NATURAL RESOURCES

INACTIVE AND ABANDONED MINE LANDS— Red Mountain Mine, Chiwawa Mining District, Chelan County, Washington

by Donald T. McKay, Jr.,
Fritz E. Wolff, and
David K. Norman

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES
Open File Report 2003-19
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site location

WASHINGTON STATE DEPARTMENT OF
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Doug Sutherland—*Commissioner of Public Lands*

DIVISION OF GEOLOGY AND EARTH RESOURCES

Ron Teissere—*State Geologist*
David K. Norman—*Assistant State Geologist*

Washington Department of Natural Resources
Division of Geology and Earth Resources
PO Box 47007
Olympia, WA 98504-7007
Phone: 360-902-1450
Fax: 360-902-1785
E-mail: geology@wadnr.gov
Website: http://www.dnr.wa.gov/geology/

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Washington Division of Geology and Earth Resources
PO 47007; Olympia, WA 98504-7007

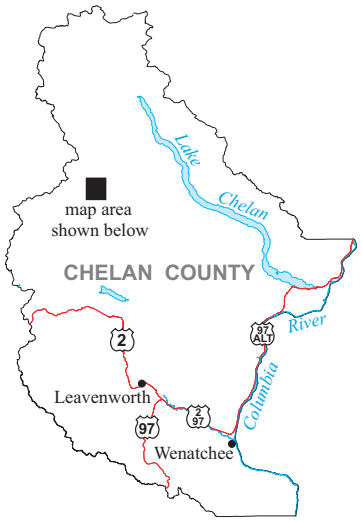
INTRODUCTION

Presently in Washington State there is no systematic database of inactive and abandoned metal mines (Norman, 2000). Previous work by the Department of Natural Resources (DNR) has had a distinctly commodity-oriented focus (Huntting, 1956; Derkey and others, 1990). The current goal is to build a single database and geographic information system (GIS) coverage of major mines in the state. Documentation will focus on physical characteristics and hazards (openings, structures, materials, and waste) and water-related issues (acid mine drainage and/or metals transport). Accurate location, current ownership, and land status information will be included. Acquisition of this information is a critical first step in any systematic approach to determine if remedial or reclamation activities are warranted. Open-File Reports (OFRs) will provide written documentation on mines or groups of mines within specific mining districts or counties.

Over 3800 mineral properties have been located in the state during the last 100 years (Huntting, 1956). Many are undeveloped prospects of little economic importance. Therefore, in considering the population to include in the Inactive and Abandoned Mine Land (IAML) inventory, we have identified approximately 60 sites that meet one of the following criteria: (a) more than 2000 feet of underground development, (b) more than 10,000 tons of production, (c) location of a known mill site or smelter. This subset of sites includes only metal mines no longer in operation.

We have chosen to use the term *inactive* in the project's title in addition to the term *abandoned* because it more precisely describes the land-use situation regarding mining and avoids any political or legal implications of surrendering an interest to a property that may re-open with changes in economics, technology, or commodity importance.

Creation of the state-managed IAML database is a cooperative effort between DNR, the U.S. Forest Service (USFS), the U.S. Bureau of Land Management (BLM), the U.S. Environmental Protection Agency (EPA), and the Washington Department of Ecology (DOE). DNR's Division of Geology and Earth Resources (DGER) is the lead agency. To date, USFS contracts have been the principal source of funding, with other contributions coming from DNR and EPA.



