No.16905). The longer adit on the North Star Lode is labeled as the "Carbonero Mine" on the PBS and topographic maps.

Development on the Carbonero Lode included a discovery cut, a 550-foot-long adit, and a 640-foot-long adit (Mineral Survey No. 16906). Adits on the Carbonero Lode probably became the upper level workings in the Carbonero Mine.

1904. Regular shipments were made to Durango and Pueblo from the Carbonero Mine. Mules packed ore from the mine to the railroad. One or two cars worth $400 to $1,000/car were shipped monthly. As of September, the company was shipping about $2,000/month of ore, leaving a small profit after expenses. New ground was continually developed (*Mining Reporter*, August, 4, p. 121-122; September 15, p. 281; December 1, p. 593, v. 50, 1904).

1905. Lead-silver ore was shipped from the Carbonero Mine (Lundgren, 1906, p. 211)**.** The North Star, Carbonero, Carbonado, Carbon, and Boston Belle Lodes were patented (USFS records). Pickett, Rouse, Stevens, and Strieby located the Vista Lode in May (BLM files). The claim adjoins the south side of the Carbon and Carbonero patented claims and covers some of the underground workings of the lower levels of the Carbonero Mine.

1906. Carbonero Gold Mining Company shipped silver-bearing galena and lead carbonate ore. Two adits, 850 and 1,200 feet in length developed the vein (Naramore, 1907, p. 234).

1907. The Carbonero Mine shipped "high-grade silver-lead ore" (Naramore, 1908, p. 273-274.)

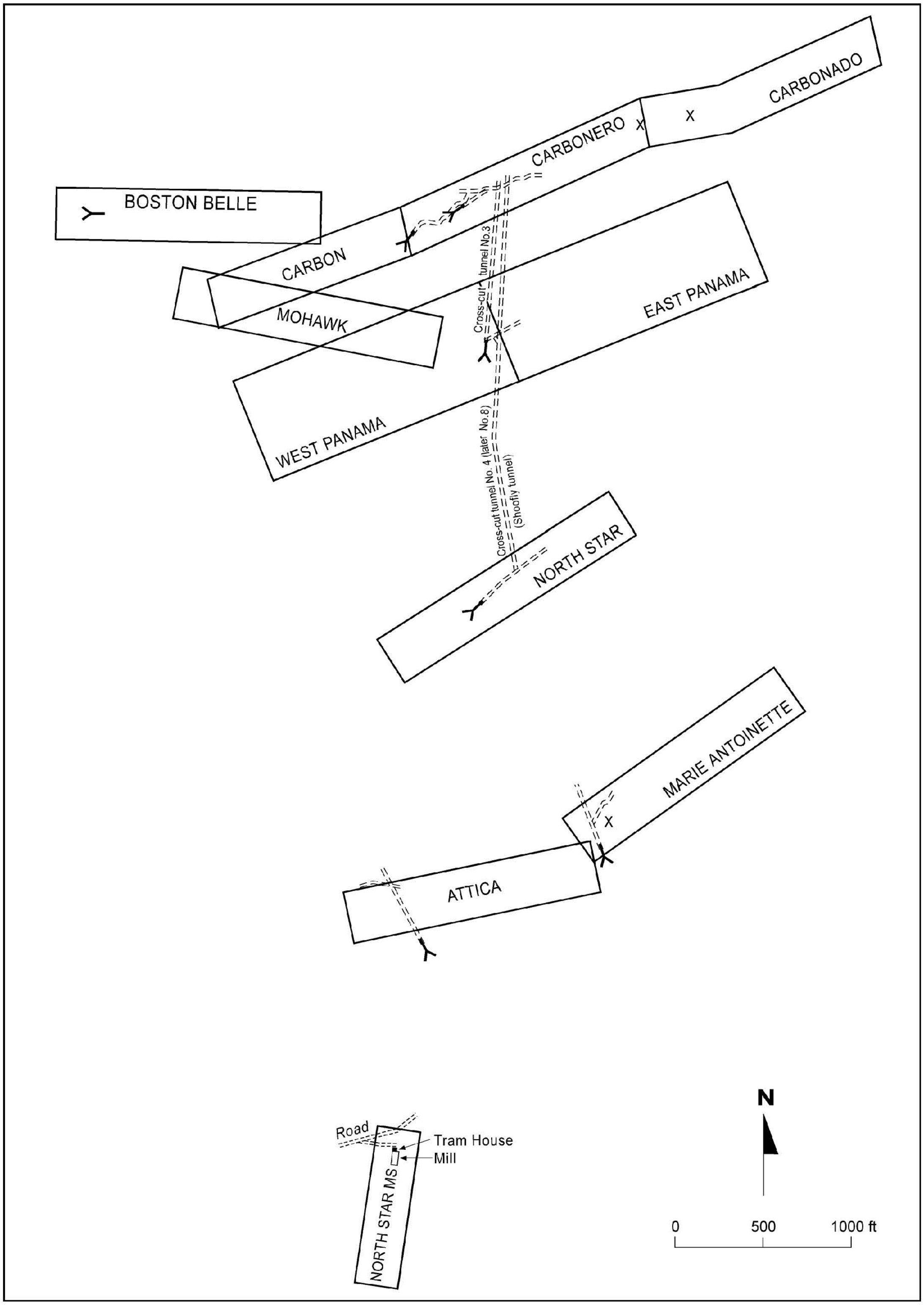

Figure 22. Map of mineral surveys in the Carbonero Mine area (modified). Workings shown are from the latest mineral survey. More recent maps (Vhay, 1962, plate 21-H) show work, done mostly under a Defense Minerals Exploration contract, extended the lowest level of the Carbonero Mine (level No. 8) about 1,400 feet east onto the Carbonado Lode.

1908. Carbonero Mines and Reduction Company owned and operated the Carbonero Mine with Pickett as the manager. Patented claims included the Carbonero, Carbon, Boston Belle, Mohawk, and North Star. The main adit was a 1,000-foot-long crosscut to the vein; 200 feet of drifts followed the vein east and west. A 1- to 6-foot-wide quartz-galena vein had a northeast strike and 80° northwest dip. Vein length was estimated at 4,000 feet, and it had a vertical extent of at least 600 feet. The mine worked continuously, with 22 workers and a foreman producing an average of 250 tons/month. Miners were stoping on the vein and were driving a raise that was 120 feet high in August. The intent of the raise was to connect to the No. 2 level (T.J. Dalzell, Inspection report-Carbonero, August 14, 1908, v. 10, p. 116, CBM). Henderson (1909, p. 399) reported that shipments of lead-silver ore from Carbonero Gold Mining Company's property in 1908 increased over 1907 production. Most likely, Carbonero Gold Mining Company and Carbonero Mines and Reduction Company are closely related companies.

1909. Lead ore was shipped from the Carbonero group (Henderson, 1911a, p. 328).

1910. Carbonero Mines and Reduction Company (Stevens-president; Rouse-secretary; Pickett-manager) owned and operated the mine with 12 employees. Silver-lead ore averaging $40/ton was shipped directly to smelters. Development included 1,000 feet of crosscut, 800 feet of drifts, 225 feet of raise, and 700 feet of stopes (1910 Mine managers report-Carbonero, p. 166, CBM). Lead ore shipments from the Carbonero group increased over the previous year (Henderson 1911b, p. 436).

1911. Pickett leased and managed the mine, which was operated with 16 employees and was owned by Carbonero Mines and Reduction Company. Shipments averaged $40/ton. A 1,000-foot-long crosscut adit accessed the vein, which was exposed by 1,400 feet of drifts, upraises, chutes, and stopes (1911 Mine managers report-Carbonero, p. 210, CBM). Lead ore shipments increased over 1910 (Henderson, 1912, p. 561).

1912. Pickett continued leasing the mine from Carbonero Mines and Reduction Company and employed an average of 20 workers. Level No. 3 was used as the main working level and was a 1,000-foot-long crosscut adit with a 1,500-foot-long east-trending drift. Levels No. 1 and 2 above connected to Level No. 3 through manways. Each level had an exit. As of May, total development included 4,000 feet of tunnels, 1,000 feet of crosscuts, and 600 feet of raises. Assays averaged $40/ton, and costs were about $23.50/ton (mining, $10; transportation, $9.50; treatment, $4). By the end of the year, total development included 1,500 feet of tunnel and drift in Level No. 2; 1,000 feet of crosscut tunnel and 1,500 feet of drifts, raises, and stopes in Level No. 3. Level No. 1 was 1,200 feet long (S. Treais, Inspectors report-Carbonero Mine, May 16, 1912, v. 14, p. 568; 1912 Mine managers report-Carbonero, p. 568, CBM; Henderson, 1913, p. 696).

1913. Pickett and 20 workers shipped ore from the mine, which was leased from Carbonero Mines and Reduction Company (Stevens-president; Rouse-secretary). The company owned the Carbonero, Carbonado, Carbon, Mohawk, and North Star patented claims, and the Cascade, Vista, Portland, Farwell, Vindicator, Vindicator No.1, Calmet, and Great View unpatented claims. Lead carbonate ore, with values in gold, silver, and lead, was mined from a vein hosted by andesite breccia. As of May, development totaled 7,100 feet (4,600 feet of tunnels and drifts; 700

feet of raises; 1,800 feet of crosscuts), and the company was driving another crosscut adit 400 feet below the main level. The new crosscut had been driven about 800 feet (S. Treais, Inspectors report-Carbonero Mine, May 7, 1913, v. 15, p. 708; 1913 Mine managers report-Carbonero, p. 449, CBM; Henderson, 1914, p. 272). The main level at this time was probably No. 3. The new crosscut was probably No. 4 and was probably an extension of the North Star adit shown on Mineral Survey No. 16905 (fig. 22). This adit is labeled as the "Carbonero Mine" on the PBS and topographic maps.

1914. Pickett operated and shipped lead-silver ore from the mine, which was leased from Carbonero Mines and Reduction Company. New development since the 1913 inspection included 1,200 feet of drifting, 700 feet of crosscuts, and 225 feet of upraises. Total development included 5,800 feet of tunnels and drifts, 2,500 feet of crosscuts, and 925 feet of raises. A 900-foot-long crosscut (Level No. 3) intersected the Carbonero vein in March (S. Treais, Inspectors report-Carbonero Mine March 27, 1914, v. 16, p. 255, CBM; Henderson, 1916, p. 302).

1915. A "small" quantity of ore was shipped from the Carbonero Mine (Henderson, 1917, p. 471-472). The East Panama and West Panama Lodes were located in June (Mineral Survey No. 19815).

1916. Carbonero Mines and Reduction Company (E.B. Adams-agent) amended the location certificates of the Panama claims in September (Mineral Survey No. 19815).

1917. In April, Carbonero Leasing Company (Stevens-president; Pickett-manager) resumed operations at the Carbonero Mine, which was leased from Carbonero Mines and Reduction Company (Stevens-president). Most of the work was concentrated on the lower crosscut tunnel (level No. 4). By September, the 2,800-foot-long level No. 4 crosscut intersected the Carbonero vein and drifted on it for 100 feet. A 200-foot-long drift was also driven on the Shoofly vein. The company intended to drive a 500-foot raise that would connect with the winze 150 feet below level No. 3 (R. Innes, Inspectors report-Carbonero Mine, August 29, 1917, CBM). "Several cars of silver ore were shipped" (Henderson, 1920, p. 844).

In September, Mineral Survey No. 19815 was conducted on the West Panama and East Panama Lodes, owned by Carbonero Mines and Reduction Company. Workings shown on the survey (fig. 22) included a 2,600-foot-long, north-trending adit (tunnel No. 4 or Shoofly tunnel) beginning on the North Star Lode and ending about 550 feet north of the East Panama Lode. Level No. 3 was a 1,000-foot-long, north-trending adit beginning on the West Panama Lode and ending about 550 feet north of the East Panama Lode. Tunnels No. 3 and 4 were nearly parallel and about 100 feet apart horizontally and about 700 feet apart vertically. Discovery points for the claims were within the underground workings, 735 feet (vertically) beneath the surface of the West Panama Lode, and 775 feet (vertically) beneath the East Panama Lode (Mineral Survey No. 19815). All of these levels were considered part of the Carbonero Mine. Tunnel No. 4 of this survey is the draining adit labeled as the "Carbonero Mine" on the PBS and topographic maps.

1918. Carbonero Leasing Company operated the mine through a lease from Carbonero Mines and Reduction Company. By July, 500 feet of drifts and a 150-foot-long by 50-foot-high stope were excavated on the Carbonero vein in Tunnel No. 4. Carbonero vein material on the No. 4 level was worth about $100/ton. The 500-foot-high, two-compartment raise started in 1917, was up 200 feet. D.A. Herron, Joseph Peterson, and Stevens did some work but discontinued operations during the year. Ruuttilla, Brown & Company subleased a 1,100-foot-long by 110-foot-deep block below the No. 3 level in October 1917 and shipped 10 cars by July 1918. Total annual production from all operations at the mine was 204 tons containing 0.11 oz/ton gold, 25 oz/ton silver, 24% lead, 2.4% copper, and 3.9% zinc. In 1918 the Carbonero was the largest producer in the Ophir district (R. Innes, Inspector reports-Carbonero Mine, July 1, 1918, July 6, 1920; 1918 Mine managers report-Carbonero Leasing Co., CBM; Henderson, 1921, p. 866).

1919. The East Panama and West Panama Lodes were patented in August (USFS records). Carbonero Leasing Company operated the Carbonero Mine through a lease from Carbonero Mines and Reduction Company. Carbonero Leasing reported no production for the year. Ruuttilla, Brown & Company (Matt Ruuttilla-manager) mined subleased ground and made regular shipments (R. Innes, Inspectors report-Carbonero Mine, August 26, 1919; 1919 Mine managers report-Carbonero Leasing Co., CBM). Henderson (1922a, p. 785) reported that “Several hundred tons of lead-silver oxidized ore was shipped” and that the Carbonero was the largest producer in the Iron Springs mining district. R. Innes (Inspectors report-Carbonero Mine, July 6, 1920) noted that the past year’s shipments totaled “about 400 tons.”

1920. Ruuttilla-Brown Leasing Company (Ruuttilla, C.L. Brown, Ed Parfet) continued mining subleased ground. Annual shipments totaled 490 tons that yielded 0.067 oz/ton gold, 47 oz/ton silver, 26% lead, 1.5% copper, and 9.0% zinc. The ore was shipped to Durango. New development included 200 feet of drifts (1920 Mine managers report-Carbonero Mine, CBM; Henderson, 1922b, p. 589).

1921. Ruuttilla-Brown Leasing Company operated the mine through a lease from Carbonero Mines and Reduction Company. The two upper levels of the mine were abandoned by 1921. Regarding the operating levels, No. 3 intersected the vein at 900 feet and drifted 1,400 feet east and 600 feet west. A 117-foot winze from Level No. 3 was connected to an 800-foot-long drift with a 350-foot-long stope. A 500-foot raise connected Level No. 4 to Level No. 3. Annual shipments totaled about 340 tons that yielded 0.063 oz/ton gold, 53 oz/ton silver, 27% lead, 1.5% copper, and 9.0% zinc. The ore was shipped to Durango and Leadville (R. Innes, Inspectors report-Carbonero Mine, September 10, 1921; 1921 Mine managers report-Carbonero Mine, CBM; Henderson, 1924, p. 504).

1922. Ruuttilla-Brown Leasing Company was mining a 250-foot-long by 170-foot-high block of ore above Level No. 5. In August, the company planned to start a new level (No. 6) from the raise 390 feet above the lower level (Level No. 4). Annual shipments totaled 183 tons that yielded 0.04 oz/ton gold, 39 oz/ton silver, 28% lead, 1.4% copper, and 8.0% zinc. Annual development done by Ruuttilla-Brown included 330 feet of drifts and 45 feet of crosscut tunnels. J.C. Ferguson, Gidion Basil, and Harry Divan subleased part of the mine, but their work and production was not included in the annual report (R. Innes, Inspectors report-Carbonero Mine, August 9, 1922; 1922 Mine managers report-Carbonero Mine, CBM). Henderson (1925, p. 546) reported that work was focused on repairing lower workings, excavating a 650-foot-raise, and starting new levels. Shipments amounted to only “several cars of lead-silver ore”.

1923. Ruuttilla-Brown Leasing Company operated the mine through a lease from Carbonero Mines and Reduction Company. In February, the company concentrated efforts on driving level No. 6, which was 300 feet long with stopes above for the entire length. Ferguson and Basil subleased part of the mine below the No. 3 level. Annual shipments (includes lessees) totaled about 926 tons containing 0.046 oz/ton gold, 35 oz/ton silver, 23% lead, 1.5% copper, and 8.1% zinc (R. Innes, Inspectors report-Carbonero Mine, February 22, 1923; 1923 Mine managers report-Carbonero Mine, CBM).

In a slightly different account of 1923, Henderson (1927a, p. 638) reports that 500 feet of drifts were driven, and 1,000 tons of lead-silver-copper ore was shipped to Durango. The ore averaged 35 oz/ton silver and 30% lead. Some of the Carbonero ore was tested at the nearby Suffolk Mill, a 60-ton 20-stamp amalgamation, gravity-concentration, and oil-flotation mill. Ophir-Colorado Mines Company was organized on November 23, 1923, and took over the mining operation on November 26. In December, the company located the North Star Mill Site and planned to construct a 50-ton mill. A 4,000-foot-long crosscut adit (probably the No. 4 level) accessed 3,800 feet of drifts in the mine.

1924. Ophir-Colorado Mines Company (Charles F. Fertig-president; O.H. Shoup, Jr.-vice president; O.H. Shoup, Sr.-treasurer; M.A. Hackett-secretary) operated the Carbonero Mine and mill through a lease (with a purchase option) from Carbonero Mines and Reduction Company. Leased property included the Boston Belle, Carbon, Carbonero, Mohawk, Carbonado, West Panama, East Panama, and North Star patented lodes; the Cascade, Vista, Mohawk #1, Farwell, Great View, Vindicator, Vindicator No. 1, Calmet, Portland, North Star #1, Governer, Sam, Oliver, Water, and Fraction unpatented lodes; and the North Star and Vista Mill Sites. In April, a 3,000-foot-long jig-back tram was constructed between the main portal (Shoofly or No. 8 Level, previously known as Level No. 4) and mill. Four adits accessed the mine, but by 1924 the upper three adits were abandoned. A raise between No. 8 and No. 3 levels provided access to levels 4 to 6. Level No. 4 drifted 863 feet east. Level No. 5 drifted 250 feet east and 200 feet west. Level No. 6 drifted 250 feet east and west. Level No. 7 was started but no drifts had been run. No. 8 Level was a 2,700-foot-long crosscut to the Carbonero vein with drifts 600 feet east and 300 feet west on the vein. In addition, Level No. 8 had drifts running 400 feet to the west and 150 feet east on the Panama vein. In May, the east drift on the Carbonero vein and the west drift on the Panama Vein (both on No. 8 Level) were extended. In November, the 50-ton flotation mill was completed. Annual shipments totaled about 71 tons of crude ore and 137 tons of concentrates from 412 tons. Crude ore yielded 0.1 to 0.4 oz/ton gold, 26.3 oz/ton silver, 27.4% lead, 2.2% copper, and 4.6% zinc. Concentrates yielded 0.13 oz/ton gold, 24.1 oz/ton silver, 25.6% lead, 2.35% copper, and 7.8% zinc. New development included 850 feet of drifts (R. Innes, Inspector reports-Carbonero Mine, April 11, May 20, 1924; 1924 Mine managers report-Carbonero Mine, CBM; Henderson, 1927b, p. 566). The mill that was completed was probably on the North Star Mill Site about 3,000 feet below the portal of Level No. 8 (the “Carbonero Mine” labeled on the PBS and topographic maps).

1925. Mineral Survey No. 20302 was conducted on the North Star Mill Site in September. Ophir-Colorado Mines Company owned the claim. A tram-house and mill were situated near the north end of the claim (Mineral Survey No.20302). Presumably the tram-house and mill on the North Star Mill Site (fig. 22) are the Carbonero Mill.

Ophir-Colorado Mines Company operated the Carbonero Mine and mill under lease from Carbonero Mines and Reduction Company until December when the contract expired and operations ceased. About 652 tons of crude ore and 1,306 tons of concentrate from 8,167 tons were shipped during the year. Crude ore yielded 0.09 oz/ton gold, 31.82 oz/ton silver, 38.92% lead, 1.57% copper, and 7.25% zinc. Concentrates yielded 0.078 oz/ton gold, 24.92 oz/ton silver, 30.95% lead, 2% copper, and 7.77% zinc. Average values were $70/ton for sorted ore and $10/ton for milled ore. New development included 535 feet of raises and 860 feet of drifts from the 5th through the 8th levels on the Carbonero vein. In June, workers were excavating a pit around a spring to store water, as water was scarce. Only a small flow of water drained from the main tunnel (J.F. Clougher, Inspector reports-Carbonero Mine, June 1, September 24, November 24, 1925; 1925 Mine managers report-Carbonero Mine, CBM). The Carbonero Mine was one of the two largest producing mines in the district. Lead concentrate was shipped to Durango (Henderson, 1928, p. 722). The low water flow of 1925 contrasts with the large flow from the mine in recent years.

1926. Carlo Girardi and F.E. Downs operated the Carbonero Mine and mill under a lease from Carbonero Mines and Reduction Company (Pickett, Rouse, and Stevens-owners). Two crosscut adits were used to access the mine, developed on eight levels. Mining was conducted by 42 workers on No. 5 through No. 8 levels. In addition, three workers were employed on the surface, and nine operated the mill. The quartz vein ranged from a few inches to 3 feet thick and contained lead and silver sulfides with gold, silver, lead, zinc, and copper values. Ore value ranged from $10 to $50 per ton. About 451 tons of crude ore and 1,697 tons of concentrate were shipped during the year. Average yield was 0.075 oz/ton gold, 36 oz/ton silver, 47% lead, and 1.6% copper. New development included 100 feet of drifts (M.L. Anderson(?), Inspector reports-Carbonero Mine, March 9, December 2, 1926; 1926 Mine managers report-Carbonero Mine, CBM; Henderson, 1929, p. 762).

1927. Girardi and Martin L. Anderson operated the mine and mill under a lease agreement from Carbonero Mines and Reduction. The mine was developed with about 7,000 feet of crosscuts, drifts, and raises. Mining was concentrated on No. 6 and No. 7 levels, which were accessed through No. 8 level. East and west drifts totaled 1,000 feet on the No. 7 level. On the No. 6 level, a 1,000-foot drift was driven to the east. Ore was transported from the No. 8 level to the mill over a 3,300-foot-long aerial tram. The mine was the second largest producer in the Ophir mining district, with annual shipments of 492 tons of crude ore that was sent directly to the smelter in Durango, and 2,774 tons of concentrate yielding 0.05 oz/ton gold, 34 oz/ton silver, 48.5% lead, and 1.55% copper. About 35 employees worked in the mine, five on the surface, and six in the mill. New development included 800 feet of drifts (M.L. Anderson(?), Inspector reports-Carbonero Mine, June 18, September 27, 1927; 1927 Mine managers report-Carbonero Mine, CBM; Henderson, 1930, p. 560). The North Star Mill Site was patented in September (USFS records).

1926-1927. Carlo Girardi acquired and operated the Carbonero Mine and Mill (McLellan, 1952, p. 3).

1928. Girardi and Anderson continued operating and leasing the Carbonero Mine and Mill from the same owners. In September, ore was mined from the No. 6 and No. 7 levels through the main level (No. 8). Shipments of crude ore totaled 600 tons, averaging $70/ton, and yielding 0.04 oz/ton gold, 35 oz/ton silver, 45% lead, 1.5% copper and 5.5% zinc. About 14,500 tons of ore worth $14/ton were processed at the mill. Crude ore prior to milling averaged 0.02 oz/ton gold, 9 oz/ton silver, 10% lead, and 3.5% zinc (J.F. Clougher, Inspector report-Carbonero Mine, September 27, 1928; 1928 Mine managers report-Carbonero Mine, CBM).

The Carbonero Mine was the principal producing mine in the district. A 2,000-foot-long crosscut adit was used to access the five upper levels connected by a 600-foot raise and 4,000 feet of drifts. New development during the year included 800 feet of drifts and 150 feet of raises. Most of the ore contained about 10% lead and 7 oz/ton silver and was processed at the company's 50-ton/day mill. Direct shipping ore averaged 48% lead and 34 oz/ton silver (Henderson, 1931, p. 857).

1929. Girardi operated and leased the mine and mill from the same owners. In September, total mine development was 8,500 feet (crosscuts, drifts, raises), and ore was mined from the Carbonero vein on the No. 6 and No. 7 levels and from the Panama vein on the main level (No. 8). Annual shipments were 154 tons of crude ore worth about $50/ton and yielding 0.06 oz/ton gold, 40 oz/ton silver, 45% lead, 0.8% copper, and 6% zinc. About 15,700 tons of ore worth $9/ton was processed at the mill. Prior to milling, the crude ore contained about 8 oz/ton silver, 8.5% lead, 3.5% zinc, and traces of gold and copper. About 1,970 tons of concentrate worth $75/ton was shipped. Concentrate averaged 0.04 oz/ton gold, 45 oz/ton silver, 55% lead, 0.8% copper, and 3.5% zinc (J.F. Clougher, Inspector report-Carbonero Mine, September 5, 1929; 1929 Mine managers report-Carbonero Mine, CBM). Zinc grade in the concentrate did not increase significantly, suggesting that much of the zinc passed through the mill and was deposited with the tailings.

In a similar account of the yearly activity, Henderson (1932, p. 956) reported that the Carbonero Mine was the principal producing mine in the district. Annual development included 500 feet of drifts on the 5th and 6th levels accessed through the 2,200-foot-long crosscut adit. Ore averaging 9% lead and 7 oz/ton silver was concentrated at the 40-ton/day (24-hour) mill.

1930. In July, Girardi was operating the Carbonero Mine and Mill and Carbonero Mines and Reduction Company continued ownership. Ore was stoped from the Carbonero vein on Level No. 6 and from the Panama vein on an intermediate level. Production was about 40 tons/day, and the ore was concentrated at a ratio of six to one at the mill (J.F. Clougher, Inspector report-Carbonero Mine, July 11, 1930, CBM). Henderson (1933, p. 1074) reported that the Carbonero Mine remained the largest producer in the district for the year. Ore was mined from the upper levels that were connected to the 2,200-foot-long crosscut adit by a 400-foot-deep inclined shaft. Drifts totaled about 14,000 feet. No development work was done during the year. High-grade silver-lead concentrate was shipped from the 65-ton/day mill.

1931. The Carbonero Mine had unspecified production (Henderson, 1934a, p. 535).

1932-1933. No production was reported.

1934. The Carbonero Mine shipped "some" ore directly to the smelter (Henderson, 1935, p. 230).

1935. No production was reported.

1936. D.E. Harrison leased the mine from Carbonero Mines and Reduction Company. About 4,000 tons of crude ore worth $12/ton and 180 tons of stockpiled middlings (partly concentrated ore) worth about $8,500 ($45/ton) in lead values were shipped. Crude ore averaged 0.05 oz/ton gold, 10 oz/ton silver, 4.5% lead, 0.4% copper, and 7.5% zinc. No workers were employed underground, although three employees worked at the mine for 300 days (1936 Mine managers report-Carbonero, CBM). Metal prices increased late in the year, and the company shipped "a sizable tonnage of low-grade middlings." The middlings, stockpiled at the Carbonero Mill, contained mostly silver and lead with minor amounts of gold and copper (Henderson and Martin, 1937, p. 333). It is not clear where the production of crude ore occurred, since no one worked underground. Perhaps the surface workers shipped waste-rock, tailings, or stockpiled crude ore; or the accounts may be erroneous.

1937. Ophir-Telluride Exploration Company (M. Ruuttila) leased the property from Carbonero Mines and Reduction Company (H.H. Stevens-president) and started operations in August. The mine had been closed since 1931. Five employees prepared the mine for production. Levels No. 8 and No. 7 were cleaned out and timbered, and the tram and mill buildings were repaired. No ore was shipped (D.C. McNaughton, Inspectors report-Carbonero Mine, September 26, 1937; 1937 Mine managers report-Carbonero, CBM).

1938. In September, Ophir-Telluride Exploration Company (Ruuttila-superintendent; N.E. Marks-secretary/treasurer) operated the mine under lease from Carbonero Mines and Reduction Company. Level No. 8 was the main working level and was a 2,400-foot-long crosscut adit with a 300-foot drift on an unnamed vein, an 800-foot drift on the Panama vein, and 840-foot east and 800-foot west drifts on the Carbonero vein. Level No. 7 was an east-trending drift 1,158 feet long. Level No. 6 was an east-trending drift of 1,200 feet. Operations were on the 7th and 8th levels. Annual shipments of crude ore totaled 157 tons, averaging $36/ton, and containing 28 oz/ton silver and 40% lead (D.C. McNaughton, Inspectors reports-Carbonero Mine, October 30, November 8, 1938; 1938 Mine managers report-Carbonero Mine, CBM).

As of November, Harrison was shipping about 150 tons/day of middlings and tailings. About 2,500 tons worth $12/ton had been shipped to date. Harrison apparently leased the tailings and waste rock from Carbonero Mines and Reduction. Harrison estimated that 6,000 tons of middlings and tailings, with values in gold, silver, and lead were on the dump (D.C. McNaughton, Inspectors reports-Carbonero Mine, October 30, November 8, 1938, CBM).

1907-1941. A total of 101,662 tons of ore was shipped from the Carbonero Mine. The ore yielded 2,488 ounces of gold and 885,501 ounces of silver and about 14 million lb of lead and

400,000 lb of zinc. About 290,000 lb of copper was recovered after the mill was built in 1924. Except for a few years, zinc was not recovered (McLellan, 1952, p.3).

1939-1941. A “small” quantity of ore was shipped from the Carbonero Mine each year (Henderson and Martin, 1940, p. 278; Henderson and Martin, 1941, p. 307; Henderson and Martin, 1943, p. 312).

1942. The U.S. Geological Survey mapped the lowest level (No. 8) of the Carbonero Mine, located on the patented North Star Lode. The portal was at an elevation of 11,480 feet, and the 2,800-foot-long crosscut tunnel accessed an 800-foot-long drift on the Panama vein at 1,700 feet. This crosscut also accessed a 2,000-foot drift on the Carbonero vein. Parts of the mine were not accessible (Vhay, 1962, plate 21-H, p. 270).

1951. Silver Bell Mines Company (Eugene H. Sanders-president and general manager; Eugene J. Nord-vice president; Edward G. O’Brien-secretary/treasurer) purchased the Carbonero Mine and prepared to resume production. Silver Bell owned an extensive block of property including the Boston Belle, Carbon, Carbonero, Mohawk, Carbonaro, West Panama, East Panama, Full Moon, Parnell, Attica, North Star, and North Star Mill Site patented claims and Vista, Mohawk #1, Farwell, Great View, Vindicator, Vindicator No.1, Calmet, Portland, Cascade, J.G., Carbonero Mill Site, and Panama Mill Site unpatented claims. Operations started in March, and the mine was ready for limited production by October. The 600 level or main level (formerly No. 8 level) accessed the mine. About 600 feet of the eastern drift on the Carbonero vein was developed for stoping. The vein had an average width of 3 feet and value of $70/ton. The raise was opened to No. 3 level, which was partially caved and not accessible from the No. 3 portal. A 4-mile-long, 11,000-volt transmission line was strung from the Silver Bell Mine to the Carbonero Mine. Silver Bell Mines intended to excavate a 6,000-foot-long crosscut adit to the Carbonero vein from the old Carbonero Mill, about 1,200 feet lower in elevation than the working portal. Annual production was 275 tons worth $7,165 (Martin, 1954, p. 1469; Inspectors report-Carbonero Mine, October 8, 1951; 1951 Mine managers report-Carbonero, CBM). Silver Bell Mines Company located the Sanders Tunnel Site and Panama and Carbonero Mill Site claims in June (BLM files). The mill site claims were adjacent to the patented North Star Mill Site claim containing the Carbonero Mill.

