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GEOLOGY OF MOUNT NANSEN (115-I/3) AND STODDART CREEK (115-I/6) MAP AREAS

DAWSON RANGE, CENTRAL YUKON

(Text with two 1:30,000 scale maps)

By

Gerald G. Carlson
151235 Canada Inc.

This report is complimentary and available from:
Exploration and Geological Services Division,
200 Range Road, Whitehorse, Yukon Y1A 3V1

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P R E F A C E

This report describes the bedrock geology and mineral occurrences of the Mount Nansen (115 I 3) and Stoddart Creek (115 I 6) areas in the Dawson Range, central Yukon.

Metamorphosed sedimentary volcanic and plutonic rocks of the Paleozoic and (?) older Yukon Crystalline Terrane are intruded by the Upper Triassic to Jurassic Klotassin Batholith and the Jurassic Big Creek Plutonic Suite. These rocks are in turn intruded by the Lower Cretaceous Dawson Range Batholith, the Casino Granodiorite, the Coffee Creek Granite, and the Mount Nansen Volcanics. The areas contain porphyry and vein related mineral occurrences which are now being re-evaluated for precious metals potential.

This work was funded under the Minerals Sub-Agreement of the Canada-Yukon Economic Development Agreement, Contract YEDA 04/86.

ABSTRACT

The Mount Nansen and Stoddart Creek map areas, NTS 115-I/3 and 115-I/6, are in the southern part of the Dawson Range. They contain a number of porphyry and vein related mineral occurrences which have been undergoing extensive re-evaluation for precious metals potential. Basement rocks are part of the Yukon Crystalline Terrane and include metamorphosed and deformed sedimentary, volcanic and plutonic rocks of uncertain age. These are intruded by two suites of foliated plutonic rocks, the Upper Triassic to Jurassic Klotassin Suite, mainly hornblende-biotite granodiorite, and the Jurassic Big Creek Suite, including K-feldspar porphyritic syenite, quartz syenite and monzonite. Latest metamorphism of basement rocks is likely related to emplacement of these suites.

Latest lower Cretaceous was marked by intrusion of the Dawson Range Batholith, consisting of the regionally exposed Casino Granodiorite and the more localized Coffee Creek Granite. The Mount Nansen Volcanics, mainly andesite with a lesser felsic component, are possibly cogenetic with these intrusives.

Numerous intermediate to felsic porphyry stocks and dykes may be of Mount Nansen age in part, but they are at least in part younger. The Bow Creek Granite is a newly defined, high level, granophyric pluton with related, peripheral quartz-feldspar porphyry dykes. These rocks appear to cut the Mount Nansen volcanics and may be as young as the Carmacks volcanism. The Caribou Creek Conglomerate is a very localized sedimentary sequence which underlies the Carmacks volcanics.

The Carmacks Volcanic Suite, uppermost Cretaceous in

age, is relatively flat-lying and has been subdivided into three units. The lowermost consists of felsic pyroclastic rocks and associated glassy domes or plugs. The middle unit, which appears to be quite thin in the map area, consists of andesite flows and pyroclastics with minor basalt. The most extensive is the upper unit, which consists mainly of basalt flows.

Mineral deposits are of four main types, including porphyries, veins, skarns and placer. Transitional varieties are associated with brecciation and porphyry dyke emplacement. The porphyries are low grade copper-molybdenum deposits with local gold enrichment in the upper parts. Breccias with elevated precious metals values occur within the porphyries and also peripherally, associated with quartz-feldspar porphyry dykes. Gold- and silver-bearing quartz veins occur in dilational fracture systems which are also peripheral to the porphyries. In the presence of calcareous meta-sediments of Yukon Crystalline Terrane, gold-bearing iron-rich skarns have formed. Base metal-rich veins are rare and distal from the porphyry centres.

Mineralization controls are recognised as follows:

1. Proximity to major regional structures such as the Big Creek Fault and the Minto Linear which extends north-northeasterly through the map area.

2. Local structures, ranging in trend from northwesterly to northeasterly, are important as hydrothermal channelways and vein sites.

3. Presence of a favourable host, including Mount Nansen volcanics, siliceous meta-sediments and Casino Granodiorite.

4. Proximity to porphyry stocks or quartz-feldspar porphyry dykes.

ACKNOWLEDGEMENTS

The project has benefited from the many prospectors and exploration companies active in the area who provided willing assistance and freely shared geological information. I would particularly like to thank the management and staff of Archer Cathro and Associates (1981) Ltd.

Valuable discussions on the geology of the area were had with Dr. John Payne and Mr. Ralph Gonzalez of Archean Engineering, who were involved with mapping adjacent map sheets NTS 115-I/5 and 115-J/9 and 10 on a similar EDA contract during the 1986 field season. Dr. Dirk Tempelman-Kluit, of the Geological Survey of Canada, provided helpful background information from his extensive experience in the district, encouragement during the program and helpful discussion during the preparation of this report.

Dr. Kelly Russell, UBC, provided computer facilities for calculating norms and assisted with interpretation of the data. Dr. John Ross provided computing facilities for plotting stereonets for structural interpretation.

I would like to thank my field crew, geologists Ingrid Reichenbach and Jesse Duke and assistants Gordon MacIntosh and Helen Kozicka. The latter two who proved themselves to be extremely resourceful and diligent assistants. All endured many long and arduous traverses. Dorell Carlson provided excellent cooking and camp management. I am also grateful to Ms. Ruth Debicki, 151235 Canada Inc., from whom the field project was sub-contracted, for entrusting me with the program and for providing excellent administrative support.

Finally, I would like to acknowledge the assistance of Dr. Jim Morin, Chief Geologist of Exploration and Geological Services Division, D.I.A.N.D., and his staff. The logistical and technical assistance they provided was extremely important to the successful completion of the project. The manuscript benefited from Dr. Morin's critical reading.

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INTRODUCTION

SCOPE OF STUDY

The study area includes two map areas: Mount Nansen, NTS 115-I/3, and Stoddart Creek, NTS 115-I/6. Considerable gold exploration has taken place, particularly in the vicinity of Freegold Mountain and west of Victoria Creek. Several placer gold operations were also active in the area during the summer of 1986.

The objective of this study was to provide an outcrop geology map of the area and to develop an understanding of mineralization in the district. Most of the recorded showings in the two map areas were visited, especially those undergoing active exploration.

Bedrock mapping of the two areas was carried out at a scale of 1:30,000 during the period 21 June to 26 August, 1986. The field crew consisted of two geologists, two assistants and a cook. Mapping was carried out from two base camps, one on Webber Creek on the Mount Nansen Sheet and one on Big Creek near Revenue Creek, as well as from a number of fly camps in the more remote parts of the map areas. Wherever possible, road access was used. In addition to a 4x4 truck, two Honda Fourtrax ATV's were very useful, enabling access along often swampy winter roads. A total of 101 traverses were completed during the 60 days in the field. Weather conditions during the summer were relatively good, with very few lost field days.

A Carmacks-based helicopter provided access to the more remote areas, particularly the western side of Mount

Nansen map area (115-I/3) and the northern half of Stoddart Creek map area (115-I/6).

The bedrock mapping involved examination of as many outcrops as possible by traversing all ridges as well as sidehills where outcrop was evident from an examination of air photographs or from general aerial reconnaissance. Numerous exploration trenches and access roads throughout much of the area also provided bedrock information.

Petrographic examination of selected samples was carried out by Dr. John Payne and Dr. Graham Nixon. Petrographic reports are included in Appendix I. Whole rock analyses were carried out on a number of samples by Bondar Clegg (see Appendix II) and multi-element geochemical analysis was carried out on these and a number of other samples by Bondar Clegg and by Acme Analytical Laboratories Ltd. (see Appendix III). A few selected samples were submitted for radiometric age determination to Dr. H. Baadsgaard at the University of Alberta (see Appendix IV) and to Dr. J. Mortensen of the Geological Survey of Canada (results pending).

ACCESS

The study area is centred approximately 50 km west-northwest of Carmacks (Fig. 1). Access is by two main gravel roads which are passable almost year-round due to the dry winter climate. The Nansen road heads due west from Carmacks to the Mount Nansen Mine, a distance of 60 km and travel time of approximately 1.5 hrs. From that point, a number of winter and 4x4 roads access approximately 50 percent of the map area. Swampy areas on the winter roads can usually be traversed by ATV during the summer months.

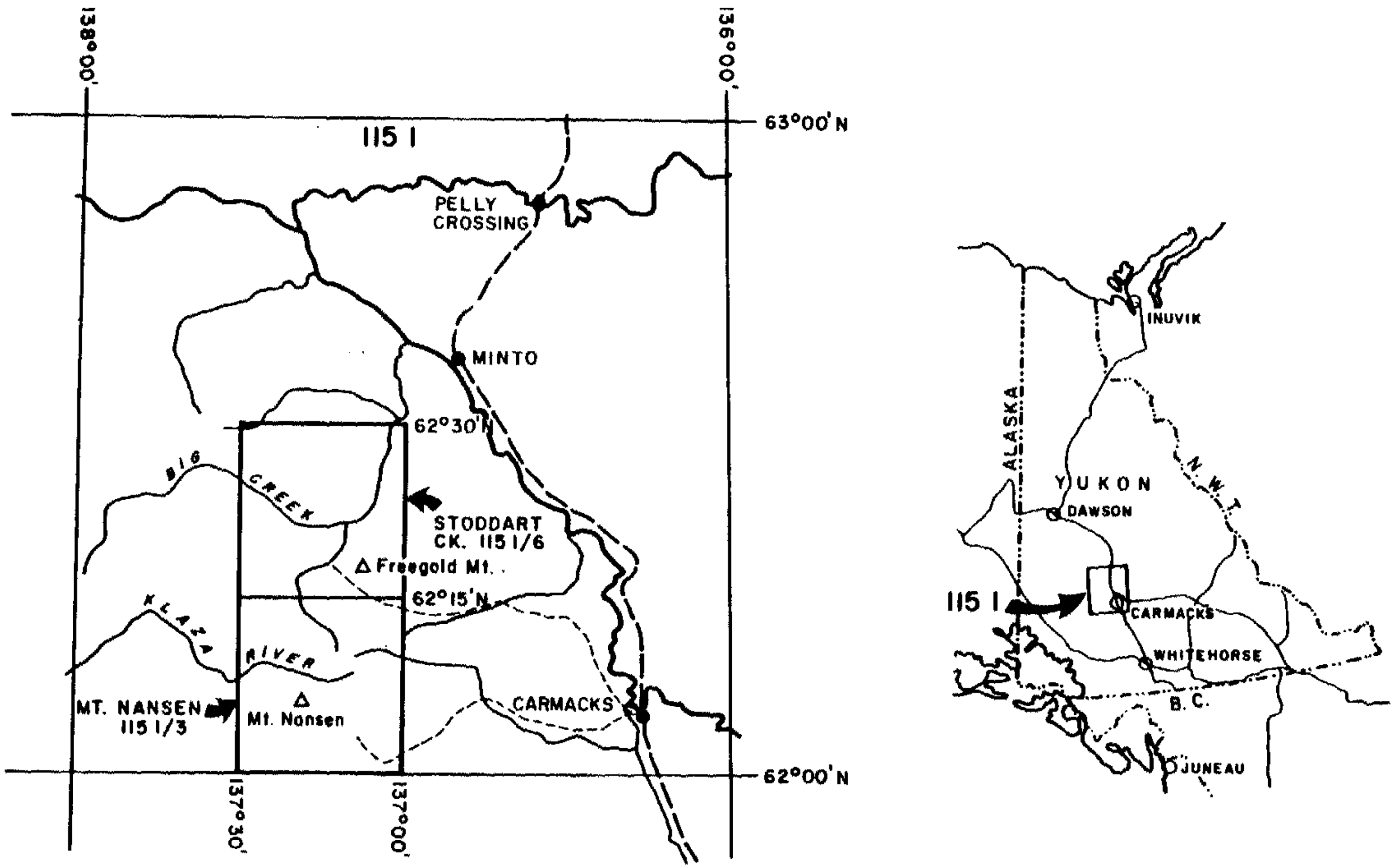
The Freegold Road runs northwesterly from Carmacks 75 km to Guder Junction at the intersection of Bow and Seymour Creeks. An extension of the road crosses the main ridge to the north to Revenue Creek and other placer workings along Big Creek. Other side roads follow Bow Creek, Seymour Creek, Caribou Creek and a large portion of Freegold Mountain and Emmons Hill. However, most of the western part of the Mount Nansen map area and the northern part of the Stoddart Creek map area are accessible only by helicopter.

Recent federal and territorial initiatives involve a proposal to build an all-weather road through the Dawson Range to Casino and ultimately Snag on the Yukon-Alaska border. This road would follow the existing Freegold Road to Guder Junction, but beyond this point the routing has not been finalized.

Charter helicopters are available from Whitehorse and during the field season, from Carmacks. The air strip at Revenue is rough, but serviceable.

PREVIOUS WORK

J.B. Tyrrell and D.D. Cairnes visited the area for the Geological Survey of Canada in 1898 and 1914 respectively. H.S. Bostock's Memoir (1936), based on mapping during the 1931-33 field seasons, presented the first comprehensive geological description and map of the Carmacks map area, NTS 115-I, at 4 inches to 1 mile. One of Bostock's assistants, J.R. Johnston, published a detailed map and brief report (1936) of a large portion of Freegold Mountain as part of his M.S. thesis.



LOCATION MAP

Figure 1

D.J. Tempelman-Kluit updated Bostock's mapping with field work carried out mainly between 1978 and 1980. Latest revisions to this work have been published at 1:250,000 as G.S.C. Open File 1011 (1984) and will be described more fully in a soon to be published Geological Survey of Canada Memoir (Tempelman-Kluit, in press, A).

PHYSIOGRAPHY

The Dawson Range is part of the Yukon Plateau Physiographic Province (Bostock, 1948), a gently rolling upland at elevations of 1200 to 1500 m that is dissected by the current drainage pattern. The deepest valleys are cut 600 m below this surface, and the highest peaks rise above the plateau to 2000 m, resulting in moderately rugged mountainous terrain.

The area is unglaciated. Ridge tops are punctuated at regular intervals by commonly high-standing, castellated outcrops. In between, loose rock fragments or felsenmeer are believed to be fairly representative of underlying bedrock. Scree and talus on the slopes have generally travelled only a short distance down slope. Weathering of outcrops can be quite deep, to several tens of meters as observed in drilling.

Alluvial, colluvial, eolian and lacustrine deposits cover the broader valley floors. Alluvial benches occur on the south side of Big Creek, especially in the eastern part of the map area.

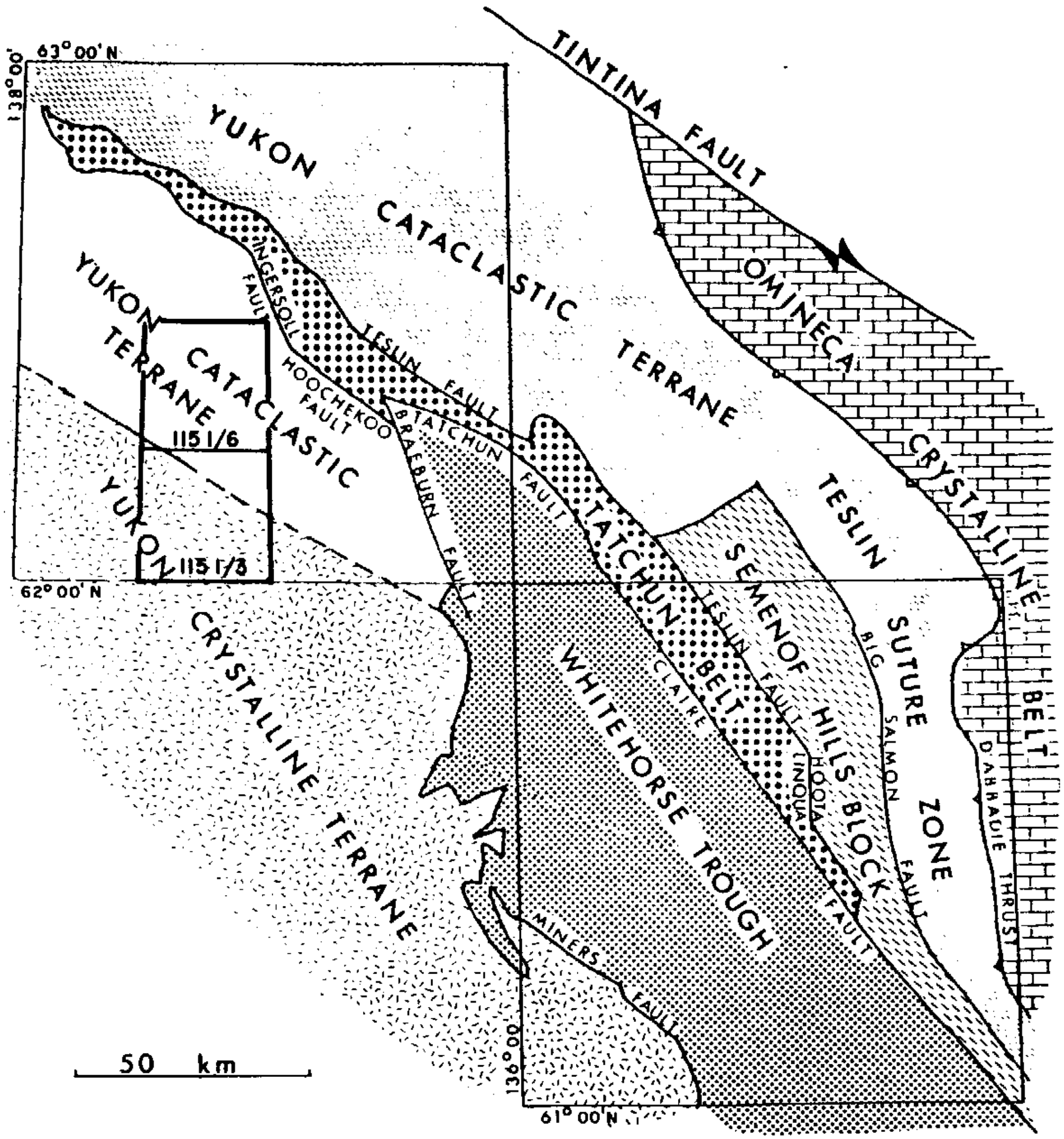
Treeline is at the 1300 to 1400 m elevation. Extending from below treeline up to approximately 1500 m, thick buckbrush can hinder travel. On north-facing slopes, permafrost results in thick moss and stunted spruce trees, while south slopes are generally well drained and, in places, so arid as to be barren of vegetation except grasses. Outcrops are restricted to ridge tops and the generally steeper south-facing slopes. Outcrop is not abundant in creek beds with the exception of the lower parts of Big Creek, although it is commonly found on lower slopes of some of the steeper-walled valleys, such as Seymour Creek.

TECTONIC SETTING

Tempelman-Kluit (1978; 1987; in press, A) has provided several discussions on the tectonic framework of central Yukon. The study area sits on the boundary between the Yukon Crystalline Terrane to the south and Yukon Cataclastic Terrane to the north (Fig. 2), separated by the Big Creek Fault. Basement rocks in the map area are mainly Yukon Crystalline Terrane schists and gneisses, which include both autochthonous metasedimentary rocks and allochthonous gneisses. Cataclastic Terrane rocks are not well represented in the map area because of large intrusions of younger plutonic rocks and extensive volcanic cover north of the Big Creek Fault. Basement rocks in the immediate vicinity of the Big Creek Fault may be part of a transition between the two terranes.

Basement rocks are in turn cut by foliated plutonic rocks which were involved with them during the latest metamorphism and uplift of the area in the Jurassic.

Youngest rocks in the map area represent two major plutonic-volcanic events; early Cretaceous Mount Nansen event and the late Cretaceous to Paleocene Carmacks event.



TECTONIC SETTING

(AFTER TEMPELMAN - KLUIT, 1978)

Figure 2

GENERAL GEOLOGY

INTRODUCTION

Due to the lack of glaciation and the apparent lack of significant erosion since the end of the Cretaceous, near-surface rocks have been deeply weathered. Only some of the most resistant units, including the Mount Nansen volcanics and some of the felsic dyke rocks, form appreciable unweathered outcrop exposure. As a result, exposure is generally poor. Contact zones in particular are seldom observed, and thus, most intrusive contact relations are inferred.

On the other hand, because of this lack of glaciation, it is possible to ascertain a fairly accurate idea of bedrock distribution by mapping broken surface rock fragments, or felsenmeer. On many ridges and upper slopes the only rock exposed is within the felsenmeer. On steeper slopes, there has been some obvious mixing due to downslope creep and solifluction, but boulders were observed which still show correlation with the bedrock geology.

The bedrock geology can be divided into three main categories: a basement metamorphic complex, Units 1 and 2; foliated plutonic rocks, Units 3 and 4; and, early Cretaceous to Paleocene plutonic and related volcanic rocks. With the exception of minor intervolcanic sedimentary cycles and one minor occurrence of conglomerate and related sediments, there are no younger sediments in the study area. A great amount of erosion is indicated both by the exposure of the early Cretaceous Dawson Range Batholithic rocks and by the lack of a significant extrusive component of Mount Nansen volcanics. This erosion occurred prior to the eruption of the Carmacks Volcanics in latest Cretaceous time.

Petrographic descriptions of a number of representative samples are included in Appendix I. Appendix II contains whole rock geochemical data and normative mineralogy, while Appendix III contains multi-element geochemical data. Radiometric age determinations on a number of samples collected during the program are described in a report by H. Baadsgaard, University of Alberta, in Appendix IV.

GEOLOGICAL LEGEND

In order to simplify comparison between this map area and EDA mapping on the three map areas to the west (Payne et. al., 1987), a common geological legend was formulated. Since this map area contained a larger proportion of some units, in particular the Mount Nansen Volcanics (Unit 7) and the foliated plutonic rocks (Units 3 and 4), there is more detail in this area of the legend than in the map sheets to the west. On the other hand, a greater variety of basement rocks and certain intrusive phases occur to the west and as a result, the detailed descriptions and subdivisions of some units may vary. Some intrusive phases, namely Units 6, 11 and 16, were mapped only in the western area and are not included in this legend (Payne et.al., 1987).

TABLE 1 - GEOLOGICAL LEGEND

17 Unconsolidated Alluvium - includes high level terraces along Big Creek

15 Late Intrusions

15a Aphanitic intermediate to mafic dykes; possibly Carmacks feeders

15c Medium to coarse grained potassic gabbro

15d Diabase dykes, plugs

CARMACKS SUITE

14 Upper Basalt Member

14a Andesite flow

14b Basalt flow: 14bv - vescicular flow top; 14bx - basal debris flow, breccia

13 Lower Andesite Member

13a Andesite flow: 13at - andesite tuff, tuffaceous sediment, conglomerate; 13x - andesite breccia, debris flow

13b Basalt to andesitic basalt flow

12 Basal Felsic Member

12a Grey to white weathering crystal-lithic tuff, minor lapilli tuff

12b Rhyolite dome

CARIBOU CREEK CONGLOMERATE

10 Conglomerate - quartz pebble to boulder conglomerate, associated black clastic sediment

MOUNT NANSEN SUITE

9 Porphyry Dykes

9a Plagioclase-hornblende porphyry, dykes and small plugs

9b Plagioclase-hornblende-quartz+/-biotite+/-K-feldspar porphyry dykes

9c Quartz-feldspar porphyry dykes; white weathering, commomnly pyritic

9d Porphyritic granodiorite to quartz monzonite stocks

9e Gabbro to syenite, plagioclase +/- hornblende porphyritic, fine- to medium-grained, multiple dykes and plugs on Victoria Mountain

8 Bow Creek Granite

8a Fine-grained biotite granite

8b Fine to very fine grained, pink weathering, often miarolitic granite; minor chlorite, biotite

8c Pink weathering aphanitic dykes and border phase to pluton; typically quartz and feldspar porphyritic

7 Mount Nansen Volcanics

7a Andesite to latite massive flows and feeders

7at Tuff, Tuffaceous sediments, in part laharic

7ax Flow breccia, probably in part intrusive

7b Leucocratic latite to rhyolite

7bt Welded vitric tuff, tuffaceous sediments

7bx Lapilli tuff, pyroclastics

7c Felsic dome - commonly flow-banded, quartz and feldspar porphyry

DAWSON RANGE PLUTONIC SUITE

5 Dawson Range Batholith

5a Casino granodiorite

5c Coffee Creek Granite

4 MOUNT FREEGOLD META-PLUTONIC SUITE

4a Orthoclase-hornblende porphyritic syenite

4b Plagioclase-hornblende monzonite

4c Hornblende segregations in subunit 4a

3 KLOTASSIN META-PLUTONIC SUITE

3a Foliated hornblende-biotite granodiorite

3b Leucogranodiorite

BASEMENT METAMORPHIC COMPLEX

2 Schist and Gneiss Units

2a Hornblende-biotite-feldspar gneiss; grades locally to Unit 3

2b Pink granite gneiss

2c Schist-gneiss Subunit - includes biotite-quartz-feldspar schist, feldspar augen gneiss, amphibolite and minor quartzite and marble

2d Amphibolite

1 Metasedimentary Unit

1a Quartzite, micaceous quartzite

1b Quartz-feldspar-mica schist, quartzofeldspathic gneiss

1L Limestone

DESCRIPTION OF UNITS

Basement Metamorphic Complex (Units 1 and 2)

All basement rocks in the map area, with the exception of some siliceous units, have a strongly developed foliation to gneissic banding. The deformation which produced this fabric was so intense as to almost completely obliterate previous structure. Deformation, ranging from broad, open folds to tight, isoclinal folding, has affected this banding. Lineations parallel the axis of this latest folding episode. Only in the metasedimentary unit does it appear that the banding may, in some cases, represent original bedding. In most cases, the banding is metamorphic, commonly with a strong cataclastic overprint.

Metasedimentary Unit (Unit 1)

Includes Subunits 1a, quartzite and micaceous quartzite; Subunit 1b, quartz-feldspar-mica schist and quartzofeldspathic gneiss; and Subunit 1L, limestone.

Distribution. This unit is exposed mainly in a northwest-trending belt from Mount Freegold along the southern edge of Big Creek and in scattered patches in the southern part of the Mount Nansen map area. Limestone and marble lenses, which are too narrow to show as discrete areas on the map, occur discontinuously from Freegold Mountain to north of Big Creek.

Lithology. The unit ranges from a very fine grained grey to black quartzite, possibly meta-chert, to impure micaceous quartzites and quartz-mica schist. In places it grades to a fine-grained quartzofeldspathic gneiss with faint compositional layering and both K-feldspar and plagioclase. In Subunit 1a, the total mica content is generally less than 10 percent and is finely disseminated, with minor plagioclase. Subunit 1b is characterized by micaceous quartzite in bands with interlayered coarse mica, predominantly muscovite, as selvages between quartzitic or quartzofeldspathic bands. There is commonly a well developed crenulation within these micaceous selvages which parallels fold axes.

The northernmost exposure of this unit which extends from the top of Freegold Mountain northwesterly along the north side of Big Creek contains minor limestone and siliceous limestone lenses, now recrystallized. A sample has been submitted to Dr. M.J. Orchard of the GSC to be examined for conodonts.

Age and Correlation. These rocks are part of the autochthonous assemblage of Yukon Crystalline Terrane (Tempelman-Kluit, 1978). They may correlate in part with the Nasina Quartzite (Tempelman-Kluit, in press, B) which is Ordovician to Devonian in age, but they mainly correlate with Pelly Gneiss, also believed to be Paleozoic in age (Tempelman-Kluit and Wanless, 1980).

Schist and Gneiss Unit (Unit 2)

This unit includes Subunit 2a, a foliated plutonic rock of intermediate composition; Subunit 2b, a pink, granitic gneiss; Subunit 2c, a layered succession of schistose and gneissic components; and Subunit 2d, amphibolite. Commonly quite distinctive in places, this unit sometimes grades to the metasedimentary unit described above and also into the younger foliated plutonic rocks of Unit 3.

Subunit 2a - Hornblende-biotite-feldspar gneiss:

Distribution. This subunit occurs in a northwest-trending belt, northwest of Freegold Mountain and north of Big Creek Fault. It includes windows of Subunit 2b and grades locally in the west to Subunit 2c and in the east to Unit 3.

Lithology. The gneiss is a metaplutonic rock consisting of plagioclase with hornblende, lesser biotite and quartz comprising up to 10 percent of the rock. It is similar to Unit 3 but it is more strongly foliated, typically compositionally banded, and in most places highly parallel to the foliation. It is also more heterogeneous, and has greater compositional and textural variations. In some areas, the gneiss is characterized by pink tablets of K-feldspar aligned parallel with the foliation. Strong local shearing is responsible for stretching of these megacrysts into thin bands.

Age and Correlation. This subunit grades over very short distances to foliated granodiorite which is indistinguishable from rocks of the Klotassin Meta-plutonic Suite, Unit 3. Tempelman-Kluit (in press, A) suggested the possibility of intrusion of Unit 3 rocks along the foliation of Unit 2 in this area with subsequent metamorphism during uplift affecting both units. It is possible that this subunit is a part of Unit 3, representing a more deeply exposed or root zone of the more typical Unit 3 rocks to the east.

Subunit 2b - Pink Granite Gneiss:

Distribution. This subunit is distributed in small lenses or windows within the presumed younger rocks of Subunit 2a north of Big Creek.

Lithology. The gneiss is a pink, coarse-grained, weakly foliated granitic rock, locally pegmatitic. Associated with it in some places is a medium- to coarse-grained ultramafic rock consisting mainly of clinopyroxene and amphibole with secondary actinolite. This rock type was observed in two northwest-trending zones probably less than 10 m wide and of uncertain strike length within the granite gneiss.

Age and Correlation. These may be the oldest rocks in the map area, perhaps originally a part of some older basement complex and they may correlate with the Pelly Gneiss (Tempelman-Kluit, 1984). The granitic component does not display any particular tectonic fabric, but the presence of the ultramafic rocks suggests the involvement of possible major tectonism.

Subunit 2c - Schist-gneiss Subunit:

Distribution. By far the most widespread of the basement rocks, this subunit occupies most of the southern part of the Mount Nansen map area as well as a northwest-trending belt extending from east of Victoria Mountain to Big Creek.

Lithology. This is a varied subunit which consists of three main rock types: feldspar-augen gneiss, quartzofeldspathic schist and gneiss and amphibolite. They are typically intercalated on a scale of metres, and commonly, all varieties occur in a single outcrop. In a few places, amphibolite predominates over a wide enough area to be mapped separately as Subunit 2d.

The gneisses consist mainly of plagioclase, lesser K-feldspar and variable amounts of quartz, typically 10 to 20 percent. Mafic minerals (15 to 20%), include hornblende and lesser biotite. Plagioclase augen are commonly rounded to oval in shape, suggesting some degree of cataclastic deformation. The quartzofeldspathic schists are more leucocratic and less well banded, with many similarities to Subunits 1a and 1b. Amphibolites range from fine- to coarse-grained and individual layers are generally less than one or two metres in thickness.

The subunit is generally heterogeneous, with considerable variation in texture and composition. Payne (pers. comm., 1986) considers less strongly metamorphosed varieties of this subunit, exposed further to the northwest, to be meta-volcanic rocks. Such an interpretation is consistent with these textural and compositional variations.

Two and perhaps three different ages of aplite have been intruded into this subunit. They consist of weakly foliated, fine-grained quartz, K-feldspar and plagioclase. Most are aligned parallel or sub-parallel with the foliation.

Subunit 2d - Amphibolite:

Distribution. Amphibolite layers occur within Unit 1 and Subunits 2a and 2c, but they are most common in Subunit 2c, in most places comprising up to 50 percent of the rock. Mappable lenses occur within Subunit 2c in the southern part of the Mount Nansen map area.

Lithology. Texturally, the subunit ranges from fine- to coarse-grained and locally pegmatitic. The rock contains variable amounts of plagioclase and hornblende and minor chlorite after biotite. Trace minerals include sphene, apatite and hematite, possibly after sulphides. Small veinlets of calcite and K-feldspar occur locally.

Age and Correlation. This subunit may have a variety of origins, including mafic lava flows, dykes and sills. It has

Figure 3. Unit 2a gneiss showing strong layering and separation of quartofeldspathic and amphibolitic bands.

Figure 4. Unit 2c, here mainly quartz-feldspar-biotite schist, cut by three ages of aplite. The oldest, at the extreme left of the photo, is foliated and parallels banding in the rock. The younger two are non-foliated and cross cutting.

apparently undergone all metamorphic and structural events which have visibly affected Units 1 and 2.

Klotassin Meta-Plutonic Suite (Unit 3)

This is part of the Klotassin Batholith originally defined by Bostock (1936) and named Granite Batholith in more recent mapping (Tempelman-Kluit, 1984). The name 'Klotassin' has been retained in this mapping project only for the older, foliated granodioritic rocks in the map area.

Subunit 3a - Foliated hornblende-biotite granodiorite:

Distribution. This subunit underlies much of the northeastern corner of the Stoddart Creek map area and is part of an extensive, northwest-trending belt which parallels the southern side of the Yukon River valley in the Carmacks map area (Tempelman-Kluit, 1984). Locally, it is covered by Carmacks volcanics.

Lithology. The rock is a relatively uniform, weakly foliated, coarse-grained, hornblende-biotite diorite to granodiorite which grades locally into a very leucocratic phase (Subunit 3b). Plagioclase comprises 50 to 75 percent of the rock, with lesser quartz, minor K-feldspar, 10 to 15 percent hornblende and less than 10 percent biotite. Accessory minerals include epidote, chlorite (after biotite), apatite, sphene, allanite, zircon, muscovite and traces of opaque oxide and pyrite. The subunit is extremely uniform throughout its exposure, with the exception of a few minor leucocratic zones described below. It is cut extensively by unfoliated aplite and pegmatite dykes north of Freegold Mountain.

Figure 5. Tight, small scale folding in Unit 2a, feldspar-quartz-amphibole gneiss.

Figure 6. Strongly deformed amphibolite. Light coloured zones are disrupted aplite stringers.

Age and Correlation. Tempelman-Kluit (in press, A) correlated this subunit with a number of similar plutons in a northwesterly trending belt through central Yukon, including the Minto Batholith, just north of the study area. A U/Pb age from this pluton gave an age of 192+/-3 Ma (Tempelman-Kluit and Wanless, 1980). This indicates a Late Triassic or Early Jurassic time of intrusion. K/Ar ages show a wider scatter, around middle Jurassic, possible reflecting metamorphic re-setting during emplacement of Unit 4 and subsequent uplift. In the vicinity of Freegold Mountain, Unit 4 rocks were observed cutting Unit 3 as narrow apophyses parallel to the foliation.

Subunit 3b - Leucogranodiorite:

This subunit was only observed on the north slope of Granite Mountain in the Stoddart Creek map area. It is very similar lithologically to Subunit 3a except that total mafic content is less than 5 percent and quartz and K-feldspar contents are greater. It is probably a gradation from Subunit 3a and is very minor in extent.

Big Creek Meta-Plutonic Suite (Unit 4)

This unit, referred to as the Big Creek Syenite by Tempelman-Kluit (1984), is probably the most characteristic rock type in the area. Subunit 4a is weakly foliated and consists mainly of very coarse, pink K-feldspar tablets set in a matrix of smaller, euhedral hornblende grains. Subunit 4b lacks the K-feldspar and consists predominantly of plagioclase and hornblende. A third variety, hornblendite, has been mapped as Subunit 4c.

Subunit 4a - Orthoclase-hornblende porphyritic syenite:

Distribution. This subunit is distributed erratically throughout the northern half of the Mount Nansen map area and the southern Stoddart Creek map area, mainly south of Big Creek. It forms a large batholith which contains a number of pendants of basement rocks and is further dissected by younger plutonic rocks.

Lithology. The subunit consists mainly of pink K-feldspar tablets, 3 cm or more in length that comprise 30 to over 50 percent of the rock. They are set in a matrix of mainly euhedral hornblende grains up to 1 cm in size that ranges from 20 to over 75 percent by volume. Interstitial plagioclase comprises less than 10 to more than 30 percent and quartz locally accounts for 10 to 15 percent of the rock. Because of the wide range of mineralogical composition, the rock is rarely a true syenite, but would more properly be referred to as a quartz-bearing syenite to monzonite. Accessory minerals including magnetite, sphene and apatite locally comprise over 5 percent of the rock, with lesser amounts of epidote, chlorite and zircon. In places, the rock is strongly magnetic, with relatively increased amounts of epidote accompanying the magnetite.

Foliation in the rock is commonly parallel to contacts and may therefore be in part due to flow alignment. In other areas, however, the weakly foliated rock will grade over a short distance into a strongly banded rock in which, due to shearing, the K-feldspar tablets have been stretched into thin, semi-continuous bands (see Figure 8). Thus, a tectonic foliation has also been imparted to this subunit. Hornblende-rich phases may be a result of gravity settling or other differentiation process in the original magma.

Age and Correlation. K/Ar radiometric ages of 142+/-10

152+/-7 and 184+/-7 Ma on hornblende are interpreted by Tempelman-Kluit (in press) to represent an Early Jurassic emplacement of this subunit followed by uplift in the Latest Jurassic. The subunit cuts Unit 3 and is presumed to be cut by unfoliated Unit 5, although no contacts were observed. Dykes related to the Mount Nansen volcanics cut this unit.

Subunit 4b - Plagioclase-hornblende monzonite:

Distribution. This subunit is closely related to the syenite, although it is less widely distributed. It occurs mainly in the north-central part of the Mount Nansen map area, east of Klaza Mountain.

Lithology. This monzonite or quartz-bearing monzonite is a gradation from Subunit 4a and contains predominantly plagioclase and hornblende, with minor orthoclase and quartz. In gradational zones, it contains variable amounts of K-feldspar tablets and is generally more strongly foliated than Subunit 4a. Foliation appears to be mainly tectonic in origin.

Age and Correlation. Subunits 4a and 4b are presumed to be different phases of the same intrusive event because of their close spatial and mineralogical association, including gradational contacts.

Subunit 4c - Hornblendite:

This subunit occurs as segregations within Subunit 4a. Exposures, mainly in the vicinity of Freegold Mountain, are too small to show on the map. The hornblendite is probably a magmatic segregation of hornblende-rich phases of the main pluton. Contacts with Subunit 4a are gradational, commonly

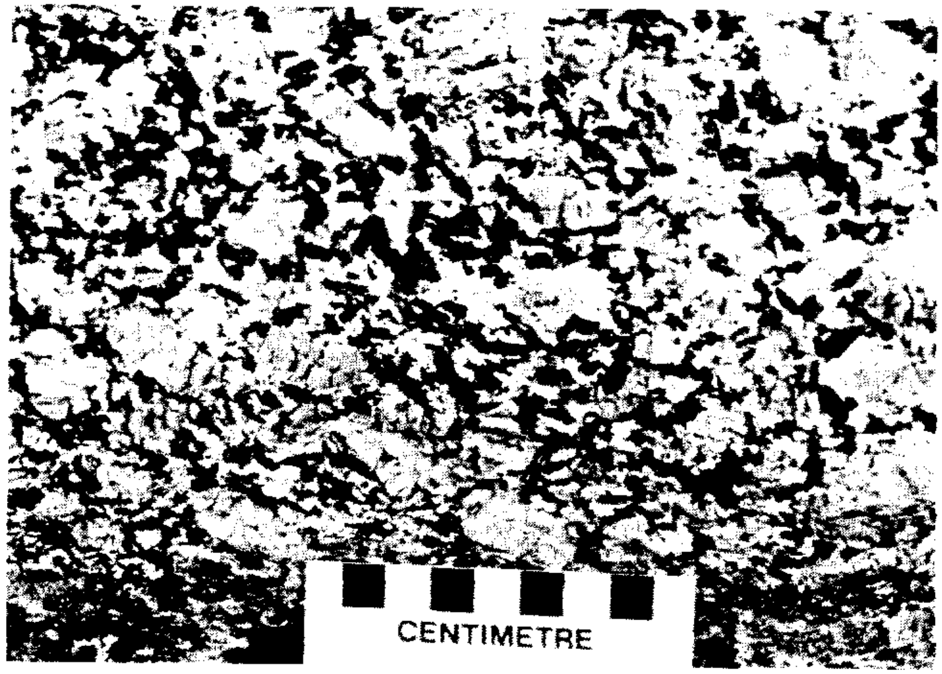


Figure 7. Big Creek Syenite showing coarse, aligned, Carlsbaad-twinned K-feldspar tablets with interstitial hornblende, plagioclase and minor quartz.

Figure 8. Strongly sheared monzonite to syenite, showing stretched K-feldspars.

with flow-aligned hornblende-rich phases concentrated along contacts with older rocks.

Dawson Range Batholith (Unit 5)

Two separate intrusive phases have been mapped: Subunit 5a, the Mount Casino Granodiorite of Tempelman-Kluit (1984); and Subunit 5c, the Coffee Creek Granite.

Subunit 5a - Casino Granodiorite:

Distribution. The Casino Granodiorite forms a large plutonic mass of unfoliated, biotite-hornblende granodiorite in the central part of the Mount Nansen map area and further to the northwest of the map area. The rock is mainly recessive within the main intrusive mass and is exposed only in widely scattered castellated outcrops. It also outcrops in a number of smaller bodies to the north towards Freegold Mountain and adjacent to the Big Creek Fault.

Lithology. The rock is typically an equigranular, medium- to coarse grained granodiorite. Plagioclase locally weakly altered to sericite, makes up 50 to 60 percent of the rock and is rarely phenocrystic. Quartz and K-feldspar are mainly interstitial and each comprises 15 to 20 percent of the rock. Biotite and hornblende, in roughly equal proportions, make up about 15 percent of the rock. They vary from very fresh to highly altered with biotite replaced by chlorite and epidote and hornblende replaced by actinolite. Common accessories are opaque (magnetite, ilmenite?), apatite and sphene.

Payne (pers. comm., 1986) has subdivided this subunit into hornblende-rich (Subunit 5a) and biotite-rich (Subunit 5b) phases. However, in this map area, biotite is the predominant mafic mineral in most exposures, although the percentages are usually close to equal. The exception is near some contacts, where very locally a hornblende-rich variety, possibly a border phase to the pluton, was noted.

Age and Correlation. A number of previous age determinations (Tempelman-Kluit, in press, A) show the Casino Granodiorite to be early Cretaceous, and this is confirmed by a single sample giving a 106 my age from the present work (Appendix IV, sample 1125). It correlates with the Nisling Granodiorite to the west. Further discussion on the age of this unit is included in the section on Mount Nansen Volcanics, Unit 7.

Subunit 5c - Coffee Creek Granite:

Distribution. The Coffee Creek Granite crops out in an elongate pattern along the northern edge of the Big Creek Fault, northwest from Seymour Creek. In eastern exposures, particularly between Revenue and Seymour Creeks, it appears to be intimately related to the granodiorite of Subunit 5a. Complete separation of the two subunits on the map was not possible.

Lithology. Compositionally, the subunit ranges from granite to quartz monzonite. The rock is characterized by a coarse grain size and pervasive alteration that is responsible for its very crumbly outcrop exposure and generally recessive nature. It consists of coarse, equigranular quartz (25-35%), plagioclase (20-40%), K-feldspar (25-40%), biotite (5 to 10%) and hornblende (less than 5%). The feldspars are variably altered to clay and sericite. Tempelman-Kluit (in press, A) considered this alteration to be a high level, post-magmatic effect, possibly related to activity along the Big Creek Fault. Accessory minerals include pervasive pyrite with minor apatite, sphene, zircon and rare allanite.

On ridges immediately north of Big Creek, the Coffee Creek Granite is cut extensively by pink quartz-feldspar porphyry dykes which are compositionally similar to and probably related to the Bow Creek Granite, Unit 8.

Age and Correlation. On the basis of similar lithology, Tempelman-Kluit (in press, A) correlated Subunit 5c with the Coffee Creek Granite to the west in Snag map sheet (Tempelman-Kluit and Wanless, 1975) which is early Cretaceous in age.

Mount Nansen Plutonic Suite (Units 7, 8 and 9)

Although there is more than one age of porphyry dykes (Unit 9) and the Bow Creek Granite (Unit 8) appears to crosscut the Mount Nansen Volcanics, none of these rocks intrude the mafic volcanic rocks which form the majority of the Carmacks Volcanic Suite. Preliminary radiometric age work reported in Appendix IV suggests that Unit 8 may correlate with Carmacks volcanics while the intermediate dykes of Unit 9 are equivalent to Mount Nansen Volcanics. Additional geochronologic analyses are currently being carried out at the Geological Survey of Canada (J. Mortensen). Unfortunately, interpretations will be compromised by the presence of altered minerals in many of the units.

Mount Nansen Volcanics (Unit 7)

These are predominantly andesitic flows and related subvolcanic intrusions included within Subunit 7a. Subunit 7b, felsic pyroclastic rocks, and Subunit 7c, felsic domes and other high level intrusions, commonly flow-banded, are more locally distributed.

Distribution. The Mount Nansen Volcanics outcrop mainly in the Mount Nansen map area in three main complexes: Mount Nansen, Victoria Mountain and Klaza Mountain. Each centre has a different make-up. The Mount Nansen complex is predominantly andesitic flows and related sub-volcanic intrusions. A minor felsic component is near the centre of the complex. Victoria Mountain is dominated by coarser-grained andesitic to gabbroic intrusive rocks with a rather small extrusive component which includes only a small portion of felsic rocks. The Klaza Mountain complex, on the other hand, is greater than 50 percent felsic rocks except in the immediate vicinity of Klaza Mountain. Small, andesitic outliers are observed locally around the main complexes. Two small centres, dominated by a felsic sub-volcanic component, are on Freegold Mountain and on Burgess Creek in the western edge of the Stoddart Creek map area.

Subunit 7a - Andesite:

Lithology. These are dark green to black coloured rocks, typically with visible feldspar laths to 2 or 3 mm and less commonly hornblende, clinopyroxene and/or biotite in a very fine grained matrix. They are predominantly andesites, but grade from basalt to latite. Coarser, probably intrusive varieties include monzogabbro to diorite. Plagioclase is normally andesine in slightly to strongly zoned laths that are variably altered to sericite and clay and make up 20 to greater than 40 percent of the rock. Mafic phenocrysts, typically less than 15 percent of the rock, are most commonly hornblende with lesser clinopyroxene, in places minor biotite and rare olivine.

Groundmass minerals are predominantly plagioclase with minor

Figure 9. Near vertical, possibly columnar jointing in Mount Nansen andesite, Unit 7a.

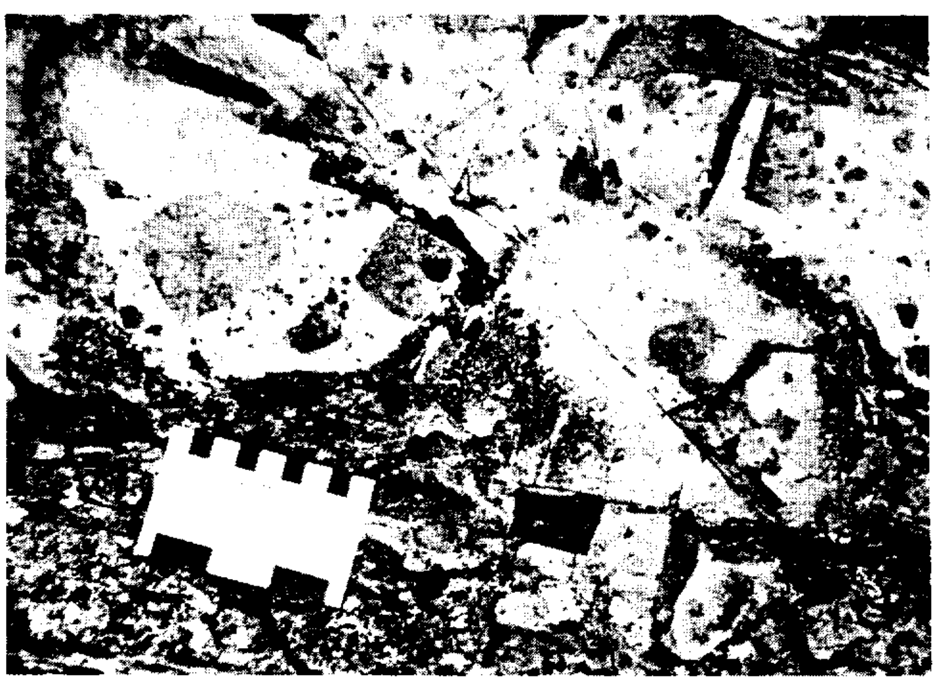


Figure 10. Volcanic breccia, matrix supported, in Mount Nansen andesite, Unit 7a. Contrast is due to epidote alteration of fragments and bleached weathering of matrix.

quartz, K-feldspar, chlorite and opaque. The rocks typically show moderate to strong magnetism and epidote, either disseminated or in veinlets, is a common alteration.

