

Preto, V.A. and Northcote, K.E., 1977: Nicola Volcanic Rocks, Related Plutons and Mineral Deposits  
Trip 5, GAC-MAC-SEG-CGU Fieldtrip Guidebooks

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Afton Mine  
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## IRON MASK BATHOLITH

The tour will leave Highway 5 at Knutsford and proceed westerly and northerly through the Iron Mask batholith.

### GEOLOGY OF THE IRON MASK BATHOLITH

(Northcote 1977)

#### REGIONAL SETTING

The Iron Mask batholith is a multi-unit intrusion comprised of Iron Mask Hybrid, Pothook, Sugarloaf and Cherry Creek units, each of which has several varieties. The rocks are fine grained and porphyritic to coarse-grained and are silica poor ranging from gabbro to syenite composition with diorite predominating.

Major systems of northwesterly, northerly and northeasterly trending recurring fractures or faults controlled emplacement of various units of the Iron Mask batholith. The batholith was emplaced in a high level volcanic to subvolcanic environment and is comagmatic with Nicola volcanic rocks and coeval with part of the upper Nicola succession. It intruded volcanic and sedimentary rocks of the lower Nicola but the Cherry Creek unit occurs both as fragments in and is in intrusive contact with uppermost Nicola rocks.

The Nicola and Iron Mask rocks are unconformably overlain by Tertiary sedimentary and volcanic rocks of the Kamloops Group. In many places along the flanks of the batholith the pre-Tertiary erosion surface seems to nearly coincide with the present day erosion surface. Erosional remnants of Tertiary volcanic rocks cap the higher hills and occur in places along their flanks. This pre-Tertiary erosional surface appears to have been very irregular although post-Tertiary faulting may have accentuated this apparent irregularity and resulted in local preservation of post-batholith rocks within the batholith.

## GEOLOGY

Rock descriptions are based on field observations of texture, composition and kind and intensity of alteration.

### Nicola Group

The southeast half of the batholith is flanked on both sides by Nicola volcanic and volcanoclastic sedimentary rocks which are lithologically quite dissimilar to overlying Tertiary volcanic and volcanoclastic rocks.

Nicola rocks on the southwestern flank consist predominantly of well indurated, weakly metamorphosed massive and bedded tuffs, breccias which are possibly lahars, and interbedded flows and monomictic flow breccias. Most of these rocks are of a fairly uniform green-grey colour.

Nicola rocks on the northeast flank are mainly tuff and tuff breccia which are, for the most part, less well indurated than on the southwest flank. They contain fragments of many different colours and in some places are abundantly hematitic. A well indurated exposure of bedded tuff and breccia similar to those on the southwestern flank crops out between Knutsford and Knutsford Hill.

The Nicola rocks on both flanks of the batholith contain augite porphyry and augite porphyry breccia which, on the north side of Jacko Lake, has been metamorphosed along the intrusive contact. Nicola rocks along the southwestern flank and at the southeast tip of the batholith contain distinctive augite-hornblende porphyries which are identical to varieties of the Sugarloaf unit which also occurs predominantly along the southwest flank of the batholith

### Intrusive Rocks of the Iron Mask Batholith

All intrusive units with the exception of "picrite" are thought to be genetically related. Most units everywhere show some degree of alteration and/or contamination which may be intense in some places. In most cases, however, original textures are still visible and are used as the main criteria for distinguishing among units and varieties.

### Iron Mask Hybrid Unit

The Iron Mask Hybrid unit occurs in the central and eastern part of the northwest half of the batholith and forms a margin about 1.2 km wide along the southwest side of the southeast half. An elongate pendant or screen of Iron Mask Hybrid rocks approximately 3.2 km long occurs in Cherry Creek rocks and extends from east of Coal Hill southeasterly towards Knutsford Hill.

Most outcrops of the Iron Mask unit can best be described as a melange of intrusive rock varieties. The rocks range from fine to coarse melanocratic and mesocratic diorite, fine to coarse-grained hornblendite, coarse-grained magnetite-rich gabbro, and xenoliths of recrystallized Nicola. All of the rock varieties contain magnetite and are commonly cut by irregular, criss-crossing, fine to coarse-grained leucocratic dioritic dyke-like bodies and dykelets. Some of the dyke-like bodies are recognizable as Cherry Creek varieties, particularly in the vicinity of Iron Mask Hybrid and Cherry Creek contacts.

Mineralization is fairly ubiquitous in Iron Mask rocks with notable concentrations of magnetite and copper. The Iron Mask Mine is located in this rock unit.