1952. Silver Bell Mines Company continued production, development, and exploration activities. A road was built to the “Shoofly” lower level at a cost of $11,000. Ore from the Silver Bell and Carbonero Mines was processed at the Silver Bell mill, a 175-ton sorting plant and flotation mill. A circuit for recovering zinc was added to the mill, and zinc concentrate was shipped to International, Utah. Gold-silver-lead-copper concentrate was trucked to Leadville in a 15-ton trailer. Part of Ophir was acquired and rehabilitated, and new houses were constructed. In June, a loan was obtained from Defense Minerals Exploration Administration for exploration of the Carbonero and Panama veins at the Shoofly level. New ore was exposed, and payments on the loan began. For the year, 17 employees produced 5,756 tons worth $119,733. Plans for the 6,000-foot-long crosscut adit were still under consideration (Colorado Mining Association, 1953, p. 64; Martin, 1955, p. 239; Information report-Carbonero Mine, December 5, 1952; 1952 Mine managers report-Carbonero Mine, CBM; *Denver Post*, December 9, 1962, p. 8).

1953. Silver Bell operated the Carbonero Mine with 15 employees continuously through the year. Ore was treated at their 175-ton flotation mill, and lead-silver-gold-copper-zinc concentrate was shipped. Production for the year was 14,196 tons worth $221,712. Drifting in the Shoofly level exposed “very good lead-zinc-silver ore” and five stopes were opened. Mining continued to be profitable, even with lower metal prices and wallrock dilution. Mill heads were worth about $20/ton. Silver Bell was anticipating moderate profits for 1954 (Colorado Mining Association, 1954, p. 100; Martin and Kelly, 1956, p. 271; 1953 Mine managers report-Carbonero Mine, CBM). About 1,000 feet of the Carbonero vein and 300 feet of the Panama vein were mined under a Defense Minerals Exploration Administration contract between June 1952 and August 1953 (Vhay, 1962, plate 21-H, p. 270; McLellan, 1952, fig. 2).

1954. Silver Bell Mines Company employed 18 workers and produced 2,000 tons/month worth $15/ton until late in the year, when all operations were suspended. Development included stoping on the Carbonero vein and driving drifts (Kelly and others, 1957, p. 291; 1954 Mine managers report-Carbonero Mine, CBM).

1955. The Carbonero Mine was idle (1955 Mine managers report-Carbonero Mine, CBM).

1959. Silver Bell Mines Company employed three workers (two underground) at the Carbonero Mine, but no ore was shipped (1959 Mine managers report-Carbonero Mine, CBM).

1969. Silver Bell Industries, Inc. (owners) operated at the Carbonero Mine for 11 days. Two employees cleaned out the “old portal to control water pollution”. No production resulted (Information report-Carbonero, October 7, 1969; 1969 Mine managers report-Carbonero, CBM).

1970. Silver Bell Industries, Inc. cleaned out and placed an 80-foot-long pipe in the portal. The pipe was intended to keep the portal open, allowing the mine to drain at a steady rate and eliminate water pressure buildup. Considerable damage was done, mostly to roads, from enormous releases of water (Information report-Carbonero, November 17, 1970, CBM). Evidently the caved portal of the Carbonero Mine dammed water in the underground workings. Because the mine has extensive underground workings on multiple levels, a tremendous amount of pressure would build behind these “dams” of caved material. Eventually the “dams” failed, and the resulting release of large volumes of water under high pressure washed out the Ophir Pass Road on several occasions. These periodic “blowouts” probably caused most of the erosion in the ravine below the Carbonero Mine (feature #104 of this inventory area) (fig. 23).

1980. Minerals Exploration Company quitclaimed interest in the Vindicator, Vindicator No. 1, Vista, Carbonero Mill Site, Panama Mill Site, and Sanders Tunnel claims to Fleet Resources, Inc. (BLM files).

1983. Fleet Resources, Inc. transferred interest in the East Panama, West Panama, and North Star Lodes and North Star Mill Site to Rapholz Silver, Inc. in November (BLM files). It is not clear if Fleet Resources acquired these patented claims along with the unpatented claims in 1980.

1985. Rapholz Silver, Inc. (William M. Wenger-president) filed a Notice of Intent to hold the Sanders Tunnel Site claim and stated that the company "will continue to prosecute work on the Tunnel with reasonable diligence for the discovery or development of the vein or lode" (BLM files). The claim straddled the gulch below the Carbonero Mine and extended from the Carbonero mill to the Carbonero Mine, including the ravine of inventory feature #104. It is unknown if any work was done to develop an underground working in this area.

Figure 23. Severely eroded gulch below the Carbonero Mine (inventory feature #104).

1986. Fleet Resources, Inc. transferred interest in the Vindicator, Vindicator No. 1, Vista, Carbonero Mill Site, Panama Mill Site, and Sanders Tunnel claims to Rapholz Silver, Inc. in April (BLM files).

1993. BLM closed the case file on the Vindicator, Vindicator No.1, and Vista lodes and the Carbonero and Panama Mill Site claims (BLM files, lead file 130726).

1995. CDMG wrote a letter to Mr. Fleet indicating that they were interested in installing a bulkhead at the portal of the Carbonero Mine on the North Star Lode (reception no. 318835).

1996. Fleet Resources quitclaimed the North Star Lode to Glenn Pauls (bk. 564, p. 237). Pauls remained the owner as of May 2001.

2001. Edward Pauls owned the Carbonero, Carbonado, Carbon, and East and West Panama Lodes as of May. David Wolf owned the North Star Mill Site (courthouse records). It is not clear when Pauls acquired the claims. Pauls probably acquired the claims with the North Star Lode in 1996.

Marie Antoinette Group

The Marie Antoinette group probably includes the Marie Antoinette and Attica Lodes and possibly others. Adit #101 is close to the boundary of the patented Marie Antoinette and Attica Lodes. The Portland, Yellow Jacket, and Gay No. 2 unpatented claims were also in this area.

Perry Davis was one of the early miners at the Marie Antoinette claim, and a map of mines in the Iron Springs district (Cox, 1978) suggested that adit #101 is the Davis adit (fig. 10). No historical or production data was found regarding the Davis or Perry Davis mines, however.

In any event, production was minimal from this entire group of claims. Most occurred prior to 1900, however, some ore was shipped in the early 1940's.

1886. The Attica Lode was originally located in February (BLM files).

1895. Judge Gabbert (owner) shipped a "considerable" quantity of gold ore from the "Atticus" (probably Attica) (*Denver Republican*, January 1, 1896, p. 12).

1898. Perry Davis, D.T. Martin, and J.E. Mulkey located the Marie Antoinette Lode in July (bk. 73, p. 407; Mineral Survey No. 16421). Berkey and Wallace leased the Attica group from Gabbert, Tendick, and others, and 6 carloads of ore were shipped (Dunbar, 1898, p. 298; *Mining Reporter*, October 13, 1898, v. 38, p. 14.)

1899. Large quantities of ore from the Marie Antoinette group were treated at the Suffolk mill. Ore grade varied from $8 to $40 per ton. A "considerable" amount of development work was done, and by December the upper crosscut tunnel was 275 feet long with 300 feet of drifts. The 275-foot-long lower crosscut tunnel had 175 feet of drifts. A winze connected the two levels. J.B. Tendick operated the mine (*Denver Times*, May 31, 1899, p. 3; *Mining Reporter*, June 29, v. 39, p. 24; December 14, v. 40, p. 363, 1899).

Gust Anderson located the Portland Lode in September (BLM files). A claim map (Silver Bell Industries, 1971) shows the Portland Lode near adit #101. Underground workings could undercut part of this unpatented claim.

1902. In July, Mineral Survey No. 15953 was conducted on the Rockwell Lode owned by J.J. O'Brien. Workings shown on the survey are in the southwestern part of the claim and include a discovery cut and a 500-foot-long adit with a 250-foot-long drift. The portal of the adit is about 150 feet south of the southern boundary of the Rockwell Lode. This adit is probably feature #100 of inventory area 252-4194-2 (fig. 2) The Rockwell Lode adjoined the western side of the Marie Antoinette Lode and coincided almost exactly with the Attica Lode.

1903. In May, J.E. Mulkey, Perry Davis, and D.J. Martin amended the location certificate, and a mineral survey was conducted on the Marie Antoinette Lode. Surveyed workings included a 20-foot-long adit ending in a 30-foot-deep winze, and a 445-foot-long crosscut with a 190-foot-long drift on the Marie Antoinette vein, which was intersected 130 feet below the surface. The portal of the larger mine was 15 feet south of the claim boundary, and the adit extended about 100 feet north of the claim (Mineral Survey No. 16421). Adit #101 of the Carbonero Area inventory area (fig. 2) is probably the larger mine.

In July, W.H. Gabbert, Robert Neely, and J.M. Hall amended the location certificate of the Attica Lode to secure ownership of all abandoned and overlapping claims. A mineral survey was conducted on the Attica, which nearly perfectly overlapped the previously surveyed Rockwell Lode. Workings on the surveys appeared identical (Mineral Survey No. 16654). Presumably the Rockwell Lode, which was never patented, was abandoned by this time.

1904. The Marie Antoinette Lode was patented in August, and the Attica Lode was patented in November (USFS records).

1911. Davis quitclaimed interest in the Marie Antoinette to Mulkey (bk. 104, p. 105).

1924. Carbonero Mines and Reduction Company relocated the Portland Lode at the same location originally staked in 1899 (BLM files).

1934. The Yellow Jacket unpatented claim was originally located in the area of adit #101 (BLM files). The claim owners in 1934 were not listed in BLM files.

1940-1941. A "small" quantity of ore was shipped from the Yellow Jacket Mine (Henderson and Martin, 1941, p. 307; Henderson and Martin, 1943, p. 312). Vhay (1962, p. 288) reported that the nearby Silver Tip Mine is another name for the "Yellowjacket" Mine, however, the location plotted for the Silver Tip Mine (Vhay, 1962, plate 16) would place it outside the Yellow Jacket claim, and on the patented Iron Springs placer claim. It is doubtful that adit #101 is the Yellow Jacket Mine.

1971. A claim map of the Ophir area showed the Yellow Jacket and Portland claims near or overlying adit #101. Silver Bell Industries, Inc. owned these claims and most of the other patented and unpatented claims in the area (Silver Bell Industries, 1971). The patented Attica and Marie Antoinette claims had split ownership, 50% leased to Silver Bell and 50% owned by Mrs. George Wagner.

1980. After the Federal Land Policy and Management Act became effective in late 1979, Molycorp and John J. Pollman filed the Yellow Jacket Lode with BLM. This unpatented claim was originally located in 1934. Also in 1980, Rapholz Silver, Inc. filed the Portland Lode with BLM. This claim was located in 1899 and relocated in 1924. Minerals Exploration Company quitclaimed interest in the Portland Lode to Fleet Resources, Inc. in November (BLM files).

1983. Fleet Resources, Inc. transferred interest in the Attica Lode to Rapholz Silver, Inc. (BLM files). It is not clear when Fleet Resources acquired the claim.

1984. George and Gay Cappis located the Gay No. 2 Lode in February. This unpatented claim covered adit #101 (BLM files).

1985. BLM closed the case file on the Yellow Jacket Lode (BLM files).

1986. Fleet Resources transferred interest in the Portland Lode to Rapholz Silver (BLM files).

1993. BLM closed the case file on the Portland Lode (BLM files).

1998. In May, Randolph and Vera Belisle granted permission to CDMG to perform reclamation or closure activities on the Marie Antoinette claim (reception no. 318839). R. Belisle quitclaimed his interest in the claim to Vera Belisle in June (reception no. 319740). It is not clear when or how the Belisles acquired the Marie Antoinette patented claim, but Vera was the listed owner in May 2001 (courthouse records).

GEOLOGY

The main adit of the Carbonero Mine was driven in a dacite plug within the San Juan Formation (fig. 4). Near the portal the adit followed a weakly mineralized vein for a short distance, but most of the workings were designed to produce from the east-northeast-trending Carbonero and Panama veins to the north.

The Carbonero was by far the richer of these veins, with ore-grade material extending at least 1,000 feet vertically and 2,000 feet horizontally. The vein averaged 1 foot wide, but was up to 3 feet wide and dipped steeply north. Pyrite, silver-bearing galena, sphalerite, and chalcopyrite were the dominant sulfides with subordinate argentite, cerussite, and gold occurrences. Gangue minerals were quartz, gypsum, and calcite, with minor rhodochrosite (Vhay, 1962, p. 287).

The Panama vein was much less mineralized, and ore-grade material had much less horizontal and vertical extent. This vertical vein consisted nearly completely of sulfide minerals and was 1 to 6 inches wide. Sphalerite, galena, pyrite, and chalcopyrite were the most abundant minerals. Gangue minerals were sparse and comprised quartz and gypsum (Vhay, 1962, p. 287).

Adit #101 of the Carbonero Area inventory area was driven in volcanic rocks of the lower portion of the San Juan Formation (fig. 4). Much of the material on dump #201 is dark, fine-grained, siliceous rock with moderate amounts of pyrite occurring as disseminations and in veinlets. Neither Vhay (1962, plate 16) nor Luedke (1996) mapped any veins in this area. However, a fault map by Vhay (1962, plate 17), a sketch map by Cox (1978), and the orientation of underground workings (figs. 10, 22) suggest that a zone of east-northeast-trending mineralized faults cuts this area, which lies along the eastern extension of the Attica fault zone. Mineralogy of the ore was not described, but it was probably similar to that of the Carbonero although lower in grade.

SITE DESCRIPTION

The Carbonero Mine and associated features are reached by traveling about 1.5 miles east of Ophir on the Ophir Pass Road, then heading north on a 4WD road with numerous switchbacks. Access roads to the Carbonero Mine and adit #101 shown on the topographic map (fig. 7) are not completely accurate.

The main adit of the Carbonero Mine was not examined in detail for this study because it is on private land (fig. 2). Brief reconnaissance revealed that the adit had a grated culvert at its portal. A large volume of water flowed from the mine into a steep, rocky, severely eroded gulch. The portal of the Carbonero Mine appeared to be the headwaters for surface flow in this gulch. The effluent was slightly turbid and had no associated precipitate. The steep-walled gulch, which has cut through soil and colluvium, is in sharp contrast to the grassy hillsides and shallow gullies more common on this south-facing, steep mountain (fig. 23). This severe erosion extends onto NFS land, and sediment is transported onto NFS land each time the oversteepened gully walls collapse. This erosional scar is feature #104 of the Carbonero Area inventory area. In October 2000, the surface flow of effluent disappeared below the portal, and the water flowed beneath the thick layer of loose rocks and boulders in the ravine. Water in the ravine resumed surface flow near the lowest switchback in the Carbonero Mine access road (fig. 24).

The portal of adit #101 has caved and/or filled with red-orange precipitate and was not visible, but it was probably at about the elevation of the Carbonero Mine access road, which crossed the top of dump #201. A large volume of metal-rich water, presumably from adit #101, emerged on the forested slope about 10 feet above the probable location of the portal. Because the portal has plugged with debris and precipitate, the underground workings of the mine are probably entirely flooded. The mine water evidently found a release point in the fractured bedrock slightly above the adit. The effluent has formed terracettes of ferrosinter and coated tree roots between its outlet and the road (fig. 25). The mine water flowed across the access road onto the top and sides of dump #201. The top of dump #201 was muddy and had some red-brown precipitate on its surface because some of the effluent soaked into the pile. However, most of the water flowed down both sides of the pile and into a channel in the forest area below (fig. 26). The effluent and the associated red-brown, muddy precipitate crossed the access road again below a switchback, then gradually braided and dispersed on the steep, wooded slope to the south-southwest. When traced in October 2000, surface flow approached, but did not quite reach the large ravine below the Carbonero Mine slightly above its intersection with the Ophir Pass Road.

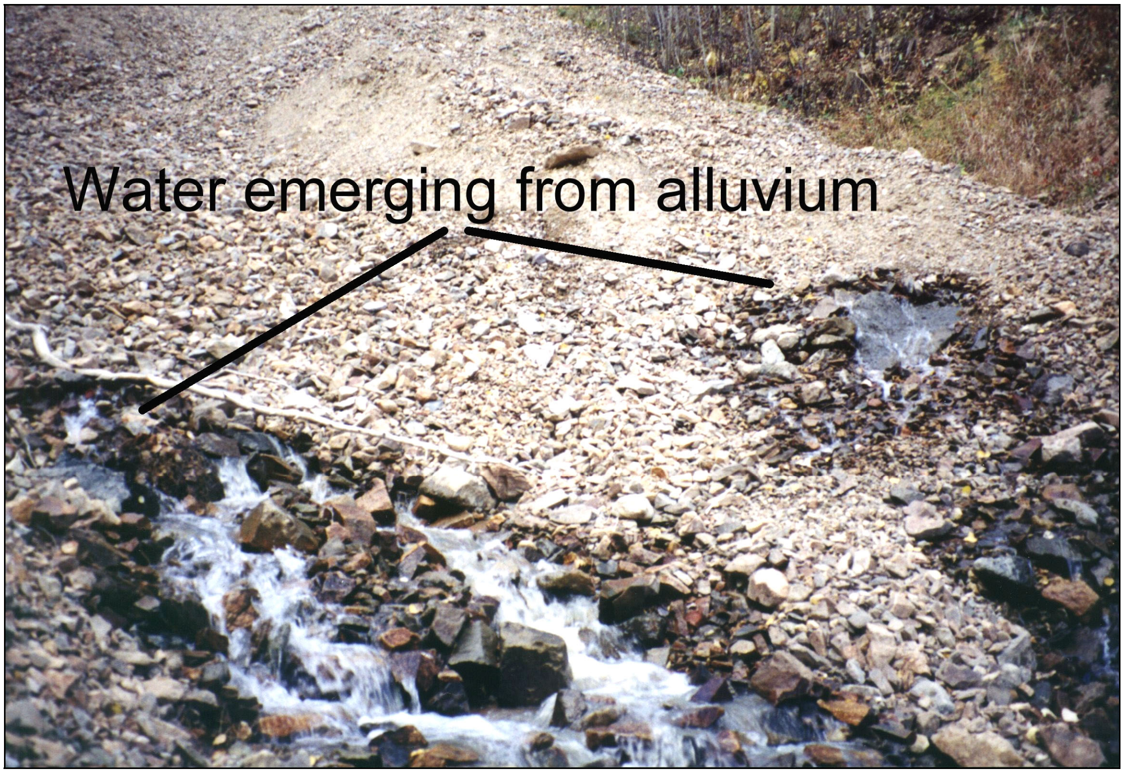

Figure 24. Water emerging in gulch below the Carbonero Mine.

WASTE AND HAZARD CHARACTERISTICS

Adit #101. CGS sampled this adit during the abandoned mine inventory in 1996 and during this site-specific investigation in 2000. In August 1996, adit #101 was draining 150 gpm of water with pH of 5.49 and conductivity of 885 µS/cm. The effluent contained iron (24,000 µg/L trec) concentrations that exceeded State standards by 80 times. Aluminum (830 µg/L), manganese (1900 µg/L), sulfate (430 mg/L), and zinc (350 µg/L) also exceeded State standards (Neubert and Harris, 1996, p. 16-17).

In October 2000 the effluent was flowing at 87 gpm and had 6.37 pH and 938 µS/cm conductivity. The abundant red-orange precipitate varied from fresh, soft, muddy material to older, moderately hardened ferrosinter. Effluent sampled in 2000 contained similar metal concentrations as the 1996 sample with one notable exception (Table 1, sample MH-2000-54). Although copper was not detected (<4µg/L) in 1996, copper concentration was 43 µg/L and exceeded State standards in the 2000 sample.

Dump #201 contained about 300 cubic yards of dark, siliceous fine-grained volcanic rock with iron staining and moderate amounts of pyrite disseminated and in veinlets. Although effluent flowed along both flanks, dump #201 was not severely eroding, and trees were growing in the dump material (fig. 26). In the upper one-fourth of the dump, effluent had deposited dark red precipitate that was mixed with the waste rock on the surface of the dump. Composite sample MWR-2000-13 from dump #201 contained low to moderate concentrations of most metals (Table

2). Although generally weakly mineralized, this sample contained the highest molybdenum concentration (78 ppm) of the dumps and tailings sampled near Ophir during this investigation. The sample was mildly acidic with net acid-base potential of -5.9 tons $CaCO_3$/1,000 tons and paste pH of 4.63.

Figure 25. Effluent and ferrosinter mound at adit #101.

Figure 26. Dump #201, red precipitate, and effluent.

When examined and sampled in August 1980, effluent from adit #101 (Perry Davis Mine) seeped into the ground just above the Ophir Pass Road (McLaughlin, 1981, p. VI-37), similar to the situation in October 2000. Although this sample was analyzed for total metals, most of the concentrations were similar to the dissolved concentrations in the 2000 sample. Total lead (26 μg/L) and total copper (180 μg/L) were much higher in the 1980 samples (McLaughlin, 1981, p. A-207).

In 1994, a sample collected by CDMG in June (high flow) contained about double the concentrations of cadmium and copper than a November sample (low flow). The other analyzed metals remained relatively constant through the year (site 13, Appendix). All of the low flow parameters in 1994 were similar in concentration to the October 2000 sample. (Jim Herron, CDMG, unpublished data.)

In 1998 effluent sampled by CDPHE near the portal was rich in total iron (29,600 μg/L) and contained elevated concentrations of total copper (127 μg/L), total lead (20.6 μg/L), and total zinc (422 μg/L). The total zinc concentration amounted to a load of about 0.5 lb/day (CDPHE, 1999).

Adit #101 is upslope and about 1,300 feet north of privately owned Iron Springs, a natural secondary iron deposit once mined by a crayon manufacturer because of its deep red color (Camille Farrell, Colorado Department of Health, oral communication, 1996). The Iron Springs deposit, for which the mining district was named, suggests that iron-rich ground water has been a phenomenon of this area for thousands of years. Adit #101 apparently intercepts a portion of this ground water, releasing it to the surface for a few hundred feet before it returns to subsurface flow.

The Silver Tip Mine is on private land and is located between adit #101 and Iron Springs. When it was sampled in August 1980, it was draining about twice the amount of effluent as adit #101, and the effluent had similar metal concentrations. Lead (70 µg/L) was higher, and copper (49 µg/L) and manganese (1,100 µg/L) were lower (McLaughlin, 1981, p. A-207).

Carbonero Mine. Because it was private land, no sample was collected in 2000 from the Carbonero Mine at the portal. After flowing partway down the steep, rocky ravine below the mine, the effluent infiltrated and flowed beneath the loose rocks and boulders. Water sample MH-2000-55 was collected where the effluent reemerged near the lowest switchback in the Carbonero Mine access road, about 2,000 feet downstream and 1,000 feet lower in elevation than the adit (figs. 7, 24). Although no other inflows of surface water were observed between the portal and the sample site, the effluent was probably partly diluted by alluvial ground water. At the sample site, flow was 423 gpm, and the water had 6.83 pH and 1,321 µS/cm conductivity. The water was slightly murky. Small amounts of algae grew in the water, and some of the rocks in the channel had minor iron staining. Dark-brown precipitate accumulated on the water-sample filters. A well-indurated ferricrete ledge was exposed on the east bank of the gulch, indicative of a long history of iron-rich water in this area. Where it reemerged, the water exceeded State standards in iron and sulfate concentrations (Table 1). Zinc, manganese, and aluminum (total recoverable) were also elevated but within standards. Although the concentrations were not extremely high, metal loads were high because of the high flow rate.

During the CDMG abandoned mine inventory in 1980 (McLaughlin, 1981, p. A-216), water draining from the Carbonero adit contained 2,900 µg/L iron, 9,900 µg/L zinc, 110 µg/L lead, and 430 µg/L copper (all total concentrations). McLaughlin also sampled water just upstream of where the Carbonero ravine crosses the Ophir Pass Road. This sample contained a notable increase in iron concentration (43,000 µg/L). Concentrations of lead increased (330 µg/L), zinc was constant (9,900 µg/L), and copper decreased (370 µg/L). The date of this sampling event was not listed.

In late June 1980 portal water was sampled by McLaughlin (1981, p. A-207) and contained 12,000 µg/L iron, 9,300 µg/L manganese, 8,000 µg/L zinc, 30 µg/L cadmium, 310 µg/L lead, and 500 µg/L copper (all total concentrations). When sampled in August 1980, the quality of the effluent at the portal had improved to 3,400 µg/L iron, 2,300 µg/L manganese, 1,300 µg/L zinc, 7.6 µg/L cadmium, 55 µg/L lead, and 46 µg/L copper. A sample collected near the Ophir Pass Road in August was much improved compared to the portal water, but still had significant concentrations of iron (1,900 µg/L), manganese (1,600 µg/L), zinc (820 µg/L), cadmium (4.9 µg/L), lead (41 µg/L), and copper (30 µg/L).

In 1994 a high-flow sample in June revealed far more metals than a low-flow sample in November (site 12, Appendix). The high-flow sample was highly degraded with respect to cadmium (total recoverable, dissolved), copper (total recoverable, dissolved), iron (total recoverable, dissolved), lead (total recoverable), manganese (total recoverable, dissolved), and zinc (total recoverable, dissolved). In November, the effluent remained degraded but was much improved in terms of metal concentrations and loads compared to June. For copper, iron, and lead, total concentrations were at least double the dissolved concentrations during both the high flow and low flow sampling events. Dissolved lead was not detected during high flow or low flow, and dissolved copper was not detected in the low flow sample. (Jim Herron, CDMG, unpublished data.)

When sampled by CDPHE in June 1998 (CDPHE, 1999, p. 8), Carbonero effluent at the portal contained 3,800 µg/L total zinc and carried a load of almost 19 lb/day. Near its confluence with Howard Fork, and downstream of CGS sample site MH-2000-55, total zinc had decreased to 467 µg/L, equating to a load of almost 6 lb/day. This indicates that zinc in coming out of solution.

Howard Fork. In 1980 CDMG sampled Howard Fork upstream and downstream of its confluence with the inflow from the Carbonero Mine. The upstream sample contained 800 µg/L iron, 120 µg/L zinc, 28 µg/L lead, and 10 µg/L copper. The downstream sample showed significant increases in total iron (2,600 µg/L), total zinc (640 µg/L), total lead (68 µg/L), and total copper (250 µg/L) (McLaughlin, 1981, p. A-216).

In 1994 CDMG collected samples from Howard Fork that bracketed the inflow from the Carbonero Mine (sites 5, 6, Appendix). The samples showed significant increases in iron and manganese during high flow, and significant zinc increase during high and low flow. (Jim Herron, CDMG, unpublished data.) Despite the higher concentrations, iron and manganese remained within State water-quality standards at the downstream site. Zinc slightly exceeded standards.

Samples collected in June 1998 suggest that effluent from the Carbonero Mine affects Howard Fork. Concentrations and loads of aluminum, copper, iron, lead, manganese, and zinc in Howard Fork were higher downstream of the confluence with Carbonero (total concentrations). However, only about half of the load increases were directly attributable to Carbonero effluent (CDPHE, 1999, p. 8, 14-15).

NEW DOMINION MINE

The New Dominion inventory area (251/4193-1) is northeast of Ophir (fig. 2). Access is via mine roads off of Forest Road 630. CGS assigned EDRs of 3 to adits #100 and #102 in this inventory area. The portals of these mines are on NFS land, but the underground workings trend toward the patented New Dominion Lode. Adits #100 and #102 discharge effluent. The original New Dominion adit is on private land and was not inventoried.

Mine feature #100 is a mostly caved adit just north of Forest Road 630. This working is probably the lowest level of the New Dominion Mine. Mine feature #102, an adit with a locked door, is probably the middle level of the New Dominion Mine. A cabin on dump #202 appeared occupied during site visits in 1996 and 2000. Nearby residential buildings are located in the Ophir annex development, within 1,000 feet of these mines. Unpatented claims associated with the New Dominion Mine include the Floater Lode, Frank B. Lode, Frank B. Mill Site (fig. 27).

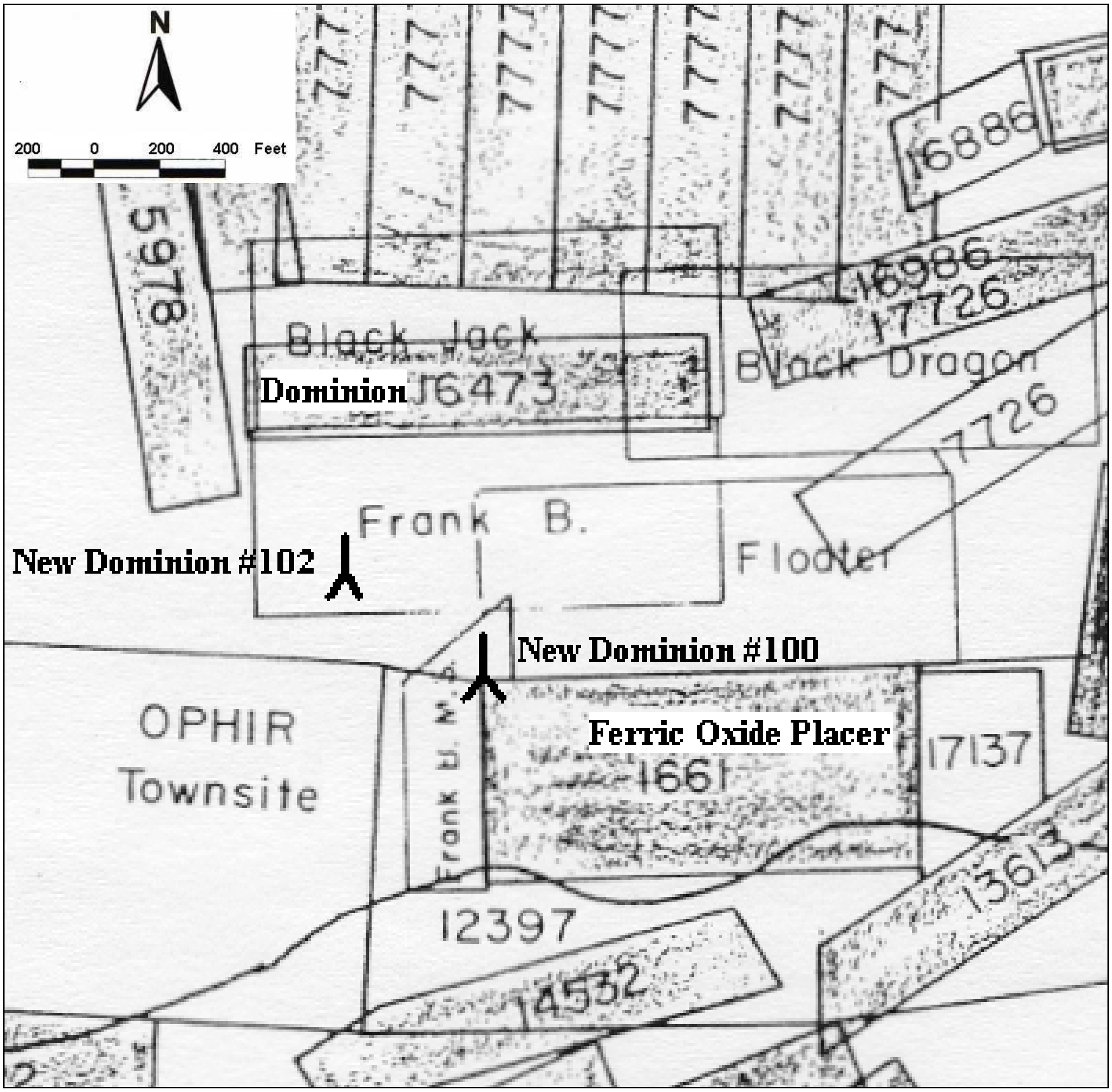

Figure 27. Mineral surveys in the New Dominion Mine area. (Modified; New Dominion inventory features and selected patented claim names added; numbers are mineral surveys; scale is approximate).

MINING HISTORY

The New Dominion Mine was located in 1902, relatively late compared to most of the mines in this area. It produced intermittently from 1905 to1970 (Table 4). Peak years of production were 1931 to 1940. The New Dominion was a small producer compared to the Carbonero or Carribeau Mines, but produced much more than the mines in Chapman Gulch or the Marie Antoinette.

Table 4. Production from the New Dominion Mine. (From various sources, see following text for details; X refers to production of an unknown quantity; ? refers to probable production.)

