NATURAL RESOURCES

INACTIVE AND ABANDONED MINE LANDS— First Thought Mine, Orient Mining District, Stevens County, Washington

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

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES
Information Circular 103
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INTRODUCTION

The Washington State Department of Natural Resources (DNR), Division of Geology and Earth Resources (DGER), is building a database and geographic information system (GIS) coverage of major mines in the state. Site characterization was initiated in 1999 (Norman, 2000). Work is funded through interagency grants from the U.S. Forest Service (USFS), Region 6. Other agencies sharing in the project are the U.S. Bureau of Land Management (BLM), the U.S. Environmental Protection Agency (EPA), and the Washington Department of Ecology (DOE).

More than 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 Lands (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.

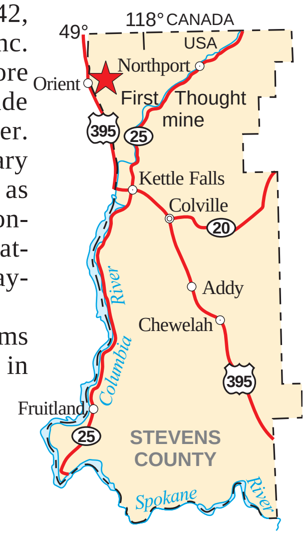
We have chosen to use the term inactive in the project's title in addition to the term abandoned because it more precisely describes the land-use situation regarding mining and avoids any political or legal implications of surrendering an interest to a property that may re-open with changes in economics,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

The IAML database focuses 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 are also included. Acquisition of this information is a critical first step in any systematic approach to determine if remedial or reclamation activities are warranted at a particular mine. Reports such as this one provide documentation on mines or groups of mines within specific mining districts or counties. The IAML database may be viewed by contacting Fritz Wolff (360-902-1468). IAML reports are posted online at http://www.dnr.wa.gov/geology/pubs/.

SUMMARY

The First Thought mine is located 3 miles east of Orient, Wash., at elevation 2900 feet in an area of complex volcanic features (Fig. 1). The mine had two periods of production. From 1904 to 1910, First Thought Gold Mines, Ltd., mined 36,000 tons of ore averaging 0.84 ounces/ton (opt) gold and 0.30 opt silver. Gross value of production at the prevailing price of gold at $20/ounce was $610,600. From 1934 to 1942, First Thought Mine Corporation, Inc. (FTMC), produced 45,000 tons of ore valued at $275,000. The average grade was 0.18 opt gold and 0.12 opt silver. FTMC re-registered with the Secretary of State's Corporations Division as Gold Syndicate, Inc., in 1948, but conducted no mining operations. This latter entity was dissolved for nonpayment of fees in 1952.

The mine is located on four claims patented under Mineral Survey 532 in sec. 18, T39N R37E. Champion Gold and Silver, Inc., of Spokane, Wash., purchased them in 1969 and remains the present owner. The mill is located on an adjoin-



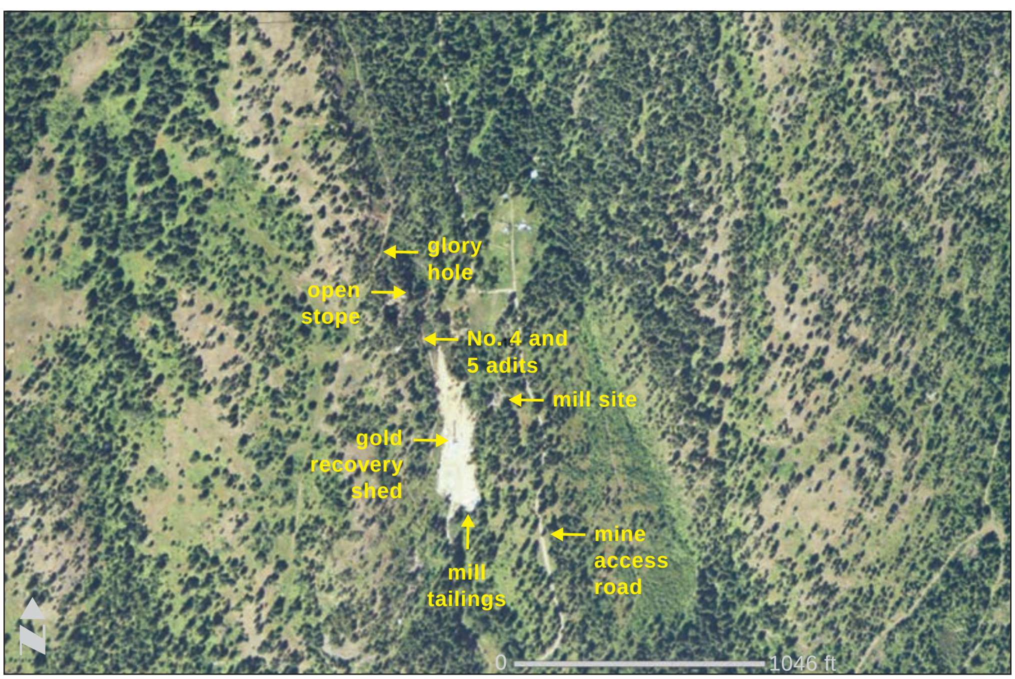


Figure 1. Map showing the location of the First Thought mine in Stevens County *(top)* and an air photo of the mine site *(bottom)*. Photo downloaded Oct. 10, 2006, from DNR's State Uplands Viewing Tool.

ing but separate patented claim owned by private parties. Shell Minerals Co., Inc., leased the property from Champion in 1982 and conducted extensive core drilling and underground sampling. Additional gold mineralization was found in erratic locations and concentrations around the mine's periphery.

The Eocene Sanpoil Volcanics host the ore body. The deposit lies in the approximate center of a summit caldera that may have existed at First Thought Mountain during late Sanpoil time. These volcaniclastic sediments were subjected to intense brecciation and silicification associated with epithermal hot springs. Most of the historic production came from a series of highly irregular branching [quartz/calcite] veins of varying thickness crosscutting each other and the sediments in random directions. Shell's drill data indicates that this stockwork vein system is abruptly discontinuous at depth and thins out or disappears south of the mine under the approximate location of the mill and within a few hundred feet northwest of a large open stope on the crest of the mine ridge.

