



## GEOLOGY AND MINERAL DEPOSITS OF THE KITSALT VALLEY\* (103P/11, 12)

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### INTRODUCTION

The Kitsalt River valley was mapped from July 1 to September 1, 1985. Objectives of the program are to:

- (1) Establish a stratigraphic column.
- (2) Document the regional geological setting.
- (3) Delineate areas of high mineral potential.

The area mapped, which covers 700 square kilometres, extends from Alice Arm north to the Cambria Icefield and for approximately 10 kilometres east and west of the Kitsalt River. Work was carried out by two two-man fly camps moved every two to five days. Data was recorded on 1:25 000-scale enlargements of 1982 series 1:50 000-scale air photographs.

### HISTORY

Prospecting in the Kitsalt valley started in the early 1900's because of interest generated by discoveries at Anyox and in the Stewart region. By 1913 numerous claims had been staked, mainly on silver veins.

The Dolly Varden, Homestake, North Star, and Torbrit properties were mined between 1915 and 1959. Total production was 1 284 882 tonnes grading 485 grams silver per tonne, 0.38 per cent lead, and 0.02 per cent zinc.

The area saw renewed exploration focused on porphyry copper-molybdenum deposits from 1965 to 1970. The Ajax molybdenum prospect was staked during this period. Drilling at Ajax outlined indicated reserves of 526 967 000 tonnes grading 0.09 per cent Mo.

The regional geology has previously been described by McConnell (1913), Turnbull (1916), Hanson (1921, 1922a, 1922b, 1923, 1928), and Black (1951).

### REGIONAL SETTING

The map-area lies at the western margin of the Intermontane Belt (Fig. 31-1). The volcanic and sedimentary rocks are correlative with the Lower to Middle Jurassic Hazelton Group. The Kitsalt rocks were deposited in an active volcanic environment; characteristically units wedge and are intermixed. A sedimentary sequence of probable Middle Jurassic age overlies the volcanic-sedimentary assemblage. The entire Jurassic section has undergone greenschist facies metamorphism.

### VOLCANIC AND SEDIMENTARY ROCKS

#### MAP UNIT 1

Unit 1 is a thick sedimentary formation consisting of interbedded, finely laminated black siltstone, argillite, and minor wacke. Rare sills or flows of augite porphyritic basalt and hornblende porphyritic andesite occur within the unit; four small quartz-feldspar porphyritic and biotite porphyritic quartz monzonite stocks intrude the unit. The base of unit 1 is not exposed in the map-area, but the unit is at least 1 200 metres thick.

The thick package of thin-bedded elastic rocks in unit 1 represents a period of flysch sedimentation in a deep water environment.

#### MAP UNIT 2

Unit 2 is a mixed sequence of volcanic and epiclastic rocks -- augite, feldspar, and olivine porphyritic basalt flows, pyroclastics, and derived conglomerates. The unit is 150 to 700 metres thick. The contact with underlying unit 1 sedimentary rocks is sharp and marked by black limestone overlain by a discontinuous flow of olivine porphyritic basalt.

Dark green augite porphyritic basalt flows and pillowed flows are found above the olivine basalt. The augite phenocrysts range from 2 to 15 millimetres in diameter. An excellent exposure of pillowed flows crops out along the western side of the Varden Glacier. Above the augite porphyry flows are minor and discontinuous layers of olive green to black, locally augite or feldspar porphyritic basaltic tuff and breccia. Olive green to grey cobble conglomerates are uppermost in the unit. Clasts are rounded to subangular, matrix supported, and dominantly augite porphyritic basalt. The matrix consists of black volcanic silt to sand-sized grains.

These rocks represent a period of subaqueous basaltic volcanism followed by erosion and deposition of sediment derived from the basaltic flows and tuffs.

#### MAP UNIT 3

A sedimentary and volcanic sequence of siltstone, sandstone, wacke, grit, pebble to cobble conglomerate, and volcanic breccia comprise unit 3. The unit varies in thickness from 2 000 metres in the east to less than 400 metres in the west part of the map-area. The basal contact is gradational.

