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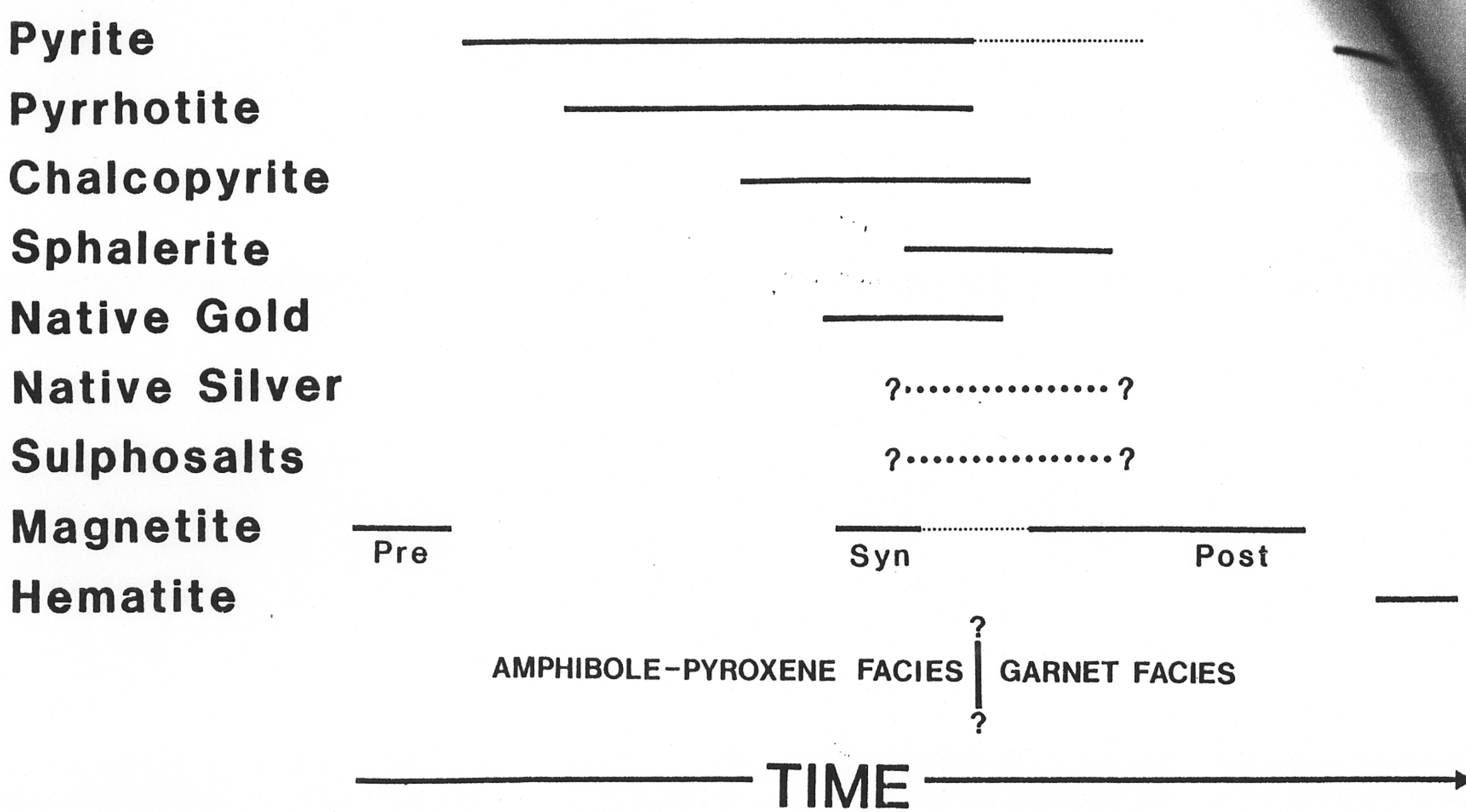
CHAPTER 3-PETROCHEMISTRY

3A INTRODUCTION

The igneous rocks and associated mineralization-alteration at the Aylwin Creek gold-copper-silver deposit exhibit characteristics of both the calc-alkalic and alkalic types of porphyry copper deposit found in the Canadian Cordillera (Sutherland-Brown, ed, 1976). The low quartz phenocryst content of the intrusive suite, the high gold content of the mineralization and the calc-silicate alteration assemblages are characteristics of the 'alkalic' deposits (Barr et al., 1976). Here, the chemical compositions of the igneous suite at Aylwin Creek are compared with those mineralized environments of alkalic and calc-alkalic type from the Quesnel Trough, B.C. (Barr et al., 1976; Lefebure, 1976; Briskey and Bellamy, 1976; Schink, 1977; Cooper, 1978; Bailey, 1978; and Cox, 1979), and with rocks of the Rossland Group from the Rossland area, B.C. (Beddoe-Stephens and Lambert, 1981) (figure 10; tables 5A and 5B).