YEAR	PRODUCTION (tons unless noted)	Au (oz)	Ag (oz)	Cu (lb)	Pb (lb)	Zn (lb)	Operator
1905	X		X		X		
1906	X						New Dominion Gold Mining Co.
1907	X						
1908	X						New Dominion Gold Mining Co.
1909	X						
1910	X ($12-$30/ton)						Pickett
1917	44	19	544	2,378	5,368	10,000?	Ophir Gold Mines & Reduction Co.
1921	110	50	1,210		8,800	11,000	J.F. Morgan
1922	80	40	960	3,200	9,600	17,600	Ophir Gold Mines & Reduction Co.
1926	?						Pihlstrom & Bickerstaff
1928	Small lots						
1931	40	22	480		7,200	12,000	Oakes
1933	23	12	230		2,760	2,760	Noyes
1934	X						Belisle
1936	50 ($50/ton)	?	?		?	?	Noyes
1937	46	6	552		8,280	11,040	Noyes et al.
1939	160	80	1,920	4,800	19,200	25,600	Belisle
1940	150	75	1,500	4,500	24,000	21,000	Belisle
1941	Small quantity	?	?		?	?	Belisle
1946	Small quantity	?	?		?	?	
1947	21	14	200	420	2,310	1,470	Belisle
1950	Some	?	?		?		Belisle & Reed
1952	X	X	X		X		Belisle, Reed, & Crandell
1958	1,700 pounds	7.1					Belisle
1961	?						
1970	? (295 ton stockpile)						Belisle

1902. J.R. McCaskey and J.M. Belisle located the New Dominion Lode in March (Mineral Survey No. 16473). By September, a 2-foot-wide vein worth $20/ton was exposed in a 150-foot-long drift. It was anticipated that ore would be shipped to the Bullion Mill after repairs were complete (*Mining Reporter*, September 11, 1902, v. 46, p. 218).

1903. In February, J.M. Belisle and J.R. McCaskey amended the location certificate for the New Dominion Lode, and Frank Carroll and Robert Skelly had a three-month contract to drive a 150-foot-long crosscut tunnel to intersect the New Dominion vein. A mineral survey was conducted on the New Dominion in March. A discovery cut and a 225-foot-long adit were shown on the survey (Mineral Survey No. 16473; *Denver Times*, February 24, 1903, p. 10). On the topographic map, the adit symbol adjacent to a shaft symbol on the eastern side of Spring Gulch at an elevation of about 10,200 feet probably represents the original mine on the New Dominion Lode (fig. 7). These workings lie on private land and were not inventoried (fig. 2).

1904. The New Dominion Lode was patented (USFS records).

1905. Lead-silver ore was shipped from the New Dominion (Lundgren, 1906, p. 211).

1906. New Dominion Gold Mining Company shipped some ore (Naramore, 1907, p. 234).

1907. Ore was shipped from the New Dominion Mine (Naramore, 1908, p. 274).

1908. New Dominion Gold Mining Company shipped ore (Henderson, 1909, p. 399).

1909. Shipments from the New Dominion "mines" included both crude ore and concentrates (Henderson, 1911a, p. 328).

1910. George B. Pickett (who was also involved in the Carbonero Mine) operated the New Dominion Mine through a lease from New Dominion Gold Mining Company (S.L. Morris-president; J.H. Frank Smokey-secretary). The value of shipments ranged from $12 to $30/ton. The mine was developed by two 1,000-foot-long adits. The upper adit was driven on the main vein, from which "several thousand dollars worth of ore" had been extracted. The lower crosscut adit was about 350 feet below and intersected the vein about 400 feet below the surface (Mine manager report-New Dominion, p. 169, CBM). The description of this crosscut's position relative to the original adit closely coincides with mine maps done by Varnes in 1942 (Vhay, 1962, plate 21). He showed the portal of the lowest adit about 1,000 feet southeast of the main adit (fig. 28). This lower crosscut is probably adit #100 of the New Dominion Mine inventory area.

1916. Ophir Gold Mines & Reduction Company (Newton Sankey-president; J. Belisle-secretary) started operations at the New Dominion Mine in October. The property included the patented New Dominion Lode, the April Fool and B.B. unpatented lode claims, and the New Dominion Mill Site claim. Twenty additional claims owned by San Miguel Mining Company (L.L. Nunn) were leased (R. Innes, Inspector report-New Dominion Mine, August 28, 1917, CBM).

1917. The 1,000-foot-long upper adit followed the New Dominion vein, which ranged from a seam to 1-foot-wide. Extensive stoping had been done along the vein in the upper level, which connected to the surface through two raises. The 1,200-foot-long lower crosscut adit intersected the New Dominion and B.B. veins. On the lower level, drifts were 200 feet on the New Dominion vein and 50 feet on the B.B. vein. The mill was almost completed. Ophir Gold Mines & Reduction Company employed 3 to 5 people and produced 44 tons of crude ore containing 0.44 oz/ton gold, 12.3 oz/ton silver, 6.1% lead, 2.7% copper, and 8% to 18% zinc. The ore was shipped to a smelter in Durango (R. Innes, Inspector report-New Dominion Mine, August 28, 1917; 1917 Mine manager report-New Dominion, CBM).

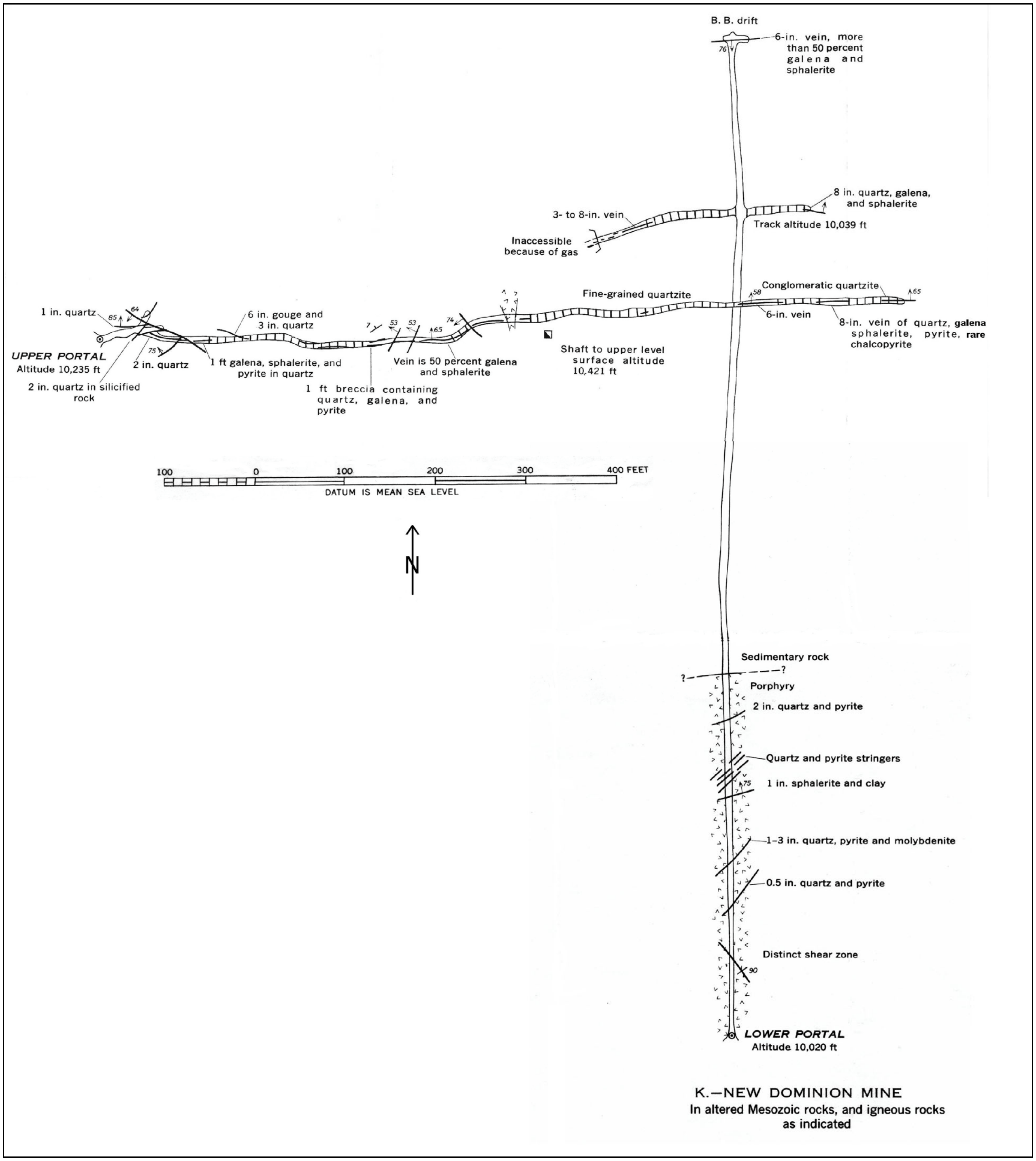

Figure 28. Map of underground workings in the New Dominion Mine, 1942. (Modified from Vhay, 1962, plate 21.)

1918-1919. Ophir Gold Mines & Reduction Company (G.W. Dennison-president; J. Belisle-secretary-manager) operated the New Dominion Mine intermittently. No ore was sold (1918 and 1919 Mine manager reports-New Dominion, CBM).

1921. J.F. Morgan leased the New Dominion from Ophir Gold Mines & Reduction Company. Development included 100 feet of raises and 80 feet of drifts. About 110 tons of crude ore were shipped containing 0.45 oz/ton gold, 11 oz/ton silver, 4% lead, and 5% zinc. About 350 feet of the vein had been stoped in the upper adit (R. Innes, Inspector report-New Dominion Mine, September 9, 1921; 1921 Mine manager report-New Dominion, CBM; Henderson, 1924, p. 504).

1922. Ophir Gold Mines & Reduction Company operated the mine. Development included 80 feet of raises, 50 feet of drifts, and 15 feet of crosscuts. Eighty tons of crude ore were shipped averaging 0.5 oz/ton gold, 12 oz/ton silver, 6% lead, 2% copper, and 11% zinc (1922 Mine manager report-New Dominion Mine, CBM; Henderson 1925, p. 546).

1925. The Frank B. Lode (fig. 27), which adjoins and parallels the south side of the New Dominion Lode, was located in May (BLM files).

1926. C.W. Pihlstrom (manager) and A.R. Bickerstaff leased the New Dominion Mine from Ophir Gold Mines & Reduction Company. Underground workings included an upper adit that followed the vein and a lower crosscut adit that intersected the vein 950 feet from the portal and drifted east on the vein for 75 feet. In April, three miners were stoping the 14-inch-wide vein 40 feet above the drift (M.L. Anderson(?), Inspector report-New Dominion Mine, April 16, 1926, CBM).

1928. “Small lots of smelting ore” were shipped (Henderson, 1932, p. 956).

1931. John and Earnest Oakes leased the New Dominion group from Ophir Gold Mines & Reduction Company (G.W. Dennison-president; J. Belisle-secretary-manager). The property included the patented New Dominion Lode, and the unpatented April Fool, B.B., and Frank B. Lodes. No production was reported by the owner; lessees shipped about 40 tons of crude ore averaging 0.56 oz/ton gold, 12 oz/ton silver, 15% zinc, and 9% lead. Development on the claim group included crosscuts, drifts, and an aggregate of about 2,400 feet of small stopes. The main operating level was a 1,200-foot-long, north-trending crosscut adit with a 250-foot-long drift. A 1,000-foot-long, east-trending adit was driven along the vein above the crosscut (J.F. Clougher, Inspector report-New Dominion Group, December 15, 1931; 1931 Mine manager report-New Dominion Group, CBM).

1932. James Knowles (Noyes?) and Fred Aiken leased and operated the New Dominion group. The lessees were extending the crosscut adit 160 feet to the north to intersect another vein with reported gold values (J.F. Clougher, Inspector report-New Dominion Group, October 31, 1932, CBM).

1933. James Noyes leased the New Dominion group from Ophir Gold Mines & Reduction Company. About 23 tons of crude ore were shipped in August. The ore averaged 0.5 oz/ton gold, 10 oz/ton silver, 6% lead, and 6% zinc. In October, work focused on extracting ore during the excavation of an inclined raise 20 feet east from the breast of the 1,000-foot-long crosscut adit (J.F. Clougher, Inspector report-New Dominion Group, October 17, 1933, CBM).

1934. Belisle shipped ore from the New Dominion (Colorado Mining Association, 1935, p. 46.)

1936. James Noyes leased the New Dominion group from J.M. Belisle (owner). In June, miners were drifting east and west on a 0.5- to 3-foot-wide vein that was exposed 1,100 feet from the portal of the crosscut adit. Drifts extended 75 feet east and 325 west of the crosscut. By June, about 50 tons of ore worth $50/ton were shipped (J.F. Clougher, Inspector report-New Dominion Mine, October 17, 1933, CBM; Henderson and Martin, 1937, p. 333).

1937. James Noyes, C.H. Southward, Joe Jackson, Kenneth Spillman, and Earl Spillman (manager) leased the New Dominion group. In May, 125 feet of drift was stoped 50 feet above the level. Shipments totaled 46 tons worth $18/ton. Average grade was 0.125 oz/ton gold, 12 oz/ton silver, 9% lead, and 12% zinc (D.C. McNaughtam, Inspector report-New Dominion Mine, May 10, 1937; 1937 Mine manager report-New Dominion, CBM).

1939. The Belisle brothers operated the New Dominion Mine. The 325-foot-long west-trending drift was extended, and 100 feet of the drift was stoped 20 feet above the level. This drift was 1,100 feet from the portal of the lower crosscut adit. Shipments totaled 160 tons worth $30/ton and containing 0.5 oz/ton gold, 12 oz/ton silver, 6% lead, 1.5% copper, and 8% zinc (D.C. McNaughtam, Inspector report-New Dominion Mine, July 16, 1939; 1939 Mine manager report-New Dominion, CBM). Henderson and Martin (1940, p. 278) reported that "J.M. Belisle shipped several cars of zinc-lead-gold-silver-copper ore from the New Dominion Mine."

1940. The Belisle brothers continued operating the mine. In September, a new stope, 1,400 feet from the portal, was 50 feet long and 20 feet high with a two-compartment raise excavated to open a new level. Shipments totaled 150 tons averaging $30/ton. Average grade was 0.5 oz/ton gold, 10 oz/ton silver, 8% lead, 1.5% copper, and 7% zinc (D.C. McNaughtam, Inspector report-New Dominion Mine, September 7, 1940; 1940 Mine manager report-New Dominion, CBM). According to Henderson and Martin (1941, p. 307), the Belisle brothers shipped "several cars of zinc-lead-gold-silver-copper ore" to the custom mill at Midvale, Utah.

1941. Ray Belisle and Associates operated the mine for two months and shipped 40 tons of ore from the 375-foot-long westerly drift (D.C. McNaughtam, Inspector report-New Dominion Mine, October 2, 1941, CBM). A "small" quantity of ore was shipped (Henderson and Martin, 1943, p. 312). The Frank B. Mill Site was located in October (BLM files). The north end of this unpatented claim was close to and may have included adit #100 of the New Dominion inventory area.

1942. The U.S. Geological Survey mapped the New Dominion Mine (fig. 28). Two portals were driven at different elevations. The 900-foot-long, east-trending upper level followed the vein virtually its entire distance. The 1,100-foot-long, north-trending lower level intersected the vein about 900 feet from the portal and drifted along the vein for more than 250 feet. Part of the lower level was inaccessible because of gas (Vhay, 1962, plate 21). The upper level adit is probably on the patented New Dominion Lode and was not inventoried. The lower mine is probably adit #100 of this inventory area. Adit #102 was not mapped and probably did not exist. Elevations of the portals shown on the 1942 mine map should be considered relative. These workings are shown on more recent topographic maps and are about 75 to 100 feet lower in elevation, but remain about 200 feet apart vertically and slightly more than 1,000 feet apart horizontally.

1946. "A small quantity of bullion was shipped from the New Dominion to the Denver Mint" (Gustavson, 1948, p. 1409).

1947. The Belisle brothers operated the mine. A 40-foot-long by 40-foot-high stope in the 375-foot-long western drift was the focus of the miners in July. Annual shipments totaled 21 tons worth $30/ton and containing 0.68 oz/ton gold, 9.5 oz/ton silver, 5.5% lead, 1% copper, and 3.5% zinc (D.C. McNaughtam, Inspector report-New Dominion Mine, July 23, 1947; 1947 Mine manager report-New Dominion, CBM). According to Martin (1949, p. 1372), the Belisle brothers shipped a "small" amount.

1949. The Floater Lode was originally located in August (BLM files). The Floater unpatented claim probably covered dump #200 and the portal of adit #100 (fig. 27).

1950. Most of a 0.5-ton/hour gravity-flow mill was completed (J.H. Pakka, Information report-New Dominion mill, June 8, 1966, CBM). The ruins of a small mill adjacent to dump #200 may be the remains of this 1950 mill. "Belisle and Reed shipped some ore from the New Dominion Mine" (Martin, 1953, p. 1459).

1952. "Belisle, Reed, and Crandell shipped silver-gold-lead ore from the New Dominion Mine" (Martin, 1955, p. 239).

1958. Randy Belisle owned and operated the New Dominion Mine, and Belisle and Reed owned the New Dominion Mill. A gas-powered, 15-ton/day gravity mill utilized a small crusher, ball mill, mineral jig, and a shaking table. Production was 1,700 pounds of concentrates yielding 7.1 ounces of gold worth $248. Underground activity was confined to exploration work (J.H. Pakka, Information report-New Dominion Mine and Mill, July 22, 1958; 1958 Mine manager report-New Dominion Mine and Mill, CBM). The mill probably processed stockpiled material from earlier mining.

1961. An unspecified, but probably small amount of ore was processed at the mill (J.H. Pakka, Information report-New Dominion mill, June 8, 1966, CBM).

1963. R. Belisle owned and operated the New Dominion Mine. The property included the patented New Dominion Lode and Ferric Oxide Placer claims; and the unpatented Black Jack, Black Dragon, Frank B., and Floater Lodes, and Frank B. Mill Site claims. Belisle started a new 5-foot-wide by 7-foot-high crosscut adit intended to intersect the vein 600 feet from the portal. By July, the crosscut was 40 feet long. No ore was shipped during the year (J.H. Pakka, Information report-New Dominion 2nd level tunnel, July 25, 1963; 1963 Mine manager report-New Dominion, CBM). Adit #102 is probably the "new" crosscut tunnel.

1964. By September, the "new" adit was about 400 feet long and was expected to reach the vein within the next 30 feet (E. Ray, Information report-New Dominion, September 18, 1964, CBM).

1965. R. Belisle was the owner/operator. By July, ore was exposed at the end of the 400-foot-long crosscut adit, but no shipments were made during the year (J.H. Pakka, Information report-New Dominion tunnel, July 7, 1965; 1965 Mine manager report-New Dominion, CBM).

1966. By June, a 15-foot-long drift had been dug on the vein at the end of the 400-foot-long crosscut adit. Repairs were done at the mill, which was built in 1950 and last operated in 1961. No shipments were made (J.H. Pakka, Information report-New Dominion tunnel and Mill, June 8, 1966; 1966 Mine manager report-New Dominion, CBM).

1967. By mid-September the 500-foot-long crosscut adit had a 100-foot-long, east-bearing drift on the vein, but no ore was shipped (T. High, Information report-New Dominion, September 19, 1967; 1967 Mine manager report-New Dominion, CBM).

1969. R. Belisle contracted the Boyles brothers to conduct a diamond-drilling program at the New Dominion Mine. No ore was shipped (T. High, Information report-New Dominion, October 7, 1969; 1969 Mine manager report-New Dominion, CBM).

1970. Belisle was the owner/operator of the New Dominion Mine and associated properties. No ore was shipped, but about 295 tons were stockpiled. Stockpiled ore had an estimated value of $1,704 and contained 1 oz ($36) of gold, 212 oz ($371) of silver, 2,535 pounds ($360) of lead, 3,510 pounds ($526) of zinc, and 702 pounds ($411) of copper (1970 Mine manager report-New Dominion, CBM).

1971. Silver Bell Industries, Inc. operated the New Dominion Mine, which was still owned by R. Belisle. No ore was shipped (1971 Mine manager report-New Dominion, CBM).

A claim map of the Ophir area (Silver Bell Industries, Inc., 1971) showed the unpatented Frank B. Lode and Mill Site, and Floater Lode south of the patented New Dominion Lode. Silver Bell Industries, Inc. owned or controlled the New Dominion Lode and Frank B Lode and Mill Site claims. R. Belisle (mineral rights) and Hughs Brothers, Inc. (surface rights) owned the Floater Lode. Adit #102 and associated waste-rock pile #202 are probably on the Frank B. Lode, adjacent to the south side of the New Dominion Lode. Adit #100, dump #200, and the mill ruins are probably on the Floater Lode and/or Frank B. Mill Site.

1975. Silver Bell Industries, Inc. (Stephen L.R. McNichols-president) operated the New Dominion Mine, which was owned by R. Belisle. In July, Silver Bell was planning to extend the eastern drift in the 900-foot-long crosscut adit. In August, miners were driving a two-compartment raise 40 feet from the face of the 625-foot-long crosscut adit. The raise, which was expected to intersect the upper level at about 100 feet, was needed for ventilation and as a second exit. No shipments were made during the year (Information report-New Dominion, July 15, August 14, 1975; 1975 Mine manager report-New Dominion, CBM).

1978. A map of the principal mines in the Iron Springs mining district (Cox, 1978) showed the New Dominion area workings (fig. 10). Adit #100 is the lower working, shown at 9,950 feet in elevation. Adit #102 is the next highest adit shown, with no associated underground workings. The original New Dominion Mine is the east-trending adit slightly higher.

1979. R. Belisle amended the location certificate for the Floater and Frank B. Lodes and Frank B Mill Site in October (BLM files).

1980. Molycorp, R. Belisle, and Vera L. Belisle filed the Frank B Lode and Frank B Mill Site claims with BLM (BLM files).

1985. BLM closed the case file on Molycorp and R. Belisle's claim to the Frank B Lode (BLM files).

1998. R. Belisle quitclaimed his interest in the Frank B and Floater Lodes and Frank B Mill Site to Vera Belisle in July (BLM files). He quitclaimed interest in the New Dominion Lode to Vera, also (reception no. 319740).

2001. Vera Belisle was the listed owner of the New Dominion Lode as of May, and her case file on the Frank B. and Floater Lodes and Frank B. Mill Site unpatented claims remained active (courthouse records; BLM files, lead file 130726).

GEOLOGY

The portal of adit #102 was driven in Cutler Formation sedimentary rocks (fig. 4). The portal of adit #100 is mapped as talus by Luedke (1996) and as altered igneous rocks by Varnes (Vhay, 1962, plate 21). When visited in 2000, fine-grained, gray sedimentary rock overlain by a hardened ferricrete deposit was exposed adjacent to the portal. This small exposure of sedimentary rock is probably Cutler Formation siltstone.

Both of these adits were driven to intersect the east-striking New Dominion vein, which ranged from a seam to 3 feet wide and contained various amounts of pyrite, sphalerite, chalcopyrite, and galena in quartz gangue. The map of the underground workings shows several other small east- to northeast-trending veins near the portal of the lower adit (#100), including a quartz-pyrite-molybdenite vein (fig. 28).

Both dumps contained quartz vein fragments with pyrite, sphalerite, chalcopyrite, and galena. Disseminated pyrite was common in the gray, fine-grained host rock.

SITE DESCRIPTION

Mine features in the New Dominion inventory area are close to the residential development in the Ophir Annex (fig. 29). Adit #102 and associated dump #202 are apparently on NFS land (fig. 2), but a cabin that appeared to be occupied at least intermittently was on the western end of the dump bench (figs. 30, 31). "No Trespassing" and "Private Property" signs were also posted. The portal of adit #102 was enclosed in a locked snowshed (fig. 32). Dump #202 had two lobes, each with a set of rails. Partly collapsed cribbing once retained part of the western lobe of the dump (fig. 31). A large volume of effluent that deposited abundant light red-brown precipitate was draining under the door at the portal and flowing along the east side of dump #202 (figs. 32, 33). The effluent flowed in a south-southeasterly direction across a 4WD road below dump #202. When traced in October 2000, the flow rate and the amount of associated precipitate gradually diminished as the effluent stream braided and infiltrated into the unconsolidated material of a marshy, well-vegetated sloping wetland. At the elevation of adit #100, which was about 240 feet lower than adit #102, surface flow from adit #102 was nonexistent. The presumed effluent path was about 300 feet west of adit #100, between adit #100 and the Ophir Annex.

The portal of adit #100 was almost completely filled with yellow-red precipitate that was deposited by a large flow of mine effluent (fig. 34). The effluent crossed the grassy bench of dump #200 (fig. 35). Most of the discharge flowed between the west side of dump #200 and the ruins of a mill (fig. 36), and into turbid, red-green beaver ponds on the south side of the Ophir Pass Road (fig. 37). Small volumes of effluent flowed both directions on the seldom-used, well vegetated, 4WD mine road that accessed the site. These small flows soaked into the road within about 100 feet of the portal. Some effluent infiltrated the top of dump #200, which was large and almost reached the Ophir Pass Road. Much of the toe was damp, but no water was draining from dump #200.

WASTE AND HAZARD CHARACTERISTICS

Adit #102. During the CGS abandoned mine inventory in August 1996, water with pH of 5.21 and conductivity of 586 µS/cm was draining from the portal of adit #102 at an estimated rate of 300 gpm. Although the effluent was clear, yellow-red-gray precipitate coated the channel. Where the mine water crossed a 4WD road about 250 feet south of adit #102, pH had increased slightly to 5.87, and conductivity dropped to 511 µS/cm (Neubert and Harris, 1996, p. 16). No samples were collected.

In October 2000, 90 gpm of water with 6.38 pH and 565 µS/cm conductivity flowed beneath the door at the portal of adit #102. The water appeared clear, but minor red precipitate accumulated on the water-sample filter. Abundant red-brown precipitate was in the channel, and moss lined the banks. Water sample MH-2000-56, collected near the portal of adit #102, exceeded standards in concentrations of iron, aluminum, copper, manganese, and zinc (Table 1). Sulfate concentration approached the standard. Relatively large disparities between dissolved and total values for iron and aluminum suggested that the precipitate is rich in those metals.

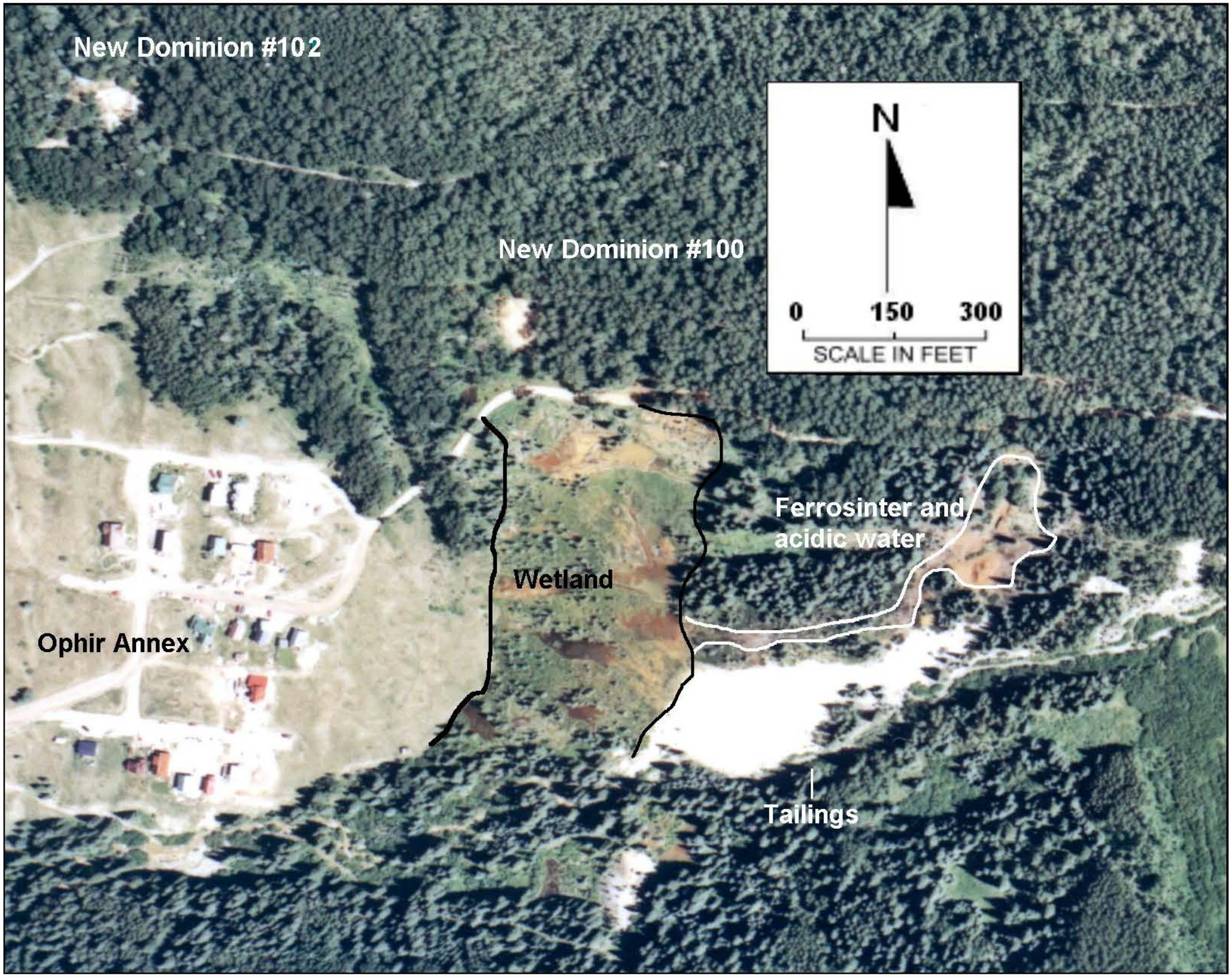

Figure 29. Aerial photograph of the New Dominion Mine and Carbonero tailings.

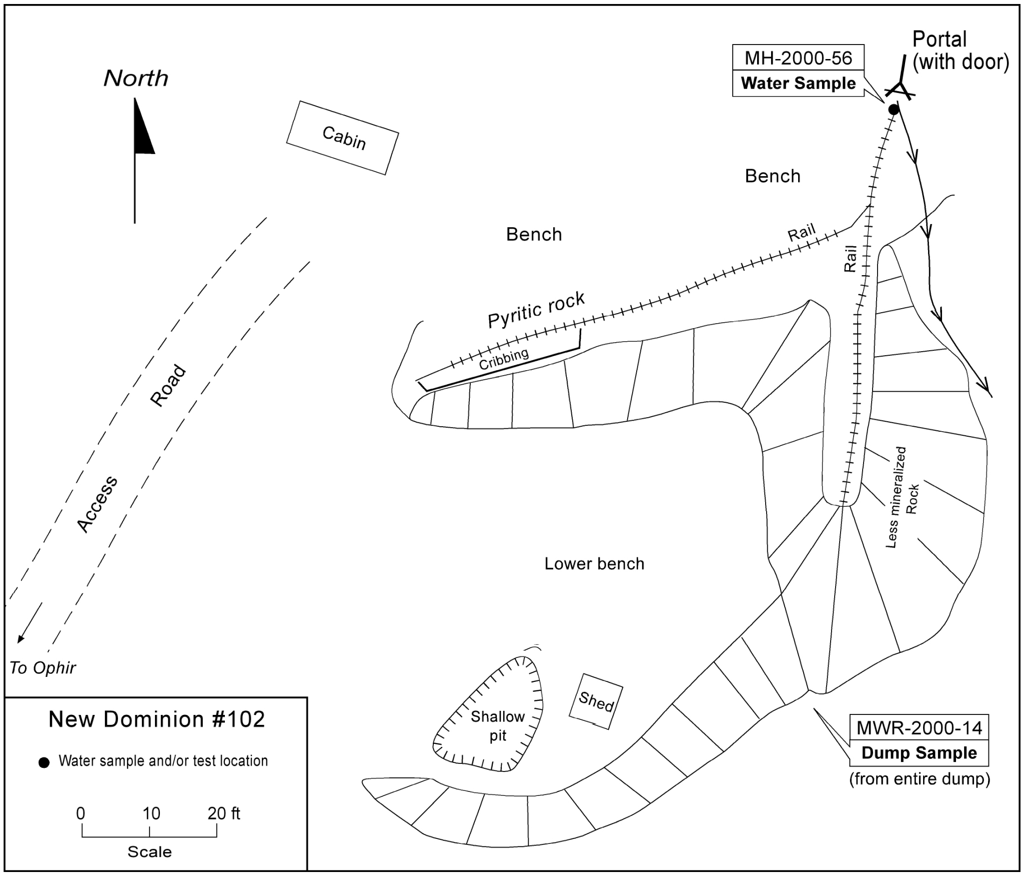

Figure 30. Surface map of the New Dominion #102/202 site.