Total development at the First Thought is approximately 8000 feet on seven levels, the lowest of which is approximately 250 feet below the surface outcrop (Fig. 2). The open stope is the main development-related feature still accessible. It is approximately 150 feet in diameter at the top, with vertical and past-vertical overhangs of 90 feet or more around the perimeter. The rockfall potential is extreme. An unfenced winze at the bottom of this stope descends to the No. 3 level.

DGER performed site characterization work in June 2002 and August 2006. The 50-ton/day (tpd) cyanide-based mill built by FTMC in 1937 has collapsed, and the crusher, ball mill, classifier, thickener, and precipitation tanks have been removed. The cyanide tank, inaccessible because of debris, is the only currently recognizable feature. The mill tailings cover 2.8 acres in a dry ravine immediately below the mill. The volume is approximately 33,000 cubic yards, based on the tonnage mined during the mill's operation which ended in 1942. Champion Gold and Silver cleared the tailings of brush and logging slash some time in 2003/2004 and erected a rudimentary processing plant to recover gold from the waste rock dump. The project appeared to be abandoned in September 2006. The level of arsenic found in the tailings exceeded the Washington Model Toxics Control Act standards for industrial use and unrestricted use (see Table 5). Although standards for cyanide in soils have not been established for these categories, the same sample yielded an anomalously high analysis of 3.6 milligrams/kilogram total cyanide.

The original bunkhouse, office, blacksmith shop, power plant, and accessory buildings clustered around the No. 5 level portal in early photos are gone. The site is essentially devoid of water with the exception of a small seep with a flow of less than 1 gallon/minute at the toe of the waste rock dump. The discharge collects in a 10-foot-diameter pond used by open-range cattle, and the overflow infiltrates within a few feet of the pond. Table 8 shows the results of a water sample ana-

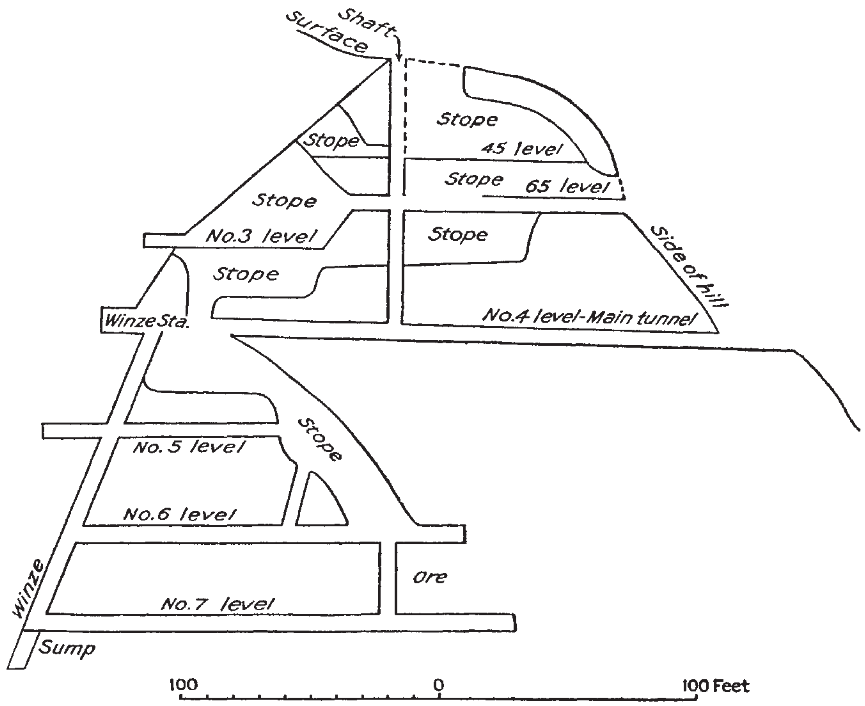


Figure 2. Longitudinal section of the First Thought mine. *Note:* No. 5 level was extended to the surface in 1936. View to the north. (Reprinted from Bancroft and Lindgren, 1914.)

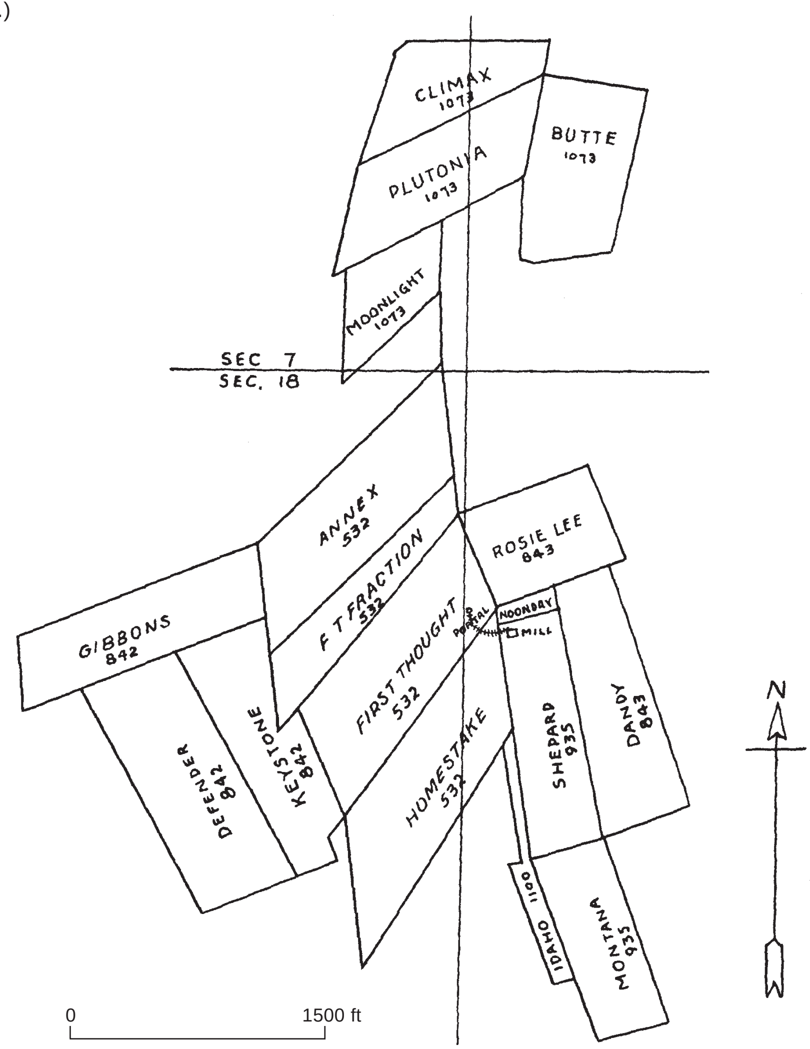


Figure 3. Patented claims surrounding First Thought mine. (Adapted from First Thought Mine Corporation, Inc., 1945).

lyzed for arsenic, cadmium, lead, and zinc. Notes on Shell's underground sample map indicate that the mine was flooded in 1982 below the floor of No. 5 level at elevation 2850 feet.