All rocks within the Aylwin Creek roof pendant have undergone lower greenschist metamorphism with a large percentage of these also having undergone some degree of metasomatism. This alteration must be considered when interpreting chemical data in terms of igneous processes. Samples analyzed in this study were selected on the basis of having no megascopically detectable alteration, but a combination of aphanitic groundmasses and groundmass selective alteration makes identification of unaltered specimens in the field virtually impossible. Similar problems were en-

Table 8 RELATIVE TIMING OF THE GOLD–COPPER–SILVER MINERALIZATION



wrapping around the southern portion of the heterolithic breccia pipe and joining up.

The mineralization in all the zones consists of native gold with pyrite, pyrrhotite, magnetite and chalcopyrite in virtually any combination. Locally, these minerals may be accompanied by sphalerite and/or hematite, and traces of Pb-Bi bearing Sb-sulphosalt (Gasparrini, 1980). Table 8 summarizes the relative timing of each of these phases. The mineralization occurs as massive sulphide (plate 67), breccia matrix replacements (plate 68), stockworks (plate 69) in peripheral crackle breccia zones, and as disseminations (plate 25) and veins.

The mineralized zones at Aylwin Creek are characterized by high total sulphide-oxide content (10 - 15% on average) (figure 38). Distribution of these sulphides-oxides and precious metals on the deposit scale is depicted in figures 38 - 44). In figures 38 through 42 the percentage of sulphide(s) (or oxide) is estimated from visual inspection of drill core (with the exception of Cu, figure 42). The 'ore' zones, shown on the various cross sections by fine dashed lines, are based on a cut off grade of >0.5 gram/tonne Au equivalent (where 1% Cu = 1 gram/tonne Au; with no equivalent calculated for silver). The 'ore' zones average 10-15% total sulfide + oxide in the upper portions and greater than 15% in the lower portions.

Pyrite is ubiquitous in the Aylwin Creek mineralized area (figure 39), but in general greater than 5% pyrite occurs only in the 'ore' zones. The total amount of pyrite in the 'ore' increases slightly with depth (figure 39), as does the ratio of pyrite occurring as vein fillings to

CHAPTER 8-CONCLUSIONS

The following are the major conclusions of the study:

(1) The Aylwin Creek roof pendant represents the partial remains of a Lower Jurassic volcanic island-arc complex comprised of pyroclastics, augite porphyry flows and minor volcaniclastic sediments of the Rossland Group.

(2) The Quartz Latite Porphyry (Qlp) and Feldspar Porphyry (Fp) intrusive bodies are interpreted as being comagmatic and in part coeval with the Rossland Group volcanics.

No - younger (Russ Wong July 2/86) - but pre-date Nelson

(3) The Rossland Group volcanics exhibit an alkalic character, and the Qlp and Fp intrusives are transitional between sub-alkalic and alkalic, based on their intermediate alkali to silica ratios, and low primary modal quartz contents. These igneous rocks are similar to those associated with alkalic-type porphyry copper-gold deposits within the Quesnel Trough of British Columbia.

(4) The development of the Heterolithic Breccia pipe appears to be related to a deep, undiscovered and late member of the intrusive complex.

(5) Surface fractures in the Aylwin Creek mineralized area are in three principal orientations which may parallel major faults. Many geologic features are elongated and/or orientated north-south, suggesting structures in this orientation may have existed throughout the geologic history of the Aylwin Creek deposit. The other principal fracture orientations are 060° (e.g., Willa Shear Zone) and 120°.

mineralized zones that occur near the surface are in areas of high fracture density (i.e., > 5-6 per meter).

(7) The hydrothermal system associated with the Aylwin Creek intrusive complex produced two groups of early alteration assemblages: a quartz +/- MoS_2 stockwork with minor albitization and seritization associated with the Qlp; and potassic and propylitic alteration assemblages related to the Fp stock.

(8) The potassic alteration consists of two facies: a widespread development of secondary biotite and a more selective development of secondary K-feldspar.