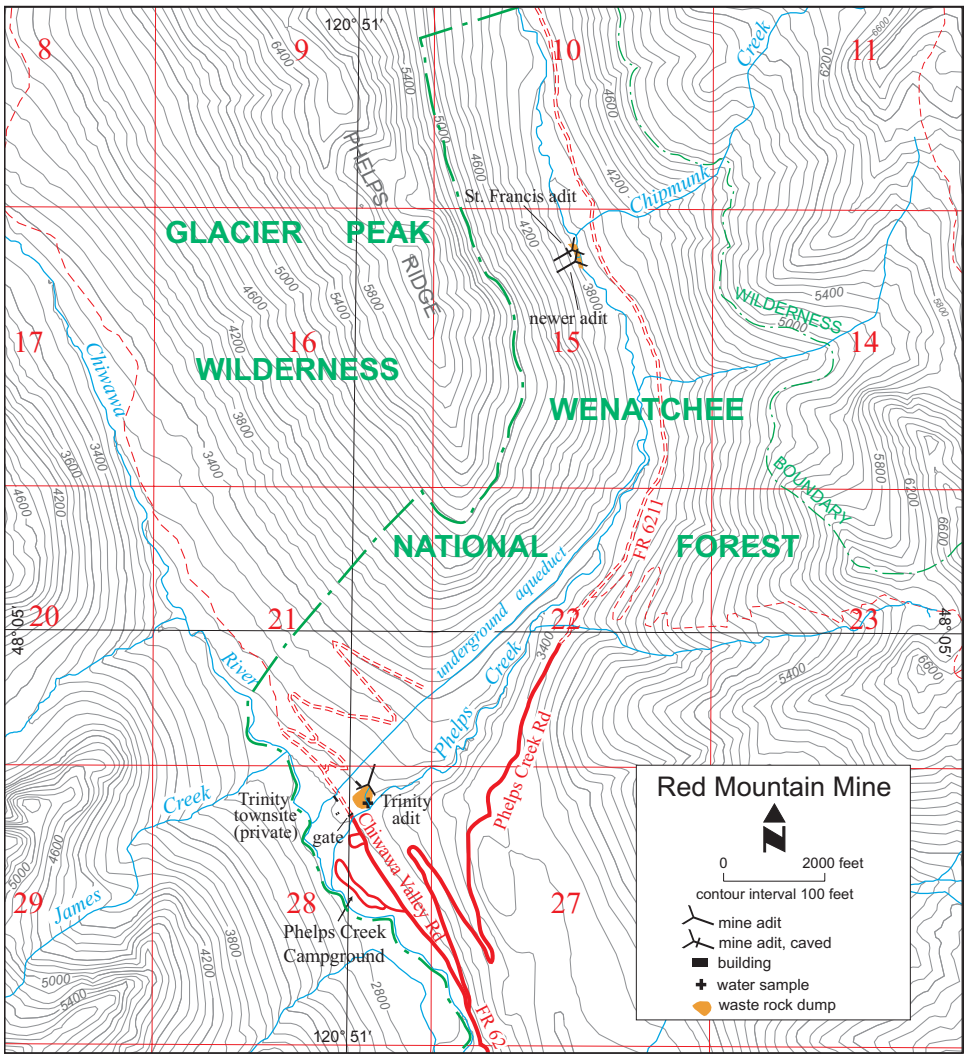


Figure 1. Map showing general location of the Red Mountain mine in Chelan County *(top)* and a site map of the mine.

SUMMARY

The Red Mountain mine lies in secs. 15, 21, 22, 27, and 28, T30N R16E, near the confluence of the Chiwawa River and Phelps Creek in Chelan County (Fig. 1). Between 1930 and 1940, approximately 18,000 tons of ore were mined from a low grade copper deposit (Stotelmeyer and others, 1982). DGER personnel visited the site on July 12, 2001. Workings observed consisted of the open 11,000-foot Trinity tunnel adit, the caved St. Francis adit located 2.5 miles up Phelps Creek, and an open unnamed newer adit. The openings have locked but ineffective doors. Both open adits discharge water into Phelps Creek. Previous work by the USFS raised concerns about elevated zinc levels in Phelps Creek. One sample of the Trinity tunnel discharge analyzed at nearly ten times the WAC 173-201A chronic water quality standard for zinc (Table 5). Waste rock from all openings totals approximately 30,000 cubic yards of mostly unmineralized shot rock. Waste rock in the St. Francis area is eroding into Phelps Creek. Little remains of the 350-ton flotation mill at the Trinity townsite. No tailings were identified during this visit.

SETTING

The Royal Development Company operated the Red Mountain mine on the southern end of Phelps Ridge in the Entiat Mountains. Phelps Ridge is the south-southeast–trending shoulder of Red Mountain that divides Phelps Creek from the Chiwawa River.

The site is approximately 42 miles north of Leavenworth. The privately owned townsite of Trinity includes the mill site and camp. It lies at 2800 feet elevation at the end of the Chiwawa River Road, near the Phelps Creek/Chiwawa River confluence and the Phelps Creek campground (Fig. 1).

Approximately 2.5 miles up Phelps Creek from this confluence, at 3800 feet elevation, are the adits accessing the upper limit of the St. Francis ore body. The mineral showings at the Galena/Leprechaun and Copper Point areas, located 4 and 8 miles respectively above Trinity on Phelps Creek, were acquired by Royal Development, but are not considered part of the Red Mountain mine Both the privately and publicly owned portions of the site lie within the Wenatchee National Forest. Much of the area is in timber and is typical snow-covered during winter months.

