TEXTURAL CHARACTERISTICS OF THE VENUS VEIN AND IMPLICATIONS FOR ORE SHOOT DISTRIBUTION

Lori Walton
Department of Geology
University of Alberta
Edmonton, Alberta

WALTON, L., 1986. Textural characteristics of the Venus Vein and implications for ore shoot distribution; in Yukon Geology, Vol. 1; Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 67-71.

INTRODUCTION

The Venus Mine is a gold-silver-lead-zinc quartz vein, 120 km south of Whitehorse, in Upper Cretaceous volcanic rocks known as the Montana Mountain volcanic complex (Roots, 1982).

Gold at Venus is concentrated in steeply pitching ore shoots of varying size, shape and continuity. The purpose of this study is to develop a model explaining the distribution of gold by determining the paragenetic sequence of events and physio-chemical controls operating during ore deposition.

This paper is based on field observations made during a six week period of systematic sampling along each of the five levels in the mine. The emphasis is on describing various mineralogical, textural and structural features, and discussing their controls on ore shoot distribution.

The mine is situated on a steep, southeast facing slope overlooking Windy Arm of Tagish Lake, at latitude 60°01'N and longitude 134°37'W on N.T.S. mapsheet 105 D 2 (Fig. 1). The volcanic complex encompasses an elevated region roughly 8 by 12 km in area, containing both gently dipping plateaus and severe topography. Access to the mine is by Klondike Highway 2.

Intermittent mining and exploration of the deposit has been carried out since the early 1900's, when mineralized quartz veins were first discovered on Montana Mountain. In 1912, mining operations shut down, and since then exploration and development of Venus has been sporadic. The current owner is United Keno Hill Mines Ltd., who conducted an extensive underground and surface exploration program during the summer of 1984. Ore reserve figures for Venus indicate 70,460 tonnes (77,600 tons) of 9.3 g/t Au (0.27 oz/ton), 246.8 g/t Ag (7.20 oz/ton), 2.11% Pb and 1.38% Zn. These figures have not yet been updated using 1984 exploration results.

The Whitehorse map sheet was mapped by Wheeler (1961). C. Roots (1981) described the geological setting of gold-silver veins on Montana Mountain and the geology of Montana Mountain (1982). K. Ralfs (1975) from U.B.C. did a BSc thesis on Venus, and J. Morin included Venus in his study of element zoning in Yukon gold-silver veins (1981). T. Stubens from U.B.C. is currently studying the geostatistics of the Venus vein system.

For the purpose of this study, "Venus Vein" will refer only to that portion of the vein sampled underground, unless specified otherwise.

REGIONAL GEOLOGY

The Venus Mine is located between the western dip of the Whitehorse Trough and the eastern edge of the Coast Crystalline Complex (Fig. 1). The Montana Mountain volcanic complex was probably generated during the late stages of a Mesozoic collision between the North American craton and allochthonous island arc derived volcanic and sedimentary rocks (Roots, 1982).

LOCAL GEOLOGY

The geology of Montana Mountain was mapped by C. Roots (1982). A simplified version of his geology map is shown in Figure 1.

Upper Paleozoic Cache Creek Group rocks border the northeast part of the complex and outcrop across Windy Arm. They consist of amphibolites interlayed with chert and limestone.

Lower Jurassic Laberge Group sedimentary rocks occur along the west boundary of the volcanic complex and separate older Cache Creek Group rocks from younger granites on the east side of the complex.

Volcanic rocks on Montana Mountain are now considered by Roots (1982) to be equivalent to Mt. Nansen Group volcanic rocks in south central Yukon. Mt. Nansen Group volcanic rocks belong to the Sloko province of Late Cretaceous to Early Tertiary volcanic rocks distributed over 500 km along the border between the Coast Crystalline Complex and the Intermontane Belt.

The Montana Mountain volcanic complex consists of lower greenschist facies, andestic to dacitic flows, and breccias. Detailed descriptions of the various volcanic units are given by Roots (1982). In the vicinity of the mine, a felsic orange weathering quartz latite to trachyte dyke intrudes and crosscuts the gently deformed succession of volcanic flow rocks.

Granitic to granodioritic plutons intrude the north part of the complex. Since erosion has exposed the pluton in this area, it is inferred to lie at shallow depths below the rest of the complex (Roots, 1982).