(9) Overprinting the potassic alteration and closely linked to the formation of the breccia pipe is a calc-silicate alteration. The calc-silicate alteration can be sub-divided into four facies which represent increasing degrees of Ca-metasomatism: amphibole facies, pyroxene facies, epidote facies and garnet (-anhydrite) facies. The more calcic-facies overprint the less calcic.

(10) The calc-silicate alteration minerals and their compositions (i.e, Ti, Fe, Al contents) reflect both the original protolith (i.e, volcanic or intrusive) and, in the case of those developed in the heterolithic breccia pipe matrix, proximity to mineralization. In general, the $Mg/(Mg + Fe^{2+})$ ratio in the silicates decreases towards the mineralization.

(11) Mineralized zones are structurally controlled within the Heterolithic Breccia pipe. Its marginal zone of crackle breccia is particularly favourable for mineralization. There are good correlations

between: (a) surface calc-silicate alteration with minor mineralization (figure 31), (b) zones of high (i.e., >5-6 per meter) fracture density (figure 20), and (c) indicated or proven mineralized zones (figure 9).

(12) The total percentage of sulphide-oxide increases to 10-25% within the known mineralized zones.

(13) The pyrite/pyrrhotite ratio decreases with depth within the mineralized zones.

(14) The bulk of the magnetite appears to be later than the pyrite-pyrrhotite-chalcopyrite assemblage.

(15) High gold grades are not necessarily always associated with high chalcopyrite contents.

(16) High silver grades can be found within known mineralized zones, but also occur outside of the sulphide-rich areas. There is a definite correlation of high silver grades with the presence of sphalerite, both within and outside of mineralized zones.

(17) The silver-bearing mineral phase(s) are still not all identified. Minor amounts of native silver were observed in an argentiferous portion of drill core. In addition, an unknown mineral associated with sphalerite was tentatively identified as a silver-bearing sulphosalt.

(18) There is a strong spatial relationship between the mineralized zones (i.e., high gold grades) and the development of high-Ca mineral assemblages, in particular andradite (upper portions of the mineralized zones) and anhydrite (lower portions of the mineralized zones).

(19) Retrograde alteration of the calc-silicate alteration facies to epidote, amphibole, zeolites and other minerals is the result of a small volume of cooling fluid passing through the deposit.

(20) Rock and mineral chemistry indicates that the potassic alteration is characterized by major additions of K and Mg, and the calc-silicate alteration is characterized by major additions of Ca and Fe.

(21) The Aylwin Creek deposit has characteristics of both the alkalic clan of porphyry copper deposits found within the Intermontane Belt, and the iron-skarn deposits found on Vancouver Island, B.C..

(22) It is proposed that the gold mineralization was deposited under conditions which prevailed during transition from those conducive to the formation of the pyroxene facies to those leading to the formation of the garnet (-anhydrite) facies. The replacement of pyroxene-sulphide by garnet-magnetite is an oxidation reaction which could be caused by increasing fO_2/fS_2 and/or pH, or decreasing temperature. All of these chemical effects would have decreased the solubility of gold in the fluid if, as it appears most likely, the gold were carried as a thio complex.

There is a good chance that deposits similar to Aylwin Creek occur in other regions of British Columbia. The following is a list of areas which are deemed favorable:

(a) Other roof pendants of Rossland Group volcanics within the Nelson Batholith and other major batholiths which intrude this arcuate belt of Mesozoic volcanic-sedimentary rocks. The fact that the Aylwin Creek roof pendant was incorrectly mapped as Slocan sediments, by early workers, raises the possibility that other roof pendants also were incorrectly mapped.

(b) A re-evaluation of the timing and occurrence of gold in the Rossland Gold Camp is warranted, considering especially the intrusives coeval with the Rossland volcanics (eg., Rossland Monzonite). If Aylwin Creek is the root zone of a Rossland Gold Camp-type system, then there is potential for finding an Aylwin Creek-type deposit within the Rossland Camp, in association with the intrusions coeval with the Rossland volcanics.

(c) There is potential for Aylwin Creek type deposits within the Quesnel and Whitehorse Troughs of British Columbia. Areas with Upper Triassic-Lower Jurassic intrusions of alkalic to transitional alkalic-subalkalic type, especially if there is associated high-Ca alteration, would be favorable. The Galore Creek, Gnat Lake, Lorraine, Cariboo Bell and Copper Mountain deposits all occur in favorable areas. In fact, all of the deposits explored for alkalic-type copper mineralization in the