Figure 31. Cabin and western lobe of dump #202, New Dominion inventory area.

Figure 32. Enclosed portal and effluent at adit #102, New Dominion.

Figure 33. New Dominion dump #202 and effluent.

Figure 34. Effluent and precipitate at portal #100, New Dominion.

Dump #202 contained about 1,500 cubic yards of moderately cemented waste rock. The waste rock contained abundant disseminated pyrite in the fine-grained country rock. Numerous fragments of quartz vein with variable amounts of pyrite, sphalerite, chalcopyrite, and galena were also observed. Vegetation was sparse, but healthy. A few shallow dry gullies suggested periodic erosion, probably during storm events. Effluent was in contact with the eastern side of the eastern lobe of dump #202 for about 20 feet. Material along the western set of tracks appeared more mineralized and had more sphalerite than the rock along the southern tracks. Waste rock along the southern tracks probably represents barren or weakly mineralized country rock discarded during the excavation of the crosscut to the New Dominion vein. The western lobe probably comprises material removed during the latter stages of mining, including some vein material. The lowest bench was moderately mineralized and may represent material that was moved around after underground mining had ceased. Sample MWR-2000-14 was a composite waste-rock sample collected from both lobes and the lower bench of dump #202. The sample contained more than 0.5% lead and almost 0.2% zinc (Table 2). Concentrations of gold (0.015 oz/ton), copper (552 ppm), and molybdenum (78 ppm) were also elevated. Although moderately mineralized with metals and low in calcium, the sample was nearly neutral in terms of acid-generating capability (+1.9 tons $CaCO_3$/1,000 tons). Paste pH was slightly acidic at 5.75. Much of the sulfur in the waste rock may exist as sulfate minerals, which are not major acid generators.

Figure 35. Effluent crossing the vegetated bench of dump #200, New Dominion.

Figure 36. Mill ruins, New Dominion.

Figure 37. Wetland below adit #100, New Dominion.

Adit #100. The portal of this adit was nearly filled with red precipitate deposited by mine effluent. In August 1996 the mine discharge rate was 224 gpm. The average of three water tests showed pH was relatively neutral at 6.30, and conductivity was quite high at 1,585 µS/cm. Two water samples were collected at the portal. The water was moderately degraded; concentrations of iron (7,350 µg/L), manganese (1,400 µg/L), and sulfate (895 mg/L) exceeded standards. Calcium concentration (870 mg/L) was also quite high (Neubert and Harris, 1996, p. 15-16).

In October 2000 adit #100 was draining 269 gpm of water with 6.86 pH and 1,540 µS/cm conductivity. The effluent was clear, but the channel was coated with abundant light red precipitate. Most of the precipitate was soft and muddy, but some was slightly hardened. Abundant filamentous algae grew in the water, and thick moss lined the channel. Water sample MH-2000-57 was collected at the portal of adit #100 and had similar metal concentrations as the 1996 samples, exceeding State standards in iron, manganese, and sulfate (Table 1). Because of the high flow in conjunction with moderately high metal concentrations, loading of iron (>23 lb/day) and manganese (>4 lb/day) from the effluent was significant. Zinc load was less than 0.5 lb/day.

When sampled by CDPHE (1999) in Spring 1998, effluent from the New Dominion (adit #100) contained similar concentrations of iron, manganese, and zinc as the sample collected in October 2000. Total lead was high at 64.8 µg/L in 1998; no lead (dissolved analyses only) was detected in the 2000 sample. Waste rock samples collected by CDPHE in 1998 and CGS in 2000 were similar, except that the CDPHE (1999) sample contained less lead (0.14%) and more zinc (0.14%) than the CGS sample (Table 3).

During an abandoned mine inventory done by CDMG in 1980 (McLaughlin, 1981, p. A-216), the New Dominion Mine was draining water containing 3,700 µg/L iron, 1,000 µg/L zinc, 38 µg/L lead, 130 µg/L copper (recorded as total concentrations).

Samples collected from the lowest portal of the New Dominion Mine in June, August, and October 1980 were also analyzed for total metals. Manganese was about 1,200 µg/L in all of the samples. From June to October, iron decreased from 7,300 µg/L to 6,200 µg/L, zinc decreased from 420 µg/L to 100 µg/L, and copper decreased from 48 µg/L to 11 µg/L. Lead fluctuated between 10 µg/L and 57 µg/L (McLaughlin, 1981, p. A-207). Concentrations of iron, manganese, and zinc were similar in the 1980 and 2000 samples. Lead and copper (dissolved) were not detected in the 2000 sample, however.

This pattern of higher metal concentrations during high flow mimics the pattern in the main stem of Howard Fork. The Spring flush carries the highest metal concentrations and has the highest flow rates. Metal loads in Howard Fork are highest in the Spring.

Dump #200 contained about 3,000 cubic yards of moderately cemented to uncemented fines and sand-size material. Most pieces large enough to identify were fine-grained gray rock (Cutler Formation siltstone?) with variable amounts of disseminated pyrite. Minor amounts of chalcopyrite, galena, and sphalerite were observed. The steep face of dump #200 was slightly affected by sheet wash and was almost barren of vegetation. The bench was well vegetated with grass and trees (fig. 35). Although most of the effluent flowed alongside the western flank of dump #200, severe erosion was not evident. Some mine water probably soaked into the pile, because most of the toe was damp. However, in June and August of 1996 and October of 2000, no water emerged from the toe. Composite waste-rock sample MWR-2000-15 from dump #200 was moderately mineralized with respect to lead (>0.5%), gold (0.026 oz/ton), copper (483 ppm), and zinc (888 ppm) (Table 2). Calcium concentration was high (>2%), and the net acid-base potential was very alkaline (+19.6 tons $CaCO_3$/1,000 tons). Paste pH was nearly neutral at 6.13.

A total of less than 70 cubic yards of tailings were discovered in two small piles adjacent to the mill ruins and in a small "tailings pond" below the mill ruins. Tailings were reddish orange and gray (USFS-AMLIP inventory form 04-05-251/4193-1, available at CGS).

CARBONERO TAILINGS

Tailings that presumably originated from the Carbonero mill were deposited in the floodplain on the north side of Howard Fork (figs. 29, 38). The tailings were not inventoried during the CGS inventory in 1996 because brief reconnaissance in the area suggested that they were confined to private land (fig. 2). After a request by the U.S. Forest Service and a more thorough site visit, it was determined that a small portion of the tailings probably extends onto NFS land. A survey to determine property boundaries is needed in this area.

HISTORY

The Carbonero Mill was completed in 1924 and operated almost continuously until about 1930. No indications of mill operations after 1930 were found in the literature. During the 1930's, lessees shipped some of the tailings and middlings, as described in the **Carbonero Mine Area** section of this report. It is not clear if tailings were processed close to the mill, which was located on the North Star patented mill site claim (figs. 21, 22), or from the main pile near Howard Fork. Later production from the Carbonero Mine was processed at the Silver Bell mill near Ophir Loop.

Several patented and unpatented placer and mill site claims are or were in the vicinity of the Carbonero tailings pile. However, these claims had no known operational relationship to the Carbonero Mine or to the deposition of the tailings pile.

Most of the tailings are probably deposited on the privately owned Ferric Oxide Placer claim and on NFS land between the Ferric Oxide claim and Howard Fork. Thornburg Mining Company owned the claim in 1883 when a mineral survey was conducted (Mineral Survey No. 1661). Vera Belisle owned the claim as of May 2001 (courthouse records) This claim includes a large, actively forming ferrosinter (bog-iron) deposit (fig. 4, deposit A) that adjoins the north side, and probably partly underlies the tailings.

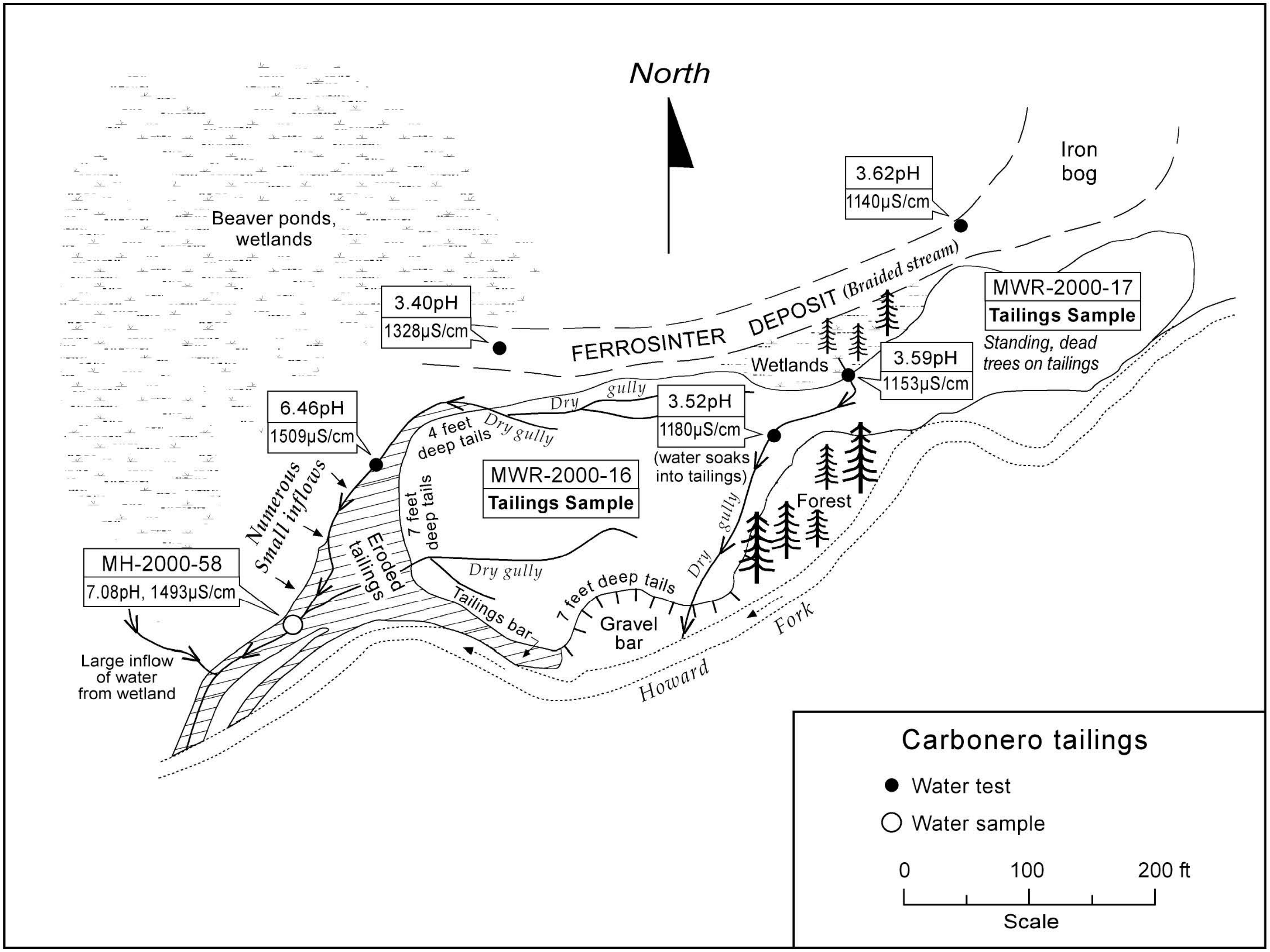

Figure 38. Surface map of the Carbonero tailings and sample sites.

Charles G. Seipp and A.H. Segel located the Favorite Mill Site in October 1929. The case was closed on this claim in 1994 (BLM files). The western edge of the Carbonero tailings pile may extend onto the eastern part of this mill site claim (Silver Bell Industries, Inc., 1971), but there is no evidence in the historical literature indicating that the sites were operationally related.

The unpatented Frank B. Mill Site claim was located in 1941 and was still a valid claim in 2001. Vera Belisle owns the claim, which covers much of the wetland that lies adjacent to the western side of the Ferric Oxide Placer and south of New Dominion adit #100. It is possible that some of the Carbonero tailings extend onto the Frank B. Mill Site, but no operational relationship is known. More information regarding the Frank B. Mill Site is reported in the **New Dominion** section of this report.

Mark Silversher located the Sher #1 Placer in 1979. This unpatented claim was south of and partly overlapped the southern part of the Ferric Oxide Placer patented claim. The Sher #1 probably included part of the tailings pile that lies on NFS land between the Ferric Oxide and Howard Fork. The case was closed for the Sher #1 in 1993 (BLM files). No mining, placer operations, or tailings processing is recorded for this claim.

GEOLOGY

The tailings pile was placed on talus, alluvium, and a ferrosinter deposit (figs. 4, 38, 39). The ferrosinter deposit is still actively forming around several small acidic springs on the north side of the tailings (fig. 40). The source of the acidic, metal-rich ground water that is forming the ferrosinter deposit is presumably the large area of hydrothermally altered Tertiary rocks on the slopes north of the tailings.

SITE DESCRIPTION

The Carbonero tailings are reached by a short access road that branches south of the Ophir Pass Road about one-fourth of a mile east of the Ophir Annex. The tailings comprised interlayered light yellow and orange-red sand and clay with a sulfide smell. The eastern end of the pile was thin with a few dead, standing trees (fig. 41). The western part was thicker and barren of vegetation (fig. 42). Gullies cut the surface of the pile in several places (figs. 42, 43). Most of the acidic water associated with the adjacent ferrosinter deposit flowed in a braided channel immediately north of the pile, but a small volume of the acidic water was flowing across the middle part of the pile before infiltrating (fig. 44). Howard Fork was in contact with about 40 feet of the pile. Some tailings were eroded and redeposited in areas along the southern and western side of the pile, between the pile and Howard Fork (figs. 38, 45). A large wetland adjoins the northwestern side of the pile (figs. 38, 46). This wetland receives water from the New Dominion inventory area, the ferrosinter deposit, and presumably from other sources as well (fig. 47). Surface water from the tailings does not flow into the wetland.

Figure 39. Actively forming ferrosinter deposit adjacent to and above Carbonero tailings.

Figure 40. Ferrosinter deposit on the north side of the Carbonero tailings.

Figure 41. Eastern end of Carbonero tailings, looking west.

Figure 42. Western end of Carbonero tailings, looking east.

Figure 43. Thickest part of the Carbonero tailings pile, showing rills and gullies.

Figure 44. Degraded water from the ferrosinter deposit crossing the tailings.

Figure 45. Western end of tailings pile, where eroded tailings have been redeposited.

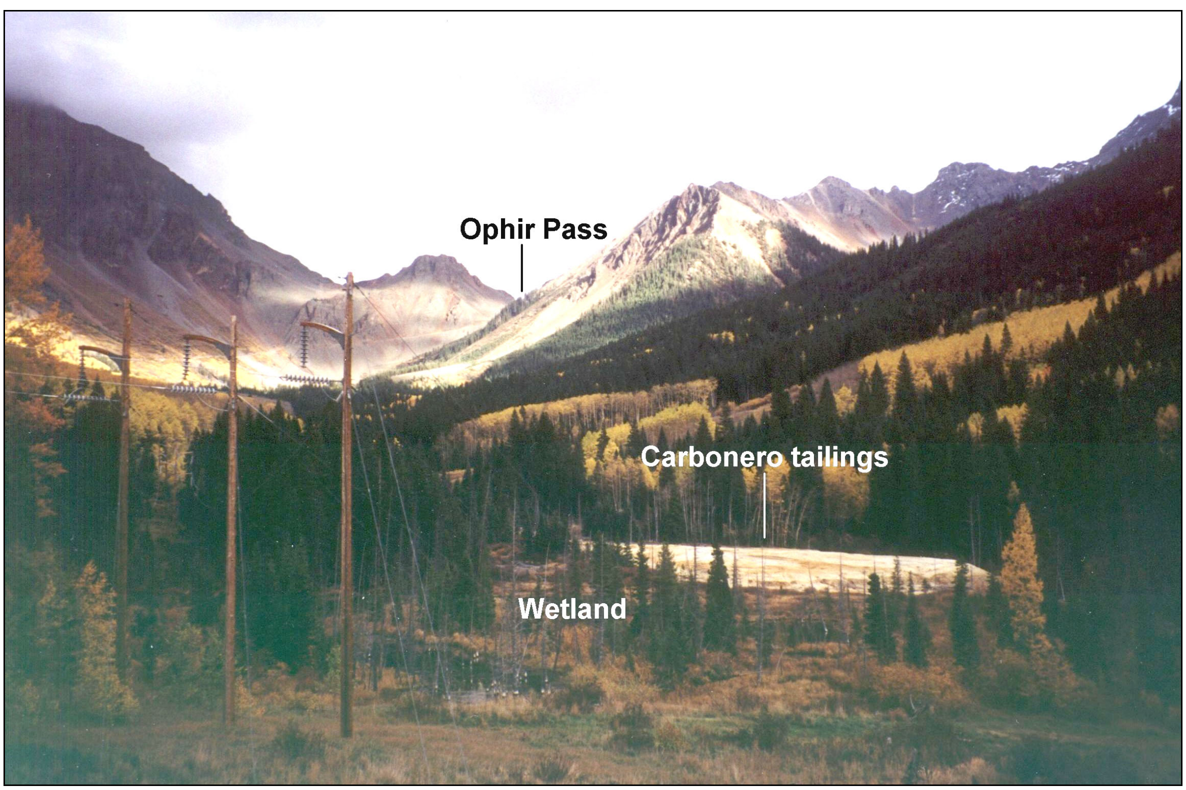

Figure 46. The Carbonero tailings and the upper Howard Fork basin.

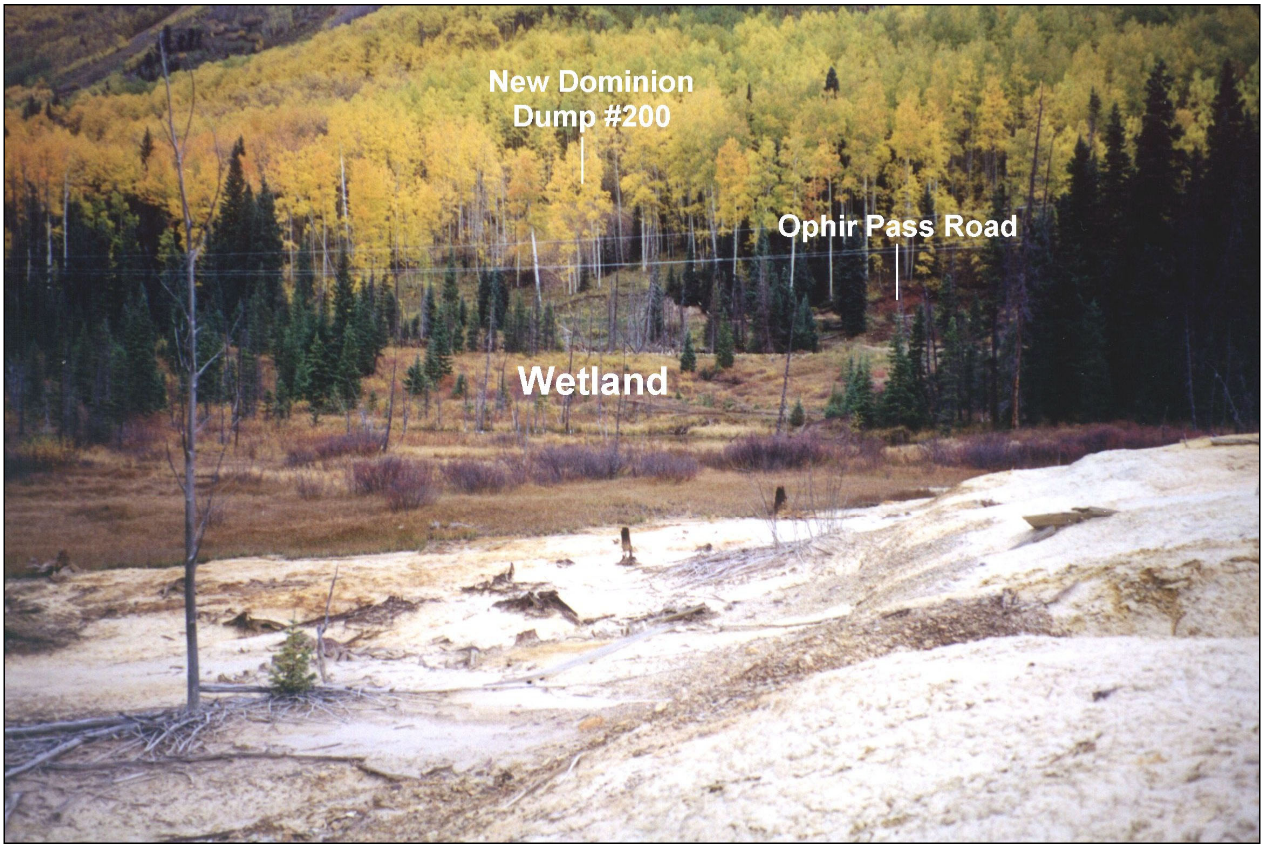

Figure 47. Wetland between the New Dominion Mine and Carbonero tailings.

At its east end, a thin and sporadic coating of tailings extended into the forest east of the mapped area. In many places soil and/or live vegetation covers this thin residue, and no effort was made to determine the full extent of this volumetrically small portion of tailings. Presumably, a "trail" of tailings should be traceable eastward and northward from the main pile uphill to the old mill. If so, about 600 linear feet of the tailings "trail" would cross NFS land between the patented Ferric Oxide Placer claim and the patented North Star Mill Site claim (fig.2). The tailings "trail" was not traced during this investigation.

WASTE AND HAZARD CHARACTERISTICS

The main part of the tailings pile was about 650 feet long and varied from 40 feet to almost 200 feet wide. Past erosion by Howard Fork has exposed a maximum depth of 7 feet (fig. 43), but in other places the tailings were only a thin covering on the forest floor (fig. 41). Calculations based on an average length of 600 feet, an average width of 120 feet, and an average depth of 3 feet result in an estimated volume of 8,000 cubic yards for the main body of tailings. The tailings were stratified into yellow, gray, and red layers of sand-, fine sand-, and clay-size material with a moderate to strong sulfide odor. CDPHE (1999, p. 8) estimated the pile covered 1.75 acres and contained 2,000 cubic yards. The surface area of 1.75 acres corresponds well with the CGS estimate, but the CDPHE estimated volume of 2,000 cubic yards appears low.

In October 2000, composite tailings samples were collected from the eastern and western lobes of the pile (fig. 38). The samples were collected from 6 to 12 inches deep on an approximate 20-foot grid. The samples were similar in composition and represent highly mineralized material (Table 2). The samples contained abundant lead (>1.2%), zinc (>0.4%), sulfur (>2.3%), and silver (>2 oz/ton). Copper (>250 ppm) and mercury (2 ppm) were also elevated. The western tailings sample (MWR-2000-16) had a very acidic paste pH of 2.93, but only a moderately acidic net acid-base potential (-6.0 tons $CaCO_3$/1,000 tons). The eastern sample (MWR-2000-17) was less acidic, with paste pH of 3.97 and nearly neutral net acid-base potential of -2.8 tons $CaCO_3$/1,000 tons.

Because these samples were collected from near the surface, they primarily represent the most recently deposited material. Deeper tailings may have a different composition, depending on the milling process and the mineralogy of the ore during the various phases of mining. Auger samples from the pile would be useful to determine the composition of the older tailings, the depth of the pile in different areas, and the approximate depth to ground water. Alternatively, samples could be collected from the embankment near Howard Fork, where seven vertical feet of tailings are exposed (fig. 43).

A sample of tailings collected by CDPHE in 1998 was considerably more mineralized than the composite sampled collected by CGS in 2000. Lead concentration was about 6 times higher (78,500 ppm), copper was about 3 times higher (910 ppm), silver was about 3 times higher (254 ppm, or about 7.6 oz/ton), but zinc (2,610 ppm) was less than half of the concentration of the CGS sample (CDPHE, 1999, p. 8). The type and location of the CDPHE sample was not detailed, so comparison with the CGS sample is difficult.

In October 2000 no surface water was flowing from the tailings. Water sample MH-2000-58 was collected from a shallow stream channel near the western edge of the tailings pile. This water was a combination of drainage from the ferrosinter deposit and several small inflows from the wetland (fig. 38). At the sample site the flow was 18 gpm, pH was 7.05, and conductivity was 1,491 µS/cm. The water was clear, but the channel had moderate amounts of light red and dark red precipitates. Moss lined the banks, and thin algae coated some of the rocks. The sample exceeded State standards in iron and sulfate concentrations (Table 1). Zinc concentration was high, but did not exceed standards because of the high hardness of the sample (zinc standard is based on water hardness). Manganese was also elevated. Metal loads were low because of the low flow rate of the stream.

In terms of pH, conductivity, and major ion concentrations, this water was remarkably similar to effluent from New Dominion adit #100 (sample MH-2000-57). This suggests that the bulk of the flow in this stream was derived from the wetland between the New Dominion and this sample site. Zinc concentration was much higher here than in New Dominion effluent. This could represent unseen inflows of ground water from the tailings, or perhaps the naturally degraded springs associated with the ferrosinter deposit are zinc rich. In early June 1998 a sample of runoff from the tailings was highly degraded with respect to total concentrations of cadmium, copper, lead, and zinc (CDPHE, 1999, p. 8).

Water samples collected from Howard Fork in June 1998 indicate that total zinc concentration doubled in the reach that included the Carbonero tailings, from 78.9 µg/L to 160 µg/L. Total zinc load approximately doubled to 55 lbs/day. Large impacts of other metals were not detected (CDPHE, 1999, p. 15).

CDMG samples from Howard Fork collected in November 1994 showed similar results, with total zinc concentration doubling (150 µg/L to 290 µg/L) in the Carbonero tailings reach (sites 6 and 18, Appendix). However, total zinc in June 1994 showed only a minor increase from 230 µg/L to 270 µg/L. Dissolved zinc showed no significant change from upstream to downstream during either sampling event. In the November sampling, total lead also showed a large increase, from 5 µg/L to 38 µg/L. In June 1994 total lead was below detection limits (<5 µg/L) upstream and downstream of the tailings, and dissolved lead was not detected upstream or downstream of the tailings during either sampling events. (Jim Herron, CDMG, unpublished data.)

Additional water sampling during high-flow and low-flow events, and samples of the water associated with the ferrosinter deposit are needed to better characterize the geochemistry and hydrology of this site. This stream reach also includes input from Nevada Gulch, which contains several mines in its drainage basin. Water samples should be collected from Nevada Gulch to determine if it is a metal source.

CARRIBEAU MINE

The 13th level of the Carribeau Mine was not included in the CGS abandoned mine inventory of NFS land. On the Ophir PBS map the portal, waste-rock pile, mill ruins, and tailings appeared to be on the privately owned Sarah Placer claim (fig. 3). A survey completed in 2000 indicated that effluent emerges from the caved portal on NFS land about 20 to 30 feet from the property line. The entire dump, mill ruins, and tailings are apparently on private land. In the summer of 2000, the U.S. Forest Service requested historical and environmental information regarding this site.

Higher on the slope above the 13th level, the 6th level crosscut tunnel (adit #107) and the 200-level tunnel (adit #105) of the Carribeau Mine were included in the Montezuma inventory area (250/4193-1, fig. 3).

Mining History

Initially the Carribeau Mine was worked through an adit and shaft higher on the hillside, mostly on the patented Carribeau Lode. A lower access adit was eventually driven to intersect the ore zone at depth and possibly to drain the upper workings. This lower adit was the 13th level of the Carribeau Mine. The associated Tunnel Site claim was never patented, although two lode claims (Mountain Queen and Harvest Moon) positioned over the lowest crosscut adit were patented. A mill was built on part of the patented Sarah Placer claim near the portal of the 13th level. Workings on the nearby patented Montezuma Lode eventually connected to the Carribeau Mine. Some information on the Montezuma Mine and Sarah Placer is included in this historical summary of the Carribeau Mine. Over the years, different reports have used a variety of spellings for the Carribeau, including Caribou, Carribean, and Carribbeau. It is assumed that these similar names refer to the Carribeau Mine/Lode.

The Carribeau and/or Montezuma Mine produced almost every year from 1878 to 1936 (Table 5). Silver and lead were the principal commodities. Peak years of production were probably in the late 1880's and early 1890's, and about 1899 to 1908. Carribeau Mining Company was the principal producer, although Yellow Mountain Mines Company also produced significant volumes of ore from about 1903 to 1910. The 13th level crosscut was apparently completed by about 1895. It is not clear when excavation of this lower haulageway and drainage adit began. The original mill was operating by 1896 or 1897, and it was renovated in 1917.

1878. The first recorded activity at the site was in 1878, when the Carribeau Lode claim was located. The 300- by 1,500-foot claim was on the northern slope of Yellow Mountain, southwest of Ophir. In June, the Carribeau Lode was relocated (bk. 1, p. 401). The claim was originally located by E.L. and J.R. Grim, then relocated by American Midland Mining and Milling Company.

Beaty, Davis, and another partner located the Montezuma Lode that adjoins the eastern side of the Carribeau (fig. 48). "Some" ore was shipped to Silverton (*Rocky Mountain News*, March 27, 1880, p. 6).

1879. Rich & Company were "running a 40 foot cross cut tunnel and sinking a 70 foot shaft on the Montezuma lode" (*Rocky Mountain News*, December 2, 1879, p. 3). In a summary for the year, it was reported that M. Rich, Harry Beattie, and A.Y. Davis owned the Montezuma. A 26-foot-deep shaft developed a 5-foot-wide, east-striking, vertical vein. The vein had an 8-inch-wide pay zone that averaged 135 oz/ton silver and contained gray copper (tetrahedrite group) and galena. Production was valued at $800 (Corbett, 1879, p. 310). Late in the year, Kline and Sneathen purchased Davis and Beaty's interest for $40,000 and formed the Montezuma Mining Company. Contracts were let to sink 100 feet of shaft and drive a 150-foot-long crosscut adit (*Rocky Mountain News*, March 27, 1880, p. 6).

1880. Mineral Survey No. 347 was conducted on the Montezuma Lode and Mill Site in February. Rich and others owned the claims. Development on the lode claim included a 10-foot-deep discovery shaft and a 90-foot-deep shaft (at or near the location of adit #102, inventory area 250/4193-1) that connected to a 143-foot-long crosscut adit (adit #103) (figs. 3, 48). The vein was exposed at the face of the crosscut adit, and colored water was emerging in the adit near the vein. A parallel vein exposed in the crosscut was an extension of the vein worked on the Parsons Lode on the eastern side of the Montezuma Lode. Disregarding the high cost of shipping ($50/ton), ore produced from the shaft would have paid for sinking the shaft. A previous owner dug the discovery shaft and the initial 10 feet of the deeper shaft (Mineral Survey No. 347; *Rocky Mountain News*, March 27, 1880, p. 6).

Table 5. Production from the Carribeau/Montezuma Mine. (From various sources, see following text for details; X refers to production of an unknown quantity; ? indicates probable production.)

