# BABINE PROJECT* (93L/15)

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*KEYWORDS:* Regional geology, Babine Range, stratigraphy, Hazelton Group, Bowser Lake Group, Skeena Group, Kasalka Group, structural geology, mineral occurrences.

## INTRODUCTION

The objective of the Babine project is to map the Babine Range at 1:50 000 scale and to develop metallogenic models for the mineral deposit-types present. The project began in 1984 and earlier work is summarized in two previous reports (MacIntyre, 1985a; MacIntyre *et al.*, 1987).

This report summarizes work completed during the 1987 field season. The area mapped to date is shown in Figure 1-16-1. The work was done from the town of Smithers using both four-wheel-drive vehicles and helicopters for transportation. A total of 444 geological stations were recorded within an area of approximately 196 square kilometers. The field data were coded and entered into a database file using a Compaq II microcomputer and are available to the public either as a printout or on a floppy diskette.

The major conclusions from the work completed in 1987 are:

(1) A thick pile of Late Cretaceous to Tertiary volcanic and sedimentary rocks and associated high-level intrusions is preserved in an arcuate belt of tilted and thrusted fault blocks in the vicinity of Mount Cronin. These rocks are probably related to a major eruptive centre and cauldron subsidence complex of Late Cretaceous age.

(2) The Cretaceous and Tertiary volcanic rocks are folded, thrust faulted and offset by northeast-striking shear zones, indicating a very young compressional tectonic event has affected rocks of the Babine Range. This tectonic event appears to be unique to the Babine Range and may be related to opposing transcurrent movement on bounding faults, that is, transpressional tectonics.

(3) Sericite-pyrite alteration zones and gold-silver-bearing quartz veins occur in zones of intense foliation or shearing within Tertiary, Late Cretaceous and older rocks. Many of these zones trend northeast. There is also a spatial association with rhyolite and diorite intrusions, especially along the eastern fault boundary of Late Cretaceous volcanic rocks. Dykes that parallel this contact may have been emplaced along ring fractures produced during the main episode of volcanic eruption and subsidence.

## REGIONAL GEOLOGIC SETTING

West-central British Columbia is part of the Stikine terrane. This terrane includes: submarine calcalkaline to alkaline immature volcanic island-arc rocks of the Late Triassic Takla Group; subaerial to submarine calcalkaline volcanic, volcaniclastic and sedimentary rocks of the Early to Middle Jurassic Hazelton Group; Late Jurassic and Early Cretaceous successor basin sedimentary rocks of the Bowser Lake, Skeena and Sustut groups; and Late Cretaceous to Tertiary calcalkaline continental volcanic-arc rocks of the Kasalka, Ootsa Lake and Goosly Lake groups. The younger volcanic rocks occur sporadically throughout the area, mainly in downthrown fault blocks and grabens. Plutonic rocks of Jurassic, Cretaceous and Tertiary age are known and form distinct intrusive belts (Carter, 1981). The most economically important exploration targets are porphyry copper and molybdenum deposits and mesothermal and epithermal precious metal veins. A few small massive sulphide occurrences have also been discovered.

## GEOLOGY OF THE BABINE RANGE

The Babine Range is a northwest-trending horst of folded and faulted Jurassic and Cretaceous volcanic and sedimentary rocks. Younger Tertiary volcanic and sedimentary rocks crop out in the Bulkley Valley, which lies west of the range (Figure 1-16-1). The structural setting is similar to the Basin and Range province of the United States and is probably related to extensional tectonics induced by right lateral movement on major northwest-trending transcurrent faults.

The structural style of the Babine Range is characterized by asymmetric to overturned, southeast-plunging folds that are truncated by northeast-trending shear zones and northwest-striking high-angle reverse and normal faults. Downward stepping of tilted fault blocks occurs to the northwest, exposing progressively higher stratigraphic levels in this direction. Faults created during an early episode of block faulting were apparently reactivated during a Tertiary compressional event, resulting in squeezing of subsided blocks upward and over adjacent fault blocks.

## GEOLOGY OF THE STUDY AREA

The preliminary geology of the study area, as determined by fieldwork completed in 1987, is shown in Figure 1-16-2. Relationships between the different map units are shown diagrammatically in Figure 1-16-3. Table 1-16-1 lists the map units as defined to date.

### HAZELTON GROUP

The Hazelton Group (Leach, 1910) is a continental to island-arc calcalkaline assemblage that was deposited in the northwest-trending Hazelton trough in early to middle

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British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1987, Paper 1988-1.

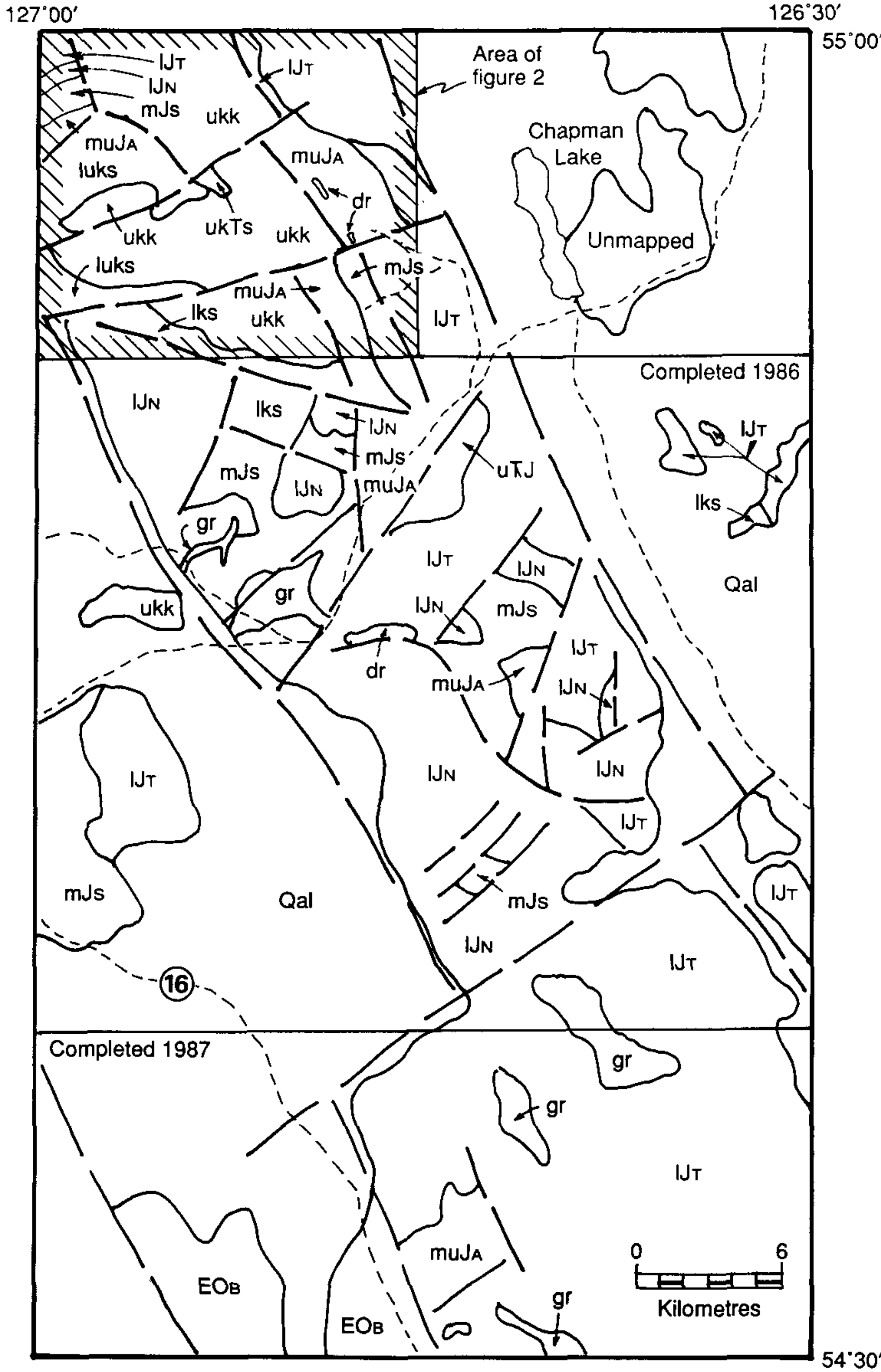


Figure 1-16-1. General geology of the Babine Range (93L/10, 93L/15). *See* Table 1-16-1 for description of map units.