A volcanic breccia, with angular, matrix supported fragments ranging to tens of centimetres occurs locally. Because the composition of the clasts is typically identical to the matrix, the breccia texture is difficult to determine and is visible only on some lichen-free, weathered outcrop surfaces. The origin of this rock could be either intrusive or extrusive. Where recognised, this unit has been mapped as Subunit 7ax. If the Mount Nansen rocks are predominantly lava flows, the interflow units and contacts must be recessive, because none were definitely recognised in outcrop. The rocks are commonly strongly jointed, although not necessarily orthogonally. In many exposures, several directions were determined normal to a near-horizontal orientation and were interpreted as possible cooling fractures.

Layering was not commonly observed in the andesitic subunit. The rocks range from ash to lapilli tuff and rarely to volcanic conglomerate (Subunit 7at). Occurrences of this facies tend to be distal, for example within an outlier north of Klaza River and along the extreme western and southeastern edges of the Victoria Mountain complex. While the finer ashes are interpreted to be air fall deposits, some of the coarser units have a laharic appearance. Dips in these locations range from 10 to 40 degrees and are in agreement with the sub-horizontal joint planes in the more massive units if the latter are columnar joints. Only minor tilting of these rocks is suggested by this evidence.

Small, angular fragments of jasper are common in felsenmeer within the Mount Nansen complex. A narrow, linear breccia zone with a jasper matrix occurs in outcrop on the southwestern edge of the complex. Geochemical analysis of

Figure 11. Contrast between dark outcrop areas of andesite and lighter, fine scree which is predominantly felsic. Mount Nansen volcanics, Units 7a and 7b.

Figure 12. Subangular, matrix supported volcanic breccia or conglomerate.

this material showed no anomalous metal values (Appendix III, sample no. C-1167).

Subunit 7b - Felsic pyroclastics:

Lithology. This is an extrusive subunit, identified mainly by its association with pyroclastics. It is a light grey to white unit, locally weakly porphyritic. The pyroclastics range from densely welded tuff (Subunit 7bt) to uncompacted lapilli tuff with sub-angular fragments of tuff and flow-banded rhyolite (Subunit 7bx). These rocks grade very locally to fine, tuffaceous sediments. Petrographic examination has shown this subunit to vary from densely welded vitric to lapilli tuff. In the coarser fragmentals, the fragments are angular, variably bleached and altered volcanic rocks, often containing plagioclase phenocrysts. The groundmass consists of fine dust, devitrified glass shards and some pumiceous fragments. Biotite is a common accessory in the glass. The rocks are variably altered to clay and carbonate with pyrite and secondary iron oxides.

Subunit 7c - Felsic subvolcanic intrusives:

Lithology. This subunit is a biotite bearing rhyolite, characterized by a pink-grey colour and it is typically weakly porphyritic with less than 10 percent feldspar phenocrysts, up to 2 mm in length. Flow banding is observed in places. The rock commonly grades laterally into the pyroclastics, Subunit 7bt, over relatively short distances and thus is interpreted to be in part coeval with the pyroclastics. In other locations, it is simply a massive, felsic porphyry with flow banding quite common along contacts. On Freegold Mountain, dykes with similar texture and appearance are also interpreted to be coeval, despite the lack of

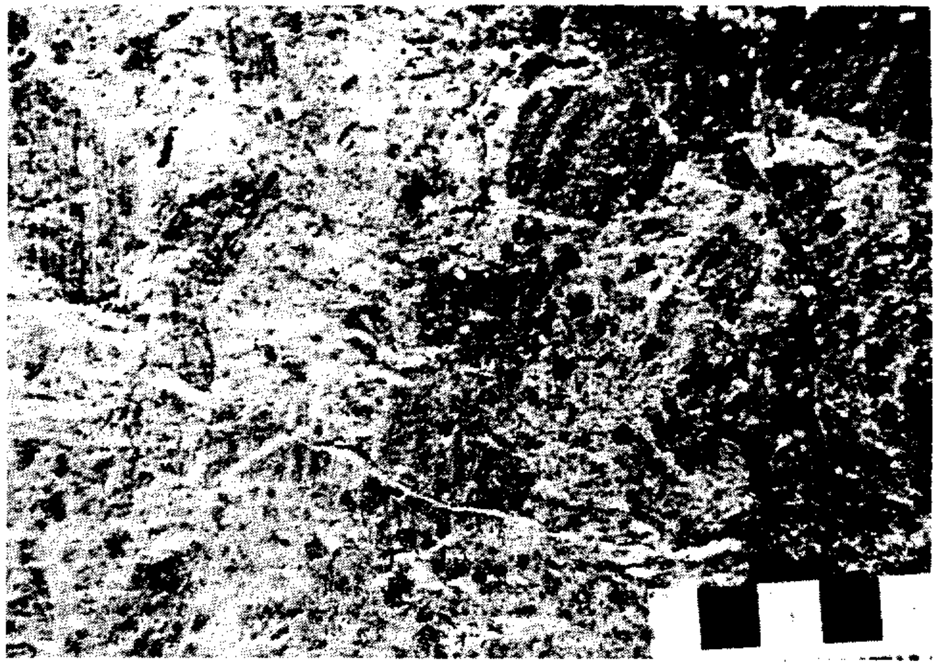


Figure 13. Felsic lapilli tuff, Unit 7bt, with angular, flow banded rhyolite fragments in an ash matrix.

Figure 14. Lightly flow banded rhyolite porphyry, Unit 7c, with large, spherulitic sructure.

pyroclastics at this location.

The rock is predominantly glass, often with spherulitic devitrification texures. The common phenocrysts are plagioclase, with lesser resorbed quartz and rare biotite lathes. Total phenocryst content is less than 10 percent. Moderate to extensive carbonate alteration, with sericite, is common in the groundmass. The pinkish colouration results from a dusting of iron oxides in the groundmass.

Age and Correlation. A single whole rock K/Ar radiometric age of 109+/-3 Ma (Tempelman-Kluit, 1984), suggests an early Cretaceous age for these rocks. Nelson (1985), in her compilation of Cretaceous and younger plutonism in western Canada, correlates the Mount Nansen rocks with an Albian to Cenomanian episode. Also included in this episode are the South Fork volcanics, northeast of the Tintina Trench in the vicinity of Faro.

Interpretation. Some of the felsic components of this unit indicate a subaerial volcanic environment: the welded felsic tuffs probably represent ash flows while the lapilli tuffs are commonly unwelded. However, the majority of these rocks lack definite evidence of extrusion, and may represent predominantly subvolcanic rocks. The exposure in this area is small compared to the type and variety of volcanism observed, suggesting all but the very roots of this volcanic episode have been eroded away. Tempelman-Kluit (pers. comm., 1986) suggests that the present level of erosion is a section through the base of a caldera.

Although previous work suggests Unit 5 plutonic rocks to be older than the Mount Nansen volcanics (Bostock, 1936), there is evidence to suggest that the opposite is true. West of Victoria Mountain, northeast of Klaza Mountain and also reportedly on Tritop Mountain (G. Abbott, pers.com., 1986), dykes of granodiorite have been observed in the volcanics. The opposite relationship, volcanics resting on the batholith, has not been observed, but only inferred. Since radiometric ages for both units, reported above, are similar, it seems more likely that the pluton is co-magmatic with the volcanic rocks. Either the granodiorite intruded and partly engulfed its own earlier volcanic products or the volcanics were erupted through, and subsequently collapsed back into a freshly cooled granodiorite pluton derived from a secondary magma chamber at depth. Rb/Sr mineral isochron ages from two dykes of Subunit 9a, feldspar-hornblende porphyry, which cut Unit 7, appear to be cogenetic with Unit 5a at 106+/-0.4 Ma (Appendix IV, samples 1083 and 1115).

Due to a lack of exposure of contacts showing these intrusive and extrusive relationships, the relative ages of Units 5 through 9 is equivocal and can only be determined through additional radiometric dating.

Big Creek Granite (Unit 8)

This is a newly defined unit which previously has been included either with the porphyry dykes and related granophyres (Bostock, 1936) or with the Mount Nansen volcanics (Tempelman-Kluit, 1984) . It has been separated into three subunits. Subunit 8a is a medium to fine grained, biotite-bearing quartz monzonite to granite; Subunit 8b is a fine grained alaskitic granophyre, commonly miarolitic; and Subunit 8c is a very fine-grained border phase, in places porphyritic. The unit is recognised by its characteristic salmon pink to buff colour.

Distribution. The unit forms one major batholithic mass, approximately 10 by 15 km in size and several satellitic dykes and plugs. The batholith trends northwesterly along the Bow Creek valley and is dominated by Subunits 8b to 8c. Subunit 8a was mapped as a small mass in the southern part of the batholith, as well as two other satellitic plugs, one centered at Guder Junction, where Stoddart and Bow Creeks join, and the other south of the main batholith and north of Victoria Mountain.

Several dykes of material very similar to Subunit 8c were mapped peripheral to the batholith and over a large area to the north, extending to the north side of Big Creek.

Subunit 8a - Biotite granite to quartz monzonite:

Lithology. This is a light pink weathering, medium to fine grained equigranular rock with 40 to 45 percent plagioclase, 20 to 30 percent K-feldspar and approximately 25 percent quartz. Biotite content is less than 10 percent and is the characteristic mafic component throughout the unit. Accessories include epidote, chlorite, opaques and traces of apatite and sphene. In the south-central part of the batholith, Unit 8 was interpreted to intrude Subunit 7b, although the contact was obscured by the felsenmeer and may be gradational. The other two plugs mapped as Subunit 8a at Guder Junction and near Victoria Mountain are very similar in texture and mineralogy.

Subunits 8b and 8c - Granophyric biotite granite:

Lithology. This is a light salmon pink to buff weathering, fine to very fine grained, typically miarolitic rock. Some phases are quartz and feldspar porphyritic. Local inhomogeneities in composition and grain size and patches of chlorite and biotite give the rock a mottled appearance.

The rock is composed of up to 50 percent quartz and only slightly less K-feldspar with minor plagioclase. In porphyritic varieties, all three minerals form phenocrysts which may be 2 to 3 mm in size and rarely comprise over 15 percent of the rock. Graphic intergrowths are commonly observed in groundmass and quartz and feldspar phenocrysts. The feldspars are variably altered to clay and sericite.

Biotite, which comprises only a few percent of the rock, occurs in patches and is normally altered to chlorite. Sericite and clay minerals also occur as secondary minerals in veinlets and patches. Oxides include primary ilmenite and magnetite and secondary hematite and limonite. The latter two minerals occur as a dusting throughout the rock and are responsible for its unique colouration.

Miarolitic cavities are typically small, less than 5 mm, irregular in shape and lined mainly with fine sericite. Graphic intergrowths of quartz and K-feldspar commonly surround the cavities.

Age and Correlation. The unit has formerly been ascribed a Mount Nansen age (Tempelman-Kluit, 1984). Bostock (1936) mentions granophyres in this area, along Maloney Creek to the west and in other locations. He includes them with the porphyries in his Tertiary Acid Intrusives unit which likely correlate Unit 8. Although this Unit is spatially associated with the Mount Nansen volcanics, it appears to cut the volcanics and it therefore more likely correlates with the younger porphyry dykes, especially Subunit 9c described below. A single age, from the porphyritic border phase, Subunit 8c, gave close to 60 Ma (Appendix IV, sample 1136, both U/Pb and Rb/Sr). This supports the correlation of this unit with the felsic Carmacks volcanism, Unit 12, described below. Dykes which bear a strong resemblance to this unit cut the Coffee Creek Granite (Unit 5c) in numerous places along the north side of the Big Creek Fault.

This unit bears a striking similarity and spatial association with the glassy rhyolite and related felsic pyroclastics of Unit 12, at the base of the Carmacks Volcanic Suite. Mineralogy is very similar, with minor biotite as the main accessory for both. The age reported above supports this correlation and suggests important implications for mineral exploration, as described below under Economic Geology. The unit bears a strong petrographic resemblance to the Pattison Pluton, 100 km west (Lynch, 1983).

A biotite K/Ar age of 85.2+/-2.6 Ma (Tempelman-Kluit, 1984) was obtained from the plug at Guder Junction. The extrapolation of this age to the main pluton is speculative.

Porphyry dykes (Unit 9)

The porphyry dykes and plugs show an extremely wide range in texture and composition. However, age relationships are difficult to determine because of the lack of exposed contacts. The porphyries are concentrated in the vicinity of Mount Nansen volcanic rocks and related intrusives. There are fewer porphyries exposed north of the Big Creek Fault, other than within and immediately adjacent to Cretaceous intrusive rocks.

Subunit 9a - Feldspar-hornblende porphyry:

Distribution. This unit occurs mainly in the vicinity of Mount Nansen and Victoria Mountain as very narrow diameter plugs (Mount Nansen) and larger dykes and stocks (north and east of Victoria Mountain).

Lithology. The unit is intermediate in composition with phenocrysts of plagioclase and hornblende predominating. Euhedral phenocrysts up to 8 mm in length are set in an aphanitic groundmass of feldspar, minor quartz and biotite and trace amounts of chlorite, epidote and apatite. Most phenocrysts are fresh, and the feldspar phenocrysts show strong oscillatory zoning. The unit rarely outcrops, but can be distinguished by coarse, angular felsenmeer typically within the finer, sharp, angular felsenmeer produced from the felsic volcanics.

Age and Correlation. This subunit shows a strong spatial relationship to the Mount Nansen volcanic rocks. It comprises in part Tempelman-Kluit's (1984) Unit Ky northeast of Victoria Mountain which he considered a feeder to the Mount Nansen volcanics. At Mount Nansen, the small plugs of porphyry intrude the volcanics, in particular the felsic units. Two ages of 106 Ma (Appendix IV, samples 1083 and 1115) correlate this unit with Unit 5a.

Subunit 9b - Feldspar-hornblende+/-quartz+/-biotite porphyry:

Distribution. This unit occurs south of the Big Creek Fault and north of the main occurrences of the Mount Nansen Volcanics. Host for these dykes is commonly the Big Creek and Dawson Range Plutonic Suites, Units 4 and 5, and adjacent units which these rocks intrude. The dykes are typically too narrow and discontinuous to accurately represent at map scale.

Lithology. These dykes are very similar texturally to Subunit 9a but they are more felsic and they display a greater variety of phenocrysts, including plagioclase, K-feldspar, quartz, hornblende and biotite. Some phenocrysts, in particular K-feldspar, are commonly megacrystic. Quartz phenocrysts are commonly rounded and resorbed. Feldspars show a high degree of alteration to sericite and clays in places whereas mafic minerals may be completely altered to chlorite, epidote and opaques. Groundmass minerals include feldspar laths, commonly flow aligned, with quartz, clays, carbonate, sericite and oxide opaques.

Age and Correlation. This subunit is mineralogically gradational from Subunit 9a and is therefore probably correlative.

Subunit 9c - Quartz-feldspar porphyry:

Distribution. Dykes of this subunit are distributed throughout the study area except in the northern part of the Stoddart Creek map area. They are spatially associated with the Mount Nansen Volcanics, and may be genetically related to precious metal deposits in the area.

Lithology. The porphyries are white to pink weathering and are more leucocratic than the other porphyries. Quartz and/or plagioclase occur as small phenocrysts typically less than 2 mm in size and comprising only about 10 percent of the rock. Mafic minerals are present only in trace amounts and the groundmass consists of quartz and alkali feldspar with sericite, clay and minor opaques, mainly pyrite. Feldspar phenocrysts and the feldspathic groundmass are typically extensively altered to clays, sericite and carbonate.

Age and Correlation. While showing some lithological similarities to Subunit 9b, the degree of alteration and lack of mafic minerals make this a distinctive subunit. It ranges from a highly altered, chalky grey-white weathering rock to a pinkish-weathering rock which is similar in appearance to the finer grained phases of Subunit 8. Although no direct cross-cutting relations were observed, this unit is interpreted to be the youngest of the porphyries. Crosscutting relationships are suggested by the distribution of fragments in felsenmeer.

Subunit 9d - Granodiorite to quartz monzonite stocks:

Distribution. Within this subunit are the porphyry stocks observed at the Mount Nansen porphyry property, the Klazan property and the Revenue property along Big Creek.

Lithology. These are mainly porphyritic stocks which show a wide range in composition, from intermediate to felsic. They display multiple intrusive events and contain or are associated with intrusive breccias and, in the case of Klazan, quartz stockwork zones. They are typically extensively altered, pyritic, and show a close association with porphyry-style mineralization in the two map areas. The reader is referred to Sawyer and Dickinson (1976) for a complete description of the porphyries and related quartz-tourmaline breccias at the Mount Nansen (Cyprus) porphyry property.

Age and Correlation. These rocks show many similarities to porphyry dykes, in particular Subunit 9c, with which they are normally closely associated. They were also considered to be Mount Nansen in age because of a close spatial association, particularly at the Klazan property and Mount Nansen. Similar rocks at Casino were dated as young as 70 Ma (Godwin, 1976), and were mapped separately as Unit 6 by Payne (pers. comm., 1986). The high degree of alteration of this subunit and Subunit 9c, make a precise radiometric age difficult to de-

Figure 15. Porphyry plug, subunit 9a, is distinguished in foreground by coarse felsenmeer, cutting Mount Nansen felsic Unit 7b, very fine felsenmeer. Castellated outcrops in background are andesite, Unit 7a.

Figure 16. Flat lying Carmacks basalt flows, Unit 14b, showing characteristic rounded, chocolate-brown weathering outcrops.

termine.

Subunit 9e - Gabbro to syenite:

Distribution. This subunit occurs predominantly around Victoria Mountain as a complex of dykes and related intrusions. Dykes of similar material occur throughout the Mount Nansen rocks but were not normally separated from Unit 7 because of their small size and typically indeterminate contacts.

Lithology. This subunit is a dark grey to black rock with a gabbroic texture and is distinguished from Unit 7 by a slightly coarser grain size. Syenitic varieties are a distinctive mauve colour. The rock is typically porphyritic with phenocrysts of intermediate plagioclase (20 to 30 %), hornblende (10 to 15 %) and clinopyroxene (less than 10 %), all in the 0.5 to 2 mm size range. The groundmass consists of plagioclase laths with some K-feldspar and quartz. Opaques, mainly magnetite, make up 1 to 2 percent of the rock. Feldspars are variably altered to sericite and clay and the mafic minerals are commonly strongly altered, mainly to chlorite. Epidote is a common accessory in the groundmass and as an alteration product. Minor apatite is also present.

The subunit occurs mainly as dykes and, in the vicinity of Victoria Mountain, as dykes and plugs. However, since the subunit is exposed primarily in felsenmeer and not in outcrop, no contacts were observed.

Age and Correlation. This unit displays a strong spatial, compositional and textural similarity to Unit 7, Mount Nansen andesite, and is therefore considered a part of the feeder complex for that unit. It correlates, at least in part, with Tempelman-Kluit's hornblende syenite Unit Ky (1984), on

Victoria Mountain.

Caribou Creek Conglomerate (Unit 10)

Distribution. This unit is exposed in a few outcrops along the west side of Seymour Creek, most particularly at the old Caribou Creek gold mine. Bostock (1936) showed the unit to be more widely distributed further to the southeast along the same trend.

Lithology. This sedimentary unit consists of a black, graphitic, gritty sandstone grading to quartz pebble conglomerate and boulder conglomerate, both with black, gritty matrix material. Fragments contained in the conglomerate include various basement rocks, porphyries and Big Creek Granite. Boulders are rounded and range up to tens of centimetres in diameter. Quartz pebbles are believed to be coarse quartz grains derived from the Coffee Creek Granite and suggest a source from the north, with transport and deposition along the present Seymour Creek valley.

Age and Correlation. The unit is overlain by Carmacks Volcanics, but includes fragments of all older rocks, including Mount Nansen Volcanics, Dawson Range Plutonic Suite and the porphyry dykes. With the exception of a debris flow mapped by Payne (pers. comm.), there are no other sediments of comparable age in the region.

Carmacks Volcanic Suite (Units 12, 13 and 14)

Three distinct units have been defined: Unit 12, a basal rhyolite; Unit 13, a middle intermediate unit; and Unit 14, an upper basalt. The latter is by far the most extensive unit in the Mount Nansen and Stoddart Creek map areas.

Lower Felsic Member (Unit 12)

Distribution. This unit is exposed only in a very localized area at the headwaters of Bow Creek in central Mount Nansen map area. However, it likely correlates with an extensive area of ash flows with a very similar appearance that occur to the south and west (Unit Tva of Tempelman-Kluit, 1974a).

Lithology. The unit is characterized by felsic pyroclastics, Subunit 12a. These are predominantly crystal tuffs which weather a distinctive grey colour in flaggy slabs. The base of the unit is marked by a lapilli tuff. Near the centre of the exposure is an outcrop of vertically flow-banded glassy rhyolite, Subunit 12b. This rock is composed of up to 10 percent fine phenocrysts of quartz, plagioclase and K-feldspar, concentrated in layers which probably represent flow banding. Graphic intergrowths of quartz and K-feldspar are common and biotite occurs as an accessory, along with minor opaques. Some devitrification of the glass occurs along spheroidal, perlitic fractures.

Middle Andesite Member (Unit 13)

Distribution. This unit outcrops peripheral to exposures of the basalts (Unit 14) particularly in the vicinity of the Unit 12 exposure. Because it is a recessive unit, the actual extent of Unit 13 is probably much greater than that indicated, particularly under large areas of Unit 14 in the Stoddart Creek map area.

Lithology. The unit is characterized by intermediate pyroclastics, Subunit 13a. These are made up of ash and lapilli, and are usually oxidized, exhibiting various shades of pink to red weathering. They display a platey or flaggy cleavage. Phenoclasts include both plagioclase and hornblende set in a groundmass of quartz, clay derived from feldpars and a dusting of more than 1 percent hematite. Intermixed within this subunit are andesite lava flows that are highly oxidized, weather a reddish brown and are commonly vesicular. Phenocrysts, including plagioclase and clinopyroxene, are a relatively minor component of the rock. The groundmass is predominantly plagioclase with minor sericite and hematite. Vesicle fillings include ankerite, hematite and quartz.

To the north, along Big Creek, outcrops of interlayered pyroclastics, debris flows and reworked volcanic sediments have been included within the middle unit.

Basalt lava flows, Subunit 13b, were not observed in the map area but are a part of the sequence to the west (Payne, pers. comm., 1986).

Upper Basalt Member (Unit 14)

Distribution. These rocks cover much of the northwestern part of the Stoddart Creek map area north of Big Creek. They also occur in east-central Mount Nansen map area as part of a major exposure that extends easterly almost to Carmacks.

Lithology. The basalts, Subunit 14b, are flat-lying lava flows. They are typically black to dark chocolate brown weathering, characterized by phenocrysts of clinopyroxene up to 5 mm across, and lesser olivine. Pyroxenes are euhedral, commonly glomeroporphyritic, and variably altered to mainly calcite. Olivines are euhedral to rounded, and variably altered to serpentine and amphibole. The groundmass consists of plagioclase and clinopyroxene with lesser magnetite, ilmenite and biotite and the rock is typically very magnetic.

Clinkery, oxidized interflow units are common and weather brownish-red. The flow tops are strongly vesiculated and non-porphyritic.

Subunit 14a consists of andesitic interflow material very similar to Subunit 13a. Minor pyroclastics also occur.

Although the basalt flows appear to be predominant, this is in part because they are the least recessive. Digging through the soil layer on many of the non-outcrop ridges in the Stoddart Creek map area commonly results in the exposure of fragments of andesitic flow or pyroclastic rocks.

Blocky basaltic debris flows occur locally low on the slopes of the Big Creek and Bow Creek valleys. The presence of these flows suggests that major valleys in the area were in existence by late Cretaceous and have been altered little since that time.

Age and Correlation. Several radiometric age determinations, in particular reported by Grond et. al. (1984) and Lowey et. al. (1986) show a Late Cretaceous age, averaging 68 Ma, for this unit. Nelson (1985), correlates these rocks with similar volcanics such as the Donjek Group in western Yukon and the Hutshi Volcanics near Atlin Lake, with a range in ages from 75 to 64 Ma.

Late Intrusions (Unit 15)

Included within this unit are a number of dykes and plugs related to Carmacks volcanism, as well as a gabbroic plug which appears to be a younger intrusion, but has no apparent genetic link to other Units.

Subunit 15a - Intermediate Dykes:

Distribution. This subunit is exposed only very locally as resistant ridges within the area of Carmacks basalts, Unit 14b, in the Stoddart Creek map area.

Lithology. The rock is dark grey, fine-grained, relatively dense and resistant. It is exposed as dykes in steep-walled, narrow, elongate outcrops.

Age and Correlation. This subunit may be related to the Carmacks volcanics, probably as feeder dykes, because of the close spatial association and similar composition.

Subunit 15c - Potassic Gabbro:

Distribution. This subunit is exposed in a small plug on the steep north valley wall Big Creek.

Lithology. The rock has a distinctive reddish colour. One thin section examined showed a medium to coarse-grained grano-gabbro with 40 to 45 percent K-feldspar, 20 to 25 percent plagioclase, 5 percent quartz and 15 to 20 percent mafics, including clinopyroxene, hornblende and biotite. The rock is porphyritic, with early-formed clinopyroxene, hornblende, biotite, plagioclase and K-feldspar as subhedral to euhedral crystals in a groundmass of K-feldspar and quartz. Hornblende is altered to tremolite, biotite and sericite and plagioclase shows some sericitization.

Age and Correlation. The age of this subunit is uncertain. It may be related to the Subunit 9b porphyry dykes or to a younger plutonic event, perhaps of Carmacks age. A second plug, to the north, which had been included in this subunit, gave a radiometric age of 106 Ma (see Appendix IV, sample C-1083) and has been therefore reclassified as Unit 9a.

Subunit 15d - Diabase dykes and plugs

Distribution. These rocks, apparently feeders to the Carmacks basaltic volcanics, occur in two small complexes north and east of Victoria Mountain.

Lithology. These are very similar in appearance to Subunit 14b basaltic flows, with phenocrysts of clinopyroxene and, to a lesser extent, olivine. They show the distinctive, chocolate-brown weathering but they are distinguished by a lack of horizontal flow layering. The easternmost complex is the largest and forms a roughly circular, 1 to 1.5 km diameter plug-like body with vertical contacts. The rocks are strongly magnetic.

Age and Correlation. These rocks are probably feeder complexes for the Carmacks volcanics because of the lithological similarities and the spatial association with the Carmacks basalts. Two other smaller exposures of Carmacks basalts, on the west side of Bow Creek, are on a northwesterly trend from the two larger exposures, and may also represent Carmacks feeders.

Unconsolidated Deposits (Unit 17)

Distribution. This unit includes present day valley fill in the broader valleys, such as Big Creek, Klaza River and Lonely Creek, as well as older terrace deposits, 100 to 200 m above the present base level, observed particularly along the south side of Big Creek in the vicinity of Stoddart Creek. Loess and volcanic ash are observed in scattered patches throughout the map area.

Description. The alluvium is only vaguely defined by the occurrence of benches and otherwise flat-lying valley fill. On terraces above Big Creek in northeastern Stoddart Creek map area, rounded cobbles of mainly Carmacks volcanics are occur in the soil profile. In the Big Creek canyons just below, stratified gravels sit on Unit 3 bedrock. These are probably Tertiary gravels derived from erosion of Carmacks volcanics.

In the smaller tributaries, very poorly sorted gravels are mixed with black, organic muck. They are typically exposed in placer workings, such as at Revenue Creek. Mammoth tusks are frequently unearthed from this permanently frozen material.

Glacial lake deposits and minor boulder clay have been reported from some of the valleys, in particular lower Victoria and Nansen Creeks (Bostock, 1936). Fine, unsorted sand was observed mantling many of the hills in the vicinity of Mount Nansen and Victoria Mountain, probably representing loess deposits from the glacial epoch. Similar deposits, which show little or no internal stratification, apron these hills as colluvial or windblown fans.

White ash, from a Recent eruption in the Wrangell Mountains on the Yukon/Alaska border, mantles much of the countryside. They are usually masked by a few centimetres of soil and are exposed in river or road cuts.

STRUCTURAL GEOLOGY

Structural geology of the area is very important to the control of mineralization in the map area. It is discussed below first from a regional perspective and then on a more local basis, from the study of field measurements. These measurements have been plotted on stereonets and contoured by computer using the Kamb (1959) method. This is a method of statistical contouring of data points in terms of standard deviation (sigma), using a variable counting area which is a function of the number of data points. Any density greater than 3 sigma indicates a non-random distribution of data points.

Regional Structural Elements

Major regional structures parallel the northwest-trending Tintina Fault, a major strike-slip fault with approximately 450 km right-lateral displacement, 100 km northeast of the map area. The most significant feature in the map area is the Big Creek Fault, northwest trending, in the lower half of the Stoddart Creek map area. This has been interpreted by Tempelman-Kluit (1987; in press, A) as a normal fault, southwest side down, formed as a collapse or graben structure in response to extensive Mount Nansen volcanism. The southwest side of this graben, not so clearly defined, would be south of Mount Nansen. The present study is in agreement with this hypothesis, although the timing may be younger, at least in part, and related to the Bow Creek Granite and possibly the earliest Carmacks felsic volcanism. The Big Creek Fault follows the major Big Creek and Seymour Creek valleys, although from west to east across the Stoddart Creek map area it appears to splay, with perhaps several branches trending through and to the north of Freegold Mountain.

It has been noted that there is a distinct change in lithology (Tempelman-Kluit, in press, A), mineral deposits and even geochemical signature (A. Archer, pers. com., 1986) across Big Creek Fault. The Big Creek valley is not the precise locus for this change, since many of the southern characteristics are observed for at least a short distance to the north. This suggests that perhaps an older, more profound structure was re-activated locally during the Cretaceous Mount Nansen and Carmacks phases of plutonism and related vertical tectonism.

A second parallel zone, following the main axis of the Casino granodiorite, Unit 5a, passes north of Mount Nansen and south of Klaza Mountain. It is not marked by a specific linear feature but rather by a broad topographic low and magnetic linear. This zone passes through the Mount Nansen mineral occurrences. Tempelman-Kluit (1984) mapped a fault on the northern edge of this zone, on the south side of Klaza Mountain.

The Miller Fault is an east-northeast structure that passes along the north side of Victoria Mountain and Mount Nansen (Tempelman-Kluit, 1984). It also is expressed topographically, following Crossing Creek valley, and magnetically, as a truncation of northwesterly trending features.

A major regional structure with north-northeasterly trend can be defined from its expression on topographic maps and satellite imagery. The structure passes through Pelly Crossing and Minto along a broad valley and extends southward into the study area along the Big Creek valley. Magnetic features are truncated by the structure. Here referred to as the Minto Linear, it extends from north of Pelly Crossing through Minto and into the map area along Big Creek and Seymour Creek. The topographic expression is lost south of Big Creek Fault, but the magnetic expression persists. This suggests that it also is an older feature.

A study of aerial photographs and topographic base maps revealed numerous linears, trending mainly northeasterly and northwesterly. North-south directions predominate locally. These structures control topographic features and local drainage patterns.

Basement Structures

Primary structures were seldom observed in the basement rocks because of the high degree of metamorphism. Where sedimentary bedding was suspected, it paralleled adjacent metamorphic fabric. In the gneissic rocks, mineral foliation was in places observed to be at a very slight angle to banding, less than 5^0, and the difference was not measured in the field. In the more schistose rocks, a weak to strong crenulation is common in the micaceous bands. Although folds were not frequently observed, they are locally abundant, particularly in the amphibolite-rich units as tight, irregular drag folds. Fold axes, where measurable, paralleled the crenulation.

Measurements of basement structures have been subdivided into sets from north and south of the Big Creek Fault. Foliations in the southern basement rocks (Figure 17) show a constant northeasterly trend, ranging from 015 to 050^0, with a range of dips from 75^0SE to 75^0NW. The most common attitude is 025^0 with a dip of 40^0SE. The trend indicates regional folding with the fold axis par-

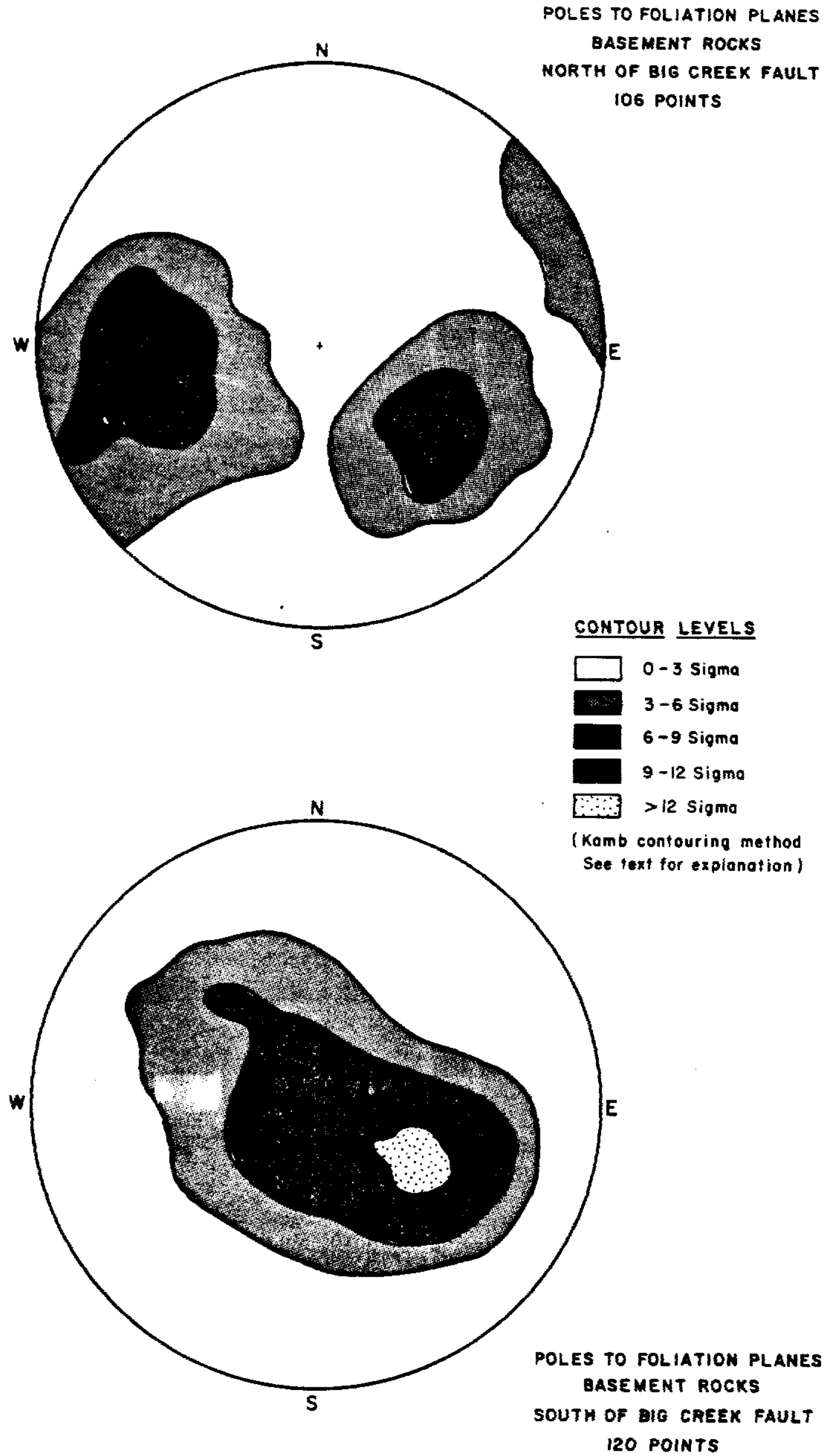

POLES TO FOLIATION PLANES
BASEMENT ROCKS
NORTH OF BIG CREEK FAULT
106 POINTS
N
W
E
S
CONTOUR LEVELS
0 - 3 Sigma
3 - 6 Sigma
6 - 9 Sigma
9 - 12 Sigma
>12 Sigma
(Kamb contouring method
See text for explanation)
N
W
E
S
POLES TO FOLIATION PLANES
BASEMENT ROCKS
SOUTH OF BIG CREEK FAULT
120 POINTS

Figure 17.

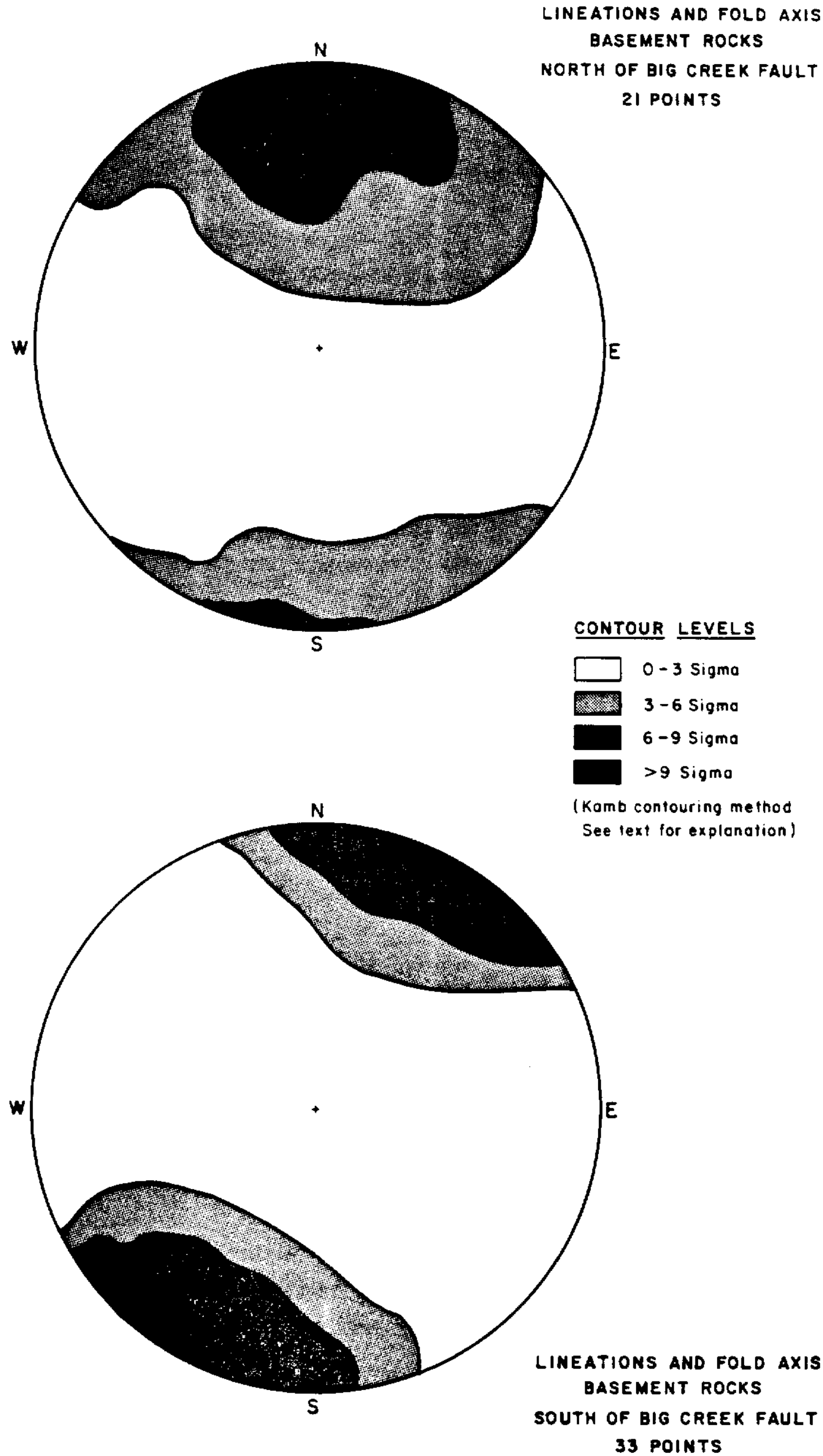

LINEATIONS AND FOLD AXIS
BASEMENT ROCKS
NORTH OF BIG CREEK FAULT
21 POINTS
N
W
E
S
CONTOUR LEVELS
0 - 3 Sigma
3 - 6 Sigma
6 - 9 Sigma
>9 Sigma
(Kamb contouring method
See text for explanation)
N
W
E
S
LINEATIONS AND FOLD AXIS
BASEMENT ROCKS
SOUTH OF BIG CREEK FAULT
33 POINTS

Figure 18.

allel to the average foliation direction and a very gentle plunge to the northeast. Lineations and minor fold axes, with an average trend of 025 to 030^{0} and horizontal attitude (Figure 18), confirm this interpretation.

Two foliation directions are observed north of the Big Creek Fault. The predominant direction ranges from 350 to 330^{0}, with 60 to 90^{0} dips to the SW while the second averages 035^{0} with a dip of 60^{0}SE. Lineations and fold axes show a broad range of orientations, centred on a north-south direction with a gentle northerly plunge. Two interpretations are possible. The linear structures may reflect an axis of warping in the northwesterly oriented foliation. However, it is more likely that they parallel the axis of a regional, north-plunging fold set and the two foliations represent dominant limb orientations on these folds. Most of the north sector measurements were taken from a transitional tectonic regime, between the Yukon Crystalline Terrane to the south and the Yukon Cataclastic Terrane to the north.

Joint measurements from basement rocks (Figure 19) are all steeply dipping, in the 80 to 90^{0} range, and display a 360^{0} range in strike. South of Big Creek Fault, a roughly orthogonal set at 305^{0} and 025^{0} was outlined.To the north, a similar set at 315^{0} and 040^{0} was less strongly defined. Horizontal joints were evident in outcrop but were seldom strong enough to provide a good measuring surface.

Foliated Plutonic Rocks

Though Units 3 and 4, are defined by their foliation, it was seldom strong enough to provide an accurate measure

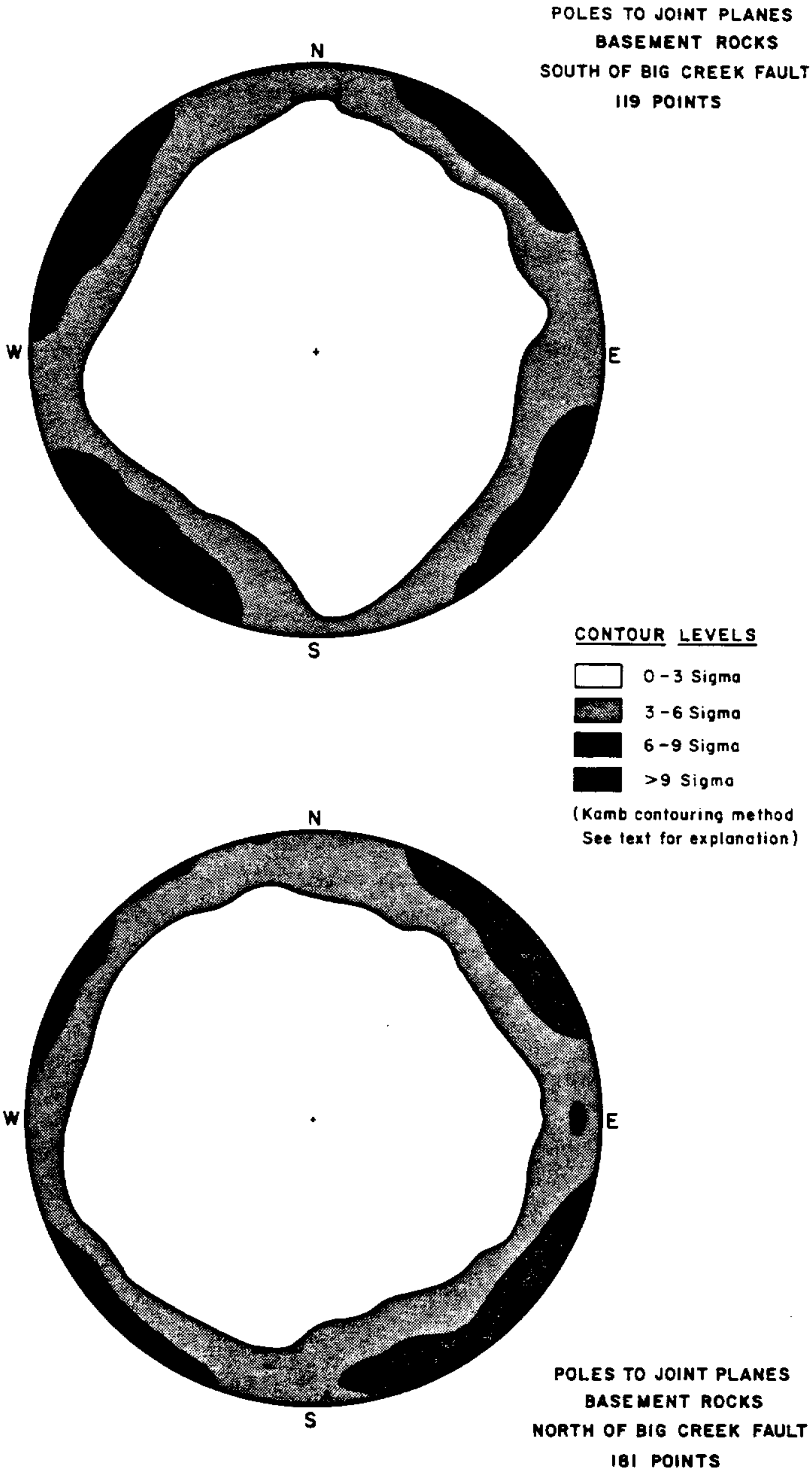

POLES TO JOINT PLANES
BASEMENT ROCKS
SOUTH OF BIG CREEK FAULT
119 POINTS
N
W
E
S
CONTOUR LEVELS
0 - 3 Sigma
3 - 6 Sigma
6 - 9 Sigma
>9 Sigma
(Kamb contouring method
See text for explanation)
N
W
E
S
POLES TO JOINT PLANES
BASEMENT ROCKS
NORTH OF BIG CREEK FAULT
181 POINTS

Figure 19.

of its orientation. Where measurable, a northeasterly orientation predominates in Unit 3. In the syenite, Unit 4a, attitudes are more variable and seldom measurable, whereas within the more strongly foliated Unit 4b, trends are mainly northwesterly.

Mount Nansen Plutonic Suite

Joint surfaces were the only significant measurements made in the volcanic rocks and adjacent, associated intrusives (Figure 20). Again, a 360^0 range in strike is evident on the diagrams, with steep dips. Major concentrations occur at 025 to 050^0, 325 to 340^0 and 295^0. The first two sets show a fairly wide range, particularly towards the north-south direction, where they almost join. A fourth direction, with fewer measurements but nonetheless well defined, is roughly north-south with a flat to gentle easterly dip.

This range of joint directions appears to reflect at least two tectonic events. The first, represented by a 295^0 and 025^0 orthogonal set, is probably related to extrusion of the Mount Nansen volcanic rocks and emplacement of related intrusive bodies. The second set parallels the Carmacks-related tectonic regime described below.

As mentioned in the discussion of Unit 7 in the geology section of this report, some of the near-vertical joints in the Mount Nansen volcanic rocks have the appearance of columnar cooling fractures.

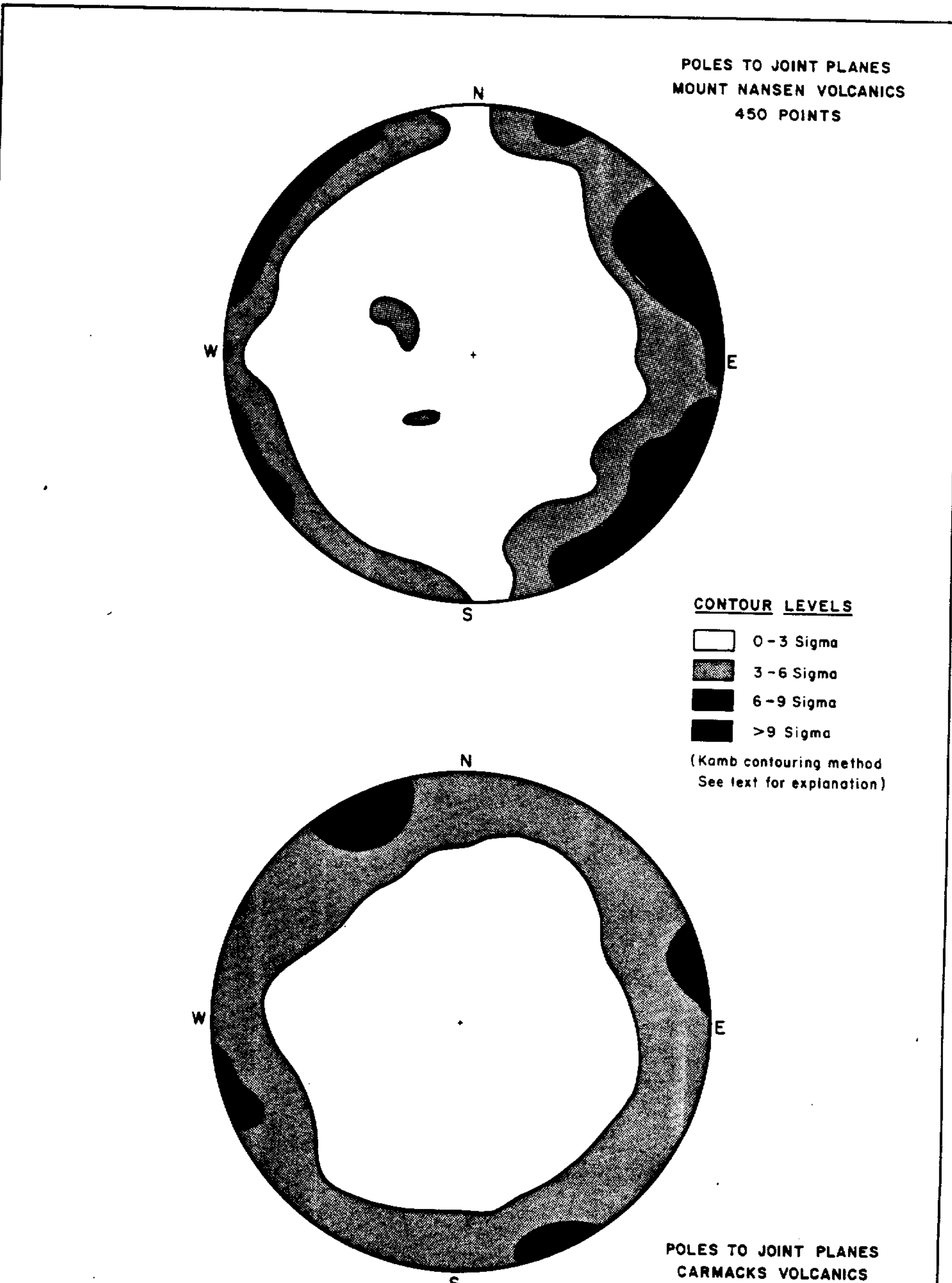

POLES TO JOINT PLANES
MOUNT NANSEN VOLCANICS
450 POINTS
N
W
E
S
CONTOUR LEVELS
0 - 3 Sigma
3 - 6 Sigma
6 - 9 Sigma
>9 Sigma
(Kamb contouring method
See text for explanation)
N
W
E
S
POLES TO JOINT PLANES
CARMACKS VOLCANICS
40 POINTS

Figure 20.