### Pothook Unit

The Pothook unit occurs mainly in the northwest half of the batholith and is less prevalent in the southeast half. It appears as narrow, mafic-rich, gradational zones between Iron Mask Hybrid and Cherry Creek units. The rock is more uniform in texture and composition than Iron Mask Hybrid rocks. It is fairly coarse-grained, generally dioritic but has varied K-feldspar content, is mafic-rich, and lacks the characteristic speckled appearance of Cherry Creek varieties.

At the northwest end of the batholith the Pothook unit is more extensive than to the southeast, is of dioritic composition except near Cherry Creek contacts, is medium to coarse-grained, and is mafic-rich. Commonly coarse interstitial masses of biotite 2 or 3 cm across are visible in this unit.

There appears to be a gradation from the melange of Iron Mask varieties through Pothook diorite to the Cherry Creek unit showing an increasing degree of differentiation to more K-spar rich varieties. Intrusive contacts between these units are also evident.

Mineralization is prevalent in many places in the Pothook unit with notable magnetite occurring in uniformly dipping veins south and southeast of Afton.

### Picrite Unit

The problem of the origin and age of the Picrite unit remains unresolved. The picrite is of basaltic composition with serpentized olivine reported by Carr (1956), Preto (1967), and Carr and Reed (1976). Picrite bodies appear to be associated with recurring, northwesterly trending fracture systems and are found in many parts of the batholith commonly in association with mineralization (Carr, 1956; Carr and Reed, 1976). The unit is cut by clean fine-grained rocks akin to the Cherry Creek unit. Inclusions of picrite are reported in the Iron Mask unit (C. Godwin, personal communication).

### Cherry Creek Unit

The name Cherry Creek is retained for the unit of rocks which extends along the north margin of the batholith (Preto, 1967) and is applied to equivalent rocks underlying Iron Mask Hill and brecciated, ankeritic rocks east of Galaxy. Mapping during the 1976 field season has shown that this same unit of Cherry Creek rocks forms the eastern half of the southeastern part of the batholith. A pendant or screen of Iron Mask Hybrid unit occurs within it extending from east of Coal Hill and projecting southeasterly towards Knutsford Hill. A body of Sugarloaf-like rocks extends up the north side of the Knutsford ski hill and heals brecciated fragments of Cherry Creek rocks.

There is a wide variety of Cherry Creek rocks which retain a characteristic speckled texture resulting from a clustering of fine-grained mafic minerals with indistinct outline. The rocks are commonly weakly porphyritic to porphyritic, fine-grained and range in composition from diorite to syenite. They include varieties which can be termed macrodiorite, microdiorite, micromonzonite, microsyenite and Cherry Creek porphyry (Carr, 1956; Preto, 1967 and 1973). The wide variety of Cherry Creek rock types may be the result of tapping of magma of different stages of differentiation, and emplacement and crystallization under varied pressure-temperature-volatile content conditions existing in an intermittently venting subvolcanic to volcanic environment.

Copper and lesser iron mineralization are prevalent in the Cherry Creek unit particularly in zones of intense brecciation and K-feldspathization. Preto (1967) points out the significance of the brecciation and K-feldspathization. Similar brecciation to that reported by Preto (1967) and Northcote (1974) in Cherry Creek rocks along the north side of the batholith occurs in Cherry Creek rocks on the Kimberly Copper property northwest of Knutsford (Preto, 1967). A breccia consisting largely of Cherry Creek fragments also occurs on the extreme southeast tip of the batholith.

### Sugarloaf Unit

The Sugarloaf unit occurs mainly along the southwest flank of the batholith and as small bodies within the batholith such as on the north flank of Knutsford ski hill and at the southeast tip of the batholith. Several varieties were noted which are mainly the result of differences in grain size. Almost everywhere the unit is of fairly uniform andesitic composition and is medium green in colour. The distinguishing characteristic of this unit is the persistent presence of hornblende and/or augite phenocrysts. Identical rocks were observed in the Nicola. Their relationship to Nicola rocks was not determined but probably form dykes or sills.

Conflicting age relationships were observed where Cherry Creek rocks appeared to be cutting rocks of the Sugarloaf unit and breccia fragments of Cherry Creek rocks were healed by matrix of Sugarloaf-like rocks.

Copper mineralization occurs within Sugarloaf rocks in several localities; notably at the Ajax property east of Jacko Lake where Sugarloaf rocks are brecciated and albitized (Preto, 1967).