TABLE 1-16-1
TABLE OF FORMATIONS

**SEDIMENTARY AND VOLCANIC ROCKS**

| EPOCH | FORMATION | MAP UNIT | LITHOLOGY |
|---|---|---|---|
| Late Cretaceous and Early Tertiary | | uKTs | Well-bedded, tuffaceous siltstones, argillites and chert. Lapilli tuff and tuffaceous siltstone at base. |
| | | Unconformity | |
| Late Cretaceous | Kasalka Group | uKK2d | Maroon to grey hornblende feldspar porphyry intrusions. |
| | | uKK2c | Maroon to grey hornblende feldspar porphyry flows, breccia. |
| | | uKK2b | Crystal tuff, ash tuff, and minor mudstone. |
| | | uKK2a | Volcanic breccias and lapilli tuffs; hornblende-biotite-feldspar-phyric clasts and a feldspathic crystal-rich matrix. |
| | | | unconformity |
| | | uKK1f | Siliceous maroon ash flow, crystal tuff, breccia, lapilli tuff. |
| | | uKK1e | Bedded lahar, epiclastics, porphyry flows, breccia. |
| | | uKK1d | Lapilli tuffs and volcanic breccias; maroon and green feldspar-phyric clasts. |
| | | uKK1c | Augite basalt and andesite, amygdaloidal, vesicular and massive; local flow breccia. |
| | | uKK1b | Tuffaceous siltstone, sandstone, and conglomerate. |
| | | uKK1a | Poorly sorted heterolithic pebble conglomerate and siltstone. |
| | | Unconformity | |
| Early to Late Cretaceous | | luKS5 | Siltstone, argillite, shale, matrix-supported pebble and boulder conglomerate. |
| | | luKS4 | Well-bedded siltstone, sandstone and pebble conglomerate. |
| | | luKS3 | Tuffaceous siltstone; flaser bedding; orange weathering. |
| | | luKS2 | Shale, siltstone; minor conglomerate beds. |
| | | luKS1 | Maroon and green phyllite. |
| | | Disconformity? | |
| Early Cretaceous | Skeena Group | lKS | Polymictic pebble conglomerate; sandstone and shale. Micaceous with shale clasts and plant impressions. |
| | | Unconformity | |
| Middle to Late Jurassic | Bowser Lake Group Ashman Formation | muJA | Argillite, shaly siltstone, quartzose wacke. |
| | | Unconformity? | |
| Early to Middle Jurassic | Hazelton Group Smithers Formation | mJS | Feldspathic wacke, siltstone, glauconitic sandstone, conglomerate; fossiliferous. |
| | | Unconformity | |
| Early Jurassic | Nilkitwa Formation | lJN | Amygdaloidal basalt, red epiclastic, phyllite, shale, siltstone, conglomerate. |
| | | Unconformity | |
| | Telkwa Formation | lJT | Lapilli tuff, breccia. |

**INTRUSIVE ROCKS**

gr quartz monzonite, granodiorite, quartz diorite
dr diorite, quartz diorite
rh rhyolite, quartz porphyry

Jurassic time. Tipper and Richards (1976) divide the group into three major formations in the Smithers map area (93L). These are the Late Sinemurian to Early Pliensbachian Telkwa Formation, the Early Pliensbachian to Middle Toarcian Nilkitkwa Formation and the Middle Toarcian to Early Callovian Smithers Formation.

## TELKWA FORMATION (lJT)

The Telkwa Formation, which is comprised of subaerial and submarine pyroclastic and flow rocks with lesser intercalated sedimentary rocks, is the thickest and most extensive formation of the Hazelton Group. The mixed subaerial to submarine Babine Shelf facies of the Telkwa Formation, which separates the subaerial Howson facies to the west from the submarine Kotsine facies to the east, underlies the Babine Range (Tipper and Richards, 1976).

The only outcrops of Telkwa Formation in the study area are located north of Reiseter Creek and south of Debenture Creek. Here the formation is comprised of maroon and green lapilli tuff and volcanic breccia with poorly defined interbeds of lithic, crystal and ash tuff. These rocks typically contain clasts of porphyritic andesite or crystal tuff in a fine-grained hematitic matrix of feldspar crystal and lithic fragments. In places the clasts are flattened and elongate parallel to bedding. These rocks are difficult to distinguish from lithologically similar Late Cretaceous volcanic rocks. Stratigraphic position and an older, more altered and weathered appearance are the criteria used in this study to distinguished Telkwa rocks from their younger counterparts.

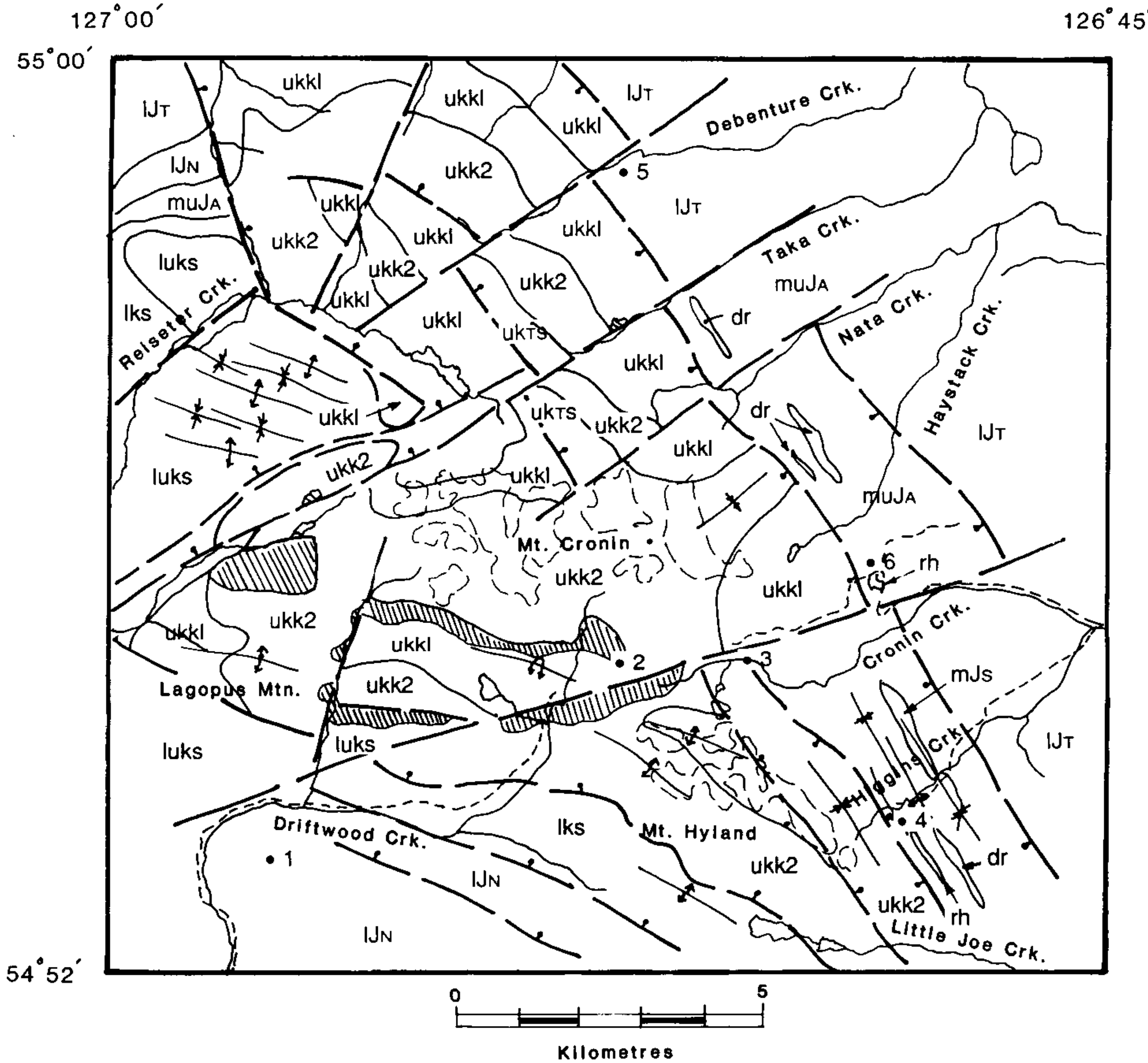


Figure 1-16-2. Geology of the Mount Cronin area (93L/15NW). *See* Table 1-16-1 for description of map units and Table 1-16-2 for list of mineral occurrences. Cross hatched areas are pyritic gossans.

## Nilkitkwa Formation (lJN)

The Nilkitkwa Formation conformably to disconformably overlies the Telkwa Formation and is an important host to mineral occurrences in the Babine Range (MacIntyre *et al.*, 1987). West of the Babine Range it is comprised of predominantly red epiclastic rocks; to the east it includes Early Pliensbachian to Middle Toarcian transgressive marine sedimentary rocks that overlie rhyolite and basalt flows and red epiclastic rocks. Units within the Nilkitkwa Formation were described in an earlier report (MacIntyre *et al.*, 1987).