OWNERSHIP

The mine is located on four claims in sec. 18, T39N R37E, patented under Mineral Survey 532 (Fig. 3; Table 1). Champion Gold and Silver, Inc., has been the owner since 1969. The mill, also in sec. 18, lies on land patented under Mineral Survey 935 that is owned by D. R. Price and others of Colville, Wash. Additional patented claims surround the mine proper (Stevens Co. Assessor, written commun., 2006). BLM manages most of the remaining property in sec. 18; sec. 7 immediately north of the mine is in the Colville National Forest.

HISTORY

The claims were first staked in 1897 and immediately sold to a Canadian group, First Thought Gold Mines, Ltd. (FT Ltd.), a year later for $25,000. This company began development and made shipments from 1904 through 1910. Thirty-six thousand tons of crude ore from this period averaged 0.84 opt gold and 0.30 opt silver (Fulkerson and Kingston, 1958). Most of this production came from an area 190 feet long, 40 feet wide, and 250 feet deep near the east end line of the First Thought claim (Sharp, 1911). The glory hole and open stope described below lie directly above the underground workings in this area. Ore was transported to a railhead 1.5 miles north of Orient by a 12,880-foot tramline, then to smelters at Northport, Wash., or Trail, B.C., depending on economics. FT Ltd. was stricken from the records of registered corporations in 1928 for nonpayment of fees and dissolved in 1931. Gross value of production with gold at $20/ounce was $610,600.

The mine lay idle from 1910 until 1934 when Russell Parker, a former superintendent of the mine, purchased the property from Stevens County for $27,000 to settle unpaid taxes and labor liens. Parker formed First Thought Mine Corporation, Inc. (FTMC) in 1936, constructed a 50-tpd cyanide mill, and drove approximately 3500 feet of development work until Government Order L-208 shut down all gold mining in March of 1942 in support of the World War II war effort. This is the last reported date of production. The mine produced 45,000 tons of ore valued at $275,000 during Parker's ownership, at an average grade of 0.18 opt gold and 0.12 opt silver (Fulkerson and Kingston, 1958). Total development from both periods of activity was approximately 8000 feet on seven levels.

FTMC re-registered with the Secretary of State's Corporations Division as Gold Syndicate, Inc., in 1948 but conducted no mining operations. This latter entity was dissolved for nonpayment of fees in 1952. In 1969, Silver Champion, Inc., also known as Champion Gold and Silver, Inc., purchased the four patented claims referred to above from which all the prior surface and underground production was taken (*Wallace Miner*, June 26, 1969). Shell Minerals Co., Inc., leased the property from Champion in 1982 to explore the precious metal potential in an area immediately northwest of the mine by core drilling. Shell sub-leased the property to Rochester Minerals of Vancouver, B.C., in 1986. The combined expenditure for exploration work by these two companies amounted to $218,000 (*Wallace Miner*, Sept. 16, 1986).

Some time in 2004/2005, operators erected a shed on the tailings that appears to house a rudimentary batch cyanide process aimed at recovering gold from the waste rock bulldozed into a headwall (Fig. 4). The effort has been abandoned.

Figure 4. Gold recovery processing shed sitting on tailings from original mill. Bulldozed waste rock dump left center. View to the north.

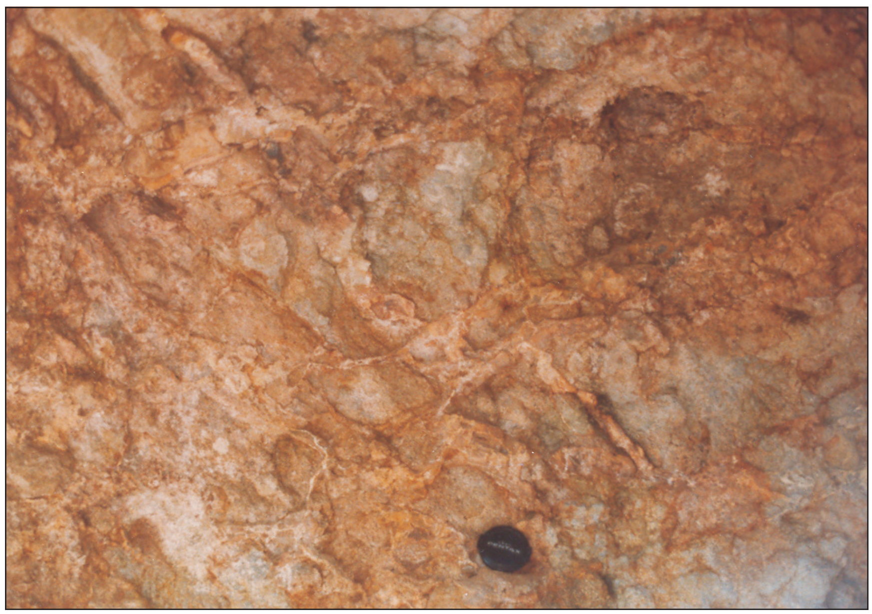


Figure 5. Typical exposure of stockwork veining in the open stope. Lens cap for scale. (Reprinted from Goetz, 1990.)

