

Michael B. Jones

Hydrothermal Alteration & Mineralization of the Valley Copper Deposit  
Highland Valley, B.C.

1974

Oregon State University

### SYNOPSIS

The Batholith which is calc alkaline and its contained metal are related to an early Mesozoic subduction zone (Pacific [Farallon] and North American Plates). Paleosubduction zone was about 140 km below the Batholith.

- (1) Major alteration minerals  
Kaolinite, sericite, microcline and quartz
- (2) Lesser alteration minerals  
Calcite, biotite, gypsum, anhydrite

Location and distribution of alteration minerals is controlled by fractures - they occur in: . . . veins . . . vein selvages . . . pervasive zones.

Most of the copper is in quartz-sericite veins.

#### A. Superimposed and Prograde Alteration Sequence.

- (1) Propylitic (?)
- (2) Argillic
- (3) Pervasive sericite (pyrite, chalcopyrite, sphalerite)
- (4) Barren quartz vein stockwork and potassic alteration
- (5) Quartz sericite (bornite, chalcopyrite, MoS<sub>2</sub>)
- (6) Mineralized quartz veins (bornite, chalcopyrite, MoS<sub>2</sub>, chalcocite, covellite).
- (7) Gypsum veins

#### B. K/Ar Age Dates.

Sericite (198 + 8 My) MoS<sub>2</sub> (202 + 8 My)

Bsda dyke (pre - ore) (204 + 4 My) vogesite, lamprophyre (132 + 3 My)

C. Hydrothermal alteration mainly by base leaching of Ca<sup>++</sup> and Na<sup>+</sup> from plagioclase and by metasomatic addition of K<sup>+</sup>, H<sup>+</sup> and SiO<sub>2</sub> to the host.

Heat dissipation in the deposit (to get rid of heat generated

by alteration reactions) by conduction, convection, throttling, and influx of relatively cool fluids via connate or ocean water.

D. Oxygen & Hydrogen Isotope Data.

|                                |   |
|--------------------------------|---|
| (1) Primary Minerals           | Quartz (10)* $\delta^{18}O$ permil values are + 7.27 to + 8.98  |
|                                | Kspar (7) $\delta^{18}O$ permil values are + 5.67 to + 9.70     |
|                                | Plagioclase (9) $\delta^{18}O$ permil values are + 5.22 to 8.96 |
| $\delta D =$ - 66.1 to - 111.8 | Biotite (8) $\delta^{18}O$ permil values are + 1.95 to 5.02     |

\* number in brackets is number of determinations.

|   |               |                 |
|---|---------------|-----------------|
| (2) Alteration Minerals: $\delta^{18}O$ : | Quartz (9)    | + 8.74 to 12.51 |
|   | Kspar (6)     | + 7.65 to 8.74  |
|   | Sericite (6)  | + 6.60 to 7.56  |
|   | Kaolinite (4) |                 |

|              |               |                  |
|--------------|---------------|------------------|
| $\delta D$ : | Sericite (6)  | - 64.8 to - 53.1 |
|              | Biotite (2)   | - 91 to - 76     |
|              | Kaolinite (3) | - 116 to 95.2    |

|                   |                      |                  |
|-------------------|----------------------|------------------|
| $\delta S^{34}$ : | MoS <sub>2</sub> (1) | + 0.50           |
|                   | Pyrite (1)           | - 3.08           |
|                   | Sphalerite (1)       | - 4.11           |
|                   | Chalcopyrite (5)     | - 3.30 to 1.53   |
|                   | Bornite (4)          | - .94 to 1.45    |
|                   | Anhydrite (2)        | + 11.76 to 14.48 |
|                   | Gypsum (2)           | + 13.13 to 15.22 |

The mean (- 0.81) and range (5.64) of  $\delta S^{34}$  for sulphides is typical of other cordilleran porphyry deposits in which sulphur is thought to come from a deep crustal or mantle source.

(3) Temperature Determinations

(a) Oxygen Isotopes: Primary minerals 850°C to 265°C.  
Hydrothermal minerals 480°C for quartz-sericite in sulphide bearing quartz veins to 260°C for quartz-sericite pervasive alteration zones.

(b) Sulphur Isotopes  
480°C for anhydrite-bornite in pervasive kspar alteration zones to 266°C for pyrite-sphalerite in pervasive sericite alteration zones.

Therefore Margin of deposit about 300°C.

Core of deposit about 500°C.

Temperatures increase with alteration paragenesis.

(4) Chemical Conditions

(a) At 400°C pH 1.74 to 4

- log  $f_{O_2}$  20 to 23 Hydrothermal alteration.

- log  $f_{S_2}$  1.4 to 4.5

(b) pH 2.5 - 3

- log  $f_{O_2}$  22.2

- log  $f_{S_2}$  1.5 to 3.6

Vein sericite alteration and  
sulphide deposition.

(5) Fluid Inclusions

A few sylvite & halite crystals and liquid CO<sub>2</sub> were found,  
therefore maximum concentrations are: K<sup>+</sup> 4.6M

and Na<sup>+</sup> 6.4M

It is estimated that PCO<sub>2</sub> was 100 to 300 bars.

(6) Isotopic composition of hydrothermal fluid . . . It was a  
mixture of magmatic water and ocean water (based on oxygen and  
hydrogen isotope values from sericite). Alteration stage:

Early pervasive sericite . . . ocean water 70%

Main stage quartz-sericite veins . . . ocean water 20%

Gypsum veins . . . ocean water 94%

The late stage large influx of oceanic water is presumed to  
have quenched the hydrothermal system.

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