In the study area, the Nilkitkwa Formation is predominantly green and maroon amygdaloidal flows with red-weathering phyllitic tuff and epiclastic interbeds. The sedimentary part of the formation is thin or absent. The amygdaloidal flows are best exposed in Little Joe Creek where they form the steep fault scarps along the south side of the valley. Similar, but much thinner, flows are also exposed in the extreme northwest corner of the study area, and in an anticlinal core north of the headwaters of Higgins Creek.

## Smithers Formation (mJS)

In the northern part of the Babine Range, the Smithers Formation, which elsewhere is predominantly Bajocian in age, disconformably overlies the Nilkitkwa Formation. It is comprised of fossiliferous, green glauconitic sandstone and

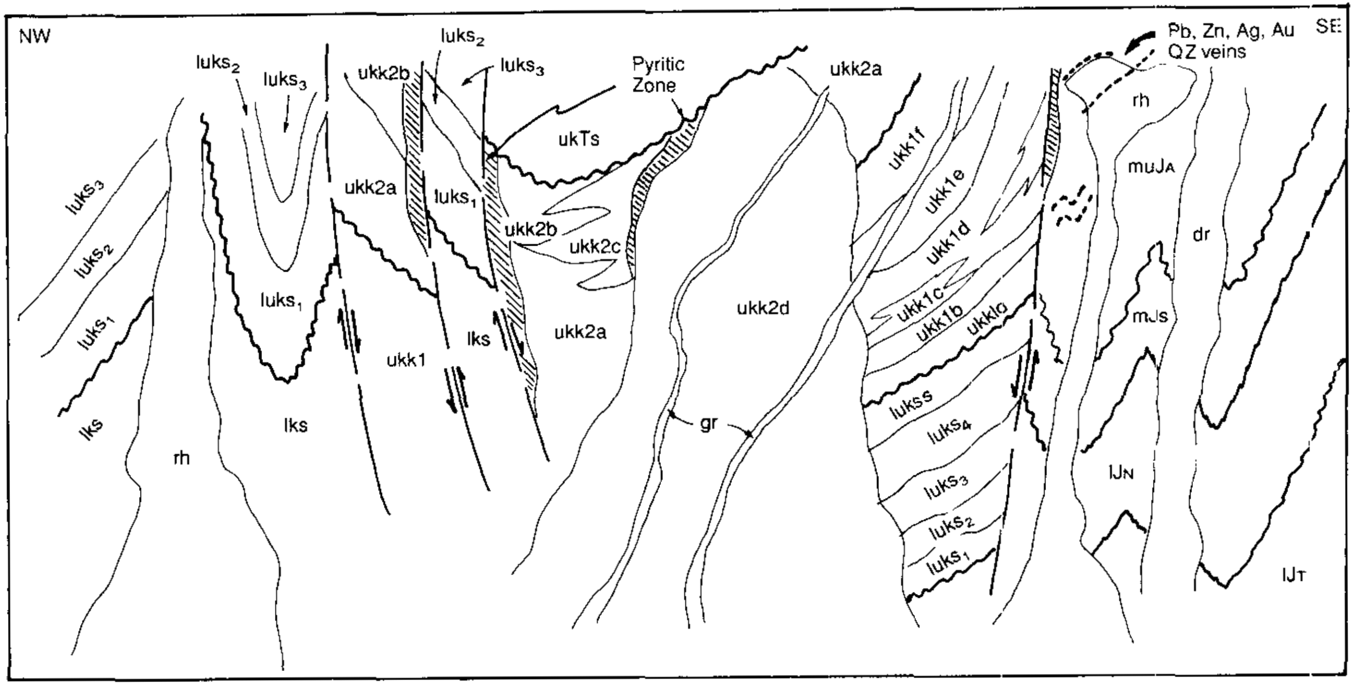


Figure 1-16-3. Diagrammatic sketch of relationships between map units in the Mount Cronin area. *See* Table 1-16-1 for description of map units.

siltstone, with lesser intercalated felsic tuff. These rocks were deposited during a marine regression.

To the south and west of the Babine Range, the Smithers Formation is either absent or rests directly on Telkwa Formation. In the current study area, the best exposures are located in the Higgins and Cronin Creek areas where fossiliferous, well-bedded shale, wacke and pebbly sandstone disconformably overlie amygdaloidal flows of the Nilkitkwa Formation. The Geological Survey of Canada has identified several fossil collections from this area as Middle Jurassic in age. None of the fossils collected could be assigned a more specific age.

### BOWSER LAKE GROUP

Within the Hazelton trough, successor basin deposits of the Bowser Lake Group (Duffell and Souther, 1964) conformably overlie the Smithers Formation. These rocks range in age from Late Bajocian to Early Oxfordian. Only the lowermost Ashman Formation is believed to be present in the study area. It was deposited during a mid-Jurassic marine transgression that apparently advanced as far south as the Skeena arch (Tipper and Richards, 1976).

## Ashman Formation (muJA)

In the northern Babine Range, phyllitic, tightly folded dark grey argillites and siltstones, with lesser intercalations of quartzose wacke and chert-pebble conglomerate, crop out along the eastern fault margin of Late Cretaceous volcanic rocks extending from Higgins Creek in the south to Debenture Creek in the north. These rocks are tentatively correlated with the Ashman Formation on the basis of stratigraphic position and lithology. A fossil collection from near the forestry lookout tower east of the Cronin mine yielded a possible Callovian age. The quartz and chert-bearing turbidite interbeds distinguish this unit from lithologically similar rocks of the Nilkitkwa Formation.

In the absence of fossils, the Ashman Formation is difficult to distinguish from the overlying Red Rose Formation of the Skeena Group which is also mapped as black shale and chert-pebble conglomerate. However, the coarse clastic beds of the Red Rose Formation often contain detrital mica and this has been used by other workers in the Babine Range to distinguish the two formations.

### SKEENA GROUP

The Skeena Group (Leach, 1910) comprises interbedded marine and nonmarine sedimentary strata of an Early Cretaceous successor basin. West of Telkwa these rocks unconformably overlie the Telkwa Formation and contain important coal seams (Koo, 1984). The coal seams occur in upward-fining fluvial clastic sequences of conglomerate, sandstone, siltstone and mudstone.

## Red Rose Formation (lKS)

The Geological Survey of Canada has mapped much of the area north of McKendrick Pass as the Red Rose Formation (Sutherland Brown, 1960) of the Skeena Group. It is uncertain what criteria have been used to establish the age of these rocks. Rocks that have been mapped as Red Rose Formation within the study area vary from well-bedded sandstone, mudstone and pebble conglomerate to graphitic black shale. They include well-bedded, strongly foliated dark grey, micaceous siltstone, argillite and mudstone with abundant wood and plant impressions (lKS1). These rocks grade upsection into a pebble conglomerate (lKS2) with tectonically