Roots (1982), studied the structural relations of the various units and suggested that upwards arching of the volcanic rocks caused by intrusion of granitic magma opened fissures and faults in a semi-radial pattern. Felsic dykes then intruded and filled these openings. Venus partially follows a zone of structural weakness marked by one of these dykes.

Venus has a known strike length on surface of 2 km, with a strike orientation of N20°E, which changes to N65°E in the southern part of the mine. It has an average dip of 30-35°NW into the hill and a known vertical depth of 390 m. It has an average width of 0.8 m to 1.0 m, but can vary up to 3.0 m. The five main levels in the mine follow the vein at elevations 2600, 2650, 2700, 2800 and 2850 feet (792, 808, 823, 853, and 869 metres).

FIELD OBSERVATIONS

Physcial characteristics of Venus resemble those of a fissure opened up by movement along slightly curved planar surfaces. The undulatory nature of the vein reflects this movement. Due to the absence of marker beds, it is difficult to determine how much movement has taken place.

The vein exhibits both open space filling and replacement textures. It is frequently separated from the hanging wall and footwall by a pervasive layer of clay gouge. In other places, the vein-wallrock boundary is poorly defined due to replacement of wallrock by vein material. In the southern part of the mine, parallel, quartz-filled veins interbanded with altered host rock are common in the hanging wall and footwall of the main vein. The veins are commonly connected by a network of barren quartz stringers.

The gangue material in the vein is quartz, which ranges from milky white grains 1 mm in size, up to well-developed euhedral crystals 15 cm long. The larger crystals are frequently developed in single and multiple layers of comb structures, and in vugs located near the center of the vein. Vein quartz is slightly finer grained on upper levels than on lower levels.

The ore assemblage is relatively simple. Four sulphides comprise over 95% of the ore minerals. In order of decreasing abundance, these are arsenopyrite, pyrite, galena and sphalerite. Arsenopyrite-pyrite-quartz is the most common assemblage.

Pyrargyrite, tetrahedrite, realgar and orpiment are locally visible underground. Chalcopyrite, diaphorite, jamesonite and electrum have been reported in polished section (K. Ralfs, 1975, D. Prince, pers. comm.).

Limonite, yukonite, scorodite and covellite are found in the supergene weathering zone and on surface. Galena and arsenopyrite are the most common sulphides found in surface exposures