The lowermost lithology of unit 3 consists of finely laminated siltstone with lesser fine sandstone and wacke, and rare conglomerate. Overlying the siltstones are mottled, grey and maroon massive volcanic breccias that are the major component of the unit. The clasts are generally angular to subrounded, randomly orientated, and matrix supported. The breccias are heterolithic with clasts derived mainly from feldspar-hornblende andesite and to a lesser degree from augite porphyritic basalt. Minor finely laminated siltstone, sandstone, and limestone beds are intercalated within the breccias. Volcanic breccias are thickest along the eastern side of the map-area and wedge out in the centre.

The top of unit 3 is a sequence of grey to black interbedded finely laminated siltstones, sandstones, and grits including a distinctive polymictic conglomerate. Clasts of the conglomerate are well rounded and consist largely of white chert and black siltstone; there are also local volcanic pebbles and cobbles. The conglomerate is clast supported, with a matrix of silt to fine sand-sized grains.

#### MAP UNIT 4

Unit 4 consists dominantly of andesitic pyroclastics, although within it are flows or subvolcanic sills of similar composition. Thin beds and lenses of epiclastic sedimentary rock, argillite, limestone, chert, jasperoidal chert, and barite comprise 10 to 15 per cent of the unit and are randomly distributed throughout the andesite strata. The unit is 500 to 2 000 metres thick; it has a sharp basal contact with unit 3 rocks.

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British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1985, Paper 1986-1.