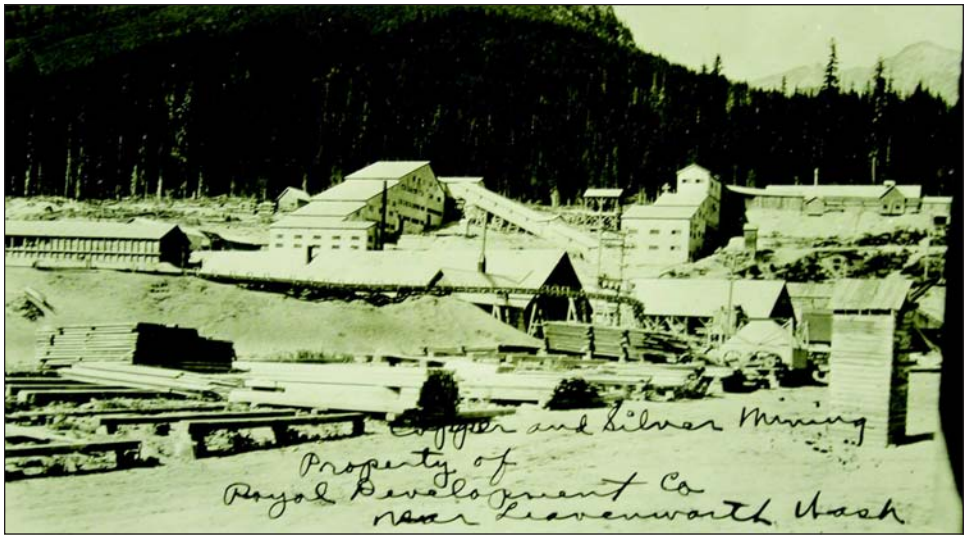


Figure 2. Trinity townsite circa 1937. Concentrating mill in center; powerhouse in background on right; saw mill in foreground. Only the powerhouse remains today. View to the north.

Figure 3. Trinity tunnel adit portal (bears N18°E). Photo taken through gap in wooden doors. Note sloughing inside on left.

HISTORY AND PRODUCTION

An early history of the mine can be pieced together from two University of Washington bachelor of science theses—Vincent (1927) and Barquist (1927). The original discovery was made in the early 1890s. This same year, the Una Basin Mining and Milling Company and/or the Chelan Mining Company did some development work on a rich surface showing of chalcopyrite. Ownership passed to the Red Mountain Mining Company, then to the North Star Mining and Milling Company (1902–1907), and then to the Lamb Davis Company before the Royal Development Company took over the claims in 1908.

Apparently no work was done for nine years. The Royal Development Company incorporated on July 3, 1917, and the surface extent of the ore body in the St. Francis area was explored with open cuts and pits. The St. Francis tunnel was excavated in 1918. In 1923, excavation began on the Trinity tunnel with the entrance located just above the camp at the Trinity townsite. In 1929, 50 men were employed at the mine. In 1930, a total of 200

men worked underground or on the surface constructing a sawmill, office, store, boarding house, power plant, several houses, and a mill (Fig. 2). Huntting (1943) reports that the mill operated for a short time in 1930. In 1931, the project was abruptly shut down (*Wenatchee World*, 1978). Reports indicate that the machinery was sold to a salvage company in 1934 (*Wenatchee Daily World*, 1959). In 1935, 18 men were employed. General manager James J. Naughten petitioned the State for a 'mine to market' road in letters dated Oct. 21, 1935, and March 11, 1936 (DGER mine file). He stated that the mine had produced 39,660 pounds of copper and 2863 ounces of silver and had 30,390 pounds of copper concentrates on hand at Trinity in 1935. The mill operated during the last quarter of 1935 (Huntting 1943). The *Mining Journal* (excerpt from news section, Feb. 2, 1937, DGER mine file) reported that several carloads of concentrates were trucked to the Tacoma smelter in 1936. Morrison (1954) writes that "10,000 tons of ore were milled in 1936, and 5,825 tons in 1937. The mine was closed on March 1, 1937 and has not been operated since then".

Attempts to re-open the mine were made in 1939, and the mill was reportedly operating at 60 tons per day capacity (*Mining Journal*, excerpt from news section, June 15, 1939, DGER mine file). Hans Lundberg, Inc., of New York conducted a geophysical survey for more than six weeks in an attempt "to locate bodies of higher grade material in the vicinity of the present mine workings" (letter by Douglas Burton, Royal Development Co., Oct. 18, 1939, DGER mine file). Huntting (1956) reported an additional 12 tons produced in 1940. A Bureau of Mines mineral investigation (Stotelmeyer and others, 1982) stated that between 1929 and 1940 there was a total output of "about 18,000 tons (16,300 t [metric tons]) of ore, from which approximately 215,000 lbs (98,000 kg) of copper, 17,000 oz (530,000 g) of silver, and 29 oz (902 g) of gold were recovered." A form filled out for the Department of Conservation and Development in 1936 indicates that concentrates were trucked to the Tacoma smelter (DGER mine file). Most activity in the 1940s appears to have been in the form of a legal battle between the shareholders and management. The corporation was dissolved in 1946. From 1958 to the mid-1960s, the property was operated as a resort.

The following entities conducted various exploration activities during brief periods from the 1960s through the early 1980s:

- U.S. Bureau of Mines
- Placer Amex
- American Exploration and Mining Company of San Francisco did exploration in 1967 (Moen, 1969)
- Citation Copper Mines, Inc., of Vancouver, B.C., and Seattle reportedly had a crew of six men diamond drilling and cleaning out the old workings in 1970 (DGER mine file)
- Texasgulf Incorporated of Denver did exploration in 1977 (Milne and Walker, 1978)
- E & B Exploration, Inc., of Vancouver, B.C., did exploration in 1980 and/or 1981 (Walsh and others, 1982).