GEOLOGIC SETTING

The geology of the First Thought mine and surrounding area is complex. It lies in the approximate center of a summit caldera surrounded by "elliptical topography, inward dipping sediments partially encircling elliptical outcrops, and ring dikes" (Goetz, 1990). Structural faulting and pervasive regional and local hydrothermal alteration processes add to the complexity. The following discussion is a condensation of Venice Goetz's comprehensive (1990) work on the mine's geology and includes some of Bancroft and Lindgren's earlier (1914) observations made shortly after the mine's initial period of production.

In the area immediately proximal to the deposit, wall rock of andesitic origin has undergone significant hydrothermal alteration, principally propylitic and sericitic. Eocene Sanpoil Volcanics volcaniclastic sediments within the mine are andesite-derived sandstones, siltstones, and conglomerates described by Goetz as "variably dipping in a chaotic mass. Sediment bedding is discontinuous in the mine workings with dips ranging from nearly horizontal to nearly vertical". Gold mineralization appears most commonly in a brecciated stockwork of randomly branching quartz- and calcite-filled veins following zones of weakness around clasts in conglomerate units, along siltstone and sandstone bedding planes, in fault gouge, and at fault intersections. The veins vary in thickness from 1 inch or less to 3 feet and crosscut each other in random directions. The stockwork veins are exposed from the mine's lowest level to the open stope on the surface (Fig. 5). Core data obtained by Shell indicate that the stockwork system is abruptly discontinuous at depth, especially below No. 7 level, the lowest level mined.

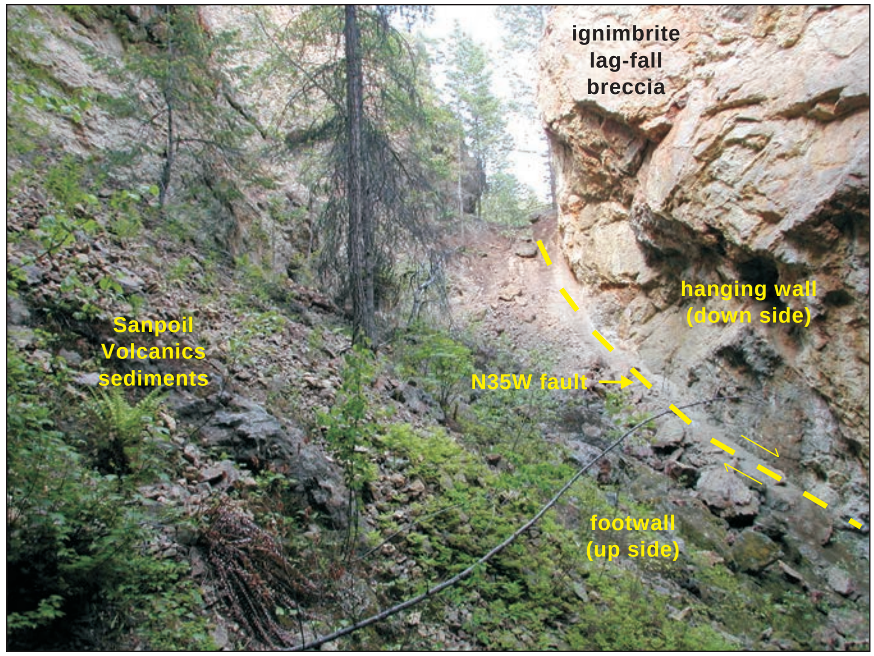


Figure 6. Open stope exposure. View to the northeast.

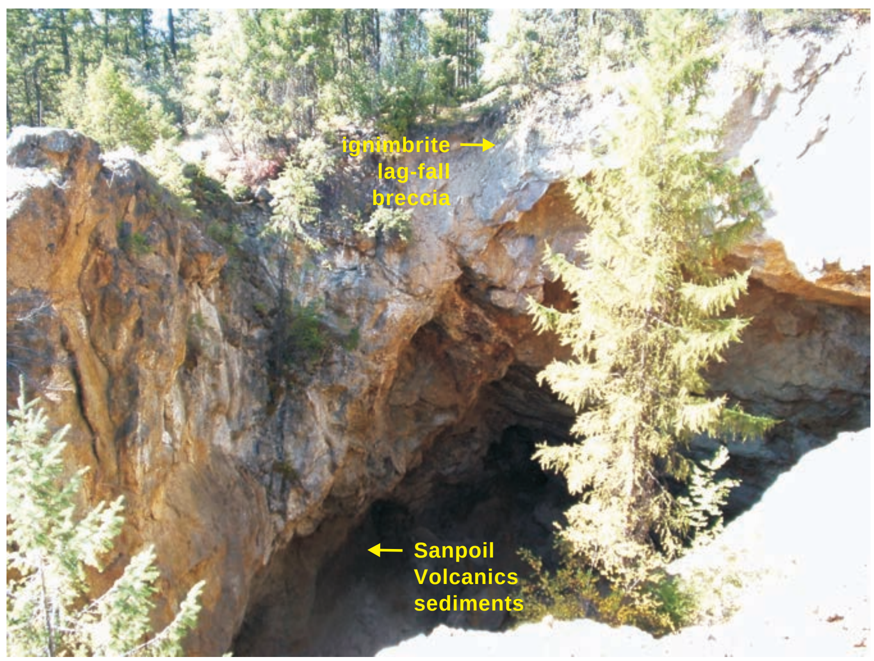


Figure 7. Glory hole exposure. View to the west.

Goetz (1990) identified the youngest rock unit at the mine as an ignimbrite lag-fall breccia, which resembles rhyolitic tuff. It lies unconformably over an eroded paleosurface, which in turn overlies the mineralized volcaniclastic sediments. It is not hydrothermally altered or mineralized. It is light pinkish-gray in color with subangular clasts up to 6 feet in diameter and forms a 90-foot overhang in the open stope and glory hole (Figs. 6 and 7).

