STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS

July 1982

This is a preliminary publication of the Alaska Division of Geological and Geophysical Surveys and has not received final editing and review. The author will appreciate candid comments on the accuracy of the data and will welcome suggestions to improve the report.

Alaska Open-file Report 157

GEOLOGY OF THE CLIPPER GOLD MINE, FAIRBANKS MINING DISTRICT, ALASKA

by

T.K. Bundtzen, M.S. Robinson, J.T. Kline, and M.A. Albanese

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ABSTRACT

Mineralization in the Clipper Gold Mine consists of auriferous quartz-sulfide zones along the north-northwest-trending, nearly vertical fracture that cuts foliation and compositional banding in polymetamorphic schist and quartzite. The Clipper vein fault has been traced underground for approximately 650 ft and is open ended to the north. Seven cross-cutting faults striking N. 50°-85° E. and dipping 35°-65° N. laterally displace the vein faults from 2 to 11 ft. The Clipper vein varies from 1 to 24 in. wide; auriferous silica-sulfide-sulfosalt deposition was apparently controlled by late-stage tensional flexures along the fracture system and by the competency of host rocks.

INTRODUCTION

This prospect examination is part of a continuing study of ore deposits in the Fairbanks Mining District. Studies by Bundtzen and Kline (1981), Conwell (in preparation), Robinson (1981), Robinson and Bundtzen (in preparation), and Hall (in preparation) summarize the geologic features in the Grant Gold Mine, the Yellow Pup tungsten deposit on Gilmore Dome, the Scrafford antimony lode at the head of Treasure Creek and other deposits.

The authors spent 7 person-days mapping approximately 800 ft of underground workings at the Clipper Gold Mine, 8 mi west of Fairbanks, on the south flank of Ester Dome at the 1100 ft elevation near the head of Eva Creek, SW¼ sec. 32, T. 1 N., R. 2 W., Fairbanks Meridian (pl. 1). A brunton compass-tape traverse at a scale of 1 in. = 10 ft was the principal survey method. Magnetic errors caused by underground steel were minimized by numerous back sightings, but these corrections may not account for all magnetic disruption. Field investigations of host rocks and vein material were augmented with thin-section and cut-slab examination. Fire assays of channel samples were provided by the DGGS Minerals Laboratory (table 1).

HISTORY OF THE PROPERTY

Little published information is available for the deposit, and most historical information was derived from conversations with G.P. Lounsbury of Fairbanks, the present mine owner. The Clipper gold vein was one of the last auriferous lode deposits discovered on Ester Dome. Initial development work dates back to 1927. Investigations by Hill (1933) and Pilgrim (1931, 1932, 1933) indicate that by 1932, a 235- to 250-ft-long drift explored a thin, 1- to 8-in.-thick, steeply dipping vein trending N. 10°-15° E. It is unclear whether this early work constitutes some of the present workings or is part of older caved workings on the hillside about 60 vertical ft above the present portal. No record of production exists through 1932. Reed (1938) reported

Table 1. Channel-sample assay results, Clipper Gold Mine, Fairbanks District, Alaska
Analyses by DGGS Minerals Laboratory

Field number	Cu (ppm)	Pb (ppm)	Zn (ppm)	Au (oz/ton)	Ag (oz/ton)	Sb (ppm)	Hg (ppm)	Remarks
81MR1	67	79	28	0.05	0.12	66	60	18 in. channel, splayed vein
81MR2	121	18	50	0.04	0.60	23	-	24 in. channel, massive vein
81MR3	93	10	31	0.01	0.20	14	-	8 in. channel, NE vein-fault gouge
0269	104	440	17	0.71	0.80	2920	-	14 in. channel, visible gold in footwall; disseminated sulfides
0270	127	41	23	0.34	0.08	570	-	10 in. channel, massive quartz, with Mn stain; visible gold
0271	35	32	16	0.03	0.03	212	-	8 in. channel of footwall schist
0272	114	250	18	4.39	2.09	373	-	6 in. channel, vein pinches and swells
82BT3	112	5	23	0.05	0.40	18	-	11 in. channel, multiple splay on west side of drift
82BT2	120	15	36	0.08	0.70	29	-	10 in. channel, main vein
0274	101	470	69	3.04	0.93	251	-	12 in. channel, massive quartz with stibnite selvage
82BT6	93	19	25	0.02	0.02	14	-	14 in. channel, no sulfides
82BT7	119	297	34	0.02	0.03	81	-	12 in. channel, no sulfides
82BT8	-	-	-	26.09	7.87	-	-	3 in. channel, in winze; 5% Sb_2S_3
82BT9	-	-	-	0.32	0.07	-	-	4 in. channel, 2 splays