GEOLOGIC SETTING

Sulfide mineralization (principally pyrrhotite and chalcopyrite) is most extensive in a brecciated zone between the pre-Tertiary Swakane Biotite Gneiss and an unnamed Tertiary labradorite-granodiorite intrusion (Cater and Crowder, 1967). Traces of the tungsten mineral scheelite occur as disseminated grains, veinlets, and small masses in the sulfides (Culver and Broughton, 1945). The wide (up to 250 feet) breccia zone lying between the contact of the biotite gneiss and the labradorite granodiorite is the principal structural feature associated with mineralization (Culver and Broughton, 1945). The mineralized zone may be hosted by a breccia pipe associated with the Cloudy Pass pluton (Church and Stotelmeyer, 1984). The breccia fragments vary in size from small sharp particles to blocks many feet in diameter. Calcite, quartz and the metal sulfides are the main cementing agents.

Figure 4. Deteriorating wooden covering over a hole near the banks of Chiwawa Creek. Notebook for scale.

ASSAYS

No assay maps are available. Ore samples provided by the Royal Development Company for flotation tests in 1927 and 1930 yielded assays of 1.53 to 3.02 percent copper by weight and 2.1 to 2.2 ounces/ton silver. Assays reported by Huntting (1943) show "a trace to 1.93% copper, 0.61 to 5.38 oz. silver, and a little gold per ton". In 1956, Huntting wrote that "Company records indicate only 1 or 2 very small areas with more than 1% Cu. One area on Trinity level 20 ft. wide, 100 ft. long averaged 0.85% Cu, 1.2 oz. Ag, and another area 2 or 3 times this size averaged 0.5% Cu and 0.8 oz. Ag. Only traces of tungsten [were found]." The tungsten ore was discovered in 1943, but "no masses or concentrations were noted that suggest commercial possibilities except as a by-product" (Culver and Broughton, 1945). In their evaluation of the mineral-resource potential of the Glacier Peak Wilderness study area, Church and Stotelmeyer (1984) describe the Red Mountain mine area as "a small

area of substantiated resource potential in a breccia pipe containing inferred resources of 8.5 million tons of 0.4 percent copper and 0.9 oz silver/ton". The term 'inferred resources' indicates that the potential for ore exists, based on the stream-sediment and bedrock geochemistry, gravity and aeromagnetic studies, geologic mapping, mineral exploration and occurrence studies, and other geologic investigations used in the study. 'Inferred resources' indicates that the resource is not proven and quantitative estimates of tonnage and grade are made in only a general way; no ore is actually identified or blocked out.

Figure 5. Collapsed portal of the St. Francis adit. View to the west.

Figure 6. Taking water measurements at the newer adit portal, St. Francis area.

MINE DEVELOPMENT

The southern end of Phelps Ridge is reportedly dotted with numerous prospect pits and several more-substantial workings. The caved 650-foot St. Francis adit trends S42°W, and 460 feet from its portal, a drift extends 350 feet at N40°W. The adit is driven through the labradorite granodiorite for 192 feet before it enters the mineralized breccia zone. The breccia zone is about 250 feet wide at this point. It "consists of porphyry fragments for approximately 100 feet, beyond which most of the fragments are in gneiss....The ore occurs in the matrix of this breccia" (unpub. report, author and date unknown, DGER mine file). A 30- or 40-foot adit (at the original ore discovery site) is of unknown condition and said to be 200 to 250 feet directly above the St. Francis adit. The LD adit, of unknown condition, is reported to be about 200 feet long. It lies about 170 feet above the St. Francis level. At a location 200 feet downstream from, parallel to, and at about the same elevation as the St. Francis adit, an unnamed newer adit was driven. The T.A.K. adit, reportedly 280 feet long and lying downstream from and about 50 feet lower in elevation than the St. Francis adit, was observed by Simmons (1994) to be totally caved. Approximately 2 miles south-southwest, the Trinity adit is driven through the Swakane Biotite Gneiss. It "trends N18E for 10,020 feet where it turns to N55E, ending at 10,957 feet. It is connected with the St. Francis adit by an 850-foot raise at a distance of 10,644 feet from the portal. A number of drifts have been driven to the southeast in the breccia from the main transportation adit" (Morrison, 1954).

The USFS (Simmons, 1994) examined additional mining properties upstream from the St. Francis. The Leprechaun lode claim and the Galena mill site claim lie near the center of sec. 3, T30N R16E. Simmons writes that "The Leprechaun lode claim has been developed by a reported 1,500 foot adit, which is partly caved at the portal but may remain open for most of its length." The Copper Point group of six lode claims (sec. 21, T31N R16E) includes several short adits, cuts, and prospect pits. During Simmons' (1994) field reconnaissance "little evidence of any exploration or mining activity was observed. Most of the reported workings were either totally caved and eroded or covered by talus materials."

