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A proposal for the study of alteration, mineralization and fracture patterns on the property of Similkameen Mining Company at Princeton, B.C.

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The Problem

Orebodies of the type which occur at Ingerbelle and Copper Mountain are found throughout the area of Upper Traissic to Lower Jurassic rocks in B.C., and represent an important exploration target. Published geological studies, and general "street information" suggest that most examples of the ore type have the following features in common:

1) They are associated with undersaturated or quartz-free, potassium-rich intrusive rocks and perhaps also with chemically similar volcanic rocks of approximately the same age.

2) The geometry or shape of the mineralized zones is generally complex: individual zones tend to be small and irregular, through several may occur in the same general area, and be economically viable as a group.

3) There are no obvious, simple zoning patterns shown by the mineralization or alteration in most areas; nevertheless, alteration associated with mineralization is commonly widespread.

4) The alteration mineral assemblages are characteristically alkali (Na,K) and calcium-rich: alkali feldspar, biotite, sericite, carbonate, scapolite, diopside-hedenbergite, etc.

Recently a study of John Gunton of Queen's University has shown large scale chemical patterns in the Copper Mountain-Ingerbelle Area which appear to be due to alteration associated with ore. The discovery of these chemical patterns suggest that perhaps there are, in fact, zonal patterns in the alteration and subeconomic mineralization which occurs near the ore. But some ambiguity remains in the interpretation;

for example, it is not clear which of the chemical patterns are due to mineralization and alteration, and which of these are related directly with ore-forming, in contrast to non-oreforming events (pre- or post-ore metasomatism along faults, etc.). Without being sure of the nature of the chemical changes resulting from alteration, it is difficult to be sure that the patterns found by Gunton do not, at least in part, reflect some type of distinctive lithology which pre-dates the ore, i.e., perhaps a pile of alkali-rich volcanic rocks which were chemically like the alkali-rich, silica-poor intrusions (Lost Horse) from which the ore was apparently derived.

It is suggested that a specific study of the chemistry and geometry of the mineralization--alteration would go a long way towards answering some of these questions, and might provide valuable exploration criteria for ore in the area, and the same ore type in similar areas throughout B.C.

Research Approach

Background: Epigenetic ore deposits like those at Princeton are the result of the reaction of magmatically-derived solutions with wall rocks. The ore-depositing process can be defined in terms of a general chemical reaction as follows:

hydrothermal solution + unaltered rocks ⟶ altered and mineralized rocks + changed hydrothermal solution.

The character of the alteration and mineralization at any one point in the zone of deposition, at any one time, is controlled by two types of processes: (a) equilibria between the solution and magma at the point of origin of the solution and (b) any reaction between solutions and rocks in the channelway below the point in question. For virtually all points and all times, the "solution" on the left hand side of the equation will be "changed" hydrothermal solution, due to its previous reaction with wall rocks. With these two independant variables affecting solutions, and the additional possibilities of variability in the "unaltered" rock

type (in part due to alteration of the rock by previous increments of solution which have passed the reference point), as well as temperature and pressure, it is no wonder that the patterns of "altered and mineralized rock" in an area of ore deposition may be complicated. However, the situation is normally saved by the fact that changes tend to be gradual and systematic, both at source (due to magma-solution equilibria during the progressive solidification of the magma) and in the zone of deposition (due to the progression alteration of the solutions, by reaction with wall rocks).

The essence of the problem, in trying to understand and analyse a complex situation like Ingerbelle, is to separate the effects of solutions which pass through a given reference point, i.e., a given part of the ore zone, at different times. In other words, it is necessary to define the course of solution (and rock) alteration due to the progressive reaction of the solution with wall rocsk at essentially one time, and then compare this with sequences produced at other times. The effect of solution-rock reaction at one time (i.e., one type of solution being fed into the system from the magma) can be determined both from large scale mineralogical zoning patterns, and from the changes in the mineralogy and chemistry of the rocks out from fractures; there may be some differences in the patterns developed on these two scales, but invariably the detailed and careful study of small scale patterns provides invaluable clues to the interpretation of large scale patterns.

General Approach: The basic approach in alteration studies, as first clearly set out and practiced by Sales and Meyer in their study of Butte, Montana, is as follows.

1) Define, on the basis of general appearance and mineralogy, and map the distribution of the various alteration types, taking care to determine local age relations (cross-cutting relationships) of the types, any association of mineralization-alteration types with particular host rocks types, any patterns of preferred orientation, etc.

2) Determine in the laboratory the chemical and mineralogical character of the alteration types, with particular emphasis

on any changes in chemistry and mineralogy out from alteration centers (either on the scale of an individual vein, and/or on the scale of the map).

3) From the spatial and temporal mineralogical patterns, deduce a model for the change in solutions (a) at source due to magma-solution equilibria and (b) in the zone of deposition due to solution-wall rock equilibria.

4) Use this preliminary model to direct the search for more subtle mineralogical and chemical patterns in the rocks.

Progress: In July, 1973, a map was made on a scale of 1":100' of part of the pit, and several key drill holes logged and sampled. Approximately 100 samples were collected and are presently being prepared for petrochemical study. The work done so far has not added in any significant way to the understanding of the geology of the deposit, though it is felt that pit mapping has helped substantially in defining the broader features of the alteration. This is significant in as much as one of the major problems in the area is to see the general over-all picture through the incredible complexity of detail.

Plan for 1974: The study of the samples will be completed during the winter; next summer, more pit mapping will be done, but the primary focus of the field work will probably be on logging the drill core.