	Carribeau				Montezuma		
Year	**Production**	**Gold**	**Silver**	**Lead**	**Production**	**Silver**	**Lead**
1878					X	?	
1879					$800	?	
1880					X	?	
1881	600 lb		?				
1882	240 tons ($90/ton)		X	X			
1883	900 or 200 tons		10,000 oz	200,000 lb	X	X	X
1884	? ($70 to $90/ton)		?	?			
1885	X		X	?	?	?	
1886	400 tons		?	?			
1887	X	$1,059	$29,438	$8,797	X	$17,426	$7,988
1888	X	$1,500	$25,212	$7,956	X	$9,697	$3,978
1890	X	$8,340	$2,157		X	$6,206	
1891	Large quantity		$274,095				
1892	?				X	$5,000	
1896	31 carloads of concentrate				14 carloads of concentrate	?	?
1897	133 carloads of concentrate	X	X	X	5 carloads of concentrate	?	?
1898	102 carloads of concentrate	?	?	?	7 carloads of concentrate	?	?
1899	2,000 tons of concentrate	?	?	?	X		
1900	"Steady" production	?	?	?	?	?	?
1901	X		?	?	"Considerable" quantity	?	?
1902	X	?	?	?	X	?	?
1903	"Steady tonnage"	?	?	?	?	?	?
1904	4 carloads/week concentrate; 2-3 carloads/week smelter grade	?	?	?	?	?	?
1908	"Large tonnage" treated	?	?	?			
1909	Unspecified tonnage treated	?	?	?			
1910	"Small quantity"	?	?	?			
1911	Shipments more than in 1910	?	?	?			
1913	"Small quantity" of concentrate		?	?			
1914	X		X	X			
1917	Several hundred tons		X				
1918	X		X	X			
1919	"Small quantity"			X			
1922	"Small quantity"		?	?			
1923	X		?	?			
1929					?	?	?
1933	X		?	?			
1934	Small quantity		?	?	Small quantity	?	?
1935	Small quantity		?	?	Small quantity	X	
1936	X		?	?	X	?	

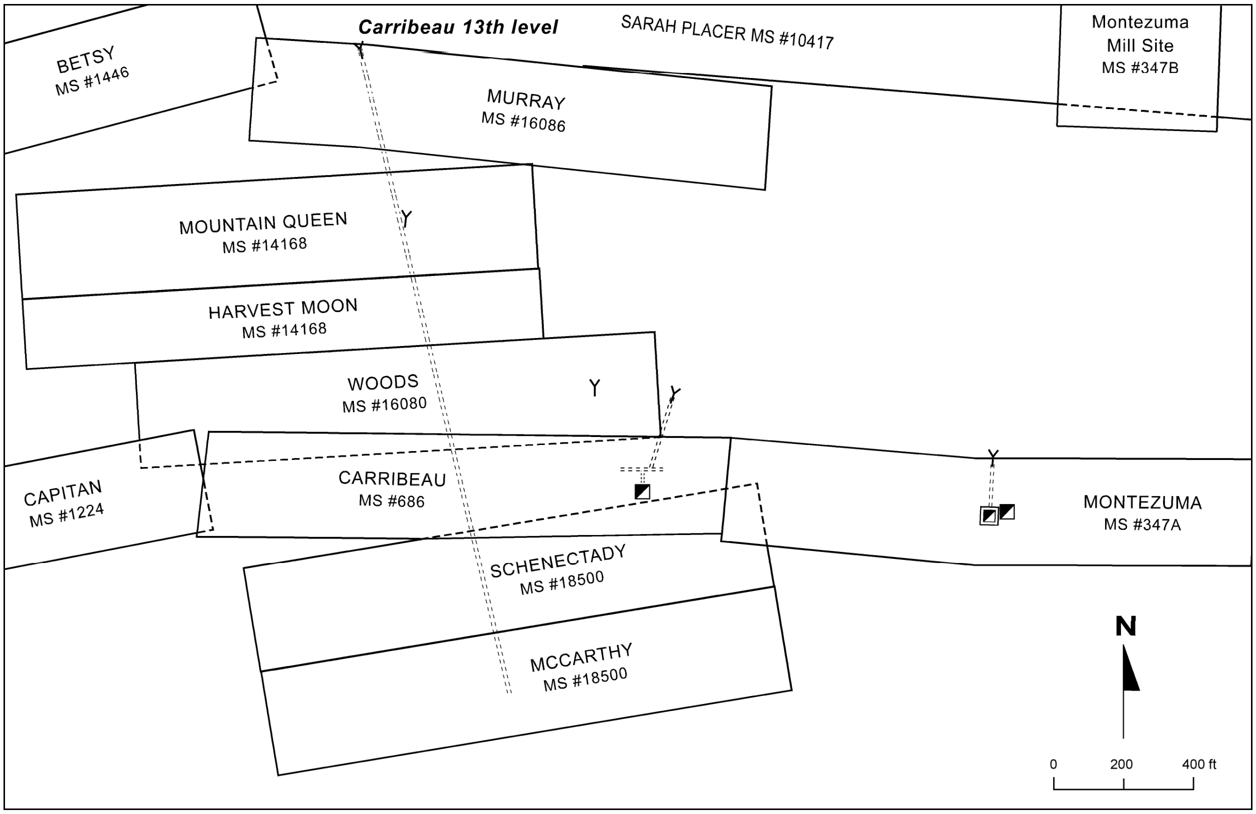

Figure 48. Composite map of some of the mineral surveys in the Carribeau Mine area. (Scale is approximate.)

1881. A 16-inch-thick vein of "high grade" galena and gray copper ore was exposed in the Carribeau Mine in March. About 600 lb of ore was recovered from shaft sinking during a one-week period, and the ore was shipped to Silverton. In July, Mineral Survey No. 686 was conducted on the Carribeau Lode. Workings surveyed on the claim included a 12-foot-deep discovery shaft, 175-foot-deep shaft, 202-foot-long crosscut tunnel (adit #105, inventory area 250/4193-1, fig. 3), and 115 feet of drifts. Apparently, the deeper shaft, crosscut tunnel, and drifts were connected. The portal of the crosscut tunnel was about 100 feet north of the Carribeau Lode. The mine owners, American Midland Mining and Milling Company (G.W. Guebel-agent), filed articles of incorporation (Mineral Survey No. 686; *Denver Republican*, March 4, p. 2; June 15, p. 1, 1881; *Rocky Mountain News*, December 5, 1881, p. 6; *San Juan Herald*, July 14, 1881, p. 3).

1882. In February, a 5-foot-wide white quartz vein with a 12-inch-wide gray copper zone was exposed in the Carribeau Mine. Seven carloads of the material were shipped. More than 350 feet of development work was done during the winter, and by May, 200 tons of high-grade ore was stockpiled in the ore house and more low-grade ore was on the dump. A contract for an additional 600 feet of drift on the 2nd level was let; the 1st level had 217 feet of drifts. A 200-lb specimen of galena and gray copper was displayed at the Mining Exposition in Denver in July. On July 26, a patent was granted to American Midland Mining and Milling Company for the Carribeau Lode. The mine was worked on three levels, and by the end of November production averaged 15 tons/week netting $80/ton after shipping to Rico. High-grade ore contained 110 to 120 oz/ton silver; “second class” ore had 60 to 70 oz/ton silver and 40% to 58% lead. Workings included a 175-foot-deep shaft, 200 feet of crosscut, 132 feet of winze, and 690 feet of drifts. The company planned to build a tram and mill. For 1882, about 240 tons of ore (netting $90/ton) were shipped from the Carribeau (Caribou) Mine, which was managed by Mark Folsom (bk. 21, p. 81; *Rocky Mountain News*, February 27, p. 7; July 27, p. 7; November 30, p. 6, 1882; *San Juan Herald*, May 11, p. 3; May 18, p. 3; August 3, p. 3; December 7, 1882, p. 3; Burchard, 1883, p. 522). The Rocky Mountain News (January 12, 1883, p. 2) reported that shipments during 1882 had an estimated value of $15,000.

The Montezuma Mine was owned by a Pittsburg company and was developed by a 100-foot crosscut and a 100-foot shaft (*San Juan Herald*, August 11, 1882, p. 3).

1883. In January, the Carribeau Mine shipped an average of 5 tons/week and was owned by American Midland Mining and Milling Company (S.D. Loring-president; Mark Folsom-managing director; John C. Curtis-superintendent). In February, six men worked in a crosscut and four men worked in a drift. The crosscut was going in about 155 feet below the operating level. In August, 30 workers produced daily, 3½ tons of “first class” ore (95 oz/ton silver, 45% to 50% lead), 10 tons of “second class” ore that was concentrated at a 4:1 ratio, and 4 tons of “third class” ore, which may have been placed on the dump. Ore was shipped to the Boston & Ophir smelter in Ames, Colorado. Year-end summaries reported that workings included a 200-foot-long crosscut tunnel, a 175-foot-deep airshaft, and a 180-foot-deep winze. The ore zone was 6 to 15 inches wide. Ore was developed into nine 60-foot-deep by 100-foot-wide blocks on three levels below the crosscut adit. Between 500 and 700 tons of ore had been stoped and shipped from two of the blocks. Sorted and milled ore assayed 40% lead and 80 oz/ton silver, but several lots contained as much as 150 oz/ton silver (Corregan and Lingane, 1883, p. 686; Burchard, 1884, p. 423-425; *Rocky Mountain News*, January 19, 1883, p. 3; *San Juan Herald*, February 15, p. 3; August 2, 1883, p. 3). Published production figures for the Carribeau Mine in 1883 differ. Burchard (1884, p. 425) reported that shipments totaled 200 tons containing 10,000 oz silver and 200,000 lb lead. Corregan and Lingane (1883, p. 686) reported 900 tons of production from the Carribeau and Keystone Lodes.

Montezuma Mining Company (J.B. Sneathen-president; Jacob Klee-vice president; Moritz-secretary; J.H. Maugham-treasurer; B.F. Klee-manager) owned the Montezuma Lode. A 100-foot-deep shaft, 143-foot-long crosscut, and a 37-foot-long drift developed the claim. Sorted and milled ore assayed 28% copper, 35% lead, and 111 oz/ton silver. The mill processed 40 tons/day (Corregan and Lingane, 1883, p. 715).

1884. In May, Carribeau Mining Company incorporated (Moses Newton-president; Robert S. Parish-secretary; Charles S. Newton-designated agent). The Colorado division was based at the Carribeau Mine (San Miguel County Courthouse, Articles of Incorporation, bk. 27, p. 414; BLM records). A 1-foot-wide galena-bearing ore zone was richest at a depth of 360 feet and had average values of $70 to $90/ton (Burchard, 1885, p. 247). The Rocky Mountain News (August 9, 1884, p. 6) reported that the Carribeau Mine was worked under a lease agreement.

1885. H.P. Roberts of Minneapolis, Minnesota, and W. Thomas of Silverton leased the Carribeau Mine. A 3- to 14-inch-wide ore zone containing wire and ruby silver and worth $100/ton was exposed in February. About 150 tons of ore awaited shipment. In August, the entire workforce (15 men) was stoping ore. Carribeau Mining Company located the 1,500-foot-long Carribeau Tunnel Site claim in November. This claim commenced at a point 300 feet north of the Carribeau boarding house and was located to develop the Carribeau Lode and any other veins revealed along its course. In October, lessees started driving a 700-foot-long crosscut adit to intersect the Carribeau vein at a depth of 500 feet. Operations also resumed under a lease on the Montezuma Lode, an extension of the Carribeau vein (bk. 24, p. 114; *Rocky Mountain News*, February 17, p. 3; August 13, p. 6; August 27, p. 6; October 22, p. 6; November 10, p. 6, 1885; *San Juan Herald*, February 12, 1885, p. 2). The 700-foot-long crosscut was probably adit #107 of the Montezuma inventory area (250/4193-1) and probably lies on NFS land (fig. 3).

1886. Thomas and Heffron leased the Carribeau and Montezuma Mines and employed 20 workers. By October, the mine had produced about 400 tons of ore, most of which was shipped to Rico. Ore houses and other buildings were under construction, and supplies were being stored for the approaching winter. The crosscut adit 500 feet below the apex of the vein was complete, or nearly so, and production was expected to double (*San Juan Herald*, October 28, 1886, p. 3).

1887. In June, 200 tons of ore produced during winter development work were stockpiled on the dumps of the Caribou and Montezuma. Lessees H.C. Heffron and William H. Thomas planned to ship the stockpiled ore and new production to Silverton. Daily shipments continued at least through August, and the last shipment of the year was in October. The company planned to operate all winter, stockpiling the ore until the following summer. Production from the Carribeau (Caribou) Mine was worth $1,059 in gold, $29,438 in silver, and $8,797 in lead. Production from the Montezuma Mine was worth $17,426 in silver and $7,988 in lead (Munson, 1888, p. 184; *San Juan Herald*, June 9, p. 2; June 16, p. 2; July 7, p. 3; August 11, p. 3; September 22, p. 3; December 11, 1887, p. 5.)

The Capitan Lode is the patented claim that covers the Carribeau vein on the west side of the Carribeau Lode (fig. 48). Major R. Lawder of Mexico, Missouri, and W.P. Chamberlain of Knoxville, Tennessee owned the Capitan, which was previously owned by Mexico & San Juan Mining Company. In August, Lawder operated the mine through a crosscut that intersected the Carribeau vein 157 feet below the surface. In the crosscut the galena-gray copper vein was 1 foot wide. Although hopes for a rich mine were high in August, the Capitan Mine closed in September (*San Juan Herald*, August 11, p. 3; August 18, p. 3; September 22, 1887, p. 3). Although no production was recorded, later workings of the Carribeau may have connected with the Capitan.

1888. In July, a crosscut connected the Carribeau and Montezuma lodes and opened new ground. Captain Thomas obtained a 5-year lease on the Carribeau property in September and extended the lease in November. Reported production from the Carribeau (Caribou) Mine was valued at $7,956 in lead, $1,500 in gold, and $25,212 in silver. Production from the Montezuma Mine was worth $3,978 in lead and $9,697 in silver (*Telluride Republican*, July 20, September 14, November 9, 1888; Munson, 1889, p. 124).

1890. Production from the Carribeau Mine was worth $8,340 in gold and $2,157 in silver. Production from the Montezuma Mine had a value of $6,206 in silver (Smith, 1891, p. 140).

1891. A "large" amount of silver was produced from the Carribeau Mine (Henderson, 1926, p. 53). Smith (1892, p. 184) reported that the mine produced $274,095 in silver for the year, much higher than recorded production figures for previous years.

1892. Production from the Montezuma Mine had a value of $5,000 in silver (Smith, 1893, p. 90).

1893. The silver panic of 1893 caused the closure of the Carribeau and Montezuma Mines. A group of Massachusetts and Connecticut investors owned the company that owned the mines (*Denver Republican*, January 1, 1896, p. 9, 12).

1894. Suffolk Globe Mining and Milling Company located the Sarah Placer claim along the Howard Fork (fig. 48). Part of the Sarah Placer later became the Carribeau Mill Site claim, and became the repository for waste rock from the Carribeau 13th level adit and tailings from the Carribeau mill.

1895. A 1,000-foot-long crosscut adit intersected the Carribeau(?) vein below the old workings (*Denver Republican*, January 1, 1896, p. 9, 12). This is probably the 13th level adit, but the description is too vague to be certain.

1896. Thirty-one carloads of concentrate from the Carribeau Mine and 14 carloads from the Montezuma Mine were shipped (*San Miguel Examiner*, September 11, 1897; *Mining Reporter*, October 13, 1898, v. 38, p. 14.)

A mineral survey of the Sarah Placer claim was conducted. None of the workings or processing facilities associated with the Carribeau Mine were illustrated on the mineral survey, although the previous paragraphs suggest that the 13th level adit and mill existed by about 1895 or early 1896 (Mineral Survey No. 10417).

1897. Charles Newton (superintendent) continued managing the Carribeau and Montezuma Mines, which were owned by Carribeau and Montezuma Mining Company. Between 60 and 65 workers, mostly mining on leased ground, operated 24 hours/day throughout the year. High-grade ore averaging $50 to $125/ton in gold, silver, and lead was shipped directly to the smelter. Low-grade ore was treated at a 20-stamp mill at the mouth of the lower crosscut adit. This lower crosscut intersected the main vein 1,700 feet below the upper workings. The mill operated 24 hours/day and concentrated 30 to 35 tons/day of low-grade ore at a 4:1 or 5:1 ratio. Low-grade ore from the lower workings averaged $10 to $15/ton in gold values; upper workings had no remaining gold values. Not including silver and lead, concentrates averaged $50 to $60/ton in gold. Concentrates were shipped to Durango and Pueblo for further processing. In November, Tom Boy Gold Mines Company purchased or leased the Carribeau and Montezuma Mines. Large, high-grade silver ore bodies were exposed, and one exceptionally rich carload of ore netted leaseholders $1,100. Shipments averaged three carloads/week of concentrate, and by late November, 123 carloads had been shipped. For the year, shipments totaled 133 carloads of concentrate from the Carribeau Mine and 5 carloads from the Montezuma Mine (*Mining Reporter*, October 13, 1898, v. 38, p. 14; *San Miguel Examiner*, September 11, October 9, October 19, October 23, November 9, 1897). The lower crosscut adit with the associated mill is almost certainly the 13th level adit, which is the draining mine on NFS land near Howard Fork.

1898. Carribeau Mining Company (Carribeau and Montezuma Mining Company?) continued as owners/operators of the Carribeau Mine and 10-stamp mill (20 stamps?). For the previous ten years the Newton family (Moses Newton-president, John C. Newton-treasurer, Charles S. Newton-general manager) were the principal owners of the company. Development at the mine included about 2 miles of tracked tunnels and 4,000 to 5,000 feet of stoped ground. Between 30 and 60 employees worked in the mine and mill. The mill operated 24 hours/day. Ore value averaged $25/ton. Two to seven carloads/week of concentrate were shipped, and some carloads netted as high as $1,200. During an 18-month period that included 1898, stockholders received "successive monthly dividends." Jones & Company operated the adjacent Montezuma Mine under a lease from Carribeau Mining Company. Seven carloads of concentrate were shipped from the Montezuma Mine, and 102 carloads were shipped from the Carribeau Mine during the operating season (*Mining Reporter*, August 18, v. 38, p. 17; September 29, v. 38, p. 19; October 13, 1898, v. 38, p. 13-14; *Denver Times*, August 25, p. 2, December 22, 1898, p. 2).

In May, a mineral survey was conducted on the Sarah Placer claim owned by Suffolk Globe Mining and Milling Company (Mineral Survey No. 10417).

1899. Carribeau Mining Company continued operations at the mine. Labor problems forced the smelters to close early in the year, severely affecting mines that produced silver-lead ore. Shipments from the Carribeau Mine decreased, and concentrate was stored in cars along sidetracks at Ophir Loop and San Bernardo. Eventually the mine was idled for two weeks. This mine was the leading producer in the Iron Springs mining district for several years, and when it was operating at a normal level the mine and mill usually employed 70 to 100 workers. An average of only 30 workers was employed in 1899, however. The discovery of some high-grade ore bodies in June allowed the resumption of full operations by September. Between three and four carloads of concentrate were shipped weekly. In October, Charles S. Newton located the Mountain Queen and Harvest Moon Lode claims over a portion of the lower crosscut adit. In November, Venture Corporation, Limited, of London expressed interest in purchasing the Carribeau Mine and associated 20 ton/day (24 hour) stamp mill. An average value of $20.75/ton was obtained from 386 samples, and the prospective owners planned to increase the mill capacity by installing 50 rapid-drop stamps. About 8,000 tons valued at $20/ton were milled, and 2,000 tons of concentrates were shipped to smelters. Concentration ratio varied from 4:1 to 6:1. Total underground development included 2,000 feet of crosscut tunnels, 800 feet of raises, and about 2 miles of drifts. An "abundance" of water drained from the 13th level crosscut adit throughout the year (*San Miguel Examiner*, July 29, September 2, 1899; *Denver Times*, June 24, p. 3; October 23, p. 3; November 11, 1899, p. 4; Hodges, 1900, p. 105-107; *Mining Reporter*, June 29, 1899; Mine manager report-Carribeau, 1899, p. 348, CBM; Mineral Survey No. 10417). Water from the 13th level adit may have been used in the milling operation.

A patent was granted to B.N. Griffin, George Griffin, Cornelius Pierport, J.N. Pierport, John M. Marvin, William A. Erring, Trudi L. Bishop, Aron Buttrick, A. Sutton, and Will J. Scoutt for the Sarah Placer in October (bk. 52, p. 153A-C).

1900. The purchase by Venture Corporation was not completed, and Carribeau Mining Company continued operations with an average of 27 workers. The main adit (13th level) intersected the vein 2,000 feet from the portal. Another crosscut adit (6th level) intersected the vein 600 feet from the portal. About 2 miles of drifts had been dug on the vein, and a 1,100-foot-deep shaft connected the drifts near the surface to the 13th level. Above the 6th level the workings were abandoned because the vein was completely stoped to the surface, a vertical distance of 400 feet. Large blocks of ore had been stoped below the 9th level. Overhand stoping was progressing on the 10th level. Assays averaged $20/ton. Capacity of the 10-stamp mill was 30 tons/24-hour day. The mine manager reported that development consisted of 2,000 feet of tunnels and 4,500 of drifts (P.H. Clifford, Inspector report-Carribeau Mine, July 29, 1900, v. 4, p. 210; Mine manager report for 1900-Carribeau Mine and Mill, p. 569-570, CBM). According to the Mining Reporter (December 6, 1900, p. 361), “steady production” continued throughout the year.

Mineral Survey No. 14168 was conducted on the Mountain Queen and Harvest Moon Lodes owned by Charles Newton (fig. 48). Workings included two 15-foot-long discovery cuts and about 500 feet of the 1,770-foot-long 13th level adit (4½ feet wide by 6½ feet high) (Mineral Survey No. 14168).

Moses Newton leased the Montezuma Mine to Moses Hill & Company. An average of seven employees worked the mine, which operated the entire year (Mine manager report for 1900-Montezuma Mine, p. 570, CBM).

1901. In February, two sets of lessees removed a “considerable” quantity of ore from the 400- and 500-foot levels in the Montezuma Mine, which was still owned by the Newtons. Carribeau Consolidated Mining Company incorporated in August with Wallace Murray, George A. Herrington, James A. Wood, Paul A. Haberl, and W.A. Leonard as the Board of Directors. Haberl, Herrington, and F.C.L. Sargent formed the Colorado division. In November, Carribeau Consolidated Mining Company acquired the Carribeau Mill Site, Carribeau Lode, Lower Carribeau Tunnel Site, and Carribeau ditch and water rights from Carribeau Mining Company for $350,000. Ore exposed in the mine at the time of the sale was worth over $1,000,000, and previous owners “realized an annual profit of $50,000.” An undetermined tonnage of ore was shipped from the Carribeau and Montezuma Mines during the year (Dunbar, 1902, p. 180; *Mining Reporter*, February 7, v. 43, p. 88; September 5, v. 44, no. 10, p. 181, 1901; *Denver Times*, April 10, p. 11; May 27, p. 9; August 18, 1901, p. 9; San Miguel County Courthouse, Articles of Incorporation; bk. 81, p. 535; Hodges, 1902, p. 138). The Mine manager report (Carribeau Mine-1901, p. 331, CBM) stated that Carribeau Mining Company (Moses Newton-president; Charles S. Newton-manager) owned the Carribeau, Montezuma, Mountain Queen, and Harvest Moon Lodes. An average workforce of 22 operated the mine continuously all year.

C.S. Newton located the Woods Lode in August**.** This claim was between the Harvest Moon and Carribeau Lodes (fig. 48) (Mineral Survey No. 16080).

In January, Ophir Consolidated Mines Company incorporated. The company's holdings included 71 claims on Yellow Mountain that covered all the ground between the Butterfly-Terrible and Carribeau-Montezuma Mines (about two miles). The claim block covered four of the most important veins on Yellow Mountain (*Denver Times*, January 27, 1901, p. 11; Hodges, 1902, p. 138). It is unclear, but unlikely, that the company acquired any holdings in the Carribeau and Montezuma Mines.

1902. In January, the Carribeau Mine was operating at 33% to 50% capacity, and ten stamps were in use at the mill. Carribeau Mining Company (Moses Newton-president; C.S. Newton-manager) operated the mine continuously with 18 miners and 11 other workers at the Carribeau and 6 employees at the Montezuma Mine. Estimated dividends from the Carribeau and Montezuma Mines for the year were $60,000 (*Denver Times*, January 12, 1902, p. 10; Mine manager report-Carribeau Mine-1902, p. 317; Mine manager report-Montezuma Mine-1902, p. 324, CBM; Wahlgreen, 1902, p. 115-116; *Mining Reporter*, January 15, 1903, v. 47, p. 66.)

The Woods Lode (Mineral Survey No. 16080) and the Murray Lode (Mineral Survey No. 16086), both owned by C.S. Newton, were surveyed in August. Nearly 300 feet of the 1,900-foot-long 13th level adit crossed the Woods Lode, and about 300 feet of the 13th level undercut the Murray Lode. When the Murray Lode was surveyed, the portal and a blacksmith shop were shown on the northern claim line. The 13th level adit extended beyond the Carribeau Lode, ending about 450 feet south of the Carribeau Lode (fig. 48) (Mineral Survey Nos. 16080 and 16086).

B.N. Griffing, owner of the Sarah Placer, filed a "Notice to Vacate" in September. Griffing demanded that Carribeau Mining Company cease trespassing and depositing tailings, refuses, or waste, and remove all improvements made on the Sarah Placer claim. In December, Charles D. Hoyt (plaintiff) attached the Carribeau Mill Site, Carribeau Lode, Lower Carribeau Tunnel Site, and Carribeau ditch and water rights to the Carribeau Consolidated Mining Company (defendant) in a "Writ of Attachment" (bk. 86, p.137, 211).

1903. Early in the year Carribeau and Montezuma Mining Company employed 35 to 50 people. A "steady tonnage" of ore was mined and treated at the company's 10-stamp mill. Large ore bodies were blocked out in the shaft, and drifts were run at 100-foot intervals. In March, Yellow Mountain Mining Company acquired the property of Carribeau Mining Company. The new owners planned to operate "on a much larger scale." About 30 employees cleaned out the workings to prepare the mine for steady production. In September, workers at the Carribeau, Montezuma, and other nearby mines demanded an 8-hour day with the same wage as the 10-hour day; and the owners of the Carribeau agreed. In November, adverse weather stopped production, and the mill closed for the winter. Workers continued excavating a ventilation raise. The mill was equipped for amalgamation and concentration (bk. 86, p.261-271; *Mining Reporter*, February 5, v. 47 p. 134; April 23, v. 47, p. 381; July 30, v. 48, p. 104; November 12, v. 48, p. 471; November 26, 1903, v. 48, p. 522; *Denver Times*, September 21, 1903, p. 8).

1904. In March, 30 employees were engaged in development work at the Carribeau-Montezuma Mine. In April, Yellow Mountain Mines Company replaced mine superintendent William

Davidson with F.T. Axtell. In May, milling operations resumed with new equipment that had been installed during the six months of inactivity. A 3-foot-wide ore body was exposed in a raise between the 13th and 14th levels. This direct shipping ore had values in gold, silver, lead, and copper and assayed $50 to $60/ton. During July, about four carloads/week of concentrates were shipped. In addition, weekly shipments of two to three carloads of high-grade ore were sent directly to the smelter. A test batch of Carribeau Mine dump material was processed at the Suffolk mill in October. The owners believed that material placed on the dump around 1893, when silver was about $1/oz, could be profitable (*Mining Reporter*, March 3, v. 49, p. 228; April 21, v. 49, p. 410; May 5, v. 49, p. 462; July 7, v. 50, p. 18; October 27, 1904, v. 50, p. 447; Downer, 1905, p. 117). In December, Suffolk Mining and Milling Company sold the 15 acre Carribeau Mill Site portion of the Sarah Placer to B.N. Griffing (bk. 95, p. 135).

Ophir Consolidated Mines (J.O. Buckley-president; H.A. Salzer-vice president; W.S. Buckley-manager; T.F. Somers-secretary; J.E. Wheeler-treasurer) owned the Denver and Georgiana unpatented claims. A map in the company's prospectus showed the claims lying between the Carribeau and Woods claims, which conflicts with the mineral surveys (fig. 48). The prospectus stated that the highest grade ore at the Carribeau Mine originated from the Ida vein, which parallels the Carribeau vein. The prospectus also included a cross-section showing the extent of underground workings on the Ida vein in the Carribeau Mine (fig. 49) (Ophir Consolidated Mines Company prospectus, 1904, available at Denver Public Library).

1907. In October, Yellow Mountain Gold Mines Company was incorporated with E.K. Austin, Charles H. Luscomb, C.B. Austin, Otto Erickson, and Axtell as the Board of Directors (San Miguel County Courthouse, Articles of Incorporation; bk. 103, p. 103). Later in October the company acquired full use of the Carribeau group of properties from Yellow Mountain Mines Company. The agreement included use of the power generating plant, buildings, flume line, tailings pond, tunnels, drifts, shafts, and the part of the Carribeau Mill Site situated on the Sarah Placer (bk.103, p. 107-108).

Mineral Survey No. 18500 was conducted on the Delta, Security, McCarthy, O.K., Schenectady, Florence, and Celt Lodes owned by B.N. Griffing. Earlier surveys showed the 13th level Carribeau crosscut adit extending south of the Carribeau Lode, and the adit should have undercut the Schenectady and McCarthy Lodes as shown on figure 48. Mineral Survey No. 18500 did not show the adit, and the mine was not listed with improvements on the claim group, suggesting that Griffing had no ownership of the adit.

1908. Yellow Mountain Mines Company acquired use of mining properties held by D. MacLean. The property included the Carribeau and Montezuma Lodes and buildings and equipment on the Sarah Placer (20-stamp mill, boarding house, and mining equipment) (bk. 103, p.232-234). Ralph Morgan (president), Lynn J. Morgan (vice-president), and Harriet Semler (secretary) were the principal officers of Carribeau Mining Company. Other company officials were J.L. Brown, V.O. Rodgers, O.C. Thomas, Albert C. Blatz, Win J. Morgan, and H. Semler (San Miguel County Courthouse, Articles of Incorporation). Henderson (1909, p. 399) reported that Yellow Mountain Mining Company treated a "large tonnage" of ore during the year. Yellow Mountain Mines Company and Carribeau Mining Company were probably closely related.

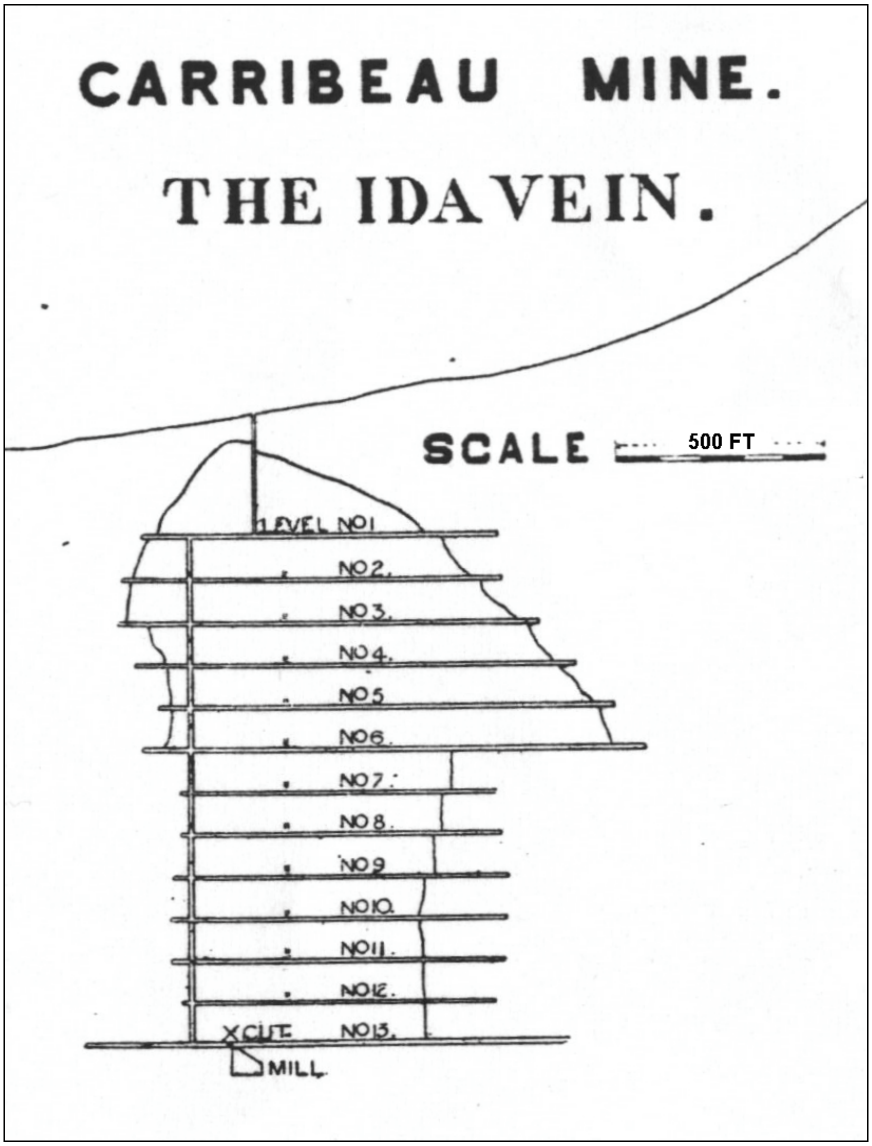

Figure 49. Cross-section of the Carribeau Mine workings along the Ida vein circa 1904. (From Ophir Consolidated Mines Company prospectus, 1904.)