Carmacks Volcanics

Although a similar 360^{0} range of steeply dipping joints is noted (Figure 20), this Unit shows an almost perfectly orthogonal set of vertical joints at 340^{0} and 070^{0}. This latest tectonic signature possibly represents extension normal to a west-northwesterly axis of eruption during Carmacks volcanism.

Flow layering was measured in a few locations and is typically within 10^{0} of horizontal.

ECONOMIC GEOLOGY

Mineralization Styles

Six main types of mineralization occur in the map area: porphyry copper-molybdenum, disseminated gold, vein gold-silver, polymetallic vein, magnetite-gold skarn and placer gold.

First discovered were the placers, followed by the gold-bearing magnetite skarns on the north side of Freegold Mountain. Subsequent prospecting led to the discovery of gold-quartz veins on Caribou Creek, the La Forma vein on Freegold Mountain and the Brown-McDade and Heustis-Webber veins at Mount Nansen, as well as a number of others. Polymetallic veins with significant precious metal values were discovered on Emmons Hill, east of Freegold Mountain and Tinta Hill, south of Granite Mountain. Lead and zinc sulphides have been observed at a number of other locations, but in general they are quite rare.

More recently, the porphyry exploration boom of the late 1960's and 70's resulted in significant exploration along the south side of Big Creek, particularly at the Klazan and Revenue properties, and at the Mount Nansen property to the south. None of these properties attained appreciable grades, but since interest has shifted from copper to gold over the past decade, these properties, or zones peripheral to them, are being re-evaluated for their gold potential.

The new gold zones are, in some cases, the leached cap immediately within the porphyry system, as at Casino to the west. However, in this map area the gold values appear to be associated with intrusive breccias and quartz

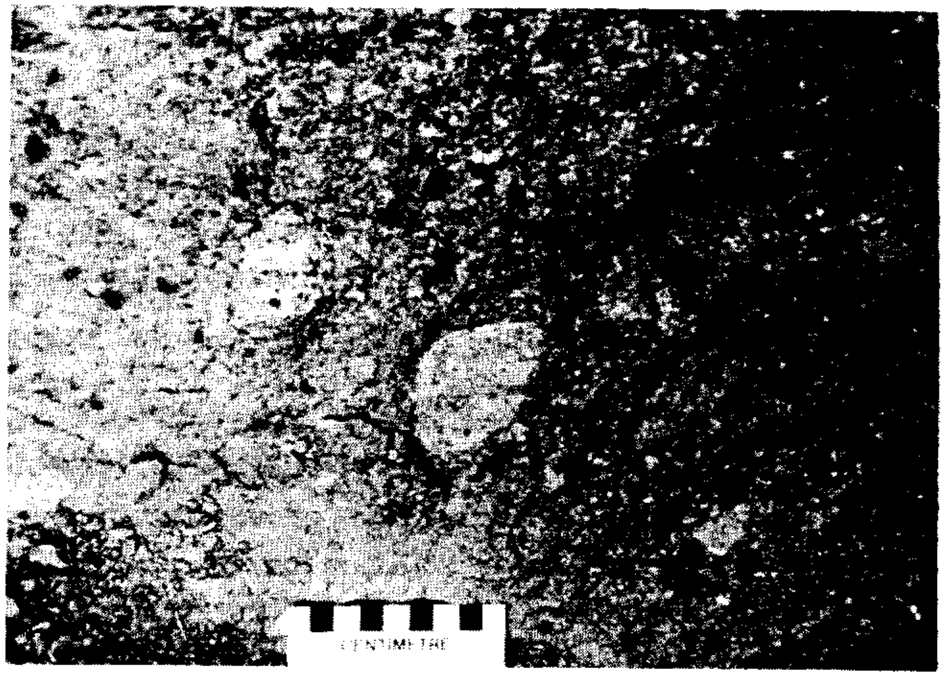


Figure 21. Revenue breccia. Subrounded fragments are highly altered igneous rock and breccia in a finely comminuted matrix.

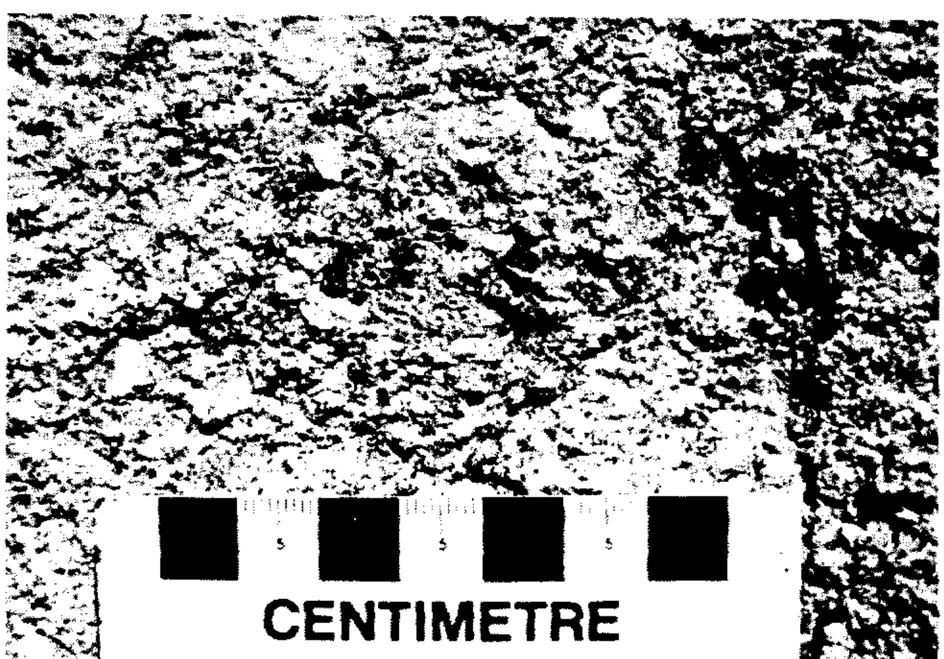


Figure 22. Close-up of Revenue breccia showing matrix which includes fragments of altered rock, limonite and pyrite as well as pyrite cubes (centre of photo).

stockworks which have very low base metal values and low pyrite content. At Mount Nansen, brecciation is related to the margins of quartz-feldspar porphyry dykes, while at Freegold Mountain (Antoniuk) and at Revenue, the breccias are more extensive. The best gold values at Antoniuk come from within the breccia. By contrast, the gold within the breccia at Revenue is erratically distributed. The highest grade values and source of the placer gold in Revenue Creek may actually be a quartz stockwork zone outside the breccia (C.A. Main, pers. comm., 1986).

Mineralization Controls

There is little evidence to suggest that the variety of mineralization observed within the map area might be the result of a single event or a number of mineralizing periods. However, most of the important zones show a spatial association with the porphyry systems. The evidence suggests that a late Cretaceous event may have been responsible for most of the mineralization observed. This evidence is based on a 70 Ma age on the porphyry mineralization at Casino (Godwin, 1974) and the similarities between felsic porphyry dykes, which show a close relation to mineralization, and felsic volcanism at the base of the Carmacks volcanics (Unit 12). At least some of the vein mineralization is earlier, however, as shown by a K/Ar age of 122.9+/-1.9 Ma obtained from adularia collected from the Heustis vein in the Mount Nansen area by Morin (pers. com., 1987).

In a mineral deposit model for the area, the porphyry systems were the locus of the mineralization with adjacent skarns developed when favourable, limy metasedimentary country rocks were encountered by the porphyry plugs. Farther from the porphyries, mesothermal to epithermal precious metal vein and breccias developed. The mineralizing fluids were low in base metals and relatively low in sulphur. Peripheral base metal vein deposits formed only locally.

The plutonic event with which this mineralization is associated is uncertain. Veins and breccias cut basement rocks, foliated plutonic rocks and the unfoliated batholithic rocks (Unit 5) but they rarely cut Mount Nansen volcanics and have not been observed cutting Carmacks volcanics. The porphyry dykes, with which most of the gold deposits appear to be intimately associated, appear to be younger than the Mount Nansen volcanics and may be as young as, and related to, the felsic, basal Carmacks event. The presence of gold veins cutting the Caribou Creek conglomerate, immediately basal to the Carmacks, adds further weight to this argument. However, the early Cretaceous age of adularia in the Heustis vein indicates that at least some of the mineralization is earlier.

The most important control for mineralization appears to have been structure. Regardless of the age of mineralization, regional structures such as the Big Creek Fault and possibly other major crosscutting structures, such as the Minto Linear discussed in the section on regional structure, were important in localizing igneous activity and thus the related ore deposits. While the major structures controlled the igneous activity and thus the heat source for formation of the deposits, smaller related structures provided plumbing systems and openings for ore deposition.

Tempelman-Kluit (1987) described the formation of a graben-like stucture in response to Mount Nansen age igneous activity, extensive volcanism and subsequent caldera collapse. He stressed the importance of the bounding faults, most notably the Big Creek Fault, as loci for mineralization.

Local plutonism within this general area began with emplacement of the Big Creek Syenite during the Jurassic. Many of the mineral deposits are spatially associated with this unit, in particular with zones of secondary epidote-magnetite enrichment. The early Cretaceous Dawson Range Batholith, Unit 5, and the Mount Nansen volcanics, show an even stronger association with mineralization. Finally, the late Cretaceous Carmacks volcanic event is marked by a minor felsic event that correlates with an extremely voluminous outpouring from the south (Morin, pers. com., 1986), followed by extensive intermediate to mafic flows and pyroclastics.

Based on field evidence, it would appear that the Carmacks event provided a greater volume of extrusive material than Mount Nansen. In addition, the latest stage of porphyry dykes, the quartz-feldspar porphyries, and possibly the Bow Creek Granite may represent feeders or magma reservoirs for this volcanism. Therefore, it is proposed that, while the Mount Nansen event may have provided important initial stuctural controls and even some early mineralization, the important mineralizing event was later, possibly even as late as the earliest Carmacks volcanism. Tempelman-Kluit's structural model would still be accurate, but the timing would be later.

In order to form ore deposits, hydrothermal fluids must be focussed. In the map area, host rock appears to play an important part in ore deposit formation. The most common hosts are basement rocks, in particular silicified schists and quartzofeldspathic gneisses, and the Dawson Range Batholith rocks. The former units are relatively brittle and would hold an open fracture. The association with the batholithic rocks may have to do with their structural competency or simply with a spatial association with the hydrothermal systems.

Exploration Methods

Initial discoveries were made during early prospecting forays into the area. However, because of the lack of exposure, a number of discoveries, particularly in the Mount Nansen area, were made by following up panned placer gold anomalies in the creeks. In the late 1960's, regional stream sediment geochemical surveys carried out by a number of companies resulted in most of the more recent discoveries. The 1986 stream sediment geochemical release (ref) confirms the value of this exploration method. All known occurrences were reflected in the survey data. As well, a number of unexplained anomalies were defined by this survey.

A wide range of airborne and ground geophysical surveys have been used in the area. Some of the rock types have distinctive magnetic signatures. IP has been used with success in defining disseminated sulphide zones associated with porphyry systems. Electromagnetic surveys, such as VLF, have been helpful in defining fault and vein systems. Low level, high resolution aerial photography has been very helpful to some companies in defining vein targets and in detecting faulted offsets. Soil geochemistry has been helpful in the area, but anomalies are often subdued or transported due to mechanical dispersion in the soil profile, especially on steeper slopes.

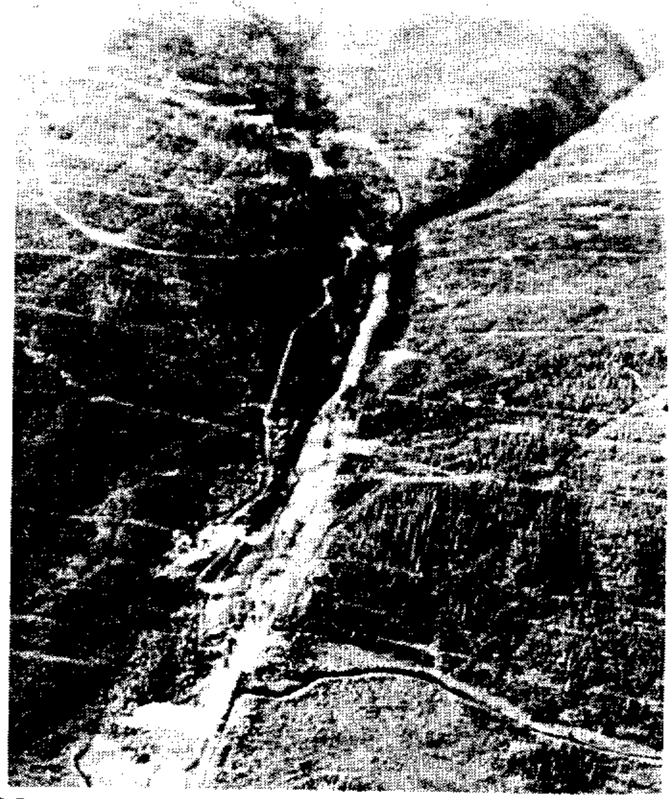


Figure 23. Revenue property showing placer workings along creek, line grids, trenching and access road. Breccia zone trends across property above fork in creek.

Figure 24. Nucleus property showing backhoe trenches used to establish limits of mineralization.

Geological mapping has been a valuable tool for defining target areas. The major rock type associations mentioned above are important, in particular the quartz-feldspar porphyry dykes. Clay alteration and pyritization of these dykes and silicification and brecciation of adjacent wall rocks are also important. Trace metal signatures in rocks immediately adjacent to ore zones may prove to be very helpful in exploration. A number of samples were collected and analyzed in this study, and although no strong patterns were observed, the typical gold pathfinders, such as arsenic, antimony and mercury, as well as a number of others, showed variable levels of enhancement in the vicinity of known showings. The results are shown in Appendix III.

In the area of defined targets, trenching, by tractor or by backhoe, has usually been utilized to expose bedrock and outline mineralized zones for sampling. Surface leaching may have resulted in a depletion of base metals in the surface bedrock, but it is expected that the precious metal values are less affected.

A note of caution has been expressed by Mr. Gordon Dickson (pers. comm., 1986) with respect to the analysis for silver in surface rock samples. He carried out a comparison between a normal acid leach extraction versus fire assay, followed by atomic absorption on a number of anomalous samples from the Rusk property. The fire assay method produced a tenfold or greater increase in values compared to the acid leach. These results were from the same pulp and carried out concurrently by the same lab. The reason for this disparity is uncertain.

Percussion drilling has not been used extensively in the area, but it may prove to be a more valuable tool in areas where overburden is too deep for trenching.

Conventional diamond drilling is the best tool for target delineation, and no major nugget effect problems have been reported from drill core assays in current gold exploration programs.

Note: Property numbers are located on geology maps and the same numbers used in DIAND publications.

24. KLAZAN
Nat Joint Venture
Copper, molybdenum (gold, silver)
115-I/6
62°23'N, 137°30'W

References: Craig and Laporte (1972, p.87-88)
Sinclair et al. (1976, p.136-137)
Morin et al. (1977, p.172-173)
DIAND (1982, p.217)
DIAND (1983, p.202)
Archer, Cathro (1986)

Claims: NITRO

Source: Above references and property examination.

History: Discovered during reconnaissance geological and geochemical progam in 1965 and explored by geochemical surveys, mapping, trenching and magnetometer. Drilled in 1970 with 966.5m in 5 holes. Re-staked by present owners in 1981 who have carried out additional mapping and geochemical sampling.

Description: A strong gossan, with associated anomalous Mo, Cu, Pb, Zn, Ag, Au and As values, is situated on the west side of Burgis Creek, south of Big Creek. The gossan is centred on an altered orthoclase porphyry stock (Unit 9d) intruding Mount Nansen felsic volcanic rocks (Unit 7b). The stock and adjacent volcanics are very strongly pyritized, with locally minor molybdenite, galena, sphalerite and chalcopyrite. Drilling indicated only short intervals of low grade Cu and Mo values.

Recent work has shown the presence of a number of intrusive stocks and dykes. Anomalous Au and Ag values were obtained from soils and rock chips.

25. COM

Cu
115-I/6
62°22'N 137°23'

References: Archer, Cathro (1986)

Claims: ERL/NUCLEUS

Source: Above reference.

History: Originally staked in 1969, followed by soil sampling and mapping. Later, in 1975, additional sampling and mapping was followed by limited bulldozer trenching.

Description: The property is located on the south side of Big Creek valley in an area with very limited outcrop exposure. Float indicates the presence of porphyry stocks and dykes intruding basement metasediments (Unit 1b). Minor soil geochemical anomalies were outlined, and minor malachite, fluorite and scheelite were reported from float.

26. REVENUE
Yukon Revenue Mines Ltd.
Copper, Gold
115-I/6
$62^{0}20$'N, $137^{0}16$'W

References: Craig and Laporte (1972, p.79-82)
Sinclair et.al. (1975, p.114-115)
DIAND (1982, p.217)
Archer, Cathro (1986)

Claims: REVENUE, COPPER, ADDITION

Source: Above references and property examination.

History: Placer gold was discovered by P.F. Guder around 1934, who would fund his prospecting in the area from his diggings in the creek. The first quartz claims were staked on a copper showing in 1953 and was subsequently explored by Conwest, Teck, Cominco, Meridian Syndicate (Canex, Noranda Exploration Co. Ltd. and Asbestos Corp.) and General Enterprises Ltd. Yukon Revenue Mines Ltd. was formed in 1967 to explore the property, with subsequent options to Kaiser Resources Ltd. and Shakwak Exploration. The property is currently under option to Permian Resources Ltd. and Nordac Mining Corp. Over 6000 m of drilling has been carried out in over 65 holes and a short adit was drifted into the breccia zone.

Description: An intrusive breccia cuts granodiorite to granite of Unit 5 which in turn cuts metasedimentary rocks, Unit 1. The breccia, highly kaolinized, is mainly a fine-grained tuffaceous Unit but with some angular fragments to 10 cm. Pyrite occurs throughout, as euhedral crystals and angular fragments. A broad zone of silicification and pyritization with associated weak argillic alteration surrounds a stronger phyllic zone adjacent to the breccia. High grade copper mineralization was reported from a small massive sulphide lens within the breccia. Gold, silver, copper and tungsten occur in structural zones within the breccia, with values up to 5 g/t Au, 20 g/t Ag and 1% Cu over several metres in recent drilling.

The drilling by Kaiser was directed at a large, low grade porphyry system, but most assays in a wide-spaced grid drilling program assayed less than 0.05% Cu and trace MoS2. Recent sampling in a pyritic quartz stockwork zone within phyllic altered intrusive in Revenue Creek returned some local high grade gold values. This zone may be the source of placer gold.

27. COMBO
A. MacDonald, B. Preston, K. McCrory
Lead, Zinc
115-I/6
$62^{0}19$'N, $137^{0}14$'W

References: Craig and Laporte (1972, p.83-84)
DIAND (1986, p.190)
Archer, Cathro (1986)

Claims: LUCK

Source: Above references.

History: Early prospectors reported showings in the area, but subsequent work by R. McKamey, Samson Mining Ltd., Monarch Metal Mining Ltd., Yukon Revenue Mining Ltd., Cominco and Shakwak Exploration Ltd. has failed to located any mineralization.

Description: A lead-zinc vein was reported within Big Creek Syenite (Unit 4a) south of Big Creek fault. The area is largely overburden covered.

28. BOW (Newkirk)
No Owner
Copper, Molybdenum
115-I/6

$62^{0}18$'N, $137^{0}18$'W

References: Craig and Laporte (1972, p.82-83)
DIAND (1981, p.262)
Archer, Cathro (1986)

Claims: None present.

Source: Above references.

History: The property was staked originally in 1954 by

Newkirk Mining Corporation, which carried out geological and geophysical surveys. Meridian Sydicate (Canex, Noranda and Asbestos Corp.) and later Golden Gate Exploration Ltd. conducted soil sampling, more geophysics and trenching. The property was re-staked by Noranda Exploration Co. Ltd., which carried out soil sampling and hand trenching and later by Shakwak Exploration Ltd, who carried out mapping and sampling.

Description: Granodiorite (unit 5a) and porphyry dykes (unit 9) cut metasedimentary rocks (unit 1b). Soil copper, zinc and molybdenum anomalies and strong, northwest-trending conductors have been defined. Noranda Exploration Co. Ltd. discovered chalcopyrite and molybdenite in a porphyry body.

29. LIL
No Owner
Gold
115-I/3
62°13'N, 137°15'W

References: Archer, Cathro (1986)

Claims: None

Source: Above reference.

History: Staked by P.F. Guder in the 1930's. No recent work recorded.

Description: Gold bearing quartz veins are reported to have been discovered by Guder in this area.

30. CARIBOU CREEK
Noranda Exploration Co. Ltd.
Gold, Silver
115-I/6
62°15'N, 137°11'W

References: Bostock (1939, p.15-16)
Sinclair et.al. (1976, p.118-119)
DIAND (1985, p.255)
Archer, Cathro (1986)

Claims: CARA

Source: Above references and property examination.

History: Staked by W. Teare in 1937, a 1.8 tonne mill and aerial tramway were built in 1938 with production of 2500 g Au from 12.7 tonnes of ore from an open cut. Subsequent surface exploration was carried out by P.F. Guder, R. Granger, Carmacks Syndicate (Castlemain Exploration Ltd., Welcome North Mines Ltd., W.M. Bath Investments Ltd. and Ventures West Capital Ltd.) and a joint venture between Western Mining Ltd., Cream Silver Mining Ltd. and Belmoral Mining Ltd.

Description: Gold occurs in a quartz stockwork zone. Bedrock is Big Creek Syenite (unit 4a) cut by quartz-feldspar porphyry dykes (unit 9c) and overlain by Caribou Creek Conglomerate (unit 10). Quartz veins cutting these younger sediments are apparently unmineralized.

31. KOOK (CAR, CASTLE)
G. Dickson
Copper
115-I/6
62°19'N, 137°08'W

References: Sinclair et.al. (1976, p.134-136)
Archer, Cathro (1986)

Claims: NULEE

Source: Above references.

History: Montana Mines Ltd. staked the property in 1969 and carried out soil sampling. It was later re-staked by the Carmacks Syndicate (Castlemain Exploration Ltd., Welcome North Mines Ltd., W.M. Bath Investments Ltd. and Ventures West Capital Ltd.) and optioned to the Western Mines Ltd., Cream Silver Mines Ltd. and Belmoral Mines Ltd. joint venture in 1974, which carried out further geochemical sampling and geophysics.

Description: The property lies on the edge of a large aeromagnetic anomaly on the north flank of Freegold Mountain. Work in 1974 outlined a zone of kaolinization and silicification in granodiorite surrounded by a halo of quartz veining with pyrite and minor chalcopyrite.

32. RED FOX
Guder Mining Exploration Ltd.
Silver, lead
115-I/6
62°18'N, 137°09'W

References: Sinclair et.al. (1975, p.115-116)
DIAND (1981, p.261)
Archer, Cathro (1986)

Claims: RAG, MAY

Source: Above references and property examination.

History: Originally staked in 1931 by P.F. Guder who intermittently prospected the claim wtih hand trenching and bulldozer trenching. The property was optioned in 1969 by Yukon Revenue Mines Ltd. which carried out geological mapping and sampling and in 1973 by Prism Resources Ltd. and then Dynasty. Additional surface work was followed by 4 drill holes totalling 318 m. Arctic Red Resources Corp. optioned the claims in 1982 and in 1982 they were transferred to Guder Mining Exploration Ltd, which carried out additional trenching.

Description: A quartz vein associated with a porphyry dyke contains minor sulphide lenses with sphalerite, galena and chalcopyrite. A surface sample of massive galena reortedly assayed 70% Pb and 4460 g/t Ag. The drilling failed to intersect significant mineralization at depth.

33. GUDER (MARGARETE, AUGUSTA)
Guder Mining Exploration Ltd.
Gold, silver
115-I/6
62°17'N, 137°08'W

References: Sinclair et.al. (1975, p.115-116)
DIAND (1981, p.261)
Archer, Cathro (1986)

Claims: MARGARETA; AUGUSTA

Source: Above references and property examination.

History: This was the original discovery on Freegold Mountain, made by P.F. Guder in 1930, with intermittent exploration by hand pits and shallow shafts. In 1959 Conwest optioned the property, drilled 5 holes for 305 m on the main vein and trenched a number of other showings. The property was optioned in 1969 to Yukon Revenue Mines Ltd. which carried out additional mapping and trenching and, in 1973, to Prism Resources Ltd., which carried out surface geophysics. Dynasty Exploration Ltd. optioned the property in 1974 and carried out additional surface exploration followed by 650 m of diamond drilling in 8 holes. Arctic Red Resources Corp. optioned the property in 1982 and subsequently transferred the property to Guder Mining Exploration Ltd.

Description: A northwest trending vein system and system of porphyry dykes cut metasediments of Unit 1 in a

zone which parallels the Big Creek Fault. Mineralization, in discontinuous lenses, consists of disseminated pyrite, chalcopyrite and arsenopyrite in quartz. Surface samples over 30 to 40 cm widths were reported with grades of 110 to 160 g/t Au and 360 to 665 g/t Ag.
Drilling encountered lower grades with poor recovery over widths of 1.2 to 2.6 m.

At the east end of the vein system, a lens of magnetite with hematite, chalcopyrite, pyrite and gold occurs in actinolite-garnet-epidote skarn. The lens is 100 m long and up to 10 m wide. Grab samples from surface have assayed up to 11 g/t Au and 41 g/t Ag, but values are much lower with depth. A second vein, the Cabin vein, 600 m southwest, has reported surface assays from grab samples of 16 g/t Au and 190 g/t Ag A breccia zone, similar to that observed at Revenue and at adjacent Antoniuk, is reported between these two vein systems at the head of Cabin Gulch.

Placer gold from Seymour Creek directly below this property has a close association with magnetite, suggesting a skarn source for the gold.

34. LAFORMA
Arctic Red Resources Corp.
Gold, silver
115-I/6
$62^{0}16$'N, $137^{0}07$W

References: Sinclair et.al. (1975, p.116-117)
Sinclair et.al. (1976, p.139-142)
DIAND (1981, p.261)
DIAND (1985, p.254-255)
Archer, Cathro (1986)

Claims: RICK, CABAGE, GREENSTONE, etc.

Source: Above references and property examination.

History: The property was first staked by Livingston Wernecke in 1931 and was explored by short adits until, in 1936, a 9 tonne mill was constructed on the Wild Rose Vein. In 1938, the mill was moved to the G-3 Vein and in 1939-40, 1288 tonnes were milled.

A number of groups carried out diamond drilling and underground exploration and, in 1964, Discovery Mines Ltd. constructed a 113 tonne mill. Only 8660 tonnes were mined before the operation was shut down due to poor recovery.

Further drilling was carried out on the property and, in 1980, Arctic Red Resources acquired the property, rehabilitated the underground workings, carried out additional drilling and performed metallurgical testing.

Description: The property is underlain by a complex sequence of intrusive rocks, including extensive, altered quartz-feldspar porphyry. Up to 10 northeast-trending quartz vein zones have been defined. The largest of these, the G-3, is a strongly sheared vein up to 2.4 m wide. It has been explored along a strike length of 405 m and over a vertical range of 300 m. As of March, 1984, a drill indicated reserve figure, diluted to a 1.5 m minimum mining width, was 180,000 tonnes grading 11 g/t Au.

35. EMMONS HILL (DART)
Noranda Exploration Co. Ltd.
Gold, silver, antimony
115-I/6
62°16'N, 137°03'W

References: Craig and Laporte (1972, p.78-79)
DIAND (1981, p.262)
Archer, Cathro (1986)

Claims: NAT, DART

Source: Above references and property examination.

History: This showing was originally discovered in 1935 by T. Bee and W. Renworth. The following year, a 28 m shaft was sunk, with two crosscuts driven along the vein. No production was recorded. Surface exploration has been carried out intermittently, most recently by Noranda Exploration Co. Ltd. which staked the property in 1978 and is carrying out an ongoing program.

Description: The original American Yukon showing was in a northwest-trending quartz vein with stibnite and pyrite and erratic gold values. Assays up to 24 g/t Au, 5.5 g/t Ag and 3.6% Sb were reported. The nearby Whale vein consists of chalcedonic quartz and low gold values in an east-west trending porphyry dyke.

Drilling in 1980 intersected pyrrhotite with minor quartz in altered metasediments adjacent to a felsic porphyry intrusive on the DART property, 2 km south of the Whale showing.

37. TINTA HILL
Silver Tusk Mines Limited
Copper, gold, silver, lead, zinc
115-I/6 and 7
62°17'N, 137°00'W

References: Craig and Laporte (1972, p.85)
Sinclair et.al. (1975, p.120-121)
Morin et.al. (1977, p.174-177)
DIAND (1981, p.72)
Archer, Cathro (1986)

Claims: TINTA

Source: Above references and property visit.

History: The original showing was discovered in 1930 and explored by trenches and shallow shafts in 1931-32. Exploration with two additional shafts was carried out by W. Teare in 1940. Conwest staked the ground in 1959 and carried out trenching and drilling of 5 holes.

The property was re-staked in 1966 by Canex Placer which, under a number of different option agreements, carried out surface exploration. Exeter Mines Ltd. optioned the property in 1973 and drilled 1680 m in 25 holes and, in 1975, an additional 330 m in 3 holes. The claims reverted to Placer and were subsequently optioned by Silver Tusk Mines Ltd. and Panther Mines Ltd. which, in 1980 and 1981 completed 975 m of underground exploration on two levels.

Description: A vein up to 1.2 m wide cuts foliated Klotassin granodiorite (unit 3) in a steeply dipping east-west trending shear. The vein is quartz-rich with galena, sphalerite and minor tetrahedrite and chalcopyrite. Wall rocks are sheared, with weak potassic and phyllic envelopes and disseminated pyrite and chalcopyrite.

The structure has been traced for approximately 1000 m on surface. In a calculation for Silver Tusk, indicated reserves were estimated at 516,000 tonnes grading 220 g/t Ag, 4.1 g/t Au, 7.2% Pb, 2.6% Zn and 0.4% Cu. These extended for 760 m along strike, 150 m down dip and across 1.5 m.

38. FOSTER
R. Granger, B. White
Gold
115-I/3
$62^{0}12$'N, $137^{0}08$'W

References: Bostock (1937, p.10-11)
Archer, Cathro (1986)

Claims: GOLDEN FLOAT

Source: Above references and property examination.

History: The original discovery, by W. Their and C. Miller, was made in 1935 and hand trenched. Asarco staked the ground in 1974 and carried out surface work. The present owners restaked the ground in 1984.

Description: Trenching has exposed a 20 m wide shear zone in granodiorite, Unit 5a, near greenstone, probably Unit 7a. Narrow stringers of quartz and pyrite occur within the shear. Only low gold values have been noted.

39. BROWN-MCDADE
B.Y.G. Natural Resources Inc.
Gold, silver
115-I/3
$62^{0}03$'N, $137^{0}07$'W

References: Findlay (1969, p.23)
Archer, Cathro (1986)

Claims: DD, JEFF, etc.

Source: Above references and property examination.

History: The original showing was discovered in 1943 by A. Brown and G. McDade using gold panning in the local creeks. Original work by Yukon Northwest Exploration Ltd. included trenching and drilling. Brown-McDade Mining Ltd. carried out underground exploration in 1947, including 600 m of drifting.

In 1964, control of the property was acquired by Peso Silver Mines Ltd. and transferred to Mount Nansen Mines Ltd., a subsidiary, which carried out additional underground drilling. In 1984, control of the property was gained by BYG, which subsequently optioned the property to Chevron. Over the past two years, a significant program of geological mapping, soil sampling, tractor and backhoe trenching, diamond drilling and underground sampling has been carried out.

Description: A strong, northwest trending shear zone, up to 20 m wide, cuts granodiorite (unit 5a) and contains irregular lenses of gray quartz with pyrite and arsenopyrite and very minor chalcopyrite, galena, tetrahedrite, sphalerite and stibnite. Prior to Chevron's involvement, proven and probable reserves were calculated at 29,300 tonnes, 20.7 g/t Au and 184 g/t Ag over an average 2 m. An additional 71,000 tonnes of indicated reserves have been outlined with comparable grades.

40. MT. NANSEN (WEBBER, HEUSTIS)
B.Y.G. Natural Resources Inc.
Gold, silver
115-I/3
62°03'N, 137°09'W

References: Craig and Laporte (1972, p.88-89)
Sinclair et.al. (1976, p.131-132)
Morin et.al. (1977, p.167-168)
Archer, Cathro (1986)

Claims: DOME

Source: Above references and property examination.

History: The property was originally staked as fringe claims around the Brown-McDade property. Conwest first carried out exploration in the area, followed by the Heustis syndicate, which found and explored the Heustis Vein.

In 1962, the Mount Nansen Exploration Syndicate, supervised by Newmont, carried out surface exploration and a small amount of drilling, and formed Mount Nansen Mining Ltd. Peso Silver Mining Ltd. acquired the property in 1964 and proceeded to carry out 2100 m of undergound development and 2200 m of diamond drilling, leading to a production decision in 1967 with reported reserves of 300,000 tonnes grading 17 g/t Au and 631 g/t Ag. A further 975 m of underground development was carried out and a 180 tonne mill commenced operation in 1968. Over an 8 month period, production was limited to 77,200 g Au, 2,380,500 g Ag and 49,270.5 kg Pb from 16,300 tonnes milled. Poor recoveries were blamed on the lack of a cyanide circuit and low head grades, and the operation ceased. The mine was reopened during 1975 and 76. A total of 5838 tonnes of ore was milled, grading 10 g/t Au, 240 g/t Ag, 1% Pb and 1% Zn.

In 1983, the property was sold to BYG, with proven and probable reserves in the Huestis Vein of 77,841 tonnes grading 15 g/t Au and 312 g/t Ag, and in the Webber Vein, 53,140 tonnes grading 11.7 g/t Au and 661 g/t Ag. The property has subsequently been optioned to Chevron and a surface program of mapping, soil sampling and trenching is underway.

Description: The Webber and Heustis Veins are strong, northwest trending shear zones which cut metasedimentary rocks of Unit 1. Altered quartz-feldspar porphyry dykes and associated breccia zones are closely involved with mineralization. The mineralization consists of quartz within the shears containing pyrite and arsenopyrite with very minor galena, chalcopyrite, sphalerite and sulphosalts.

41. CYPRUS
B.Y.G. Natural Resources Inc.
Copper, molybdenum
115-I/3
62o05'N, 137o12'W

References: Sinclair and Gilbert (1975, p38-39)
Sawyer and Dickinson (1976, p.336-343)
DIAND (1981, p.261)
Archer, Cathro (1986)

Claims:

Source: Above references and property examination.

History: First recognised in 1969, this porphyry occurrence lies largely within the Mount Nansen and Brown-McDade properties. During the period 1971 to '75, the property was explored by Area Exploration Co. with surface geology, soil sampling, magnetometer and IP surveys, followed by 1750 m of diamond and percussion drilling in 11 holes. Cominco staked the western side of the property in 1980-81.

Description: Three felsic porphyry centres (unit 9d) and two associated quartz-tourmaline breccias, with a maximum diameter of 150 m, have associated porphyry style alteration and mineralization. Pyrite, chalcopyrite and molybdenite are disseminated and within quartz veinlets mainly within the phyllic alteration zone adjacent to the breccias. Oxidation and leaching extend to 60 m, resulting in a weakly enriched supergene zone. Grades of 0.1 to 0.15% Cu and 0.01% MoS_2 are typical, with approximate doubling of grades in the supergene zone. Gold values are reportedly low. Cominco's work tested the tin potential of the breccias.

42. ESANSEE
T. Hanlon
Silver, gold, lead, zinc
115-I/3
62°07'N, 137°16'W

References: Craig and Laporte (1972, p.90-91)
DIAND (1981, p.261-262)
DIAND (1982, p.217)
DIAND (1983, p.201,203)
DIAND (1986 Open File, p.222)
Archer, Cathro (1986)

Claims: TAWA

Source: Above references and property examination.

History: Mineralized float was first discovered in 1937 by K. Paulson, and the property was first staked in 1947 by G. Dickson. Conwest optioned the property and carried out bulldozer trenching. Esansee Exploration Ltd. staked the property in 1967 and carried out soil sampling, EM and additional bulldozer trenching.

BRX Mining and Petroleum Ltd. restaked the property in 1980 and carried out additional soil sampling, magnetometer and VLF surveys, trenching and diamond drilling of 447 m in 7 holes. The property was staked by the present owner in 1982 and is presently under option to Chevron.

Description: Mineralization is concentrated within a steeply dipping shear zone, about 1.6 m wide, trending northwesterly in granodiorite Unit 5a. The zone is sparsely mineralized with galena, arsenopyrite, sphalerite and pyrite over a strike length of 750 m. Selected, sulphide-rich samples average 2070 g/t Ag, 44.7% Pb, 36.3 g/t Au and 1.3% Zn. The best channel sample assayed 15 g/t Au and 483 g/t Ag over 1.8 m. Drilling produced erratic results, which ranged up to 25 g/t Au and 51.4 g/t Ag over 1.5 m.

43. DIVIDE
G. Dickson
Gold
115-I/3
62°08'N, 137°12'W

References: Sinclair et.al. (1975, p.126)
DIAND Open File (1986, p.222)
Archer, Cathro (1986)

Claims: VIC

Source: Above references and property examination.

History: The property was first staked in 1948 by G. Dickson and K. Springer who carried out trenching. Asbestos Corp optioned the property in 1958 and drilled 8 packsack holes totalling 122 m. Various companies carried out surface exploration, including mainly soil sampling and trenching. Skyline Exploration Ltd. optioned the property in 1974 and carried out trenching and bulk sampling in joint venture with Dynasty Exploration Ltd. The property is presently under option to Kerr Addison Mines Ltd. which carried out geological mapping, soil and trench sampling and diamond drilling in 1985 and '86.

Description: High grade gold values are reported from quartz float below the property, but assays from exposures in the trenches have given low gold values. Quartz veins in northeasterly trending structures are associated with porphyry dykes cutting monzonite and syenite of Unit 4. Quartz stockwork breccias are associated locally with the felsic porphyry dykes.

52. LONELY
Kerr Addison Mines Ltd.
Copper, gold
115-I/3
62°05'N, 137°20'W

References: Archer, Cathro (1986)

Claims: ONLY

Source: Above reference.

History: The property was staked in 1974 by G. Dickson, who carried out bulldozer trenching. The property was recently restaked by Kerr Addison Mines Ltd.

Description: A feldspar porphyry plug (unit 9d), weakly altered and pyritized, cuts unaltered granodiorite, Unit

5a. Minor disseminate chalcopyrite mineralization has been reported. Kerr Addison is testing the property for its gold potential.

56. GOULTER
G. Dickson
Gold, silver
115-I/3
62°05'N, 137°12'W

References: Archer, Cathro (1986)

Claims: LCGS, etc.

Source: Above reference.

History: This property was staked in 1917 by C.P. Mack, who carried out 20 m of drifting. Several subsequent owners carried out surface and additional underground exploration programs.

Description: A northwest trending mineralized structure is apparently on strike with the Brown-McDade veins, and apparently contains a similar style of mineralization. Bornite float is reported to have been found by nearby placer miners.

59. RUSK (J. BILL)
G. Dickson
Copper, molybdenum, silver, gold
115-I/3
62°05'N, 137°15'W

References: Sinclair and Gilbert (1975, p.38-39)
Archer, Cathro (1986)
Claims: J. BILL

Source: Above references and property examination.

History: First staked by Mount Nansen Mines Ltd. in 1965, which carried out an initial program of mapping and soil sampling. Area Exploration Ltd. optioned the property in 1971, carried out additional surface exploration and drilled one hole. The property was re-staked by the present owner in 1979 and optioned to Chevron in 1986.

Description: The original discovery consists of a 1 m wide vein with pyrite, arsenopyrite, galena and sphalerite in quartz cutting rhyolitic intrusive to extrusive rocks (unit 7b or 9). Considerable alteration is associated with porphyry dykes which cut through the area. Porphyry style mineralization, with trace amounts of molybdenite and chalcopyrite, is associated with a porphyry stock cutting Mt. Nansen volcanics west of the vein occurrence.

63. DART
Owner
Metals
115-I/6
62°15'N, 137°03'W

See Emmons Hill, occurrence no. 35.

64. NUCLEUS
Nat Joint Venture
Gold
115-I/6
62°20'N, 137°21'W

References: DIAND (1981, p.262)
DIAND (1983, p.202)
DIAND (1985, p.253)
DIAND (1986, p.189-190)
Archer, Cathro (1986)

Claims: NUCLEUS

Source: Above references and property examination.

History: Staked by Yukon Revenue Mines Ltd. in 1968 and optioned to Kaiser Resources Ltd. which explored with tractor trenching and some percussion and diamond drilling. Partly restaked by the Klotassin joint venture, with further geochemical sampling. The Nat Joint Venture (Armco Mineral Exploration Ltd. and Chevron Canada Ltd.) staked the property in 1980 and has subsequently carried out geological mapping, soil sampling, extensive bulldozer trenching and, in 1984, 312 m of drilling in 3 holes.

Description: Weak porphyry alteration is associated with extensive fracturing and quartz-feldspar porphyry dyke intrusion and brecciation within metasedimentary rocks of Unit 1 and lesser granodiorite, Unit 5a. The earlier exploration, directed at the porphyry target, encountered weak copper mineralization with grades below 0.1% Cu. More recent work has been directed at a low grade, bulk mineable gold target.

69. ZIT
Arctic Red Resources Corp
Copper, gold
115-I/6
62°17'N, 137°11'W

References: DIAND (1981, p.69-71, p.261)
DIAND (1982, p.218)

Claims: SEYMOUR

Source: Above references.

History: The claims were staked in 1981 as part of an evaluation of gold showings to the east on Freegold Mountain.

Description: The property is underlain by metasediments, Unit 1, and foliated granodiorite, Unit 3. These are cut by porphyry dykes, Unit 9, with accompanying weak hydrothermal alteration, brecciation and quartz veining, as well as probably later andesitic dykes.

A porphyry system, with a weak potassic core surrounded by phyllic and argillic zones, is developed concentrically around a 200 by 500 m porphyry stock. Mineralization, best developed in the phyllic zone, includes trace to 5% pyrite with traces of chalcopyrite, malachite, azurite, molybdenite, pyrrhotite and arsenopyrite.

81. J. BILL (RUSK)
G. Dickson
Metals
115-I/3
62°05'N, 137°15'W

See RUSK, property no. 59.

83. GOLDY (WHALE)
Yukon Revenue Mines Ltd.
Gold
115-I/6
62°16'N, 137°04'W

References: Craig and Laporte (1972, p.78-79)
DIAND (1985, p.255)

Claims: GOLDY

Source: Above references and property examination.

History: This property was originally staked as the Whale in 1933 by J. Carpenter and W. Forbes and explored with hand trenching. In 1969, the property was restaked by Tanzanilla Exploration Ltd., followed by Esperanza Exploration Ltd. and Arctic Red Resources Corp. Additional surface work involved mapping, soil sampling and further trenching. The present owners staked the property in 1984 and have carried out mapping and additional trenching.

Description: Quartz veining and brecciation associated with porphyry dykes follow a major northwest trending structure. Early reports describe a zone up to 11 m wide with two chip samples across 9 m grading 12 and 7 g/t Au.

84. ROW
Noranda Exploration Co. Ltd.
Gold
115-I/3
62°10'N, 137°05W

References: DIAND (1986, p.190)
DIAND (1986 Open File, p.222)

Claims: ROW

Source: Above references and property visit.

History: The claims were staked in 1984. A surface program of mapping, soil and silt sampling and trenching was carried out in 1985.

Description: The claims are underlain mainly by basement metamorphic rocks of Unit 2c, cut by intermediate porphyry dykes. Sampling returned weakly anomalous Ag-Cu-Pb-Zn zones in soils.

97. VERLENE
United Keno Hill Mines Ltd.
Copper
115-I/6
62°30'N, 137°02'W

References: Morin et.al. (1977, p.173-174)
DIAND (1983, p.202-203)
Archer, Cathro (1986)

Claims: HI

Source: Above references and property examinatior.

History: The property was originally staked in 1912, and the first recorded exploration was prospecting and soil sampling in 1971 by Hart River Mines Ltd., followed by a number of other companies and prospectors. United Keno Hill Mines Ltd. staked the property in 1976 and carried out mapping, soil sampling, resistivity and IP surveys and tractor trenching.

Description: Malachite staining occurs in weakly altered, foliated Klotassin granodiorite, Unit 3. The showings are along strike regionally from the Williams Creek property to the southeast. No significant assays have been reported.

98. ANTONIUK
Nordac Mining Corp. and Permian Resources Ltd.
Gold, silver
115-I/6
62°16'N, 137°06'W

References: Sinclair et.al. (1976, p.139-142)
DIAND (1982, p.218-219)
Archer, Cathro (1986)

Claims: NAT

Source: Above references and property examination.

History: A. Brown and G. Fairclough first staked the property in 1931. It was first explored as a vein deposit by Mount Freegold Yukon Mining Ltd. with two adits. Discovery Mines Ltd. acquired the claims in 1964 and optioned the claims in 1974 to Rayrock Mines Ltd. and Ashland Oil Canada Ltd. Nine drill holes, totalling 1270 m, were completed in 1976. Arctic Red Resources Corp. carried out surface exploration, including mapping, soil sampling, IP, magnetometer, VLF and EM surveys followed by trenching and 120 m of diamond drilling in 10 holes. In 1985, the property was optioned to Permian Joint Venture (Permian Resources Ltd. and Nordac Mining Corp.) which has carried out extensive tractor trenching and diamond drilling on the property over the past two field seasons.

Description: The Theodore Vein is a northeast trending structure on the western side of the claims and was the original target of interest. More recent work has been centered on a 425 by 375 m zone of anomalous Au and As in soils which outlines a brecciated, highly altered porphyry complex cut by quartz veins with arsenopyrite, chalcopyrite, tetrahedrite and sulphosalts. An open pittable, heap leachable reserve of 2.2 million tonnes grading 2.06 g/t Au was reported at the end of the 1985 field season.

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APPENDIX I

Petrographic Descriptions

C-33 Quartzofeldspathic Gneiss Unit Ia/3c

The rock is a well foliated and lineated quartzofeldspathic gneiss showing slight compositional banding defined by alternation of plagioclase-biotite layers and quartz-K-feldspar or quartz layers. Biotite and muscovite are concentrated in thin seams parallel to foliation.

plagioclase	30-35%	(slight alteration to sericite)
K-feldspar	30-35	(thin perthitic lenses of plagioclase common)
quartz	25-30	
biotite	2- 3	(ragged grains, slightly to moderately altered to chlorite)
muscovite	1- 1½	(generally coarser grained than biotite)
chlorite	0.5	
opaque	0.2	(ilmenite?, possibly minor pyrite)
zircon	trace	
epidote	minor	
Ti-oxide	trace	(mainly with ilmenite)
apatite	minor	(in one main cluster, see below)

The rock is fine grained, with coarser grains and lenses of quartz, K-feldspar, and muscovite.

Apatite is concentrated in one patch up to 1 mm across. It forms an aggregate of equant grains averaging 0.05-0.07 mm in size. These are surrounded by an intergrowth of plagioclase with disseminated grains of epidote and coarser flakes of muscovite.

