896639

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- a rocks
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2 Combine with blast hole data to estimate grades and outline ore blocks

Recommendations

A general layout might be as follows:

1. Alteration - relative percentage (1) weak ___ (2) moderate ___ (3) strong ___.

2. Alteration: pervasive %
: vein related %

3. Plagioclase colour (1) ________
(2) ________
(3) ________

4

Debbie more to come

Recommendations

1 Mapping of orientations and frequency of mineralized fractures and veins is critical. Density controls grade; orientation controls trend and ~~plunge~~ dip; intersections of mineralized fractures sets control plunges of ore shoots.

Recommendations

2. Bornite distribution should be mapped for the obvious reason that it is more copper-rich than chalcopyrite.

3. Grade estimating should be based on mineralized fracture + vein / density and the mineralogy of each fracture set combined with blast hole assays. This approach should make correlations from bench to bench more reliable.

Recommendations

Secondary biotite replaces hornblende and coats primary biotite; only that after hornblende is recognizable by eye (crystal edges become fuzzy and the biotite occurs as fine scaly aggregates). It also fills fractures, ~~there~~ along with sulphides. Often secondary biotite is partly to wholly replaced by chlorite; textures, however, are generally preserved.

It may be important to map ~~the~~ secondary biotite alteration, particularly if Reed and Jambor's interpretation is correct and it formed during the main stage of mineralization.

Recommendations

Secondary Kfeldspar is generally vein and fracture controlled albeit much of it comprises alteration selvedges; it is ~~often~~ associated with ore minerals.

Information from this sampling program is ~~to~~ insufficient to define its controls and significance.

check notes for related vein mineralogy, etc

ALTERATION - Introduction

The general level of alteration in the rocks is highly variable and very much related to the density of mineralized fractures. Fresh-looking rocks ~~are~~ and more altered rocks lie side by side; ~~As a result generally~~ widespread pervasive alteration zones ~~than over kept~~ are not common.

Mapping should be done in blocks of say 10 or 15 m width in terms of relative percentage of weak moderate and intense plagioclase alteration.

Plagioclase alteration ~~reflects relative~~ intensity indicates the ~~activity~~ intensity of the hydrothermal activity; it may relate to ore grade.

Summary / Introduction?

Highmont

Early biotite | propylitic

potassic } Veins with Kfspar

phyllic } Flakey sericite

late propylitic

– zeolite –

– calcite –

check Reed & Sambor

Secondary biotite was evident-ly widespread. It filled fractures, replaced primary hornblende, and formed overgrowths on primary biotite (~~see also~~ Reed and Sambor, 1976). This event was early; much of the secondary biotite was subsequently chloritized and/or epidotized. Recognition now rests on textural interpretation, however, with a hand lens altered horn-blende crystals have a distinctive felted texture and grain borders are no longer sharply defined; they are finely ragged. ~~not ok~~

Its distribution ~~and~~ relation-ship, if any, to ore distribution (should be studied to define its). It seems to be most common in the ore zone and near the Gnawed Mountain dike.

Plagioclase alteration should be considered from two points of view. On one side, as ~~As~~ intensity increases grains change from glassy to completely clouded. On the other side the colors reflect the alteration mineralogy. ~~A the~~ Gray color is generally caused by clays and sericite; chalky white by kaolinite; greenish white by sericite; carbonate - epidote; olive green or pink by sericite and carbonate; and emerald green ~~salmon pink~~ by ~~zones of pink, vuggy, feldspar~~ sericite. ~~at carbonate~~

~~alteration with and epidote Hole~~

Kfeldspar is a relatively common ~~as~~ vein and alteration product. Most forms ~~occurs~~ ~~in~~ alteration fringes on veins and fractures; some is in quartz veins or quartz sericite zones. Pervasive Kfeldspar alteration is rare.

Kfeldspar is a shade of ~~has a distinct~~ pink that is distinguishable from other pink plagioclase alteration. The other alterations represent either a dusting of hematite or sericite plus carbonate alteration.

Primary Kfeldspar is interstitial and 10-15% by volume. It was destroyed in many dull olive green alteration zones.

Flakey sericite is common in better grade copper zones and present in ~~weaker~~ lower grade zones. ~~It~~ In accordance with Reed and Jambor's interpretation (1976) ~~it~~ is a good indicator mineral for ore grade material and its distribution should be carefully mapped in the deposits.

Correlation of flakey sericite with ~~and~~ molybdenite is weak, unless there is a coincident Mo – Cu high.

While it does not always constitute ore in itself, the distribution of mineralization in veins and fractures ~~both~~ associated with flakey sericite alteration more or less delineates ~~outlines~~ the orebody (Reed and Jambor, 1976; this study).