Pyrite is pervasive in the orebody and found in all the volcanic-derived units immediately surrounding the mine. Bancroft and Lindgren (1914) also reported gold concentration in the quartz and at fault intersections, but suggested pyrite as a major gold-indicating host sulfide. This conclusion regarding the role of pyrite may have been coincidental. Shell sampled all the drift walls accessible on No. 4 and No. 5 levels in 1982 (Landress, 1982). As discussed below, these data indicate that gold anomalies were found in areas with no pyrite, and conversely, some areas mapped as high in pyrite contained only trace amounts of gold. Taken by itself, pyrite is an unreliable indicator of ore. Similarly, core drilling by Shell and others detected widely dispersed arsenic, antimony, and mercury sulfides, but found no apparent connection between these elements' concentration relative to each other or as target minerals associated with gold ore. A review of the available information indicates that the specific gold mineralization has not been positively identified in thin section or by x-ray diffraction. Goetz reported, "Gold and silver are not necessarily coincident with one another or with other elements [As, Sb, and Hg]. Therefore, gold and silver probably occur in their native form, as electrum, or in certain compounds." This view is consistent with Park and MacDiarmid's (1970) listing of gold and silver tellurides, arsenic and antimony sulfasalts, electrum, and native gold as characteristic of epithermal deposits. Production practices indicate that gold in the First Thought deposit is very finely disseminated and that visual appearance was of almost no value in judging whether a particular face contained ore or waste rock: "Assays are made of every rock face before and after blasting, all ore cars are sampled, and hourly samples are taken in the mill (FTMC, 1945)".

Most gold mineralization at First Thought mine occurred in zones structurally prepared by faulting, fracturing, or brecciation. Goetz (1990) and Shell geologists observed that locally at least 44 individual faults intersected within the mine area, and on a broader scale, field relations at First Thought Mountain "indicate a prominent structural grain of N20W. Structures with this orientation are mineralized in the [mine] deposit and this attitude is therefore older than the mineralization." An approximate 200-foot-wide shear zone with this orientation encompasses most of the mined area. It is truncated on the No. 7 level by a N35W-striking normal fault dipping 65° to 85°W (Fig. 6). This fault appears to be the major structural feature affecting economic mineralization. It is "enriched in gold only where it intersects (or truncates) other structures. Therefore, it is probably post-mineralization (Goetz, 1990)".

Shell, Champion, and Rochester Minerals drilled 14 core holes between 1980 and 1984. The hole bearings, locations, and declinations were chosen to evaluate the mineral potential along the ore body's strike northwest and southeast of the developed mine area and to crosscut the N35W-striking fault because of its effect on economic mineralization. The idealized cross section shown in Figure 8 represents a typical hole's drill log superimposed on the mine's development and geologic model. Although some widely isolated gold mineralization was encountered, the drilling revealed that the brecciated stockwork host unit thins out or disappears south of the mine under the approximate location of the mill and within a few hundred feet northwest of the open stope. The holes, varying from 400 to 700 feet in length, bottomed in lithic tuff or unaltered andesite at ~2500-foot elevation. With the exception of one intercept assaying .01 opt Au, no precious metal intercepts were found below the mine's lowest development, No. 7 level, at 2750-foot elevation. Core from this period of exploration is stored on pallets near the waste rock dump (Fig. 9). The last time these openings were readily accessible may have been during Shell's extensive sampling program of the underground openings in 1982. Thirty-one channel samples taken from drift walls on No. 4 level over a total sample-distance of 410 feet averaged 0.057 opt gold. Although gold was detectable to some degree in each sample, the values were widely erratic spatially, and the average was skewed by a few higher-grade assays of 0.102 opt to 1.200 opt. Ninety percent of the sample population fell below the average. On No. 5 level, nine samples taken over a total distance of 210 feet averaged 0.091 opt gold, with low and high values ranging from 0.001 to 0.344 opt gold (DGER map file). (See Appendix B.)

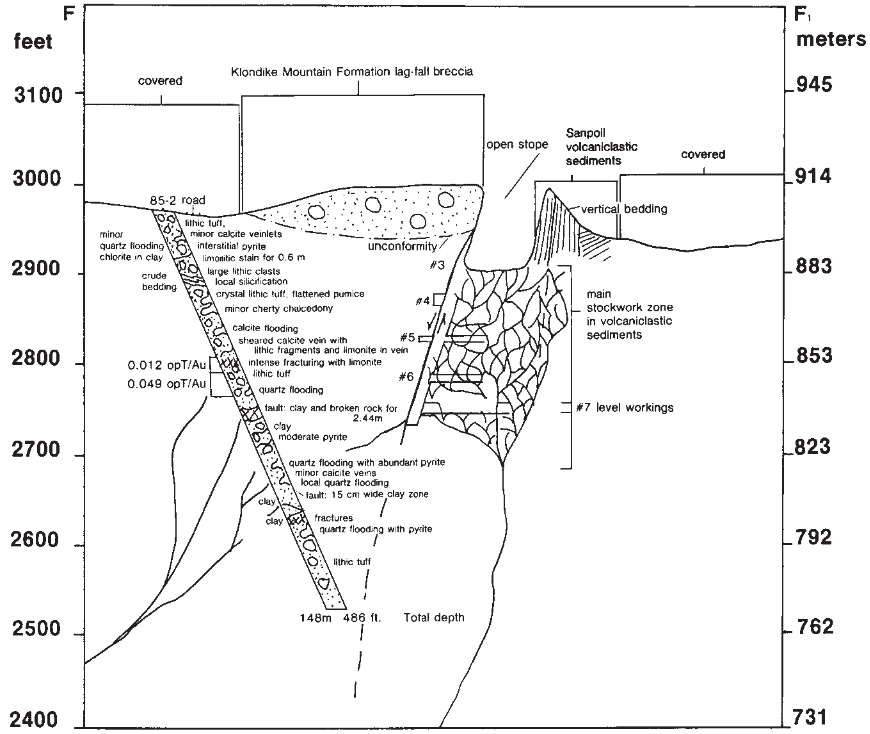


Figure 8. Cross section showing drill log of hole 85-2 superimposed on mine levels and representational model of stockwork veining. View to the north. (Reprinted from Goetz, 1990.)

Figure 9. Circa-1980s drill core storage.

OPENINGS

Total development at the First Thought is approximately 8000 feet on seven levels. The cross section shown in Figure 2 represents the vertical extent of workings in 1914, which are essentially unchanged today with the exception of additional stoping. In 1936, FTMC connected the No. 5 level with the surface. Its portal, located behind the waste rock dumps, is caved.