Chlorite occurs as an alteration of biotite, and also as discrete flakes away from biotite.

Opaque commonly has partial rims of Ti-oxide, and locally of hematite.

Zircon forms euhedral grains up to 0.1 mm in size with biotite, and a few coarser, anhedral grains away from biotite.

Epidote occurs in the apatite-rich patch and also as scattered grains associated with biotite.

C-38 Micaceous, Feldspathic Quartzite Unit I

The rock is a well foliated and lineated impure quartzite, with biotite, muscovite, and plagioclase intergrown with quartz. Muscovite is concentrated in layers and seams, along which the rock shows a preferential fracture. Foliation planes are rippled, suggesting a second-stage kink folding, with fold axes parallel to lineation. This folding is not obvious in thin section.

quartz	75-80%	
plagioclase	5- 7	(slightly altered to dusty sericite, epidote?)
biotite	5- 7	(trace of alteration to chlorite)
muscovite	5- 7	
opaque	trace	
zircon	trace	
apatite	trace	
sphene	trace	

Grain size is mainly fine, with muscovite commonly coarser, being up to 1 mm in length.

Muscovite is concentrated in certain layers, whereas biotite is more uniformly distributed, being slighly less abundant in muscovite-rich layers.

Opaque commonly is associated with minor Ti-oxide, suggesting that it is ilmenite.

Zircon forms disseminated anhedral grains.

Apatite forms single anhedral grains and a very few clusters of several grains.

Sphene forms a very few anhedral grains.

Grains of accessory minerals are mainly less than 0.07 mm in size.

D-254 Quartzofeldspathic Gneiss (Hornblende-Biotite) Unit 2a

The rock is a well foliated quartzofeldspathic gneiss of medium grain size, with scattered coarse grains and finer grained patches. Mafic and accessory minerals are concentrated in wispy lenses parallel to foliation.

plagioclase	50-55%	(variably altered to sericite ± epidote, calcite)
quartz	20-25	
K-feldspar	5- 7	(locally perthitic)
hornblende	8-10	(variably altered to chlorite-epidote-calcite)
biotite	5- 7	(completely altered to chlorite-epidote)
epidote	2- 3	
sphene	0.2	
apatite	0.1	
veinlets		
calcite	0.2	
epidote-calcite	minor	

Plagioclase is slightly to moderately altered to sericite. Alteration is more abundant in plagioclase grains intergrown with mafic minerals than in plagioclase grains intergrown with quartz and K-feldspar. Minor myrmekite is present in plagioclase along borders of a few K-feldspar grains. Dusty opaque/semipoaque is common in plagioclase.

Quartz forms anhedral patches of grains, commonly with slightly wavy extinction.

K-feldspar forms interstitial grains, and locally contains parallel exsolution lenses of plagioclase. These occur in interiors of K-feldspar grains, and less commonly in flame textures along borders of K-feldspar grains.

Hornblende ranges from fresh to altered completely. Alteration works outwards along cleavage planes. Chlorite with lesser epidote is most common, but calcite is abundant in many strongly altered hornblende grains. A few hornblende grains are elongated prismatic in habit and up to 2 mm long.

Biotite is altered completely to pseudomorphic chlorite with irregular patches of epidote.

Epidote forms irregular patches of grains up to 1 mm in size associated with hornblende (commonly with hornblende altered to chlorite-epidote).

Sphene and apatite form disseminated grains, commonly associated with mafic minerals; grain size averages 0.1 mm.

The rock is cut by wispy veinlets less than 0.15 mm wide of calcite, and thinner veinlets of calcite-epidote-(chlorite).

C-290B Banded Quartzofeldspathic Gneiss Unit 1/2c

The rock is finely compositionally banded, with alternating layers rich in plagioclase-mafic minerals and in quartz-(K-feldspar). Grain size is mainly very fine to fine, with a few medium grained layers of quartz and quartz-calcite, and a few coarser porphyroblasts of garnet. Individual layers containing mafic minerals generally are dominated by one of actinolite, biotite, or garnet.

plagioclase	45-50%	(slightly altered to sericite, muscovite, calcite)
quartz	30-35	
K-feldspar	5- 7	(difficult to distinguish in thin section from quartz)
actinolite	4- 5	(partly altered to chlorite-epidote)
calcite	3- 4	
garnet	2- 3	
biotite	1- 1½	(slightly altered to chlorite)
epidote	0.5	
chlorite	0.3	
muscovite	0.2	
sphene	0.1	
pyrite/hematite	0.1	
apatite	minor	
zircon	trace	
veinlet		
calcite-limonite	trace	

Plagioclase grains commonly are elongated in the foliation plane.

K-feldspar is strongly concentrated in a few layers with quartz; its distribution is best seen in the stained offcut block.

Actinolite forms ragged grains, which in some layers are fresh, and in others are strongly altered to irregular aggregates of chlorite-epidote, with or without calcite.

Garnet forms ragged porphyroblasts up to 1.7 mm in size. Many are in trains parallel to foliation. In one layer it is associated with biotite, but generally it is not associated with mafic minerals, but is intergrown with quartz and lesser plagioclase.

Biotite forms ragged flakes, locally slightly altered to chlorite.

Muscovite forms equant flakes, in part with plagioclase and to a lesser extent with biotite. It may be an alteration of plagioclase.

Sphene forms irregular grains.

Pyrite is concentrated in clusters of grains, some of which are strongly altered to red-brown hematite.

Apatite forms subhedral to anhedral grains.

Zircon forms a very few euhedral grains.

The rock is cut by a wispy veinlet 0.01 mm wide of calcite-limonite.

R-16 Metamorphosed Potassic Diorite Unit 2a

The rock is slightly lineated perpendicular to the plane of the section. The rock is a porphyritic meta-diorite, with plagioclase megacrysts up to 3 mm across and hornblende grains up to 1.2 mm across. These are set in a finer grained groundmass of plagioclase and hornblende, with lesser quartz and minor biotite, sphene, apatite, and opaque. The rock contains 4-5% patches and seams of very fine grained rock, dominated by plagioclase, K-feldspar, and quartz. These may represent late-stage crystallates, or may indicate slight recrystallization in response to cataclastic deformation.

plagioclase	70-75%	(slightly altered to epidote, sericite)
hornblende	17-20	
quartz	5- 7	
K-feldspar	1½-2	
biotite	1	
sphene	0.2	
apatite	0.1	
myrmekite	0.2	
opaque oxide	minor	(ilmenite?)
pyrite/hematite	minor	(pyrite altered to hematite)

Plagioclase is slightly to moderately compositionally zoned towards more-sodic rims. Composition appears to be andesine.

C-1080 Banded Biotite Quartzofeldspathic Gneiss Unit 2a

The rock is well foliated and slightly compositionally banded, with lenses rich in biotite, K-feldspar, quartz, and plagioclase respectively. Grain size is fine to medium, and locally coarse.

plagioclase	45-50%
quartz	30-35
K-feldspar	7- 8
biotite	10-12
muscovite	1- 1½
epidote	0.3
apatite	minor
opaque	minor
calcite	trace
veinlets	
quartz-calcite	0.2

Plagioclase is slightly to locally moderately altered to sericite, with a few patches of muscovite, calcite, and of epidote in more-strongly altered grains.

The rock contains moderately abundant myrmekite grains of quartz inclusions in plagioclase adjacent to grains of K-feldspar.

K-feldspar is non-perthitic.

Biotite is fresh in some lenses and clusters, and slightly to completely altered to pseudomorphic chlorite ± epidote in others.

Muscovite forms ragged grains with biotite and as an alteration of plagioclase.

Epidote forms irregular patches with biotite, and less commonly is an alteration of plagioclase with sericite.

The rock is cut by several veinlets less than 0.02 mm in width of quartz with lesser calcite.

C-902 Amphibole-Clinopyroxene Ultramafic Rock Within Unit 2b

The rock contains medium to coarse grained clinopyroxene and fine to medium grained hornblende with minor biotite. These are replaced by coarse to very fine grained actinolite. Plagioclase forms a few veinlike lenses and interstitial patches.

clinopyroxene	25-30%
hornblende	25-30
biotite	3- 4
actinolite	35-40
plagioclase	1- 1½
opaque	0.1
epidote	0.2
Ti-oxide	trace
sphene	trace
apatite	0.1

Clinopyroxene grains are fresh to moderately replaced by hornblende/actinolite; replacement generally is very irregular and patchy. Many are strongly corroded by surrounding amphibole. Grains are colorless.

Hornblende is characterized by a well developed cleavage, and by anisotropism from pale to light or medium green. It is slightly altered along cleavage to chlorite and epidote patches.

Actinolite is distinguished from hornblende by its paler green color, much weaker cleavage, and texture, which suggests that it replaces hornblende and clinopyroxene in irregular patches. It aslo forms large (up to 2 cm) poikilitic grains interstitial to hornblende/clinopyroxene aggregates. Some very fine grained patches consist of equant, anhedral grains averaging 0.05-0.15 mm in size.

Biotite forms scattered clusters of grains up to 1 mm in size. Some are replaced in patches by feathery aggregates of muscovite and patches of epidote.

Plagioclase forms fine grained aggregates in elongated patches and very fine grains in a few interstitial zones. It is slightly to moderately altered to sericite.

Opaque forms clusters of grains and single grains up to 0.1 mm in size; it is partly altered to red-brown, semiopaque hematite.

Ti-oxide and sphene form scattered, irregular grains up to 0.05 mm in size associated with hornblende.

Apatite forms clusters up to 1.2 mm long of anhedral grains averaging 0.3-0.5 mm in size.

C-954 Meta- Quartz Diorite (Potassic) Unit 2a

The rock is a medium to locally coarse grained metamorphosed potassic quartz diorite, with a strong lineation perpendicular to the plane of the section. Quartz is very abundant. Mafic minerals (biotite, hornblende, and epidote) and accessory minerals (sphene, opaque, pyrite, apatite, and zircon) are concentrated in mafic clots and lenses elongated parallel to the lineation. Plagioclase is zoned near the borders of the grains towards much-more-sodic rims. K-feldspar forms scattered medium to coarse grains. Myrmekite is concentrated along borders of K-feldspar grains. Quartz is concentrated in lenses and patches up to a few mm across.

plagioclase	40-45%	(slightly altered to sericite, muscovite)
quartz	30-35	
biotite	7- 8	
K-feldspar	4- 5	
epidote	3- 4	
hornblende	2- 3	
myrmekite	1- 2	
sphene	0.4	
apatite	0.1	
opaque	minor	
hematite	minor	(after pyrite/pyrrhotite)
muscovite	trace	(after plagioclase)
zircon	trace	

C-1090A Plagioclase-Hornblende Gneiss (Meta-andesite?) Unit 2c

The rock is a medium grained, well foliated gneiss without compositional banding. Foliation is defined by elongation of hornblende grains and aggregates. Quartz forms finer grained, interstitial patches and a few lenses parallel to foliation. Apatite is moderately abundant as anhedral grains up to 0.4 mm in size, mainly associated with hornblende.

plagioclase	65-70%	(slight alteration to sericite)
hornblende	20-25	(local alteration to chlorite-epidote, calcite)
quartz	5- 7	
opaque	2- 3	(ilmenite and magnetite, minor pyrite)
apatite	0.5	
epidote	minor	
chlorite	minor	
calcite	trace	

Plagioclase is more altered in grains associated with mafic clusters.

Most hornblende grains are fresh. A few are altered in patches to chlorite with lesser epidote. One appears to be altered to calcite in irregular patches. Calcite also forms a few interstitial grains.

Opaque forms anhedral to locally subhedral grains up to 0.5 mm in size. Locally, one patch of finer grained opaque and epidote occurs in plagioclase; irregular grains of epidote and of opaque (pyrite) and hematite (after pyrite) are scattered through irregular grains of plagioclase.

C-1091 Metamorphosed Andesite/Dacite Tuff/Tuffaceous Sediment Unit 2c

The rock shows moderate compositional banding and lensing, with vague to moderately sharp contacts between layers of different composition. The section contains a coarser grained layer dominated by plagioclase with lesser hornblende, epidote, and quartz. Finer grained layers are dominated by quartz and plagioclase with lesser biotite. Minor minerals include garnet, opaque, and chlorite.

plagioclase	45-50%	(slightly to moderately altered to sericite/muscovite, minor epidote)
quartz	20-25	
hornblende	7- 8	
biotite	7- 8	(minor alteration to muscovite along cleavage)
epidote	7- 8	
garnet	2- 3	(free of inclusions; rounded to subhedral)
opaque	1- 1½	(uncertain composition: ilmenite and magnetite,pyri
chlorite	0.3	(minor alteration along cleavage to muscovite)
sphene	minor	
zircon	trace	

In the plagioclase-rich layer, mafic minerals are concentrated in irregular clusters. These include hornblende, epidote, opaque, chlorite, and sphene. Garnet is concentrated in lenses, with grain size up to 0.7 mm across.

In quartz-rich layers, biotite forms disseminated flakes, in large part parallel to foliation. Zircon occurs within biotite.

Irregular myrmekitic intergrowths of plagioclase and quartz are widespread. These contain scattered, rounded grains of quartz within plagioclase grains.

Note: overall composition of rock is higher in quartz and biotite and lower in plagioclase, hornblende, and epidote than in the thin section.

C-487 B   Intermediate Gneiss (Dacite?)   Unit 2c

The rock is a medium to fine grained, well foliated gneiss showing slight compositional banding, with segregation of plagioclase and quartz into a few felsic layers. Mafic minerals are hornblende and biotite in about equal amounts. Biotite is variably altered to chlorite ± epidote.

plagioclase	70-75%	(slight alteration to sericite)
quartz	10-12	
hornblende	10-12	
biotite	8-10	(slight to complete alteration to chlorite ± epidote)
sphene	0.2	
apatite	0.1	
epidote	minor	
ilmenite	minor	
pyrite/hematite	0.1	(pyrite replaced by red-brown hematite)

Mafic minerals are concentrated in clusters, generally dominated within each cluster by one of hornblende or biotite. Biotite is slightly to completely replaced along cleavage by pseudomorphic chlorite, with minor to moderately abundant patches of epidote. Ilmenite occurs in lenses along cleavage in biotite.

Sphene forms irregular grains associated with mafic minerals.

Apatite forms equant, anhedral to locally subhedral grains up to 0.15 mm in size.

Pyrite occurs in clusters and single grains, commonly associated with mafic clusters; it is strongly to completely altered to bright red-brown hematite.

Quartz occurs as irregular patches of fine to medium grain size, and forms rounded, very fine grains within plagioclase grains and aggregates

C-487A   Quartzofeldspathic Gneiss (Biotite-Hornblende) Unit 2c

The rock is a well foliated, slightly lineated, fine to medium grained quartzofeldspathic gneiss, with about equal amounts of biotite and hornblende. It shows slight compositional layering, with some layers richer in biotite and others in hornblende. Sphene, hematite, and apatite are important accessory minerals.

plagioclase	30-35%
K-feldspar	30-35
quartz	20-25
biotite	4- 5
hornblende	4- 5
sphene	0.5
hematite	0.3
apatite	0.15

Plagioclase is altered slightly to moderately to sericite and to dusty opaque/semiopaque. Locally it contains myrmekitic textures against K-feldspar grains.

Hornblende forms ragged grains, which appear to have been corroded in part by chlorite and in part by quartz and feldspars.

Biotite is slightly to completely altered to pseudomorphic chlorite and Ti-oxide, with minor patches of epidote.

Sphene forms rounded to euhedral wedge-shaped grains up to 0.5 mm in size.

Hematite, locally with opaque cores, forms anhedral patches and a few cubic pseudomorphs. The former may be after pyrrhotite; the latter are after pyrite.

Apatite forms disseminated grains up to 0.2 mm across.

Specimen No. C-390 Unit 2c

Specimen Name: Aplite

Hand Sample: Pale greyish-pink to cream coloured fine-grained relatively unaltered granitic rock with intergrowths of quartz and alkali feldspar.

Modal Mineralogy (vol. %):

35% Quartz
65% Alkali feldspar (including 5% sericitic alteration)
Tr Opaques, ?biotite

Petrography:

Quartz forms anhedral crystals (<1.3 mm) with ragged finely crenulated margins, internal subgrain mosaic boundaries, and undulose extinction. Most quartz crystals are free of opaque dust-size inclusions and a seriate texture is conspicuous.

Alkali feldspar forms anhedral untwinned crystals (<1 mm) (largely K-spar where identifiable) with weak zoning that grade serially into a cryptocrystalline quartzofeldspathic mesostasis. Alteration to clay minerals and sericite is locally severe. Microperthitic exsolution textures appear to be lacking. Sericitic alteration is patchy and locally replaces entire crystals (relict plagioclase?).

Biotite is pseudomorphed completely by white mica with oriented opaque inclusions (ilmenite?).

Trace amounts of Opaque material, some of which is ilmenite and hematite, is disseminated throughout the rock.

Primary Minerals: Quartz, alkali feldspar, Fe-Ti oxides

Secondary Minerals: sericite, clay minerals, hematite

Comments: This rock is a fine-grained equivalent of C-1039 and appears to have undergone minor late-stage deformation (strained quartz).

C-13C Plagioclase-Quartz-Hornblende-Epidote Gneiss Unit 2c

The sample is a fine to locally medium grained, banded gneiss, with compositional layering defined by concentrations of quartz versus concentrations of plagioclase-hornblende, and plagioclase-hornblende-epidote. Chlorite (after biotite) occurs in one layer at one end of the section.

plagioclase	45-50%	(patchy alteration to sericite: slight)
quartz	25-30	
hornblende	12-15	
epidote	5- 7	
Ti-oxide/opaque	0.3	(ilmenite)
pyrite/hematite	0.1	(pyrite replaced by hematite)
apatite	0.2	(concentrated with hornblende)
chlorite	0.1	(after biotite)
veinlets		
epidote ± chlorite	0.3	

grain size: average 0.1-0.5 mm, with a few coarser grains and coarser grained layers from 0.5-1.2 mm in grain size

C-474 Amphibolite Unit 2d

The rock is a fine grained amphibolite with a well developed foliation and lineation defined by orientation of mafic grains and clusters. It is slightly compositionally banded, with layers richer in chlorite, and with slight variation in the ratio of plagioclase and hornblende.

plagioclase	50-55%	(slightly to strongly altered to sericite ± epidote)
hornblende	35-40	
chlorite	5- 7	(with minor epidote as alteration of biotite)
sphene	0.5	
opaque	0.1	(ilmenite)
apatite	0.1	
hematite	minor	(after pyrite)
calcite	minor	

vein
calcite- K-feldspar 1-2%

Plagioclase is variably altered, with lenses of more strongly altered plagioclase replaced by sericite and minor to moderately abundant epidote, and zones of less altered plagioclase replaced slightly by sericite.

Biotite is altered completely to pseudomorphic chlorite with tiny patches of epidote.

Sphene forms subhedral to euhedral grains up to 0.4 mm across, and smaller anhedral grains, mainly associated with mafic grains.

Ilmenite forms disseminated grains associated with mafic grains, averaging 0.1 mm in size.

Hematite forms patches up to 0.1 mm in size; it is secondary after pyrite or pyrrhotite.

Calcite forms scattered grains and clusters of a few grains.

The rock is cut by a vein averaging 0.1-0.2 mm in width (locally up to 0.7 mm wide) of very fine to fine grained calcite and K-feldspar.

C-476 Metamorphosed Quartz-Bearing Diorite Unit 3a

The rock is a moderately lineated, medium to coarse grained quartz-bearing diorite, in which hornblende dominates over biotite. Moderately abundant accessory minerals are sphene, apatite, allanite, and epidote. Chlorite and epidote form alterations of hornblende and of biotite.

plagioclase	65-70%	(slight, patchy alteration to sericite)
quartz	7- 8	
K-feldspar	3- 4	
hornblende	10-12	
biotite	7- 8	
epidote	1	(with allanite, sphene, and chlorite)
chlorite	1	
apatite	0.4	
sphene	0.4	
allanite	0.2	

Myrmekitic intergrowths of quartz in plagioclase are common in plagioclase grains bordering K-feldspar.

Quartz and K-feldspar commonly are interstitial to plagioclase and mafic grains.

Hornblende is mainly fresh, with some grains strongly altered in patches to intergrowths of chlorite and epidote.

Biotite also is mainly fresh, with some grains completely altered to chlorite with lesser epidote.

Epidote locally forms ragged to skeletal grains associated with sphene and chlorite; these are not obviously alterations of other mafic minerals, but appear to be metamorphic grains.

Apatite forms subhedral grains up to 0.5 mm in size, mainly in mafic clusters.

Sphene forms anhedral grains up to 0.5 mm in size, commonly associated with hornblende.

Allanite occurs in one cluster of two elongated prismatic grains, with the longer one 2 mm in length. The mineral is pleochroic from pale to medium brown. Allanite grains are surrounded by colorless epidote.

C-1078 Metamorphosed Quartz Diorite — Unit 3a

The rock is a medium to coarse grained, metamorphosed quartz diorite, with hornblende and biotite in about equal amounts. A slight foliation is defined by elongation of mafic clusters. Minor and accessory minerals (sphene, epidote, opaque, calcite, and apatite) are associated with mafic clusters.

plagioclase	60-65%	(slight patchy alteration to sericite, epidote)
quartz	12-15	(in patches up to a few mm across)
hornblende	10-12	
biotite	8-10	
K-feldspar	1	(scattered interstitial grains; minor alteration of plagioclase)
opaque	½- 1	(ilmenite-magnetite)
sphene	½- 1	(subhedral to euhedral grains up to 1 mm long)
epidote	1½-2	(medium to coarse anhedral grains)
apatite	0.2	
calcite	minor	
chlorite	minor	(with hornblende; not a replacement of biotite)
muscovite	minor	(parallel aggregates along biotite cleavage, possibly secondary)
zircon	trace	

Biotite flakes locally show internal distortion in patches; these zones are altered to muscovite/chlorite with a pale color and low to moderate birefringence. A few other distorted patches have a deeper green color than the main grains.

C-1011 Potassic Hornblende-Biotite Quartz-bearing Diorite — Unit 3a

The rock is a medium to coarse grained quartz-bearing diorite, with about equal amounts of hornblende, biotite, and quartz, and lesser K-feldspar. Accessory minerals are sphene, opaque (ilmenite), apatite, calcite, and zircon.

plagioclase	65-70%	(slightly altered to sericite ± epidote, calcite)
quartz	8-10	
hornblende	8-10	
biotite	7- 8	
K-feldspar	3- 4	
chlorite	1- 1½	
sphene	0.4	
opaque	0.2	
apatite	0.1	
calcite	minor	
epidote	minor	
zircon	trace	

Plagioclase is slightly compositionally zoned, with composition in the andesine range. It is slightly altered in patches to sericite, with some moderately altered zones, mainly along borders of grains. A few grains contain irregular patches and veinlets of epidote and/or calcite, in part alone and in part associated with sericite/muscovite.

Quartz forms interstitial grains and aggregates. One grain contains acicular rutile grains up to 0.08 mm in length.

Hornblende and biotite occur together in mafic clusters, along with other mafic and accessory minerals. Some hornblende grains contain irregular flakes and patches dominated by chlorite and quartz, with some opaque. Others contain a few to several flakes of biotite, mainly altered to pseudomorphic chlorite with minor Ti-oxide and/or epidote. Some patches of biotite are slightly to moderately altered along cleavage to pseudomorphic chlorite.

K-feldspar forms interstitial patches. A few grains contain exsolution lenses of plagioclase; these occur in clusters in parallel orientation in small patches in the K-feldspar grains.

Along the borders of several K-feldspar grains, plagioclase grains contain myrmekitic intergrowths of quartz.

Sphene forms grains up to 0.5 mm in size, mainly with mafic clusters.

Calcite forms irregular, interstitial patches.

Epidote forms a few grains associated with biotite, and much smaller grains associated with plagioclase (alteration of plagioclase).

Zircon forms rounded grains 0.02 mm in size with biotite and with hornblende.

C-1092 Porphyritic Hornblende Quartz-bearing Monzonite (Unit 4a)

The rock contains a few coarse phenocrysts of plagioclase, K-feldspar, and hornblende surrounded by fine to medium grains of the same minerals and quartz, with irregular interstitial patches of much finer grained feldspars and quartz, commonly showing myrmekitic intergrowths of quartz in plagioclase. Minor minerals associated with hornblende include sphene, chlorite (after biotite), epidote, apatite, and ilmenite-magnetite.

plagioclase	40-45%	(minor patches in cores altered to sericite)
K-feldspar	17-20	(commonly interstitial to plagioclase)
hornblende	17-20	
quartz	7- 8	(interstitial patches and scattered rounded grains)
myrmekite	5- 7	(irregular patches in plagioclase along borders of K-feldspar)
sphene	1½-2	(euhedral to subhedral)
ilmenite-magnetite	1-1½	
apatite	½- 1	(grains up to 0.7 mm across)
epidote	0.3	(patches in hornblende, possibly secondary after hornblende)
chlorite	0.2	(with minor epidote)
zircon	trace	(euhedral prism 0.08 mm long)

Myrmekite and other very fine to fine grained feldspars and quartz appear to have formed from minor late-stage magmatic fluids trapped between the larger crystals.

The rock is slightly magnetic, suggesting some magnetite is associated with ilmenite. Ilmenite-magnetite in some grains is surrounded by thin rims of sphene.

Chlorite forms pseudomorphs after biotite, and contains tiny patches of epidote scattered throughout grains and in patches along borders.

Plagioclase grains commonly are slightly to moderately zoned near their margins, with gradation to more-sodic rims.

C-74 Foliated Hornblende Quartz-bearing Diorite Unit 3a

The rock is a medium to coarse grained, moderately foliated quartz-bearing diorite, with abundant hornblende and much less chlorite (after biotite). Important minor minerals are sphene, apatite, opaque, and epidote. The rock contains minor very fine to fine grained interstitial patches, in which are concentrated K-feldspar and myrmekite. The rock is cut by a wispy veinlet containing abundant extremely fine grained opaque.

plagioclase	65-70%	(slightly zoned near margins, moderately altered to sericite)
hornblende	15-17	(anhedral, some plagioclase inclusions)
quartz	8-10	(in patches, partly interstitial)
chlorite	2- 3	(after biotite, with Ti-oxide, some quartz lenses)
K-feldspar	1- 1½	(interstitial)
sphene	1- 1½	(anhedral with hornblende)
epidote	0.5	(patches up to 0.7 mm in size with hornblende, plagioclase)
apatite	0.5	(subhedral to euhedral prisms)
opaque	0.5	(anhedral with chlorite, hornblende)
myrmekite	0.1	(along borders of K-feldspar in finer grained patche

Plagioclase locally is strongly altered to sericite, with alteration commonly stronger near mafic grains.

Biotite is altered completely to chlorite with minor to moderately abundant Ti-oxide lenses along cleavage. Some grains contain minor to abundant lenses of quartz parallel to cleavage.

D-84 Biotite-Hornblende Granodiorite — Unit 5a

The rock is a medium to coarse grained granodiorite with biotite more abundant than hornblende. Minor minerals are opaque (ilmenite-magnetite), sphene, allanite, and apatite.

plagioclase	50-55%	(moderately zoned, slightly to moderately altered)
quartz	17-20	(interstitial, some very large grains)
K-feldspar	15-17	(interstitial, slightly perthitic)
biotite	8-10	(fresh to strongly altered to chlorite-epidote)
hornblende	4- 5	(fresh)
opaque	1	(with mafic minerals)
sphene	minor	(anhedral with mafic minerals, skeletal in K-spar)
allanite	minor	(orange-brown, zoned grains to 0.5 mm across)
apatite	minor	(anhedral to locally euhedral prismatic up to 0.3 m
zircon	trace	(anhedral with mafic minerals; up to 0.08 mm across

Plagioclase is andesine, with moderate to strong zonation near the rims to more-sodic compositions. Alteration is variable to sericite, with greater intensity in cores of grains. A few grains show corroded margins against K-feldspar. Locally, in strongly altered cores of grains are scattered irregular grains of epidote up to 0.05 mm in size.

Biotite alteration is to pseudomorphic chlorite with tiny lenses of epidote along cleavage. A few biotite grains are subhedral to euhedral in outline.

Hornblende is anhedral to subhedral prismatic in outline.

Opaque and accessory minerals commonly are associated in clusters, with or without mafic minerals.

C-991 Biotite-Hornblende Granodiorite — Unit 5a

The rock is a medium to coarse grained granodiorite with biotite and lesser hornblende, and minor sphene, opaque, epidote, and apatite. Minor patches of much finer grain size occur along borders of feldspar grains, mainly borders of K-feldspar against K-feldspar. Plagioclase locally is corroded by K-feldspar, and elsewhere appears to be replaced slightly by K-feldspar.

plagioclase	45-50%	(slightly to moderately zoned, slightly altered)
K-feldspar	15-17	(locally perthitic, interstitial to plagioclase)
quartz	12-15	(concentrated in patches, interstitial to plag.)
biotite	10-12	
hornblende	4- 5	(replaced by actinolite)
epidote	1½-2	(patches in biotite, plagioclase)
sphene	0.3	(anhedral, locally subhedral, with mafic grains)
opaque	0.2	(locally with rims of chlorite and/or sphene)
apatite	0.1	(euhedral with biotite, opaque)
zircon	trace	(subhedral with biotite)

Plagioclase is slightly altered to sericite, with local patches of slightly stronger alteration. Locally it is replaced by ragged grains of epidote up to 0.8 mm in size.

Biotite is variably altered, with a few grains relatively fresh, with minor alteration along cleavage to pseudomorphic chlorite. Other grains are strongly replaced by chlorite and a phase intermediate in optical properties between chlorite and biotite. Epidote forms irregular patches of very fine to fine grains, mainly in cores of biotite grains. K-feldspar locally forms replacement patches.

Hornblende is replaced by pseudomorphic actinolite with a pale to medium green color.

C-679 Biotite-Hornblende Granodiorite (Unit 5a)

The rock is a coarse to medium grained, slightly porphyritic granodiorite, with biotite and hornblende in about equal amounts, and with minor opaque (magnetite-ilmenite) and sphene.

plagioclase	45-50%	(slightly zoned, mainly along borders of grains)
K-feldspar	17-20	(phenocrysts up to 8 mm, slightly perthitic)
quartz	17-20	
biotite	5- 7	(fresh to altered completely to chlorite)
hornblende	5- 7	(some euhedral elongate prismatic grains to 2 mm)
sphene	0.4	(one euhedral grain 1.7 mm long)
opaque	0.3	(clusters with sphene, some with mafic grains)
apatite	trace	(subhedral to euhedral, with opaque)
myrmekite	minor	(extremely fine in plagioclase on border of K-spar)
zircon	trace	(up to 0.1 mm across with biotite, hornblende)

Plagioclase forms a few phenocrysts up to 3.5 mm in length. Composition is andesine. Grains are slightly corroded against K-feldspar, with some strong compositional zoning towards more-sodic rims along K-feldspar borders. Plagioclase is slightly to moderately altered in patches to sericite, with alteration most abundant in cores of grains.

Biotite is mainly fresh, with grains slightly to completely altered to chlorite ± epidote, mainly in association with hornblende.

Hornblende forms typical elongated prismatic grains, as well as finer grains and aggregates.

Sphene and opaque commonly occur together in very fine to fine grained aggregates of anhedral grains. Some of these clusters are associated with mafic grains.

C-1117B Biotite-Hornblende Granodiorite Unit 5a

The rock is a medium to coarse grained granodiorite with biotite slightly more abundant than hornblende. Minor and accessory minerals include sphene, ilmenite/magnetite, apatite, epidote, and zircon.

plagioclase	55-60%	(concentric zoning strong; moderate alteration)
quartz	17-20	(interstitial patches)
K-feldspar	8-10	(perthitic, interstitial)
biotite	6- 8	(altered to chlorite-epidote)
hornblende	4- 5	(fresh)
opaque	1- 1½	(ilmenite-magnetite)
sphene	0.4	
apatite	0.1	
epidote	trace	
zircon	trace	
myrmekite	0.1	

Plagioclase grains range from slightly to strongly concentrically zoned. Alteration to patchy sericite commonly is more intense in cores of grains. Myrmekite forms a few patches in plagioclase grains along borders of K-feldspar grains. Locally grains are slightly to moderately corroded against interstitial K-feldspar.

Biotite grains range from fresh to strongly altered to chlorite with patches of epidote concentrated along cleavage.

Sphene forms anhedral grains associated with mafic minerals (mainly hornblende), and a few skeletal grains intergrown with quartz and feldspars.

Opaque occurs with mafic grains in patches up to 1.5 mm across. The rock is slightly magnetic.

Apatite occurs with opaque and mafic grains, and is anhedral to subhedral in outline.

Zircon forms anhedral to euhedral grains less than 0.05 mm in size.

D-211 Biotite-Hornblende Granodiorite (Unit 5a)

The rock is a medium to coarse grained granodiorite, with biotite slightly more abundant than hornblende, and with minor opaque (ilmenite ± magnetite), sphene, apatite, and epidote.

plagioclase	50-55%	(strongly zoned, moderately altered to sericite)
quartz	17-20	(interstitial patches)
K-feldspar	15-17	(interstitial, some porphyroblasts to 3 mm, slightly perthitic
biotite	5- 7	(slightly to completely altered)
hornblende	4- 5	(fresh)
opaque	1½-2	(clusters with mafic minerals)
apatite	0.1	(with biotite, opaque; prismatic grains to 0.1 mm)
sphene	0.1	(with mafic grains, up to 0.8 mm in size)
epidote	0.1	(irregular patches with chlorite, opaque)
chlorite	0.1	(interstitial patches up to 0.8 mm in size)
zircon	trace	(up to 0.05 mm long in hornblende)

Plagioclase is moderately altered to sericite with minor epidote, with alteration strongest in cores of grains. Both oscillatory and gradational zones are present, with strong gradation to more-sodic rims in a thin zone near grain borders. Locally grains are corroded against K-feldspar.

K-feldspar is interstitial to both plagioclase and quartz.

Biotite is altered to pseudomorphic chlorite with minor to abundant patches of epidote.

One cluster of opaque minerals is over 1 mm across, and contains lesser hornblende and minor sphene and apatite.

Minor minerals mainly occur with mafic grains.

Chlorite forms interstitial patches of extremely fine to very fine grains, without epidote. These patches are not secondary after biotite, but represent primary chlorite formed late in the cooling history of the rock.

C-208 Biotite-Hornblende Granodiorite Unit 5a

The rock is a medium to coarse grained granodiorite with about equal amounts of biotite and hornblende. Mafic minerals commonly occur in clusters of grains, associated with which are minor and accessory minerals: opaque, sphene, and apatite. Epidote forms replacement patches. Chlorite forms a few interstitial patches.

plagioclase	55-60%	(strongly zoned; moderately altered to sericite)
quartz	17-20	(locally graphic intergrowths with K-feldspar)
K-feldspar	7- 8	(slightly perthitic, interstitial to plagioclase)
biotite	7- 8	(moderately to completely altered to chlorite-epidote)
hornblende	7- 8	(fresh)
epidote	1½-2	(medium grained replacement)
opaque	0.5	(includes minor magnetite)
chlorite	0.1	(interstitial patches, cavity filling?)
sphene	minor	(anhedral)
apatite	minor	(anhedral to euhedral prismatic)

Zoning in plagioclase is most prominent near borders of grains. The composition is about An_{40} in cores of grains, grading outwards to An_{25-30}.

K-feldspar contains moderately abundant dusty brown oxide. Locally it contains euhedral inclusions of plagioclase and hornblende.

Biotite is altered to pseudomorphic chlorite with disseminated epidote, and with a few coarser patches and lenses of epidote. Some very fine grained aggregates of biotite are associated with mafic clusters of biotite and hornblende. Some of this biotite may be secondary.

Epidote forms irregular patches up to 2 mm across in plagioclase and smaller ones in biotite. The latter patches are irregular in some grains of biotite, and elongated parallel to cleavage in others.

Opaque occurs with biotite as equant grains. It probably is ilmenite and magnetite.

Chlorite forms very fine grained interstitial patches up to 0.4 mm in size. It is light to medium green in color.

Specimen No. C-1130 Xenolith Unit 5a

Specimen Name: Biotite-Hornblende Monzodiorite

Hand Sample: Fresh medium to dark grey amphibole-rich xenolith with feldspar phenocrysts exhibiting a hiatal texture.

Modal Mineralogy (vol. %):

45%	Plagioclase
20%	K-spar
4%	Quartz
20%	Hornblende
8%	Biotite
2-3%	Opaques
Tr	Apatite, sphene

Petrography:

<u>Quartz</u> forms anhedral crystals in a fine-grained mesostasis that are intergrown with feldspar.

<u>Plagioclase</u> occurs as subhedral lamellar-twinned andesine phenocrysts with oligoclase rims similar to those of the host. Sericite and clay mineral alteration is common. Phenocrysts grade serially into groundmass laths (<0.3 mm). Crystals are generally free of primary inclusions.

<u>K-spar</u> forms large oikocrysts (<2 mm) enclosing numerous crystals of hornblende, biotite, and opaques. K-spar also forms part of the finer-grained mesostasis. These oikocrysts resemble porphyroblasts but their origin appears to be igneous.

<u>Hornblende</u> forms fresh prismatic to acicular crystals (<2.5 mm) with brownish-green pleochroism. Crystals are arranged haphazardly in feldspar oikocrysts but take on a fluxion structure near xenolith margins. Hornblendes exhibit a seriate texture.

<u>Biotite</u> occurs as colourless to pale greenish brown serially-sized laths (<1.5 mm) partly altered to chlorite + Fe-Ti oxides +/- leucoxene.

<u>Opaque</u> microphenocrysts are predominantly pseudo-octahedral magnetite.

<u>Apatite</u> forms euhedral crystals (<0.5 mm) commonly enclosed by amphibole and biotite and intergrown with opaques.

<u>Groundmass</u> constituents are largely interlocking feldspar laths variably altered to sericite and clay minerals.

Primary Minerals: Quartz, plagioclase, K-spar, hornblende, biotite, Fe-Ti oxides, apatite, sphene

Secondary Minerals: sericite, chlorite, clay minerals, leucoxene

Specimen No. C-1039 Unit 5a

Specimen Name: Granite

Hand Sample: Cream coloured coarse-grained granite with irregular intergrowths of quartz and alkali feldspar, and a small amount of opaque/mafic material coating fractures or occurring as segregations.

Modal Mineralogy (vol. %):

30%	Quartz
69%	Alkali feldspar
1%	Opaques
Tr	Biotite

Petrography:

<u>Quartz</u> occurs as large anhedral crystals (<4.5 mm) characterized by ragged margins, subgrain mosaics, and strain extinction. Inclusion trails of opaque dust are also evident. A serial size gradation exists with the smallest crystals commonly exhibiting a polygonal outline.

<u>Alkali Feldspar</u> forms anhedral crystals (<8.5 mm) locally exhibiting Carlsbad twins and characterized by a cryptoperthitic texture involving patchy to string-like exsolution lamellae of albite. The feldspars are variably altered to sericite and clay minerals. Some of the most intensely altered feldspar grains may be relict plagioclase.

<u>Opaque</u> material lines limonite-stained fractures and forms irregular patches up to 0.8 mm across. Most opaque material appears to be secondary in origin. Hematite is common within fractures and forms the margins of oxidized opaque grains (Fe-Ti oxides).

<u>Biotite</u> is present as a few small flakes of red-brown weakly pleochroic mica.

<u>White Mica</u> forms a few large crystals possibly pseudomorphous after biotite and microcrystalline sericite is found infilling veinlets in this rock.

Primary Minerals: Quartz, alkali feldspar, opaques, biotite

Secondary Minerals: sericite, clay minerals

Comments: This rock appears to have been strained and recrystallized at relatively high temperatures.

Specimen No. D-226 Unit 5c

Specimen Name: Hornblende-Biotite Quartz Monzonite

Hand Sample: Fresh pale pinkish grey coarse-grained granitoid with crystals of plagioclase, K-spar, biotite, quartz, and amphibole. The rock has a seriate texture.

Modal Mineralogy (vol. %):

20% Quartz
24% Plagioclase
34% K-spar
9% Biotite
3% amphibole
1% Opaques
Tr Apatite, sphene

Petrography:

Quartz occurs as subhedral to resorbed phenocrysts (<2.7 mm) with inclusions of biotite and granophyric quartz and alkali feldspar. Quartz is also present as interstitial granophyric intergrowths with K-spar.

Plagioclase forms subhedral oscillatory-zoned crystals (<4 mm) of andesine-oligoclase composition that are moderately to weakly altered to sericite and clay minerals. Inclusions are quartz, sphene, biotite, and amphibole, and Fe-Ti oxides.

K-spar forms subhedral crystals (<1 mm) and occurs extensively in well-developed granophyric to micrographic intergrowths with quartz. K-spar exhibits alteration to clay minerals and sericite.

Biotite occurs as subhedral laths (<3 mm) that are fresh or partly altered to chlorite + Fe-Ti oxides + hematite + leucoxene + sphene.

Hornblende forms euhedral to subhedral crystals (<2.5 mm) that are fresh or partly decomposed to chlorite + Fe-Ti oxides. Most amphiboles are fresh.

Euhedral to subhedral Opaque microphenocrysts (<0.4 mm) of magnetite and minor ilmenite are commonly intergrown with biotite and amphibole.

Sphene forms colourless to brownish weakly pleochroic anhedral to subhedral grains (<0.8 mm).

Primary Minerals: Quartz, K-spar, plagioclase, biotite, hornblende, apatite, Fe-Ti oxides, sphene

Secondary Minerals: Chlorite, sericite, clay minerals, sphene/leucoxene, hematite

Comments: This rock contains a well-developed granophyric interstitial texture.

Specimen No. D-230 Unit 5c

Specimen Name: Hornblende-Biotite Quartz Monzonite

Hand Sample: Missing?

Modal Mineralogy (vol. %):

25% Quartz
27% Plagioclase
40% K-spar
6% Biotite
1% Amphibole
1% Opaques
Tr Apatite, sphene, zircon

Petrography:

K-spar forms anhedral to subhedral crystals (<3 mm) with cryptoperthitic albite exsolution blebs and stringers. Some cross-hatched twinned crystals of microcline are present. The K-spar in this rock is characterized by simple Carlsbad twins and moderate to intense alteration to clay minerals and sericite.

Plagioclase forms subhedral lamellar-twinned crystals of oligoclase (<2 mm) whose core regions may exhibit preferential alteration to sericite and clay minerals, though alteration is less intense than that associated with K-spar.

Quartz occurs as anhedral to subhedral crystals (<1 mm) with inclusions of biotite, K-spar, plagioclase, apatite, and rare opaques.

Hornblende forms relatively rare subhedral colourless to pale green weakly pleochroic crystals (<1 mm) with inclusions of Fe-Ti oxides and biotite.

Biotite forms orange-brown to dark brown pleochroic laths (<1.3 mm) partly altered to chlorite. Inclusions of apatite and opaques are common.

Opaque microphenocrysts (<0.5 mm) of magnetite and subordinate ilmenite are locally intergrown with biotite or form monomineralic aggregates.

Euhedral Apatite prisms (<0.3 mm) are intergrown with Fe-Ti oxides and biotite.

Primary Minerals: Quartz, plagioclase, K-spar, magnetite, ilmenite, apatite, hornblende, biotite, zircon, sphene

Secondary Minerals: chlorite, sericite, clay minerals

Comments: Relatively fresh unaltered rock.

Specimen No. 86-C-296 Unit 7a

Specimen Name: Hornblende (-Pyroxene?) Andesite

Hand Sample: Medium grey fine-grained volcanic rock with phenocrysts of feldspar and mafic minerals set in a finely crystalline groundmass.

Modal Mineralogy (vol. %):

35% Plagioclase (including alteration products)
10% Mafic pseudomorphs (after amphibole and ?pyroxene)
2% Opaques
53% Groundmass

Petrography:

Plagioclase occurs as relict lamellar-twinned andesine phenocrysts (<1 mm) that have been altered extensively to secondary opaques, mosaic quartz, plus minor clay minerals, sericite, and epidote.

Mafic phenocrysts (<1 mm) have been completely replaced by granular epidote + chlorite + opaques + quartz. A few euhedral outlines of amphibole are recognizable. However, most pseudomorphs have indistinct outlines.

Opaques are predominantly granular and appear to be of both primary and secondary origin. They occur disseminated throughout the rock and as fracture coatings.

The Groundmass is also intensely altered and consists of a fine-grained assemblage of devitrified volcanic glass (quartz + feldspar), feldspar microlites, chlorite, and minor sericite, clay minerals, and opaques.

A thin veinlet (<1 mm in width) is filled with sericite + minor opaques, epidote, and quartz.

Primary Minerals: Plagioclase, amphibole, ?pyroxene, opaques

Secondary Minerals: Clay minerals, sericite, chlorite, quartz, opaques

Comments: This rock appears mineralogically similar to 86-C-85 but is finer-grained and more altered. An associated flow? Alteration makes the percentages of silicate phenocrysts difficult to estimate precisely.

Specimen No. 86-C-89 Unit 7a

Specimen Name: Hornblende-Pyroxene Andesite

Hand Sample: Medium grey medium-grained rock with phenocrysts of plagioclase and pyroxene set in a fine-grained groundmass.

Modal Mineralogy (vol. %):

40% Plagioclase (including sericite and clay minerals)
10% Clinopyroxene
4% Mafic pseudomorphs (after Orthopyroxene?)
1% Amphibole
2% Opaques
43% Groundmass
Tr Apatite

Petrography:

Plagioclase forms euhedral to subhedral lamellar-twinned phenocrysts (<2 mm) with oscillatory zoning and partially altered to sericite and clay minerals. Inclusions of groundmass oriented parallel to cleavage directions are common. Other inclusions comprise opaques, pyroxene, and apatite.

Augite occurs as pale green to brownish euhedral to subhedral phenocrysts (<1.5 mm). The larger crystals exhibit continuous or oscillatory zoning, and some have inclusion-rich rims. Common inclusions are apatite, opaques, groundmass, and minor plagioclase.

Amphibole appears as pale reddish-brown weakly pleochroic laths (<0.8 mm) that are distributed sporadically throughout the rock. Inclusions comprise opaques, apatite, and plagioclase.

Certain Mafic phenocrysts (<1.7 mm) of subhedral to euhedral outline are completely replaced by chlorite and fibrous serpentine and appear to be relict orthopyroxene (bastite?).

Opaque minerals are largely subhedral to anhedral Fe-Ti oxides, largely magnetite, occurring as microphenocrysts (<0.3 mm) and as dust throughout the groundmass.

Apatite forms euhedral prisms (<0.4 mm) commonly intergrown with opaques and enclosed in ferromagnesian silicates.

The Groundmass is rich in feldspar and subordinate quartz, minor clinopyroxene and opaques, and secondary chlorite, epidote, leucoxene, sericite, and clay minerals.

Primary Minerals: Plagioclase, augite, ?orthopyroxene, amphibole, Fe-Ti oxides, apatite

Secondary Minerals: Clay minerals, sericite, chlorite, epidote, leucoxene, serpentine

Comments: Very low grade hydrothermally altered flow or dyke rock.

C-1137 Hornfelsed Granodiorite/Quartz Diorite Porphyry Unit 7a

The rock contains phenocrysts of plagioclase and hornblende in an extremely fine grained groundmass dominated by plagioclase and quartz, with lesser secondary biotite and actinolite. Hornblende phenocrysts are replaced strongly by secondary aggregates of biotite-actinolite-opaque-quartz. Textures indicate that the rock was hornfelsed. Replacement patches, possibly formed during metamorphism are dominated by quartz with lesser actinolite and minor biotite.

phenocrysts		
plagioclase	20-25%	
hornblende	4- 5	
groundmass		
plagioclase-quartz ± K-feldspar	55-60%	
biotite	3- 4	
actinolite	3- 4	
opaque	1	(magnetite-ilmenite)
Ti-oxide	0.2	
apatite	0.1	
zircon	trace	
replacement patches		
quartz	5- 7	
actinolite	1½-2	
biotite	0.1	

Plagioclase phenocrysts are slightly zoned. Alteration is slight to moderate to sericite and minor epidote. Composition is about An_{40-45}.

Hornblende phenocrysts up to 2 mm in length are strongly replaced, and in part the original texture is destroyed. Hornblende has been replaced by very fine grained aggregates of actinolite and biotite, with some grains containing moderately abundant quartz, and many containing abundant extremely fine grained opaque. Associated with some of the patches are a few grains of apatite, sphene, and opaque. Chlorite forms scattered grains in a few patches.

The groundmass is dominated by extremely fine grained aggregates of plagioclase with lesser quartz and K-feldspar (0.01-0.02 mm), with disseminated biotite and actinolite. The mafic minerals commonly are concentrated in patches less than 1 mm in size, in which grain size of mafic minerals commonly is larger than in parts of the groundmass where mafic grains are less abundant. Some of the latter grade into altered hornblende phenocrysts. Opaque forms grains up to 0.5 mm in size; commonly associated with mafic grains and clusters. Much of the opaque is magnetite. Some large opaque grains are rimmed by thin zones of sphene/Ti-oxide, suggesting that the opaque is ilmenite. Apatite forms anhedral to subhedral grains up to 0.1 mm in size. Zircon forms a few equant grains up to 0.04 mm across.