- = not analyzed

that 19 tons and 25 tons of ore averaging about 0.8 oz/ton gold were milled in 1937 and 1938, respectively. Killeen and Mertie (1951) describe a massive stibnite kidney 'midway along a 500-ft-long winding tunnel' at the property, but mention no production of either antimony or gold from the deposit.

According to G.P. Lounsbury, the principal productive years were 1937-42, when approximately 1,400 oz of gold worth $50,000 were recovered from an unknown amount of high-grade, hand-sorted ore. His father, Lloyd Lounsbury, processed the ore at the mine site using a Blake jaw crusher and a 10 ton/day Straub ball mill. Stope volume estimates and channel-sample assay data from this study support this level of production. A minimum of 1200 tons of waste rock and ore have been removed from six small, chimney-like stopes, a larger stoped-vein section, and a small winze. 'Ore-grade' assays appear to be spotty; however, the average content of 12 channel samples in the mine (table 1) is 0.78 oz/ton and selected zones run much higher.

Sporadic production and development of the lode have occurred since World War II. In the early 1960s, Lamont-Doherty Observatory installed a seismograph station in the Clipper workings to monitor nuclear detonations in the USSR; this equipment has since been removed. During the late 1960s, guided tours of the mine and mill offered tourists and the general public a glimpse of historical lode-gold-mining activities in the Fairbanks area.

Since the late 1970s, G.P. Lounsbury has sunk a 9 ft by 22 ft by 4 ft winze about 120 ft from the portal and recovered free-milling gold ore from exceptionally rich vein material. All mining by present and past operators involved simple hand methods and a minimal labor force.

BEDROCK DESCRIPTION

Bedrock units in the Ester Dome area are part of a large regional polymetamorphic terrane in Interior Alaska and Canada variously named the Birch Creek Schist (Mertie, 1937), the Yukon-Tanana complex (Foster and others, 1973), the Yukon crystalline terrane (Templeman-Kluit, 1976), and more recently the Fairbanks schist and Cleary sequence (Smith and others, 1981) of early Paleozoic or Precambrian age. The Fairbanks schist occurs throughout the Fairbanks District and is characterized by volumetrically important amounts of muscovite-quartz schist, biotite-muscovite schist, and porphyroblastic quartzite. Four lithologic units mapped in the Clipper underground workings and assigned to this informal rock package include a chlorite-muscovite schist, a quartz-mica schist with quartzite bands, a porphyroblastic feldspathic schist, and a bleached, garnetiferous biotite-muscovite schist. The quartzose varieties form blocky, resistant walls in mine workings. Because the more micaceous varieties form irregular walls, cavities, and open spaces, more timbering was apparently necessary in stopes in these units.

In thin section, the schists are composed of up to 50 percent white mica, 30-65 percent interlocking quartz grains 0.3 to 3 mm long (with variable amounts of pleochroic green to brown biotite), minor albitized plagioclase, books or stacks of chlorite, and very minor to trace amounts of garnet, tourmaline, sphene, and zoisite inclusions. Porphyroblasts of garnet less than 1 mm in diameter have been largely altered to chlorite, leucoxene, and other opaque minerals. In the five thin sections examined, mineral assemblages in disequilibrium are recognizable. The presence of biotite, plagioclase, garnet, white mica, chlorite, zoisite, tourmaline, quartz, and sphene suggests that a prograde, upper green-schist-facies metamorphism (garnet + plagioclase + biotite + white mica) has been overprinted by a lower grade metamorphic event (chlorite + albite + zoisite). These observations are consistent with other district-wide petrologic data summarized by Forbes and Weber (in preparation).

The lithologies exposed in the Clipper Mine contain mineral assemblages and textures that contrast with the Cleary sequence that hosts many of the area's known lode deposits (Smith and others, 1981).