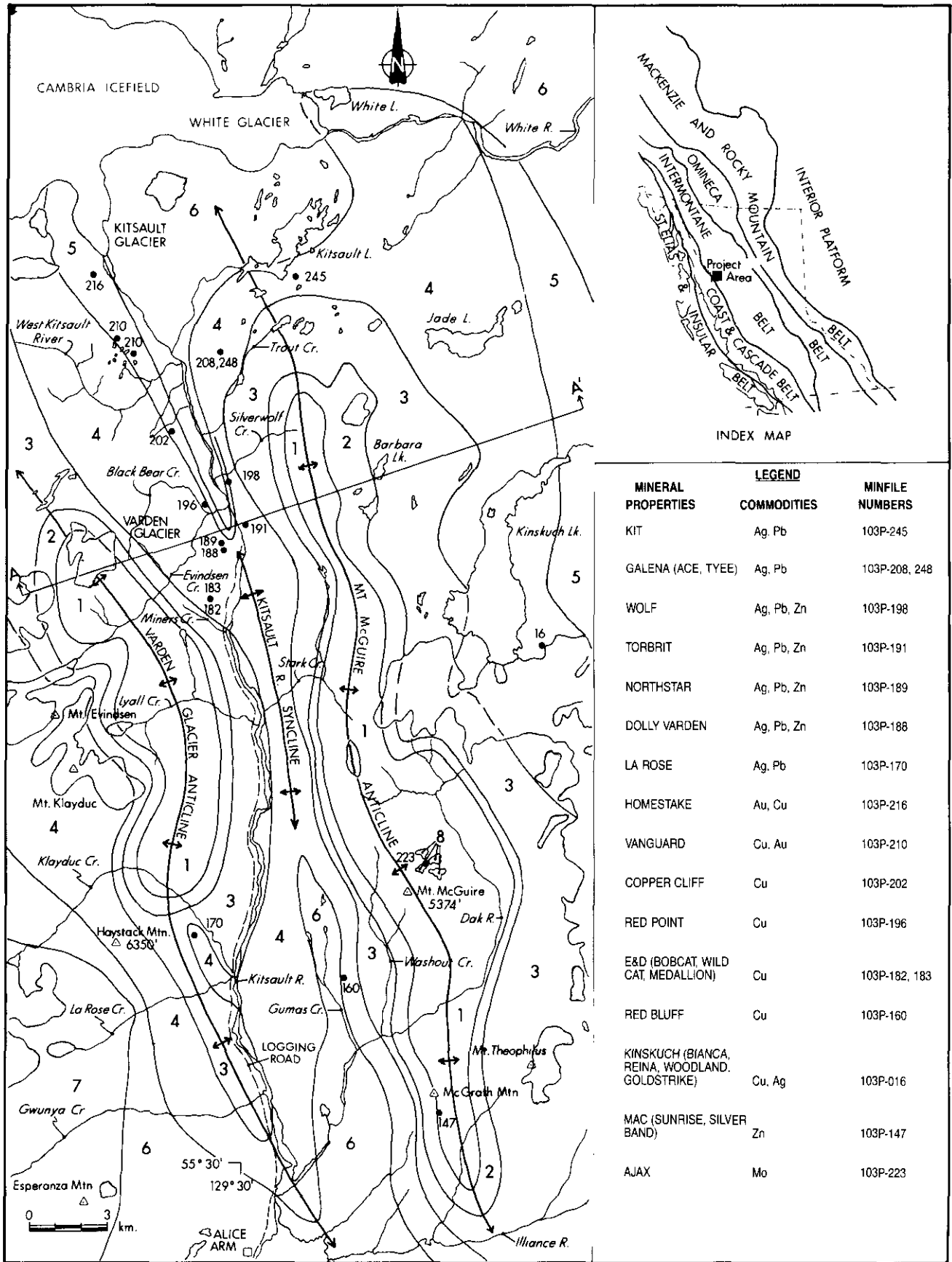


Figure 31-1. Geology and major mineral occurrences in the Kitsault valley (for legend see Fig. 31-2).