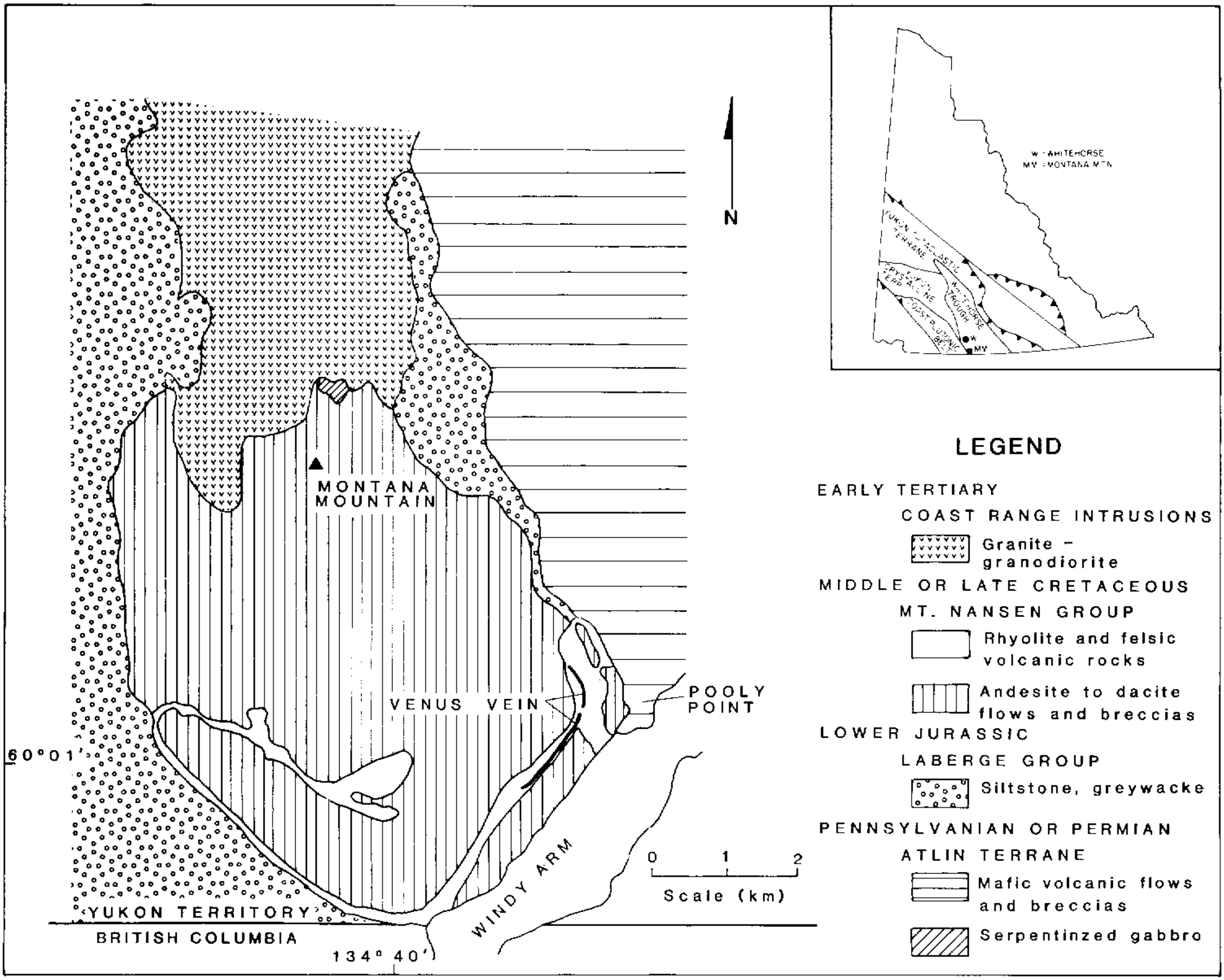

Figure 1. Location map and geology of Montana Mountain (after Roots, 1982).

of the vein.

Crude bands of arsenopyrite and pyrite concentrated on outer edges of the vein are prevalent. In some places, it is the center of the vein which is sulphide rich, with barren quartz concentrated on outer edges. Sulphide bands range in width from 1 cm to over 1 m, and can be monomineralic or consist of narrow alternating bands of arsenopyrite and pyrite. On upper levels, arsenopyrite has developed locally into comb structures, with long bladed crystals growing perpendicular to the walls. Single grains, and disseminations of arsenopyrite and pyrite are common in altered host rock near the vein.

Galena and sphalerite also occur in bands, but more frequently fill interstitial spaces between euhedral quartz crystals towards the center of the vein, and locally replace arsenopyrite and pyrite.

Thick sulphide bands are more common on upper levels where sulphides constitute 30 to 60% of the vein material, as opposed to lower levels which usually contain less than 15% sulphides. Most banding in the vein is crude and massive, except for thin streaks of sulphides (usually arsenopyrite) or host rock smeared out in ribbon textures, concentrated towards the center of the vein. Large scale banding is usually asymmetrical. Crustiform mirror image banding is more common on a smaller scale in individual bands, thin stringers or veinlets.

Crosscutting bands generated by multiple fluid phases and replacement processes, indicate sphalerite and galena were deposited later than arsenopyrite and pyrite. Some parts of the vein contain all four major sulphides but lack evidence of multiple fluid injections.

Venus has many features which suggest there has been repeated movement along the vein system. These features include:

1) slickensides on vein walls;
2) clay gouge separating the vein from the hanging wall and footwall;
3) asymetric banding;
4) multiple layers of comb quartz;
5) one-sided comb structures;
6) quartz filled sulphide fractures; and
7) ribbon textures in the vein walls.

Intercalated wallrock in the vein, either as bands or unsupported angular fragments, is common. Where the bands of host rock are thin and clayey, it is possible that reopening of the fissure tore loose slabs of wallrock which were incorporated into the vein and smeared by later movement. Thick banding between wallrock and quartz could be caused by replacement of wallrock or by secondary quartz filled fissures close to the main vein.

Many of the features described above are illustrated in Figures 2, 3 and 4.