STRUCTURE AND VEIN EMPLACEMENT

At least two periods of penetrative deformation have affected bedrock lithologies in the district (Hall, 1982). In the Clipper workings, an early crenulation-kink band deformation (f_1) consistently records a north-west-southeast stress field that plunges to the northeast. During a later f_2 event, bedrock units were gently folded into synclines and anticlines with amplitudes ranging from 6 to 50 ft. A few rock units are repeated on the limbs of gentle fold structures (underground), but there is a gradual climb up-section to the north. Apparent bedrock thickness exposed underground is about 45 ft.

A major north-northwest trending, steeply dipping, joint-fracture set cuts the layered lithologies underground. These conspicuous structural features are parallel to a majority of ribs in the drift and stopes and served as primary channels for ore fluids. A few prominent, steeply dipping joints and fractures strike N. 25°-35° W. but are apparently unmineralized.

The Clipper vein fault strikes N. 5° E. to N. 25° W. and generally trends N. 5°-10° W., almost normal to regional structure. The mineralized shears dip from 65° SW. to vertical and probably average 75° SW.; only rarely does the vein-fault system dip steeply northeast. Locally, slickensided vein walls, brecciated quartz, and minor gouge indicate that structural readjustment followed vein formation, but in general, the auriferous silica injections have sealed to the fault zones. The Irishman vein in the Grant Mine 1-1/2 miles northwest of the Clipper property was emplaced in similar fashion (Bundtzen and Kline, 1981). However, both contrast with other veins in the district such as the Odea breccia zone (the main ore control in the Grant workings), the Scrafford deposit (Hall, in preparation; Robinson and Bundtzen, in preparation), and the Ryan lode (Hill, 1933), where recurrent movement along the fault zones has resulted in heavily oxidized, broken and brecciated quartz, sulfides, schist, and extensive mylonite clay gouge.

The Clipper vein system south of the seismograph station (pl. 1) consists of thin auriferous veinlets 1 to 3 in. wide in 2 to 4 ft wide, horse-like stockwork zones (fig. 1). Within these zones, tedious handsorting of auriferous quartz from barren wallrock yielded some rather spectacular examples of high-grade gold ore. A 3-in. channel cut from the Bonanza winze assayed 26.09 oz/ton gold (table 1). Waste-to-ore ratios, however, are high in the measured stopes and average 10:1, or greater.

Fig. 1. Clipper vein system exposed in crosscut approximately 45 ft from portal. A horse of schist and quartzite 4 to 6 ft wide contains stockwork-like auriferous quartz veinlets 1 to 3 in. wide. Free gold was observed in a foot-wall veinlet.

North of the seismograph station, the vein occupies a significantly wider 4 to 24 in. zone in single or rarely multiple splays (fig. 2). Assay results from eight channels along two major sections averaged 0.87 oz/ton gold over an average 12-in. width. Although ore grades tend to be lower than the 'chimney-style' stockwork ore bodies to the south, locally high-grade zones of up to 4.39 oz/ton gold were encountered. Waste-ore ratios averaged about 4:1 in the northern mine sections.

Winze and stope orientations suggest that the auriferous vein sections fill tensional flexures in the fracture system. All seven small, chimney-like stopes mapped underground occupy 8° to 15° horizontal bends in the fracture sets. In the 65-ton stope above the Bonanza winze, the veins radically change dip from about 45° in the stope roof to about 78° in the main drift level, suggestive of vertical flexure control. In the larger stoped vein sections north of the seismograph station, the Clipper system gradually changes strike from N. 10° W. to N. 25° W.; several sinuous flexures occur in this larger bend.