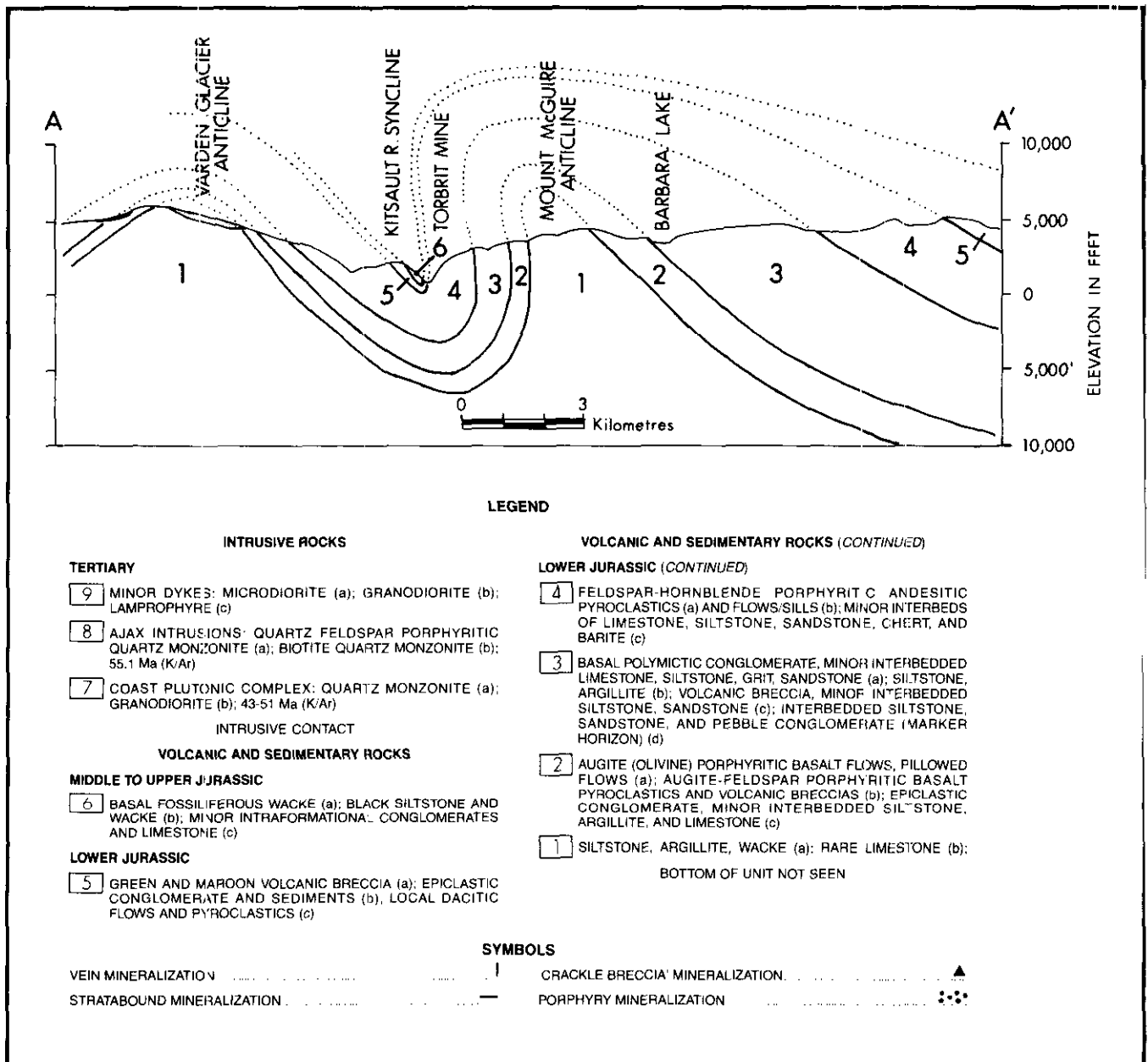


Figure 31-2. Geological cross-section, Kitsault valley (for location see Fig. 31-1).

The andesitic pyroclastics are generally green with local, minor maroon mottling; they comprise dust tuff, ash tuff, lapilli tuff, and minor tuff breccia. Lapilli are angular to subangular, randomly orientated, matrix supported, and heterolithic, although feldspar and/or hornblende crystal-rich andesites predominate. The matrix is fine grained.

Greyish green, massive, fine to medium-grained feldspar and/or hornblende porphyritic andesite units are probably flows or sub-volcanic sills within the andesitic pile. Similar composition and limited exposure make lithological contacts difficult to distinguish, but the sills or flows may constitute up to 500 metres of the total thickness of map unit 4.

Although interbeds of brick red, epiclastic siltstone and sandstone, grey to black limestone, pale grey barite, red to pink jasperoidal chert, and white to grey chert are not volumetrically important, they are valuable because they enable structure within the volcanic sequence to be determined. Individual beds and lenses are generally less than 5 metres thick; however, on Tsimstol (Haystack) Mountain a 150-metre-thick lens of grey to black, interlaminated siltstone and limestone occurs within the andesite sequence. These sedimentary rocks represent brief periods of quiescence during andesitic pyroclastic activity in a predominantly subaqueous environment.

#### MAP UNIT 5

Unit 5 is a marine assemblage of alternating green and maroon volcanic breccias and conglomerates, with lesser dacite flows and pyroclastics, and minor black siltstones and limestones. The unit is exposed only along the northern and eastern perimeter of the map-area. Along the western edge of the Kitsault Glacier and northeast of Kinskuch Lake it has a maximum thickness of 1 500 metres. In the area of the Wolf mine the unit consists of dacitic dust tuff and is less than 100 metres thick. The lower contact of the unit is gradational.

The green and maroon volcanic breccias contain fragments which are angular to subrounded, matrix supported, and composed dominantly of feldspar crystal-rich unit 4 andesite. The matrix consists of sand-sized feldspar grains. The rock is generally massive but locally contains interbeds and lenses of finely laminated black siltstone, limestone, and sandstone. The alternating green and maroon colour of these breccias and conglomerates, and the interbedded limestone layers suggest the clastic rocks may be debris flows deposited in an alternating subaqueous to subaerial environment.

Pale green dacite flows and pyroclastics in the unit range up to 900 metres in thickness but are laterally discontinuous. The flows are fine to medium grained; often they contain megacrysts of zoned K-feldspar or prismatic plagioclase phenocrysts up to 3 centimetres long. Dacitic tuffs and lapilli tuffs on the west side of the Kitsault Glacier are rhythmically bedded, suggesting that they may be water-lain pyroclastics.