ORE SHOOTS

Ore shoots at Venus are defined solely on the basis of assay information, since the gold is microscopic. For mining purposes, the assay information is taken to a 1.5 m (5 ft) mining width, reworked, then plotted as mineral blocks. Each block is assigned an average grade, tonnage and value. Correlation between blocks of

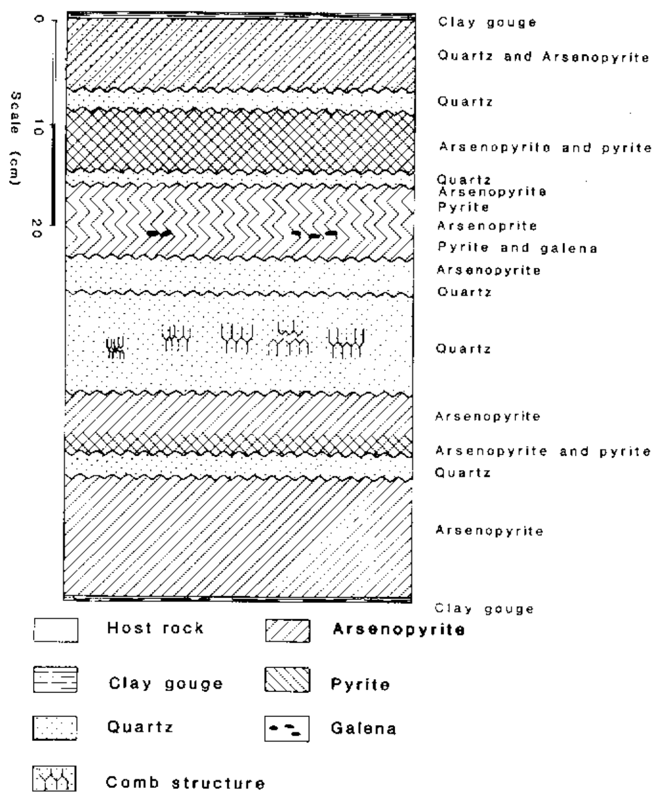

Figure 2. Section of vein from 2850 level showing asymetrical sulphide bands concentrated on the outer edges of the vein.

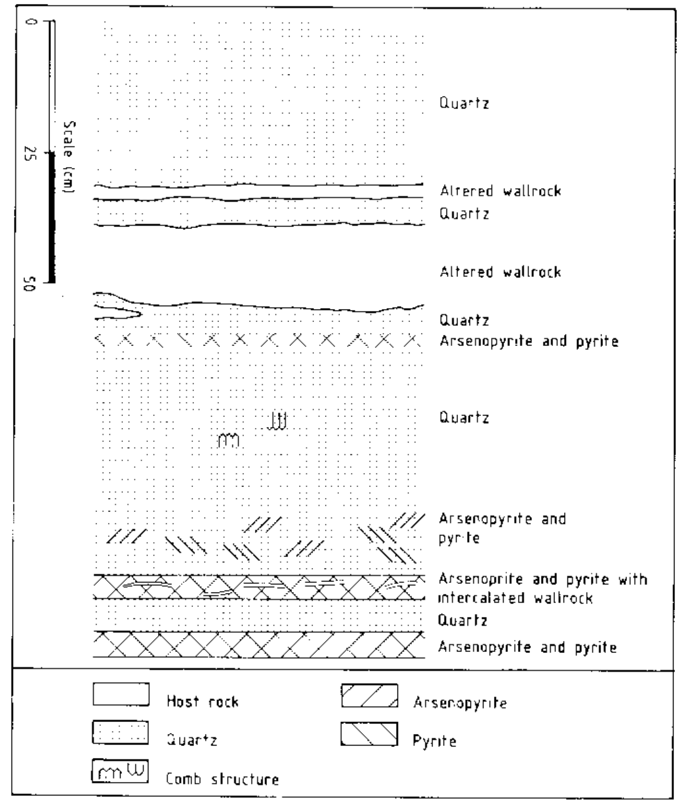

Figure 3. Section of vein from 2700 level showing a quartz core with bands of sulphides and altered wallrock.

equal value roughly outline ore shoot location.

Like many other deposits of this type, ore shoots at Venus are concentrated in columnar, steeply-pitching bodies of varying size, shape and continuity. The shoots comprise 20% of the vein system and have a dip length to strike length ratio of 10:1 to 5:1. Some of the more persistent shoots extend through all five levels in the mine. They are more regularly spaced in the northern part of the mine than in the south.