### Kamloops Volcanic and Sedimentary Rocks

Early Tertiary volcanic and sedimentary rocks unconformably overlie the batholith and Nicola rocks. The Kamloops volcanic rocks in the Iron Mask area are mainly of basaltic composition and occur as vesicular flows, flow breccias and vent breccias. The present erosion surface fairly closely approximates the pre-Tertiary erosion surface so that erosional remnants of Tertiary rocks are prevalent capping the tops of some of the higher hills on the batholith, in former depressions on the pre-Tertiary erosion surface, and in down-faulted blocks both within and flanking the batholith.

#### ALTERATION

Most of the batholithic rocks show some degree of saussuritization which locally may be very intense. Some K-feldspathization is evident locally in most rock units but is most abundant in Cherry Creek rocks where the relatively high K-feldspar was introduced into the rocks through processes of normal crystallization of potassium-rich magma and by alteration of previously crystallized dioritic to monzonitic rocks by introduction of potassium-rich solutions.

#### ENVIRONMENT OF EMPLACEMENT OF THE BATHOLITH

An increasing amount of evidence suggests a shallow volcanic to subvolcanic environment of emplacement especially for Cherry Creek varieties and a comagmatic and partly coeval relationship between Nicola volcanic rocks and units of the Iron Mask batholith.

Cherry Creek rocks at the north end of the batholith occur as criss-crossing dyke-like bodies of varied grain-size and composition. Their fine-grained texture suggests near surface conditions and, as noted by Carr (1957), the Cherry Creek unit had previously been mapped as volcanic rocks. Intrusive brecciation associated with K-feldspathization is prevalent in many places particularly in a narrow zone extending westerly from a point near Iron Mask Lake to the Afton ore body. This brecciation appears to involve mainly varieties of Cherry Creek although fragments of Iron Mask Hybrid or Pothook are also visible in drill core. The brecciation may have been the result of venting at a slightly higher level. Fragments of Cherry Creek rocks and other Cherry Creek-like rocks occur in tuff breccia of the Nicola which indicates that some of the Cherry Creek rocks are older than some of the Nicola. However, intrusive contacts between these same Nicola volcanic rocks and Cherry Creek rocks indicate the opposite relationships; some Cherry Creek rocks are younger than some of the Nicola rocks they intrude. Intense epidotization of Nicola rocks which contained Cherry Creek fragments and some mineralization were noted at the north edge of the batholith which suggests that volcanic-plutonic processes were going on simultaneously.

It is unnecessary to postulate three separate magmatic events; one for Nicola volcanism, a second to emplace the Iron Mask batholith and a third for later volcanism to explain Cherry Creek fragments in volcanic rock described as being identical to Nicola (Cockfield, 1948). The observed geologic features and relationships would be consistent with a single but pulsating comagmatic and partly coeval volcanic-plutonic system operating in a subvolcanic to shallow volcanic environment.

#### IRON MASK AGE DETERMINATIONS

<u>Sample No.</u>	<u>Age</u>	<u>Rock Type</u>	<u>Location</u>
VP 72 KA-3	197 $\pm$ 6 m.y.	Cherry Creek Micromonzonite porphyry	Near east end Iron Mask Lake
VP 72 KA-5	190 $\pm$ 6 m.y.	Pothook	Afton
VP 72 KA-4	205 $\pm$ 6 m.y.	Cherry Creek Micromonzonite porphyry	Near Iron Mask Lake
VP 72 KA-1	201 $\pm$ 6 m.y.	Iron Mask Hybrid	Gas pipeline near Ajax property
VP 72 KA-2	198 $\pm$ 6 m.y.	Hydrothermal Biotite Cherry Creek Micro- diorite	Near Iron Mask Lake

Mileage

- 0.0 Knutsford.
- 3.2 Morrison Ranch, gate at Peterson Creek crossing.
- 3.6 STOP 3 - 3 - Outcrops on the south side of the access road are relatively unaltered Sugarloaf Porphyry which is of andesitic composition and has characteristic hornblende and augite phenocrysts. Sugarloaf unit intrudes older units of the Iron Mask batholith and occurs within Nicola, probably as dykes and sills.
- 4.5 STOP 3 - 4 - Ajax Property. Outcrops to the east of the pipeline access road are albitized, brecciated Sugarloaf porphyry with chalcopyrite mineralization occurring mainly as stringers, blebs, and fine disseminations. (Preto 1967; Carr, 1956.)

The bluffs immediately to the northeast consist of Iron Mask Hybrid unit.

- 4.9 STOP 3 - 5 - Leave pipeline access road and proceed west approximately 0.4 mile to observe Nicola - Iron Mask Hybrid contact on north side of Jacko Lake.

At this point Iron Mask Hybrid rocks consist mainly of coarse-grained dioritic to gabbroic rocks rich in coarse-grained disseminated magnetite. Towards the southwest, approaching the Nicola contact, the rock becomes finer grained, dioritic and grades to indeterminate recrystallized Nicola or contaminated intrusive and gradually to foliated or schistose augite porphyry with a micaceous matrix.