The dacite flows and pyroclastics probably derive from more than one felsic volcanic centre and the thick sections indicate that the exposures are near-vent accumulations. The felsic volcanic rocks lie at the top of unit 5 and mark the last volcanic event before an extended period of quiescence, during which unit 6 sedimentation took place.

#### MAP UNIT 6

Sedimentary rocks of unit 6 are well preserved in structural depressions. They are exposed around the margins of the map-area and in the axis of a north-south, doubly plunging syncline along the Kitsault River. The assemblage is marine and consists of black siltstone, shale, and wacke, with lesser amounts of sandstone, limestone, and intraformational conglomerate. The rocks are well bedded and display disharmonic fold features at outcrop and larger scales.

The lower contact of unit 6 is marked by a massive, 1 to 15-metre-thick, fossiliferous wacke. Macrofossils include belemnites and

pelecypods. The contact with units 4 and 5 appears to be concordant, but the erosional interval represented by the accumulation of unit 5 conglomerates indicates the lower contact of unit 6 is a disconformity (Fig. 31-2 and 31-3).

## INTRUSIONS

### AJAX QUARTZ MONZONITE

The Ajax intrusions are four small stocks covering an area of 0.58 square kilometre on the east slope of Mount McGuire. The two northern stocks are medium grey, biotite-rich quartz monzonite; the two southern stocks are white to pink, quartz-feldspar porphyritic quartz monzonite. Potassium/argon analyses of biotite from the northern stocks give an age of  $55.1 \pm 3$  Ma (Carter, 1982; p. 88; recalculated with constants from Steiger and Jager, 1977).

Sedimentary rocks of unit 1 have undergone contact metamorphism in a 250 to 1 000-metre-wide zone around the stocks. The thinly bedded siltstones grade from quartz-albite-epidote-garnet skarn near the stocks to brown and purple biotite hornfels further from the intrusive rocks.

### COAST RANGE BATHOLITH

Quartz monzonite to granodiorite of the Coast Range batholith intrude all formations in the area and are exposed in the southwest corner of the map-area. Sedimentary and volcanic rocks along the contact show little or no contact metamorphism and little sign of deformation. The batholith can be distinguished on air photographs by its light colour and the presence of two prominent oblique fracture sets. The eastern Coast Range batholith has yielded K/Ar ages of 43 to 51 Ma (Carter, 1982).

### DYKES

Numerous 0.5 to 3.0-metre-thick, microdiorite to lamprophyre dykes intrude rocks of the Kitsault valley. Dykes are the youngest intrusive rocks in the area and crosscut all the formations and mineralized rocks.

## STRUCTURE

Northwest and northeast-trending faults transect the map-area. Displacements appear to be small on a regional scale. Many of these faults have been intruded by Tertiary microdiorite and lamprophyre dykes.

Faulting on a property scale complicates the search for mineral zones. Silver-rich quartz-jasper-barite mineralization at Dolly Varden and Torbrit is bounded by north-northeast-striking faults which are offset as much as 45 metres by northwest-striking faults. Brecciated and recrystallized gangue and sulphide minerals in the fault zones indicate that many have been reactivated (Campbell, 1959; Skerl, 1963).

Three parallel regional scale folds have been defined within the map-area (Figs. 31-1 and 31-2). These are:

- (1) The Varden Glacier anticline, which is a doubly plunging anticline. Its axial trace lies 5 kilometres west of the Kitsault River.
- (2) The Kitsault River syncline, which is also doubly plunging. Its axial trace lies along and just east of the Kitsault River.
- (3) The Mount McGuire anticline, which is another doubly plunging anticline. Its axial trace lies 5 kilometres east of the Kitsault River.

Unit 6 sedimentary strata exhibit complex disharmonic folds at different scales due to ductility contrasts between shales, siltstones, wackes, and adjacent volcanic rocks.