OBSERVATIONS

DGER personnel made a reconnaissance investigation on July 12, 2001. The Trinity tunnel portal is closed with a locked plywood and timber frame door. It is evident that people have climbed over this structure to enter the adit. The adit is open and has sloughing just inside the collar, but appears solid as far as we could see from the entrance (Fig. 3). Clear water is draining from the portal at a rate of 15 to 20 gallons per minute (gpm).

In the area of the old mill, we noted two locations where deep holes lie in and under roadways. One of these is partly concealed by a deteriorating wooden cover (Fig. 4). Two and a half miles up Phelps Creek lies what appears to be the caved portal of the St. Francis adit. The hillside above the adit has slid, and the timbered collar is partly crushed and filled—the opening is not accessible (Fig. 5). Faint diesel fumes emanate from a crushed 55-gallon drum lying in the ruins. A subsidence feature uphill from the portal suggests that the adit is caved inside. Two hundred feet downstream and at approximately the same elevation as the St. Francis adit is a newer adit (Fig. 6). Here miners avoided the caving problems posed by the loose colluvium at the surface by installing a steel culvert. This adit is open, but a locked steel grating, which appears to have been bent to allow human access, secures the entrance. The culvert extends about 50 feet to a point where support timbers were installed. Some sloughing has occurred. Simmons (1994) writes that this newer adit was driven in the 1980s to re-open the St. Francis workings.

Figure 7. Face of the Trinity adit waste-rock dump. View to the west.

Figure 8. Trinity tunnel discharge sample location. Waste-rock dump in background.

TAILINGS

We saw no tailings during our site visit. We examined an area between the existing powerhouse and the Chiwawa River. Sediment consisted of rounded gravels in silty fine sand with rare cobbles. The frequency of cobbles increased toward the river. We recommend that any future examination for tailings use the historic photo (Fig. 2) and USFS aerial photos as a guide. A photo taken in September 1938 looking southwest from the Trinity adit has a caption that reads "The dykes [*sic.*] in the right distance will impound the mill tailing and keep it out of the Chiwawa River" (Starmont, 1938). The dikes in the photo lie about 100 yards south of the sawmill and power plant.

WASTE ROCK

The Trinity tunnel waste-rock dump covers approximately 2.5 acres and has an estimated volume of 25,000 cubic yards. The toe of the dump has been excavated, and its face is approximately 40 feet high and has a slope of up to 55 degrees (Fig. 7). The dump is composed of unmineralized gneiss and granodiorite. Figure 8 shows the site of the water sample taken from Trinity tunnel discharge as it flows down the dump slope and into Phelps Creek. Much of the surface of the dump supports a

thick cover of vegetation including mountain hemlock, monkey flower, bracken and other ferns, alder, ponderosa pine, manzanita, clover, Indian pipe, pinesap, and Douglas fir. Small surface depressions are stained orange where water has evaporated.

The St. Francis area waste-rock dump covers approximately 0.6 acres and has an estimated volume of 5000 cubic yards. It forms the west bank of Phelps Creek for approximately 500 feet. It extends 30 to 40 feet horizontally from the caved St. Francis and newer adit portals. Its face slopes at 37 degrees for 60 feet and ends in the creek. Dump material is sloughing into the creek (Fig. 9). Much of this material is iron stained and contains sulfide minerals. At the time of our visit, water draining the unnamed newer adit flowed at approximately 10 gpm across the surface of the dump into a small pool, then into Phelps Creek about 80 feet distant. No sample was collected. Patches of thick vegetation grow on the dump, including small alder, spruce, and hemlock trees.

We did not visit the T.A.K. adit. Maps in DGER mine file indicate that it is 650 feet south of the St. Francis adit, about 125 feet above the west bank of Phelps Creek. Simmons (1994) reported the waste-rock dump was not on the creek and appeared to be relatively stable. It was highly iron stained and was revegetating itself naturally.

We did not observe the Galena/Leprechaun or Copper Point areas. Simmons (1994) describes the Leprechaun adit (1500 feet long) waste-rock dump as “large” and “a large portion of it is iron-stained”.