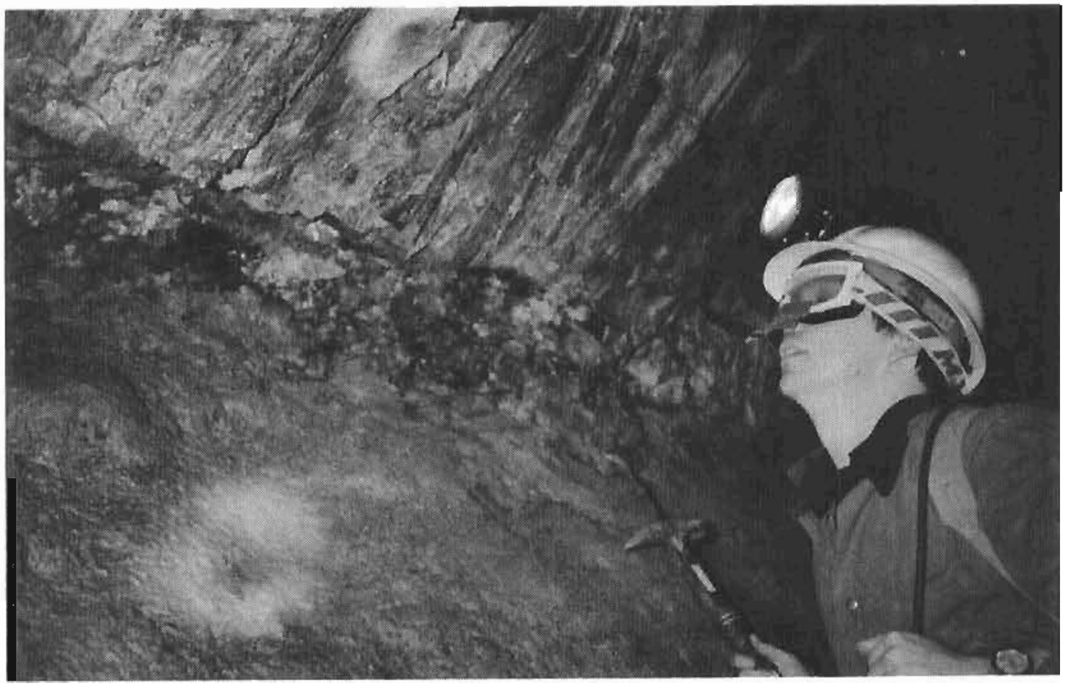

Fig. 2. Clipper vein system near channel-sample location 82BT3 (pl. 1). Vein varies from 8 to 16 in. thick and averages 10 in. wide at this location.

Both the small and large flexures in the fracture system are dilatant zones where auriferous solutions apparently migrated into favorable depositional sites. Similar flexures may control pipe-like or chimney-like ore chutes in the Irishman vein system and the Discovery ore body of the Odea breccia zone in the Grant Mine (Bundtzen and Kline, 1981; Murton and Bundtzen, 1981).

Another apparent control of ore deposition is the relative competency of host lithologies. Typically, the Clipper vein pinches and swells over short distances. In micaceous-rich lithologies near the end of the drift and in the 520-ton stope, the vein splits and recombines, resulting in inclusions of chlorite-muscovite schist. The greatest vein widths are crudely confined to more massive quartzose lithologies. Additionally, the preponderance of stoped areas in quartzose lithologies seems to indicate that tensional stress was relieved in these rocks by brittle deformation, whereas micaceous units were deformed more plastically. However, two of the production stopes south of the seismograph station contain chlorite-muscovite schist wallrock. Hence, lithologic control for ore deposition is not as strongly expressed in the Clipper mine as in the Grant, Scrafford, or other properties under investigation.

The last observable structural event in the Clipper mine is marked by a series of faults that trend N. 50°-85° E. and dip 35°-55° N. These faults contain extensive limonitically stained gouge and mylonite zones up to 6 in. in width and offset the Clipper vein system laterally from 2 to 11 ft in at least six places. The actual sense of motion along these fault planes involves complex vertical and lateral components, and true fault-plane solutions were not determined. One major crosscutting feature about 40 ft north of the seismograph station offsets the main vein left laterally 8 ft, but drag folding indicates low-angle reverse movement as well. None of the crosscutting features result in large offsets.

The pattern of north-northwest-trending, high-angle, auriferous vein faults offset by apparently barren northeast to east-west-striking lower angle fractures markedly contrasts with ore controls in the Grant Mine workings (Bundtzen and Kline, 1981). There, the primary ore-bearing fractures strike northeasterly and are cut by barren, high-angle, north-northwest-trending shear zones. Obviously, a single structural model will not adequately explain ore deposition in the Fairbanks district -- even for deposits 1-1/2 miles away from each other.