Replacement patches up to 2 mm in size are irregular and consist of quartz with lesser, very irregular actinolite and minor biotite grains. Grain size averages 0.03-0.07 mm, with mafic grains coarser (up to 0.15 mm)

Specimen No. 86-C-85 Unit 7a

Specimen Name: Hornblende (-Pyroxene?) Andesite

Hand Sample: Medium-grey porphyritic rock with phenocrysts of plagioclase and dull altered ferromagnesian silicates set in a fine-grained groundmass. Tiny disseminated pyrite crystals are conspicuous under a hand lens.

Modal Mineralogy (vol. %):

35%	Plagioclase (including minor chlorite and clay minerals)
15%	Mafic pseudomorphs
2-3%	Opaques (including 1-2% Pyrite)
47%	Groundmass
Tr	Apatite

Petrography:

Plagioclase forms euhedral to subhedral lamellar-twinned phenocrysts (<2 mm) exhibiting oscillatory-normal zoning. All crystals display weak alteration to sericite and clay minerals, especially along irregular microfractures and cleavages. Inclusions of opaques are common and some of these are secondary pyrite cubes.

Anhedral to subhedral Mafic phenocrysts (<2 mm) have been completely replaced by epidote, chlorite, opaques, quartz, and ?alkali feldspar. Amphibole cross-sections are preserved and some pseudomorphs may be after pyroxene.

Opaques form euhedral to subhedral crystals (<0.3 mm) and include a high proportion of pyrite disseminated evenly throughout the rock.

The Groundmass is formed largely by devitrified volcanic glass (alkali feldspar and quartz mosaics), plus opaques, plagioclase microlites, and clay minerals, chlorite, and minor hematite.

The rock is traversed by a thin (<1 mm) veinlet of epidote with diffuse outer boundaries.

Primary Minerals: Plagioclase, amphibole, opaque oxides, apatite, ?pyroxene

Secondary Minerals: Clay minerals, sericite, chlorite, epidote, hematite, pyrite, quartz, ?alkali feldspar

Comments: Mafic phenocrysts are more altered than 86-C-89 and more epidote is present in this rock. Disseminated pyrite is conspicuous.

C-301 Porphyritic Monzongabbro (Unit 15c?) Unit 7a/9e

The rock contains phenocrysts of plagioclase, hornblende, and clinopyroxene in a groundmass dominated by intimate intergrowths of feldspars and lesser quartz, with disseminated chlorite and opaque-Ti-oxide. It may be associated with Unit 15c (because of the clinopyroxene phenocrysts). An alternate association would be a mafic variety of Unit 9a).

phenocrysts		
plagioclase	25-30%	(variably altered)
hornblende	7- 8	
clinopyroxene	4- 5	
opaque	0.3	
apatite	trace	
groundmass		
feldspar intergrowths ± quartz	50-55%	
chlorite	5- 7	
opaque	1	
carbonate	minor	
apatite	minor	
quartz grains	trace	
zircon	trace	

Plagioclase phenocrysts range from uniform to moderately zoned, and from fresh to moderately altered to sericite and minor epidote. Grains are up to 3 mm in length and subhedral to euhedral in outline. Composition probably is andesine. Some grains are altered on wispy fractures (see below)

Hornblende forms subhedral to euhedral phenocrysts up to 1.5 mm in size. They are altered completely to aggregates of actinolite, with patches and veinlets of chlorite, and scattered patches of calcite. Actinolite is fibrous and very pale colored; its color is masked by moderately abundant light brown Fe-oxide.

Clinopyroxene forms subhedral phenocrysts up to 1 mm in size. Most are fresh. A very few contain patches of calcite.

Opaque forms a few patches up to 1.2 mm in size, with grains averaging 0.2-0.3 mm across. Associated with opaque are patches of semiopaque Ti-oxide (leucoxene). Most of the opaque is ilmenite, probably with some exsolution magnetite (identified by weak magnetism of rock).

Apatite fors a very few prismatic grains up to 0.4 mm in length associated with mafic phenocrysts, and equant grains averaging 0.1 mm in size associated with mafic clusters.

The groundmass is dominated by feldspar aggregates forming anhedral, equant grains averaging 0.1 mm in size, within which are extremely fine grained intergrowths of plagioclase and K-feldspar, with quartz present in some patches. Interstitial to these are extremely fine grained patches of light green chlorite. Opaque forms disseminated grains averaging 0.05 mm in size. Carbonate forms extremely fine grained, irregular replacement patches. Apatite forms subhedral prismatic grains averaging 0.03 mm in length. Quartz forms a very few interstitial patches up to 0.07 mm long. Zircon forms a very few subhedral to euhedral equant grains up to 0.08 mm across.

Plagioclase grains are variably altered along wispy fractures to more sodic plagioclase. Alteration is concentrated near the margins and ends of prismatic grains.

C-1161 Andesite Porphyry (Unit 15, possibly Unit 15c, but low K-spar)

The rock contains abundant phenocrysts of plagioclase, lesser ones of clinopyroxene and hornblende, and minor ones of biotite and opaque. A few patches of similar size to the phenocrysts consist of very fine grained aggregates of clinopyroxene, with or without moderately abundant opaque, and minor biotite. The groundmass is dominated by plagioclase with minor K-feldspar, chlorite, opaque, apatite, and calcite. The rock is cut by wispy veinlets up to 0.2 mm wide of chlorite and lesser epidote.

phenocrysts		
plagioclase	30-35%	(subhedral-euhedral, 0.5-1.5 mm, variably zoned)
clinopyroxene	4- 5	(+ clusters with or without opaque)
hornblende	3- 4	(altered completely to chlorite-epidote-(calcite))
biotite	0.3	(with abundant dusty to ex.fine grained opaque)
opaque	0.5	
groundmass		
plagioclase	50-55	(lathy to anhedral)
K-feldspar	1- 2?	
chlorite	1- 1½	
opaque	½- 1	
apatite	minor	
calcite	minor	
veins		
chlorite-epidote	1- 1½	

Plagioclase is slightly to strongly compositionally zoned from calcic cores to more-sodic rims. One composition determination gave a core of An_{48} grading outwards to a rim of An_{36}. Cores in some grains are replaced completely by extremely fine grained aggregates of plagioclase?-opaque. Other grains are altered slightly to strongly to sericite. A few grains were strongly fragmented.

Clinopyroxene forms euhedral to subhedral grains from 0.2-0.5 mm in average size, with a few up to 1 mm across. Clusters of very fine grains (0.1-0.2) commonly contain abundant opaque grains. One also contains a porphyroblast of biotite. Grains are fresh to slightly altered to chlorite.

Hornblende forms euhedral to subhedral prismatic grains up to 1.5 mm long; alteration is complete to very fine to fine grained aggregates of chlorite with lesser epidote, and locally with irregular patches of calcite.

Biotite forms phenocrysts from 0.1-0.3 mm in average size, with a few up to 1 mm long. It contains abundant extremely fine grained inclusions of opaque, somewhat concentrated along cleavage and grain borders. A few phenocrysts are rimmed by thin zones of pale brown mica.

Opaque phenocrysts are anhedral, equant grains up to 0.5 mm in size, mainly associated with mafic phenocrysts.

The groundmass is dominated by plagioclase, with laths averaging 0.05-0.1 mm in length set in an anhedral groundmass of plagioclase and minor K-feldspar averaging 0.01-0.03 mm in grain size. Disseminated, extremely fine grained minerals include wispy chlorite flakes, equant opaque grains, and subhedral prismatic grains of apatite. The latter also forms a few coarser prismatic grains up to 0.1 mm long. Calcite forms irregular replacement patches in the groundmass and in a few plagioclase phenocrysts.

Veinlets are dominated by chlorite, with a few narrower seams dominated by epidote. Elsewhere, epidote is concentrated as disseminated, extremely fine grains near borders of chlorite-rich parts of the veinlets.

Specimen No. 86-D-107

Specimen Name: Biotite-bearing Rhyolite (?Vitric Welded Tuff?)

Hand Sample: Pale greenish-grey nearly aphanitic crystalline rock with a conspicuous flow foliation. Feldspar and biotite laths aligned along the flow foliation occur as phenocrysts. Disseminated limonite-stained pyrite is also visible.

Modal Mineralogy (vol. %):

1-2% Plagioclase
<1% Biotite pseudomorphs
1% Opaques
97% Groundmass

Petrography:

Plagioclase occurs as sparse subhedral oligoclase phenocrysts (<0.5 mm) with Carlsbad twinning and weak normal zoning. Some crystals exhibit subgrain boundaries and sweeping extinction possibly indicative of incipient albitization.

Subhedral Biotite laths (<0.8 mm) are pseudomorphed by an assemblage of coarse white mica, Fe-Ti oxides aligned along cleavages, and some flakes contain euhedral pyrite cubes.

The dominant Opaque mineral in this rock is disseminated pyrite. Fractures are coated with limonite and hematite.

The Groundmass consists of a silicic glass devitrified to a mosaic of quartz and alkali feldspar, and secondary sericite, clay minerals, minor carbonate, opaque oxides (including hematite and limonite), and pyrite.

Thin stringers (<0.2 mm) of quartz + pyrite + minor carbonate cut the rock.

Primary Minerals: Plagioclase, biotite, Fe-Ti oxides

Secondary Minerals: Sericite, clay minerals, carbonate, quartz, limonite, hematite, pyrite, other opaque oxides

Comments: I would be willing to bet a beer this is a densely welded tuff. Check your field notes.

Specimen No. 86-C-343 Unit 7b

Specimen Name: Lapilli Tuff

Hand Sample: Dark grey to grey-green partially chloritized angular fragments of fine-grained to aphanitic volcanic rocks set in a fine-grained well-consolidated medium-grey clastic matrix.

Modal Mineralogy (vol. %):

40% Lithic lapilli
60% Matrix

Petrography:

The Lapilli comprise angular to subangular fragments of variably bleached and altered volcanic rocks. The dominant variety of clast is porphyritic with phenocrysts (<2 mm) of plagioclase (relict andesine where discernible) variably altered to epidote-zoisite aggregates, minor sericite, and clay minerals. Subordinate mafic phenocrysts (<1 mm) are completely replaced by chlorite. The groundmass comprises devitrified silicic glass and opaque dust. The majority of clasts appear to be lava fragments of rock types similar both mineralogically and texturally to 86-C-296 though generally less porphyritic. A few clasts are aphanitic. Open vitroclastic pumiceous fragments are also present.

The Matrix is fine-grained (<1 mm) and consists of broken crystals and lithic fragments and devitrified glass shards set in a finely comminuted dust rich in hematite.

Comments: This rock was probably deposited directly from a pyroclastic flow with little to no reworking.

Specimen No. 86-C-173 Unit 7b

Specimen Name: Biotite-Quartz Rhyolite (extensive sericite-carbonate alteration)

Hand Sample: Pale grey to brownish weathering porphyritic rock with phenocrysts of altered feldspar, quartz, and minor mafics set in a fine-grained groundmass.

Modal Mineralogy (vol. %):

6%	Plagioclase (including carbonate + sericite)
2%	Quartz
1%	Biotite pseudomorphs
<1%	Opaques
90%	Groundmass
Tr	Zircon

Petrography:

<u>Plagioclase</u> occurs as relict lamellar-twinned subhedral phenocrysts (<2.8 mm) of oligoclase composition. Weak normal zoning is preserved and all phenocrysts are extensively altered to a fine-grained assemblage of carbonate + sericite + clay minerals + secondary opaques (including hematite).

<u>Quartz</u> occurs as subhedral to resorbed phenocrysts (<1.5 mm) with inclusions of altered groundmass.

Subhedral <u>Biotite</u> laths (<0.8 mm) have been bleached and completely replaced by white mica and secondary opaques aligned along biotite cleavages, and minor carbonate and leucoxene. Biotite pseudomorphs are commonly intergrown with plagioclase.

Granular <u>Opaques</u> (<0.2 mm), mostly Fe-Ti oxides, are distributed evenly throughout the rock.

A single euhedral zircon prism (<0.3 mm) is intergrown with opaques.

The <u>Groundmass</u> is composed of volcanic glass devitrified to quartz and feldspar, opaques, and carbonate, sericite, and clay minerals.

A small <u>xenolith</u> (<1 cm) is a subvolcanic fragment composed of altered plagioclase and biotite phenocrysts set in a quartzofeldspathic groundmass with interstitial opaques possibly including pyrite.

Primary Minerals: Plagioclase, quartz, biotite, Fe-Ti oxides, zircon

Secondary Minerals: Carbonate, clay minerals, sericite, hematite

Comments: Check field descriptions to ascertain if this could be a poorly preserved welded tuff.

Specimen No. 86-C-777 Unit 7b

Specimen Name: Quartz Rhyolite (?Crystal-Vitric Tuff?)

Hand Sample: Medium-grained altered rock with irregular and isolated oxidized dark red blotchy regions surrounded by a pink to brownish to cream coloured variably bleached mesostasis. Phenocrysts of Feldspar and Quartz are present.

Modal Mineralogy (vol. %):

1%	Quartz
4%	Plagioclase
<1%	Opaques
94%	Groundmass

Petrography:

<u>Plagioclase</u> forms euhedral to subhedral lamellar twinned individuals (<1.5 mm) of oligoclase composition dusted with clay minerals and minor sericite and secondary opaques. Glomeroporphyritic intergrowths are present and some crystals appear broken.

<u>Quartz</u> occurs as subhedral to resorbed phenocrysts (<1.3 mm) with inclusions of altered groundmass. Some crystals are broken and have strain extinction and subgrain mosaics.

<u>Opaque</u> minerals are anhedral grains or aggregates ranging from 0.3 mm to dust-sized particles in the groundmass. Most opaques appear to be secondary in origin and opaque material lines fractures in the rock.

The <u>Groundmass</u> is composed of devitrified volcanic glass (quartz and feldspar), opaque dust, and clay minerals. There are areas of rounded perlitic devitrification cracks and a suggestion of vitroclastic texture in the groundmass. I cannot recognize any definitive shard outlines.

Primary Minerals: Plagioclase, quartz, opaques

Secondary Minerals: Sericite, clay minerals, opaques

Comments: The blotchy red and green texture is reminiscent of hydrothermally devitrified welded tuffs. Check field observations to decide between tuff or flow.

Specimen No. 86-C-65A Unit 7b

Specimen Name: Biotite-Quartz Rhyolite or Dacite

Hand Sample: Greenish-grey nearly aphanitic rock with sparse partially altered phenocrysts of feldspar set in a fine-grained groundmass.

Modal Mineralogy (vol. %):

8% Plagioclase (including clay minerals + chlorite + sericite)
<1% Quartz
<1% Opaques
90% Groundmass
Tr Biotite pseudomorphs

Petrography:

Plagioclase occurs as single subhedral phenocrysts (<1 mm) or glomeroporphyritic aggregates (<2 mm) of oligoclase composition. Most crystals have Carlsbad or lamellar twins and exhibit weak normal zoning. Most crystals are partly altered to sericite, clay minerals, and minor coarse flakes of chlorite.

Quartz is present as small rounded to resorbed phenocrysts (<0.4 mm).

Biotite is preserved as rare pseudomorphs comprising chlorite + opaques + leucoxene, the latter two minerals aligned along cleavage traces.

Granular Opaques are distributed throughout the rock and also occur as fracture coatings.

The Groundmass is composed of variably altered plagioclase microlites with well-preserved pilotaxitic texture, volcanic glass devitrified to quartz and feldspar, and disseminated chlorite, sericite, clay minerals, opaque dust, and minor carbonate.

Primary Minerals: Plagioclase, quartz, opaques

Secondary Minerals: Sericite, carbonate, clay minerals, chlorite, opaques, leucoxene, hematite

Comments: Irregular stringers (<0.3 mm wide) of quartz + chlorite + minor opaques cut the rock. A chemical analysis is needed to distinguish this rock as a rhyolite or dacite.

Specimen No. C-480 Unit 7c

Specimen Name: Rhyolite (altered)

Hand Sample: Very pale grey aphanitic rock containing irregular vuggy cavities (<2 mm across) partly to completely infilled with manganese oxide and pyrite. The rock weathers to a distinctive cream-brown rind.

Modal Mineralogy (vol. %):

73% Quartz and Feldspar
20% Sericite and trace carbonate
5% Opaque dust and clay minerals
2% Opaque crystals (some pyrite)

Petrography:

Microcrystalline Quartz and Feldspar form the matrix of this rock. This holocrystalline texture may be original or result from the post-consolidation devitrification of rhyolitic glass.

Sericite flakes are dispersed throughout the rock and also form irregular patches of interlocking crystals. Some of the latter may represent complete replacement of feldspar microlites. Large optically coherent crystals of white mica with well-developed fourth-order polarization colours may represent pseudomorphs after trace amounts of biotite.

Opaque dust and clay minerals are disseminated throughout the rock. Larger opaque crystals of pyrite with rounded to cubic outlines appear secondary in origin. Some of these larger crystals are contained in cavities.

Primary Minerals: Quartz, feldspar, opaque dust

Secondary Minerals: Sericite, clay minerals, pyrite, rare carbonate

Comments: This rock cannot be adequately classified petrographically. It appears to be a biotite-bearing rhyolite that has been extensively altered to sericite-clay mineral assemblage.

Specimen No. 86-C-303

Specimen Name: Biotite-bearing Rhyolite (severely carbonatized)

Hand Sample: Very pale grey to pale greenish-grey aphanitic crystalline rock with irregular limonite patches and ?manganese oxide staining.

Modal Mineralogy (vol. %):

- 3% Feldspar (replaced by calcite + sericite + quartz)
- <1% Opaques
- 96% Groundmass
- Tr Biotite pseudomorphs

Petrography:

<u>Feldspar</u> phenocrysts (<0.7 mm) with euhedral to subhedral ghost outlines have been completely replaced by coarsely crystalline calcite exhibiting glide deformation twins, or a finely crystalline assemblage of calcite + sericite + minor quartz.

Rare subhedral <u>Biotite</u> laths (<0.3 mm) have been pseudomorphed by white mica with opaques and leucoxene concentrated along cleavages.

<u>Opaque</u> minerals occur as discrete granules and dust-sized particles in the groundmass. Secondary pyrite cubes are conspicuous in isolated patchy intergrowths of quartz + carbonate + sericite + limonite + pyrite.

The <u>Groundmass</u> is a fine-grained mosaic of quartz and alkali feldspar representing devitrified silicic glass, opaque dust and secondary sericite and carbonate and clay minerals.

Primary Minerals: Feldspar (?plagioclase), biotite, Fe-Ti oxides

Secondary Minerals: Sericite, carbonate, clay minerals, quartz, pyrite, limonite

Comments: The limonite staining observed in hand specimen is related to disseminated pyrite.

Specimen No. 86-C-122B

Specimen Name: Biotite-bearing Rhyolite (former obsidian with spherulitic devitrification)

Hand Sample: Medium reddish-brown to greyish-brown crystalline rock with a pronounced flow foliation and white 'quartz-eyes' up to 1 cm in diameter representing centers of spherulitic devitrification. Sparse feldspar phenocrysts are visible.

Modal Mineralogy (vol. %):

- 3% Plagioclase
- 1% Opaques
- 96% Groundmass
- Tr Biotite pseudomorphs
- Tr Zircon

Petrography:

<u>Plagioclase</u> occurs as subhedral to rounded phenocrysts (<0.7 mm) exhibiting simple Carlsbad or lamellar twins. Their composition is that of sodic oligoclase. All phenocrysts are dusted with minor sericite and clay minerals.

Rare <u>Biotite</u> forms rare subhedral pseudomorphs (<0.5 mm) comprising white mica with opaque granules and leucoxene preferentially located along cleavages.

<u>Opaque</u> minerals are largely Fe-Ti oxides. They form subhedral crystals or granular aggregates (<0.4 mm) and exhibit a serial size gradation into the groundmass. Secondary recrystallization is evident where opaque granules are concentrated along spherulite boundaries.

A minute <u>Zircon</u> prism is observed intergrown with opaques.

The <u>Groundmass</u> is composed of silicic glass devitrified to quartz and alkali feldspar, opaque dust, and secondary sericite, chlorite, clay minerals, epidote, carbonate, and leucoxene. Spherulitic or mosaic recrystallization is well-advanced and plagioclase phenocrysts often serve as nuclei.

Primary Minerals: Plagioclase, biotite, Fe-Ti oxides, zircon

Secondary Minerals: Sericite, chlorite, epidote, clay minerals, leucoxene, carbonate

Comments: The flow fabric in this rock could well be a eutaxitic structure in densely welded rhyolitic vitric tuff. Check field criteria.

Specimen No. C-217a Unit 8b?

Specimen Name: Amphibole Diorite

Hand Sample: Pale greyish pink intensely altered holocrystalline rock with seriate texture and decomposed mafic phenocrysts set in a feldspar-rich matrix. Mottling is visible on the wetted surface due to patchy oxidation and saussaritization.

Modal Mineralogy (vol. %):

- 9% Mafic pseudomorphs
- 6% Ghost feldspar phenocrysts
- 85% Matrix (feldspar + quartz + chlorite + sericite + calcite + opaques + epidote + clay minerals)
- <1% Apatite and opaques

Petrography:

<u>Feldspar</u> occurs as relict phenocrysts (<3.5 mm) intensely altered to sericite + carbonate + clay minerals stained with hematite. No original feldspar optical properties can be discerned. It is likely that these phenocrysts were originally plagioclase.

<u>Mafic</u> pseudomorphs of amphibole phenocrysts (<3 mm) comprise a granular assemblage of chlorite + opaque oxides + calcite + epidote. Amphibole cross-sections are well preserved and no biotite pseudomorphs have been recognized.

<u>Apatite</u> occurs as euhedral prisms (<0.4 mm).

<u>Opaques</u> are common as anhedral microphenocrysts(<0.9 mm) and tiny grains distributed evenly throughout the matrix.

The <u>Groundmass</u> is dominated by variably altered plagioclase laths and subequant crystals and disseminated chlorite, sericite and coarse white mica, clay minerals, and granular calcite rarely exhibiting glide twins due to deformation. Coarser segregations of euhedral quartz + chlorite + calcite occur locally, and account for the very pale green patches seen in hand specimen.

Primary Minerals: Feldspar (plagioclase), amphibole, quartz, Fe-Ti oxides

Secondary Minerals: Chlorite, calcite, epidote, sericite, clay minerals, hematite

Comments: This rock is an altered shallow-level intrusive (dyke?) originally containing plagioclase and amphibole phenocrysts.

Specimen No. C-808 Unit 8a

Specimen Name: Biotite Granodiorite

Hand Sample: Pale greyish-pink oxidized medium-grained granitoid containing phenocrysts of quartz, K-spar, biotite, and amphibole. A seriate texture characterizes the feldspar phenocrysts which have weak clay mineral alteration.

Modal Mineralogy (vol. %):

- 25% Quartz
- 45% Plagioclase (including clay minerals + sericite)
- 20% K-spar (including clay minerals + sericite)
- 5% Biotite (including chlorite + epidote pseudomorphs)
- 1% Opaques
- 1% Epidote
- 2-3% Chlorite
- Tr Apatite, sphene

Petrography:

<u>Quartz</u> forms anhedral subequant crystals (<2.5 mm) with ragged margins and inclusions of biotite and feldspar. Some of the largest crystals exhibit strain extinction.

<u>Plagioclase</u> occurs as subhedral to anhedral crystals (<3 mm) of oligoclase composition that exhibit lamellar twinning and normal to oscillatory-normal zoning. Plagioclase is slightly altered to sericite and clay minerals especially in crystal cores.

<u>K-spar</u> is present as anhedral untwinned crystals (<2.5 mm) moderately altered to clay minerals and trace amounts of sericite. A string-like to patchy cryptoperthitic texture involving albite exsolution lamellae is commonly observed in crystal cores and at the margins of some crystals.

<u>Biotite</u> forms subhedral laths (<3 mm) with very pale orange to deep brown pleochroism where fresh and partly or completely pseudomorphed by chlorite + Fe-Ti oxides (along cleavages) +/- epidote. Inclusions of apatite are common.

Primary <u>Opaque</u> oxides (ilmenite + magnetite) occur as discrete microphenocrysts commonly intergrown with apatite.

<u>Sphene</u> occurs as colourless to very pale brown anhedral crystals.

Primary Minerals: Quartz, plagioclase, K-spar, biotite, Fe-Ti oxides, apatite, sphene

Secondary Minerals: sericite, clay minerals, epidote, chlorite

Comments: Note the absence of amphibole in this rock.

Specimen No. C-798 Unit 8b

Specimen Name: Granophyre

Hand Sample: Relatively fresh pale pink holocrystalline intrusive rock characterized by irregular intergrowths of quartz and alkali feldspar.

Modal Mineralogy (vol. %):

50%	Quartz
49%	Alkali feldspar (including sericite and clay minerals)
<1%	Opaques
<1%	Sericite and hematite veinlets
Tr	Epidote

Petrography:

<u>Quartz</u> exhibits well-developed micrographic or granophyric textures in intergrowth with alkali feldspar. Segregations of anhedral quartz mosaics exhibiting strain extinction are fairly common. Some quartz crystals included in alkali feldspar are faceted.

<u>Alkali feldspar</u> occurs as vermicular intergrowths with quartz and also as blocky crystals bordered by granophyric intergrowths. Some patchy twinning is evident (?microcline) and most feldspar is extensively altered to clay minerals.

<u>Sericite</u> commonly accompanied by <u>hematite</u> and <u>limonite</u> occurs in thin veinlets and locally forms coarse rosettes centered on these veinlets. Some coarse sericite-opaque intergrowths may represent pseudomorphs after biotite phenocrysts.

<u>Opaque</u> minerals are represented largely by hematite and minor Fe-Ti oxides.

Primary Minerals: Quartz, alkali feldspar, Fe-Ti oxides

Secondary Minerals: sericite, epidote, clays, hematite, limonite

Comments: The mineralogy and composition of this rock is identical to C-1139.

<u>C-1033A</u> Porphyritic Quartz Monzonite/Granite (Unit 8)

The rock contains phenocrysts of plagioclase and K-feldspar and minor ones of biotite in a very fine grained groundmass dominated by perthitic K-feldspar and quartz. Minor minerals are biotite, opaque, and sphene. Several plagioclase phenocrysts are rimmed by K-feldspar overgrowths. Some K-feldspar phenocrysts contain ragged patches of plagioclase, suggesting a replacement origin. All feldspars contain abundant dusty opaque (hematite?).

phenocrysts		
K-feldspar	10-12%	(subhedral, gradational to groundmass)
plagioclase	4- 5	(slightly to moderately compositionally zoned)
biotite	0.2	(grains up to 1 mm in size)
groundmass		
K-feldspar		(with irregular patches of plagioclase)
plagioclase	8-10	(in K-feldspar)
quartz	20-25	(interstitial, gradational to graphic intergrowths)
biotite	2- 3	
sphene	1	(equant anhedral to skeletal grains)
opaque	0.2	
apatite	minor	
chlorite	0.1	(secondary interstitial aggregates)

Plagioclase phenocrysts commonly are rimmed by K-feldspar overgrowths up to 0.2 mm thick. Plagioclase grains are up to 2 mm long, with subhedral prismatic habit.

K-feldspar phenocrysts are up to 3 mm long (average 1-1.5 mm), and commonly contain subhedral to irregular plagioclase cores or irregular patches scattered through the grains. These may be exsolution perthite, but more probably are of replacement origin, with K-feldspar replacing original plagioclase.

Biotite phenocrysts are fresh to very slightly altered to chlorite.

Groundmass feldspar ranges from very fine to fine grained, and is intergrown with quartz in irregular to graphic textures. Feldspar textures are as in the phenocrysts.

Biotite forms ragged grains from 0.1-0.3 mm in size. Some are slightly to completely altered to pseudomorphic chlorite.

Sphene is abundant, mainly associated with biotite or opaque, but with a few large grains away from the Fe-bearing minerals.

Opaque forms grains from 0.03-0.1 mm in size.

Apatite is associated with mafic and opaque grains as subhedral to anhedral grains up to 0.03 mm in size.

Chlorite forms a few interstitial patches up to 0.3 mm in size. These consist of radiating aggregates of very fine grains.

Specimen No. C-1139 Unit 8b/c

Specimen Name: Granophyre

Hand Sample: Medium-grained holocrystalline intrusive granitoid with intergrowths of quartz and feldspar. Weak to moderate oxidation and alteration to clay minerals.

Modal mineralogy (vol. %):

- 45% Quartz
- 50% Alkali feldspar
- 2-3% Sericite
- <1% Opaques (Magnetite+Ilmenite+Hematite)

Petrography:

Quartz forms granular to vermicular aggregates with subgrain mosaic boundaries and undulose strain extinction.

Alkali Feldspar forms radiating vermicular intergrowths with quartz and exhibits intense alteration to clay minerals and sericite. Some subequant feldspar phenocrysts serve as nucleation sites for granophyric outgrowths.

Sericite and Clay Minerals occupy 30-40% of the feldspar sites. Coarsely crystalline white mica also occurs in thin veinlets and irregular patches. All of this mica appears secondary in origin.

Opaque Oxides comprise rod-like ilmenite, pseudo-octahedral magnetite, and hematite flakes. The margins of Fe-Ti oxide grains are also altered to hematite. Hematite was also introduced with clay minerals in veinlets.

Primary Minerals: Quartz, alkali feldspar, Fe-Ti oxides

Secondary Minerals: Sericite, clay minerals, hematite

Comments: The texture and mineralogy of this rock are consistent with emplacement as a high-level intrusive.

Specimen No. C-259b Unit 8b/c

Specimen Name: Quartz-Feldspar Porphyry

Hand Sample: Light grey to light reddish grey weakly oxidized porphyry with phenocrysts of quartz, feldspar, and dull altered mafics set in a fine-grained quartzofeldspathic groundmass.

Modal Mineralogy (vol. %):

- 10% Quartz
- 22% Feldspar (partially altered to sericite + clay minerals)
- 7% Mafic pseudomorphs after amphibole and biotite
- 1% Opaques
- 60% Groundmass
- Tr Apatite

Petrography:

Quartz occurs as subhedral to intricately resorbed phenocrysts (<1 mm) commonly occurring in monomineralic aggregates or intergrown with pseudomorphs of mafic phenocrysts. The margins of some quartz phenocrysts support thin granophyric rims extending into the groundmass.

All Feldspar phenocrysts appear to be of plagioclase (oligoclase) composition. Many phenocrysts exhibit lamellar twinning and preserve oscillatory-normal zoning. Crystals are partly altered to sericite and clay minerals and rare epidote.

Mafic phenocrysts are represented by:

1) minor fresh reddish-brown to coffee brown pleochroic biotite locally enclosed in 2 below

2) amphibole phenocrysts completely replaced by a granular assemblage of epidote + sphene + leucoxene + Fe-Ti oxides + chlorite. Some of these pseudomorphs could be after biotite.

Apatite forms small euhedral prisms (<0.3 mm) commonly enclosed in quartz phenocrysts, altered mafic phenocrysts, and Fe-Ti oxide microphenocrysts.

The Groundmass is composed of equigranular quartz and alkali feldspar and is locally microgranophyric. Sericite, clay minerals, and chlorite are the main alteration minerals.

Primary Minerals: Quartz, plagioclase, biotite, amphibole, alkali feldspar, apatite, opaques

Secondary Minerals: sericite, clays, chlorite, epidote, leucoxene/sphene

Comments: This section is the one with the corner of the rock slice missing.

C-1115 Porphyritic Monzonite (Unit 9a)

The rock contains phenocrysts of plagioclase and lesser ones of hornblende and biotite in an extremely fine grained groundmass dominated by plagioclase and K-feldspar.

phenocrysts		
plagioclase	30-35%	(1-2.5 mm, fresh to strongly altered)
hornblende	4- 5	(up to 1 mm long, euhedral, minor alteration)
biotite	4- 5	(up to 1.2 mm; altered completely to chlorite-epidote)
groundmass		
plagioclase	20-25	(ratio uncertain, but strong yellow color indicate high K-feldspar content)
K-feldspar	30-35	
chlorite	1½-2	
opaque	1	(minor magnetite)
apatite	minor	
epidote	minor	

Plagioclase phenocrysts are variably altered. Some grains are fresh. Others have fresh cores surrounded by zones of moderate alteration. Others are moderately to strongly altered throughout. Alteration is mainly extremely fine grained sericite, with a few grains containing minor to moderately abundant extremely fine grained epidote.

Medium green hornblende grains are fresh, with a few containing patches of calcite, and others slightly to moderately altered to patches of chlorite and epidote.

Biotite is altered completely to aggregates of chlorite and lesser epidote, in part showing an oriented texture parallel to original cleavage in biotite. However, cleavage was destroyed during alteration. Thus, in altered grains showing no preferred orientation, it is impossible to determine whether the parent was biotite or hornblende. Most grains altered to chlorite-epidote are interpreted as having been originally biotite.

The groundmass is an unoriented aggregate of equant grains averaging 0.01-0.02 mm in size, with finer grained interstitial material of similar composition. Although only one phase appear to be present in thin section, both Na-and K-feldspars probably are represented.

Chlorite forms disseminated, anhedral flakes of extremely fine grain size.

Opaque forms scattered grains up to 0.3 mm in size, and more abundant ones from 0.02-0.05 mm across. Larger grains commonly are associated with mafic phenocrysts.

Apatite forms a very few subhedral prismatic grains over 0.1 mm in length, mainly associated with mafic phenocrysts. In the groundmass are scattered prismatic grains from 0.02-0.05 mm in length.

Epidote forms irregular, extremely fine grains associated with chlorite.

C-223 Porphyritic Quartz Monzonite (Unit 8)

The rock contains phenocrysts of K-feldspar, quartz, plagioclase, and biotite from 1 to 2 mm in size in a variable, mainly very fine to fine grained groundmass of K-feldspar, quartz, and plagioclase in about equal amounts. Minor minerals include pyrite and opaque oxide. In the groundmass, K-feldspar and quartz commonly form graphic intergrowths.

phenocrysts		
K-feldspar	17-20%	(slightly perthitic, gradational to groundmass)
quartz	12-15	(commonly subhedral to euhedral)
plagioclase	10-12	(strongly zoned throughout, variably altered)
biotite	3- 4	(some altered to chlorite ± epidote)
groundmass		
feldspar/quartz	50-55	(irregular to graphic intergrowths)
pyrite	0.2	(up to 0.6 mm in size; replaced by hematite)
opaque	0.1	(oxide?)
apatite	trace	(subhedral prismatic grains up to 0.1 mm long)

K-feldspar phenocrysts are in optical continuity with groundmass K-feldspar adjacent to the grain. Groundmass K-feldspar commonly is in coarse graphic intergrowths with quartz. Some K-feldspar phenocrysts contain minor patches of plagioclase, suggesting replacement of plagioclase by K-feldspar.

Plagioclase is zoned from small calcic cores towards more sodic rims; alteration to sericite and minor epidote is most intense in cores, and generally weak to absent in outer parts of grains.

Some biotite grains have lenses of opaque (Ti-oxide?) along cleavage. Alteration in a few grains is to pseudomorphic chlorite and minor epidote.

Groundmass plagioclase shows slight alteration to sericite.

Specimen No. D-102 Unit 9b

Specimen Name: Quartz-Feldspar Porphyry

Hand Sample: Pinkish-grey coarse-grained porphyry with megacrysts of K-spar and phenocrysts of K-spar, plagioclase, amphibole, biotite and quartz set in a fine-grained quartzofeldspathic groundmass.

Modal Mineralogy (vol. %):

5%	Quartz
9%	K-spar
21%	Plagioclase
10%	Amphibole + biotite pseudomorphs
1%	Opaques
55%	Groundmass
Tr	Apatite

Petrography:

K-spar forms euhedral megacrysts (<2 cm) and smaller euhedral to subhedral phenocrysts exhibiting simple Carlsbad twins and weak normal or oscillatory zoning. Phenocrysts are dusted with sericite and clay minerals; the most intense alteration occurs at crystal margins.

Plagioclase occurs as subhedral to euhedral lamellar-twinned phenocrysts (<4 mm) of andesine oligoclase composition that exhibit oscillatory-normal zoning. Plagioclase exhibits slight alteration to sericite and clay minerals.

Amphibole forms fresh colourless to pale green pleochroic phenocrysts (<2.5 mm) that are found as inclusions in feldspar. Most amphibole is pseudomorphed completely by chlorite + epidote + Fe-Ti oxides.

Biotite forms fresh colourless to pale brown pleochroic phenocrysts (<1.5 mm) found as inclusions in feldspar and quartz. Most phenocrysts are pseudomorphed to varying extents by chlorite + epidote + Fe-Ti oxides. Inclusions of apatite and opaques are common.

Euhedral Opaque microphenocrysts (<0.3 mm) of magnetite and ilmenite are distributed throughout the rock.

Euhedral Apatite prisms are intergrown with Fe-Ti oxides and occur as inclusions in other phenocrysts.

The Groundmass consists of fine-grained quartz and alkali feldspar with minute Fe-Ti oxides partly altered to hematite, and clay minerals plus minor sericite, chlorite, and trace epidote.

Primary Minerals: Quartz, K-spar, plagioclase, alkali feldspar, amphibole, biotite, magnetite, ilmenite, apatite

Secondary Minerals: Sericite, chlorite, epidote, clay minerals, hematite, limonite

C-80A Granodiorite Porphyry (Plagioclase-Quartz-Biotite-Hornblende) (Unit 9b)

The rock contains abundant phenocrysts of plagioclase and quartz, and lesser ones of biotite and hornblende, plus fragments of fine grained diorite in a very fine grained groundmass of K-feldspar, quartz, and plagioclase.

phenocrysts		
plagioclase	25-30%	(moderately concentrically zoned, patchy alteration
quartz	12-15	(irregular rounded, locally euhedral)
biotite	5- 7	(subhedral; mostly altered)
hornblende	4- 5	(subhedral to euhedral, locally altered)
groundmass and minor minerals		
K-feldspar/quartz/plagioclase	35-40%	(0.03-0.05 mm)
opaque	0.3	
epidote	0.2	
chlorite	0.3	
apatite	0.1	(needles to 0.5 mm long; equant grains)
allanite	trace	(anhedral, equant grain 0.2 mm, surrounded by epidote)
zircon	trace	(euhedral prismatic 0.1 mm)
inclusions		
diorite	7- 8	

Plagioclase is altered in patches to sericite. Some cores of grains are strongly altered, and in some zoned grains, alteration is restricted to certain zones. Elsewhere, alteration is disseminated through grains and slightly to moderately concentrated in more-calcic parts.

Biotite is altered to pseudomorphic chlorite with patches of epidote; most grains are altered completely, a few moderately, and a few show only slight alteration along rims.

Hornblende is mainly fresh. A few grains are altered to actinolite with patches of calcite and/or epidote.

The groundmass is an aggregate of equant grains of feldspars and quartz, with a composition of quartz monzonite. Interstitial disseminated grains of chlorite and epidote are present in minor amounts.

Opaque commonly is associated with hornblende and biotite. It is locally magnetic, suggesting that it is mainly ilmenite with minor magnetite.

Diorite inclusions are fine grained with locally coarser plagioclase grains. Interstitial to plagioclase are biotite and hornblende (15-30%) in part with patches of epidote. Biotite is altered completely to chlorite, and hornblende is altered to actinolite. Minor opaque is present.

Specimen No. C-224 Unit 9b

Specimen Name: Quartz-Feldspar Porphyry

Hand Sample: Pale greyish pink altered porphyry rich in amphibole phenocrysts and megacrysts (<1.3 cm) accompanied by phenocrysts of quartz and feldspar (<1.2 cm) set in a fine-grained holocrystalline groundmass.

Modal Mineralogy (vol. %):

- 15% Mafic pseudomorphs (after amphibole and biotite)
- 25% Plagioclase
- 5% Quartz
- 1% Opaques
- 54% Groundmass
- Tr Apatite

Petrography:

<u>Quartz</u> phenocrysts (<2 mm) are euhedral to intricately resorbed with deep embayments and inclusions of groundmass, opaque oxides, apatite, and chlorite (after biotite). Some crystals have ragged granophyric margins involving groundmass alkali feldspar.

<u>Plagioclase</u> occurs as subhedral weakly zoned andesine-oligoclase phenocrysts (<3 mm) partially altered to clay minerals, sericite, and epidote. Many phenocrysts preserve lamellar twinning. A few megacrysts (>1 cm) are observed in hand specimen.

<u>Mafic</u> phenocrysts of biotite and amphibole have been completely pseudomorphed:
1) Biotite has been replaced by chlorite + epidote + opaque oxides (ilmenite?) + sphene. The latter two minerals outline biotite cleavage traces.
2) Amphibole has been replaced by epidote + calcite + chlorite + opaque oxides + sphene. Epidote and calcite are generally much more abundant on amphibole sites than on biotite.

<u>Opaque</u> minerals are largely Fe-Ti oxides (magnetite microphenocrysts) partly altered to hematite.

The <u>Groundmass</u> is composed of equigranular quartz and variably altered alkali feldspar, opaque dust, chlorite, calcite, epidote, and clay minerals.

Primary Minerals: Quartz, plagioclase, amphibole, biotite, Fe-Ti oxides, apatite

Secondary Minerals: chlorite, calcite, epidote, sericite, sphene, hematite, clay minerals

Comments: This rock is mineralogically similar to C-259b and C-259f but contains more mafic phenocrysts and is more altered.

Specimen No. C-108 Unit 9b

Specimen Name: Quartz-Feldspar Porphyry (severely altered)

Hand Sample: Pale greenish-pink oxidized porphyry exhibiting intensely altered feldspars and mafic minerals (<1 cm) set in a finely crystalline groundmass.

Modal Mineralogy (vol. %):

- 35% Feldspar (replaced by quartz + sericite + calcite)
- 12% Mafic pseudomorphs of biotite and amphibole
- 1% Quartz
- 1-2% Opaques
- 50% Groundmass (quartz + feldspar + sericite + calcite + clay minerals
- Tr Apatite

Petrography:

<u>Feldspar</u> occurs as euhedral to subhedral relict phenocrysts (<5 mm) completely replaced by granular quartz, sericite, calcite, clay minerals, and minor opaque material. Original twinning has been completely destroyed by alteration.

<u>Mafic</u> pseudomorphs may be subdivided into two types:
1) euhedral to subhedral <u>Amphiboles</u> pseudomorphed by granular calcite + chlorite + quartz + Fe-Ti oxides + hematite/limonite + clay minerals. These crystals attain 1 cm in length.
2) <u>Biotite</u> flakes pseudomorphed by granular calcite + chlorite + quartz + hematite/limonite + ilmenite + rutile + sericite. The opaques are commonly oriented preferentially along biotite cleavage traces.

<u>Opaque</u> minerals comprise Fe-Ti oxide microphenocrysts and secondary hematite and rutile, and ?pyrite.

The <u>Groundmass</u> is composed of equigranular quartz and alkali feldspar (some K-spar is identifiable) along with calcite, sericite, clay minerals, chlorite, and opaque dust.

Primary Minerals: Quartz, feldspar, amphibole, biotite, apatite, Fe-Ti oxides

Secondary Minerals: sericite, calcite, limonite, chlorite, hematite, rutile, clays

Comments: This rock represents the most intensely altered and carbonatized sample. There is a notable lack of epidote.

Specimen No. C-334 Unit 9b

Specimen Name: Quartz-Feldspar Porphyry

Hand Sample: Missing?

Modal Mineralogy (vol. %):

- 12% Quartz
- 15% Feldspar (K-spar)
- 1-2% Biotite
- <1% Opaques
- 65% Groundmass
- 5% Carbonate/sericite

Petrography:

Quartz forms euhedral to rounded and resorbed phenocrysts (<4 mm) with deep embayments and inclusions of groundmass and rare biotite and opaques.

Feldspar forms euhedral to rounded weakly zoned or unzoned phenocrysts (<4 mm) preferentially affected by calcite replacement. Their overall lack of lamellar twinning, very low relief, and presence of simple Carlsbad twins suggests that these phenocrysts are largely K-spar (could be quickly confirmed by cobaltinitrite staining).

Biotite occurs as reddish-brown to coffee brown euhedral laths (<1.5 mm) that are slightly altered to hematite and Fe-Ti oxides and white mica.

Opaques are present as a few pseudo-octahedral microphenocrysts of Fe-Ti oxides altered at their margins to hematite or limonite.

Groundmass minerals constitute a fine-grained assemblage of quartz and alkali feldspar along with dust-size opaque material.

Carbonate/Sericite are disseminated throughout the groundmass, locally concentrated on feldspar sites, and occur in thin fractures and irregular patches.

Primary Minerals: Quartz, feldspar (K-spar), biotite, Fe-Ti oxides, alkali feldspar

Secondary Minerals: Sericite, carbonate (calcite), hematite, limonite, minor clay minerals

Comments: If it is important to know the precise amount of K-spar phenocrysts present, this rock should be stained with sodium cobaltinitrite.

Specimen No. C-1169a (2 thin sections) Unit 9b

Specimen Name: Biotite-Plagioclase Porphyry (dyke rock?)

Hand Sample: Pale brownish-grey porphyry with phenocrysts of fresh biotite and feldspar set in a fine-grained holocrystalline feldspar-rich groundmass.

Modal Mineralogy (vol. %):

- 10% Plagioclase
- 4% Biotite (+ secondary biotite + chlorite + minor actinolite)
- <1% Opaques
- 95% Groundmass
- Tr Apatite, zircon

Petrography:

Plagioclase occurs as subhedral lamellar-twinned phenocrysts (<4.5 mm) or glomeroporphyritic clusters (<6 mm) of oligoclase composition. Phenocrysts exhibit normal or weak oscillatory-normal zoning and are lightly dusted by clay minerals and sericite. Inclusions of biotite and Fe-Ti oxides are common.

Biotite forms orange-brown to almost black pleochroic flakes (<1.2 mm) partly altered to chlorite and secondary Fe-Ti oxides. Inclusions of apatite, Fe-Ti oxides, and zircon have been identified. Secondary biotite + chlorite + actinolite occurs in irregular patches.

Opaques occur as microphenocrysts (<0.2 mm) of Fe-Ti oxides and dust-sized particles in the groundmass.

Apatite forms euhedral prisms (<0.1 mm); Zircon occurs as colourless subhedral crystals (<0.1 mm).

Groundmass constitutes lath-like to equant plagioclase and alkali feldspar and interstitial quartz that are locally granophyric, opaque dust, minor sericite, chlorite, clay minerals, and hematite. A flow fabric can be distinguished in the lath-like feldspars.

Primary Minerals: Plagioclase, biotite, alkali feldspar, quartz, Fe-Ti oxides, apatite, zircon

Secondary Minerals: Sericite, chlorite, clay minerals, hematite, biotite, opaques, actinolite

Comments: This rock is fairly leucocratic with >20% quartz in the groundmass.

Specimen No. C-1175 — Unit 9c (La Forma)

Specimen Name: Quartz-Feldspar Porphyry

Hand Sample: Very pale grey to cream coloured altered porphyry with phenocrysts of quartz and feldspar set in a fine-grained bleached quartzofeldspathic groundmass.

Modal Mineralogy (vol. %):

4% Quartz
1% K-spar?
8% Plagioclase
87% Groundmass
Tr Opaques, biotite

Petrography:

Quartz appears as subhedral to resorbed phenocrysts (<2 mm) that contain inclusions of altered groundmass.

Plagioclase forms euhedral to subhedral phenocrysts (<2 mm) or glomeroporphyritic aggregates (<3.5 mm) of oligoclase, moderately to extensively altered to calcite + minor sericite and clay minerals. Inclusions of biotite and opaques are observed.

K-spar? occurs as a few euhedral phenocrysts with subgrain mosaics apparently produced during alteration.

Biotite is preserved as a few euhedral pseudomorphs (<0.5 mm) of sericite + Fe-Ti oxides + leucoxene.

Opaque microphenocrysts (<0.1 mm) occur as a few subhedral magnetite grains enclosed by feldspar.

The Groundmass is composed of quartz and alkali feldspar intensely altered to calcite + sericite + clay minerals (20% of the matrix).

Primary Minerals: Quartz, plagioclase, ?K-spar, biotite, Fe-Ti oxides, alkali feldspar

Secondary Minerals: sericite, calcite, clay minerals, leucoxene, opaques. The rock contains thin (<0.1 mm) stringers of quartz + calcite + sericite.

Comments: This specimen is mineralogically and texturally similar to C-1174 but C-1175 is extensively carbonatized.

Specimen No. C-1174 — Unit 9c

Specimen Name: Feldspar-Quartz Porphyry

Hand Sample: Pale brownish-grey to cream-coloured porphyry with phenocrysts of quartz and altered feldspars set in a finely crystalline quartzofeldspathic matrix.

Modal Mineralogy (vol. %):

8% Quartz
3% Plagioclase
89% Groundmass
Tr Opaques, zircon, ?biotite

Petrography:

Quartz forms subhedral to resorbed phenocrysts (<3 mm) with inclusions of altered groundmass.

Plagioclase occurs as subhedral weakly zoned phenocrysts (<2.5 mm) of oligoclase composition that are partially altered to clay minerals and sericite. Glomeroporphyritic intergrowths are evident in hand specimen.