Many shoots are associated with wide portions of the vein. These shoots typically contain a high percentage of all four major sulphides. If a vein section displays massive bands of arsenopyrite-pyrite and later injections of galena-sphalerite, there is a good possibility it contains high grade ore. However, sections of vein displaying typical quartz-arsenopyrite-pyrite could also be high grade, and look identical to low grade portions on either side.

Assay information across vein segments show a distinct correlation between gold, arsenopyrite and pyrite. This is illustrated in Figure 4. Silver is carried mainly by galena. Gold increases with elevation, which is reflected in the greater amount of massive arsenopyrite-pyrite mineralization relative to quartz gangue on the upper levels.

DISCUSSION

Underground observations indicate Venus formed from hydrothermal solutions by both open space filling and replacement processes. Quartz depostion was ubiquitous throughout the sequence. Arsenopyrite and pyrite occur underground in bands near outer edges of the vein, implying early precipitation.

Repeated movement along curved planar surfaces opened more space for sulphide deposition. Wallrock slabs and fragments occasionally dropped from the wall to be incorporated in the vein and smeared as a result of later movement. As mineral precipitation continued, galena and sphalerite replaced arsenopyrite and pyrite, and precipitated in open spaces and vugs. At some point in the sequence, gold was introduced and deposited in the wider portions of the vein and in other areas.

Although precipitation of gold was probably controlled by physio-chemical conditions operating during ore deposition, the mechanism for concentration of gold into ore shoots is unknown. In many vein systems of this type, there is no known structural control for occurrence of ore shoots along the vein. The presence of other features may complicate attempts to develop a model for ore shoot distribution based solely on structure. For instance, intense clay alteration is associated with a strong ore shoot in the northern part of the mine, and is found locally in other areas along the vein.

Recurrent opening and closing of the fissure along warped planar surfaces generated available open spaces for movement of gold-rich fluid. The larger the opening, the easier was fluid movement. Many ore shoots are contained in wider sections of the vein. Thinner portions of the vein would fill quickly and block fluid movement, creating localized stagnant areas. There may be a relation between dip and gold grade at Venus (D. Prince, pers. comm.). In this case, it is possible that normal or reverse faulting would create steep or flat open spaces (depending on fault type) which would localize gold-rich fluids.

If there is a structural control on ore shoot occurrence at Venus, it is most likely that the ore is concentrated in shoots by physical fluid behavior and available open space during deposition of gold-bearing fluids.

FUTURE WORK

Field study provided valuable information on the mineralogy, texture, structure and alteration of the Venus deposit. Current laboratory work includes fluid inclusion research, polished and thin section petrography and X-ray diffraction analysis of wallrock alteration. Consolidation of research data should generate a useful model defining controls on gold distribution in the Venus Vein and other similar vein systems.

ACKNOWLEDGEMENTS

This project was supported by Exploration and Geological Services Division, Department of Indian Affairs and Northern Development in Whitehorse, Yukon. I am grateful to J. Morin for suggesting the topic. I am especially grateful to Dennis Prince and the rest of the United Keno Hill Mines Ltd. staff who provided addi-