Figures 10 and 11, taken from the same vantage point 92 years apart, indicate where the various openings are located on the northeast-facing mine ridge. Bancroft's (1914) photo shows the "65" stope daylighting into the cliff. Subsequent mining continued through the overlying ore body to the surface, thus forming the open stope (Fig. 10). The unfenced winze found at the bottom of this stope shown in Figure 12 descends to the No. 3 level (Bancroft and Lindgren, 1914). Wall angles around the perimeter range from vertical to past-vertical overhangs of 90 feet or more. The rockfall potential is extreme.

A feature identified by Bancroft as a "glory hole" lies about 50 feet S15E from the open stope. The ladder in Figure 11 provided access to this feature at the time of Bancroft's examination. An exploration road now passes within a few feet of the glory hole. One of the five interior perimeter openings is connected to the No. 4 level by a raise. The 25-foot vertical overhang is spalling badly, as evidenced by the floor detritus (Fig. 7).

MATERIALS AND STRUCTURES

The circa-1937 mill building has collapsed (Fig. 13). The crusher, ball mill, classifier, thickener, and precipitation tanks have been salvaged. The cyanide tank is recognizable but inaccessible because of debris. The original bunkhouse, office, blacksmith shop, power plant, and accessory buildings are gone. The 200-bucket tramline used prior to 1910 has been salvaged. A private residence is situated on the Rosie Lee claim 800 feet northeast of the mine dump.

The wood-frame building erected in 2004/2005 to recover gold from the waste rock dumps is empty and in a state of disrepair (Fig. 4).

WATER

FTMC's stock prospectus (1945) states that the mine made "water sufficient to run the mill." However, the site was dry in June 2002 and August 2006, with the exception of a small seep at the toe of the waste dump. The less than 1 gallon/minute discharge collects in a 10-foot-diameter pond (Fig. 14) used by open-range cattle. Analysis of the water sample taken here is shown in Table 8. Notes on Shell's 1982 underground sample map (Landress, 1982) indicate that the mine was flooded below the No. 5 level at elevation 2850 feet.

MILLING OPERATIONS

FTMC constructed a 50-tpd cyanide-based gold extraction mill in 1937, which operated until 1942. The mill tailings have been cleared of timber and leveled. They are spread out in a dry ravine immediately below the mill, covering 2.8 acres. The tailings are up to 12 feet thick in places. The arsenic content of the tailings soil sample exceeded the Washington Model Toxics Control Act levels for industrial use and unre-

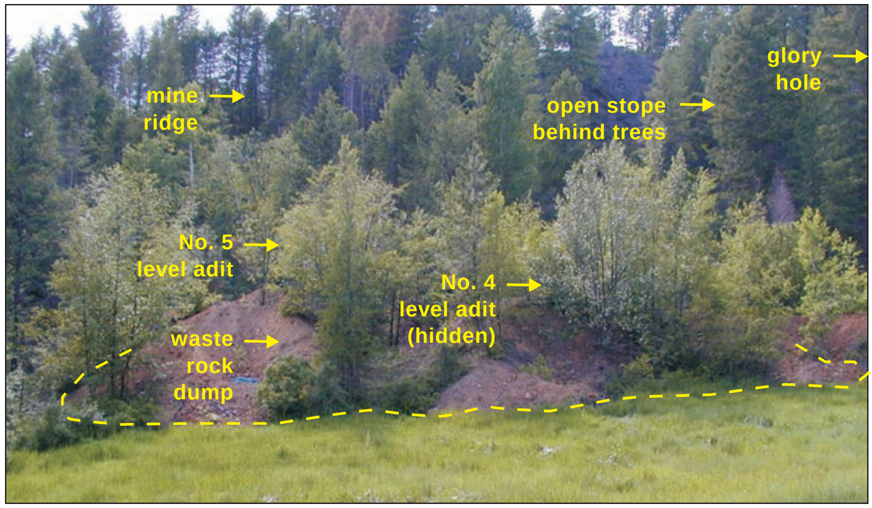


Figure 10. Overall view of the waste rock dumps and mine ridge taken in 2006. View to the west.

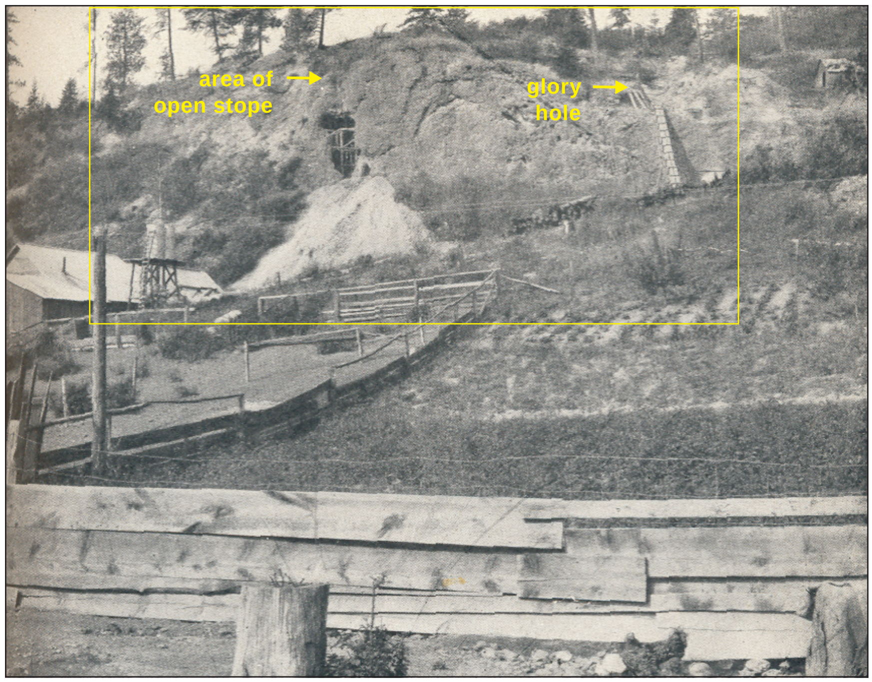


Figure 11. Overall view of the waste rock dumps and mine ridge taken circa 1914. Yellow rectangle outlines area shown in Figure 10. The opening in the center of the mine ridge later became the open stope (Fig. 6). The ladder on the right center leads to the glory hole. View to the west. (Reprinted from Bancroft and Lindgren, 1914.)