Opaque minerals occur in trace amounts and comprise subhedral magnetite and dust in the groundmass.

Biotite may be represented by a few euhedral hematitic pseudomorphs.

Zircon is found as rare euhedral prisms (<0.1 mm).

The Groundmass is composed of quartz + alkali feldspar + rosettes of sericite + clay minerals + opaques. A few coarse sericite flakes may represent pseudomorphs after biotite.

Primary Minerals: Quartz, plagioclase, alkali feldspar, Fe-Ti oxides, ?biotite, zircon

Secondary Minerals: sericite, quartz, clay minerals, hematite, limonite. A few thin (<0.1 mm) quartz stringers are present in addition to irregular fractures filled with limonite and hematite.

Comments: This rock is very similar to C-1175.

Specimen No. C-259f — Unit 9c

Specimen Name: Quartz-Feldspar Porphyry

Hand Sample: Pale pinkish grey porphyry with phenocrysts of quartz, feldspar, and altered mafics set in a fine-grained quartzofeldspathic groundmass.

Modal Mineralogy (vol. %):

30%	Feldspar (partly altered to sericite + clay minerals)
7%	Quartz
7%	Mafics (partly to completely replaced biotite and amphibole)
1%	Opaques
55%	Groundmass
Tr	Apatite

Petrography:

Quartz forms subhedral to strongly resorbed phenocrysts (<3 mm) and contains inclusions of altered mafics, groundmass, opaque oxides, fresh hornblende, and rare apatite. Some phenocrysts have ragged vermicular margins intergrown with groundmass alkali feldspar.

Feldspar phenocrysts (<4 mm) appear to be composed entirely of plagioclase (oligoclase). Many have well-developed lamellar twins and oscillatory-normal zoning. Some cores are preferentially altered to sericite + clay minerals + sparse epidote.

Mafic minerals comprise:
1) fresh green pleochroic hornblende phenocrysts (<2 mm) that have been partly to completely replaced by chlorite + epidote + minor opaques
2) phenocrysts (<1 mm) of green weakly pleochroic biotite extensively altered to chlorite + Fe-Ti oxides + leucoxene. The latter two minerals preferentially lie along biotite cleavage planes and this together with the lack of epidote among the alteration products serves to distinguish these pseudomorphs. Altered phenocrysts of biotite and amphibole are locally intergrown.

The majority of Opaque minerals are primary Fe-Ti oxides except for secondary opaques along biotite cleavages.

Euhedral Apatite prisms are generally incorporated in opaques and hornblende.

The Groundmass is composed of granular quartz and alkali feldspar, minor opaques, and secondary clay minerals and sericite.

Primary Minerals: Quartz, plagioclase, biotite, hornblende, alkali feldspar, apatite, Fe-Ti oxides

Secondary Minerals: Sericite, chlorite, epidote, clays, leucoxene

Specimen No. C-1150 (2 thin sections) — Unit 9c

Specimen Name: Quartz-Feldspar Porphyry

Hand Sample: Relatively fresh greyish pink porphyry with phenocrysts of plagioclase, K-spar, biotite, and quartz set in a fine-grained quartzofeldspathic groundmass.

Modal Mineralogy (vol. %):

14%	Plagioclase
6%	Quartz
3%	K spar
1-2%	Biotite
<1%	Opaques
75%	Groundmass
Tr	Zircon

Petrography:

Quartz forms subhedral to rounded phenocrysts (<2 mm) containing inclusions of groundmass and exhibiting irregular curvilinear fractures filled with sericite. Monomineralic aggregates are fairly common.

Plagioclase forms subhedral weakly zoned lamellar-twinned individual crystals (<2.5 mm) or glomeroporphyritic aggregates (<3 mm across) of oligoclase composition that rarely contain inclusions of biotite and opaque oxides. Crystals are generally weakly altered to sericite and clay minerals; locally intense alteration to calcite also occurs.

K-spar occurs as subhedral individuals or glomeroporphyritic clusters (<3 mm) that exhibit Carlsbad twinning and are weakly altered to clay minerals and sericite. Patches and string-like cryptoperthitic textures are also observed.

Biotite forms subhedral phenocrysts (<2 mm) that are completely pseudomorphed by chlorite + Fe-Ti oxides + hematite + leucoxene + sericite + rare epidote.

Opaques form sparse microphenocrysts of magnetite and granules dispersed throughout the rock.

The Groundmass is dominated by equigranular quartz and alkali feldspar with minor chlorite, sericite, calcite, and limonite.

Primary Minerals: Quartz, plagioclase, K-spar, biotite, alkali feldspar, Fe-Ti oxides, zircon

Secondary Minerals: Sericite, chlorite, clay minerals, calcite, epidote, hematite, limonite, leucoxene

Comments: This rock is mineralogically and texturally similar to C-1166.

C-310B Porphyritic Granogabbro (Unit 9a)

The rock contains phenocrysts of plagioclase, hornblende, and clinopyroxene from 0.5 to 2 mm in size in a very fine grained groundmass dominated by K-feldspar and quartz, with lesser plagioclase. Minor groundmass (±phenocryst) minerals include opaque, Ti-oxide/leucoxene, epidote? and apatite.

phenocrysts		
plagioclase	30-35%	
hornblende	10-12	(altered completely to chlorite-epidote-(calcite))
clinopyroxene	5- 7	(mainly fresh)
groundmass		
K-feldspar	15-17	(some with extremely fine graphic quartz intergrowths)
quartz	12-15	(interstitial)
plagioclase	7- 8	(subhedral)
opaque	1½-2	(common with mafic phenocrysts)
Ti-oxide	½- 1	(common with mafic phenocrysts)
chlorite	1½-2	(interstitial patches)
epidote	0.5	(elongated lenses and dense patches)
apatite	minor	

Plagioclase phenocrysts are fresh to moderately altered to sericite and minor epidote. Some grains also are altered to more-sodic plagioclase along a network of wispy fractures, in part associated with sericite alteration. A few large ones contain subrounded inclusions of clinopyroxene up to 0.05 mm in size.

Hornblende forms subhedral to euhedral prismatic phenocrysts and aggregates, in part associated with clinopyroxene. It is completely altered to chlorite with patches of epidote, and in some grains of calcite. Associated with hornblende phenocrysts are moderately abundant opaque, Ti-oxide, and apatite.

Clinopyroxene forms subhedral to euhedral prismatic to equant grains from 0.3-1 mm in size. Irregular opaque inclusions are present in some grains. Locally, clinopyroxene is replaced by chlorite patches.

The groundmass consists of very fine to fine grained aggregates of anhedral K-feldspar, interstitial quartz, and subhedral prismatic plagioclase. Dusty opaque inclusions are common in feldspars. Some patches of K-feldspar contain extremely fine grained graphic intergrowths of quartz. Quartz also forms coarser grained patches, with grains up to 0.7 mm in size. Associated with a few of these are patches of feathery? to fibrous epidote? containing abundant dusty inclusions. This mineral has high relief and low birefringence. Epidote also forms elongated lenses up to 0.2 mm in length scattered through the groundmass.

Opaque and Ti-oxide form equant grains averaging 0.2-0.4 mm in size, mainly associated with mafic phenocrysts. The rock is slightly magnetic, suggesting that the opaque is ilmenite with much less magnetite.

Chlorite forms interstitial, very fine grained patches up to 0.2 mm in size.

Apatite forms a few subhedral prismatic grains up to 0.12 mm in size, mainly associated with mafic phenocrysts.

Specimen No. C-441 Unit 9e/a

Specimen Name: Hornblende Diorite or Hornblende Monzodiorite metamorphosed to epidote-actinolite grade.

Hand Sample: Pinkish-grey mildly oxidized medium- to fine-grained intermediate intrusive rock containing altered phenocrysts of plagioclase and mafics that grade serially into a fine-grained mesostasis.

Modal Mineralogy (vol. %):

25% Plagioclase
10% Mafic pseudomorphs
2% Opaques
62% Groundmass (<0.2 mm)
<1% Apatite

Petrography:

Plagioclase forms subhedral to anhedral andesine-oligoclase phenocrysts (<2 mm), many with relict lamellar-twinning, that have been moderately to severely altered to a fine-grained assemblage of sericite + clay minerals + epidote + minor chlorite.

Mafic pseudomorphs after amphibole comprise an interlocking mosaic of chlorite + epidote + Fe-Ti oxides + leucoxene + pale yellow to green pleochroic actinolite. Fibrous actinolite rarely pseudomorphs entire phenocrysts rarely preserving original igneous twinning. A few pseudomorphs contain oriented opaques + leucoxene possibly after biotite.

Opaque microphenocrysts of magnetite and ilmenite and unidentified secondary opaques are distributed throughout the rock.

Apatite forms euhedral crystals reaching 0.3 mm in length.

The Groundmass of the rock is formed by an interlocking fabric of plagioclase laths weakly altered to sericite and clay minerals, granular alkali feldspar, and quartz (<5 %), chlorite, epidote, minor actinolite and calcite, opaques, and leucoxene.

Primary Minerals: Plagioclase, amphibole, quartz, alkali feldspar, Fe-Ti oxides, apatite, ?biotite

Secondary Minerals: actinolite, epidote, chlorite, sericite, calcite, clay minerals, leucoxene
Comments: This specimen represents the highest grade of metamorphism I have seen in the suite.

D-86 Porphyritic Basalt cut by veinlets of Clinopyroxene-Biotite (Unit 14a)

The rock contains phenocrysts of clinopyroxene and of plagioclase, and patches of very fine to fine grained aggregates of these minerals with opaque in a groundmass dominated by lathy plagioclase with interstitial plagioclase, clinopyroxene, opaque, and K-feldspar (as judged from the stained offcut block). It is cut by veins and veinlets of very fine to extremely fine grained clinopyroxene-biotite with interstitial plagioclase in coarser parts of veins. Veins offset phenocrysts of clinopyroxene by up to 1.5 mm.

phenocrysts and patches		
clinopyroxene phenos	12-15%	(1-3 mm, some clusters)
plagioclase phenos	3- 4	(0.5-1.5 mm, some clusters)
patches	5- 7	
groundmass		
lathy plagioclase		(0.05-0.15 mm average length)
clinopyroxene	10-12	(interstitial, 0.02-0.05 mm average)
anhedral plagioclase	10-12	(interstitial, 0.02-0.03 mm average)
opaque (magnetite-rich)	2- 3	(0.01-0.02 mm, disseminated)
biotite	0.1	(associated with veins, 0.01-0.02 mm)
veins		
clinopyroxene-biotite	2- 3	(up to 0.5 mm wide)

Clinopyroxene phenocrysts are fresh to moderately altered to dusty to extremely fine grained opaque. Fine to very fine grained patches may be replacements of clinopyroxene. These generally consist of aggregates of clinopyroxene with lesser opaque and interstitial plagioclase and minor quartz. In one cluster of clinopyroxene phenocrysts, such patches contain clinopyroxene with a bright green color; these grains grade into coarser clinopyroxene phenocrysts surrounding the patch. The xetinction angle of the green variety is moderately lower than that of the colorless variety, suggesting that the green variety is aegirine-augite. Other patches occur away from clinopyroxene phenocrysts.

Plagioclase phenocrysts form aggregates with slightly radiating textures. Most grains are prismatic with irregular outlines. A few clusters contain irregular interstitial patches of clinopyroxene.

Lathy plagioclase is randomly oriented, and interstitial grains are irregularly intergrown between them.

The rock is cut by veins which grade along their length from extremely fine to very fine. Extremely fine grained zones are dominated by clinopyroxene and/or biotite; grains are equant and granular. Coarser grained aggregates commonly are dominated by clinopyroxene with interstitial plagioclase. Opaque grains occur in irregular patches, mainly associated with coarser grained clinopyroxene.

The rock is moderately magnetic, indicating that at least half of the opaque is magnetite.

C-868 Slightly Porphyritic Obsidian (Quartz Monzonite Composition) Unit 12

The rock contains scattered phenocrysts and aggregates of plagioclase, K-feldspar, quartz, and minor biotite, as well as graphic intergrowths of K-feldspar and quartz. These are set in a groundmass of volcanic glass of quartz monzonite composition containing tiny crystals of plagioclase and biotite. The tiny crystals are concentrated strongly in a few subparalle layers, possibly indicating primary flow banding. The volcanic glass shows well developed spheroidal perlitic fractures, with minor to moderately abundant devitrification along such fractures.

phenocrysts		
plagioclase	3- 4%	(average 0.5-1 mm)
quartz	2- 3	(")
K-feldspar	2- 3	(" , well developed basal cleavage)
biotite	0.2	
graphic K-feldspar/quartz	0.1	(very fine intergrowths)
groundmass		
glass	88-90	
plagioclase crystals	1½-2	(stubby prismatic grains)
biotite	minor	(wispy flakes)
opaque	minor	

Phenocrysts range from subhedral and euhedral to subrounded and very irregularly embayed. All are fresh. Graphic quartz-K-feldspar intergrowths form individual grains, aggregates of a few grains of different optical orientation, and a few thin rims on phenocrysts of plagioclase. Biotite phenocrysts mainly are thin flakes averaging 0.1-0.3 mm in length.

Spheroidal perlitic fractures are common in the glass. They are up to 2 mm across, with larger ones containing subsidiary spheroids up to 0.3 mm in size. Most are in the range of 0.2-1 mm.

Crystals in the groundmass average 0.02-0.07 mm in length.

Opaque forms scattered grains up to 0.05 mm i- size, mainly with coarser phenocrysts.

C-1067D Amygdaloidal Andesite/Basalt Flow Top (Unit 14bv)

The rock contains clusters of clinopyroxene phenocrysts and scattered plagioclase phenocrysts in a groundmass dominated by lathy plagioclase, with interstitial anhedral plagioclase and K-feldspar (as judged from stained offcut block), patches of sericite, and disseminated hematite. It contains abundant amygdules up to a few mm across dominated by ankerite/dolomite with patches of hematite along borders. Replacement patches/amydgules consist of aggregates of cherty quartz and minor hematite, in part showing spherulitic textures.

phenocrysts		
clinopyroxene	3- 4%	(0.5-1 mm, subhedral clusters)
plagioclase	1- 1½	(0.3-0.7 mm prismatic grains, a few over 1.5 mm)
apatite	trace	(up to 0.4 mm long, prismatic to acicular)
groundmass		
plagioclase		
lathy	65-70	
anhedral	10-15	(includes K-feldspar)
sericite	4- 5	
hematite	2- 3	
amygdules, replacement patches		
ankerite	7- 8	
hematite	1	
quartz	1½-2	

Clinopyroxene is altered completely to ankerite. It is distinguished from amygdules of ankerite by the presence of acicular to prismatic apatite inclusions, and by subhedral crystal outlines.

Plagioclase generally is altered completely in the cores of grains, with only a thin rim preserved in section. A few coarse phenocrysts is one cluster contain cores of extremely fine grained secondary minerals (hematite, ankerite, plagioclase?) replacing the original plagioclase.

Lathy plagioclase in the groundmass is unoriented and averages 0.07-0.15 mm in grain length, with a few coarser ones grading up to the smaller phenocrysts.

Sericite forms extremely fine grained patches up to 0.2 mm in size, and averaging less than 0.05 mm across.

Hematite forms disseminated extremely fine grains.

Amygdules are filled with fine to locally medium grained ankerite, with partial rims of dense hematite on some.

Replacement patches and a few irregular amygdules contain extremely fine grained cherty quartz with minor hematite, containing scattered to locally abundant cryptocrystalline, spheroidal patches of silica ± hematite averaging 0.03-0.05 mm across.

D-24 Altered Crystal Tuff Unit 13/14

The rock contains phenocrysts of plagioclase and hornblende in a groundmass dominated by quartz with patches of kaolinite, and dusty hematite disseminated through quartz. Plagioclase is altered to kaolinite, and hornblende is altered to hematite, with or without quartz.

phenocrysts (crystal fragments in tuff)		
plagioclase	20-25%	(0.5-1 mm long, a few over 2 mm across)
hornblende	20-25	(0.3-1 mm average length, a few over 1.5 mm long)
groundmass		
quartz	40-45	
kaolinite	7- 8	
hematite	1- 1½	

Plagioclase is identified by rectangular outlines of prismatic grains, and by a few other euhedral outlines of more complex shape. It is replaced by kaolinite averaging 0.005 mm in grain size.

Hornblende shows euhedral to subhedral crystal outlines, with cross sections showing typical rhombic sections. It is altered to dense, opaque hematite, in part with patches of extremely fine grained quartz, mainly concentrated in the cores of grains, and in a few disseminated through the hematite.

Groundmass quartz ranges from 0.02-0.1 mm in grain size, with grains irregular and slightly interlocking. Kaolinite is as in the plagioclase phenocrysts, and commonly is interstitial to subhedral quartz prismatic grains up to 0.1 mm long. Hematite forms dusty to extremely fine grains throughout the quartz.

D-169 Olivine Basalt (Unit 14b)

The sample contains abundant phenocrysts of olivine and lesser ones of clinopyroxene and plagioclase in a groundmass containing subhedral to euhedral clinopyroxene and anhedral plagioclase, with disseminated opaque and biotite. Minor K-feldspar is indicated by the weak stain on the offcut block.

phenocrysts		
olivine	8-10%	
clinopyroxene	3- 4	
plagioclase	1- 1½	
groundmass		
clinopyroxene	30-35	
plagioclase	45-50	
opaque	1½-2	(partly magnetite)
biotite	½- 1	
apatite	minor	
K-feldspar	1- 2?	

Olivine forms rounded to subhedral phenocrysts up to 2 mm in size. Most larger ones contain spherical fractures, which might outline an original rounded grain which later had an overgrowth of olivine to produce the subhedral to euhedral outlines. Some are slightly to moderately altered along fractures to extremely fine grained, light brown amphibole and/or mica.

Clinopyroxene forms single phenocrysts and clusters of phenocrysts averaging 0.3-0.8 mm in size, with a few from 1 to 1.5 mm across. Larger phenocrysts commonly have a thin zone near the margins containing abundant tiny inclusions of plagioclase. These grains also show weak compositional zoning near margins. Clinopyroxene is pale green in color.

Plagioclase forms subhedral phenocrysts averaging 0.5-1 mm in length. They are altered in irregular patches to extremely fine grained sericite, with overall intensity of alteration slight to moderate.

In the groundmass, clinopyroxene forms subhedral prismatic grains averaging 0.05-0.1 mm in length. These are enclosed in anhedral, very fine grained plagioclase, with a few subhedral to euhedral plagioclase grains up to 0.15 mm in length. Apatite forms clusters of tiny acicular grains in interstitial plagioclase. K-feldspar probably occurs in interstitial grains with plagioclase, although none was identified in thin section.

Opaque forms disseminated grains averaging 0.01-0.02 mm in size, with a few up to 0.05 mm across.

Biotite forms ragged, commonly irregular grains up to 0.1 mm in size. It is medium to deep brown in color.

Specimen No. C-394 Unit 14b

Specimen Name: (Alkali-olivine?) Basalt

Hand Sample: Medium-grey porphyritic basaltic flow or subvolcanic intrusive with partially altered phenocrysts of olivine and clinopyroxene set in a fine-grained feldspar-rich groundmass.

Modal Mineralogy (vol. %):

10% Olivine
15% Clinopyroxene
75% Groundmass

Petrography:

Olivine forms euhedral to subhedral phenocrysts (<3 mm) of forsteritic composition altered at their margins to green-yellow serpentine-like minerals (chlorophaeite?) and mineral mixtures (iddingsite, bowlingite?). Tiny octahedra of brownish chrome-rich spinel occupy the cores of some of the larger olivine phenocrysts.

Clinopyroxene occurs as large colourless subhedral phenocrysts (<5 mm) of augitic pyroxene are locally intergrown with olivine. These crystals exhibit lamellar or simple twinning and may form glomeroporphyritic aggregates. Many phenocrysts exhibit oscillatory zoning pointing to a complex crystallization history. Alteration products enclosed in clinopyroxene probably include inclusions of devitrified basaltic glass as well as olivine.

The Groundmass is composed of microlites of calcic plagioclase, intergranular augite and opaque oxides (largely magnetite, possibly minor ilmenite), and sparse interstitial devitrified glass partially altered to clay minerals.

Primary Minerals: Olivine, augite, plagioclase, Fe-Ti oxides

Secondary Minerals: Sericite, clay minerals, serpentine-like minerals

Comments: This sample probably comes from a flow interior. The presence of microphenocrystic magnesian olivine without an orthopyroxene reaction rim indicates an alkalic affinity.

C-1063 Grano-gabbro Unit 15c

The rock is a medium to coarse grained grano-gabbro, containing clusters of mafic minerals intergrown with feldspars and lesser quartz. Mafic minerals include clinopyroxene, in part rimmed by hornblende, altered hornblende, and biotite. K-feldspar is dominant over plagioclase. Both form prismatic phenocrysts intergrown with finer grained feldspars and quartz. Graphic intergrowths of K-feldspar and quartz are common. Plagioclase commonly is strongly zoned; composition appears to be in the labradorite/andesine range.

K-feldspar	40-45%	(dusty opaque inclusions common)
plagioclase	20-25	(slight to moderate patchy alteration to sericite)
graphic quartz/K-feldspar	5- 7	(very fine grained intergrowths)
quartz	4- 5	
clinopyroxene	5- 7	
hornblende	3- 4	(mainly altered to secondary tremolite/biotite/sericite)
biotite	7- 8	(minor alteration to chlorite)
opaque	0.5	(ilmenite?, occurs with mafic clusters)
apatite	0.2	(occurs with mafic clusters)
Ti-oxide	trace	
hematite	trace	(after pyrite?)
calcite	trace	(in K-feldspar)
zircon	trace	
secondary biotite? patches	0.5%	(pale to medium yellow to brownish yellow)
calcite veinlets	trace	
epidote veinlet?	trace	

The rock is porphyritic, with early formed clinopyroxene, hornblende, biotit plagioclase, and K-feldspar as subhedral to euhedral crystals in a groundmas of K-feldspar-quartz.

D-164 Slightly Porphyritic Basalt (Unit 14b)

The rock is layered, with slight differences in grain size and composition between layers. Both layers are slightly porphyritic basalts, with phenocrysts of clinopyroxene in a groundmass dominated by lathy plagioclase and abundant hematite. The smaller (in section) layer contains less hematite in the groundmass, and contains scattered quartz phenocrysts. Hematite is moderately concentrated in irregular patches in the groundmass.

phenocrysts		
clinopyroxene	4- 5%	
quartz	minor	(in one layer only)
groundmass		
plagioclase		
lathy	50-55	
anhedral	25-30	
hematite	5- 8	
veins and replacement patches		
calcite-(tremolite)	2- 3	
cavities	3- 4	

Clinopyroxene phenocrysts and clusters of phenocrysts are subhedral to euhedral in outline, and average 0.5-0.8 mm in grain size. A few grains are over 1.5 mm across. They are altered partly to completely to very fine to fine grained aggregates of calcite. In partly altered grains, clinopyroxene forms relic remnants in cores of grains. Phenocrysts are surrounded by thin concentrations of hematite. Numerous phenocrysts were altered completely, and calcite later removed during weathering or section preparation.

Quartz forms phenocrysts from 0.2-0.5 mm in size; its identification was confirmed by a positive uniaxial interference figure on the largest grain.

The groundmass is very slightly to slightly foliated, with foliation defined by orientation of lathy plagioclase. These grains average 0.05-0.1 mm in size, with grain size coarser in the larger layer. Interstitial to these are patches of plagioclase averaging 0.01-0.02 mm in size. The pale yellow color on the stained block in the smaller layer suggests the presence of minor K-feldspar. This and the quartz phenocrysts suggest that this layer may have been contaminated by crustal material of granitic composition.

Hematite forms dusty to extremely fine grained patches. In the smaller layer, it is less abundant generally than in the larger layer, and is concentrated in irregular patches up to 1 mm in size. These may have formed during weathering.

The rock is cut by irregular veinlets up to 0.3 mm in width of very fine grained calcite. Smaller, very irregular replacement patches of calcite are scattered through the rock. One vein has a cavity filled by radiating fibrous tremolite? crystal averaging 0.05 mm in length.

The rock contains vesicles up to 1 mm in size.

Specimen No. C-1146 Unit 15d

Specimen Name: Biotite-Augite Diorite

Hand Sample: Very fresh grey medium-grained intermediate holocrystalline rock containing crystals of plagioclase, biotite, and pyroxene.

Modal Mineralogy (vol. %):

72% Plagioclase
5% Biotite
10% Clinopyroxene
5% Quartz + Alkali Feldspar
2% Fe-Ti oxides
<1% Apatite
5% Secondary biotite + minor chlorite and muscovite

Petrography:

Plagioclase forms subhedral to anhedral crystals (<3 mm) of andesine-oligoclase with pronounced discontinuous fine lamellar twinning, locally curved (deformed). Most crystals exhibit oscillatory-normal or normal zoning and are generally free of secondary alteration products.

Clinopyroxene forms subhedral to granular crystals (<2 mm) of augite with simple/lamellar twinning and partly altered to secondary biotite/chlorite. Inclusions of Fe-Ti oxides, apatite, biotite, and plagioclase are common.

Biotite forms subhedral orange-brown to colourless laths (<1.5 mm) fresh or partly altered to chlorite/muscovite. Inclusions of apatite and Fe-Ti oxides are common.

Opaques comprise microphenocrysts (<0.5 mm) of octahedral magnetite and rod-like ilmenite.

Apatite euhedra (<0.3 mm) are commonly intergrown with Fe-Ti oxide microphenocrysts.

Quartz and Alkali Feldspar occur as an interstitial residuum and locally exhibit well-developed granophyric texture.

Primary Minerals: Plagioclase, biotite, augite, quartz, alkali feldspar, Fe-Ti oxides, apatite

Secondary Minerals: Sericite, chlorite, biotite, clay minerals, hematite

Comments: This is the only specimen in which biotite and clinopyroxene coexist.

C-283 Porphyritic Monzongabbro (Unit 15c)

The rock contains phenocrysts of plagioclase and clinopyroxene in a groundmass of plagioclase, K-feldspar, clinopyroxene, and biotite, with minor minerals including abundant opaque and apatite, and minor hornblende and quartz.

phenocrysts		
plagioclase	10-12%	(moderately to strongly compositionally zoned)
clinopyroxene	5- 7	(anhedral, corroded, replaced by bio, hblde)
groundmass		
plagioclase	25-30	(slightly altered to sericite)
K-feldspar	30-35	(anhedral granular aggregates)
clinopyroxene	8-10	(ragged, replaecd by biotite ± hornblende)
biotite	7- 8	(irregular grains surrounding cpx and alone)
opaque	2- 3	(associated with biotite; minor magnetite)
apatite	1½-2	(subhedral to euhedral prismatic to acicular)
quartz	0.2	(interstitial to K-feldspar/plagioclase)
hornblende	0.2	(replacement of clinopyroxene)

Plagioclase forms phenocrysts and clusters from 1 to 1.5 mm in size. Twins are not well developed. Composition probably is andesine. One determination gave a composition of An_{45} in the core of a zoned grain, grading outwards to An_{33} at the rim.

A few clinopyroxene phenocrysts are up to 3 mm across. These contain inclusions of opaque and plagioclase, mainly in growth zones near the margins of the grain. Grains are irregularly replaced along their margins by very fine to fine grained biotite and locally hornblende.

The groundmass averages 0.1-0.2 mm in size, with K-feldspar and plagicolase forming granular to slightly interlocking aggregates. Quartz occurs in a few parts of the section as very fine grains interstitial to feldspars. Clinopyroxene forms ragged grains, surrounded by and partly replaced by biotite and minor hornblende. Some contain moderately abundant opaque.

Mafic clusters contain cores of clinopyroxene rimmed by biotite, with abundant associated opaque and apatite. Opaque forms equant grains averaging 0.05-0.1 mm in size. Apatite forms prismatic grains up to 0.3 mm in length in mafic patches. It also forms prismatic to acicular grains of slightly smaller size in the felsic groundmass.

Biotite is medium to deep brown in color. Hornblende is light to medium green (possibly actinolite).

APPENDIX II

Whole Rock Analyses
and
Calculated Norms

Analyses by: Bondar Clegg & Company Ltd.

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1078 Unit: 3a

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	60.20	Quartz	15.44
TiO2	0.68	Corundum	1.22
Al2O3	18.26	Orthoclase	9.69
Cr2O3	0.01	Albite	35.12
Fe2O3	2.82	Anorthite	23.03
FeO	2.65	Plagioclase	58.15
MnO	0.11	Wollastonite	
MgO	2.46	Enstatite	
CaO	5.09	Ferrosilite	
Na2O	4.15	Diopside	0.00
K2O	1.64	Enstatite	6.13
P2O5	0.34	Ferrosilite	1.61
		Hypersthene	7.74
Total	98.41	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	4.09
		Ilmenite	1.29
		Apatite	0.81

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-0476 Unit: 3a

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	65.05	Quartz	20.84
TiO2	0.36	Corundum	0.47
Al2O3	16.90	Orthoclase	13.71
Cr2O3	0.01	Albite	34.95
Fe2O3	2.25	Anorthite	19.43
FeO	1.85	Plagioclase	54.38
MnO	0.07	Wollastonite	
MgO	1.63	Enstatite	
CaO	4.18	Ferrosilite	
Na2O	4.13	Diopside	0.00
K2O	2.32	Enstatite	4.06
P2O5	0.20	Ferrosilite	1.07
		Hypersthene	5.13
Total	98.95	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	3.26
		Ilmenite	0.68
		Apatite	0.47

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: D-0300 Unit: 4a

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	57.46	Quartz	9.97
TiO2	0.76	Corundum	
Al2O3	14.50	Orthoclase	26.33
Cr2O3	0.01	Albite	25.13
Fe2O3	4.05	Anorthite	13.09
FeO	3.85	Plagioclase	38.22
MnO	0.16	Wollastonite	3.68
MgO	2.93	Enstatite	2.47
CaO	5.10	Ferrosilite	0.93
Na2O	2.97	Diopside	7.08
K2O	4.45	Enstatite	4.83
P2O5	0.52	Ferrosilite	1.82
		Hypersthene	6.65
Total	96.76	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	5.87
		Ilmenite	1.44
		Apatite	1.23

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-0208 Unit: 5a

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	64.34	Quartz	25.12
TiO2	0.43	Corundum	1.49
Al2O3	16.31	Orthoclase	14.83
Cr2O3	0.01	Albite	24.12
Fe2O3	2.52	Anorthite	20.23
FeO	2.20	Plagioclase	44.35
MnO	0.08	Wollastonite	
MgO	2.46	Enstatite	
CaO	4.25	Ferrosilite	
Na2O	2.85	Diopside	0.00
K2O	2.51	Enstatite	6.13
P2O5	0.13	Ferrosilite	1.39
		Hypersthene	7.52
Total	98.09	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	3.65
		Ilmenite	0.82
		Apatite	0.31

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1117 Unit: 5a

Oxide	Wt.Pct.
SiO2	64.73
TiO2	0.44
Al2O3	15.38
Cr2O3	0.01
Fe2O3	2.18
FeO	1.65
MnO	0.10
MgO	1.69
CaO	3.33
Na2O	3.54
K2O	3.34
P2O5	0.17
Total	96.56

Mineral	Mol.Pct.
Quartz	21.87
Corundum	0.29
Orthoclase	19.74
Albite	29.95
Anorthite	15.41
Plagioclase	45.36
Wollastonite	
Enstatite	
Ferrosilite	
Diopside	0.00
Enstatite	4.21
Ferrosilite	0.68
Hypersthene	4.89
Forsterite	
Fayalite	
Olivine	0.00
Magnetite	3.16
Ilmenite	0.84
Apatite	0.40

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: D-0211 Unit: 5a

Oxide	Wt.Pct.
SiO2	64.80
TiO2	0.42
Al2O3	16.26
Cr2O3	0.01
Fe2O3	2.19
FeO	1.65
MnO	0.09
MgO	1.51
CaO	3.48
Na2O	3.47
K2O	3.63
P2O5	0.18
Total	97.69

Mineral	Mol.Pct.
Quartz	21.21
Corundum	0.73
Orthoclase	21.45
Albite	29.36
Anorthite	16.09
Plagioclase	45.45
Wollastonite	
Enstatite	
Ferrosilite	
Diopside	0.00
Enstatite	3.76
Ferrosilite	0.69
Hypersthene	4.45
Forsterite	
Fayalite	
Olivine	0.00
Magnetite	3.18
Ilmenite	0.80
Apatite	0.43

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-0991 Unit: 5a

Oxide	Wt.Pct.
SiO2	64.89
TiO2	0.45
Al2O3	16.32
Cr2O3	0.01
Fe2O3	1.80
FeO	2.45
MnO	0.06
MgO	1.81
CaO	2.73
Na2O	3.36
K2O	3.92
P2O5	0.21
Total	98.01

Mineral	Mol.Pct.
Quartz	21.31
Corundum	2.09
Orthoclase	23.16
Albite	28.43
Anorthite	12.17
Plagioclase	40.60
Wollastonite	
Enstatite	
Ferrosilite	
Diopside	0.00
Enstatite	4.51
Ferrosilite	2.37
Hypersthene	6.88
Forsterite	
Fayalite	
Olivine	0.00
Magnetite	2.61
Ilmenite	0.85
Apatite	0.50

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-0679 Unit: 5a

Oxide	Wt.Pct.
SiO2	68.45
TiO2	0.38
Al2O3	15.29
Cr2O3	0.01
Fe2O3	1.60
FeO	1.35
MnO	0.09
MgO	1.33
CaO	3.08
Na2O	3.02
K2O	3.96
P2O5	0.20
Total	98.76

Mineral	Mol.Pct.
Quartz	27.40
Corundum	0.91
Orthoclase	23.40
Albite	25.55
Anorthite	13.97
Plagioclase	39.52
Wollastonite	
Enstatite	
Ferrosilite	
Diopside	0.00
Enstatite	3.31
Ferrosilite	0.69
Hypersthene	4.00
Forsterite	
Fayalite	
Olivine	0.00
Magnetite	2.32
Ilmenite	0.72
Apatite	0.47

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: D-0226 Unit: 5c

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	66.04	Quartz	20.05
TiO2	0.36	Corundum	0.51
Al2O3	15.76	Orthoclase	23.52
Cr2O3	0.01	Albite	33.42
Fe2O3	1.42	Anorthite	12.13
FeO	1.60	Plagioclase	45.55
MnO	0.05	Wollastonite	
MgO	1.32	Enstatite	
CaO	2.63	Ferrosilite	
Na2O	3.95	Diopside	0.00
K2O	3.98	Enstatite	3.29
P2O5	0.14	Ferrosilite	1.25
		Hypersthene	4.54
Total	97.26	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	2.06
		Ilmenite	0.68
		Apatite	0.33

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1039 Unit: 5c

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	78.20	Quartz	61.15
TiO2	0.11	Corundum	7.72
Al2O3	12.53	Orthoclase	23.05
Cr2O3	0.01	Albite	2.45
Fe2O3	0.95	Anorthite	0.30
FeO	0.25	Plagioclase	2.75
MnO	0.01	Wollastonite	
MgO	0.21	Enstatite	
CaO	0.10	Ferrosilite	
Na2O	0.29	Diopside	0.00
K2O	3.90	Enstatite	0.52
P2O5	0.03	Ferrosilite	
		Hypersthene	0.52
Total	96.59	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	0.50
		Ilmenite	0.21
		Apatite	0.60

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1161 Unit: 7a

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	60.74	Quartz	18.66
TiO2	0.74	Corundum	0.19
Al2O3	16.19	Orthoclase	14.48
Cr2O3	0.01	Albite	25.72
Fe2O3	2.81	Anorthite	22.78
FeO	2.95	Plagioclase	48.50
MnO	0.13	Wollastonite	
MgO	2.83	Enstatite	
CaO	4.83	Ferrosilite	
Na2O	3.04	Diopside	0.00
K2O	2.45	Enstatite	7.05
P2O5	0.18	Ferrosilite	2.11
		Hypersthene	9.16
Total	96.90	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	4.07
		Ilmenite	1.41
		Apatite	0.43

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1137 Unit: 7a

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	64.97	Quartz	25.62
TiO2	0.66	Corundum	1.72
Al2O3	16.42	Orthoclase	15.30
Cr2O3	0.01	Albite	23.02
Fe2O3	2.26	Anorthite	20.25
FeO	2.85	Plagioclase	43.27
MnO	0.11	Wollastonite	
MgO	2.51	Enstatite	
CaO	4.24	Ferrosilite	
Na2O	2.72	Diopside	0.00
K2O	2.59	Enstatite	6.25
P2O5	0.12	Ferrosilite	2.47
		Hypersthene	8.72
Total	99.46	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	3.28
		Ilmenite	1.25
		Apatite	0.28

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1146 Unit: 8

Oxide	Wt.Pct.
SiO2	58.89
TiO2	0.92
Al2O3	17.10
Cr2O3	0.01
Fe2O3	3.23
FeO	2.50
MnO	0.10
MgO	2.61
CaO	4.14
Na2O	3.94
K2O	4.68
P2O5	0.52
Total	98.64

Mineral	Mol.Pct.
Quartz	6.93
Corundum	
Orthoclase	27.66
Albite	33.34
Anorthite	15.15
Plagioclase	48.49
Wollastonite	0.83
Enstatite	0.67
Ferrosilite	0.06
Diopside	1.56
Enstatite	5.83
Ferrosilite	0.52
Hypersthene	6.35
Forsterite	
Fayalite	
Olivine	0.00
Magnetite	4.68
Ilmenite	1.75
Apatite	1.23

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-0229 Unit: 8b

Oxide	Wt.Pct.
SiO2	75.17
TiO2	0.10
Al2O3	13.21
Cr2O3	0.02
Fe2O3	1.00
FeO	0.25
MnO	0.03
MgO	0.25
CaO	0.83
Na2O	3.53
K2O	3.94
P2O5	0.08
Total	98.41

Mineral	Mol.Pct.
Quartz	37.63
Corundum	1.82
Orthoclase	23.28
Albite	29.87
Anorthite	3.59
Plagioclase	33.46
Wollastonite	
Enstatite	
Ferrosilite	
Diopside	0.00
Enstatite	0.62
Ferrosilite	
Hypersthene	0.62
Forsterite	
Fayalite	
Olivine	0.00
Magnetite	0.58
Ilmenite	0.19
Apatite	0.19

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1032 Unit: 8

Oxide	Wt.Pct.
SiO2	70.14
TiO2	0.37
Al2O3	14.39
Cr2O3	0.01
Fe2O3	1.64
FeO	0.65
MnO	0.04
MgO	0.43
CaO	0.83
Na2O	3.78
K2O	5.14
P2O5	0.08
Total	97.50

Mineral	Mol.Pct.
Quartz	26.29
Corundum	1.29
Orthoclase	30.37
Albite	31.99
Anorthite	3.59
Plagioclase	35.58
Wollastonite	
Enstatite	
Ferrosilite	
Diopside	0.00
Enstatite	1.07
Ferrosilite	
Hypersthene	1.07
Forsterite	
Fayalite	
Olivine	0.00
Magnetite	1.14
Ilmenite	0.70
Apatite	0.19

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-0259 Unit: 8

Oxide	Wt.Pct.
SiO2	71.80
TiO2	0.28
Al2O3	13.97
Cr2O3	0.01
Fe2O3	1.67
FeO	0.95
MnO	0.07
MgO	1.02
CaO	2.46
Na2O	3.37
K2O	3.37
P2O5	0.08
Total	99.05

Mineral	Mol.Pct.
Quartz	32.72
Corundum	0.50
Orthoclase	19.91
Albite	28.52
Anorthite	11.68
Plagioclase	40.20
Wollastonite	
Enstatite	
Ferrosilite	
Diopside	0.00
Enstatite	2.54
Ferrosilite	0.02
Hypersthene	2.56
Forsterite	
Fayalite	
Olivine	0.00
Magnetite	2.42
Ilmenite	0.53
Apatite	0.19

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-0808 Unit: 8

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	72.63	Quartz	31.03
TiO2	0.22	Corundum	1.23
Al2O3	14.28	Orthoclase	25.47
Cr2O3	0.02	Albite	31.31
Fe2O3	1.03	Anorthite	6.27
FeO	0.75	Plagioclase	37.58
MnO	0.08	Wollastonite	
MgO	0.50	Enstatite	
CaO	1.37	Ferrosilite	
Na2O	3.70	Diopside	0.00
K2O	4.31	Enstatite	1.25
P2O5	0.08	Ferrosilite	0.29
		Hypersthene	1.54
Total	98.97	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	1.49
		Ilmenite	0.42
		Apatite	0.19

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-0189 Unit: 8

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	76.03	Quartz	36.92
TiO2	0.09	Corundum	1.68
Al2O3	12.95	Orthoclase	27.42
Cr2O3	0.02	Albite	29.95
Fe2O3	0.42	Anorthite	1.15
FeO	0.25	Plagioclase	31.10
MnO	0.01	Wollastonite	
MgO	0.18	Enstatite	
CaO	0.31	Ferrosilite	
Na2O	3.54	Diopside	0.00
K2O	4.64	Enstatite	0.45
P2O5	0.06	Ferrosilite	
		Hypersthene	0.45
Total	98.50	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	0.55
		Ilmenite	0.17
		Apatite	0.14

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1139 Unit: 8

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	77.80	Quartz	40.21
TiO2	0.10	Corundum	2.04
Al2O3	12.81	Orthoclase	28.42
Cr2O3	0.01	Albite	27.33
Fe2O3	0.23	Anorthite	0.68
FeO	0.25	Plagioclase	28.01
MnO	0.01	Wollastonite	
MgO	0.03	Enstatite	
CaO	0.15	Ferrosilite	
Na2O	3.23	Diopside	0.00
K2O	4.81	Enstatite	0.07
P2O5	0.01	Ferrosilite	0.11
		Hypersthene	0.18
Total	99.44	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	0.33
		Ilmenite	0.19
		Apatite	0.02

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1150 Unit: 8c

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	74.54	Quartz	36.36
TiO2	0.12	Corundum	1.84
Al2O3	13.22	Orthoclase	29.19
Cr2O3	0.01	Albite	26.15
Fe2O3	0.57	Anorthite	2.60
FeO	0.25	Plagioclase	28.75
MnO	0.06	Wollastonite	
MgO	0.12	Enstatite	
CaO	0.55	Ferrosilite	
Na2O	3.09	Diopside	0.00
K2O	4.94	Enstatite	0.30
P2O5	0.02	Ferrosilite	
		Hypersthene	0.30
Total	97.49	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	0.64
		Ilmenite	0.23
		Apatite	0.05

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-0441 Unit: 9a

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	64.12	Quartz	20.49
TiO2	0.47	Corundum	0.48
Al2O3	15.89	Orthoclase	20.33
Cr2O3	0.01	Albite	29.11
Fe2O3	2.63	Anorthite	16.45
FeO	1.85	Plagioclase	45.56
MnO	0.11	Wollastonite	
MgO	2.05	Enstatite	
CaO	3.54	Ferrosilite	
Na2O	3.44	Diopside	0.00
K2O	3.44	Enstatite	5.11
P2O5	0.17	Ferrosilite	0.64
		Hypersthene	5.75
Total	97.72	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	3.81
		Ilmenite	0.89
		Apatite	0.40

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1115 Unit: 9b

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	62.37	Quartz	16.84
TiO2	0.54	Corundum	1.30
Al2O3	16.84	Orthoclase	21.63
Cr2O3	0.01	Albite	31.05
Fe2O3	1.87	Anorthite	15.13
FeO	2.10	Plagioclase	46.18
MnO	0.11	Wollastonite	
MgO	1.95	Enstatite	
CaO	3.34	Ferrosilite	
Na2O	3.67	Diopside	0.00
K2O	3.66	Enstatite	4.86
P2O5	0.22	Ferrosilite	1.62
		Hypersthene	6.48
Total	96.68	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	2.71
		Ilmenite	1.03
		Apatite	0.52

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1125 Unit: 9b

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	70.23	Quartz	27.48
TiO2	0.29	Corundum	2.20
Al2O3	15.73	Orthoclase	23.64
Cr2O3	0.01	Albite	34.02
Fe2O3	1.37	Anorthite	7.05
FeO	0.60	Plagioclase	41.07
MnO	0.07	Wollastonite	
MgO	0.68	Enstatite	
CaO	1.50	Ferrosilite	
Na2O	4.02	Diopside	0.00
K2O	4.00	Enstatite	1.69
P2O5	0.06	Ferrosilite	
		Hypersthene	1.69
Total	98.56	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	1.31
		Ilmenite	0.55
		Apatite	0.14

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1169 Unit: 9b

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	73.08	Quartz	31.56
TiO2	0.18	Corundum	1.67
Al2O3	14.38	Orthoclase	29.78
Cr2O3	0.01	Albite	29.19
Fe2O3	1.30	Anorthite	4.32
FeO	0.85	Plagioclase	33.51
MnO	0.03	Wollastonite	
MgO	0.13	Enstatite	
CaO	0.91	Ferrosilite	
Na2O	3.45	Diopside	0.00
K2O	5.04	Enstatite	0.32
P2O5	0.03	Ferrosilite	0.24
		Hypersthene	0.56
Total	99.39	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	1.88
		Ilmenite	0.34
		Apatite	0.07

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1174 Unit: 9c

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	79.00	Quartz	50.74
TiO2	0.09	Corundum	4.52
Al2O3	12.50	Orthoclase	21.69
Cr2O3	0.01	Albite	20.14
Fe2O3	0.45	Anorthite	0.25
FeO	0.20	Plagioclase	20.39
MnO	0.01	Wollastonite	
MgO	0.18	Enstatite	
CaO	0.09	Ferrosilite	
Na2O	2.38	Diopside	0.00
K2O	3.67	Enstatite	0.45
P2O5	0.03	Ferrosilite	
		Hypersthene	0.45
Total	98.61	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	0.40
		Ilmenite	0.17
		Apatite	0.07

WHOLE ROCK ANALYSIS AND CALCULATED NORM

Sample Number: C-1175 Unit: 9c

Oxide	Wt.Pct.	Mineral	Mol.Pct.
SiO2	73.06	Quartz	34.61
TiO2	0.04	Corundum	1.62
Al2O3	13.89	Orthoclase	29.19
Cr2O3	0.01	Albite	24.29
Fe2O3	0.50	Anorthite	6.01
FeO	0.15	Plagioclase	30.30
MnO	0.03	Wollastonite	
MgO	0.17	Enstatite	
CaO	1.25	Ferrosilite	
Na2O	2.87	Diopside	0.00
K2O	4.94	Enstatite	0.42
P2O5	0.03	Ferrosilite	
		Hypersthene	0.42
Total	96.94	Forsterite	
		Fayalite	
		Olivine	0.00
		Magnetite	0.45
		Ilmenite	0.08
		Apatite	0.07

APPENDIX III

Multi-element Geochemical Results

Analyses by: Acme Analytical Laboratories Ltd.
Bondar Clegg & Company Ltd.
(As noted on each sample)

UNITS

Au	ppb	Se	ppm	Cu	ppm	Fe	%	K	%
Ag	ppm	Te	ppm	Pb	ppm	Mn	ppm	Na	%
As	ppm	U	ppm	Zn	ppm	Tl	ppm	Ca	%
Sb	ppm	Th	ppm	Mo	ppm	V	ppm	Al	%
Hg	ppb	B	ppm	W	ppm	Ni	ppm	Ba	ppm
				Co	ppm	Cr	ppm	Sr	ppm

C-0009 Altered, pyritic, vuggy, locally flow-banded quartz-feldspar porphyry. Sample from felsenmeer which has minor hand trenching. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	4	Fe	47.00	K	0.16
Ag	0.1	Te	0.2	Pb	15	Mn	202	Na	0.03
As	7	U	5	Zn	12	Ti	0.01	Ca	0.18
Sb	2	Th	17	Mo	1	V	1	Al	0.19
Hg	5	B	4	W	1	Ni	2	Ba	123
				Co	1	Cr	3	Sr	9

C-0016 Felsic breccia and crystal lapilli tuff, feldspar > quartz, trace to 1% disseminated py, local clots of mafic minerals. (Lab - Bondar Clegg)

Au	87	Se	0.2	Cu	896	Fe	3.83	K	0.39
Ag	3.4	Te	0.6	Pb	37	Mn	788	Na	0.40
As	5	U	5	Zn	156	Ti	0.12	Ca	1.45
Sb	2	Th	9	Mo	1	V	39	Al	2.95
Hg	5	B	6	W	1	Ni	6	Ba	144
				Co	9	Cr	12	Sr	92

C-0018 Felsic breccia and crystal lapilli tuff, feldspar > quartz, trace to 1% disseminated py, local clots of mafic minerals. (Lab - Bondar Clegg)

Au	63	Se	0.2	Cu	253	Fe	2.35	K	0.71
Ag	1.4	Te	0.6	Pb	21	Mn	450	Na	0.44
As	4	U	5	Zn	90	Ti	0.10	Ca	1.46
Sb	2	Th	10	Mo	1	V	53	Al	3.05
Hg	5	B	2	W	1	Ni	7	Ba	136
				Co	6	Cr	15	Sr	84

C-0179 Trench area SW of Mt. Nansen. Andesitic volcanics intruded by fine-grained, pyritic, dacite dike(?). (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	4	Fe	3.18	K	0.06
Ag	0.1	Te	0.2	Pb	8	Mn	170	Na	0.16
As	6	U	5	Zn	34	Ti	0.05	Ca	0.39
Sb	2	Th	3	Mo	1	V	15	Al	1.27
Hg	30	B	2	W	1	Ni	1	Ba	17
				Co	6	Cr	1	Sr	54

C-0217 Feldspar porphyry dyke in lowlands E of Tritop Mountain. Minor pyrite and trace of chalcopyrite. Sample is in contact area between Mt. Nansen andesite and granodiorite.