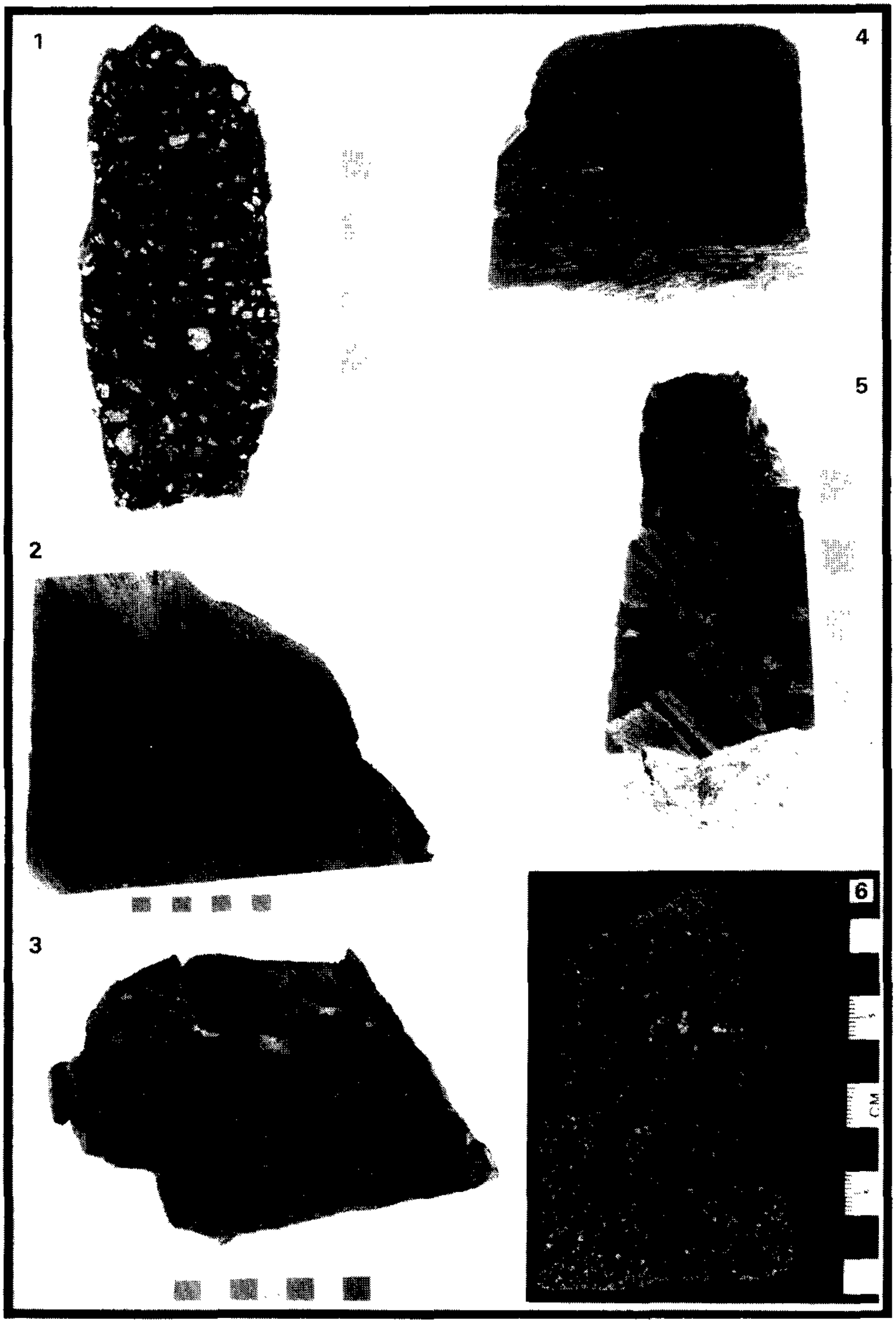


Plate 1-16-1. Bedded lapilli tuff and ash of lower division Kasalka Group. Sample from Silver King basin. Plate 1-16-2. Lapilli tuff with maroon and green clasts, lower division, Kasalka group. Sample from north of Mount Cronin. Plate 1-16-3. Banded siliceous maroon ash-flow tuff, lower division, Kasalka Group. Sample from north of Mount Cronin. Plate 1-16-4. Siliceous maroon volcanic breccia with angular clasts of banded ash-flow tuff, lower division, Kasalka Group. Sample from north of Mount Cronin. Plate 1-16-5. Crowded hornblende-feldspar-porphyritic andesite, upper division, Kasalka Group. Sample from Mount Hyland. Plate 1-16-6. Sparse maroon hornblende-feldspar porphyritic andesite, upper division, Kasalka Group. Sample from north of Mount Cronin.

flattened clasts of chert, quartz, granite, black argillite and orange-coloured siltstone. The best exposures of these rocks occur along the south side of Little Joe Creek valley and in the area northwest and southeast of Reiseter Creek.

### EARLY TO LATE CRETACEOUS SEDIMENTARY ROCKS (luKs)

In the Tahtsa Lake area of west-central British Columbia, Late Cretaceous volcanic rocks rest with angular discordance on the Skeena Group (MacIntyre, 1985b). However, in the Babine Range there is a succession of predominantly sedimentary strata that separates rocks correlated with Skeena Group from rocks correlated with the Late Cretaceous Kasalka Group.

The Early to Late Cretaceous sedimentary succession, from base to top, includes a maroon and green phyllite (luKs1), dark grey argillaceous siltstone (luKs2), resistant orange-weathering, flaser-bedded, foliated dolomitic siltstone (luKs3), well-bedded grey siltstone, wacke, chert-pebble conglomerate, cherty and shaly mudstone (luKs4) and poorly bedded, intensely folded dark grey argillite (luKs5) with bands of matrix-supported volcanic and intrusive clasts. The most complete section is exposed along the crest of the ridge south of Reiseter Creek. The basal phyllite unit lies conformably to disconformably on pebble conglomerate of the Skeena Group. The unit is apparently overlain by a heterolithic pebble conglomerate that constitutes the basal member of the Late Cretaceous volcanic succession.

### KASALKA GROUP (uKK)

The Kasalka Group (MacIntyre, 1985b) is a Late Cretaceous continental volcanic succession that is predominantly porphyritic andesite and associated volcaniclastic rocks. Sutherland Brown (1960) mapped similar rocks in the Rocher Déboulé Range north of Smithers as the Brian Boru Formation. Porphyritic volcanics in the vicinity of Mount Cronin were also mapped by the Geological Survey of Canada (Tipper and Richards, 1976) as Brian Boru Formation. These rocks are correlated with the Kasalka Group in this study.

In the current study area, the Kasalka Group has been subdivided into lower and upper divisions. The lower division (uKK1), which varies from 100 to 500 metres thick, includes heterolithic volcanic conglomerate and breccia (uKK1a), volcanic wacke and tuff (uKK1b), feldspar and augite-phyric amygdaloidal and vesicular flows (uKK1c), air-fall lapilli and crystal tuff and associated epiclastic rocks (uKK1d), and siliceous maroon ash flow, lapilli and crystal tuff with occasional conglomerate interbeds (uKK1e). The upper division (uKK2) is up to 1000 metres thick and is mainly hornblende feldspar porphyry and crystal tuff breccia (uKK2a), foliated hornblende feldspar crystal tuff (uKK2b), coarse-grained maroon to greenish grey hornblende feldspar porphyry flows and flow breccia (uKK2c) and hornblende feldspar porphyry subvolcanic intrusions (uKK2d).

The lower division represents explosive subaerial volcanism and possible cauldron subsidence; the upper division represents a period of lava eruption and construction of volcanic cones. Within the lower division there are several hematitic conglomerate beds that probably represent periods of erosion between volcanic events. The resistant Late Cretaceous volcanic rocks underlie the highest peaks in the area — Mount Hyland, Mount Cronin and Lagopus Mountain. The alpine plateau northeast of Reiseter Creek is also underlain by these rocks.

The contact between the Kasalka Group volcanic rocks and Ashman Formation argillites is exposed along the east margin of the Babine Range and appears to be a high-angle reverse fault with the Late Cretaceous rocks thrust upwards over the older strata. A similar relationship was observed south of Mount Hyland and Lagopus Mountain. However, south of Reiseter Creek the opposite situation is observed. Here, the older ocks have been thrust over the Late Cretaceous volcanic rocks.

### LOWER DIVISION

### Basal Conglomerate (uKK1a)

The basal member of the Kasalka Group is a maroon and green, heterolithic, poorly sorted pebble conglomerate that has rounded to subangular maroon and green tuff clasts. The conglomerates are interbedded with sandstone, siltstone and mudstone. Best exposures occur at the toe of several glaciers that occupy cirques on the north face of Mount Cronin. Here the conglomerates conformably overlie well-bedded argillites and siltstones (luKS4 and luKS5).

### Bedded Tuffs and Epiclastics (uKK1b)

Grey, recessive, thin-bedded tuffs, epiclastics and tuffaceous siltstone, sandstone and conglomerate (Plate 1-16-1) crop out in Silver King basin. These rocks are overlain by mafic flows and are probably underlain by maroon and green conglomerates. Rocks of this unit are often strongly foliated. Best exposures are on the ridge east of Silver King basin and in the cirque east of Mount Lagopus. Black siltstone containing angular felsic fragments crops out on the west side of a southerly flowing creek that empties into Reiseter Creek, and may be part of the same unit.

### Mafic Flows (uKK1c)

Overlying and interfingering with volcaniclastic rocks of the lower division are flows of augite-feldspar-phyric, green to maroon, vesicular and amygdaloidal basalt and andesite. These flows are most common in the eastern part of the study area, particularly from Mount Cronin to Debenture Creek. In one locality, north of Reiseter Creek, massive flows are exposed as a resistant knob that lies on a hematitic conglomerate bed. Underlying volcaniclastic rocks are orange to rust coloured and may have been oxidized or altered prior to eruption of the mafic flows.