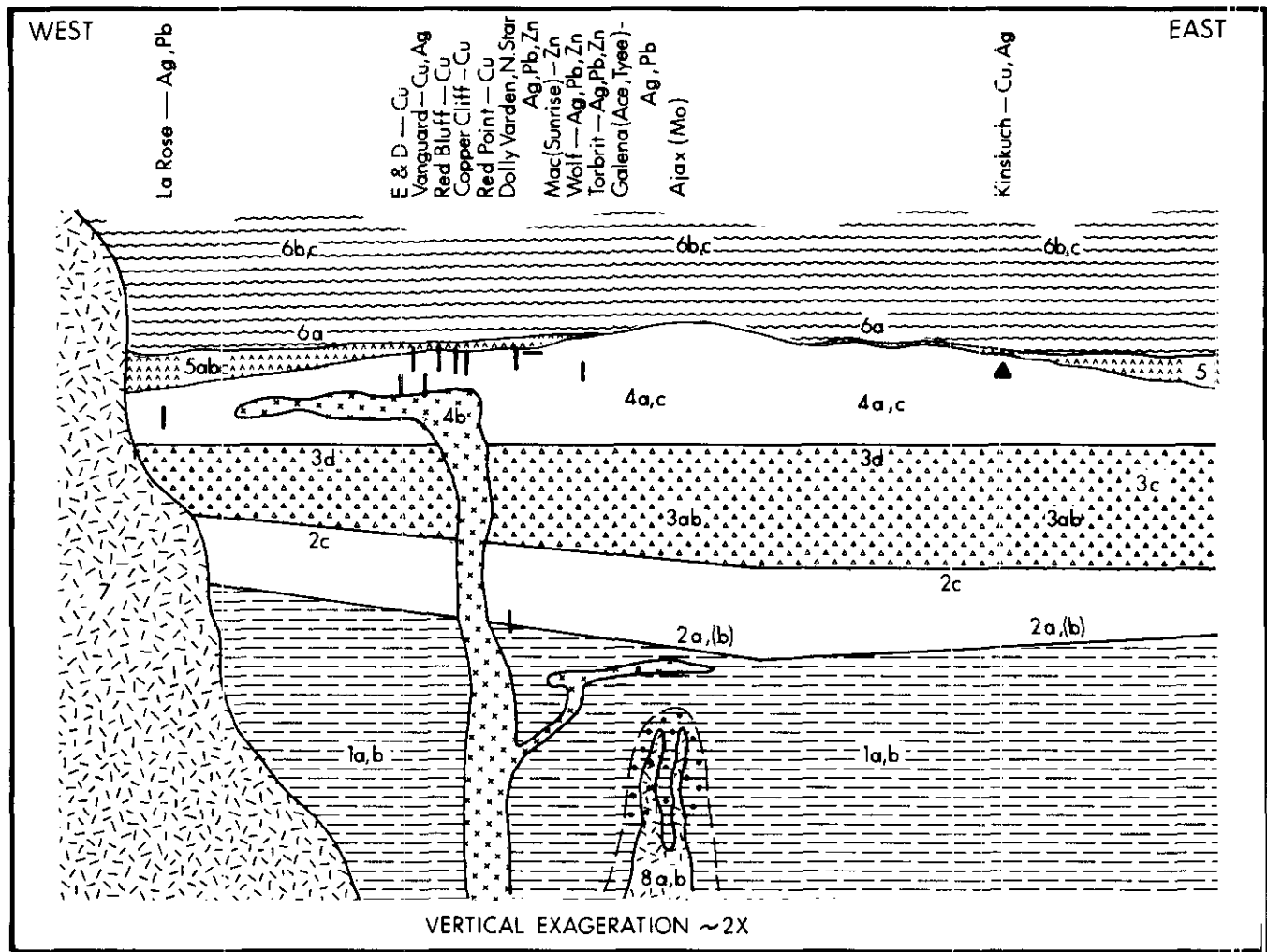


Figure 31-3. Schematic stratigraphic section showing major mineral occurrences, Kitsault valley (see Table 31-1).