Au	6	Se	0.5	Cu	49	Fe	3.68	K	0.32
Ag	0.7	Te	0.2	Pb	52	Mn	923	Na	0.27
As	13	U	5	Zn	246	Ti	0.05	Ca	1.43
Sb	2	Th	11	Mo	1	V	68	Al	2.56
Hg	5	B	4	W	1	Ni	7	Ba	125
				Co	10	Cr	10	Sr	52

C-0221 East side of granodiorite, within Mt. Nansen andesitic to dacitic pyroclastics. Sample is of med. gr. hornblende-feldspar porphyry dyke with 2-3% disseminated py

Au	1	Se	0.2	Cu	9	Fe	2.93	K	0.22
Ag	0.2	Te	0.2	Pb	8	Mn	315	Na	0.28
As	4	U	5	Zn	38	Ti	0.19	Ca	0.98
Sb	2	Th	12	Mo	1	V	89	Al	1.79
Hg	5	B	3	W	1	Ni	4	Ba	129
				Co	8	Cr	13	Sr	81

D-0255 Silicified meta-sediments with traces of pyrite, chalcopyrite and arsenopyrite (?) on south side of Big Creek, east of Revenue. Happy claims? (Lab - Bondar Clegg)

Au	1260	Se	0.4	Cu	49	Fe	5.08	K	0.06
Ag	1.3	Te	22.7	Pb	17	Mn	620	Na	0.08
As	24452	U	15	Zn	10	Ti	0.01	Ca	9.04
Sb	42	Th	8	Mo	2	V	3	Al	0.11
Hg	20	B	3	W	1	Ni	3	Ba	28
				Co	4	Cr	1	Sr	186

D-0064 Black, silica-cemented breccia. Float sample from ridge east of Bow Creek headwaters. (Lab - Bondar Clegg)

Au	2	Se	0.2	Cu	13	Fe	1.27	K	0.07
Ag	0.1	Te	0.2	Pb	14	Mn	422	Na	0.04
As	4	U	5	Zn	37	Ti	0.01	Ca	0.08
Sb	2	Th	2	Mo	1	V	11	Al	0.72
Hg	5	B	2	W	1	Ni	10	Ba	64
				Co	6	Cr	4	Sr	8

C-0260 N-S trending clay altered zone with variety of porphyry, altered country rock and qtz. vein over 1-2 m width. (Lab - Bondar Clegg)

Au	2	Se	0.2	Cu	28	Fe	0.86	K	0.07
Ag	0.4	Te	0.2	Pb	226	Mn	1044	Na	0.01
As	7	U	6	Zn	74	Ti	0.01	Ca	0.01
Sb	8	Th	10	Mo	3	V	9	Al	0.23
Hg	100	B	2	W	1	Ni	5	Ba	178
				Co	3	Cr	2	Sr	25

C-0264 Propylitically altered (?) K-feldspar-hornblende syenite with veinlets of epidote and magnetite. (Lab - Bondar Clegg)

Au	5	Se	0.2	Cu	14	Fe	2.59	K	0.06
Ag	0.1	Te	0.2	Pb	7	Mn	581	Na	0.08
As	67	U	5	Zn	55	Ti	0.10	Ca	0.47
Sb	2	Th	11	Mo	1	V	62	Al	0.58
Hg	5	B	5	W	1	Ni	3	Ba	48
				Co	5	Cr	6	Sr	33

C-0279 Propylitically altered (?) K-feldspar-hornblende syenite with veinlets of epidote and magnetite. (Lab - Bondar Clegg)

Au	1	Se	0.4	Cu	14	Fe	3.81	K	0.12
Ag	0.2	Te	0.2	Pb	8	Mn	699	Na	0.15
As	6	U	5	Zn	66	Ti	0.19	Ca	1.29
Sb	2	Th	4	Mo	1	V	110	Al	1.30
Hg	10	B	5	W	1	Ni	4	Ba	72
				Co	9	Cr	7	Sr	214

C-0284 Rusty weathering, locally brecciated and quartz flooded, banded quartz-mica schist. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	13	Fe	2.34	K	0.07
Ag	0.1	Te	0.2	Pb	13	Mn	375	Na	0.02
As	17	U	5	Zn	35	Ti	0.01	Ca	0.55
Sb	2	Th	9	Mo	1	V	21	Al	0.28
Hg	140	B	5	W	1	Ni	3	Ba	439
				Co	6	Cr	5	Sr	23

C-0313 Silicified, brecciated quartz-feldspar porphyry in saddle on west shoulder of Victoria Mtn. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	10	Fe	0.64	K	0.09
Ag	0.1	Te	0.2	Pb	16	Mn	110	Na	0.01
As	19	U	5	Zn	16	Ti	0.01	Ca	0.02
Sb	5	Th	7	Mo	1	V	10	Al	0.23
Hg	660	B	3	W	1	Ni	3	Ba	52
				Co	2	Cr	4	Sr	30

C-0313 Silicified, brecciated quartz-feldspar porphyry in saddle on west shoulder of Victoria Mtn. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	4	Fe	0.36	K	0.06
Ag	0.1	Te	0.2	Pb	4	Mn	62	Na	0.01
As	8	U	5	Zn	13	Ti	0.01	Ca	0.01
Sb	2	Th	6	Mo	1	V	5	Al	0.50
Hg	110	B	3	W	1	Ni	3	Ba	20
				Co	1	Cr	4	Sr	34

C-0414 Small quartz vein cuts basement, undeformed, no sulphide. East of Victoria Mtn. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	17	Fe	1.55	K	0.02
Ag	0.1	Te	0.2	Pb	14	Mn	84	Na	0.02
As	2	U	5	Zn	10	Ti	0.02	Ca	0.10
Sb	3	Th	1	Mo	1	V	12	Al	0.10
Hg	10	B	4	W	1	Ni	2	Ba	121
				Co	3	Cr	3	Sr	7

C-0446 East of Victoria Mtn., sample is fine-grained rhyolitic intrusive with trace pyrite. (Lab - Bondar Clegg)

Au	2	Se	0.2	Cu	4	Fe	0.43	K	0.14
Ag	0.1	Te	0.2	Pb	8	Mn	49	Na	0.04
As	5	U	5	Zn	191	Ti	0.01	Ca	0.07
Sb	2	Th	7	Mo	1	V	1	Al	0.32
Hg	5	B	5	W	1	Ni	1	Ba	123
				Co	1	Cr	1	Sr	17

C-0470 Revenue property trench near ridge road. Sample is of intrusive breccia, strongly pyritic with minor disseminated chalcopyrite and copper staining. (Lab - Bondar Clegg)

Au	66	Se	0.5	Cu	1576	Fe	1.97	K	0.13
Ag	1.4	Te	0.2	Pb	5	Mn	254	Na	0.03
As	9	U	5	Zn	31	Ti	0.01	Ca	0.90
Sb	2	Th	5	Mo	6	V	18	Al	0.26
Hg	5	B	2	W	4	Ni	6	Ba	521
				Co	2	Cr	5	Sr	34

C-0480 Antoniuk central breccia zone. Rusty weathering, white, aphanitic intrusive (?) with 1-2% disseminated pyrite cubes. (Lab - Bondar Clegg)

Au	127	Se	0.8	Cu	47	Fe	0.61	K	0.18
Ag	0.3	Te	0.6	Pb	127	Mn	21	Na	0.01
As	235	U	5	Zn	192	Ti	0.01	Ca	0.01
Sb	7	Th	6	Mo	4	V	1	Al	0.18
Hg	20	B	4	W	1	Ni	2	Ba	162
				Co	1	Cr	1	Sr	6

C-0486 North end Goldy property, trenches on ridge. Rusty, quartz veined and silicified siliceous schist (Yukon Group). (Lab - Bondar Clegg)

Au	3	Se	0.3	Cu	62	Fe	1.01	K	0.12
Ag	0.1	Te	0.2	Pb	6	Mn	135	Na	0.02
As	28	U	5	Zn	20	Ti	0.01	Ca	0.04
Sb	6	Th	27	Mo	1	V	3	Al	0.18
Hg	500	B	2	W	1	Ni	1	Ba	45
				Co	2	Cr	4	Sr	7

C-0486 North end Goldy property, trenches on ridge. Rusty, quartz veined and silicified siliceous schist (Yukon Group). (Pyritic intrusive?) (Lab - Bondar Clegg)

Au	9	Se	0.2	Cu	5	Fe	1.02	K	0.06
Ag	0.1	Te	0.2	Pb	28	Mn	762	Na	0.01
As	85	U	5	Zn	126	Ti	0.01	Ca	0.08
Sb	2	Th	14	Mo	1	V	15	Al	0.37
Hg	480	B	3	W	1	Ni	3	Ba	313
				Co	9	Cr	5	Sr	9

C-0486 North end Goldy property, trenches on ridge. Rusty, quartz veined and silicified siliceous schist (Yukon Group). (Pyritic intrusive?) (Lab - Bondar Clegg)

Au	2	Se	0.2	Cu	5	Fe	2.76	K	0.01
Ag	0.1	Te	0.2	Pb	16	Mn	24	Na	0.01
As	50	U	5	Zn	106	Ti	0.01	Ca	0.13
Sb	14	Th	5	Mo	4	V	5	Al	0.41
Hg	1100	B	3	W	1	Ni	4	Ba	10
				Co	5	Cr	2	Sr	17

C-0471 Revenue Property. Fine grained, lightly pyritic, felsic dike cutting coarse grained granodiorite. (Lab - Bondar Clegg)

Au	6	Se	0.2	Cu	46	Fe	1.04	K	0.12
Ag	0.1	Te	0.2	Pb	6	Mn	63	Na	0.22
As	4	U	5	Zn	8	Ti	0.04	Ca	0.66
Sb	2	Th	16	Mo	2	V	14	Al	1.29
Hg	5	B	5	W	1	Ni	2	Ba	32
				Co	2	Cr	3	Sr	23

C-0493 South end Goldy property. Rusty weathering, pyritic quartz-feldspar porphyry dyke. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	3	Fe	0.73	K	0.19
Ag	0.2	Te	0.2	Pb	75	Mn	48	Na	0.01
As	79	U	5	Zn	139	Ti	0.01	Ca	0.09
Sb	17	Th	17	Mo	1	V	3	Al	0.27
Hg	2800	B	6	W	1	Ni	1	Ba	57
				Co	1	Cr	2	Sr	8

C-0508 Goldy property, main trenches. 2-3% disseminated pyrite in rhyolitic dykes cutting rusty and silicified basement schist and gneiss. Quartz veins parallel foliation in basem

Au	310	Se	0.8	Cu	8	Fe	1.16	K	0.16
Ag	0.5	Te	2.2	Pb	41	Mn	20	Na	0.01
As	1276	U	5	Zn	131	Ti	0.01	Ca	0.02
Sb	10	Th	10	Mo	6	V	3	Al	0.17
Hg	1500	B	4	W	1	Ni	2	Ba	60
				Co	2	Cr	3	Sr	19

C-0517 Pyritic rhyolite to quartz-feldspar porphyry dykes cutting altered granodiorite (possibly Coffee Creek granite). (Lab - Bondar Clegg)

Au	260	Se	0.4	Cu	11	Fe	1.24	K	0.13
Ag	2.1	Te	5.6	Pb	43	Mn	90	Na	0.01
As	3572	U	5	Zn	72	Ti	0.01	Ca	0.09
Sb	13	Th	4	Mo	8	V	4	Al	0.41
Hg	70	B	6	W	1	Ni	4	Ba	56
				Co	4	Cr	3	Sr	18

C-0518 Core samples from Laforma mine of pyritic, quartz-feldspar porphyry dyke, sheared and clay altered, graphite on some fracture faces. (Lab - Bondar Clegg)

Au	21	Se	0.2	Cu	5	Fe	0.50	K	0.11
Ag	0.3	Te	0.4	Pb	15	Mn	35	Na	0.02
As	26	U	5	Zn	43	Ti	0.01	Ca	0.02
Sb	3	Th	6	Mo	8	V	1	Al	0.20
Hg	10	B	6	W	1	Ni	2	Ba	197
				Co	1	Cr	2	Sr	18

C-0519 Near Antoniuk camp, rhyolitic intrusive, locally flow-banded and vuggy, other places looks tuffaceous (breccia?), quartz veined and rusty weathering. (Lab - Bond

Au	220	Se	0.9	Cu	17	Fe	1.38	K	0.18
Ag	3.4	Te	0.3	Pb	82	Mn	45	Na	0.01
As	123	U	5	Zn	46	Ti	0.01	Ca	0.02
Sb	7	Th	3	Mo	36	V	2	Al	0.21
Hg	20	B	3	W	1	Ni	2	Ba	738
				Co	1	Cr	4	Sr	33

C-0520 Road cut north of Antoniuk camp. Rusty quartz-feldspar porphyry to breccia (similar to C-0519) cut by domed siliceous intrusive with disseminated pyrite. (Lab - Bondar

Au	15	Se	0.2	Cu	5	Fe	0.75	K	0.14
Ag	0.5	Te	0.2	Pb	105	Mn	1313	Na	0.04
As	17	U	5	Zn	324	Ti	0.01	Ca	1.17
Sb	2	Th	7	Mo	6	V	1	Al	0.21
Hg	10	B	3	W	1	Ni	3	Ba	83
				Co	2	Cr	2	Sr	578

C-0520 Road cut north of Antoniuk camp. Rusty quartz-feldspar porphyry to breccia (similar to C-0519) cut by domed siliceous intrusive with disseminated pyrite. (Lab - Bondar

Au	390	Se	0.2	Cu	9	Fe	0.58	K	0.14
Ag	1.6	Te	0.4	Pb	153	Mn	33	Na	0.02
As	44	U	5	Zn	66	Ti	0.01	Ca	0.01
Sb	2	Th	5	Mo	5	V	1	Al	0.27
Hg	20	B	4	W	1	Ni	2	Ba	1214
				Co	1	Cr	2	Sr	29

C-0542 West of Seymour Creek between La Forma and Caribou Creek, white to rusty weathering rhyolitic quartz-feldspar porphyry cut by minor quartz veinlets. (Lab - Bondar Clegg)

Au	1	Se	0.3	Cu	3	Fe	0.56	K	0.12
Ag	0.1	Te	0.2	Pb	9	Mn	153	Na	0.04
As	6	U	5	Zn	18	Ti	0.01	Ca	0.02
Sb	2	Th	16	Mo	1	V	1	Al	0.30
Hg	40	B	2	W	1	Ni	2	Ba	97
				Co	1	Cr	3	Sr	5

C-0547 Granodiorite showing mild propylitic alteration, cut by quartz porphyry with brecciation and more intense alteration along contact. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	3	Fe	1.52	K	0.29
Ag	0.1	Te	0.2	Pb	9	Mn	295	Na	0.11
As	3	U	5	Zn	42	Ti	0.15	Ca	0.74
Sb	4	Th	1	Mo	1	V	33	Al	1.32
Hg	5	B	5	W	1	Ni	5	Ba	95
				Co	3	Cr	9	Sr	136

C-0547 Granodiorite showing mild propylitic alteration, cut by quartz porphyry with brecciation and more intense alteration along contact. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	3	Fe	1.38	K	0.16
Ag	0.1	Te	0.2	Pb	3	Mn	254	Na	0.07
As	2	U	5	Zn	26	Ti	0.11	Ca	0.51
Sb	2	Th	1	Mo	1	V	22	Al	0.94
Hg	10	B	4	W	1	Ni	5	Ba	164
				Co	5	Cr	10	Sr	71

C-0547 Granodiorite showing mild propylitic alteration, cut by quartz porphyry with brecciation and more intense alteration along contact. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	4	Fe	0.43	K	0.10
Ag	0.1	Te	0.2	Pb	2	Mn	92	Na	0.10
As	4	U	5	Zn	14	Ti	0.02	Ca	0.29
Sb	2	Th	1	Mo	1	V	3	Al	0.51
Hg	5	B	3	W	1	Ni	3	Ba	74
				Co	1	Cr	5	Sr	39

C-0617 Small outcrop of propylitically altered granodiorite - unusual intrusive which may or may not be part of Mt. Nansen Batholith. (Lab - Bondar Clegg)

Au	5	Se	0.3	Cu	31	Fe	2.44	K	0.05
Ag	0.1	Te	0.2	Pb	6	Mn	500	Na	0.06
As	2	U	5	Zn	48	Ti	0.08	Ca	0.78
Sb	2	Th	13	Mo	1	V	38	Al	1.46
Hg	10	B	5	W	1	Ni	5	Ba	64
				Co	8	Cr	10	Sr	107

C-0716 Big Creek Granite cut by extensive pink rhyolitic intrusive dykes. (Lab - Bondar Clegg)

Au	3	Se	0.2	Cu	4	Fe	0.49	K	0.16
Ag	0.1	Te	0.2	Pb	12	Mn	78	Na	0.03
As	3	U	5	Zn	6	Ti	0.01	Ca	0.03
Sb	2	Th	27	Mo	1	V	1	Al	0.20
Hg	5	B	2	W	1	Ni	2	Ba	44
				Co	1	Cr	4	Sr	8

C-0739 Vuggy, pink, Bow Cr. Granite, rusty weathering, cut by quartz veinlets. (Lab - Bondar Clegg)

Au	2	Se	0.2	Cu	6	Fe	0.74	K	0.11
Ag	0.1	Te	0.2	Pb	5	Mn	41	Na	0.05
As	3	U	5	Zn	42	Ti	0.01	Ca	0.01
Sb	2	Th	18	Mo	2	V	3	Al	0.23
Hg	10	B	2	W	1	Ni	2	Ba	68
				Co	1	Cr	2	Sr	10

C-0789 White, rhyolitic, quartz-cemented breccia. (Lab - Bondar Clegg)

Au	5	Se	0.4	Cu	4	Fe	0.35	K	0.06
Ag	0.1	Te	0.2	Pb	9	Mn	35	Na	0.03
As	11	U	5	Zn	18	Ti	0.01	Ca	0.01
Sb	2	Th	5	Mo	1	V	3	Al	0.17
Hg	30	B	2	W	1	Ni	2	Ba	33
				Co	1	Cr	2	Sr	21

C-0800 Bow Creek Granite, fine-grained, miarolitic, hematitic, cut by minor quartz veinlets. (Lab - Bondar Clegg)

Au	5	Se	0.2	Cu	4	Fe	0.32	K	0.09
Ag	0.1	Te	0.2	Pb	6	Mn	95	Na	0.01
As	17	U	5	Zn	18	Ti	0.01	Ca	0.01
Sb	2	Th	10	Mo	1	V	1	Al	0.24
Hg	20	B	2	W	1	Ni	2	Ba	42
				Co	1	Cr	2	Sr	18

C-0801 Freegold syenite, adjacent to Bow Creek Granite contact, highly fractured and brecciated with veinlets of epidote and magnetite. (Lab - Bondar Clegg)

Au	5	Se	0.5	Cu	108	Fe	3.26	K	0.13
Ag	0.5	Te	0.2	Pb	11	Mn	880	Na	0.08
As	2	U	5	Zn	95	Ti	0.15	Ca	1.41
Sb	2	Th	9	Mo	9	V	75	Al	1.06
Hg	10	B	6	W	1	Ni	5	Ba	57
				Co	10	Cr	8	Sr	135

C-0830 White to pink rhyolitic crystal-lithic tuff, somewhat silicified appearance. (Lab - Bondar Clegg)

Au	7	Se	0.2	Cu	4	Fe	0.41	K	0.11
Ag	0.1	Te	0.2	Pb	9	Mn	139	Na	0.03
As	3	U	5	Zn	15	Ti	0.01	Ca	0.07
Sb	2	Th	15	Mo	1	V	1	Al	0.24
Hg	5	B	2	W	1	Ni	2	Ba	74
				Co	1	Cr	3	Sr	6

C-0848 Altered rhyolitic crystal-lithic tuff, rusty weathering with disseminated pyrite, possibly silicified. (Lab - Bondar Clegg)

Au	5	Se	0.2	Cu	4	Fe	0.50	K	0.13
Ag	0.1	Te	0.2	Pb	15	Mn	66	Na	0.05
As	113	U	5	Zn	8	Ti	0.01	Ca	0.02
Sb	2	Th	13	Mo	1	V	1	Al	0.23
Hg	5	B	2	W	1	Ni	3	Ba	72
				Co	1	Cr	4	Sr	6

C-0868 Devitrified rhyolite glass. (Lab - Bondar Clegg)

Au	7	Se	0.2	Cu	191	Fe	3.66	K	0.07
Ag	0.3	Te	0.7	Pb	10	Mn	378	Na	0.07
As	67	U	8	Zn	27	Ti	0.01	Ca	5.60
Sb	36	Th	8	Mo	1	V	39	Al	0.38
Hg	5	B	7	W	1	Ni	5	Ba	27
				Co	10	Cr	2	Sr	135

C-0876 Big Creek Granite, sheared and altered along base of north valley wall, some carbonate zones. (Lab - Bondar Clegg)

Au	3	Se	0.2	Cu	5	Fe	0.71	K	0.16
Ag	0.1	Te	0.2	Pb	7	Mn	581	Na	0.09
As	2	U	5	Zn	13	Ti	0.01	Ca	2.28
Sb	2	Th	19	Mo	1	V	4	Al	0.22
Hg	5	B	2	W	1	Ni	3	Ba	169
				Co	1	Cr	5	Sr	77

C-0876 Big Creek Granite, sheared and altered along base of north valley wall, some carbonate zones. (Lab - Bondar Clegg)

Au	5	Se	0.2	Cu	4	Fe	1.15	K	0.14
Ag	0.1	Te	0.2	Pb	14	Mn	547	Na	0.06
As	2	U	5	Zn	30	Ti	0.01	Ca	0.74
Sb	2	Th	33	Mo	1	V	7	Al	0.20
Hg	5	B	2	W	1	Ni	3	Ba	54
				Co	2	Cr	5	Sr	31

C-0876 Big Creek Granite, sheared and altered along base of north valley wall, some carbonate zones. (Lab - Bondar Clegg)

Au	6	Se	0.3	Cu	4	Fe	1.01	K	0.13
Ag	0.1	Te	0.2	Pb	13	Mn	408	Na	0.04
As	4	U	5	Zn	23	Ti	0.01	Ca	0.33
Sb	2	Th	30	Mo	1	V	5	Al	0.17
Hg	5	B	2	W	1	Ni	2	Ba	66
				Co	2	Cr	4	Sr	16

C-0940 Feldspar porphyry west of Granite Mountain containing extensive quartz stockwork with silicification. (Lab - Bondar Clegg)

Au	7	Se	0.4	Cu	4	Fe	1.03	K	0.08
Ag	0.2	Te	0.2	Pb	7	Mn	160	Na	0.32
As	40	U	5	Zn	19	Ti	0.08	Ca	1.14
Sb	4	Th	5	Mo	1	V	23	Al	1.48
Hg	5	B	4	W	1	Ni	3	Ba	62
				Co	2	Cr	5	Sr	95

C-0940 Feldspar porphyry west of Granite Mountain containing extensive quartz stockwork with silicification. (Lab - Bondar Clegg)

Au	5	Se	0.5	Cu	3	Fe	1.78	K	0.09
Ag	0.1	Te	0.2	Pb	5	Mn	128	Na	0.32
As	70	U	5	Zn	18	Ti	0.17	Ca	1.22
Sb	2	Th	5	Mo	1	V	43	Al	1.47
Hg	5	B	6	W	1	Ni	6	Ba	108
				Co	3	Cr	31	Sr	115

C-0940 Feldspar porphyry west of GraniteMountain containing extensive quartz stockwork with silicification. (Lab - Bondar Clegg)

Au	5	Se	0.3	Cu	3	Fe	1.80	K	0.11
Ag	0.2	Te	0.2	Pb	5	Mn	227	Na	0.16
As	56	U	5	Zn	24	Ti	0.15	Ca	2.27
Sb	2	Th	6	Mo	1	V	60	Al	0.86
Hg	5	B	6	W	1	Ni	9	Ba	41
				Co	5	Cr	30	Sr	46

C-0940 Feldspar porphyry west of Granite Mountain containing extensive quartz stockwork with silicification. (Lab - Bondar Clegg)

Au	6	Se	0.2	Cu	4	Fe	1.18	K	0.09
Ag	0.1	Te	0.2	Pb	9	Mn	122	Na	0.25
As	51	U	5	Zn	19	Ti	0.11	Ca	0.89
Sb	2	Th	4	Mo	1	V	28	Al	1.33
Hg	5	B	5	W	1	Ni	3	Ba	121
				Co	3	Cr	4	Sr	109

C-1017 Grussy zone in Triassic foliated granodiorite along Big Creek. Sample from zone of rusty crosscutting veinlets. (Lab - Bondar Clegg)

Au	3	Se	0.4	Cu	4	Fe	2.56	K	0.12
Ag	0.1	Te	0.2	Pb	3	Mn	695	Na	0.07
As	8	U	5	Zn	65	Ti	0.02	Ca	2.05
Sb	2	Th	4	Mo	1	V	57	Al	0.76
Hg	5	B	7	W	1	Ni	5	Ba	43
				Co	6	Cr	7	Sr	88

C-1017 Grussy zone in Triassic foliated granodiorite along Big Creek. Loose sand from possible argillically altered zone. (Lab - Bondar Clegg)

Au	7	Se	0.5	Cu	3	Fe	2.74	K	0.30
Ag	0.1	Te	0.2	Pb	3	Mn	490	Na	0.05
As	3	U	5	Zn	65	Ti	0.06	Ca	0.42
Sb	4	Th	5	Mo	1	V	51	Al	0.62
Hg	100	B	8	W	1	Ni	4	Ba	129
				Co	7	Cr	7	Sr	33

C-1017 Grussy zone in Triassic foliated granodiorite along Big Creek. Rock fragments from possible argillically altered zone. (Lab - Bondar Clegg)

Au	1	Se	0.9	Cu	3	Fe	1.53	K	0.25
Ag	0.2	Te	0.2	Pb	3	Mn	350	Na	0.06
As	2	U	5	Zn	38	Ti	0.05	Ca	0.69
Sb	2	Th	3	Mo	1	V	29	Al	0.50
Hg	20	B	3	W	1	Ni	4	Ba	118
				Co	4	Cr	6	Sr	59

C-1017 Argillic to phyllic alteration in granodiorite adjacent to grussy zone. Possible fault zone. (Lab - Bondar Clegg)

Au	1	Se	0.3	Cu	3	Fe	1.28	K	0.09
Ag	0.3	Te	0.2	Pb	3	Mn	461	Na	0.06
As	4	U	5	Zn	34	Ti	0.01	Ca	1.71
Sb	2	Th	3	Mo	1	V	19	Al	0.31
Hg	80	B	3	W	1	Ni	3	Ba	100
				Co	4	Cr	4	Sr	133

C-1059 Birch Tree Showing. Rusty weathering, quartz-veined and brecciated rhyolitic intrusive, locally quartz-feldspar porphyry, sometimes vuggy, yellow Fe oxide precipitate on frac's

Au	8	Se	0.2	Cu	52	Fe	0.75	K	0.22
Ag	2.8	Te	0.3	Pb	202	Mn	39	Na	0.01
As	40	U	5	Zn	13	Ti	0.01	Ca	0.04
Sb	13	Th	11	Mo	26	V	3	Al	0.36
Hg	40	B	4	W	1	Ni	4	Ba	136
				Co	1	Cr	7	Sr	76

C-1059 Birch Tree Showing. Rusty weathering, quartz-veined and brecciated rhyolitic intrusive, locally quartz-feldspar porphyry, sometimes vuggy, yellow Fe oxide precipitate on frac's

Au	1	Se	0.5	Cu	11	Fe	0.93	K	0.26
Ag	2.2	Te	2.1	Pb	179	Mn	41	Na	0.01
As	25	U	5	Zn	4	Ti	0.01	Ca	0.03
Sb	2	Th	5	Mo	3	V	2	Al	0.27
Hg	20	B	4	W	1	Ni	5	Ba	191
				Co	1	Cr	7	Sr	13

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C-1059 Birch Tree Showing. Rusty weathering, quartz-veined and brecciated rhyolitic intrusive, locally quartz-feldspar porphyry, sometimes vuggy, yellow Fe oxide precipitate on frac's

Au	2	Se	0.7	Cu	15	Fe	0.93	K	0.27
Ag	1.3	Te	1.1	Pb	133	Mn	42	Na	0.01
As	28	U	8	Zn	4	Ti	0.01	Ca	0.04
Sb	4	Th	7	Mo	3	V	3	Al	0.32
Hg	5	B	8	W	1	Ni	2	Ba	105
				Co	1	Cr	7	Sr	144

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C-1108 Nucleus property trenches. Silicified schist, quartz veined and locally brecciated, very rusty weathering, cut by minor quartz-feldspar porphyry dykes. (Lab - Bondar Clegg)

Au	310	Se	0.4	Cu	40	Fe	0.43	K	0.09
Ag	0.6	Te	0.8	Pb	4	Mn	15	Na	0.01
As	33	U	5	Zn	1	Ti	0.01	Ca	0.02
Sb	3	Th	14	Mo	1	V	1	Al	0.26
Hg	10	B	20	W	1	Ni	1	Ba	24
				Co	1	Cr	3	Sr	7

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C-1167 Jasper matrix from breccia zone within Mount Nansen andesite, west of Mount Nansen. (Lab - Bondar Clegg)

Au	35	Se	0.4	Cu	22	Fe	8.19	K	0.01
Ag	0.1	Te	0.2	Pb	8	Mn	592	Na	0.07
As	4	U	5	Zn	24	Ti	0.05	Ca	0.66
Sb	2	Th	2	Mo	5	V	242	Al	1.00
Hg	20	B	11	W	5	Ni	6	Ba	27
				Co	8	Cr	9	Sr	34

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C-1168 Thin-bedded, siliceous basement rocks cut by quartz and epidote veinlets, possibly skarnified. (Lab - Bondar Clegg)

Au	1	Se	0.2	Cu	26	Fe	0.49	K	0.12
Ag	0.1	Te	0.2	Pb	4	Mn	93	Na	0.40
As	8	U	5	Zn	22	Ti	0.10	Ca	1.42
Sb	2	Th	1	Mo	1	V	24	Al	1.97
Hg	5	B	2	W	2	Ni	8	Ba	60
				Co	3	Cr	9	Sr	96

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C-1168 Massive magnetite in thin (1-2 cm) beds within skarn zone. (Lab - Bondar Clegg)

Au	1	Se	1.2	Cu	7	Fe	41.99	K	0.05
Ag	0.1	Te	0.2	Pb	20	Mn	583	Na	0.07
As	9	U	5	Zn	33	Ti	0.02	Ca	0.12
Sb	3	Th	4	Mo	2	V	19	Al	0.30
Hg	50	B	15	W	1	Ni	3	Ba	20
				Co	10	Cr	1	Sr	3

C-1168 Tremolite-epidote(?) skarn. (Lab - Bondar Clegg)

Au	3	Se	0.3	Cu	5	Fe	0.82	K	0.02
Ag	0.1	Te	0.2	Pb	4	Mn	160	Na	0.39
As	11	U	5	Zn	24	Ti	0.06	Ca	5.37
Sb	2	Th	2	Mo	1	V	7	Al	6.06
Hg	10	B	2	W	4	Ni	2	Ba	23
				Co	1	Cr	3	Sr	154

C-0898 Pink weathring quartz-feldspar porphyry, north side Big Creek, strongly veined with epidote. (Lab - Bondar Clegg)

Au	4	Se	0.3	Cu	3	Fe	1.60	K	0.05
Ag	0.2	Te	0.2	Pb	2	Mn	233	Na	0.07
As	2	U	5	Zn	25	Ti	0.11	Ca	0.76
Sb	3	Th	16	Mo	1	V	34	Al	1.14
Hg	5	B	4	W	1	Ni	10	Ba	37
				Co	8	Cr	13	Sr	65

C-0017 Altered porphyry from western side of Rusk property. (Lab - Bondar Clegg)

Au	4	Se	0.6	Cu	41	Fe	2.59	K	0.61
Ag	1.1	Te	0.2	Pb	88	Mn	1029	Na	0.12
As	2	U	5	Zn	409	Ti	0.19	Ca	0.36
Sb	3	Th	10	Mo	72	V	42	Al	1.31
Hg	5	B	6	W	1	Ni	7	Ba	101
				Co	4	Cr	12	Sr	18

C-0017 Altered porphyry from western side of Rusk property. (Lab - Bondar Clegg)

Au	4	Se	0.2	Cu	48	Fe	2.40	K	0.94
Ag	1.6	Te	0.2	Pb	81	Mn	1214	Na	0.20
As	3	U	5	Zn	315	Ti	0.26	Ca	0.55
Sb	2	Th	9	Mo	25	V	61	Al	1.92
Hg	5	B	2	W	2	Ni	8	Ba	139
				Co	4	Cr	15	Sr	47

C-0189 Finely bedded meta-chert or quartzite, Subunit 1a, western edge Mount Nansen volcanic complex. (Lab - Acme Analytical)

Au	39	Se	10.0	Cu	21	Fe	0.50	K	
Ag	0.5	Te	0.2	Pb	35	Mn	59	Na	
As	21	U	4	Zn	14	Ti		Ca	
Sb	2	Th	28	Mo	2	V		Al	
Hg	20	B	25	W	6	Ni	50	Ba	980
				Co	10	Cr	150	Sr	78

C-0441 Feldspar-hornblende porphyry, Subunit 9a, slightly altered. From east of Victoria Mountain. (Lab - Acme Analytical)

Au	10	Se	10.0	Cu	23	Fe	2.30	K	
Ag	0.5	Te	0.2	Pb	24	Mn	554	Na	
As	7	U	5	Zn	79	Ti		Ca	
Sb	1	Th	16	Mo	2	V		Al	
Hg	10	B	20	W	2	Ni	50	Ba	1400
				Co	10	Cr	50	Sr	310

C-0969 Highly altered foliated granodiorite, quartz stockwork, in Revenue Creek below breccia zone. Part of porphyry system. (Lab - Acme Analytical)

Au	33	Se	10.0	Cu	75	Fe	1.10	K	
Ag	0.7	Te	0.2	Pb	12	Mn	54	Na	
As	43	U	14	Zn	9	Ti		Ca	
Sb	2	Th	31	Mo	2	V		Al	
Hg	10	B	20	W	7	Ni	50	Ba	830
				Co	10	Cr	50	Sr	125

C-0969 Porphyry dyke cutting through area of sample 969a. (Lab - Acme Analytical)

Au	9	Se	10.0	Cu	59	Fe	1.70	K	
Ag	0.5	Te	0.2	Pb	9	Mn	103	Na	
As	27	U	11	Zn	9	Ti		Ca	
Sb	2	Th	23	Mo	5	V		Al	
Hg	5	B	15	W	5	Ni	50	Ba	5100
				Co	10	Cr	50	Sr	265

C-0971 Highly altered (no mafics, Coffee Creek?) granitic rock cut by quartz veinlets with minor pyrite +/- chalcopyrite. (Lab - Acme Analytical)

Au	55	Se	10.0	Cu	341	Fe	4.30	K	
Ag	1.5	Te	0.2	Pb	8	Mn	176	Na	
As	43	U	7	Zn	18	Ti		Ca	
Sb	1	Th	23	Mo	66	V		Al	
Hg	5	B	15	W	16	Ni	50	Ba	1400
				Co	16	Cr	50	Sr	450

C-0973 Medium-grained feldspar porphyry dyke, strongly fractured, minor disseminated pyrite. Revenue property. (Lab - Acme Analytical)

Au	10	Se	10.0	Cu	31	Fe	0.90	K	
Ag	0.6	Te	0.2	Pb	8	Mn	47	Na	
As	6	U	8	Zn	7	Ti		Ca	
Sb	1	Th	36	Mo	2	V		Al	
Hg	5	B	10	W	2	Ni	50	Ba	730
				Co	10	Cr	50	Sr	795

C-0973 Medium-grained feldspar porphyry dyke, strongly fractured, minor disseminated pyrite. Revenue property. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	8	Fe	0.50	K	
Ag	0.7	Te	0.2	Pb	5	Mn	39	Na	
As	12	U	4	Zn	3	Ti		Ca	
Sb	3	Th	18	Mo	2	V		Al	
Hg	5	B	20	W	2	Ni	50	Ba	970
				Co	10	Cr	50	Sr	385

C-0991 Relatively fresh granodiorite, unit 5a, southeastern side of Revenue property. (Lab - Acme Analytical)

Au	19	Se	10.0	Cu	17	Fe	2.70	K	
Ag	0.5	Te	0.2	Pb	7	Mn	259	Na	
As	10	U	6	Zn	19	Ti		Ca	
Sb	2	Th	19	Mo	2	V		Al	
Hg	5	B	15	W	2	Ni	50	Ba	2600
				Co	10	Cr	50	Sr	225

C-1000 Lightly foliated, Cu-stained granodiorite from trenches in northeastern corner Stoddart Creek sheet. (UKHM) (Lab - Acme Analytical)

Au	14	Se	10.0	Cu	806	Fe	0.90	K	
Ag	0.5	Te	0.2	Pb	6	Mn	99	Na	
As	2	U	1	Zn	16	Ti		Ca	
Sb	0	Th	2	Mo	2	V		Al	
Hg	5	B	10	W	2	Ni	50	Ba	2800
				Co	10	Cr	50	Sr	425

C-1039 Granitic rock (5a or 5c) from shoulder, northwest of Freegold Mountain. Rusty and somewhat altered adjacent to porphyry dyke. (Lab - Acme Analytical)

Au	12	Se	10.0	Cu	76	Fe	0.70	K	
Ag	0.7	Te	0.2	Pb	14	Mn	50	Na	
As	45	U	2	Zn	7	Ti		Ca	
Sb	12	Th	29	Mo	2	V		Al	
Hg	50	B	40	W	4	Ni	50	Ba	780
				Co	10	Cr	50	Sr	150

C-1063 Rusty, pink weathering biotite granite (Unit 8), north side Big Creek. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	50	Fe	2.90	K	
Ag	0.5	Te	0.2	Pb	12	Mn	228	Na	
As	8	U	7	Zn	54	Ti		Ca	
Sb	1	Th	22	Mo	2	V		Al	
Hg	5	B	65	W	3	Ni	50	Ba	1000
				Co	13	Cr	170	Sr	43

C-1078 Foliated granodiorite along Big Creek, eastern Stoddart Creek map area. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	10	Fe	3.40	K	
Ag	0.9	Te	0.2	Pb	5	Mn	367	Na	
As	1	U	1	Zn	65	Ti		Ca	
Sb	0	Th	3	Mo	2	V		Al	
Hg	5	B	10	W	2	Ni	50	Ba	1100
				Co	10	Cr	50	Sr	815

C-1100 Klazan property. Rusty, pyritic scree, possibly felsic Mount Nansen pyroclastics. (Lab - Acme Analytical)

Au	54	Se	10.0	Cu	12	Fe	0.50	K	
Ag	5.5	Te	0.2	Pb	79	Mn	113	Na	
As	23	U	2	Zn	25	Ti		Ca	
Sb	125	Th	6	Mo	53	V		Al	
Hg	185	B	35	W	5	Ni	50	Ba	1900
				Co	10	Cr	130	Sr	275

C-1101 Klazan property. Siliceous quartz-feldspar porphyry, few percent pyrite disseminated and in veinlets, locally brecciated. (Lab - Acme Analytical)

Au	33	Se	10.0	Cu	6	Fe	0.80	K	
Ag	1.2	Te	0.2	Pb	40	Mn	13	Na	
As	31	U	2	Zn	9	Ti		Ca	
Sb	29	Th	7	Mo	29	V		Al	
Hg	60	B	35	W	6	Ni	50	Ba	2800
				Co	10	Cr	50	Sr	535

C-1103 Klazan property. Quartz-feldspar porphyry, highly altered, 5% disseminated pyrite. (Lab - Acme Analytical)

Au	210	Se	10.0	Cu	210	Fe	4.00	K	
Ag	2.0	Te	1.6	Pb	42	Mn	658	Na	
As	104	U	2	Zn	477	Ti		Ca	
Sb	8	Th	5	Mo	2	V		Al	
Hg	25	B	20	W	4	Ni	50	Ba	760
				Co	10	Cr	120	Sr	460

C-1104 Klazan property. Quartz stockwork zone collected from drill core. (Lab - Acme Analytical)

Au	100	Se	10.0	Cu	25	Fe	1.30	K	
Ag	9.8	Te	0.6	Pb	124	Mn	27	Na	
As	64	U	1	Zn	14	Ti		Ca	
Sb	28	Th	4	Mo	59	V		Al	
Hg	65	B	25	W	12	Ni	50	Ba	690
				Co	10	Cr	50	Sr	290

C-1110 Nucleus property. Breccia zone within meta-sediments. Similar appearance to Revenue breccia. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	7	Fe	0.50	K	
Ag	0.7	Te	0.2	Pb	5	Mn	10	Na	
As	96	U	1	Zn	1	Ti		Ca	
Sb	33	Th	9	Mo	2	V		Al	
Hg	5	B	25	W	2	Ni	50	Ba	950
				Co	10	Cr	50	Sr	83

C-1117 Fresh biotite granite, Unit 8a, Seymour Creek road. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	8	Fe	1.90	K	
Ag	0.5	Te	0.2	Pb	13	Mn	337	Na	
As	11	U	4	Zn	37	Ti		Ca	
Sb	1	Th	24	Mo	2	V		Al	
Hg	20	B	15	W	2	Ni	50	Ba	1300
				Co	10	Cr	50	Sr	460

C-1139 Mottled (chloritic), pink biotite granophyre, Unit 8b, from north of Victoria Mountain. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	1	Fe	0.50	K	
Ag	0.5	Te	0.2	Pb	7	Mn	43	Na	
As	16	U	6	Zn	12	Ti		Ca	
Sb	2	Th	19	Mo	2	V		Al	
Hg	10	B	25	W	2	Ni	50	Ba	1500
				Co	10	Cr	50	Sr	70

C-1146 Fresh biotite-clinopyroxene diorite, ridge north of Victoria Mountain. (Lab - Acme Analytical)

Au	18	Se	10.0	Cu	58	Fe	3.50	K	
Ag	0.5	Te	0.2	Pb	17	Mn	206	Na	
As	3	U	6	Zn	60	Ti		Ca	
Sb	0	Th	22	Mo	3	V		Al	
Hg	15	B	20	W	2	Ni	50	Ba	1700
				Co	13	Cr	160	Sr	345

C-1150 Mount Nansen. Banded felsic crystal tuff, west of peak. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	3	Fe	0.50	K			
Ag	0.5	Te	0.2	Pb	13	Mn	313	Na			
As	5	U	10	Zn	23	Ti		Ca			
Sb	6	Th	34	Mo	2	V		Al			
Hg	15	B	15	W	2	Ni	50	Ba	610		
				Co	10	Cr	50	Sr	105		

C-1161 Fresh, feldspar porphyritic andesite, ridge south of Mount Nansen. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	14	Fe	4.00	K	
Ag	0.5	Te	0.2	Pb	12	Mn	488	Na	
As	5	U	4	Zn	59	Ti		Ca	
Sb	1	Th	13	Mo	2	V		Al	
Hg	10	B	20	W	3	Ni	50	Ba	1000
				Co	12	Cr	50	Sr	84

C-1169 Feldspar-hornblende porphyry intrusive adjacent to newly discovered magnetite skarn, western edge Mount Nansen complex. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	18	Fe	1.40	K	
Ag	0.5	Te	0.2	Pb	10	Mn	117	Na	
As	2	U	4	Zn	36	Ti		Ca	
Sb	1	Th	22	Mo	2	V		Al	
Hg	5	B	10	W	2	Ni	50	Ba	1700
				Co	10	Cr	50	Sr	165

C-1174 Quartz-feldspar porphyry dyke, above Victoria Creek east of Mount Nansen. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	2	Fe	0.50	K	
Ag	1.2	Te	0.2	Pb	28	Mn	36	Na	
As	11	U	4	Zn	7	Ti		Ca	
Sb	14	Th	19	Mo	2	V		Al	
Hg	20	B	35	W	2	Ni	50	Ba	1900
				Co	10	Cr	50	Sr	410

C-1176 Nucleus property - silicified and brecciated quartz-feldspar porphyry. (Lab - Acme Analytical)

Au	3000	Se	10.0	Cu	118	Fe	0.70	K	
Ag	4.6	Te	2.2	Pb	28	Mn	28	Na	
As	178	U	6	Zn	5	Ti		Ca	
Sb	40	Th	13	Mo	2	V		Al	
Hg	15	B	20	W	12	Ni	50	Ba	2300
				Co	10	Cr	50	Sr	260

C-1177 Nucleus property - silicified meta-sediments. (Lab - Acme Analytical)

Au	240	Se	10.0	Cu	69	Fe	0.80	K	
Ag	0.7	Te	0.5	Pb	19	Mn	24	Na	
As	117	U	2	Zn	2	Ti		Ca	
Sb	17	Th	26	Mo	2	V		Al	
Hg	10	B	20	W	3	Ni	50	Ba	1600
				Co	10	Cr	50	Sr	785

C-1178 Nucleus property - altered quartz-feldspar porphyry. (Lab - Acme Analytical)

Au	89	Se	10.0	Cu	153	Fe	0.60	K	
Ag	0.7	Te	0.2	Pb	15	Mn	24	Na	
As	981	U	4	Zn	2	Ti		Ca	
Sb	32	Th	17	Mo	5	V		Al	
Hg	30	B	25	W	2	Ni	50	Ba	1700
				Co	10	Cr	50	Sr	

C-1179 Rusk property - felsic volcanic rock. (Lab - Acme Analytical)

Au	100	Se	10.0	Cu	4	Fe	0.50	K	
Ag	2.0	Te	0.2	Pb	18	Mn	90	Na	
As	170	U	4	Zn	17	Ti		Ca	
Sb	9	Th	21	Mo	5	V		Al	
Hg	65	B	85	W	2	Ni	50	Ba	540
				Co	10	Cr	50	Sr	

C-1180 Rusk property - altered felsic breccia. (Lab - Acme Analytical)

Au	390	Se	44.0	Cu	216	Fe	3.10	K	
Ag	50.0	Te	0.2	Pb	10000	Mn	116	Na	
As	17600	U	5	Zn	471	Ti		Ca	
Sb	464	Th	14	Mo	11	V		Al	
Hg	2600	B	50	W	14	Ni	60	Ba	350
				Co	10	Cr	220	Sr	

D-0226 Fresh biotite-hornblende quartz monzonite, Unit 5a/5c. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	5	Fe	2.00	K	
Ag	0.5	Te	0.2	Pb	52	Mn	207	Na	
As	52	U	4	Zn	20	Ti		Ca	
Sb	1	Th	14	Mo	2	V		Al	
Hg	20	B	15	W	2	Ni	50	Ba	1100
				Co	10	Cr	50	Sr	

D-0270 Klazan property breccia and quartz stockwork. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	4	Fe	0.50	K	
Ag	0.5	Te	0.2	Pb	50	Mn	33	Na	
As	43	U	2	Zn	7	Ti		Ca	
Sb	5	Th	10	Mo	2	V		Al	
Hg	10	B	70	W	2	Ni	50	Ba	3000
				Co	10	Cr	50	Sr	

D-0280 Biotite quartz monzonite, Unit 5c. (Lab - Acme Analytical)

Au	6	Se	10.0	Cu	34	Fe	1.30	K	
Ag	0.6	Te	0.2	Pb	47	Mn	163	Na	
As	28	U	5	Zn	42	Ti		Ca	
Sb	1	Th	37	Mo	2	V		Al	
Hg	5	B	20	W	2	Ni	50	Ba	1200
				Co	10	Cr	50	Sr	

D-0300 Big Creek Syenite, Unit 4a. (Lab - Acme Analytical)

Au	5	Se	10.0	Cu	17	Fe	4.80	K	
Ag	0.5	Te	0.2	Pb	22	Mn	342	Na	
As	8	U	2	Zn	51	Ti		Ca	
Sb	1	Th	6	Mo	2	V		Al	
Hg	5	B	20	W	2	Ni	50	Ba	2000
				Co	12	Cr	50	Sr	

D-0301 Antoniuk property - pyritic quartz-feldspar porphyry. (Lab - Acme Analytical)

Au	180	Se	10.0	Cu	54	Fe	1.10	K	
Ag	1.0	Te	0.2	Pb	125	Mn	39	Na	
As	487	U	2	Zn	112	Ti		Ca	
Sb	13	Th	7	Mo	2	V		Al	
Hg	25	B	50	W	2	Ni	50	Ba	2000
				Co	10	Cr	50	Sr	

D-0302 Laforma property - brecciated wall rock to vein. (Lab - Acme Analytical)

Au	65	Se	10.0	Cu	6	Fe	1.30	K	
Ag	0.9	Te	0.2	Pb	27	Mn	354	Na	
As	293	U	12	Zn	46	Ti		Ca	
Sb	14	Th	19	Mo	2	V		Al	
Hg	5	B	25	W	3	Ni	50	Ba	1300
				Co	10	Cr	230	Sr	

D-0303 Laforma property - quartz vein. (Lab - Acme Analytical)

Au	30000	Se	29.0	Cu	1574	Fe	1.40	K	
Ag	33.3	Te	3.6	Pb	76	Mn	168	Na	
As	3290	U	2	Zn	75	Ti		Ca	
Sb	429	Th	2	Mo	8	V		Al	
Hg	220	B	45	W	7	Ni	50	Ba	1100
				Co	10	Cr	130	Sr	

R-0034 Mount Nansen (Cyprus) property - brecciated porphyry. (Lab - Acme Analytical)

Au	310	Se	10.0	Cu	32	Fe	1.00	K	
Ag	1.5	Te	0.2	Pb	16	Mn	42	Na	
As	55	U	4	Zn	7	Ti		Ca	
Sb	8	Th	10	Mo	2	V		Al	
Hg	15	B	25	W	4	Ni	50	Ba	1600
				Co	10	Cr	160	Sr	

R-0037 Mount Nansen (Cyprus) property - brecciated porphyry. (Lab - Acme Analytical)

Au	1770	Se	10.0	Cu	44	Fe	1.20	K	
Ag	1.8	Te	0.2	Pb	12	Mn	96	Na	
As	166	U	2	Zn	19	Ti		Ca	
Sb	12	Th	8	Mo	3	V		Al	
Hg	5	B	5230	W	23	Ni	50	Ba	680
				Co	10	Cr	300	Sr	

APPENDIX IV

Report on radiometric dating
by
H. Baadsgaard

Report on radiometric dating of
samples submitted under contract
No. YEDA - 86 -05 (DIAND)

Contractor:
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Edmonton, Alberta T6G 2E3

H. Baadsgaard, Feb., 1987

INTRODUCTION

Samples from the 1986 field collections of G. Carlson in the Mount Nansen Area of the Dawson Range as well as samples from the Cassiar batholith area were submitted for radiometric dating by J. Morin, DIAND, Whitehorse, Yukon. In preliminary discussions it was established that although the available samples were not collected with radiometric dating in mind, an attempt would be made to use those applicable methods which would give the most productive preliminary results. On the basis of general geological information furnished by G. Carlson and J. Morin, it was decided to do Rb-Sr whole rock analyses of all suitable samples. To check on possible metamorphic effects as well as supplement the whole rock data, suitable mineral sets would be separated and analysed (where available). The most felsic samples of larger weight would be subjected to zircon mineral separation procedures in the hope that U-Pb dating might also be used.