### Lapilli Tuff and Breccia (uKK1d)

A thick-bedded, massive, maroon and green, feldspathic lapilli tuff (Plate 1-16-2) and volcanic breccia overlies and is interfingered with green to maroon vesicular basalt. This unit has a feldspathic matrix and in places is very difficult to distinguish from lapilli tuff of the Telkwa Formation. Stratigraphic relationships are best exposed along the east slope of the Babine Range, from Mount Cronin to Debenture Creek. In this area bedding dips moderately to steeply to the southwest. The lapilli tuffs overlie or are in fault contact with orange-weathering volcaniclastic rocks which are exposed farther down slope.

## Bedded Lahar, Epiclastics and Flows (uKK1e)

South of Debenture Creek, the lapilli tuff is overlain by green and maroon heterolithic conglomerate which grades up-section into a sequence of bedded rocks that include bedded epiclastic rocks, volcanic conglomerates and breccias, lahars and porphyry flows. North of Debenture Creek, the same section of lapilli tuffs apparently underlies an orange-weathering crystal tuff and overlies feldspar-phyric andesite. Similar lapilli tuffs also crop out on either side of the lake situated north of Mount Cronin and draining into Reiseter Creek, but the contacts in this area are probably high-angle normal or reverse faults and stratigraphic position is uncertain. In fact these lapilli tuffs may be part of the Lower Jurassic Telkwa Formation.

## Siliceous Ash-Flow Tuff and Breccia (uKK1f)

Laminated to thick-bedded, siliceous, maroon and green ash-flow tuffs (Plate 1-16-3) and breccias (Plate 1-16-4) with interbeds of volcanic breccia, lapilli tuff, hematitic pebble conglomerate and feldspar-phyric flows crop out on the steep ridge just north of Taka Creek. These rocks dip moderately southwest and conformably overlie lapilli tuff and orange-weathering volcaniclastic rocks that comprise the lower part of the Kasalka stratigraphic succession. Farther up-slope the siliceous pyroclastic rocks are intruded by coarse-grained feldspar porphyry.

### Upper Division

## Volcanic Breccia (uKK2a)

A thick section of grey to greenish grey-weathering, poorly bedded volcanic breccia with interbeds of orange-weathering foliated tuff forms the core of Lagopus Mountain and Mount Hyland. These rocks contain hornblende feldspar crystal tuff and porphyritic andesite clasts. Clasts are angular and vary from matrix to clast supported. Some clasts have reaction rims and irregular ovoid shapes suggesting they may be bombs. The contact with underlying maroon volcaniclastic rocks of the lower division is not well exposed but is assumed to be conformable.

## Crystal Tuff (uKK2b)

Volcanic breccias grade up-section into grey to greenish grey, poorly bedded to faintly laminated hornblende feldspar crystal (Plate 1-16-5) and ash tuffs with minor mudstone interbeds. These rocks are locally strongly foliated. This unit is well exposed on Mount Hyland and Lagopus Mountain, on the crest of the ridge south of Reiseter Creek, and in the Silver King basin. It has also been mapped in the Debenture Creek area.

## Porphyritic Andesite (uKK2c)

Interbedded with, and in part overlying volcanic breccias and tuffs at the base of the lower division, are flows of coarse-grained hornblende feldspar porphyritic andesite. These flows have a fine-grained maroon matrix with euhedral feldspar phenocrysts up to 1 centimetre long (Plate 1-16-6). Hornblende phenocrysts are typically altered to chlorite or epidote. The flows are best exposed on Lagopus Mountain, on the east side of Mount Cronin and on Mount Hyland. It is difficult to determine if all of the feldspar-porphyritic rocks are flows; some may be intrusive.

## Subvolcanic Intrusions (uKK2d)

The jagged peaks of Mount Cronin are comprised of sheet-jointed, massive, grey to maroon hornblende feldspar porphyritic andesite. These rocks are interpreted to be the subvolcanic intrusive core of a major stratovolcano. A belt of similar, coarsely porphyritic maroon andesite extends north from Mount Cronin and cuts volcaniclastic rocks of the lower division at a high angle. The contact is irregular, with fingers of porphyry extending outward into the adjacent wallrock. No contact metamorphism was observed. Hematitic streaks are common within the porphyry.

### LATE CRETACEOUS TO TERTIARY SEDIMENTARY ROCKS (uKTs)

Northeast of Mount Cronin, a gentle syncline of well-bedded tuffaceous and argillaceous sedimentary rocks lies on top of coarse-grained intrusive feldspar porphyry. Examination of the contact indicates the feldspar porphyry was weathered prior to deposition of the sedimentary strata. This suggests the contact is an erosion surface and the sedimentary rocks were deposited directly on the porphyry. These sedimentary rocks are probably latest Cretaceous or early Tertiary in age. Both the porphyry and overlying sedimentary rocks have been offset and truncated by northeast-trending shear zones.

The sedimentary succession begins with interbedded tuffaceous siltstone and crystal tuff and grades up-section into interbedded dark grey argillite, siltstone and wacke with occasional light grey cherty bands. Chert fragments are common in overlying pebble conglomerate and wacke. In general the sequence appears to coarsen up-section.

### INTRUSIVE ROCKS

Within the study area, three major groups of intrusions have been identified. These are rhyolitic (rh), dioritic (dr) and granitic (gr). The rhyolitic and dioritic intrusions occur as dykes and plugs cutting rocks that parallel the northwestern and eastern boundaries of the area of Late Cretaceous volcanic rocks. Rhyolite dykes also cut strongly foliated Late Cretaceous volcanic rocks west of Mount Cronin and north of Lagopus Mountain. These dykes are not foliated and therefore must postdate Late Cretaceous to Tertiary folding and shearing.

A swarm of granitic dykes is exposed on the steep east-facing slope of Mount Cronin and can be followed south toward Mount Hyland. These dykes are most abundant within the Late Cretaceous volcanic pile and particularly within subvolcanic intrusions of porphyritic andesite. They may be emanating from a granitic core at depth.

## STRUCTURE

Structural trends in the study area are shown in Figure 1-16-4. The trends shown include bedding ($S_0$), slaty cleavage ($S_1$), a crenulation or fracture cleavage ($S_2$) and a late cleavage ($S_3$) related to northeast shearing. Minor fold axes and dyke trends are also shown. In general there is a swing from easterly to southeasterly trends going from northwest to southeast.

Four deformational phases are recognized. The earliest phase is related to a regional compressional tectonic event in the late Early Cretaceous that was accompanied by folding and uplift of much of the Smithers area. This was followed in Late Cretaceous and Early Tertiary time by extensional tectonics accompanied by block faulting and associated volcanism. The Late Cretaceous and Tertiary volcanic event was followed by compression and folding with reactivation of earlier high-angle faults and thrusting of subsided blocks over adjacent rocks. The latest event appears to be development of northeast-trending shear zones and offsetting of earlier structural trends.

The arcuate belt of inward-tilting fault blocks in the northern part of the study area may have been produced by explosive eruption and evacuation of magma chambers during the early stages of Late Cretaceous volcanism. Radiating normal faults occur in the northwestern part of the map area and may be part of a radial fault system centred on the area of collapse. Dykes of diorite and rhyolite that parallel the eastern and northwestern fault boundaries of subsided blocks of Late Cretaceous volcanics may have been emplaced along ring fractures.

Post-volcanic compression and folding is probably Tertiary in age and related to opposing motion on northwest-trending transcurrent fauls bounding the Babine Range — a transpressional tectonic regime. Compression in the area