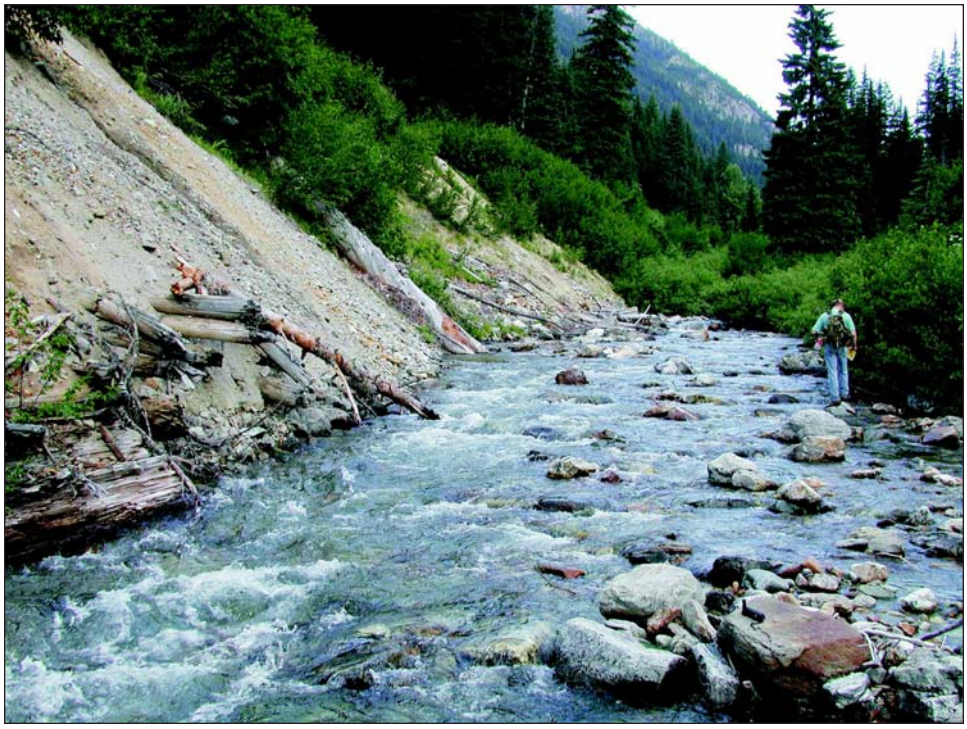


Figure 9. St. Francis area waste-rock dump along Phelps Creek. View to the northwest.

Figure 10. Pipe (18-inch diameter) carrying water from the powerhouse to the Chiwawa River. The pipe may be an aqueduct outlet.

WATER

One mine discharge sample was collected and observations were made at three locations. Simmons (1994) observed mine discharge at the Leprechaun adit. (See Tables 3 and 4.) Three samples exceed the WAC 173-201A Chronic Water Quality Standard for zinc. (See Table 5.)

USGS topographic maps show an approximately 9000-foot-long underground aqueduct that supplies water to produce electricity at Trinity. Phelps Creek is diverted into the aqueduct about 4000 feet upstream from the end of the Phelps Creek Road. An 18-inch-diameter steel pipe (Fig. 10) and a riveted spirally constructed pipe (Fig. 11) carrying water from the powerhouse to the Chiwawa River may be the aqueduct outlets.

Simmons (1994) observed no water discharge from the T.A.K. adit and no drainage related problems at the Copper Point claims.

GENERAL INFORMATION

Names: Red Mountain mine, Royal Development mine, Royal mine, Trinity mine

MAS/MILS sequence number: mine 0530070002, mill 0530079005 (McFaul and others, 2000; Derkey and others, 1990; Huntting, 1956)

Access: two-wheel-drive road, trail

Status of mining activity: none

Claim status: Per the Mining Law of 1872, lode mining claims fall in two categories:

1. *Unpatented claims* require a minimum annual expenditure of $100 assessment work per claim. A $100 maintenance fee may be paid in lieu of performing assessment work. Unpatented claims are classified as *active* or c*losed*. *Active* denotes a valid, up-to-date claim. *Closed* denotes that the maintenance fee, assessment work, or other requirements have not been met, and that the claim is no longer valid. The following table contains information on active claims only.
2. *Patented claims* are owned in fee simple by the discoverer and their assigns. A mineral survey is performed as part of the patent application process, prior to the issuance of a patent. Some lode claims initially mined underground may at a later date turn into an open pit operation. If this occurs, a Surface Mining Permit is required, which contains certain stipulations regarding reclamation.

The Red Mountain mine as developed by the Royal Development Co. eventually encompassed 112 claims, 22 were patented (Huntting, 1956). The specific location of the patented claims can be obtained from the Chelan County Assessor's Office. Nine patented lode claims in the original St. Francis group, 2 patented claims at the Galena/Leprechaun location, and 6 patented lode claims at Copper Point were acquired by the USFS with the help of the Trust for Public Lands in 1997 (Greg Graham, USFS, written commun., 2003).

Table 1. Location and map information. – – –, no data

Mine name	County	Mine location	1:24,000-scale map	1:100,000-scale map	Decimal latitude	Decimal longitude
Red Mountain (including St. Francis area)	Chelan	secs. 15, 21, 22, 27, 28, T30N R16E	Trinity	Twisp	48.075508	120.848819
Galena/Leprechaun	Chelan	sec. 3, T30N R16E	Trinity	Twisp	– – –	– – –
Copper Point	Chelan	sec. 21, T31N R16E	Holden	Twisp	– – –	– – –

Figure 11. Riveted spirally constructed pipe carrying water from the powerhouse to the Chiwawa River. May be aqueduct outlet. Hammer for scale.

Current ownership of lands formerly mined: private and USFS, Wenatchee National Forest

Surrounding land ownership: USFS, Wenatchee National Forest and Glacier Peak Wilderness

Location and map information: see Table 1

Directions: The Trinity townsite lies just beyond the Phelps Creek campground at the end of the Chiwawa Valley Road (USFS Road 62). The townsite lies on private land, is closed by a locked gate, and is posted with 'No Trespassing' signs. The St. Francis openings are approximately 1.5 miles by hiking trail from the end of the Phelps Creek Road (USFS Road 6211).