Return to pipeline access road and proceed northerly.

- 5.3 STOP 3 - 6 - On pipeline right of way Iron Mask Hybrid varieties occur as a breccia or melange of coarse to fine-grained diorite, hornblendite, and recrystallized Nicola cut by irregular fine to coarse-grained leucocratic dykelets and stringers. A K-Ar age determination of this rock yielded  $201 \pm 6$  m.y.

Proceed northerly along pipeline and ranch access roads to Galaxy Lake.

- 7.5 Galaxy Lake lies on a fault contact between Cherry Creek microdiorite on the west and Nicola volcanic rocks and Iron Mask Hybrid rocks on the east.

The Evening Star mine shaft is on the southeast side of the lake and is in altered southwest dipping volcanic rocks, picrite and Iron Mask Hybrid rocks which are hosts to copper mineralization. These rocks are separated from underlying Cherry Creek rocks by a mylonitized zone at depths of approximately 30 to 100 metres (Preto, 1967; Carr, 1956).

- 8.8 Intersection of old and new Lac Le Jeune roads.

Lake

or

Lake

- 8.9 STOP 3 - 7 - Picrite basalt occurs in a small outcrop area on the northwest side of the road opposite Iron Mask Mine. The picrite basalt is cut by a 50 foot wide dyke of Cherry Creek-like rock.

The abandoned Iron Mask Mine is located on the southeast side of the road and is in the Iron Mask Hybrid unit. In the years between 1904 and 1928 the mine produced 165,000 tonnes grading 1.47 per cent copper. Chalcopyrite occurs in lodes, stockworks, and in low grade disseminated deposits.

- 9.8 Trans Canada Highway junction. Bowers Lake and Iron Mask Lake are on the left. The white salt in these lakes and others nearby is mostly sodium sulphate (Cummings, 1940).

- 12.4 STOP 3 - 8 - At the saline lake at the east side of the Afton property on the south side of the highway.

- (a) Outcrops on north side of lake.

Nicola volcanic breccia contains fragments of Cherry Creek unit. The breccia is well indurated, altered and is in contact with contaminated Cherry Creek unit on the east side of the outcrop-area.

- (b) Outcrops on south side of lake.

Varieties of Cherry Creek unit range in composition from diorite to syenite and are generally fine grained or fine porphyritic. Dyking relationships are visible, generally with dioritic rocks cut by K-spar-rich varieties.

- (c) D.M. Zone shaft.

The D.M. Zone shaft is in mineralized Cherry Creek intrusive breccia. The breccia zone extends westerly from the vicinity of Iron Mask Lake to the Afton deposit. The breccia is K-feldspar rich as a result of differentiation of the crystallizing magma and alteration by K-rich solutions penetrating and circulating in brecciated zones.

- 12.6 STOP 3 - 9 - North side of highway.

- (a) Outcrops on pipeline right-of-way.

The exposure consists of well indurated Nicola volcanics containing widely scattered Cherry Creek inclusions.



(b) Outcrops at south edge of meltwater channel.