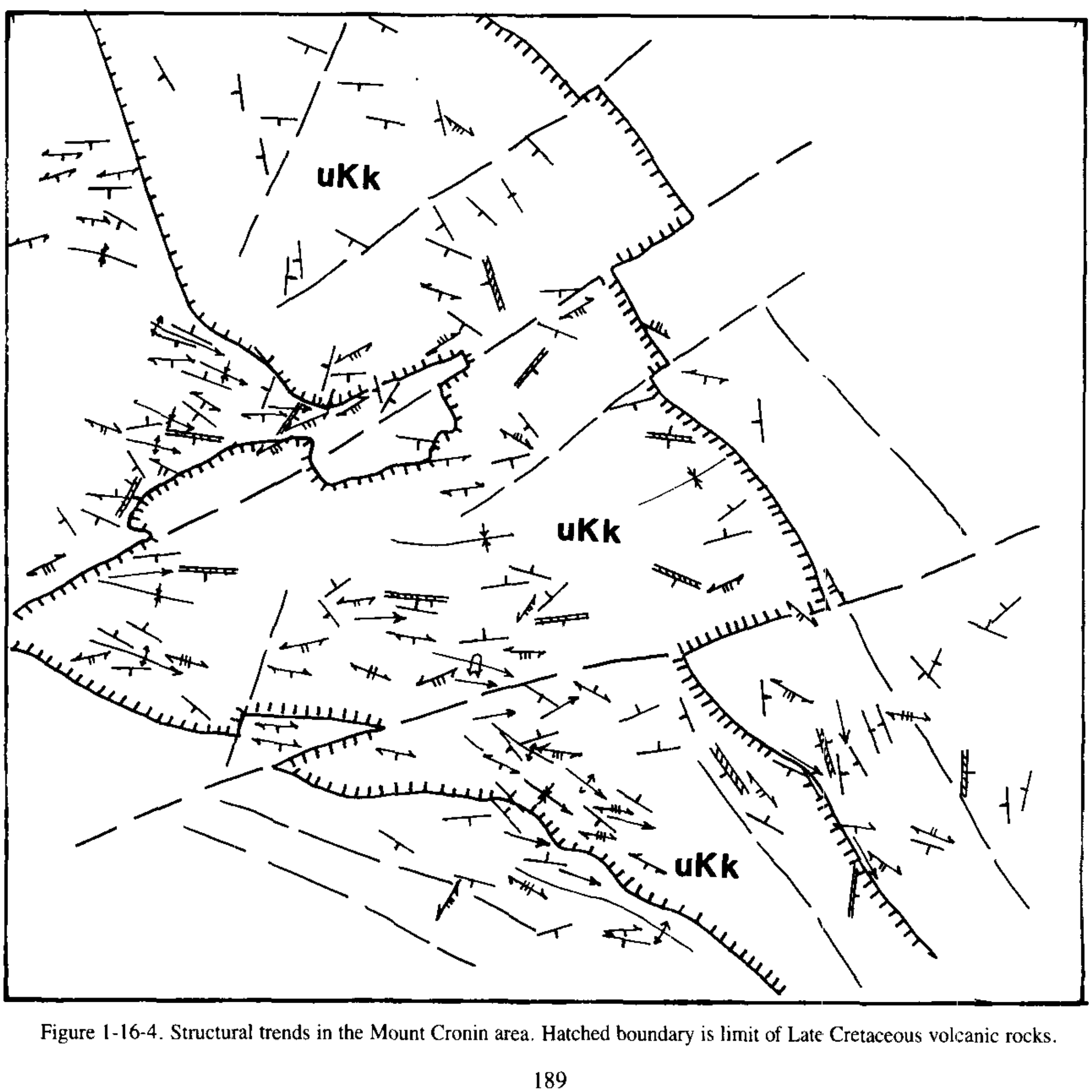


Figure 1-16-4. Structural trends in the Mount Cronin area. Hatched boundary is limit of Late Cretaceous volcanic rocks.

between the transcurrent faults resulted in squeezing upward of previously subsided fault blocks and thrusting of these fault blocks over adjacent areas. As folding and thrusting continued, northeast-trending shear zones were developed that offset the northwest-trending geology.

Incompetent sedimentary strata that are in fault contact with upward thrusted blocks of Cretaceous volcanic rocks are tightly folded with a well-developed penetrative cleavage Fold axes trend east to southeasterly with consistent plunges to the east or southeast. Change of fold axis trend appears to be related to movement and rotation along zones of northeast shearing. These folded rocks are cut by dykes that have not been deformed.

## MINERAL DEPOSITS

Mineral deposits in the Babine Range can be subdivided into six groups. These are: (1) mesothermal gold-silver-bearing quartz veins; (2) copper-silver veins in mafic and felsic volcanic rocks; (3) copper-zinc-silver massive sulphide deposits associated with mafic flows; (4) polymetallic massive sulphide occurrences associated with rhyolitic volcanic rocks; (5) porphyry copper-molybdenum deposits associated with dioritic sills; and (6) porphyry copper-molybdenum deposits associated with quartz monzonite intrusions. Types 1 and 2 are present in the study area (Table 1-16-2).

### COPPER-SILVER VEINS

### Rainbow (Minfile 093L-132)

The Rainbow property is located between 1100 to 1400 metres elevation on the east side of Driftwood Creek, 8 kilometres northeast of Smithers. The Rainbow claims were first held by a Smithers syndicate of which G.R. Wright and H.J. Kelly were the principal members. Exploration and development work was reported in 1921. The Rainbow 1 and Rainbow 2 claims were optioned by F.H. Taylor of Smithers in 1925.

In 1987, Atna Resources Ltd. worked on the property. A crew set up a grid, soil sampled and did some geophysics. A trench exposing a quartz vein carrying chalcopyrite, tetrahedrite, azurite and malachite in amygdaloidal basalt of the Nilkitkwa Formation was visited. Adjacent to the quartz vein the basalt is a light green colour with stretched out chlorite blebs and limonite and epidote alteration. Chlorite occurs along fractures that have slickensides.

### MESOTHERMAL QUARTZ VEINS

### Silver King Basin (Minfile 093L-201)

The Silver King prospect is located at the head of Driftwood Creek in the Silver King basin. Prior to 1917, this prospect was owned by P.J. Higgins of Spokane. The property was optioned to the Goldfield Consolidated Co. in 1917. Workings at that time included a 30-metre adit. Drifting was continued in the 1920s and 1930s; 6.35 tonnes of sorted ore was shipped.

George Hanson first mapped the Silver King claim in 1924. Remapping by Tipper and Richards (1976) showed the area to be underlain by varicoloured porphyritic tuff, breccia and flows of the Brian Boru Formation (Kasalka Group). The mineralization is therefore Late Cretaceous or younger in age.

Mineralized quartz veins occur in shear zones within the Late Cretaceous volcanic succession. The shear zones strike easterly and dip 45 to 70 degrees north. The veins occur as discontinuous stringers and lenticular masses of shattered quartz ranging in width from 2.5 centimetres to 1.8 metres and containing variable amounts of galena, tetrahedrite, chalcopyrite, pyrite, sphalerite, and a little native copper and silver. Similar mineralization is found in two prospect adits about 370 metres southeast from the main workings.

Rocks within the mineralized area are altered to chlorite and carbonate and contain disseminated pyrite. Adjacent to the vein these rocks are silicified.

### Hyland Basin (Minfile 093L-128)

The property is located at the 1735-metre elevation at the head of Cronin Creek and is accessible by road from the Cronin mine.

Martin Cane and Tom King held the Hyland Basin claim group from about 1922. The property was optioned by a Mr. Duthie in the fall of 1923 and an adit was driven for 58 metres along the projected strike of the veins. Various owners did trenching on the property in the 1930s and 1940s. Two lots of sorted ore were shipped to the Department of Mines sample plant at Prince Rupert in 1940. American Yellowknife Gold Mines Ltd. did some mapping and trenching in 1951.

Near the showings, rhyolite dykes intrude argillite, argillaceous quartzite, limestone and tuffs of probable Jurassic age. Some dykes follow shearing of the country rock. Quartz veins are associated with the rhyolite dykes which strike easterly, parallel to shearing or slaty cleavage in the argillites.

**TABLE 1-16-2**
**MINERAL OCCURRENCES**

| Map No. | Minfile | Occurrence | Commodities | Type of Deposit | Map Unit | Attitude | Comments |
|---|---|---|---|---|---|---|---|
| 1 | 132 | RAINBOW | Cu,Ag | VEIN | lJN | VARIES | Lenticular quartz veins |
| 2 | 201 | SILVER KING BASIN | Pb,Cu,Zn,Ag | QUARTZ VEINS | uKK2b | EAST/45°-70°N | Irregular in attitude |
| 3 | 128 | HYLAND BASIN | Pb,Cu,Zn,Ag | QUARTZ VEINS | uKK2a | EASTERLY | Lenticular quartz veins |
| 4 | 126 | LORRAINE | Pb,Zn,Cu,Ag | QUARTZ VEIN | muJA | SOUTH/70° W | Quartz stringers |
| 5 | 140 | DEBENTURE | Pb,Ag? | QUARTZ VEIN | lJT | 120°/55°NE | Bands of galena |
| 6 | 127 | CRONIN | Ag,Pb,Zn.Cu | QUARTZ STOCKWORK | muJA | NE/NW | Fault zones carry mineral |

The quartz veins vary from barren to well mineralized with galena, tetrahedrite and a little sphalerite and chalcopyrite. Grab samples were taken from these showings and are being analysed.

## LORRAINE (VICTORIA) (MINFILE 093L-129)

The property is located at the 1550-metre elevation at the head of Higgins Creek, 27 kilometres northeast of Smithers. The Victoria claim was first owned by P.J. Higgins of Spokane. A 43-metre adit and three shafts were completed between 1916 to 1918. H.L. Messner optioned the property in 1926 and formed Lorraine Copper Silver Mines Limited to conduct underground exploration on the property.