Chlorite is ubiquitous but mapping intensity (1 weak, 2 moderate, 3 pervasive) and distinguishing areas of sericite alteration of mafics ~~may~~ will be worthwhile.

Epidote occurs as an alteration product of mafics and plagioclase as well as in veins and fractures.

It is throughout the deposit but intensity varies and should be mapped. Alteration and fracture-controlled types should be distinguished from one another. The distribution of epidote and chlorite alteration shows that propylitic alteration characterizes the ore zone. This is, judging by alteration of early developed biotite, a retrogressive overprint. Peripheral propylitic alteration, however, was an early event (Reed and Jambor, 1976)

Other alteration minerals that occur are actinolite and tourmaline. Actinolite occurs ~~as~~ both in ~~a~~ fractures ~~filling~~ and replacing primary amphibole. Tourmaline is fracture controlled and is an important constituent in breccia zones (see Reed and Tambor, 1976).

Hypogene Mineral zoning
5270

Introduction

Hypogene mineral patterns are both related to the Granoed mountain dyke and fracture swarms. Perhaps permeability was the a factor. The dyke apparently acted as a heat source

Zoning patterns are subparallel to the dyke (see Reed and Jambor, 1976). Although the bornite zone is mainly in and near the dyke, ~~but~~ fingers ~~the bornite~~ extend out into the pyrite zone. These coincide with higher copper grade zones controlled by ~~along~~ northeast fracture swarms.

and heat transfer in fluids was probably the dominant heat transfer mechanism; therefore temperature distribution was probably ~~have been~~ fracture controlled.

The relative abundance of bornite relative to chalcopyrite is important in predicting grades and grade trends. The mineralogy of coexisting mineralized fractures is also important. For example, at HE11 veins with flakey sericite halos are bornite-rich and constitute ore, even though they comprise only one fracture set.

Structure copper

Highmont - Introduction

Copper contours show very clear trends that relates to several fracture directions. However, several interpretations of weaker trends are possible because overlapping patterns become diffuse. Pit mapping indicates (G. Sanford, personal communication) that average dominant trends are 025°, 040-050° and 140-150°; lesser trends are 075 and 095°.

5270 'Trends'
copper

I ~035

~060

~120 ~090

II ~035

~060

~ ~~090~~ 120 ~090

Based on Field Info

III ~025

~145

~045 Mo? ~090

~060

near dyke
Steep S dips

Fracture Sets – Cu

Grade trends on 5270 level confirm

Very strong northeasterly oriented better grade copper zones. From west to east these apparently fan slightly — from 040 to 060 in the west, to 030 to 040 centrally, and ~~to 020 to 030~~ in the east.

The pattern is strong centrally, weaker in the west and weaker still in the east, where southeast trending fractures are prominent. The southeast set trends 115 to 125 across the ~~Because the east~~ pit. It seems likely that the northeast fractures are younger; they apparently overprint the southeast set.

Adjacent to and in the Gnawed Mountain dyke grade patterns are elongated parallel to the borders of the dyke.

5270

The influence of fractures trending 140 to 150° is not ~~ob~~ evident from contoured blast hole assays — pit mapping is needed.

Copper 5310

Near the dyke on 5310 level, east-west trends predominate. ~~at for 5270 level~~ Elsewhere dominant trends are northeast and southeast, subparallel to those on 5270 level (described below).

Dips + Plunges Cu

5270 level

Adjacent to and in the Gnawed Mountain dyke grade patterns line up with the trend of the dyke.

Conclusion

Higher ~~C~~copper grades reflect strong fracturing in one direction and overlapping of two or more fracture sets. ~~Ore shoots~~ Better grade ore zone then can be expected to be in the form of dipping sheets or plunging elliptical 'pipes'. Fracture ~~pattern~~ mapping should enable trends and plunges to be predicted.

Molybdenite Distribution

Introduction

Molybdenite occurs in thick quartz veins with chalcopyrite and in fractures and veins with chalcopyrite and lesser bornite. The thick veins generally have an olive green alteration selvedge several metres in width. As at Lornex, they apparently post-date main stage mineralization. Molybdenite is not abundant in the older veins and fractures.

?

In the East pit, veins of this type strike about 030° or 060 to 080° and dip 40 to 60°, usually toward the northwest.

5270 & 5310 levels

Correlation with Copper

Molybdenite is more restricted in distribution than copper but ~~the two metals~~ better grade copper zones correlate reasonably well with zones in which molybdenum exceeds 0.016%.

Locally, particularly along the east side of the pit on 5270 level ~~local~~ molybdenum highs occur in areas with low copper concentrations. Another such area is near 111250E, 76200N on both levels. ~~Evidently, and this is seen~~

Fracture and vein mineralogy show at least two distinct episodes of molybdenum mineralization. The earlier accompanied chalcopyrite-bornite mineralization; the later occurs in quartz veins with chalcopyrite — some of these veins are up to 1m wide.