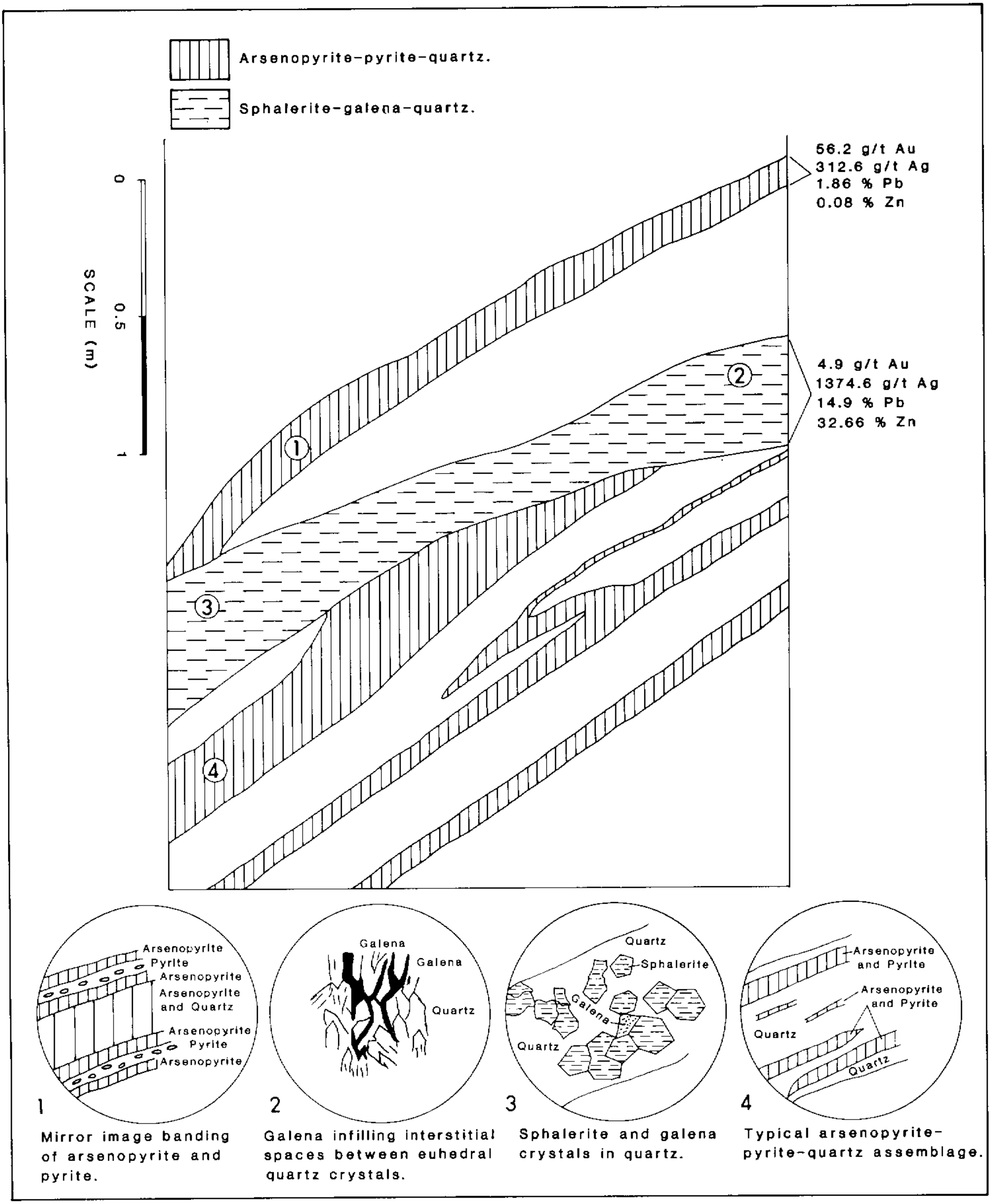

Figure 4. 2850 level north face. Section of vein in high grade ore shoot showing arenopyrite-pyrite and sphalerite-galena rich phases.

tional support, encouragement and access to the mine. I would also like to thank Teresa Potter and Donna Hudgeon for their assistance in the field. The author is a graduate student at the University of Alberta under the supervision of Dr. B. Nesbitt.

REFERENCES

MORIN, J., 1981. Element distribution in Yukon gold-silver deposits; in Yukon Geology and Exploration 1979-80, Dept. Ind. Aff. Nor. Dev., Whitehorse, Yukon, p. 68-84.

RALFS, K., 1975. A study of the mineralogy, paragenesis, zoning and wallrock alteration, Venus Vein, Montana Mountain, southwest Yukon; Unpublished BSc Thesis, University of British Columbia; Vancouver, B.C., 48 p.

ROOTS, C.F., 1981. Geological setting of gold-silver veins on Montana Mountain; in Yukon Geology and Exploration 1979-80; Dept. Ind. Aff. Nor. Dev., Whitehorse, Yukon, p. 116-122.

ROOTS, CLF., 1982. Geology of the Montana Mountain Area, Yukon; Unpublished MSc Thesis, Carleton University, Ottawa, Ont., 127 p.

WHEELER, J.O., 1961. Whitehorse map-area, Yukon Territory; Geol. Surv. Can., Memoir 312, 156 p.