ORE MINERALOGY AND HYDROTHERMAL ALTERATION

The mineralogy of the Clipper vein system is not complex. The deposit is a hydrothermal fissure vein that shows no lateral metal zonation; insufficient control is available to determine whether vertical changes exist. Massive fractured to euhedral crystalline quartz constitutes greater than 95 percent of the vein material. Wall-rock silicification extending at least 10 in. into both footwall and hanging-wall portions of the veins was followed by at least two stages of silica vein injection; the latter event accompanied free gold and disseminated to rarely massive arsenopyrite, stibnite, boulangerite, and tetrahedrite (?). In one specimen, free gold is intimately associated with fine needles of boulangerite that apparently intrude arsenopyrite. Killeen and Mertie (1951) report that 'midway' along the Clipper drift a lens of stibnite 2 to 12 in. thick, 3 ft wide, and 15 to 20 ft long was exposed in the vein fault. A sample of selected ore from this kidney assayed 56.58 percent antimony. We observed faint stibnite selvages in the Clipper workings, and massive stibnite pods up to 2 in. long in Bonanza winze, but did not locate or recognize this sulfide pod. It was possibly removed by Lloyd Lounsbury during productive years.

Free gold observed in cut-slab and hand specimens occurs as small angular segregations or thin plates averaging 0.1 to 1 mm in length. Selected samples of extremely rich ore supplied by G.P. Lounsbury show masses of free gold up to 1/4 in. diameter. One gold fineness determination from material collected near station 82BT9 yielded a value of 768, with silver as the major impurity. No gold was observed in the sulfides or sulfosalts, but channel-sample assay data suggests a strong association with anomalous lead and antimony (table 1). Arsenic values were not determined. Accessible vein exposures were examined with a long- and short-wave ultraviolet light, but only traces of scheelite were recognized. Rich channel-sample assay areas were conspicuously stained with black iron or manganese oxides.

Temperatures of formation are unknown, but preliminary unpublished fluid-inclusion determinations (M.S. Robinson, unpublished) of nearby Grant mine ore from several silica stages show primary two-phase, fluid-inclusion-homogenization temperatures ranging from 150°-340° C, with a mean value of about 260°-270° C. However, we are still unsure of the temperature of the 'ore-stage' fluids in the Grant deposits.

ECONOMIC POTENTIAL

Mining at the Clipper Gold Mine has been carried on at a small scale, even compared to other deposits in the district. However, the ground is competent and requires minimal structural support. Inexpensive stope and backfill methods of mining are applicable. Two types of ore chutes have been mined:

1) Small, chimney-shaped, stockwork-style veinlets within schist horses 2 to 4 ft wide (near mine portal);

2) Wider, auriferous quartz-sulfide zones in single or rarely multiple splayed fractures (at the north end of the drift).

The former deposits contain very rich gold-bearing veinlets, lack large 'ore' tonnages, and have very high waste-to-ore ratios. Such stopes have yielded high-grade mill ore at small scales of mining. Examination of the two crosscuts south of 'Bonanza' winze indicates that the Clipper structure is not directly in alignment. This implies a possible flexure between the two crosscut ends; such a section may contain additional prospective ore chutes.

The best underground tonnage potential lies in the north workings (pl. 1). It is unclear how far the present stopes lie below the older caved workings worked prior to the late 1930s. If the older workings are approximately 60 vertical ft above the portal, then another 35 ft of vein material remain above the two fault-separated stopes, about the same amount of ore and waste as was previously removed (about 700 tons). However, several development raises must be driven to confirm such a reserve. Extending the drift northward along the main level could block out additional reserves. Faults offsetting the vein structure are expected, but the amount of offset on all known structures is small.

Ground geophysical techniques may prove successful in locating or extending the Clipper structure laterally and vertically. Because underground workings parallel a north-trending headward gully of Eva Creek, the mine is notably wet. The Clipper vein fault appears to be water saturated and may be detected with conductivity surveys.

ACKNOWLEDGMENTS

We thank T.E. Smith for editorial review and comment, G.P. Lounsbury for excellent cooperation and mine discussions, and D.N. Solie for assistance underground. DGGS Minerals Laboratory personnel provided timely fire assays of channel samples. Funding was provided by the Fairbanks North Star Borough under the Minerals Appraisal of Interior Mining Districts study.

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