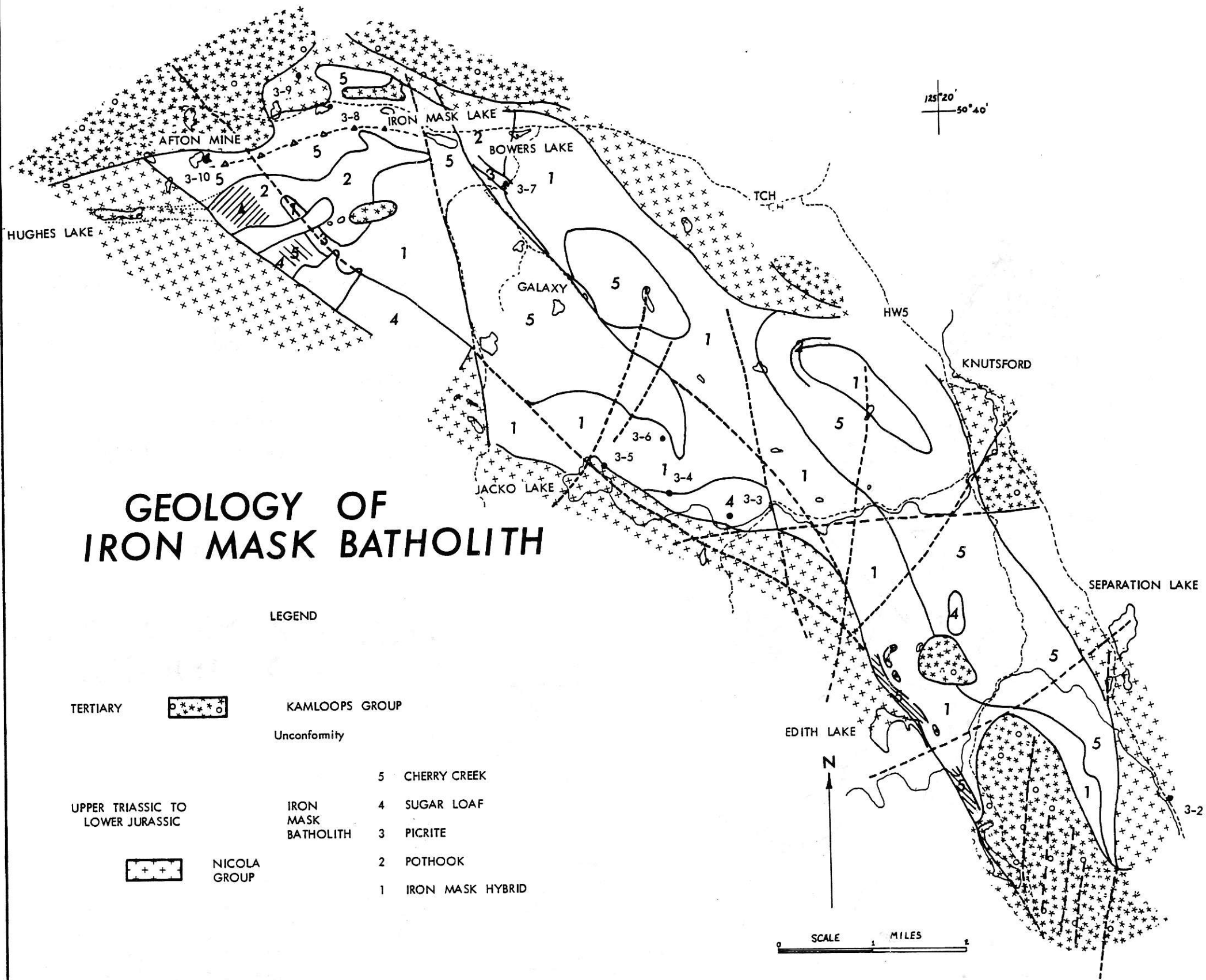
Similar tuff breccias to previous stops are exposed but contain abundant Cherry Creek and Cherry Creek-like fragments. These breccias, however, are friable and relatively unaltered. Because of Cherry Creek fragments these tuff breccias have in the past been included with Tertiary Kamloops Group or Lower Cretaceous Kingsvale or Spences Bridge Group.

The tuff breccias appear to be in unconformable contact with Tertiary sedimentary and volcanic rocks on the north side of the meltwater channel. The lithology and style of volcanism of the tuff breccias differs from overlying Kamloops volcanic rocks. Similar rocks are well indurated, epidotized and mineralized 0.5 miles to the north-east and are intruded by Cherry Creek rocks one mile to the east. Therefore these poorly indurated, unaltered, tuff breccias are being examined from the point of view that they may in fact be uppermost Nicola extrusive equivalent of the Cherry Creek unit of the Iron Mask batholith.

- 13.6 Afton Mine. See attached paper: Carr, J.M.; Reed, A.J., "Afton: A Supergene Copper Deposit", CIM Special Volume No. 15, 1976, pp. 376 - 387.

Allan Reed, Chief Geologist at Afton Mines will provide a description and tour of the property.

125°20'  
50°40'



# GEOLOGY OF IRON MASK BATHOLITH

## LEGEND

- |                                  |  |                     |
|----------------------------------|--|---------------------|
| TERTIARY                         |  | KAMLOOPS GROUP      |
|                                  |  | Unconformity        |
| UPPER TRIASSIC TO LOWER JURASSIC |  | IRON MASK BATHOLITH |
|                                  |  | 5 CHERRY CREEK      |
|                                  |  | 4 SUGAR LOAF        |
|                                  |  | 3 PICRITE           |
|                                  |  | 2 POTHOOK           |
|                                  |  | 1 IRON MASK HYBRID  |
|                                  |  | NICOLA GROUP        |

- SYMBOLS**
- LINEARS FROM AIR PHOTOGRAPHS
  - ROADS

CROSS-HATCHING INDICATES SUPERIMPOSED UNITS

- 3-2 TOUR STOPS
- HW5 HIGHWAY 5
- TCH TRANS CANADA HIGHWAY