Table 1. Patented claims. The following are owners of record according to Stevens Co. tax rolls, but mineral rights and surface rights may have been separated in some cases during recent purchase/sales agreements.

Current owner	Mineral survey	Claim name(s)
Champion Gold and Silver, Inc. Spokane, Wash.	M.S. 532	Annex 7-18, First Thought, First Thought Fraction, Homestake
Western Continental, Inc. Spokane, Wash.	M.S. 1100	Idaho Fraction
C. A. Hinman Kettle Falls, Wash.	M.S. 843	Rosie Lee
D. R. Price and others Colville, Wash.	M.S. 842 M.S. 935 M.S. 843 M.S. 1073	Butte, Climax, Dandy, Defender, Gibbons, Keystone, Montana, Moonlight 18-39-37, Noonday Fraction, Plutonia, Shepard

Figure 12. *(top)* Winze (yellow arrow) at the bottom of the open stope. It declines at –65 degrees west.

Figure 13. *(middle)* Mill site. Note the cyanide tank, which was unreachable because of debris. View to the southeast.

Figure 14. *(bottom)* Seep and pond below waste rock dump. Pack for scale.

stricted use by a factor of ten (see Table 5). In addition, the sample analyzed 3.6 milligrams/kilogram total cyanide. We calculated the tailings volume at 33,000 cubic yards, based on the tonnage mined during the mill's operation.

WASTE ROCK DUMPS

The pervasive pyrite mineralization in the orebody has resulted in heavy iron-staining of the waste rock dumps adjacent to all the historic portals. Some of this material has recently been bulldozed into a headwall above the tailings for reprocessing as discussed above. A sparse growth of fir, tamarack, alder, and cottonwood trees has established a presence on the dump exposures and, in general, around the site.

GENERAL INFORMATION

Name: First Thought

MAS/MILS sequence number: 0530650127

Access: two-wheel drive road

Status of mining activity: none

Claim status: see Table 1

Current ownership: see Table 1

Surrounding land status: Bureau of Land Management

Location and map information: see Table 2

MINE OPERATIONS

Type of mine: underground, surface

Commodities mined: gold, minor silver

Geologic setting: quartz

Ore minerals: native gold, electrum; possible arsenic and antimony sulfasalts, pyrite

Non-ore minerals: quartz, calcite, adularia, fluorite, chalcedony

Host rock: highly altered andesite

Period of production: 1904–1910, 1934–1942 (DGER mine file)

Development: 8000 feet of adits, stopes, raises, and sublevels (DGER mine file)

Production: $885,000 at historic metal prices

Mill data: crushing, grinding, cyanide extraction leach tanks, and precipitation

PHYSICAL ATTRIBUTES

Features: see Table 3

Materials: no hazardous materials; drill core stored on site

Machinery: scrap metal

Structures: collapsed mill

Waste rock dumps, tailings impoundments, highwalls, or pit walls: tailings in the ravine are not impounded; waste rock dumps ~2000 cubic yards opposite portal; overhangs in open stope and glory hole

Analysis of waste rock dumps: none

Waste rock, tailings, or dumps in excess of 500 cubic yards: three

Reclamation activity: natural reforestation

Analysis of tailings and dumps: see Tables 4 and 5

VEGETATION

Typical Montane Forest Zone plants and trees; wildflowers, shrubs, fir, alder, pine, cottonwood.

WILDLIFE

Mule deer and white-tailed deer winter range migratory concentration area. Cavity-nesting wood ducks sighted at Pierre Lake 1 mile east of the First Thought mine (WADNR, 2006). Blue grouse and a barn owl were observed. See Table 6 for bat habitat information.

WATER QUALITY

Surface waters observed: Kettle River

Proximity to surface waters: 12,000 feet

Domestic use: private home on site

Acid mine drainage or staining: yes; seep in red-brown mud

Water field data: see Table 7

Surface water migration: infiltrates 15 feet from pond

Surface water analysis: see Table 8

Table 2. Location and map information.

Mine property	County	Location	Decimal latitude	Decimal longitude	1:24,000 quad.	1:100,000 quad.
First Thought	Stevens	sec. 18, T39N R37E	48.88317	118.16055	Laurier	Republic

Table 4. Soil Analysis. Metal concentrations are milligrams/kilogram; ≤, indicates metal was not detected—the number following is the practical quantitation limit above which results are accurate for the particular analysis method—the metal could be present in any concentration up to that limit and not be detected. – – –, no data. Analyses in bold indicate levels which exceed one or more standard shown in Table 5.

Sample location	Arsenic III	Cadmium	Copper	Lead	Zinc	Mercury	Cyanide total
waste rock dump, No. 4 level	**245**	≤1.1	27.7	19.2	138	– – –	– – –
tailings	**190**	≤0.22	– – –	16	49	0.25	3.6

Table 5. Soil quality standards for unrestricted land use. WAC 173-340-900, Model Toxics Control Act, Table 749-2: Priority contaminants of ecological concern for sites that qualify for the simplified terrestrial ecological evaluation procedure (partial data). Concentrations are milligrams/kilogram. Levels for silver, gold, and iron are not specified.

Metals	Arsenic III	Cadmium	Copper	Lead	Zinc	Mercury
unrestricted land use	20	25	100	220	270	9
industrial or commercial use	20	36	550	220	570	9

Table 6. Bat habitat information.

Opening	Aspect	Air temp. (°F) at portal	Air flow: exhaust	Air flow: intake	Multiple interconnected openings	Bats or bat evidence
winze in open stope	vertical	75	none	none	yes	no

Table 7. Surface water field data.

Description	Flow (gpm)	Conductivity (µS/cm)	pH	Bed color	Temp. (°F)
seep below No. 5 adit	<1	880	6.9	orange and black mud	65

ACKNOWLEDGMENTS

The authors thank editors Jari Roloff and Karen Meyers for helpful suggestions on the layout and content of this report. Special recognition and thanks to Venice Goetz, Department of Natural Resources, Forest Practices Division, for numerous discussions that contributed materially to understanding the complexity of the First Thought mine geology. Shell Minerals Co., Inc., and Rochester Minerals, Ltd., supplied the drill core and exploration data included in Goetz's thesis (1990).