B.F. Messner was the owner of the Lorraine Group in 1946. American Yellowknife Gold Mines Ltd. optioned the property in 1951 and carried out geologial mapping, stripping, sampling, and some diamond drilling. Native Mines Limited was incorporated in 1964 and acquired the property as the Silver Queen, New Strike and Extension group. It completed an electromagnetic survey, surface stripping, surface diamond drilling and 240 metres of underground development in 1965 and 1966.

Folded, dark grey to orange-weathering phyllite underlies the Lorraine property and is cut by rhyolite, diorite and andesite dykes. Quartz stringers parallel the slaty cleavage and have been folded and dismembered. An orange-weathering massive andesite dyke cuts the phyllite and is post-tectonic. "M"-style folding and undulating slaty cleavage are common in the phyllites. Orange-weathering siltstone and less foliated massive green fragmental tuff overlie the phyllites. Thick-bedded greenish grey-weathering ash-flow tuffs which contain flow-banded rhyolite overlie the orange-weathering siltstone.

The Main vein is a bedded quartz lode in contorted argillaceous phyllite. The lode pinches and swells irregularly and probably averages about 45 centimetres in width. It is sparsely mineralized with disseminated pyrite, galena, sphalerite, chalcopyrite and occasional grains of tetrahedrite. Grab samples from this area were sent to the Geological Survey Branch analytical laboratory for assay.

The West vein consists of two parallel quartz stringer zones separated by about 50 centimetres of sheared argillite and gouge. It strikes south and dips 70 degrees to the west. The hangingwall is a rhyolite dyke and the footwall is argillite. The quartz stringers contain sparsely disseminated pyrite and base metal sulphide.

## DEBENTURE (MINFILE 093L-140)

The Debenture showing is located at the 1450-metre elevation on the south side of Debenture Creek, 29 kilometres northeast of Smithers. In 1916, Debenture Creek Mines Ltd. drove a crosscut adit 116 metres on the 1430-metre level and intersected the No. 2 vein at 99 metres. In 1964, Native Mines Limited acquired the Debenture property and drove a new adit about 30 metres. In 1966, Wanda Mines and Exploration Ltd. acquired the property and did some sampling.

A diorite sill or dyke, approximately 6 metres thick, is exposed about 61 metres below the adit. This intrusion cuts chlorite-epidote-altered lapilli tuffs of probable Late Cretaceous age that dip 40 to 45 degrees southwest. The main showing is a segmented, contorted quartz vein with variable amounts of galena, that strikes northwest and dips northeast. The vein occurs within a rusty zone of partly sericitized, silicified and sheared volcanic rock. Stringers of galena with minor pyrite occur in silicified andesite tuffs. Grab samples have been submitted to the Geological Survey Branch laboratory for assay.

## CRONIN (MINFILE 093L-127)

The Cronin mine is on the east flanks of Mount Cronin, approximately 28 kilometres northeast of Smithers. The property is accessible by a rough road that connects with the Babine Lake road just east of McKendrick Pass.

The property was first staked in 1906. In 1909, James Cronin acquired the claims and completed 122 metres of underground workings prior to 1910. The mine reopened in 1914 and development work was carried on each summer until 1923. Between 1928 and 1931, Babine Bonanza Metals Limited completed additional crosscuts and raises. Cronin Babine Mines Ltd., incorporated in 1948, drilled on surface (five holes totalling 387 metres) and underground (11 holes totalling 407 metres). Nothing further was reported until 1951 when the workings were reopened and mill construction began. The 40 tonne-per-day mill was in operation in 1952 and from 1956 to 1957. From 1962 to 1972, Kindrat Mines Ltd. carried out small-scale intermittent mining on the property. Hallmark Resources Ltd. acquired Kindrat Mines in 1972 and completed 75 metres of drifting and raising, geological mapping and a geochemical soil survey. In 1974 drifting and stope preparation were carried out on No. 2 vein and the mill operated from July to August. Coca Minerals Ltd. optioned the property in 1975 and drilled 10 surface diamond-drill holes into the Wardell zone, identifying a small high-grade body of mineralization. Goldsil Mining and Milling Inc. optioned the property in 1983 and completed extensive underground sampling and some surface diamond drilling. This work confirmed and improved the previously known reserves. Drill-indicated reserves are 317 000 tonnes grading 1.7 grams per tonne gold, 354.4 grams per tonne silver, 8.0 per cent lead and 8.0 per cent zinc (as indicated in MINFILE). In 1987 Southern Gold Resources Ltd. acquired an option on the property and, with financial support from the FAME program, did geologic mapping and sampling over the main area of interest.

The Cronin showings occur within a northeast-trending zone that cuts through a rhyolite plug or dome into sericite schist, dark grey to black argillite, quartzose sandstone, greywacke and chert-pebble conglomerate of the Ashman Formation. These rocks are in fault contact with Late Cretaceous volcanic rocks of the Kasalka Group immediately west of the showings. Diorite dykes also outcrop in the vicinity of the showings and are probably members of a series of such dykes that parallel the Kasalka Group – Ashman Formation fault boundary. Rocks near the rhyolite bodies are intensely sericitized and foliated. Foliation may have been superimposed on these rocks by overthrusting of Late Cretaceous volcanics from the west and by movement along a major northeast-trending shear zone that trends up Cronin Creek and into Silver King basin. Northwest of the showings, the lower division of the Late Cretaceous volcanic succession strikes northeasterly and dips steeply to the northwest. It is comprised of varicoloured porphyritic tuffs, breccias and flows with unaltered feldspar phenocrysts. These rocks, like older Ashman rocks to the east near the main showings, are cut by rhyolite dykes, indicating the dykes must postdate Late Cretaceous volcanism. If the rhyolite plug hosting the mineralization at Cronin is the same age as these dykes, then mineralization must also be post-Late Cretaceous, perhaps Tertiary.

Schroeter (1975) distinguishes two phases of rhyolite intrusions at Cronin. One is a grey rhyolite porphyry that is massive, medium to fine grained with 20 to 40 per cent albite laths 1 to 3 millimetres in length in an aphanitic groundmass of quartz, calcite, sericite, zoisite and chloritoid. There is no appreciable chilled margin where this unit is in contact with the sedimentary rocks. A quartz stockwork cuts the rhyolite porphyry and has been truncated by a younger rhyolite porphyry phase. This younger phase is host to a second generation of quartz veins. Quartz veinlets average 4 to 20 millimetres in width and carry variable amounts of sphalerite and galena.

A strongly sericitized, white to pale yellow rhyolite cuts the early rhyolite porphyry phases (Schroeter, 1975). This intrusion is mostly aphanitic, but locally contains up to 15 per cent quartz phenocrysts. Very fine-grained quartz, "sericite" and calcite make up the bulk of the rock. Pyrite, sphalerite and galena occur on dry fractures rather than in a quartz stockwork (Schroeter, 1975). Both rhyolitic units have undergone low-grade regional metamorphism.

The main exploration targets at Cronin are massive sulphide and quartz veins that contain argentiferous galena and sphalerite with relatively minor pyrite and chalcopyrite. Boulangerite, freibergite and arsenopyrite have also been identified. The sulphide minerals also occur in breccia zones and as fracture fillings in the rhyolite with little quartz. Massive quartz veins are up to 0.6 metre thick, strike northeast and dip 45 to 65 degrees to the northwest. One major quartz vein containing pockets of massive high-grade mineralization has been traced over a length of 75 metres.

On surface the Wardell vein, a heavily mineralized breccia, crosscuts the dominant lithological trend at approximately 90 degrees. Numerous other quartz and quartz-sulphide veins are oriented in a variety of directions in a coarse stockwork pattern.