MINE OPERATIONS DATA

Type of mine: underground with mill

Commodities mined: copper, with recoverable values in silver and gold

Geologic setting: The Red Mountain mine area is "a small area of substantiated resource potential in a breccia pipe containing inferred resources of 8.5 million tons of 0.4 percent copper and 0.9 oz silver/ton" (Church and Stotelmeyer, 1984).

Ore minerals: chalcopyrite ($CuFeS_2$), sphalerite (ZnS), galena (PbS), scheelite ($CaWO_4$) (Derkey and others, 1990)

Non-ore minerals: pyrrhotite ($Fe_{1-x}S$), pyrite (FeS_2), arsenopyrite (FeAsS), chlorite, quartz (SiO_2), calcite ($CaCO_3$), biotite, sericite ($H_2KAl_3(SiO_4)_3$) (Derkey and others, 1990)

Host rock: Pre-Tertiary Swakane Biotite Gneiss, unnamed Tertiary labradorite granodiorite intrusion (Cater and Crowder, 1967)

Period of production: 1930, 1935, 1936, 1937, 1940 (Huntting, 1956)

Development: numerous prospect pits; 650-foot St. Francis adit; 40-foot discovery adit; 200-foot LD adit; 1500-foot Leprechaun adit; newer adit, length unknown; 280-foot T.A.K. adit; 11,000-foot Trinity adit; 850-foot raise; several drifts, four production levels and interconnected stopes

Production: "18,000 tons (16,300 t [metric]) of ore, from which approximately 215,000 lbs (98,000 kg) of copper, 17,000 oz (530,000 g) of silver, and 29 oz (902 g) of gold" were recovered between 1929 and 1940 (Stotelmeyer and others, 1982)

Mill data: 350-ton flotation mill sold for scrap in 1946 (Huntting, 1956)

PHYSICAL ATTRIBUTES

Features: see Tables 2 and 3

Table 2. Mine openings. *, numbered photos online at http://www.dnr.wa.gov/geology/iaml/03-19/

Description	Condition	Gate (yes/no)	Length (feet)	Width (feet)	Height/depth (feet)	True bearing	Elev. (feet)	Decimal longitude	Decimal latitude	Digital photo*
Trinity adit	open	yes	11,000	8	9	N18E	2920	120.8497	48.07529	Fig. 3; DSCN1652
St. Francis adit	caved	no	650	unknown	unknown	S42W	3800	120.8345	48.10325	Fig. 5; DSCN1665

Table 3. Waste-rock dumps. *, numbered photos online at http://www.dnr.wa.gov/geology/iaml/03-19/

Name	Estimated volume (cubic yards)	Estimated acreage	Dimensions (feet) (l/w/slope length/ slope angle)	Material	Mineralization	Iron staining	Sediment transport to surface water	Digital photo
Trinity	25,000	2.5	400/300/40/55°	shot rock	unmineralized biotite gneiss	very minor	none	Fig. 7; DSCN1661
St. Francis area	5000	0.6	30/500/60/37°	shot rock	labradorite granodiorite, sulfide minerals	common	significant	Fig. 9; DSCN1664

Table 4. Surface water field data. – – –, no data; *, data from Simmons (1994) collected Aug. 17–18, 1994; **, numbered photos online at http://www.dnr.wa.gov/geology/iaml/03-19/

Location	Description	Estimated flow	Conductivity (μS/cm)	pH	Bed color	Temp. (°F)	Elev. (feet)	Decimal longitude	Decimal latitude	Digital photos**
Trinity adit	clear flow from adit enters Phelps Creek	20 gpm	170	5.7	natural	50	2840	120.85022	48.0747	DSCN1652
newer adit at St. Francis	clear flow from adit enters Phelps Creek	10 gpm	87	5.5	natural	43.9	3800	120.83395	48.10292	Fig. 6
aqueduct(?)	clear flow enters Chiwawa River	200 gpm	– – –	– – –	natural	– – –	2800	120.85274	48.07456	Fig. 10; Fig. 11
St. Francis adit*	– – –	<1 cfs	78–83	8.3–8.7	– – –	– – –	– – –	– – –	– – –	– – –
Leprechaun adit *	– – –	<1 cfs	16–42	8.4–8.6	– – –	– – –	– – –	– – –	– – –	– – –

Table 5. Surface water analysis. Metal concentrations are μg/L; hardness is in mg/L. – – –, no data; n/a, sample not analyzed for these metals; *, data from Roberta Bailey, USFS, collected Oct. 5, 1994. **, standards for these metals are hardness dependent. Conversion formulae are shown in http://www.ecy.wa.gov/pubs/wac173201a.pdf. Standards calculated for hardness values specific to Part 1 below, are shown in Appendix B