Table 3. Mine features. – – –, no data; N/A, not applicable.

Description	Condition	Fenced (yes/no)	Length (feet)	Width (feet)	Height/ depth (feet)	True bearing	Elev. (feet)	Decimal latitude	Decimal longitude
open stope and shaft/winze	overhangs and rockfall	no	150	75	~90	N/A	2950	48.88356	118.16149
glory hole	overhangs and rockfall	no	30	30	~25	N/A	3028	48.88374	118.16181
mill site	ruins	no	– – –	– – –	– – –	– – –	2850	48.88317	118.16055
western margin of tailings	brush, forest, partially logged	no	– – –	– – –	– – –	– – –	2840	48.88202	118.16081

Table 8. Surface water analysis. Metal concentrations are in micrograms/liter (μg/L); hardness is in milligrams/liter (mg/L); USEPA, U.S. Environmental Protection Agency; – – –, no data; **, standards for these metals are hardness dependent; ≤ indicates metal was not detected—the number following is the practical quantitation limit above which results are accurate for the particular analysis method—the metal could be present in any concentration up to that limit and not be detected. 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
Seep at toe of No. 5 dump	≤2	≤2	– – –	– – –	0.18	– – –	10.0	<2

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	– – –

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Appendix A. Methods and field equipment

METHODS

We recorded observations and measurements in the field. Longitude and latitude were recorded with a global positioning system (GPS) unit in NAD83 decimal degree format. Literature research provided data on underground development, which was verified in the field when possible.

Soil samples from dumps or tailings were taken from subsurface material and double bagged in polyethylene. Chain of custody was maintained.

Soil samples were analyzed for the metals listed in this report by inductively coupled plasma/mass spectrometry (ICP/MS) following USEPA Method 6010. Holding times for the metals of interest were observed.

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

Conversion formulae are given in WAC 173-201A at
http://www.ecy.wa.gov/pubs/wac173201a.pdf.
Chronic standard in micrograms/liter (μg/L); – – –, no data.

Sample location	Hardness (mg/L)	Cd (μg/L)	Cu (μg/L)	Pb (μg/L)	Zn (μg/L)
seep at pond below No. 5 portal	2	0.03	– – –	0.013	2.11

Appendix C. Underground sampling

Data from Landress (1982). opt, ounces/ton; ppb, parts/billion; ppm, parts/million. *Note:* 1 opt gold = 34,300 ppb.

Level	Au (opt)	Au (ppb)	Ag (ppm)	As (ppm)	Sample length (ft)	Description
4	0.0029	100	9	125	20	silica/pyrite stockwork breccia
4	0.0036	125	1	95	20	silica/pyrite stockwork breccia
4	0.0074	255	13	110	20	silica/pyrite stockwork breccia
4	0.0074	260	2	190	20	silica/pyrite stockwork breccia
4	0.0130	450	2	100	20	silica/pyrite stockwork breccia
4	0.009	310	2	94	20	silica/pyrite stockwork breccia
4	0.006	215	2	75	20	silica/pyrite stockwork breccia
4	0.036	1250	4	135	10	silica/pyrite stockwork breccia
4	0.102	3500	45	300	20	silica/pyrite stockwork breccia
4	0.027	950	23	195	10	silica/pyrite stockwork breccia
4	1.200	41,000	9	260	10	silica/pyrite stockwork breccia
4	0.201	6900	2	130	10	silica/pyrite stockwork breccia
4	0.020	700	2	155	20	along contact between N20W hanging wall fault and silica/pyrite stockwork
4	0.052	1800	1	97	20	along contact between N20W hanging wall fault and silica/pyrite stockwork
4	0.004	150	1	135	20	along contact between N20W hanging wall fault and silica/pyrite stockwork
4	0.023	775	1	135	20	along contact between N20W hanging wall fault and silica/pyrite stockwork
4	0.067	225	1	185	20	along contact between N20W hanging wall fault and silica/pyrite stockwork
4	0.007	245	2	165	20	along contact between N20W hanging wall fault and silica/pyrite stockwork
4	0.005	160	1	130	20	along contact between N20W hanging wall fault and silica/pyrite stockwork
4	0.004	150	1	145	20	along contact between N20W hanging wall fault and silica/pyrite stockwork
4	0.009	300	1	70	20	along contact between N20W hanging wall fault and silica/pyrite stockwork
4	0.007	230	2	107	10	massive silica stockwork and breccia; drift N80E
4	0.021	725	2	116	10	massive silica stockwork and breccia; drift N80E
4	0.007	235	1	97	10	massive silica stockwork and breccia; drift N80E
4	0.006	220	1	88	10	pyrite and biotite
4	0.005	170	1	67	10	massive silica stockwork
4	0.001	55	1	83	10	massive silica stockwork
4	0.001	55	1	140	10	massive silica stockwork
4	0.004	140	1	97	10	weakly bedded sediments/strong pyrite/andesitic tuff
4	0.002	65	1	90	10	weakly bedded sediments/strong pyrite/andesitic tuff
4	0.001	40	1	130	10	weakly bedded sediments/strong pyrite/andesitic tuff
5	0.022	750	3	135	20	silica stockwork veins/ breccia
5	0.175	6000	4	170	60	silica stockwork veins; strongly pyritic
5	0.344	11,800	6	160	20	silica stockwork veins; strongly pyritic
5	0.014	495	2	75	10	silica stockwork veins; strongly pyritic
5	0.031	1050	4	500	10	silica stockwork veins; strongly pyritic
5	0.046	1575	6	470	10	silica stockwork veins; strongly pyritic
5	0.072	2475	4	290	10	silica stockwork veins; strongly pyritic

5	0.077	2625	47	300	10	along hanging wall N35W fault/shear zone; strong pyrite, calcite, silica on contact
5	0.040	1350	1	75	10	along hanging wall N35W fault/shear zone; strong pyrite, calcite, silica on contact
5	0.002	70	2	200	25	doghole drift @ NW extent of No. 5 level; very strong pyrite
5	0.001	35	2	175	25	doghole drift @ NW extent of No. 5 level; very strong pyrite