## MINERAL DEPOSITS

Most mineral occurrences in the area are hosted within volcanic rocks of units 4 and 5 (Figs. 31-2 and 31-3). Exceptions to this are the Ajax porphyry molybdenum mineralization and associated silver veins on Mount McGuire, and zinc-rich veins on McGrath (Witauks) Mountain. The Ajax molybdenum deposit consists of coatings of molybdenite and quartz on random fractures within the Ajax intrusions and in the adjacent quartz-albite-epidote-garnet skarn alteration zone (Carter, 1982).

Two predominant styles of mineralization are developed within unit 4 andesite pyroclastics:

- (1) silver-rich quartz-barite mineralization, and
- (2) disseminated copper-gold mineralization.

### SILVER-RICH QUARTZ-BARITE MINERALIZATION

Silver-rich quartz-barite-jasper ± sulphide zones occur along the axis and east limb of the Kitsault River syncline in the northern half of the map-area. Campbell (1959) interpreted the mineralization to be mesothermal to epithermal veins, deposited during folding in fractures and faults developed parallel to the axial surfaces of the folds. These mineralized zones have been the most economically interesting of the deposits in the valley: they include the Dolly Varden, North Star, Torbrit, and Wolf mines.

Varying amounts of galena, sphalerite, pyrite, chalcopyrite, tetrahedrite, pyrrargyrite, and native silver occur as disseminations

and pods within the zones. At the Torbrit mine, pyrrargyrite is the principal silver mineral of the ore; it makes up approximately 80 per cent of the silver values. Gangue minerals in the deposits include quartz, barite, jasper, and minor carbonate. The veins show open vugs, banding, and colloform structures. Brecciated zones containing fragments of gangue, sulphides, and host rock are believed to be a result of later movement along the original ore-controlling structures. Host rocks show minor sericite, chlorite, and silica alteration close to the mineral zones.

This type of silver deposit occurs only in unit 4. It shows both stratabound and crosscutting relationships with individual rock layers within the unit. The silver zones also cut and postdate disseminated copper-gold mineralization of the 'Copper Belt' (Campbell, 1959, pp. 1467, 1476).

During 1985, Devlin mapped the North Star, Dolly Varden, and Torbrit mine areas as part of an M.Sc. thesis at the University of British Columbia (Devlin and Godwin, this volume). At the same time, P. Thiersh mapped the Wolf mine as part of his B.Sc. thesis at the university. Both studies are directed at documenting ore/host rock relationships and resolving the genesis of the deposits.

### DISSEMINATED COPPER-GOLD MINERALIZATION

Several showings of copper-gold mineralization occur within andesitic pyroclastics and flows or sills of unit 4 and dacitic pyroclastics of unit 5. Typically, the zone is localized along the upper contact of a feldspar and/or hornblende porphyritic flow or

subvolcanic sill. These deposits are collectively known as the 'Copper Belt.' The Copper Belt extends from a nunatak within the Cambria Icefield south-southeast along the west side of the Kitsault River to Evindsen Creek, where it crosses the Kitsault River and continues south-southeast to the Dak River. In outcrop it exhibits an extensive orange gossan due to weathering of minor but ubiquitous disseminated pyrite.

Mineralization consists of disseminations and stringers of pyrite and chalcopyrite with associated gold and traces of galena and sphalerite. Alteration is extensive along the contact and in the surrounding feldspar porphyry and pyroclastic rocks. Alteration consists of strong silicification, chloritization, and sericitization.

The Homestake, Vanguard, Red Point, and Red Bluff properties exhibit this style of mineralization, however none have been shown to have economic tonnages or grades.

## CONCLUSIONS

Volcanic and sedimentary rocks of the Kitsault valley indicate a history of active volcanism with intermittent periods of quiescence in a predominantly submarine island arc environment.

The majority of mineral deposits can be classified under three deposit types:

- (1) silver-rich quartz-barite deposits,
- (2) disseminated copper-gold deposits, and
- (3) porphyry molybdenum deposits.

The silver-rich and copper-gold deposits are distributed over a strike length of 40 kilometres and are hosted mainly in andesitic volcanic rocks of unit 4.

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