Mo 5270

The thick younger veins ~~carry~~ may carry spectacular Mo values but could be missed if blast hole drilling is not accompanied by mapping. For example, between sample sites M1 and M2 there is a molybdenite vein that strikes 080° and dips 40° northward. Contours drawn only from the blast hole assay data would ~~do~~ not show real grade trends — part of the vein would be designated waste! Similarly the vein between sites ~~9~~ M9 and M10 was intersected by only one blast hole and most would ~~be~~ show as waste.

Mo Linears
5270

see also Reed + Jambor for comments

On 5270 level

1 Molybdenum values are relatively low close to the Gnawed Mountain dyke, especially on the east side of the pit.

Dominant fracture systems are apparently northeast ~~trending~~ (about 025 to 045°) and east-northeast (080-095°) trending. Weaker trends are southeast (115°).

Overlaying the derived linear trend map for copper brings out the differences in copper and molybdenum distribution; some ~~they~~ follow roughly the same fracture systems but others are slightly offset. More than one episode of mineralization is represented.

Structural Control

Molybdenum 5310

The dominant controlling fracture set for molybdenum mineralization on 5310 level trends 030 to 045°. Distribution patterns of molybdenum are complicated by ~~overlapping~~ interaction of these and less intense fracture sets at 050 to 060°, 085-090° and 120 to 125°.

These trends correlate closely with those controlling copper mineralization on both 5310 and 5270 levels.

Section on dips + plunges
of ore shoots Mo

Orientation of Molybdenite zones

Molybdenite zones apparently plunge and dip; they narrow slightly from 5310 to 5270 level and coherent zones on 5310 split on the lower level.

Near Gnawed Mountain dyke, centered on 110600E 75800N, ameboid zones apparently plunge 30° eastward. Away from the dyke and from west to east, four major northeast trending zones apparently dip northwest at about 45°. Associated east to southeast fracture systems apparently either dip southwest or are vertical.

Conclusion - Zoning + Altn

The Anaward Mountain dyke apparently acted as a heat sink. Alteration and hypogene mineral zoning patterns are ~~patchy~~ irregular in detail but subparallel in general to the dyke (Reed and Jambor, 1976)

Near the dyke bornite is an important ore mineral; away from it chalcopyrite becomes dominant, then there is a weak pyrite 'halo.'

Ore grades occur locally in the pyrite halo and parts of the bornite zone are ~~below ore grade~~ waste.

Fracturing density during mineralization controlled ore fluid flow paths. (Fractures occur in swarms, not uniform zones.) ~~Consequent~~ Therefore grade ~~E, Grade patterns~~ and alteration patterns, ~~relate~~ which ~~will be~~ reflect ~~po~~ permeability and hence heat and fluid flow paths ~~patterns~~, ~~E~~ they ~~therefore, they~~ will be irregular in outline and variable in ~~detail~~ intensity.

~~Alteration~~
~~Figure~~

Fig 1 mapping scheme

2 alteration
+ metal zoning

3 { Copper grade
4 { patterns 5310, 5270

5 { Mo grade patterns
6 { 5310, 5270

HOW CAN WE DO IT —

Recently graduated geologists with some experience have the skills to map in the field but lack experience and judgement.

Project geologists can provide direction and temper activities with advice and supervision.

One graduate with ~~[illegible]~~ one helper, (~~supv~~ under ~~the~~ guidance), can double the area that a Project Geologist can map in a field season.

~~In the office,~~ The junior helpers ~~uninterrupted concentrated time will enable~~ are laid off August 31 but the young geologist can help the Project Geologist produce ~~the~~ maps and reports for publication, ~~do~~ carry out micro-

HIGHMONT PAPER

1 - Introduction

2 - General Geological Setting

3 - Geological Setting of the Orebodies

4 - The East Pit

4-1 Introduction - location of orebody

4-2 Host Rocks - brief description

4-3 Alteration - description

4-3-1 Timing of alteration

4-4 Hypogene ore mineralogy

4-4-1 copper veins molybdenum

4-5 Structural Features

4-5-1 Control of ore grade trends - copper < orientations / intersecting sets

4-5-2 Influence on ~~orientation~~ distribution ~~down dip~~ at depth - copper

4-5-3 Control of ore grade trends - Mo

4-5-4 Influence on distribution at depth - Mo

~~Con~~ 4-6 Concluding remarks

<u>Figures</u> - Sample Location and Geology

- Hypogene Minerals
- Alteration Minerals
- ~~#~~ Copper contour map with trends
  5310 ; 5270
- MoS_2 contour map with trends
  5310 ; 5270