1909. Yellow Mountain Gold Mines Company and Yellow Mountain Mines Company acquired a promissory note for Carribeau Mining Company's property in January. The property included the Carribeau and Montezuma Lodes, the 20-stamp mill, boarding house, and mining equipment on the Sarah Placer. An unspecified quantity of ore was crushed at the 20-stamp mill and treated at the 60-ton/day concentration mill (bk. 103, p.230-235; Henderson, 1911a, p. 328).

1910. A small quantity of ore was shipped from the Carribeau Mine (Henderson, 1911b, p. 438).

1911. Carlson & Company leased the Carribeau Mine between March and September. Nine workers were employed, and ore was concentrated in the 20-stamp mill. Concentrates had an average value of $25/ton. In August, Carribeau Mining Company (William J. Morgan-president; Otto Erickson-mine manager) purchased the property of Yellow Mountain Gold Mines Company and Yellow Mountain Mines Company including the Carribeau and Montezuma Mines, and associated mills, tunnels, and buildings and equipment on the Sarah Placer. Although litigation forced the mine to close near the end of the year, production increased from the previous year (Mine manager report, Carribeau Mine-1911, p. 209½, CBM; bk. 103, p. 411-412; Henderson, 1912, p. 561).

1912. E.C. Porter agreed to lease Carribeau Mining Company's property in November (bk. 103, p. 533-535). The Carribeau mill (20 stamps, concentrating tables, 45 tons/day maximum capacity) was idle during the year (Henderson, 1913, p. 661).

1913. Ida Gold Mining Company (John B. Olson-president/manager; R.O. Hanson-secretary/treasurer) owned a large block of claims including the Carribeau and Montezuma. Two main crosscut adits, the 13th level (2,000 feet long) and the 6th level (600 feet long), were used to access the 13 levels in the mine. Three other crosscuts accessing the surface were not used. Previous mining activity east of the 13th level crosscut had removed most of the Carribeau vein along a horizontal distance of 1,800 feet and vertically to the surface. Very little ore had been stoped on the 13th level along the 600-foot-long drift to the west of the crosscut. Underground work during the year included overhand stoping on the 13th, 3rd, and 6th levels west of the crosscut and excavation of a crosscut to connect the 6th level to the Ida vein. Total development in the Carribeau Mine was 67,800 feet (55,000 feet of drifts, 5,600 feet of crosscuts, 3,700 feet of raises, and 3,500 feet of winzes). An average of 18 workers mined ore consisting mostly of galena with an average value of $15/ton. Only a small quantity of concentrate was shipped during the year (Mine manager report Carribeau and Montezuma Mine-1913, p. 452; S. Treais, Inspector report-Carribeau Mine, 1913, v. 15, p. 710-711, CBM; Henderson, 1914, p. 272).

1914. An unspecified quantity of lead-silver ore was shipped from the Carribeau (Henderson, 1916, p. 302).

1917. Carribeau Trust Company (Carl B. Rix-secretary) owned and operated the Carribeau Mine and mill with 12 employees. The newly remodeled mill had been "equipped with ball mills, Wilfley tables, and flotation" cells. Upon completion, the mill was going to use a new process to treat the mill tailings after sorting. Mill tailings reportedly had a value of $6/ton. Underground work was limited to general repair and development of ore (R. Innes, Inspector report-Carribeau Mine and Mill, August 28, 1917, CBM) Henderson (1920, p. 844) reported that several hundred tons of silver ore were milled at the Carribeau Mine.

1918. Lead-silver ore was processed at the mill, which only operated for a short time (Henderson, 1921, p. 866).

1919. Alice H. and L.G. Cavnah, and A.J. Jasberg formed Carribeau Development Company Corporation. Andrew McIntosh, O.J. Kerschensteiner, Carl B. Rix, L.W. Shakshesky, and L.G.

Cavnah composed the Board of Directors for the Colorado division, which was located at the Carribeau Mine. A small quantity of lead-sulfide concentrate was shipped (San Miguel County Courthouse, Articles of Incorporation; Henderson, 1922, p. 785).

1922. Frank Saunders and associates employed six workers to process tailings at the Carribeau Mill for two months (R. Innes, Inspector report-Carribeau Mill, December 28, 1922, CBM). A small quantity of ore was shipped (Henderson, 1925, p. 546).

1923. The Carribeau and four other mines in the Iron Springs mining district produced unknown quantities of ore (Henderson, 1927, p. 638).

1928. L.C. Cavnah agreed to lease mill tailings from Carribeau Mining Company. Cavnah planned to treat the tailings and ship the concentrates to the Durango smelter (bk. 133, p. 464).

1929. Four patented claims at the Carribeau Mine were operated by A.A. McCloskey, G.M. Cook, and S. Penasa (partnership) through a lease from Carl B. Rix and Andrew McIntosh (owners). Work was confined to the upper level, a 400-foot-long crosscut adit, and a 25-foot-long drift (excavated by the partnership) on the Montezuma Lode. The sulfide ore zone ranged from 8 to 18 inches wide and contained 13 oz/ton silver, 25% lead, and 8% copper. The lessees expected to produce by late September (Inspector report-Carribeau Mine, September 7, 1929, CBM).

1933. John Geiger, B.B. Waltman, and E.A. Van Orsdel agreed to lease Carribeau Mining Company's property (except the Montezuma Lode) from Edward L. Soules in August (bk. 166, p. 267-268). In October, Carribeau Mining Company (A. McIntosh-trustee) leased the Carribeau Mine to Soules, who conveyed the lease to George Dusty Pugh (bk. 166, p. 278). An unspecified quantity of ore was shipped (Henderson, 1934, p. 183).

1934. Although the Carribeau mill was idle, a small quantity of crude ore was shipped directly to smelters from the Carribeau and Montezuma Mines (Henderson, 1935, p. 230).

1935. Lee Fudge and sublessees Foster Smith, Clint Stover, and Douglass Lamnon dug several 2- to 6-foot-deep pits in the Carribeau tailings. It was estimated that the 15,000 tons of tailings contained values of $3.25/ton gold, $2.75/ton silver, and small quantities of copper and lead (Inspector report-Carribeau Placer, September 9, 1935; Mine manager report-Carribeau, CBM). Henderson and Martin (1936, p. 268) reported that a small amount of ore was shipped from the Carribeau Mine and a small amount of high-grade silver ore was shipped from the Montezuma Mine.

1936. Some ore was shipped from the Carribeau and Montezuma Mines (Henderson and Martin, 1937, p. 333).

There was no recorded production from the Carribeau or Montezuma Mines after 1936.

1947. Carribeau Mining Company sold (quit claim deed) the Carribeau and Montezuma Lodes, Montezuma Mill Site, Sarah Placer, and other patented claims to E.H. Sanders (president-Silver Bell Mines Company) (bk. 204, p. 326, 352). Silver Bell Mines Company had acquired all of the ground covering the east-west vein system on Yellow Mountain between the Carribeau Mine on the east and Butterfly Mine on the west, a total distance of about 9,000 feet (Colorado Mining Association, 1947, p. 91; King and Allsman, 1950, p. 33).

1970. Silver Bell Industries Inc. formed a joint venture with W.R. Grace & Company. W.R. Grace & Company would acquire 51% interest in Silver Bell Industry's metal mining and other properties in exchange for a $1.5 million deep-drilling program. Both companies would develop any ore deposits discovered. Silver Bell Industries Inc. was reorganized from Silver Bell Mines Company (*Denver Post*, January 6, 1970, p. 35).

1971. A claim map of the Ophir area (Silver Bell Industries Inc., USFS files) showed that Silver Bell Industries Inc. owned the claims associated with the Carribeau Mine.

1972. Silver Bell Industries Inc. (E.H. Sanders-chairman of the board; Stephen McNichols-president) resumed mining operations at Ophir. The company was receiving between $30,000 and $40,000 per month for Ophir area ore. (*Denver Post*, March 5, 1972, p. 25.) It is not clear if the operations included the Carribeau Mine.

1980. Molycorp sold (quit claim deed) interest in the Carribeau and Montezuma Lodes, Montezuma Mill Site, Sarah Placer, and other patented claims to Fleet Resources, Inc. Minerals Exploration Company sold interest in the Carribeau Lode to Fleet Resources (bk. 390, p. 593-596). It is not clear when or how Molycorp and Minerals Exploration Company acquired the properties from Silver Bell Industries.

1983. Fleet Resources sold a "Special Warranty Deed" concerning the Carribeau Lode along with a group of patented mining claims to Rapholz Silver, Inc. (bk. 426, p. 850-851).

1986. Rapholz Silver agreed to purchase the Carribeau Lode and other patented mining claims from Fleet Resources with a $200,000 promissory note (bk. 427, p. 66-74).

1991. Scott Smith acquired a quit claim deed from Rapholz Silver for the Carribeau Lode, water rights, and other patented mining claims (bk. 418, p. 660-661).

1992. Rapholz Silver formalized a "Deed of Trust" with Fleet Resources concerning the Carribeau Lode and other patented mining claims and mill sites (bk. 489, p. 521-527).

1993. Fleet Resources sold (quit claim deed) the Carribeau Lode and other patented mining claims to Norman L. Fleet (bk. 521, p.75).

1994. Fleet agreed to allow CDMG to conduct reclamation activities on the Carribeau Lode (reception no. 318836).

2001. Edward Pauls was the listed owner for the Carribeau, Montezuma, Harvest Moon, Mountain Queen and several other patented claims in this area. Recla Ventures, Incorporated owned the Sarah Placer (courthouse records). It is not clear when Pauls and Recla Ventures acquired the claims.

GEOLOGY

The portal of the 13th level of the Carribeau Mine is at the contact of alluvium and talus (fig. 4). The adit extended through the mantle of talus into the Tertiary-age granodiorite Ophir stock. Higher levels of the mine were driven in various Paleozoic- and Mesozoic-age sedimentary rocks (Luedke, 1996).

The west-trending, north-dipping Carribeau vein was considered the eastern extension of the Ida and Butler veins that were mined near Lake Fork of the San Miguel River, about 2 miles to the west. The vein and its associated pay zone varied in width and grade both vertically and horizontally. During its early years, a 5-foot-wide vein at the Carribeau Mine had a galena and gray copper pay zone averaging 10 to 20 inches thick. Gray copper is part of the tetrahedrite group of minerals, a copper-antimony-arsenic sulfide that often has silver replacing some of the copper. Metallic and gangue minerals identified in the vein included quartz, galena, freibergite (similar to tetrahedrite, but with abundant silver), apatite, barite, chalcopyrite, dolomite, rhodochrosite, siderite, and sphalerite. Sorted galena-tetrahedrite ore assayed 40% lead and 80 oz/ton silver. Low-grade gold associated with chalcopyrite was present in the lower workings of the Carribeau; but upper workings were mostly barren of gold values. Ore-grade material occurred in the vein for a strike length of at least 5,000 feet and a vertical distance of at least 1,300 feet (Cross and Purington, 1899, p. 16; Varnes, 1947, p. 426; Corregan and Lingane, 1883, p. 686; *San Miguel Examiner*, October 9, 1897; Samuel Treais, Inspectors report-Carribeau Mine, 1913, v. 15, p. 710-711, CBM; Purington, 1898, p. 782-786).

At the Montezuma Mine, the Carribeau vein was 30 inches wide and had a 10- to 15-inch-thick pay zone with similar mineralogy. During the early years of mining, sorted ore assayed 28% copper, 35% lead, and 111 oz/ton silver (Corregan and Lingane, 1883, p. 686).

SITE DESCRIPTION

The 13th level of the Carribeau is about a half mile west of the town of Ophir (fig. 3) and is easily visible from the Ophir Pass Road. The mine is on the south side of Howard Fork and is only accessible by vehicles when the stream is low enough to ford.

The upper workings of the Carribeau and associated Montezuma Mines are difficult to access because of dense vegetation on this steep, north-facing slope. Dump #207 (6th level of the Carribeau) is the largest and most visible waste-rock pile on the slope above the 13th level (fig. 50).

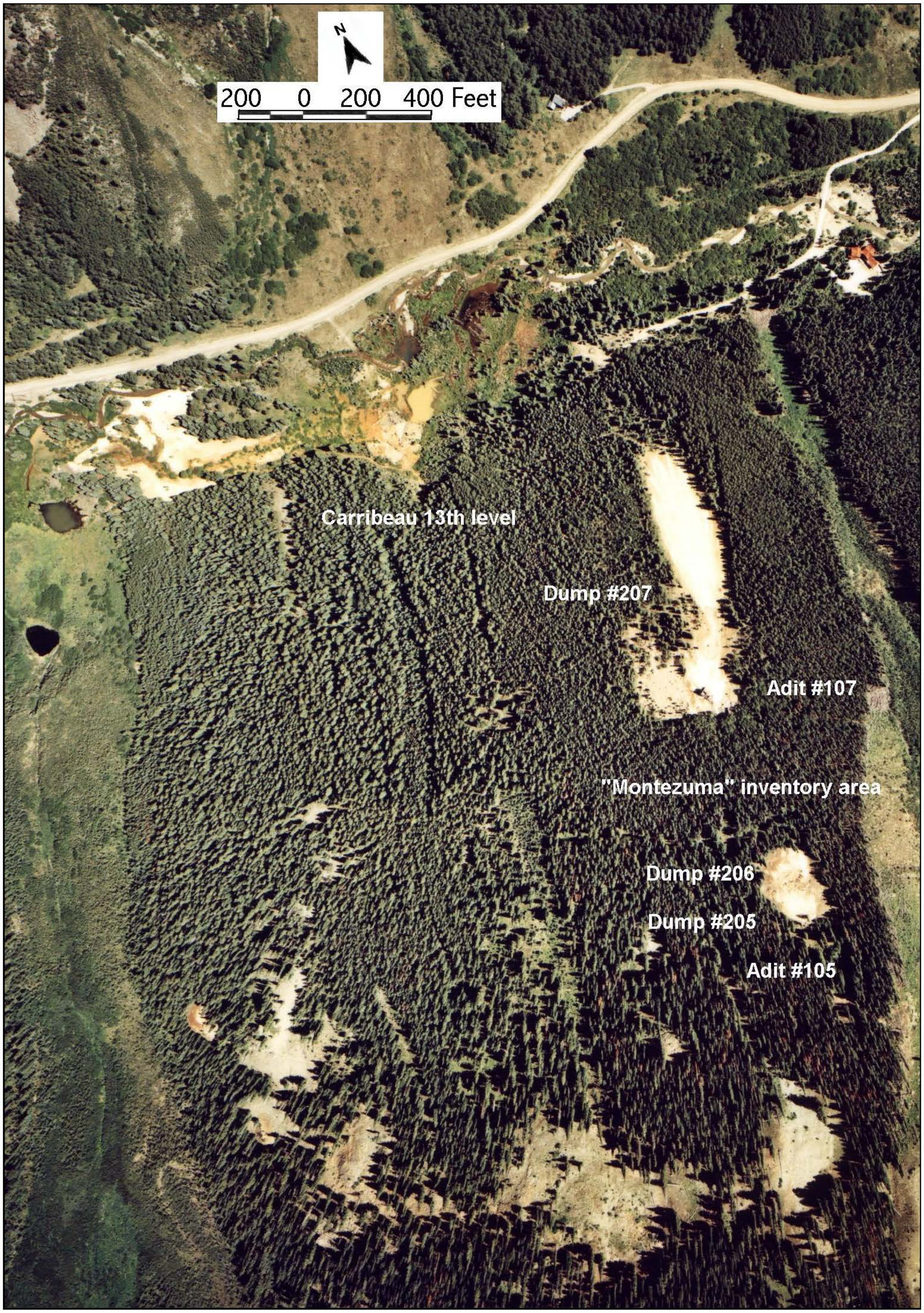

Figure 50. Aerial photograph of the Carribeau Mine area.

In June 2000, the portal of the Carribeau was completely caved, and a large volume of water emerged from the rubble behind and slightly above the original adit entrance (fig. 51). This effluent flowed partway across the bench of the waste-rock pile and then split into two main channels (fig. 52). About 85% of the water flowed down a steep gully on the western side of the pile (fig. 53). The remainder flowed through a willow-choked channel alongside the eastern lobe of the dump. The eastern branch of effluent drained into a turbid beaver pond at the toe of the dump (fig. 54). The western branch spread out into a large wetland that has developed on the Carribeau tailings within the Howard Fork floodplain (figs. 55, 56).

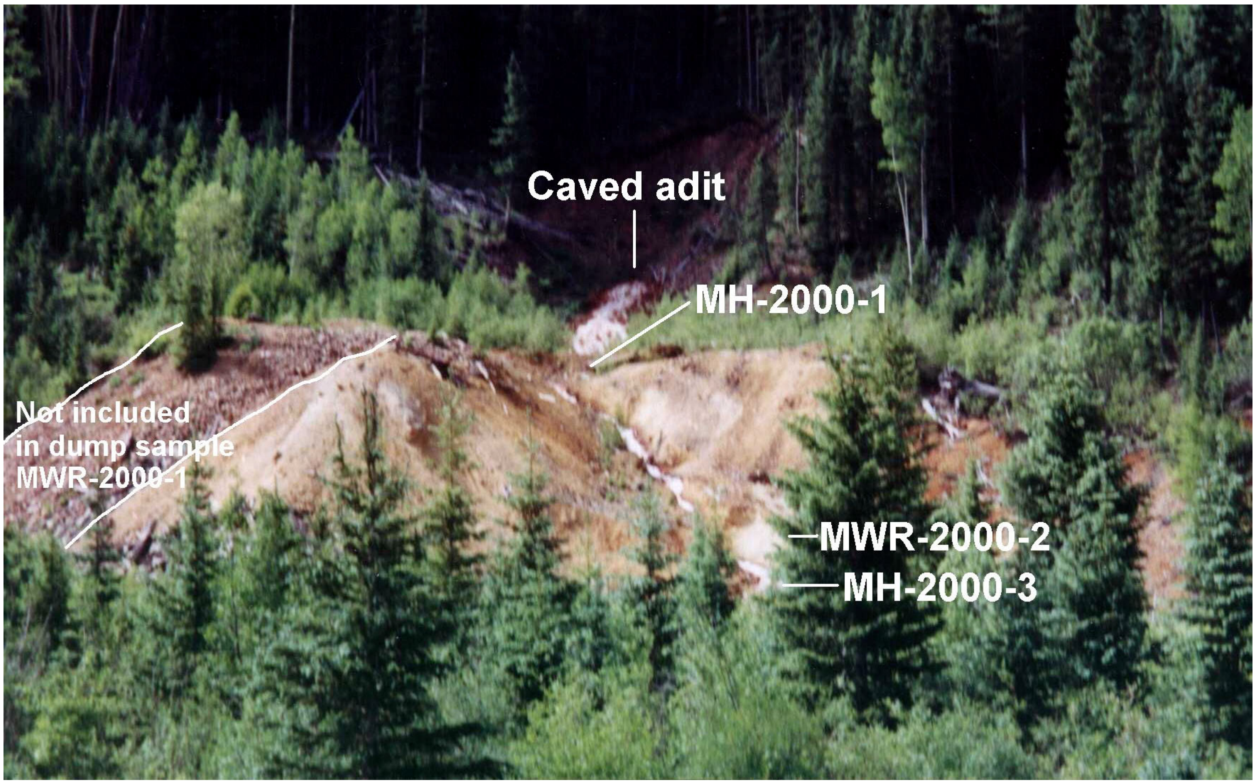

Figure 51. Effluent and waste-rock pile at the Carribeau 13th level.

The Carribeau waste-rock pile was large and had three segments. The eastern lobe was probably deposited during the excavation of the crosscut adit and appeared relatively unmineralized. The center lobe was probably used during the production phase of mining; it was about 45 feet high and toed into the mill ruins. Some water with associated red precipitate seeped from the northwest toe of the center lobe, northeast of the large effluent channel (fig. 52). The western segment was not well defined, but consisted of an inclined bench or road that led to the portal. This road or bench appeared to be built on a combination of colluvium and waste rock.

WASTE AND HAZARD CHARACTERISTICS

Effluent. In June 2000 several water samples were collected in the vicinity of the Carribeau Mine (figs. 54, 57). At the portal (sample MH-2000-1), the effluent was flowing at a rate of 760 gpm with 6.61 pH and 1,039 µS/cm conductivity. The water was turbid and deposited abundant light yellow-red precipitate. Ferns and moss lined the channel. The water was moderately degraded and exceeded standards in iron, manganese, and sulfate (Table 1). Calcium concentration, and therefore, hardness were high. Zinc was elevated but within its hardness-related standard. Arsenic approached its recommended standard of 10 µg/L. Detection limits for several parameters were elevated, probably because of the high dissolved solids content of the water. Because of the high flow rate, metal loads in the effluent were high: total iron, about 77 lb/day; dissolved iron, about 41 lb/day; manganese, about 16 lb/day; and zinc, about 2.5 lb/day.

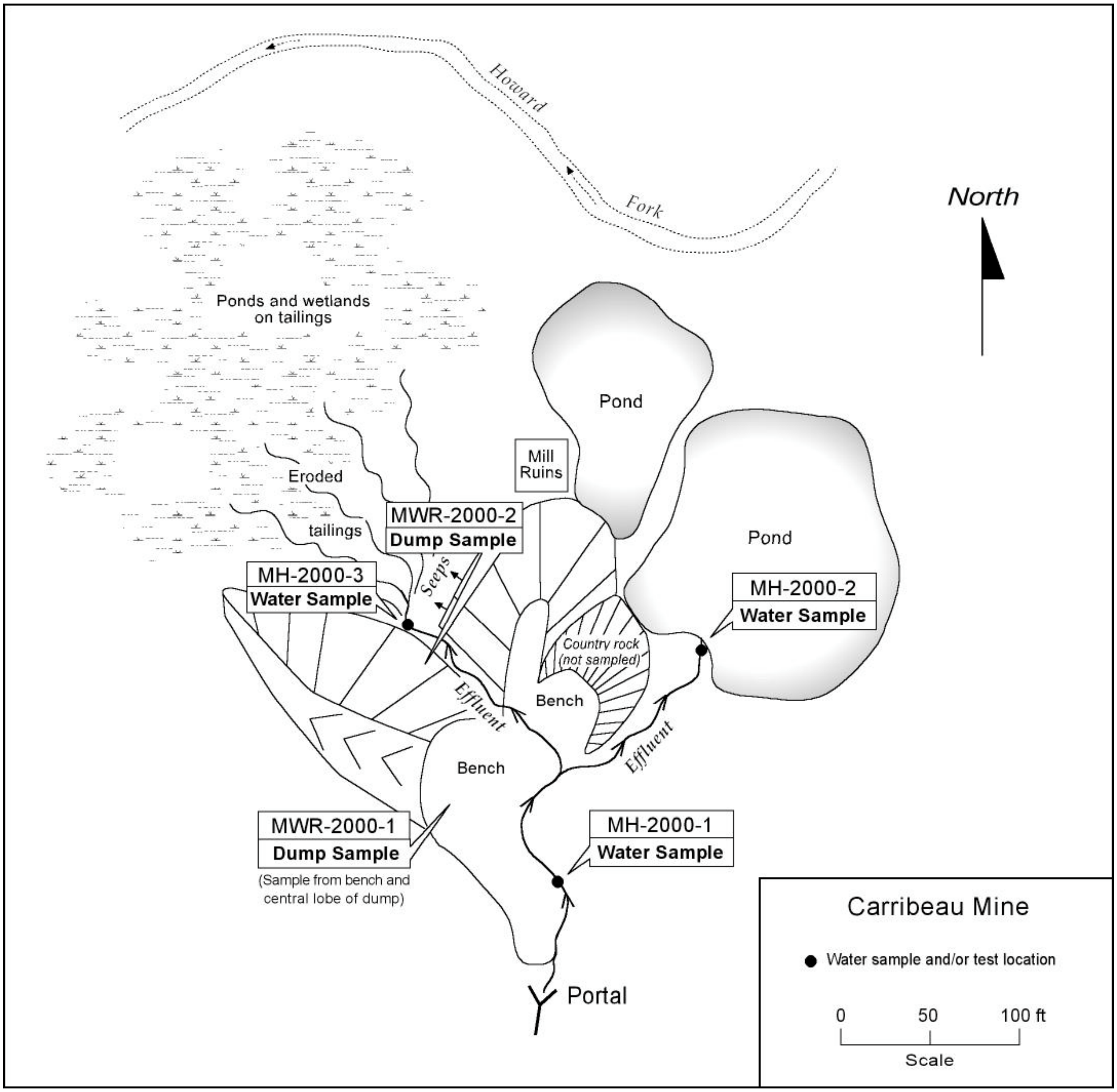

Figure 52. Sketch map of the surface at the 13th level of the Carribeau Mine.

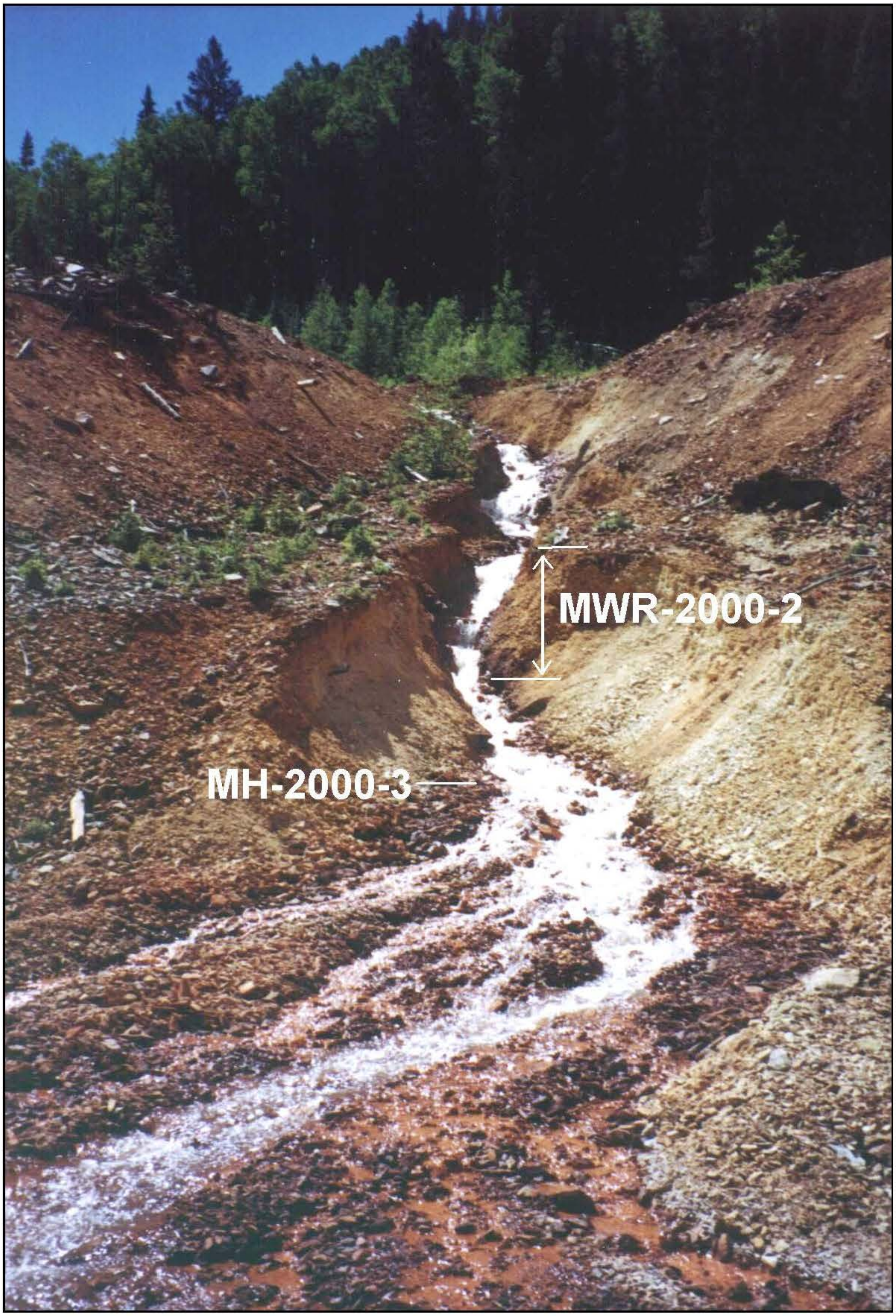

Figure 53. Effluent stream and the western part of the Carribeau waste-rock pile.

Figure 54. Aerial view of the Carribeau site and water sample locations.

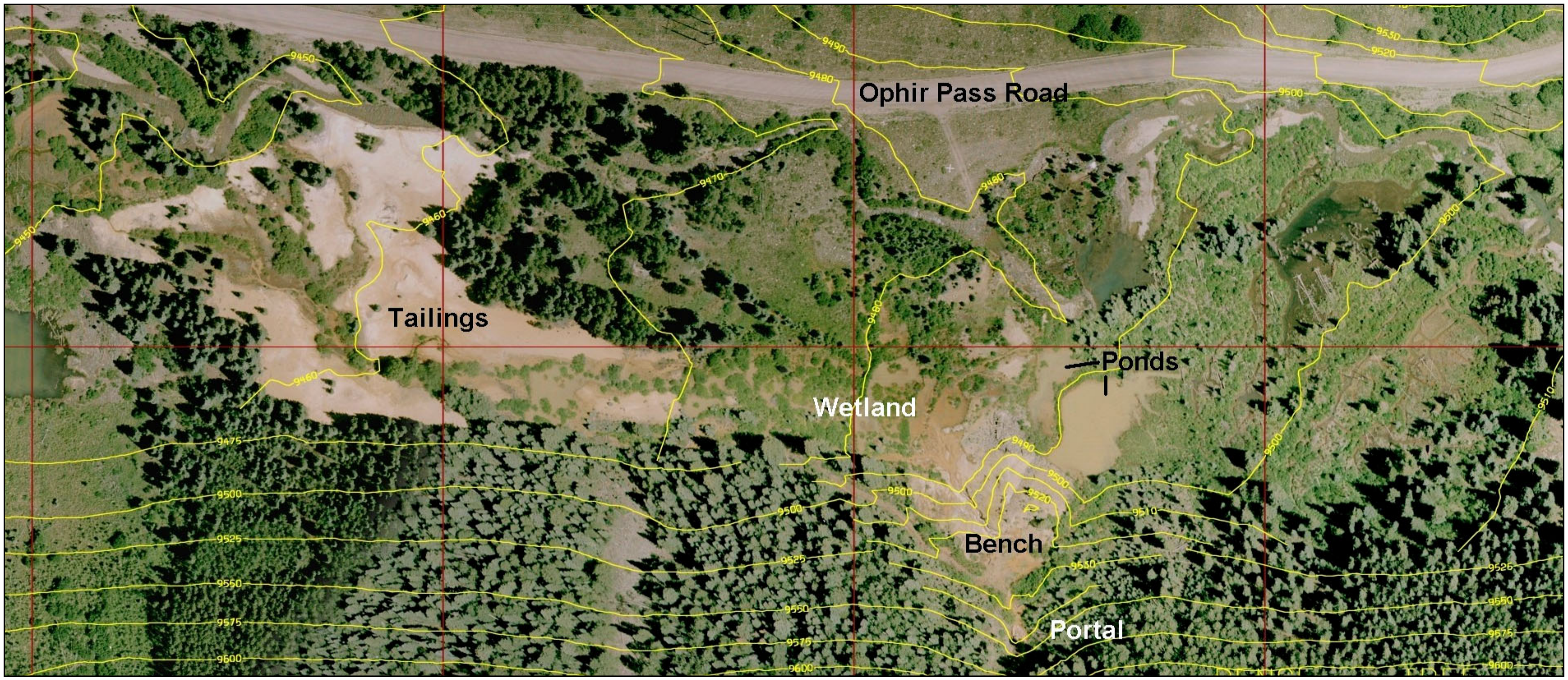

Figure 55. Aerial view of the Carribeau site showing topography. Topography in the floodplain is shown with 10-foot contours. Contours on the mountain slope are 25-foot intervals. Red gridlines are oriented north-south and are 500 feet apart (map compiled by T. Johnson, USFS Rocky Mountain Region).