## Pyritic Gossans

Prominent gossans occur within the area of Late Cretaceous volcanic rocks, particularly west of the Silver King

**TABLE 1-16-3**
**ASSAY DATA**

| Sample No. | Easting Northing | Location | Minerals | Au ppb | Ag ppm | Cu ppm | Pb ppm | Zn ppm | Ni ppm |
|---|---|---|---|---|---|---|---|---|---|
| DM87 52 1 | 634435 6093371 | DEBENTURE CK. | gossan, diss py | <20 | 0.5 | 23 | 12 | 50 | 24 |
| DM87 71 1 | 636271 6091672 | EAST OF MT. CRONIN | quartz-carb exhalite | 40 | 0.8 | 9 | 5 | 20 | 2 |
| DM87 80 1 | 638332 6089968 | EAST OF MT. CRONIN | malachite, azurite in quartz | 650 | 420.0 | 2200 | 8 | 107 | 3 |
| DM87 92 1 | 637657 6086782 | HYLAND BASIN | rusty phyllite | <20 | 0.5 | 17 | 8 | 112 | 4 |
| DM87 93 1 | 633948 6089968 | EAST OF LAGOPUS MT. | bleached sericite py | <20 | 0.5 | 13 | 42 | 113 | 5 |
| DM87 94 1 | 633934 6085553 | EAST OF LAGOPUS MT. | gossan | <20 | 0.5 | 9 | 12 | 72 | 2 |
| DM87 99 1 | 632735 6086206 | EAST OF LAGOPUS MT. | gossan bleached | <20 | 0.5 | 2 | 8 | 4 | 2 |
| PD87 270 1 | 637231 6084602 | MT. HYLAND | malachite | 80 | 0.4 | 210 | 7 | 10 | 7 |
| PD87 277 1 | 636545 6083910 | MT. HYLAND | altered andesite | <20 | 0.4 | 15 | 10 | 66 | 3 |
| PD87 282 1 | 634821 6086702 | NW OF DRIFTWOOD CK. | altered andesite | <20 | 0.4 | 27 | 13 | 17 | 0 |
| PD87 284 1 | 634668 6086694 | NW OF DRIFTWOOD CK. | gossan, diss py | 50 | 0.4 | 13 | 17 | 24 | 4 |
| PD87 287 1 | 634426 6087614 | NW OF DRIFTWOOD CK. | gossan, diss py | <20 | 0.5 | 17 | 22 | 33 | 5 |
| PD87 290 1 | 634238 6087860 | NW OF DRIFTWOOD CK. | gossan, diss py | 130 | 0.4 | 8 | 18 | 69 | 5 |
| PD87 330 2 | 634254 6094783 | WEST OF DEBENTURE CK. | gossan, diss py | <20 | 0.5 | 0 | 37 | 99 | 8 |
| PD87 331 1 | 634317 6094816 | WEST OF DEBENTURE CK. | altered andesite | 90 | 0.5 | 28 | 56 | 85 | 19 |
| PD87 353 1 | 635984 6094491 | DEBENTURE SHOWING | quartz vein | 200 | 33.0 | 27 | 12000 | * | 8 |
| PD87 353 2 | 635984 6094491 | DEBENTURE SHOWING | quartz vein | <20 | 100.0 | 217 | * | * | 4 |
| PD87 353 3 | 635984 6094491 | DEBENTURE SHOWING | quartz vein | <20 | 140.0 | 117 | * | * | 12 |
| PD87 353 4 | 635984 6094491 | DEBENTURE SHOWING | quartz vein | <20 | 0.5 | 34 | 45 | 210 | 18 |
| PD87 353 6 | 635984 6094491 | DEBENTURE SHOWING | quartz vein | <20 | 480.0 | 280 | * | * | 10 |
| PD87 372 4 | 637084 6090317 | NORTH OF MT. CRONIN | gossan | <20 | 0.5 | 32 | 13 | 150 | 28 |
| PD87 372 6 | 637096 6090394 | NORTH OF MT. CRONIN | gossan | <20 | 0.5 | 24 | 15 | 64 | 14 |
| PD87 376 4 | 637379 6090773 | NORTH OF MT. CRONIN | cp,py,malachite | <20 | 4.0 | 3600 | 758 | 557 | 420 |
| PD87 383 2 | 637668 6088342 | MT. CRONIN | limonitic qtz. | <20 | 0.6 | 8 | 13 | 62 | 9 |
| PD87 385 1 | 638217 6088304 | MT. CRONIN | rhyolite | <20 | 0.7 | 6 | 15 | 66 | 0 |
| PD87 388 1 | 639065 6088218 | MT. CRONIN | gossam sericitic | <20 | 3.0 | 106 | 123 | 335 | 42 |
| PD87 388 2 | 639065 6088218 | EAST OF LAGOPUS MT. | limonitic | 90 | 0.5 | 3 | 8 | 32 | 2 |
| PD87 392 1 | 639240 6088584 | MT. CRONIN | malachite | 370 | 420.0 | 2500 | * | * | 5 |
| PD87 400 2 | 639779 6088227 | MT. CRONIN | 7% sulphides | 520 | 310.0 | 70 | * | 107 | 2 |
| PD87 401 1 | 640053 6088205 | MT. CRONIN | quartz with gl. | 2300 | 14.0 | 13 | * | 142 | 6 |
| PD87 402 1 | 633715 6088009 | EAST OF LAGOPUS MT. | gossan, diss py | <20 | 2.0 | 20 | 93 | 38 | 9 |
| PD87 430 2 | 633936 6087795 | EAST OF LAGOPUS MT. | altered ands. dis py | <20 | 0.8 | 13 | 62 | 47 | 26 |
| PD87 403 3 | 633393 6087795 | EAST OF LAGOPUS MT. | quartz | <20 | 0.5 | 2 | 12 | 12 | 7 |
| PD87 404 1 | 633214 6083214 | EAST OF LAGOPUS MT. | gossan, py | <20 | 0.6 | 15 | 33 | 63 | 63 |
| PD87 405 2 | 633118 6087805 | EAST OF LAGOPUS MT. | quartz | <20 | 0.5 | 2 | 10 | 3 | 2 |
| PD87 409 1 | 632768 6087805 | EAST OF LAGOPUS MT. | gossan, py | <20 | 0.5 | 9 | 10 | 90 | 44 |
| PD87 410 1 | 632642 6087111 | EAST OF LAGOPUS MT. | altered ands py | <20 | 0.5 | 20 | 12 | 112 | 34 |
| PD87 411 1 | 632430 6086713 | EAST OF LAGOPUS MT. | gossan | <20 | 0.5 | 15 | 12 | 22 | 6 |
| PD87 412 1 | 632312 6086482 | EAST OF LAGOPUS MT. | altered basalt | <20 | 0.5 | 11 | 15 | 56 | 5 |
| PD87 413 1 | 632212 6086303 | EAST OF LAGOPUS MT. | gossan, sericite | <20 | 0.5 | 10 | 12 | 214 | 30 |
| PD87 413 2 | 632212 6086303 | EAST OF LAGOPUS MT. | quartz | <20 | 0.5 | 10 | 12 | 214 | 30 |

* = very high grade

basin and in the valley north of Lagopus Mountain (Figure 1-16-2). Rocks within these gossan zones are typically strongly foliated, sericitized and bleached. Disseminated pyrite occurs throughout them; locally there is silicification, quartz veining and brecciation. All of the gossans in the map area were sampled (Table 1-16-3).

The gossans appear to be related to post-Late Cretaceous shear zones. One exception may be the gossan near the head of the cirque valley northwest of Silver King basin which appears to parallel the contact of a subvolcanic intrusion of porphyritic andesite.

A gossan with approximately 3 per cent disseminated chalcopyrite, pyrite and malachite in strongly foliated and sheared volcanics occurs in Taka Creek, approximately 2 kilometres north of Mount Cronin. Together with several others to the southeast, it occurs along a major northeast-trending shear zone that offsets Late Cretaceous to Tertiary volcanic and sedimentary rocks.

### Quartz Veins

Barren quartz veins are common within the study area, particularly near major fault zones. These veins are both pre and post-shearing.

On the ridge west of Mount Hyland, a quartz vein 10 to 20 centimetres wide cuts sheared Late Cretaceous volcanic rocks. It pinches and swells within the shear zone and carries minor malachite and possibly tetrahedrite. A grab sample of vein material contained slightly anomalous (80 ppb) concentrations of gold.

On the ridge north of Lagopus Mountain, a rhyolite plug or dome cuts Cretaceous sedimentary rocks. Numerous sub-horizontal barren quartz veins, some up to 2 metres thick, occur within the plug but do not appear to extend into adjacent wallrock. Only background gold concentrations were detected in samples submitted for assay.

A northwest-trending quartz vein cuts Late Cretaceous porphyritic andesite 2 kilometres northwest of the Cronin Mine. A sample of malachite-stained quartz from a small pit along the vein contained 600 ppb gold.

### Siliceous Zones

A zone of silicified volcanic and sedimentary rocks extends for 4000 metres along the west slope of the plateau north of Mount Cronin. Strata in this area trend northwest and dip moderately southwest. East of the silicified zone are well-bedded Late Cretaceous to Tertiary sedimentary rocks (uKTs). West of the silicified zone are maroon lapilli tuffs which we believe are part of the lower division of the Kasalka Group. The apparent stratigraphic offset across the silicified zone suggests it follows a major fault zone. Samples of silicified rock have been submitted for assay but results are not yet available. There is little or no sulphide mineralization associated with the silicification but streaks of manganese oxide are common. If our interpretation is correct, this fault zone was the site of extensive hydrothermal activity and may be a favourable target for epithermal mineralization.

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