PART 1: ANALYSIS BY USEPA METHOD 6020, INDUCTIVELY COUPLED PLASMA/MASS SPECTROMETRY*

Sample location	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc	Hardness
Trinity tunnel discharge	<100	– – –	<2000	n/a	<100	n/a	450	40
St. Francis tunnel site*	<5	– – –	<20	79.0	<2.5	<0.3	43	33
30 feet from Leprechaun adit*	<5	– – –	<20	75.4	<2.5	<0.3	21.4	18

PART 2: APPLICABLE WASHINGTON STATE WATER QUALITY STANDARDS

Type of standards (applicable Washington Administrative Code)	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc	Hardness
Surface water standards (WAC 173-201A, Standard for aquatic life in surface freshwater, chronic level maximums at 100 mg/L hardness)	190	**	**	none	**	0.012	**	100
Ground water standards (WAC 246-290, Washington State Department of Health, standards for ground water, domestic consumption)	50.0	none	1300	300 (cosmetic only)	15	2.0	5000	– – –

Materials and machinery: ore cars, pumps, piping, electrical generator observed at Trinity; narrow gage rail in newer adit; crushed 55-gallon drum emitting diesel fumes at the collapsed St. Francis adit portal

Structures: Perhaps a half dozen of the approximately 40 original buildings remain. All are on private land and all appear sound, but weathered. They include two occupied dwellings, a shop adjacent to the Trinity portal, and the powerhouse. Some concrete footings and much piping remain. No traces remain of most buildings.

Reclamation activity: none

VEGETATION

Vegetation appeared healthy. Plants on the waste-rock dumps included small alder, spruce, ponderosa pine, Douglas fir, and hemlock trees, mountain hemlock, monkey flower, bracken and other ferns, manzanita, clover, and Indian pipe or pinesap.

WILDLIFE

No bats or evidence of bats observed. Rodents were observed inside the newer adit at the St. Francis site.

WATER QUALITY

Surface waters observed: Phelps Creek, Chiwawa River

Proximity to surface waters: Trinity adit discharge flows ~400 feet across the waste-rock dump and into Phelps Creek. Discharge from the newer adit at the St. Francis site flows ~80 feet across the waste-rock dump and then into Phelps Creek.

Domestic use: None. Domestic water for the Trinity site is acquired from James Creek; Phelps Creek is not used for domestic purposes (Simmons, 1994).

Acid mine drainage or staining: Minor iron staining observed in dry depressions on surface of Trinity adit waste-rock dump and at portal of newer adit at St. Francis site.

Water field data: see Tables 4 and 5

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Appendix A

PHOTOGRAPHIC DOCUMENTATION

Supplemental photos (JPEG format) available on our website at http://www.dnr.wa.gov/geology/iaml/03-19/ are:

DSCN1652. Taking water measurements at Trinity adit portal doors.

DSCN1661. View of Trinity adit waste-rock dump from Trinity townsite.

DSCN1664. St. Francis area waste rock dump at Phelps Creek.

DSCN1665. Crushed barrel in caved St. Francis adit portal. Hammer for scale.

DSCN1675. L.D. adit site at St. Francis area.

METHODS

We recorded observations and measurements in the field. Longitude and latitude were recorded in NAD83 decimal degree format. Literature research provided data on underground development, which was verified in the field when possible.

All water samples were collected as simple grab samples in pre-cleaned 500 mL HDPE bottles with preservative and kept on ice for transport to Sound Analytical Services, Inc. (SAS). Soil samples from dumps or tailings were taken from subsurface material and double bagged in polyethylene. Chain of custody was maintained.

Water and soil samples were analyzed for arsenic, cadmium, copper, iron, lead, and zinc by inductively coupled plasma/mass spectrometry (ICP/MS) following USEPA Method 6010. Samples were analyzed for mercury by cold vapor atomic absorption (CVAA), USEPA Method 7470 (water), and Method 7471 (soil).

Holding times for the metals of interest were observed (28 days for mercury, 180 days for other metals). Instrument calibration was performed before each analytical run and checked by standards and blanks. Matrix spike and matrix spike duplicates were performed with each set.

FIELD EQUIPMENT

barometric altimeter
binoculars
digital camera
flashlight
Garmin GPS III+, handheld GPS unit
Hanna Instruments DiST WP-3 digital conductivity meter and calibration solution
litmus paper, range 0–14, and 4–7
Oakton digital pH meter
Oakton digital electrical conductivity meter
Taylor model 9841 digital thermometer

Appendix B

WATER QUALITY STANDARDS FOR HARDNESS DEPENDENT METALS

WAC 173-201A. Chronic standard (μg/l). – – –, no data

Sample location	Hardness (mg/l)	Cd (μg/l)	Cu (μg/l)	Pb (μg/l)	Zn (μg/l)
Trinity tunnel discharge	40	– – –	5.2	0.9	48
St. Francis tunnel site*	33	– – –	4.4	0.7	41
30 feet from Leprechaun adit*	18	– – –	2.6	0.4	24