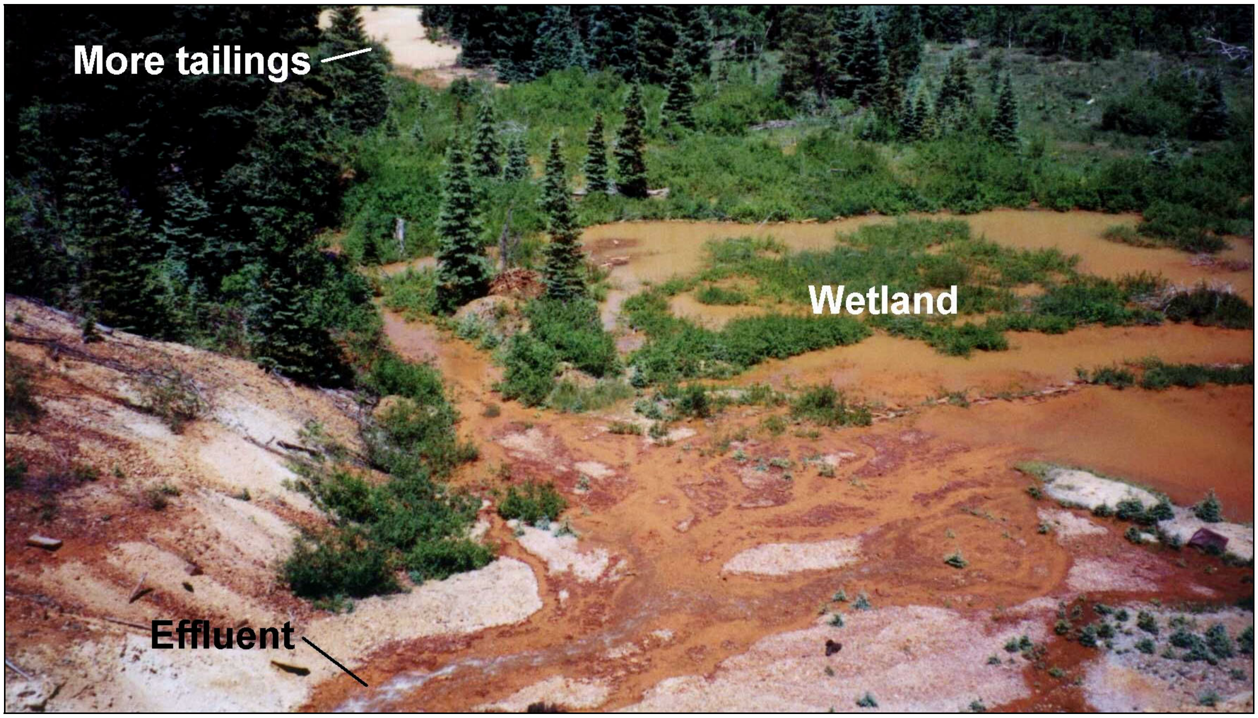

Figure 56. Wetland on the Carribeau tailings pile west of the dump.

Effluent was sampled again on the east side and near the base of the waste-rock pile and slightly upstream of a murky beaver pond (sample MH-2000-2). The channel was steep and had numerous snags of vegetation in various stages of decomposition. This smaller braid of the effluent stream flowed 98 gpm of water with 6.96 pH and 1,025 µS/cm conductivity. The water was similar to the portal water. Total recoverable iron and sulfate concentrations were greater but dissolved iron was less (Table 1). Arsenic was 11 µg/L versus 8 µg/L at the portal.

Sample MH-2000-3 was collected from the larger braid of the effluent stream near the base of a severely eroded gully on the western side of the waste-rock pile. This water was flowing at 574 gpm with 6.86 pH and 1,034 µS/cm conductivity. The effluent was less turbid than at the portal, and its channel had minor red precipitate and iron staining on some of the rocks. This sample closely resembled the composition of the portal water, although total recoverable iron was slightly greater, and dissolved iron was slightly less in concentration (Table 1).

When sampled by CDPHE in June 1998, Carribeau effluent contained 416 µg/L total zinc, equating to a load of about 2.5 lb/day. The effluent also reportedly carried 60.2 µg/L total arsenic compared to 8 µg/L (total recoverable) in 2000. In 1998, a sample of surface water on the tailings contained 830 µg/L arsenic, 1,500 µg/L copper, 2,600 µg/L lead, and 130 µg/L silver. No flow data was reported, and the sample may have been from standing water (CDPHE, 1999, p. 9). No surface water discharge points from the Carribeau site into Howard Fork were identified by CGS in June 2000.

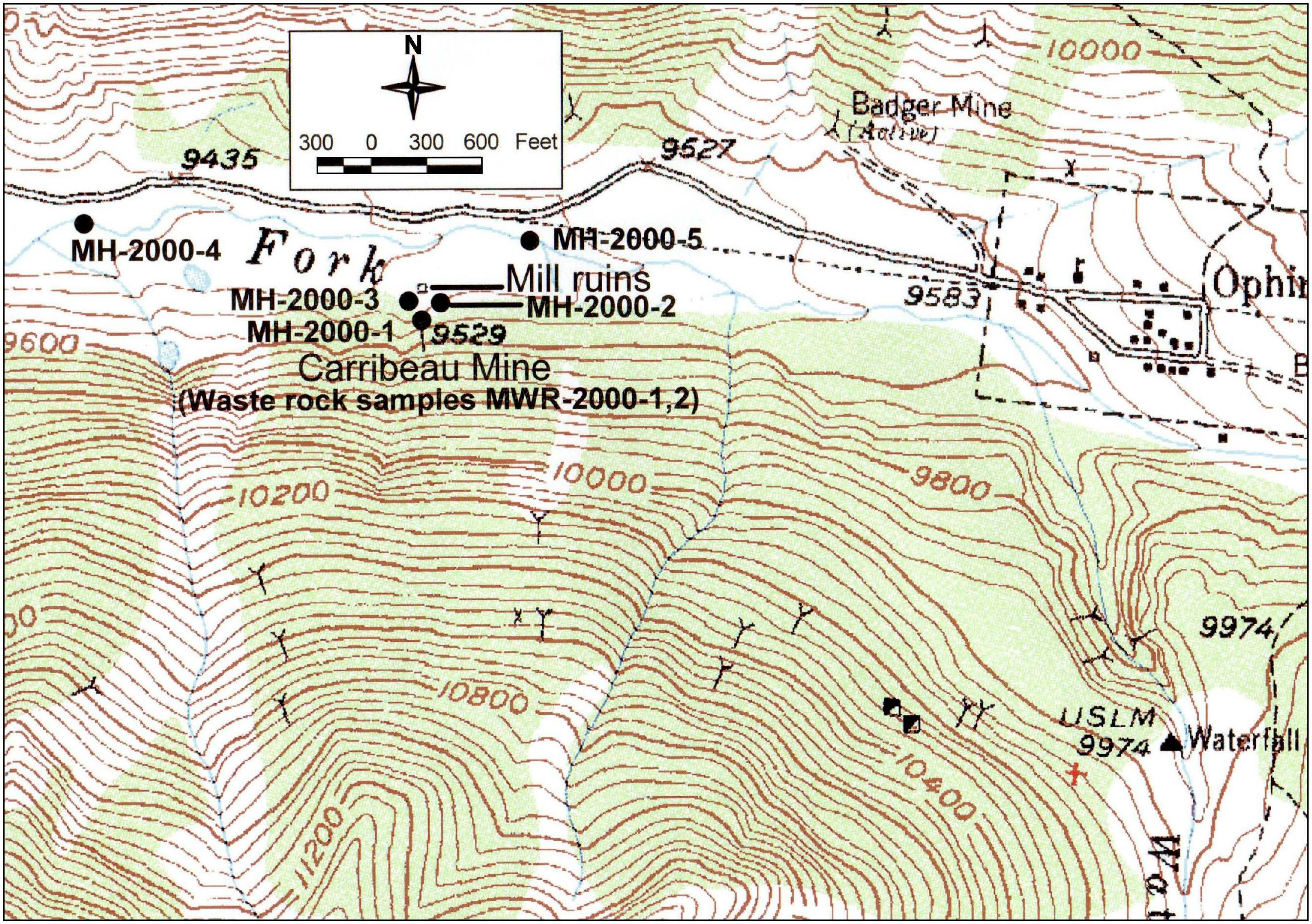

Figure 57. Map of water sample locations near the Carribeau Mine.

CDMG water samples collected from the Carribeau in 1994 contained significantly more metals during high flow compared to low flow (site 25, Appendix). During high flow, copper (210 µg/L total, 88 µg/L dissolved), iron (14,000 µg/L total, 7,500 µg/L dissolved), lead (23 µg/L total), manganese (2,200 µg/L total, 2,100 µg/L dissolved), and zinc (280 µg/L total, 260 µg/L dissolved) were high. During low flow, copper (86 µg/L total), iron (8,900 µg/L total, 5,000 µg/L dissolved), lead (13 µg/L total), manganese (2,000 µg/L total and dissolved), and zinc (200 µg/L total, 180 µg/L dissolved) were reduced, but remained elevated. Total concentrations of copper, iron, and lead were significantly higher than dissolved concentrations during both the high flow and low flow sampling events. Dissolved copper was only 9 µg/L and dissolved lead was undetected in the low flow samples. (Jim Herron, CDMG, unpublished data.)

During CDMG's 1980 abandoned mine inventory (McLaughlin, 1981, p. A-207, 216), a sample of Carribeau effluent contained 12,000 µg/L iron; 510 µg/L zinc, 110 µg/L lead, and 360 µg/L copper (totals). Samples collected from the Carribeau in 1980 during a mine drainage investigation showed a large decrease in total iron concentration from August to October (10,000 µg/L to 1,800 µg/L). Other total concentrations of metals were reduced, but not as dramatically. Manganese dropped from 2,800 to 2,000 µg/L, zinc from 360 to 190 µg/L, lead from 52 to 34 µg/L, and copper from 230 to 120 µg/L.

Waste rock and tailings. The Carribeau waste-rock pile contained about 10,000 cubic yards of light red, brown, yellow, and gray, moderately to well cemented, sand- to cobble-size material. Most of the rock was granodiorite of the Ophir stock with varying amounts of red-brown goethite staining. Less common was fine-grained greenish rock (metamorphosed Morrison Formation?). Moderate amounts of pyrite, galena, and sphalerite appeared in quartz vein fragments and mineralized country rock. A few pieces of smelter slag were identified. A small volume of water with 5.57 pH and 1,050 µS/cm conductivity seeped from the northwest toe, northeast of the large effluent channel (fig. 52). The seepage was depositing abundant red precipitate, and its channel is visible in the lower right corner of figure 56.

For this investigation, two waste-rock samples were collected. Composite sample MWR-2000-1 excluded the face of the eastern lobe, which appeared to consist of unmineralized country rock that was deposited during the excavation of the crosscut (fig. 51). This sample was moderately mineralized and contained about 0.1% lead (Table 2). Zinc and copper concentrations were elevated, but were less than 0.1%. Paste pH was 5.50 and the net acid-base potential was moderately acidic (-8.8 tons $CaCO_3$/1,000 tons).

Dump sample MWR-2000-2 was a vertical channel sample 6 feet long that was collected from the wall of the gully adjacent to the effluent stream (figs. 52, 53). This material was similar in appearance to MWR-2000-1, but was more mineralized. Concentrations of gold (0.15 oz/ton), silver (1.24 oz/ton), and lead (0.6%) were quite high. Paste pH was 4.43, and net acid-base potential was -7.4 tons $CaCO_3$/1,000 tons (Table 2).

Significant differences in metal content in these waste-rock samples may be a function of the type of samples. Because it was collected near the surface, the composite sample collected on a grid may represent only the latest material discarded onto the pile. The vertical channel sample may represent changes in the composition of the waste rock over time. Alternatively, the difference may be caused by something as mundane as the inclusion of an extraordinarily metal-rich fragment in the channel sample. Additional sampling would allow more accurate characterization of the waste rock.

Waste rock sampled by CDPHE (1999) contained metal concentrations similar to the CGS samples, with the exception of silver. The CDPHE sample contained almost 6 oz/ton, compared to a maximum of 1.24 oz/ton silver in the CGS samples.

A tailings sample collected by CDPHE (1999) was highly mineralized with respect to silver (about 8 oz/ton), and arsenic (0.38%). Lead (0.67%) and copper (0.1%) were also elevated. The high silver concentration approaches ore grade. This sample may have been selected from a highly mineralized portion of the tails, and may not represent the overall metal concentration of the pile. Additional tailings samples could help to further characterize the tailings.

The beaver ponds and wetland that covered the tailings were part of a larger wetland that encompassed much of the floodplain on the south side of Howard Fork. This large wetland extended from at least 600 feet upstream of the Carribeau to 1,000 feet downstream. All of the effluent from the Carribeau portal and the seepage from the waste-rock pile eventually reached the wetland where it dispersed and mixed with natural water. In June 2000 the wetland had no significant surface flow into Howard Fork. The majority of the wetland water, including the mine effluent, must enter the alluvial aquifer of Howard Fork.

Howard Fork. In an effort to determine the impact of Carribeau effluent and tailings on Howard Fork, CGS collected composite water samples from the river upstream and downstream of the site (fig. 54, 57). The downstream sample was collected below all of the obvious tailings related to the Carribeau and was intended to measure the effects of inflows of degraded surface water from the adit and potentially contaminated alluvial ground water associated with the tailings.

At both sites, flow rate was estimated at 18,000 gpm, and the water was slightly turbid with a greenish hue. The upstream sample (MH-2000-5) had 7.47 pH and 351 µS/cm conductivity, whereas the downstream sample (MH-2000-4) had 7.43 pH and 373 µS/cm conductivity. Lab results for both samples were nearly identical. Surprisingly, aluminum and iron concentrations (total recoverable) actually decreased below the mine. Dissolved zinc was nearly equal to the State standard at both sites, and showed no change in concentration from upstream to downstream. Total recoverable arsenic was not detected at either site (Table 1).

During the CGS sampling event in June of 2000, effluent from the Carribeau comprised less than 5% of the flow of Howard Fork. The similarity in water chemistry upstream and downstream in Howard Fork suggests that the large flow of Howard Fork effectively masked the influence of the Carribeau site. Some natural attenuation in the wetland below the Carribeau may also occur, although much of the wetland is underlain by tailings. As the flow rate of Howard Fork decreases later in the year, the impact from the Carribeau site may be more noticeable.

In June 1998, CDPHE collected water samples from Howard Fork upstream and downstream of the Carribeau Mine. Total concentrations of aluminum, copper, iron, lead, manganese, and zinc increased moderately downstrean from the Carribeau Mine (CDPHE, 1999, p. 16).

In 1994, CDMG collected water samples from Howard Fork upstream and downstream of the Carribeau Mine (sites 24, 27, Appendix). Most metal concentrations remained relatively constant from upstream to downstream during both the low-flow and high-flow sampling events. Minor amounts of total and dissolved copper were detected in both the upstream and downstream samples. Total iron decreased from upstream to downstream. Dissolved lead was not detected, and total recoverable lead decreased from 53 µg/L to 35 µg/L from upstream to downstream during low flow. Total recoverable and dissolved manganese and zinc showed minor decreases in concentration from upstream to downstream during low flow and high flow in 1994 (Jim Herron, CDMG, unpublished data).

During the abandoned mine inventory done by CDMG in 1980, water samples from Howard Fork below the Carribeau site showed increased total concentrations of iron (150 to 590 µg/L), zinc (70 to 190 µg/L), lead (44 to 48 µg/L), and copper (16 to 99 µg/L) compared to the upstream sample (McLaughlin, 1981, p. A-216).

NATURAL SOURCES OF METALS

Numerous sources of naturally degraded water exist within the Howard Fork drainage basin. A few of these sources are documented and/or quantified to some extent; many additional undocumented sources probably exist. The most obvious sources are springs associated with ferrosinter deposits, such as Iron Springs, for which this mining district was named. Interestingly, these springs are, generally, considerably more acidic than the mine effluent in this drainage basin. Ferrosinter deposits (iron bogs) are illustrated on the Ophir geologic map (fig. 4), and are readily visible on the ground and in aerial photographs (figs. 6, 21). The acidic, metal-rich water associated with these features probably results from snowmelt and/or rainfall percolating through the hydrothermally altered pyritic and weakly mineralized volcanic rocks exposed in the upper reaches of Howard Fork (fig. 6). Although the chemistry of some of these springs may have been affected by later mining activities, the evidence for pre-mining degradation is apparent.

Iron Springs is a major metal source in the Howard Fork drainage basin (McLaughlin, 1981, p. VIII-29, p. A-207). When sampled in 1980, water draining from Iron Springs varied in chemistry depending on the season. The June sample (high flow) contained 2,400 µg/L iron, 1,000 µg/L manganese, 540 µg/L zinc, 12 µg/L lead, and 520 µg/L copper (total concentrations). In summer and fall, after snowmelt was over and the flow rate was reduced, the spring water was acidic with pH of about 4. Compared to the June samples, iron concentrations decreased significantly (1,400 µg/L in summer and 1,700 µg/L in fall); manganese decreased slightly (970 and 880 µg/L); zinc remained about the same (590 µg/L in summer and 430 µg/L in fall); lead increased slightly (29 and 16 µg/L), and copper showed a minor decrease (510 and 450 µg/L).

CDMG did not sample Iron Springs directly in 1994, but they collected samples from Howard Fork that geographically bracketed the inflow (sites 4, 5, Appendix). Dissolved and total recoverable concentrations of zinc approximately doubled. Concentrations of copper and manganese showed slight increases at the downstream sample site. The values remained low, however, and apparently fell within stream standards. Surprisingly, iron concentration decreased slightly (Jim Herron, CDMG, unpublished data).

When sampled by CDPHE (1999, p. 10) in June 1998, Iron Springs water contained 6,190 µg/L aluminum, 307 µg/L copper, 2,640 µg/L iron, 11.5 µg/L lead, 968 µg/L manganese, and 485 µg/L zinc (total concentrations). A sample of the Iron Springs ferrosinter deposit contained almost 50% iron, 0.16% copper, and 298 ppm zinc. Interestingly, water emerging from Iron Springs in the 1880's was reportedly "strongly impregnated with arsenic" (*San Juan Herald*, August 3, 1882, p. 3). Arsenic was not detected in the 1998 sample, and was not analyzed in the 1980 and 1994 samples.

Another example of a natural metal source is the lake near the headwaters of Howard Fork, above Chapman Gulch and Swamp Canyon. This lake is the turquoise-colored feature about 700 feet south of the labeled ferrosinter deposit on figure 6, and is upstream of all of the significant and draining mines in the drainage basin. A sample collected in September 1999 had pH of 4.70 and exceeded State standards in dissolved aluminum (1,500 µg/L). Manganese (260 µg/L), sulfate (110 mg/L), and zinc (67 µg/L) were elevated but within standards. The lake discharged about 420 gpm and formed the headwaters of Howard Fork (Neubert, 2000, p. 28).

Another source of naturally degraded water is the gulch draining the basin north of South Lookout Peak. In June 1996, this water was tested above all of the known mines and had pH of 3.88 and conductivity of 288 µS/cm. During low flow in August 1996 the gulch was sampled near its mouth and was flowing at 86 gpm. The sample site was a quarter mile downstream of an adit that was draining about 0.2 gpm. The effect of this small volume of effluent was probably negligible compared to the much larger flow from the basin above the mine. The sample had 3.35 pH, 515 µS/cm conductivity, and contained high dissolved aluminum (6,100 µg/L), iron (2,500 µg/L), manganese (1,400 µg/L), sulfate (210 mg/L), and zinc (160 µg/L). The effects of this tributary were easily masked by the much larger flow of relatively clean water from Swamp Canyon (Neubert and Harris, 1996, p. 25-26).

MIGRATION PATHWAYS

The surface water pathway is the most important environmental degradation pathway regarding the sites described in this report. Soil exposure and air pathways are generally minimal risks.

SURFACE WATER PATHWAY

Primary targets of the mine sites described in this report include fish habitat and wetlands. No surface water intakes for drinking water are known within 15 miles downstream of these sites.

The town of Ophir draws its water either from Waterfall Creek or Spring Gulch, neither of which is affected by mines described in this report. The closest fishery is in South Fork, below the confluence of Howard Fork and Lake Fork, about 4 miles downstream of the Carribeau. The Nature Conservancy owns the San Miguel Preserve along the South Fork River, about 6 miles downstream from the Carribeau Mine. No fish live in Howard Fork except for some trout in a lake at the headwaters. These fish are reportedly stocked (CDPHE, 1999, p. 11). This lake is probably the lake described in the **Natural Sources of Metals** section of this report.

CDPHE samples indicated that average total zinc in Howard Fork from just downstream of the Carbonero tailings to near Ophir Loop was about 130 μg/L, above the 110 μg/L standard of Superfund Chemical Data Matrix Ambient Water Quality Criteria (SCDM-AWQC). Average total copper (17 μg/L) and total lead (20 μg/L) for the entire Howard Fork were above the 12 μg/L and 3.2 μg/L SCDM-AWQC standards. Despite the elevated values, the samples did not generally exceed State aquatic-life standards because of relatively high hardness in the stream (CDPHE, 1999, p. 13). In 2000, a sample collected from Howard Fork downstream of the Carribeau (the lowest mine site described in this report) had elevated concentrations of dissolved (180 μg/L) and total recoverable (210 μg/L) zinc, but the values were within standards. Dissolved copper and lead were not detected in samples collected from Howard Fork near the Carribeau in 2000, and these metals were seldom detected in mine effluent samples collected for this investigation (Table 1).

Tributaries of Howard Fork examined during this study include the ravine below the Carbonero Mine and Chapman Gulch. Samples collected from the Carbonero ravine at least 2,000 feet downstream of the portal exceeded secondary (or aesthetic) standards in total recoverable iron and sulfate. Dissolved and total manganese and zinc were elevated. Total copper and lead were elevated in samples collected in 1998 and 1980, but dissolved concentrations of these metals were low or not detected in 1998 and 2000 (McLaughlin, 1981; CDPHE, 1999; Table 1).

According to CDPHE (1999, p. 14), Chapman Gulch is moderately impacted by aluminum, cobalt, copper, iron, lead, manganese, and zinc. Results of sampling in 2000 show that Chapman Gulch immediately downstream of the lowest mine site described in this report exceeds State standards (secondary) in total recoverable iron and sulfate. Dissolved manganese and zinc were elevated, but within standards. Total recoverable aluminum was elevated, but dissolved aluminum, copper, and lead were not detected (sample MH-2000-53, Table 1).

GROUND WATER PATHWAY

The Town of Ophir obtained water from a well in Spring Gulch in 1998. Spring Gulch is not affected by any of the mines in this report. Some residents could have private wells that could be affected. Results of CDPHE sampling in 1998 were inconclusive, but some of the wells may be contaminated by metals (CDPHE, 1999, p. 17). Because of the widespread mining activity and natural sources of degraded ground water, additional detailed studies would be needed to fully evaluate the ground water pathway. A residence on the south side of Howard Fork about 1500 feet downstream from the Carribeau may be affected by metals from the Carribeau effluent and tailings if it has a well pumping from the alluvial aquifer of Howard Fork.

A well that was originally permitted as a monitoring well but was apparently recently converted to domestic use is close to the Carribeau 13th level portal, according to the coordinates in the well records at the State Engineer's office. The well yields about 25 gpm and is 83 feet deep with a static water level of 42 feet below ground surface. Another well is located near the Carbonero tailings pile east of Ophir. This well yields about 6 gpm and is 162 feet deep with a static water level of 90 feet below ground surface. The coordinates of this well plot north of Howard Fork, in an area that could be contaminated by effluent from the New Dominion or Carbonero Mines that has soaked into the ground, or by naturally degraded ground water associated with the numerous ferrosinter deposits in this area. None of these wells have a listed "1st Used Date," and it is not known if they have ever been used. In section 33, downstream of the Carribeau Mine, three wells for household or domestic use have been permitted but not drilled (Colorado Division of Water Resources records, March 2001).

SOIL EXPOSURE PATHWAY

A cabin on the west side of dump #202 of the New Dominion inventory area is occupied, at least on an intermittent basis. The moderately mineralized material at this waste-rock pile may pose a hazard to the resident(s) of the cabin. No one was at home during site visits in 1996 and 2000. As of October 2000, no one lived or worked within 200 feet of any of the other mine sites described in this report, but the population of Ophir was expanding. In general, these sites are easy to access, and some of the most visible piles are probably visited occasionally by tourists. In addition, residents of Ophir may find the tailings, especially the dry Carbonero tailings, attractive for off-road vehicle use. Because long-term exposure to the mineralized waste-rock and tailings piles examined for this investigation is unlikely, the soil exposure pathway is not considered a serious threat. If the Carbonero tailings become heavily used by off-road vehicles, the soil exposure pathway may become significant.

AIR EXPOSURE PATHWAY

Waste-rock piles examined for this investigation were generally moderately cemented and included various proportions of gravel- and cobble-size material. No evidence of wind erosion was observed, and the relatively coarse waste-rock material is unlikely to become airborne. The Carribeau and Carbonero tailings piles are both close to Ophir and close to the well traveled Ophir Pass Road. Much of the Carribeau tailings pile is encompassed in a wetland and is unlikely to become windblown. The moderately mineralized Carbonero tailings are close to the Ophir Annex residential development and may become airborne during high winds. When strong winds originate from the west, the tailings are blown away from the residential area. East winds could direct tailings toward town, however. The air pathway at the Carbonero tailings may represent a hazard. This pathway is not a significant concern at the other sites included in this study.

SUMMARY AND CONCLUSIONS

Results of numerous field investigations done in Howard Fork suggest that the stream is moderately degraded with respect to aluminum, iron, manganese, copper, lead, and sulfate, but only dissolved zinc concentration approaches aquatic-life water-quality standards. Total and/or total recoverable concentrations of aluminum, copper, and lead are elevated, but total recoverable concentrations of these metals are not included in water-quality standards for aquatic life. The sources of metals and sulfate include draining inactive mines, mill tailings that were placed in the floodplain of Howard Fork, and naturally occurring springs associated with hydrothermally altered pyritic bedrock. Most of the following discussion will revolve around zinc, because it exists in Howard Fork at concentrations approaching State standards. Remediation measures that mitigate the zinc problem should also reduce the concentrations of the other elevated parameters.

Table 6 shows a summary of the environmental problems at the sites examined during this investigation. It does not include data from previous studies. Sites are listed in the order they are discussed in the text, essentially progressing from upstream to downstream.

Chapman Gulch. A large volume of moderately degraded effluent from adit #101 of the North Chapman Gulch inventory area forms the headwaters of Chapman Gulch. Additional water from mines that were not inventoried or sampled on private land (fig. 8) adds to the stream flow and likely adds some metals. In addition, Chapman Gulch exposes altered volcanic rocks with variable amounts of disseminated pyrite, and this material presumably adds acidity and metals to the stream. Further downstream, but upstream of the Ophir Pass Road, adit #101 of the Chapman Gulch inventory area discharges a low volume of moderately degraded effluent. A small portion of the effluent soaks into dump #201. Dump #201 is the most acidic waste-rock pile sampled during this investigation, and the mine drainage is likely degraded further as it seeps through the pile. This small volume of water probably contributes slightly to degradation in the alluvial aquifer of Chapman Gulch. Just below and adjacent to the Ophir Pass Road, adit #100 of the Chapman Gulch inventory area is draining a large volume of moderately degraded water that makes an obvious visual impact to the Chapman Gulch stream.

From the headwaters of Chapman Gulch (MH-2000-47), at adit #101 of the North Chapman Gulch inventory area, to sample site MH-2000-53 below all of the sites in the Chapman Gulch area described in this report (fig. 7), surface-water quality showed minor changes when sampled in October 2000. Flow increased from 302 to 477 gpm; pH increased slightly from 6.71 to 7.06; conductivity decreased slightly from 1,301 to 1,267 µS/cm. Total recoverable iron concentration increased by about 30%, and the load nearly doubled to about 15 lb/day. Interestingly, dissolved iron concentration decreased at the downstream site, suggesting that much iron was carried as suspended solids. Zinc concentration increased slightly, but the zinc load nearly doubled to about 1 lb/day. A minor increase in sulfate concentration resulted in a greater than 50% increase in the load at the downstream site. Manganese concentration decreased by half, and the load was reduced to about 2 lb/day at the lower site. Although other mines and natural sources contribute some metals to Chapman Gulch, most of the metal loads are probably related to effluent from adit #101 of the North Chapman Gulch and adit #100 of the Chapman Gulch inventory areas.

Table 6. Summary of the environmental settings of mine features examined during this study.

Mine/inventory area name Inventory number.feature number(s)	Water quality (samples from 2000)	Waste rock	Comments
North Chapman Gulch 254/4194-1.101 (Calumet Mine)	300 gpm of effluent has 6.71 pH; exceeds standards in total recoverable Fe, sulfate; adds 0.5 lb/day Zn, 7 lb/day Fe, 3.5 lb/day Mn to upper Chapman Gulch.	Previously eroded, but very little, if any active erosion; probably not a significant problem.	Effluent from this site forms the headwaters of surface flow in Chapman Gulch. This mine is on a steep slope of barren rock and talus; passive remediation of the effluent is not practical because of the terrain; the small load from this mine does not justify remediation efforts in the near future.
Drill hole - Chapman Gulch 253/4194-3.103	30 gpm of pipe discharge has 6.68 pH; exceeds standards in total recoverable Fe, sulfate, fluoride; discharges 0.1 lb/day Zn, 3.5 lb/day Fe, 1 lb/day fluoride, 0.3 lb/day Mn. No surface flow to stream.	Not applicable.	Not a significant environmental threat; provides some insight into the ground water geochemistry in this area. Plugging the hole may be a viable option.
Chapman Gulch 253/4194-1.101/201 (Slide Mine)	16 gpm of effuent has 6.89 pH; exceeds standards in total recoverable Fe, sulfate; almost no loading because of the low flow. No surface flow to stream.	200 cubic yards; contains 0.149 oz/ton gold; net acid-base potential = -23.1 tons $CaCO_3$/1,000 tons; paste pH = 2.79; most of effluent from adit #101 soaked into this dump.	The small volume of effluent from the adit may be easily diverted to avoid contact with this highly acidic dump. This is not a major source of metals in Chapman Gulch.
Chapman Gulch 253/4194-1.100/200 (Wealth of Ophir Mine)	110 gpm of effluent has 6.77 pH; exceeds standards in total recoverable Fe, sulfate; adds 0.6 lb/day Zn, 10 lb/day Fe, 1.3 lb/day Mn to Chapman Gulch.	450 cubic yards; weakly mineralized; net acid-base potential = +0.8 tons $CaCO_3$/1,000 tons; paste pH = 5.02; small seep at toe.	Effluent is moderately degraded, but does not contribute largely to overall degradation of Howard Fork. Terrain would permit construction of passive remediation, but much of the area between this adit and Howard Fork is a natural wetland. Diversion of the effluent into the wetland may improve water quality. This site is not a serious environmental problem compared to other sites in this area.
Carbonero Area 252/4194-1.101/201 (Marie Antoinette Mine?/ "Cable" adit)	90 gpm of adit effluent has 6.37 pH; exceeds standards in total recoverable Fe, sulfate, dissolved Zn, Mn, Cu, Al; discharges 0.4 lb/day Zn, 28 lb/day Fe, 2 lb/day Mn; 0.6 lb/day Al; 0.05 lb/day Cu. No surface flow to stream.	300 cubic yards; weakly mineralized; net acid-base potential = -5.9 tons $CaCO_3$/1,000 tons; paste pH = 4.36.	This is some of the most degraded mine water sampled for this investigation, but the flow and metal loads are relatively low compared to the Carbonero and Carribeau. The effluent disperses into a wetland that may naturally attenuate the degraded water. The dump is not severely eroded and is not a significant environmental problem.
Carbonero Area 252/4194-1.104 (Ravine below the Carbonero Mine)	Sedimentation from the erosion could be a problem. Where adit effluent reemerged in the ravine, flow was 420 gpm, pH was 6.83; exceeds standards in total recoverable Fe, sulfate, carries load of 2.4 lb/day Zn, 8 lb/day Fe, 3 lb/day Mn; 5 lb/day total recoverable Al.	Not evaluated.	This is probably the most obvious mining-related scar of the sites investigated. The oversteepened ravine walls should be stabilized and revegetated to reduce additional erosion. Carbonero effluent is one of the largest metal loaders in this area, but remediation will be difficult because of the large flow and steep terrain.

Table 6. Summary of the environmental settings of mine features examined during this study--continued.

Inventory area name Inventory number.feature number(s)	Water quality	Waste rock	Comments
New Dominion Mine 251/4193-1.102	90 gpm of adit effluent has 6.38 pH; exceeds standards in total recoverable Fe, dissolved Zn, Mn, Cu, Al; discharges 0.6 lb/day Zn, 3 lb/day Fe, 2 lb/day Mn; 0.5 lb/day Al; 0.05 lb/day Cu. No surface flow to stream.	1,500 cubic yards; contains >0.5% Pb, >0.1% Zn; net acid-base potential = +1.9 tons $CaCO_3$/1,000 tons; paste pH = 5.75.	Effluent is briefly in contact with dump, but no severe erosion. Dump is accessible and would be easy to cover or remove. A residence is on the bench of the dump. The effluent disperses into a natural wetland, but there is room to place manmade remediation cells if necessary.
New Dominion Mine 251/4193-1.100	270 gpm of adit effluent has 6.86 pH; exceeds standards in total recoverable Fe, sulfate; dissolved Mn; adds 0.5 lb/day Zn, 23 lb/day Fe, 4.5 lb/day Mn to wetland that drains into Howard Fork.	3,000 cubic yards; contains >0.5% Pb, nearly 0.1% Zn; net acid-base potential = +19.6 tons $CaCO_3$/1,000 tons; paste pH = 6.13.	Large volume of effluent with moderate loads flows into beaver ponds and natural wetland prior to reaching Howard Fork. Dump is moderately mineralized and is easily accessible if removal was necessary.
Carbonero Tailings	No surface runoff from tailings in October 2000. Acidic water from adjacent ferrosinter deposit flows onto and seeps into tailings.	8,000 cubic yards; contains >1.2% Pb, >0.4% Zn, >2.3% sulfur; net acid-base potential = -6.0 tons $CaCO_3$/1,000 tons; paste pH = 2.93.	These highly mineralized tailings show evidence of erosion and could be easily removed. Other studies suggest the tailings may be a major metal source for Howard Fork.
Carribeau Mine	760 gpm of adit effluent has 6.61 pH; exceeds standards in total recoverable Fe, sulfate, dissolved Mn; discharges 2.5 lb/day Zn, 77 lb/day Fe, 16 lb/day Mn to the tailings and a wetland that drains into Howard Fork.	10,000 cubic yards; contains >0.1% Pb, net acid-base potential = -7.4 tons $CaCO_3$/1,000 tons; paste pH = 4.43; associated tailings pile is probably highly mineralized.	This site is one of the most problematic in the Ophir area. The tailings are mostly submerged beneath a cover of mine effluent and natural water. Despite the high volume of effluent flowing across and through mineralized tailings, Howard Fork showed little change in dissolved concentrations of trace metals. Diversion of the adit effluent and the natural water sources might allow the tailings to dry sufficiently to allow removal. Removal of the tailings might allow installation of passive treatment cells for the effluent. The large volume of moderately degraded effluent will be difficult to treat, however.

Samples collected in 1994 from Howard Fork above and below its confluence with Chapman Gulch showed a slight increase in total recoverable concentrations of manganese, zinc, and iron below Chapman Gulch, but remained within standards. Zinc loads below all of the mines in Chapman Gulch were only about 2% (high flow) and 4% (low flow) of the loads at the sample site in Howard Fork immediately downstream of the Carribeau tailings.

Remediation of mine drainage problems at the most important sites in Chapman Gulch is probably not practical because of steep surroundings and large volumes of effluent at the mines with the largest loads. In addition, successful mitigation of the zinc in the effluent would probably not make a measurable difference in zinc load lower in the Howard Fork drainage basin.

Drill Hole - Chapman Gulch. This drill hole discharges a moderate volume of degraded water that infiltrates into the ground prior to reaching a stream at the surface. This site is not a significant loader of zinc or other metals. The metal concentrations in its discharge may be a reasonable indication of the chemistry of ground water in this area.

Marie Antoinette Mine. Effluent from adit #101 of the Carbonero Area inventory area is severely degraded, especially with iron. A constructed wetland may not be any more effective than the present situation, where the water disperses into a natural wetland and is possibly naturally attenuated to some extent. After soaking into the ground, the mine effluent presumably mixes with the naturally degraded ground water associated with the ferrosinter deposits in this area before entering the alluvial aquifer of Howard Fork. Additional characterization of the wetland function should be done before any treatment options are implemented. Diversion of the effluent to eliminate contact with the dump could be done easily, but may not produce a measurable effect.

Carbonero Mine. Previous sampling at the portal of the Carbonero Mine indicates that this large volume of effluent is highly degraded with respect to total zinc; total iron, lead, and copper are also high. During the high-flow and low-flow sampling events of 1994 the total recoverable and dissolved zinc loads of Carbonero effluent at the portal were about 200% and 67%, respectively, of the zinc load measured in Howard Fork below the Carribeau tailings.

Samples collected between the portal and the Ophir Pass Road in October 2000 contained considerably lower metal concentrations than the portal samples from previous investigations. Total recoverable iron and sulfate concentrations exceeded standards, and zinc and total recoverable aluminum were elevated. Although the concentrations were not extremely high, loads were moderate because of the high flow rate. Samples collected in 1998 from the Carbonero drainage just above its confluence with Howard Fork also showed considerable reductions in metal concentrations compared to portal samples. At this sample site, zinc load was about 12% of the load in Howard Fork below the Carribeau. Sample results suggest that some degree of natural attenuation probably occurs in the reach between the portal and its confluence with Howard Fork.

At least four separate sampling events document that Howard Fork showed increases in total/total recoverable concentrations of iron, manganese, and zinc in the reach that includes inflow from the Carbonero. Despite the increases, metal concentrations generally fell within stream standards.

In addition to water-quality problems, effluent from the Carbonero has eroded a deep ravine. Most of the erosion probably occurred during blow-outs, when large volumes of effluent were catastrophically released under high pressure. In 1970, a culvert was installed at the portal to keep the mine open, allowing effluent to discharge freely and preventing the devastating pressure build up. Most of the present erosion involves raveling of the oversteepened ravine walls, which primarily comprise unconsolidated soil and colluvium. Using geotextiles and high-altitude reclamation practices, the steep gully walls could be stabilized and revegetated to reduce bank failures and subsequent sediment loading into Howard Fork. Another proposed solution to the erosion problem entails piping the effluent from the portal to a discharge point near Howard Fork (McLaughlin, 1981, p. VIII-29). However, the pipe may freeze in winter despite the high flow rate. If the portal is monitored and remains open, blow-outs should not be a problem in the future.

New Dominion. Adit #102 releases a moderate to high volume of moderately degraded water. Total recoverable iron, and dissolved aluminum, copper, manganese, and zinc exceed standards, but the zinc load is less than 1 lb/day, and the copper load is only about 0.05 lb/day. This effluent flows toward the area between the Ophir Annex and adit #100, but in October 2000 it soaked into natural wetlands before surface flow reached a stream. A constructed wetland may not reduce metals significantly more than the natural wetland that already exists. Additional wetland characterization should be done prior to implementing man-made water treatment options.

Dump #202 is moderately mineralized but not highly acidic. A residence is on the western side of the dump bench. Mitigating the soil exposure pathway could be accomplished by covering the waste rock with soil or removing the material if a suitable repository is available. If metal prices improve, this dump may be amenable for processing.

Adit #100 drains a large volume of effluent that is moderately degraded with metals. It carries a load of about 23 lb/day of total recoverable iron, 4 lb/day of manganese, and less than 0.5 lb/day of zinc. The effluent flows into a natural wetland and mixes with water from a ferrosinter deposit before reaching Howard Fork slightly downstream from the Carbonero tailings pile. This adit was driven into an old ferricrete deposit, indicative of poor-quality water seepage prior to mining.

Dump #200 is moderately mineralized, but has a high neutralization potential and is not actively eroding. The toe of the dump is just above the Ophir Pass Road, and this pile would be relatively easy to remove if desired.

A water sample collected from the base of the wetland below the New Dominion Mine and near the Carbonero tailings was quite similar to effluent from New Dominion adit #100 in terms of major ions, but concentrations of iron and manganese decreased about 80% and 60%, respectively. Although not conclusive, sampling results suggest that the wetland is relatively successful in removing iron and manganese from the New Dominion effluent.

Carbonero tailings. The Carbonero tailings pile contains about 8,000 cubic yards of highly mineralized material and is located adjacent to Howard Fork. In addition, a naturally occurring acidic, metal-rich spring is adjacent to the northern side of the pile, and some of the acidic spring water flows onto the tailings and percolates into the tailings. Additional acidic springs may emerge beneath the tailings as well. Results of water samples collected from Howard Fork by CDPHE and CDMG are inconclusive, but suggest that the total zinc concentration increases in the reach that includes the tailings, at least on a seasonal basis. Results for dissolved zinc are contradictory. To add to the uncertainty, inflow from Nevada Gulch on the south side of Howard Fork is included in this reach, and the water quality of Nevada Gulch is not known.

More detailed and seasonal water sampling is needed for Howard Fork, the acidic spring, and any other sources identified at this site. In addition, the tailings should be sampled with an augur to determine vertical compositional changes from older (deeper) tailings to younger (shallow) tailings. Augur sampling might reveal the depth to the water table, and might identify if and where clay layers have formed perched water tables within the pile. If auguring is not practical, vertical channel samples could be collected from the embankment near Howard Fork, where 7 vertical feet of tailings are exposed (fig. 43). A more thorough, but more expensive option entails installation of piezometers or monitor wells to determine subsurface water quality and observe if the naturally acidic waters of the ferrosinter deposit flow beneath or through the tailings. Acidic water from the ferrosinter deposit would likely be further degraded by contact with the mineralized and acid-generating tailings.

The air and soil pathways may be a concern because of the tailing's close proximity to the Ophir Annex. This situation could be remedied with a soil cover. A more expensive solution, but one that might address surface water, air, and soil pathways entails moving the pile to a suitable repository, if one is available. The tailings are easily accessible and are relatively dry, at least at the surface.

Carribeau. A large volume of moderately degraded water flows from the caved portal of the Carribeau Mine. The effluent exceeds standards in iron, manganese, and sulfate, and contains high zinc concentration. Samples collected by CDMG indicated that many metals, especially total concentrations, are higher during high flow than low flow.

The Carribeau waste-rock pile is sizeable and moderately mineralized. Mill tailings deposited below the waste rock are reportedly highly mineralized (CDPHE, 1999). Mine effluent continuously flows through a deep gully in the waste rock, then braids and flows into a wetland that has partly submerged the tailings. The beaver ponds and wetland that flood the Carribeau tailings are part of a larger wetland that covers much of the floodplain on the south side of Howard Fork. This large wetland extends from at least 600 feet upstream of the Carribeau to 1,000 feet downstream. In June 2000 the wetland had no significant surface flow into Howard Fork. The majority of the wetland water, including the mine effluent, must enter the alluvial aquifer of Howard Fork.

Despite the influence of this large volume of metal-laden water flowing across and through mineralized tailings, samples collected from Howard Fork in June 2000 showed little change from upstream to downstream. During this sampling event, the Carribeau effluent represented less than 5% of the flow of Howard Fork. The similarity in water composition upstream and downstream in Howard Fork suggests that the large flow of Howard Fork effectively masked the influence of the Carribeau site. Similarly, CDMG samples collected in 1994 showed little change from upstream to downstream. In contrast, a CDMG sample collected downstream in 1980 showed increases in total concentrations of iron, zinc, and copper compared to the upstream sample. In June 1998, the CDPHE sample collected downstream showed moderate increases in total concentrations of aluminum, copper, iron, lead, manganese, and zinc compared to the upstream sample.

Some natural attenuation in the wetland below the Carribeau may occur, although much of the wetland is underlain by tailings. When the flow rate of Howard Fork is lower later in the year, the impact from the Carribeau site may be more measurable.

The Carribeau site is extremely complex because of the large volume of moderately degraded effluent and the presence of submerged tailings in the floodplain of Howard Fork. The mixed ownership of the affected property adds to the complications. Removal of the tailings without draining the wetland might cause more short-term damage to Howard Fork than leaving them. Diverting Carribeau Mine effluent away from the tailings may help to dry them, but other natural water sources also supply the wetland, and those sources would require diversions also. Treatment of effluent from the Carribeau would not be a simple task either. If the tailings were removed, space exists in the Howard Fork floodplain for some passive treatment cells, but they would be in danger of flooding almost annually. Additionally, passive treatment of large volumes of water that is only moderately degraded generally results in only minor metal reductions, and the overall metal reduction in Howard Fork may be negligible. Remediation at the Carribeau site will require considerable further characterization, creative thinking, and cooperation between property owners and other stakeholders. The role of the wetland and its effect on water quality is especially important at this site.

Howard Fork. Howard Fork is degraded by several mining-related sources and by naturally occurring acidic springs. According to CDPHE 1998 samples, average total zinc from just below the Carbonero tailings to its confluence with South Fork is about 130 µg/L, above the 110 µg/L concentration identified by the Superfund Chemical Data Matrix Ambient Water Quality Criteria (SCDM-AWQC). Dissolved zinc seldom exceeded State standards in that reach, however, because zinc has a hardness-related standard, and the water in Howard Fork is unusually high in calcium. Average total copper (17 µg/L) and total lead (20 µg/L) in the same reach were above the 12 µg/L and 3.2 µg/L SCDM-AWQC (CDPHE, 1999, p. 13). In 1998, most of the total copper load in Howard Fork below the Carribeau (4.5 lb/day) was added in the stream reach that included the naturally occurring Iron Springs bog iron deposit (3 lb/day). Neither dissolved copper nor dissolved lead were detected in samples collected in Howard Fork near the Carribeau in 1998 and 2000. It is unknown why total copper and lead were elevated in the 1998 samples, but dissolved copper and lead were not detected in 1998 or 2000.

In the spring of 1980, iron, zinc, lead, copper, and cadmium concentrations were elevated at the mouth of Howard Fork, and nearly all of the degradation occurred in the reach including Chapman Gulch downstream to about 0.5 mile below the Carribeau Mine (McLaughlin, 1981, p. VI-38). The Carbonero and Carribeau Mines and naturally occurring Iron Springs were identified as the major contributors to zinc loads during August and October 1980 sampling events. The Carribeau and Carbonero Mines were the largest contributors of lead, too. Copper load increased significantly in the Iron Springs area. The Carribeau Mine added copper, but the effect on Howard Fork was not measurable. The recurrent theme is that the Carbonero and Carribeau Mines and naturally occurring Iron Springs are consistently reported as important metal loaders.

In 1994 CDMG conducted a high flow (June) and low flow (November) sampling program in Howard Fork. Results suggested that, in the main stem of Howard Fork, metal concentrations increase as flow rate decreases. Despite the lower concentrations, metal loads in June were significantly higher because flow rates were 4 to 6 times greater than in November. Samples of mine effluent were not as easily generalized: some showed great variability in flow rates, metal concentrations, or both, while others remained relatively constant. At least as far downstream as the sample site immediately downstream from the Carribeau tailings pile, Howard Fork was within State standards for all of the metals analyzed; iron, copper, and zinc concentrations, however, were elevated and approached standards. Total lead concentration was high during low flow. (Jim Herron, CDMG, unpublished data.)

Final Observations. Despite the relatively large number of water samples collected in the last 25 years, serious discrepancies remain between various water-quality studies conducted in Howard Fork. The most important of the discrepancies involve copper and lead concentrations in filtered and unfiltered samples. Additional samples would be useful at the most important sites to determine the lead and copper concentrations, and to determine if the metals occur in the dissolved state or as particulates. Understanding the physical state of the metals is extremely important for designing a system to effectively remove them. Water treatment systems designed for dissolved metals may not successfully remove metals carried as colloids or particulates, and vice versa. Additionally, State standards for many trace metals are based on dissolved concentrations. It is important to understand the characteristics of the undissolved trace metals to determine if they are environmentally significant.

Of the sites examined for this study, erosion in the ravine below the Carbonero Mine is considered the most serious mining-related impact. The high volumes of effluent from the Carribeau and Carbonero Mines are probably the largest trace metal loaders of the mine sites in the Ophir area. The effects of the Carbonero and Carribeau tailings, which are adjacent to and within the Howard Fork floodplain, were difficult to measure. Erosion of the tailings and the proximity of water to acid-generating mineralized material could have serious environmental consequences.

Other studies offer similar, but not identical, conclusions. The Carbonero Mine and the Carbonero and Carribeau tailings piles were cited as “significant” sources of metals in Howard Fork (CDPHE, 1999, p. 17.) The McLaughlin (1981, VI-37-47) study identified erosion in the ravine below the Carbonero and erosion of tailings at the Carribeau and Carbonero tailings piles as the most significant mining impacts in the Howard Fork drainage basin.

Both the Carribeau and Carbonero effluent streams are high volume, but contain relatively low metal concentrations. This type of water is not easy to treat in a cost-effective manner (McLaughlin, 1981, p. VIII-30). In order to provide sufficient retention time for physical and/or chemical reactions to occur, large treatment ponds or wetlands are required for treating large volumes of effluent. Even with a large passive treatment system, the moderate concentrations of metals in the Carbonero and Carribeau effluent might not be greatly reduced.

Stakeholders and various State and Federal agencies will need to reach a consensus regarding the goals for any remediation work in the Howard Fork drainage basin. At present, Howard Fork immediately downstream of the sites described in this report is within State stream standards for all of the analyzed parameters, with the exception of zinc, which virtually equals the standard. The importance of total metal concentrations in the water should be addressed. Because the metals contamination is not limited to one major source, expenditures of large amounts of capital and efforts at one site will probably not make a measurable difference in Howard Fork. Regarding sites examined during this investigation, removal of the Carbonero tailings, and stabilization and revegetation of the ravine below the Carbonero Mine might be the least expensive and easiest solutions to implement in the immediate future. Although probably not as easy to engineer or implement, effluent from the Carribeau and the natural sources of water that submerge the Carribeau tailings should be diverted away from the waste rock and tailings material.

REFERENCES

Unpublished references pertaining to the Colorado Bureau of Mines (CBM) are available at the Colorado Division of Minerals and Geology (CDMG), Denver Colorado. Throughout this text, citations of books (bk.) and pages (p.) refer to records in the San Miguel County Courthouse in Telluride. Some unpublished reports completed by consultants or mining companies were provided to CGS by USFS and are cited in this section. Copies of those reports may be available at CGS or the Uncompahgre National Forest Supervisors Office.

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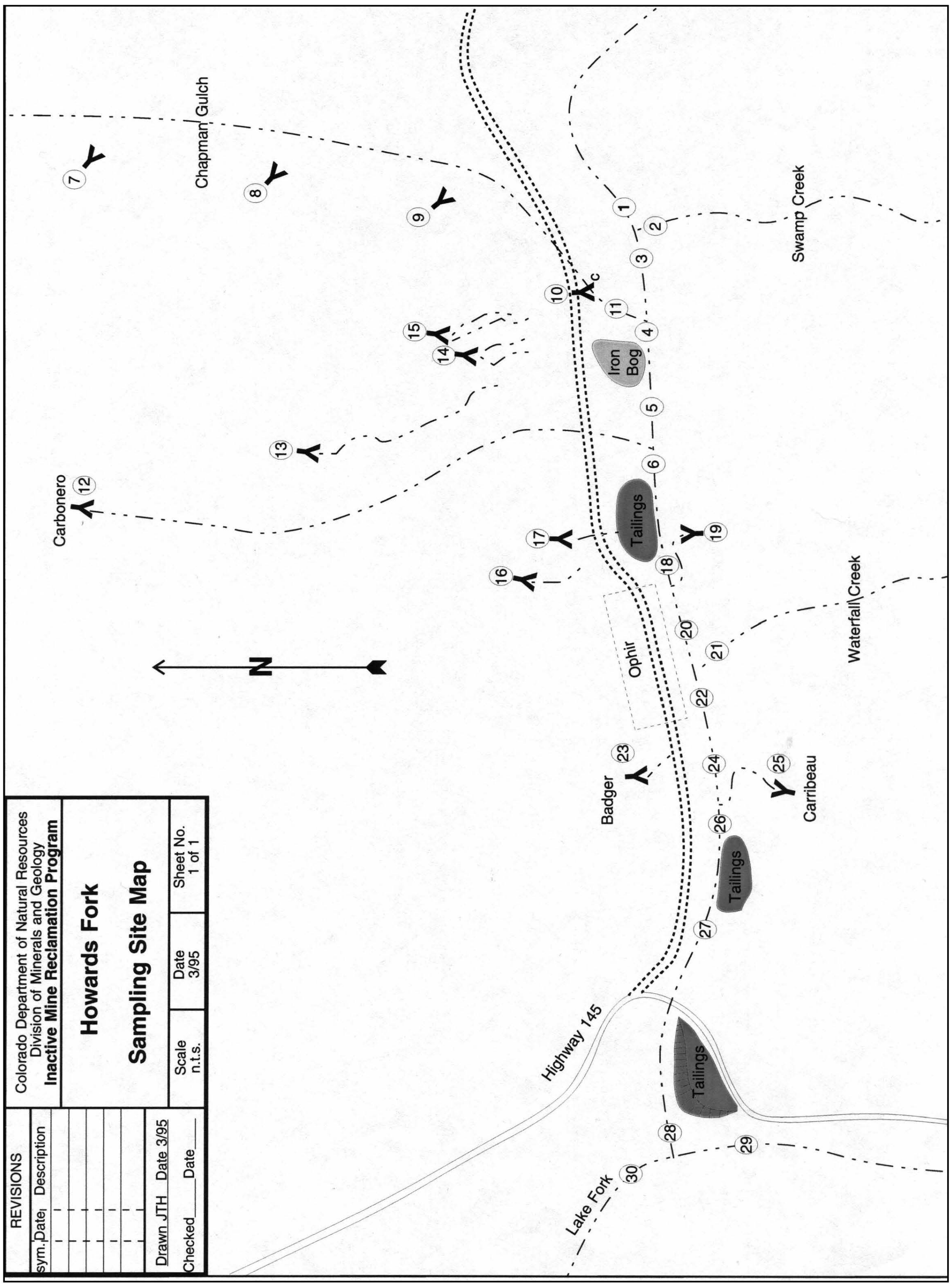
APPENDIX

Sample locations and results of CDMG sampling in 1994 (Jim Herron, CDMG, unpublished data).
[TM = total recoverable metals; FM = filtered (dissolved) metals. Column (1) was collected in June; column (2) was collected in November. Flow was measured in cubic feet per second; metal concentrations are in µg/L.]



Site #	Flow (1)	Flow (2)	Temp (1)	Temp (2)	pH (1)	pH (2)	Conductivity (1)	Conductivity (2)	CD TM (1)	CD TM (2)	CD FM (1)	CD FM (2)
1	2.94	0.37	43.5°F	43.5°F	5.3	5.75	301	338	U 0.25	< 0.25	U 0.25	< 0.25
2	23.93	2.38		46°F	6.8	7.46	225	519	U 0.25	< 0.25	U 0.25	< 0.25
3	28.49	2.68		39.7°F	6.7	7.01	236	579	U 0.25	< 0.25	U 0.25	<0.25
4	28.04	4.37		38.1°F	6.7	7.16	977	778	U 0.25	< 0.25	U 0.25	< 0.25
5	31.37	5.39		37.5°F	6.8	6.24	635	832	U 0.25	0.72	U 0.25	0.68
6	33.92	5.87		36.0°F	6.9	6.64	721	865	0.96	0.99	1.1	0.86
7	1.40	0.27		55°F	7.2	6.82	1034	991	0.52	0.72	0.48	< 0.25
8	.094	0.10		40.7	6.5	5.69	715	1,151	0.5	0.26	0.53	0.27
9	.020	0.06		39°F	7.0	7.16	536	1,002	U 0.25	< 0.25	U 0.25	< 0.25
10	.151	0.12		40.5°F	6.6	5.60	1024	1,336	1.3	1.3	1.3	1.3
11	2.83	1.07		39.2°F	7.0	5.60	762	1,363	0.39	0.40	0.37	0.32
12	4.22	1.18		38.4°F	6.0	7.17	1220	1,270	20	5	19	5
13	.285	0.17		41.1°F	6.4	6.21	870	787	1.6	0.72	1.5	0.63
14	.110	0.24		40.6°F	5.9	5.92	1163	1,230	1.1	0.94	1.1	0.92
15	.105	0.06		39.8°F	3.9	3.64	824	863	0.89	0.83	0.88	0.82
16	.607	0.30		42.1	6.8	7.66	1486	1,550	U 0.25	< 0.25	4.2	< 0.25

Site #	CU TM (1)	CU TM (2)	CU FM (1)	CU FM (2)	FE TM (1)	FE TM (2)	FE FM (1)	FE FM (2)	PB TM (1)	PB TM (2)	PB FM (1)	PB FM (2)
1	U 4	< 4	U 4	< 4	24	14	16	< 10	U 5	< 5	U 5	< 5
2	U 4	< 4	U 4	< 4	140	990	84	410	U 5	< 5	U 5	< 5
3	U 4	< 4	U 4	< 4	130	620	65	320	U 5	< 5	U 5	< 5
4	U 4	< 4	U 4	< 4	330	850	51	75	U 5	< 5	U 5	< 5
5	8	29	6	14	200	800	32	67	U 5	< 5	U 5	< 5
6	13	30	7	10	700	760	66	52	7	5	U 5	< 5
7	6	< 4	U 4	< 4	3300	2200	1500	1600	U 5	< 5	U 5	< 5
8	17	6	5	4	12000	10000	9400	8800	U 5	< 5	U 5	< 5
9	7	10	U 4	< 4	5000	7200	3100	3000	U 5	< 5	U 5	< 5
10	U 4	< 4	U 4	< 4	8300	7300	6900	6900	U 5	< 5	U 5	< 5
11	5	< 4	U 4	< 4	1600	2400	740	220	U 5	11	U 5	< 5
12	280	23	130	< 4	11000	3400	4100	1200	85	11	U 5	< 5
13	130	47	130	34	29000	26000	U 5	26000	U 5	< 5	U 5	< 5
14	46	14	46	15	22000	22000	22000	22000	U 5	< 5	U 5	< 5
15	25	18	28	19	14000	11000	14000	10000	U 5	< 5	U 5	< 5
16	U 8	< 4	U 8	< 4	6900	5500	7000	4600	U 5	< 5	U 5	< 5

Site #	MN TM (1)	MN TM (2)	MN FM (1)	MN FM (2)	ZN TM (1)	ZN TM (2)	ZN FM (1)	ZN FM (2)
1	48	26	47		27	23	27	23
2	67	210	64	190	10	20	14	17
3	65	150	62	150	13	21	12	17
4	84	190	79	190	18	42	15	34
5	100	260	95	260	33	90	33	83
6	340	340	290	330	230	150	220	130
7	910	880	920	860	110	58	110	54
8	1200	1100	1200	1100	240	200	230	200
9	840	820	830	790	36	40	34	31
10	930	940	940	930	440	420	430	420
11	440	620	440	610	110	100	100	65
12	5900	2200	5900	2200	4900	1300	4800	1100
13	2000	2100		2100	420	350		350
14	1100	1200	1100	1200	430	420	430	420
15	690	710	680	700	330	320	320	320
16	1300	1200	1400	1200	53	35	56	33

Site #	Flow (1)	Flow (2)	Temp (1)	Temp (2)	pH (1)	pH (2)	Conductivity (1)	Conductivity (2)	CD TM (1)	CD TM (2)	CD FM (1)	CD FM (2)
17	0.206	0.08		40.6°F	6.2	6.91	593	493	4.3	2.1	0.96	1.9
18	30.65	7.82		33°F	6.6	6.74	390	748	1.1	1.3	U 0.25	0.62
19	0.638	0.61		40.9°F	6.8	7.47	1525	1715	U 0.25	< 0.5	1.1	< 0.5
20	35.13	7.48		36.2°F	6.6	6.81	485	893	1.1	1.3	U 0.25	0.97
21	32.40	1.41		33.6°F	6.9	7.52	380	361	U 0.25	< 0.25	0.62	< 0.25
22	60.44	NOT DONE			7.0		740		0.62		U 0.25	
23	0.35	0.32		39.4°F	6.4	7.08	430	701	U 0.25	< 0.25	0.51	< 0.25
24	70.93	9.08		34°F	6.8	7.30	343	503	0.54	1.1	1.2	0.94
25	1.60	1.48		42.7°F	6.4	6.87	1180	1,150	1.2	0.85	0.49	0.81
26	65.71	11.60		35°F	7.2	7.13	346	476	0.49	0.78	0.48	0.71
27	68.72	14.81		35°F	7.6	7.30	375	465	0.48	0.72	0.52	0.65
28	77.72	1.19		39°F	7.6	7.66	381	132	0.52	< 0.25	0.5	< 0.25
29	98.40	3.70		37°F	7.9	7.63	168	198	0.5	< 0.25	U 0.25	< 0.25
30	196.1	11.58		40.0°F	7.9	7.70	244	340	U 0.25	0.49	0.25	0.59

Site #	CU TM (1)	CU TM (2)	CU FM (1)	CU FM (2)	FE TM (1)	FE TM (2)	FE FM (1)	FE FM (2)	PB TM (1)	PB TM (2)	PB FM (1)	PB FM (2)
17	160	46	100	15	5600	2600	2500	1600	8	< 5	U 5	< 5
18	10	33	5	4	370	2100	28	45	U 5	38	U 5	< 5
19	U 4	< 8	U 4	< 8	430	740	390	650	U 5	< 10	U 5	< 10
20	11	35	U 4	8	590	2400	36	60	U 5	58	U 5	< 5
21	U 4	< 4	U 4	< 4	28	< 10	U 10	< 10	U 5	< 5	U 5	< 5
22	5		U 4		290		U 10		U 5		U 5	
23	U 4	< 4	U 4	< 4	130	140	72	78	U 5	< 5	U 5	< 5
24	6	28	U 4	7	380	2000	23	71	U 5	53	U 5	< 5
25	210	86	88	9	14000	8900	7500	5000	23	13	U 5	< 5
26	U 4	17	U 4	6	270	1200	U 10	13	U 5	24	U 5	< 5
27	7	13		7	320	970		< 10	U 5	35	U 5	< 5
28	7	< 4	U 4	7	350	140	25	< 10	U 5	< 5	U 5	< 5
29	U 4	< 4	U 4	7	97	23	15	< 10	U 5	< 5	U 5	< 5
30	U 4	5	U 4	10	220	280	15	< 10	U 5	8	U 5	< 5

Site #	MN TM (1)	MN TM (2)	MN FM (1)	MN FM (2)	ZN TM (1)	ZN TM (2)	ZN FM (1)	ZN FM (2)
17	2600	1600	2500	1600	1000	490	1000	490
18	310	360	300	170	270	290	240	120
19	230	440	230	440	12	21	13	28
20	330	360	310	300	300	330	270	210
21	5	< 4	U 4	< 4	9	< 8	10	< 8
22	170		160		170		150	
23	180	180	170	170	14	< 8	16	< 8
24	180	270	150	230	150	300	130	160
25	2200	2000	2100	2000	280	200	260	180
26	160	200	150	170	150	210	130	140
27	150	160		130	140	190		130
28	190	83	160	38	140	< 8	130	< 8
29	53	87	38	79	17	31	16	< 8
30	110	160	86	170	63	110	51	21