A. Samples and mineral separates obtained for analysis

Table 1. Samples and separates used for dating. x = mineral or sample obtained and * = separation attempted but insufficient or unsuitable material obtained

Sample	Whole Rock	Biotite	Feldspar	Zircon
C-1125	x	x		x (.15 gm)
C-1136	x	x	x	x (.22gm)
C-1137	x			
C-1139	x	*		*
C-1150	x	*		*
C-1161	x			
P-168	x	x	x	*
P-400	x			
C-441	x			x (.22 gm)
J-682	x	x		*
C-1083	x			x (.25 gm)
C-1115	x			x (.32 gm)

Unfortunately, few of the samples possessed relatively unaltered biotite or feldspar. Of nine samples subjected to zircon separation (fine-crushing, Wilfley Table, magnetic separation, heavy liquids, acid-washing and hand picking), five produced adequate amounts of high-quality zircon. Two yielded too small amounts of zircon for analysis and two others gave essentially no zircon. After obtaining the samples listed in Table 1, the dating strategy became:

Rb-Sr whole rock and U-Pb zircon dating to give correlative ages of magmatic crystallisation and mineral Rb-Sr isochrons to check the whole rock Rb-Sr data or furnish evidence of metamorphic effects.

ISOTOPIC ANALYSIS

A. Analytical procedures

Mineral or whole rock samples for Rb-Sr analyses are first measured by X-ray fluorescence to roughly determine (±5%) the Rb and Sr content (see Appendix 1 for XRF results) so that the proper isotope dilution may be used. The appropriate sample weights are weighed out together with a known amount of a mixed ^{87}Rb-^{84}Sr isotope "spike" and decomposed with HF-HNO_3. After obtaining a strongly acid nitric acid solution of the sample, $Ba(NO_3)_2$ is added and precipitated from the solution to to carry down the Sr. Sr is separated from the Ba on a cation exchange column and further purified by a second pass through the column. The Rb in the supernatant solution for the Ba precipitation is treated with H_2SO_4 in a Pt dish, evaporated to fumes ot H_2SO_4 and ignited at 950 ^oC for ten minutes. The ignited residue is leached with a drop or two of H_2O and $HClO_4$ added to precipitate $(K,Rb)ClO_4$. Sr and Rb are added to the side filaments of separate double Re filaments and isotopically analysed on a VG-MM-30 solid source mass spectrometer equipped with semi-automatic on-line computer control.

Highly-purified zircon for U-Pb analysis is decomposed in teflon bombs with HF+HNO_3 at about 170 ^oC. Pb is separated from spiked and unspiked nitrate solutions by coprecipitation with

$Ba(NO_3)_2$. The supernatant liquid is subjected to nitrate anion exchange separation and purification of uranium. The Pb is separated from the Ba on a chloride anion-exchange resin column. The Pb is loaded onto silica gel with H_3PO_4 on a single Re filament and analysed isotopically on the MM-30 mass spectrometer. Uranium is load on the side filament of double Re filament and analysed as U^+ on the mass spectrometer. Fuller details of the current analytical procedures may be found in the Univ. of Alberta PhD. thesis of P.Cavell, 1986.

B. Results

The analytical results are given in Tables 2, 3, and 4. Tables of data are not always the most suitable manner of considering results. Correlations and comparisons between samples are more apparent when the "isochron" plot is used for the Rb-Sr data points and when the "concordia" plot is used to show the U-Pb results.

1.Rb-Sr whole rock isochron plot

In Figure 1 the Rb-Sr analytical results for the whole rock samples are plotted on a diagram of $^{87}Rb/^{86}Sr$ vs. $^{87}Sr/^{86}Sr$. On such a diagram, unmetamorphosed and/or uncontaminated igneous rock samples derived from the same source at the same time will plot on an isochron line whose slope gives the time of igneous crystallisation. It may be seen in Figure 1 that the whole rock data points scatter and only few are close to a 106 Ma reference isochron.

2. Rb-Sr mineral isochron plot

In contrast to the whole rock isochron plot, the mineral isochron plot in Figure 2 gives two sharply-distinguished isochrons. The C-1125 biotite-WR pair together with the P-168 WR-feldspar pair give a very good isochron line within analytical error at 106 Ma.

Table 2. Rb-Sr analyses of rocks and minerals. WR = whole rock, B = biotite and Feld = feldspar

SAMPLE	^{86}Sr, ppm	^{87}Sr, ppm	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$
C-1125 WR	30.52	38.21	1.250	0.70861±2
C-1136 WR	10.99	43.66	3.967	0.71028±1
C-1137 WR	34.79	22.96	0.659	0.70962±3
C-1139 WR	9.20	49.26	5.349	0.71478±3
C-1150 WR	8.40	55.95	6.650	0.71761±2
C-1161 WR	41.27	19.47	0.471	0.70753±2
P-168 WR	20.50	53.41	2.601	0.71069±15
P-400 WR	29.85	26.41	0.884	0.70902+4
C-441 WR	51.17	26.95	0.526	0.70846±3
J-682 WR	75.48	42.18	0.558	0.70575±1
C-1083 WR	33.56	27.48	0.818	0.70784±1
C-1115 WR	61.80	33.01	0.533	0.70684±5
P-168 B	1.593	214.6	134.5	0.89503±5
J-682 B	3.341	163.6	48.91	0.75235±3
C-1125 B	2.551	80.87	31.66	0.75454±3
C-1136 B	3.037	39.56	13.01	0.71763±3
P-168 Feld	24.22	127.5	5.257	0.71492±7
C-1136 Feld	8.54	80.93	9.47	0.71472±2

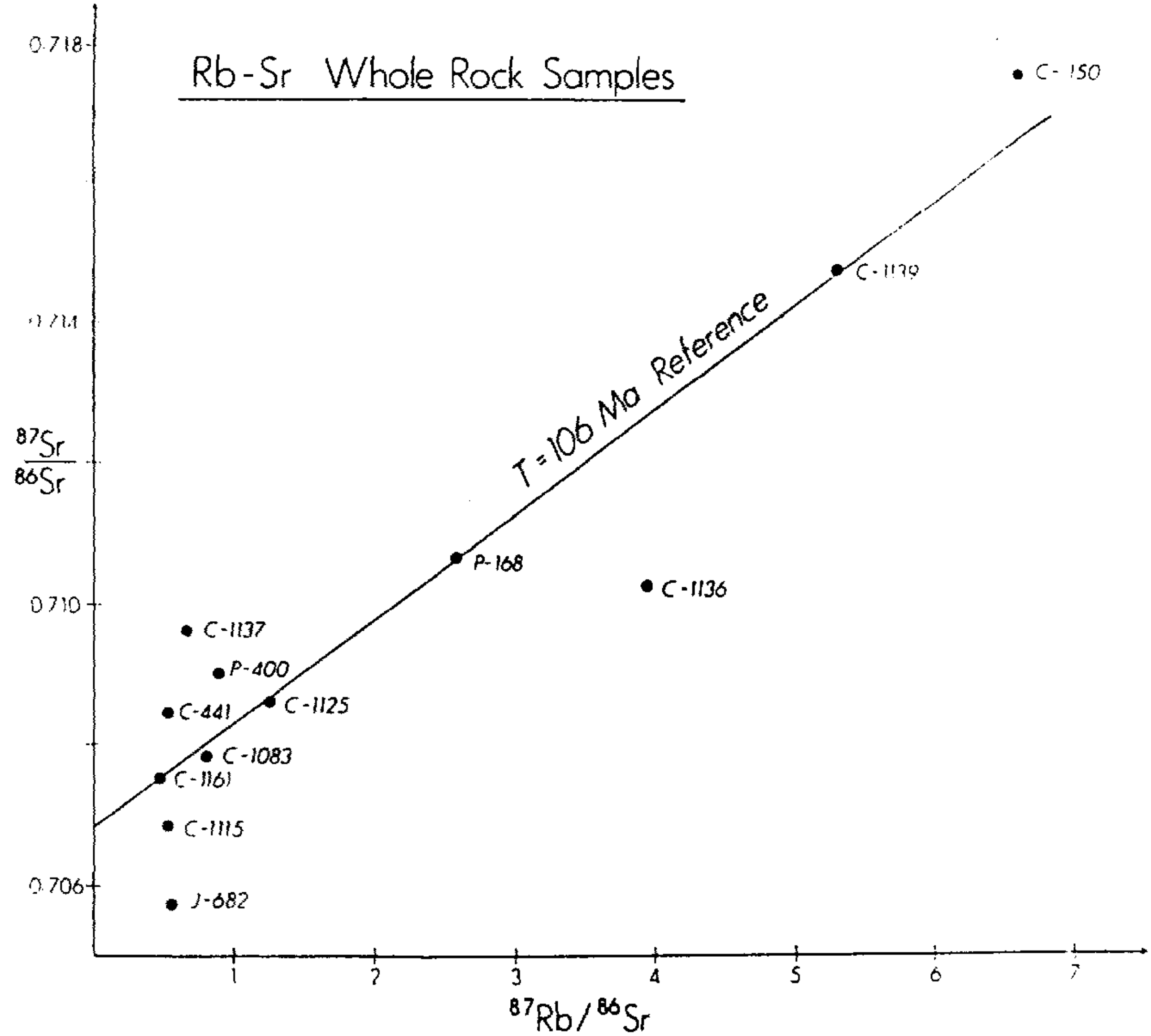


Figure 1. Rb-Sr isochron plot of whole rock samples. A 106 Ma isochron (from Fig.2) is drawn in for reference.

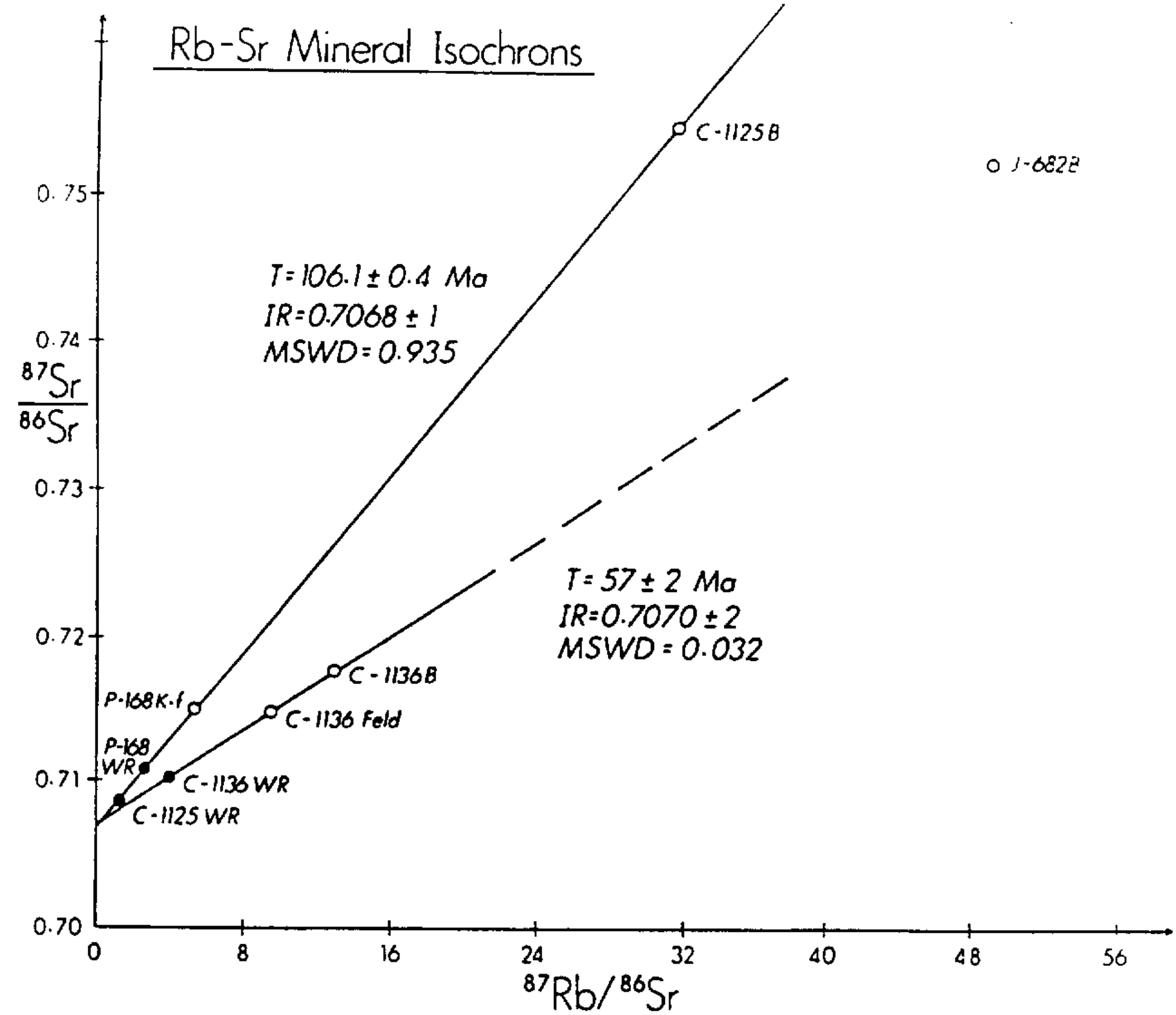


Figure 2. Rb-Sr isochron plot of selected mineral-whole rock sets. P-168 B is not plotted on this diagram since it is off scale. Inclusion of this sample in the isotope systematics is done in a regression (see APPENDIX 2).

If the P-168 B sample (see Table 2) (offscale on Figure 2) is added to the isochron line, a regression age of 100 Ma is obtained (see APPENDIX 2). This date is essentially a mineral date for the P-168 biotite and would match the probable K-Ar age for the bitotite. The three C-1125 data points in Figure 2 give a true isochron (see Appendix 2) at 57 Ma.

3. U-Pb zircon results

The zircon data in Table 4 shows reasonably correlative ages for samples C-1125, C-1083 and the two size fractions of C-1115. For such young samples the analytically most reliable age is the 206Pb/238U age. The zircon ages of sample C-1125 are close to concordant and the probable age of crystallisation of this zircon is 105-110 Ma. The other three sets of ages in this range are more discordant, most probably from minor Pb loss. The best way to make a correlation between these samples is to prepare a concordia plot of $^{206r}Pb/^{238}U$ vs $^{207r}Pb/^{235}U$ from the data. In Figure 3 such a plot is presented and gives a very good "discordia line which intersects the concordia line at about 108 Ma. The crosses on the data points in Figure 3 represent 1 per cent error bars and since the intersection of the two lines is at a small angle, a relatively large statistical error in the age is obtained (see APPENDIX 2). Considering the difficulty of analysing these lead-poor young samples, the linear correlation is very good.

Sample C-1136 gives a definitely younger age than the 108 Ma age group. The 206rPb/238U age of 61 Ma (see Table 3) is probably very close to a true Oligocene age. The very much older 207Pb/206Pb age of 280 Ma for this sample cannot possibly be explained by simple Pb loss for such a good quality zircon sample and is likely the result of minor contamination during crystallisation. A similar much higher level of contamination is indicated for the C-441, whose true age is

Table 3. Analytical data : U-Pb isotopic analysis of zircons

Sample	Measured isotopic Pb ratios 206/204	207/206	208/206	^{238}U, ppm	^{206r}Pb, ppm	Common Pb, ppm
C-1125	1004±1	0.06284±1	0.28837±1	971	13.82	0.425
C-441	339±1	0.10144±1	0.32629—4	486	11.23	1.337
C-1083	85.49±4	0.22508±1	0.58169±2	830	11.41	6.429
C-1136	783±7	0.07074±1	0.17603±7	753	6.16	0.238
C-1115 +63 mu	823±4	0.06622±1	0.22317±3	623	8.78	0.362
C-1115 -63 mu	732±4	0.06836±1	0.23892±2	691	9.61	0.450

Table 4. Dating results : U-Pb isotopic analysis of zircons

	U-Pb ages, Ma*				
Sample	206/238	207/235	207/206	$^{206r}Pb/^{238}U$	$^{207r}Pb/^{235}U$
C-1125	105.1	105.2	110	0.01644	0.1092
C-441	169.8	198	550	0.02669	0.2153
C-1083	101.5	102.0	110	0.01588	0.1057
C-1136	60.7	66.5	280	0.00946	0.0678
C-1115 +63 mu	104.0	104.4	110	0.01627	0.1083
C-1115 -63 mu	102.7	102.9	110	0.01605	0.1066

* Common Pb composition used was 204:206:207:208 = 1:18.551:15.621:38.448 (100 Ma Stacey-Kramers conformable normal Pb)
Maximum blank = 4 ng total modern Pb.

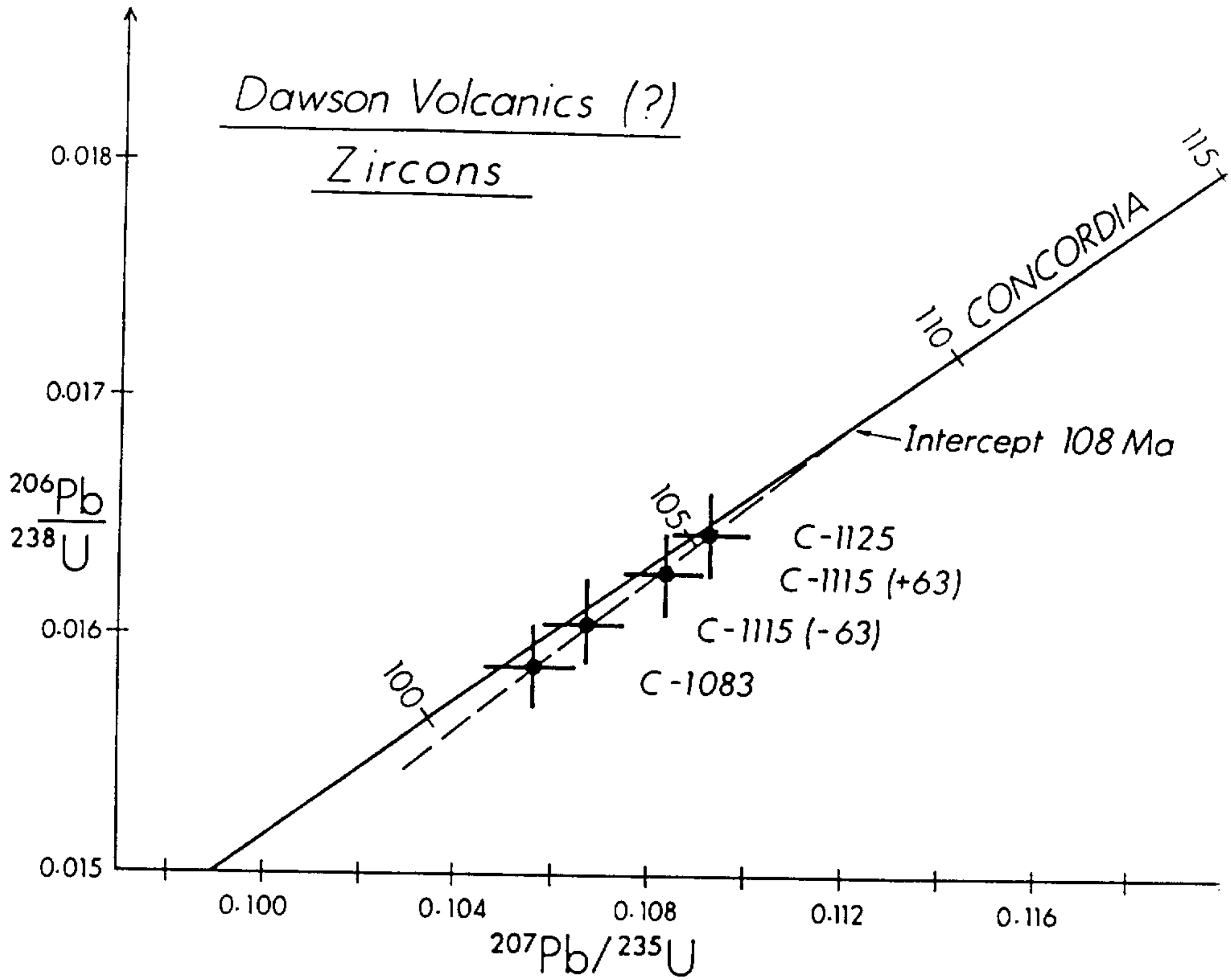


Figure 3. A concordia plot of four correlative zircon samples. The discordia line intersects the concordia line at an age interpreted as the original age of crystallisation of the zircon.

probably much closer to 170 Ma than it is to 550 Ma. Further zircon samples taken from the same rock units as C-1136 and C-441 are necessary to better establish the tentative interpretation of the single zircon sample dates obtained here.

EVALUATION OF THE RESULTS

A comparison the Rb-Sr mineral isochron date and the U-Pb zircon date for the C-1125 sample clearly confirm the crystallisation age of this sample to be very close to 106 Ma. By correlation through the zircon data, samples C-1083 and C-1115 join C-1125 as Albian in age and are also probable Dawson volcanics. P-168 is also close in age to these samples, but the correlation is only on the mineral isochron line and may be fortuitous.

Sample C-1136 is close to 60 ma in age both by Rb-Sr mineral isochron and U-Pb zircon age and is a likely representative of an extrusive associated with the Carmacks volcanics. A clear distinction in age may be made between these two age groups with isotopic dating.

Nothing definitive may be said about the other samples from the limited data and sample sets available. The scattered low-Rb whole rock data points in Figure 1 probably indicate slight crustal contamination of these samples which are most sensitive to crustal contamination. Sample J-682 give an approximate biotite Rb-Sr age of about 80 Ma and may represent an event separate from the two magmatic events.

Some recommendations for further dating in this area

Establish good reference data for the emplacement of major lithologic units by good Rb-Sr mineral + WR and U-Pb dating of zircon for carefully selected samples of the Carmack Suite, the Mount Nansen Volcanics Bow Creek Granite, the Mount Nansen and Big Creek batholiths and the metaplutonic suites.

There should be as wide a variation as possible in the lithology of the WR samples selected for Rb-Sr isochrons. A minimum of ten samples should be collected, striving to include as wide a spread as possible in felsic to mafic variations. Sample may be hand-specimen size, but should be trimmed of all weathered material before packing. Samples for zircon should be larger, preferably 25 lbs. each.

The application of Pb-Pb dating should also be carried out for all samples and especially for samples of mineralisation. Alteration zones around mineralised areas are very difficult material to use for dating the time of mineralisation unless the analysed mineral phases have formed during mineralisation. Whole rock Rb-Sr dating is almost useless on such material, but if sericite is formed in the alteration halo, it may be successfully used. Any sulfide mineralisation or accompanying carbonate will usually contain enough lead for isotopic analysis. This lead often represents the lead in the original hydrothermal fluid and can be subjected to Pb-Pb isotopic systematics if enough samples are taken to give a good lead isoptope distribution. If Pb-Pb dating is contemplated, all samples must be wrapped in polyethylene bags immediately after sampling, and this is a good general rule for all samples collected for isotopic analysis.

APPENDIX 1.

Table 5. X-ray fluorescence determinations of Rb and Sr

Sample	Rb,ppm	Sr,ppm	Rb/Sr	optimum wt.,gm
C-441	83.04	539.4	0.15	0.07
C-1083	83.58	351.7	0.24	0.10
C-1115	96.62	627.0	0.15	0.06
C-1125	130.04	358.8	0.36	0.10
C-1136	140.9	112.5	1.25	0.32
C-1137	65.38	348.5	0.19	0.10
C-1139	182.6	103.1	1.77	0.34
C-1150	192.8	83.1	2.32	0.43
C-1161	49.34	367.8	0.13	0.10
C-1174	167.8	106.2	1.58	0.33
C-1175	155.04	210.7	0.74	0.17
J-682	108.3	672.2	0.16	0.05
P-168	173.8	221.5	0.78	0.16
P-400	85.21	338.2	0.25	0.10
78-8	120.3	228.5	0.53	0.16

C-1136 Mineral Isochron

```
        X←3.967,13.01,9.47
        Y←.71028,.71763,.71472
        SIGMAX
2.57
        SIGMAY
0.222
        BB3←.01
        R
0.56
        RBSRCHRON
THE NECESSARY INPUT IS X, Y, SIGMAX, SIGMAY, BB3, AND R
SLOPE, BB = 0.0008123895529+OR-0.00002328007358
INITIAL RATIO, AA = 0.7070482168+OR-0.0002257759319
SUM OF THE SQUARED RESIDUALS = 0.03198640624
NUMBER OF DEGREES OF FREEDOM = 1
MEAN SQUARE WEIGHTED DEVIATES = 0.03198640624
CENTROID :  XBAR = 8.965769333      YBAR = 0.7143319141
DATE = 57.19+OR-1.638853433MILLIONS OF YEARS
     RB87/SR86          SR87/SR86          X-RESIDUALS        Y-RESIDUALS

  3.967000000E0      7.102800000E¯1    ¯3.140255369E¯4   ¯9.289073119E¯6
  1.301000000E1      7.176300000E¯1    ¯1.228522287E¯3   ¯1.359364209E¯5
  9.470000000E0      7.147200000E¯1     1.642716802E¯3    2.288106161E¯5

DO YOU WANT TO USE THE PLOTTING PROGRAM  (YES OR NO) ?
NO

        )OFF
=o',
```

P-168 & C-1125
Mineral Isochron
(without P-168 B)

```
      X←1.25,2.601,31.66,5.257
      Y←.70861,.71069,.75454,.71492
      SIGMAX
2.57
      SIGMAY
0.222
      BB3←.01
      R
0.56
      RBSRCHRON
THE NECESSARY INPUT IS X, Y, SIGMAX, SIGMAY, BB3, AND R
SLOPE, BB = 0.00150778456+OR-5.797265032E¯6
INITIAL RATIO, AA = 0.706824989+OR-0.0000980144829?
SUM OF THE SQUARED RESIDUALS = 1.870197518
NUMBER OF DEGREES OF FREEDOM = 2
MEAN SQUARE WEIGHTED DEVIATES = 0.9350987589
CENTROID :  XBAR = 10.98531099      YBAR = 0.7233884052
DATE = 106.1+OR-0.407944428MILLIONS OF YEARS
    RB87/SR86          SR87/SR86          X-RESIDUALS        Y-RESIDUALS

     1.25               0.70861            0.001115015103     0.000101395030
     2.601              0.71069            0.001278549735     0.0000586504241
    31.66               0.75454           ¯0.002485366369     0.0000175065391
     5.257              0.71492           ¯0.007099636855    ¯0.000179328876

DO YOU WANT TO USE THE PLOTTING PROGRAM  (YES OR NO) ?
NO
```

Biotite P-168 age + P-168
& C-1125 samples

```
      X←1.250,2.601,134.5,31.66
      Y←.70861,.71069,.89503,.75454
      SIGMAX←2.57
      SIGMAY←.222
      BB3←.1
      R←.56
      RBSRCHRON
THE NECESSARY INPUT IS X, Y, SIGMAX, SIGMAY, BB3, AND R
SLOPE, BB = 0.001419829733+OR-3.007441015E¯6
INITIAL RATIO, AA = 0.707758092+OR-0.0001002197474
SUM OF THE SQUARED RESIDUALS = 309.8213551
NUMBER OF DEGREES OF FREEDOM = 2
MEAN SQUARE WEIGHTED DEVIATES = 154.9106775
CENTROID :  XBAR = 18.08857659      YBAR = 0.7334407908
DATE = 99.92+OR-0.2116475653MILLIONS OF YEARS
    RB87/SR86          SR87/SR86          X-RESIDUALS        Y-RESIDUALS

     1.25               0.70861            0.01033459597      0.00093756686
     2.601              0.71069            0.01721565738      0.00078553635
   134.5                0.89503           ¯2.829626553       ¯0.00032633679
    31.66               0.75454            0.1639078503      ¯0.00159714900

DO YOU WANT TO USE THE PLOTTING PROGRAM  (YES OR NO) ?
NO
```

ZIRCON REGRESSION LINE

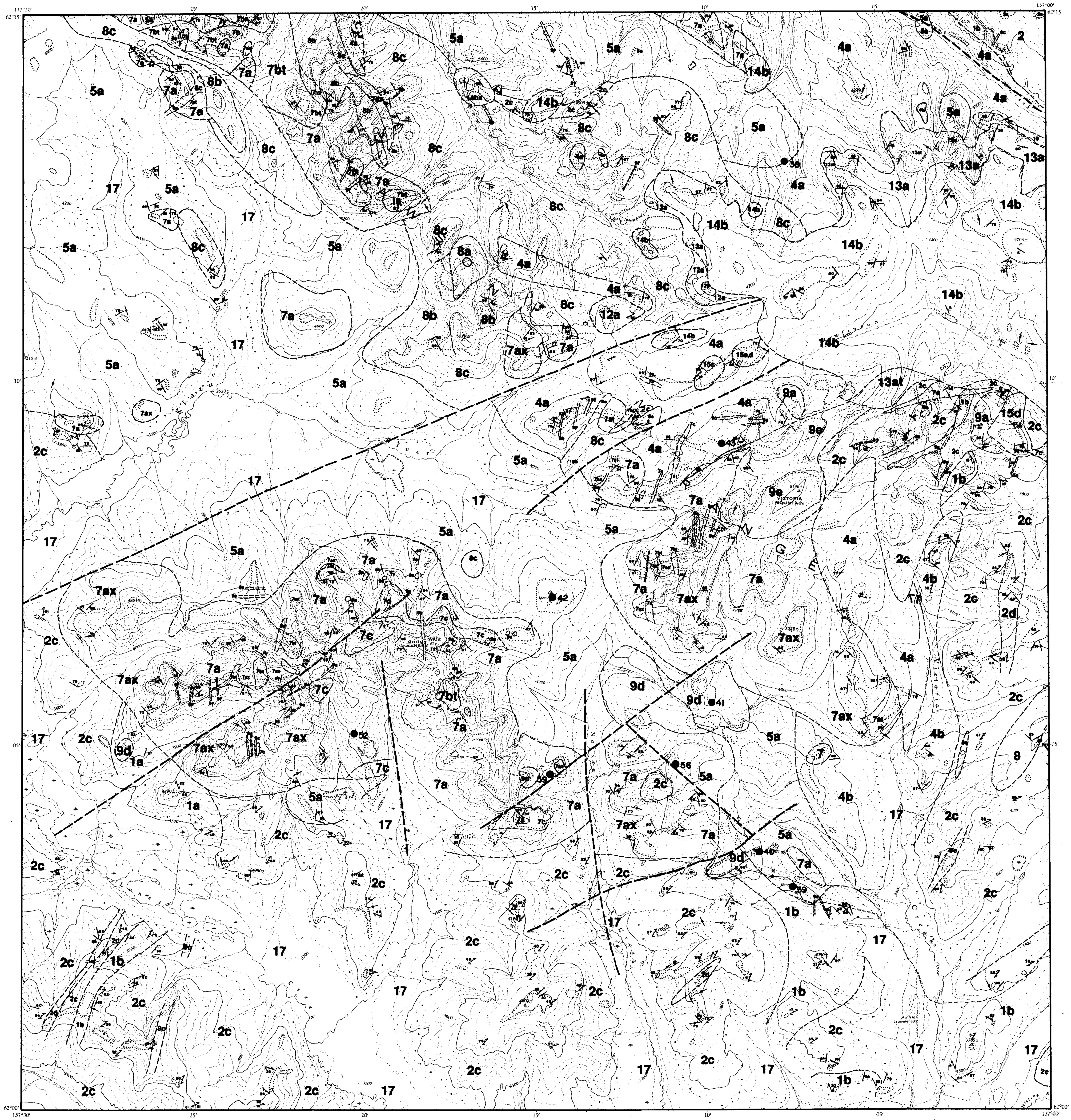
```
      X
0.1092 0.1057 0.1083 0.1066
      Y
0.01644 0.01588 0.01627 0.01605
      SIGMAX←10
      SIGMAY←10
      R←0.95
      BB3←.14
      UPBREGR
THE NECESSARY INPUT IS X, Y, SIGMAX, SIGMAY, BB3, AND R
SLOPE , BB = 0.1543960784 +OR- 0.01893088442
Y=ZERO INTERCEPT, AA = ¯0.0004836506364 +OR- 0.002033619922
SUM OF SQUARED RESIDUALS = 0.4048323127
NUMBER OF DEGREES OF FREEDOM =  2
MEAN SQUARE WEIGHTED DEVIATES =  0.2024161564

PLUS ERROR : LOWER INTERCEPT =   99.22MYR
LOWER CONCORDIA INTERCEPT =     ¯70.22MYR
MINUS ERROR : LOWER INTERCEPT = 104.65MYR

PLUS ERROR : UPPER INTERCEPT =   253000000 MYR
UPPER CONCORDIA INTERCEPT    =   108000000 MYR
MINUS ERROR : UPPER INTERCEPT =  105000000 MYR

CENTROID : XBAR =  0.1074145926  YBAR =  0.01615453446
    207PB/235U       206PB/238U             X-RESIDUALS              Y-RESIDUA

  1.092000000E¯1   1.644000000E¯2   4.501508835E¯5  ¯1.930902798E¯6
  1.057000000E¯1   1.588000000E¯2  ¯4.637831652E¯5   1.765649218E¯6
  1.083000000E¯1   1.627000000E¯2  ¯1.124098941E¯4   4.269577730E¯6
  1.066000000E¯1   1.605000000E¯2   1.092067354E¯4  ¯4.727027184E¯6
      'ZIRCON REGRESSION DIAND SAMPLES'
ZIRCON REGRESSION DIAND SAMPLES
```

} essentially zero

Canada

canada/yukon economic development agreement

Yukon



LEGEND

QUATERNARY

17 Unconsolidated Alluvium, includes high level terraces along Big Creek.

LATE CRETACEOUS TO PALEOCENE

15 LATE INTRUSIONS: 15a, aphanitic intermediate to mafic dykes, possibly Carmacks feeders; 15c, medium to coarse grained potassic gabbro; 15d, diabase dykes, plugs.

CARMACKS SUITE

14 UPPER BASALT MEMBER: 14a, andesite flow; 14b, basalt flow; 14bx, basal debris flow, breccia.

13 LOWER ANDESITE MEMBER: 13a, andesite flow; 13at, andesite tuff, tuffaceous sediment, conglomerate; 13x, andesite breccia, debris flow; 13b, basalt to andesitic basalt flow.

12 BASAL FELSIC MEMBER: 12a, grey to white weathering crystal-lithic tuff, minor lapilli tuff; 12b, rhyolite dome.

10 CARIBOU CREEK CONGLOMERATE: conglomerate-quartz pebble to boulder associated black clastic sediment.

CRETACEOUS TO PALEOCENE

MOUNT NANSEN SUITE

9 PORPHYRY DYKES: 9a, plagioclase-hornblende porphyry, dykes and small plugs; 9b, plagioclase-hornblende-quartz +/- biotite +/- k-feldspar porphyry dykes; 9c, quartz-feldspar porphyry dykes, white weathering, commonly pyritic; 9d, porphyritic granodiorite to quartz monzonite stocks; 9e, gabbro to syenite, plagioclase +/- hornblende porphyritic, fine-grained to medium-grained, multiple dykes and plugs on Victoria Mountain.

8 BOW CREEK GRANITE: 8a, fine-grained biotite granite; 8b, fine to very fine grained, pink weathering, often miarolitic granite, minor chlorite, biotite; 8c, pink weathering aphanitic dykes and border phase to pluton, typically quartz and feldspar porphyritic.

7 MOUNT NANSEN VOLCANICS: 7a, andesite to latite massive flows and feeders; 7at, tuff, tuffaceous sediments, in part laharic; 7b, leucocratic latite to rhyolite; 7bt, welded vitric tuff, tuffaceous sediments; 7bx, lapilli tuff, pyroclastics; 7c, felsic dome-commonly flow-banded, quartz and feldspar porphyry.

EARLY CRETACEOUS

DAWSON RANGE PLUTONIC SUITE

5 DAWSON RANGE BATHOLITH: 5a, Casino granodiorite; 5c, Coffee Creek granite.

EARLY JURASSIC

4 MOUNT FREEGOLD META-PLUTONIC SUITE: 4a, orthoclase-hornblende porphyritic syenite; 4b, plagioclase-hornblende monzonite; 4c, hornblende segregations in subunit 4a.

3 KLOTASSIN META-PLUTONIC SUITE: 3a, foliated hornblende-biotite granodiorite; 3b, leucogranodiorite.

PALEOZOIC AND OLDER

BASEMENT METAMORPHIC COMPLEX

2 SCHIST AND GNEISS UNITS: 2a, hornblende-biotite-feldspar gneiss, grades locally to unit 3; 2b, pink granite gneiss; 2c, schist-gneiss subunit includes biotite-quartz-feldspar schist, feldspar augen gneiss, amphibolite and minor quartzite and marble; 2d, amphibolite.

1 METASEDIMENTARY UNIT: 1a, quartzite, micaceous quartzite; 1b, quartz-feldspar-mica schist, quartzofeldspathic gneiss; 1L, limestone.

SYMBOLS

Outcrop and felsenmeer

Geological boundary (defined, assumed)

Bedding

Schistosity, foliation (inclined, vertical)

Minor fold axis, lineation

Joints (inclined, horizontal, vertical)

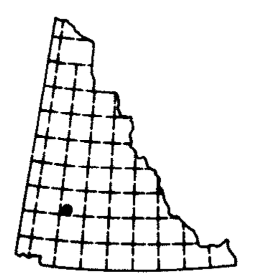
Faults, sense of movement unknown (observed, assumed)

Mineral deposit or prospect, reference number ● 40

Intrusive breccia

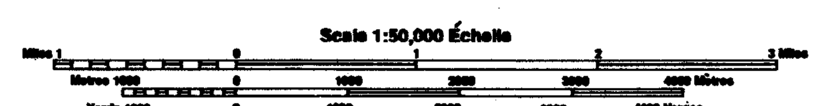
MINERAL OCCURRENCES

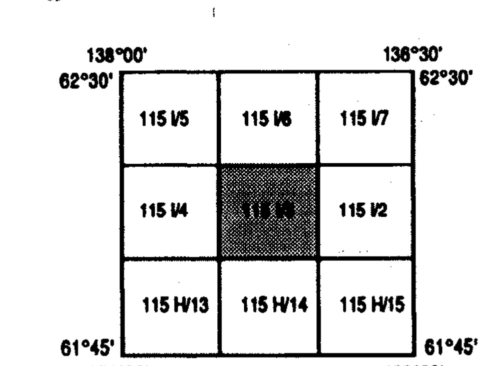
Name (Commodity)	YEX Number
LIL (Au)	115 I – (29)
FOSTER (Au)	115 I – (38)
BROWN MCDADE (Au, Ag)	115 I – (39)
MT. NANSEN (WEBER, HEUSTIS) (Au, Ag)	115 I – (40)
CYPRUS (Cu; Mo)	115 I – (41)
ESANSEE (Au, Ag, Pb, Zn)	115 I – (42)
DIVIDE (Au)	115 I – (43)
LONELY (Cu, Au)	115 I – (52)
GOULTER (Au, Ag)	115 I – (56)
RUSK (J. BILL) (Cu, Mo, Ag, Au)	115 I – (59)
ROW (Au)	115 I – (84)



Approximate magnetic declination in 1987 was N32°23'E and decreasing at an annual change of 3.7'.

Scale 1:50,000 Échelle





Index to adjoining Maps of the National Topographic System

Indian and Northern Affairs Canada
Exploration and Geological Services Division
Yukon Region

GEOLOGICAL MAP OF MOUNT NANSEN MAP AREA (115 I-3)

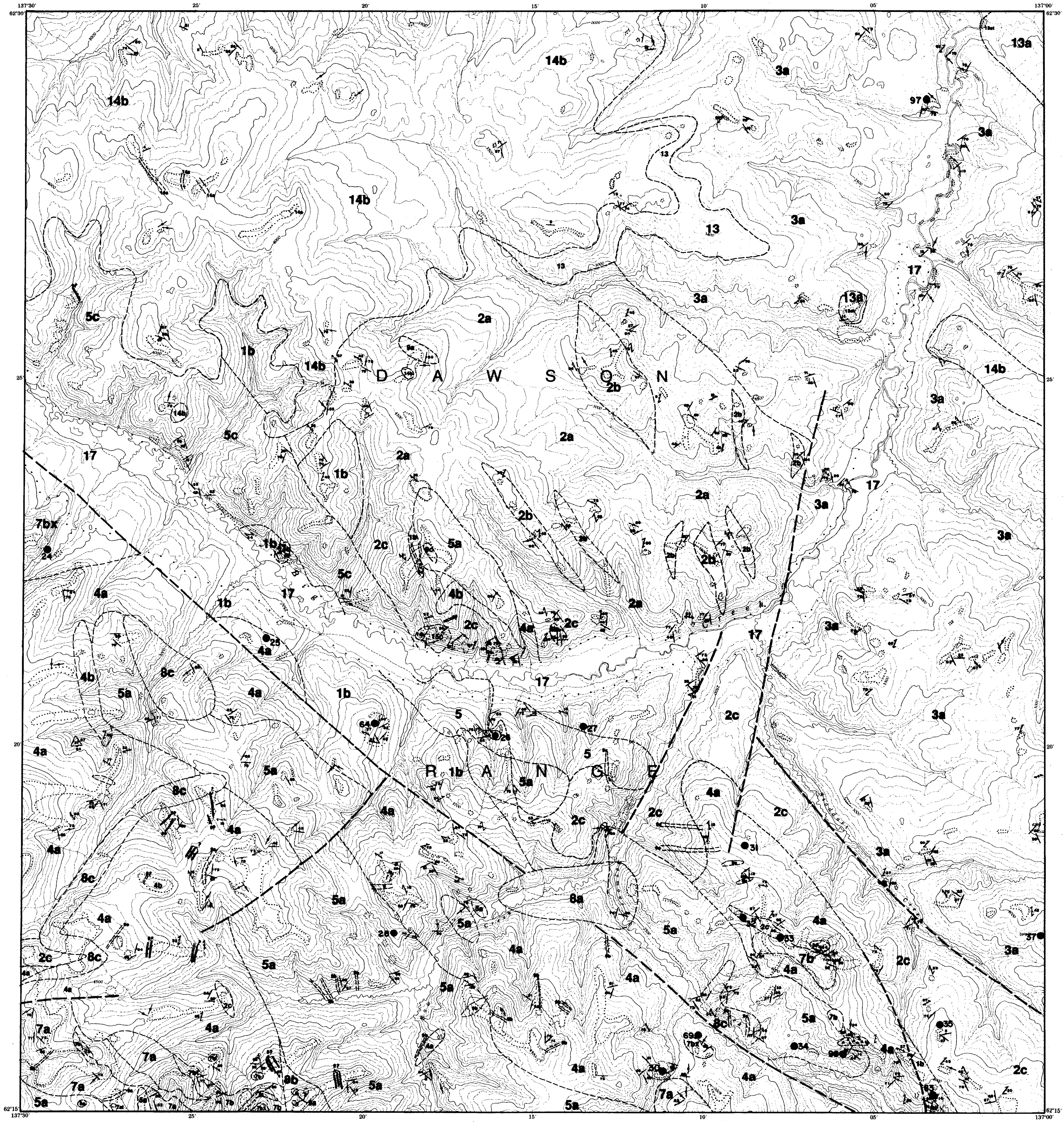
to accompany

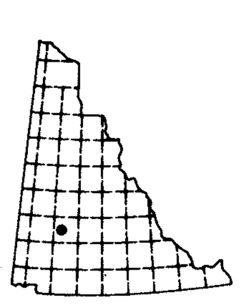
OPEN FILE REPORT 1987-2

Geology of Mount Nansen (115 I-3) and Stoddart Creek (115 I-6) map areas by G. Carlson.

Funded by Canada-Yukon Economic Development Agreement (Contract YEDA 04/86)

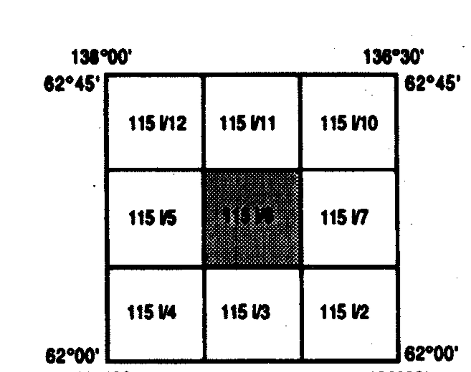
Canada
canada/yukon economic development agreement
Yukon





Approximate magnetic declination in 1989 was N33°43'E and decreasing at an annual change of 3.8'.

Scale 1:50,000 Échelle



Index to adjoining Maps of the National Topographic System

LEGEND

QUATERNARY

17 — Unconsolidated Alluvium, includes high level terraces along Big Creek.

LATE CRETACEOUS TO PALEOCENE

15 — LATE INTRUSIONS: 15a, aphanitic intermediate to mafic dykes, possibly Carmacks feeders; 15c, medium to coarse grained potassic gabbro; 15d, diabase dykes, plugs.

CARMACKS SUITE

14 — UPPER BASALT MEMBER: 14a, andesite flow; 14b, basalt flow; 14bx, basal debris flow, breccia.

13 — LOWER ANDESITE MEMBER: 13a, andesite flow; 13at, andesite tuff, tuffaceous sediment, conglomerate; 13x, andesite breccia, debris flow; 13b, basalt to andesitic basalt flow.

12 — BASAL FELSIC MEMBER: 12a, grey to white weathering crystal-lithic tuff, minor lapilli tuff; 12b, rhyolite dome.

10 — CARIBOU CREEK CONGLOMERATE: conglomerate-quartz pebble to boulder associated black clastic sediment.

CRETACEOUS TO PALEOCENE

MOUNT NANSEN SUITE

9 — PORPHYRY DYKES: 9a, plagioclase-hornblende porphyry, dykes and small plugs; 9b, plagioclase-hornblende-quartz +/- biotite +/- k-feldspar porphyry dykes; 9c, quartz-feldspar porphyry dykes, white weathering, commonly pyritic; 9d, porphyritic granodiorite to quartz monzonite stocks; 9e, gabbro to syenite, plagioclase +/- hornblende porphyritic, fine-grained to medium-grained, multiple dykes and plugs on Victoria Mountain.

8 — BOW CREEK GRANITE: 8a, fine-grained biotite granite; 8b, fine to very fine grained, pink weathering, often miarolitic granite, minor chlorite, biotite; 8c, pink weathering aphanitic dykes and border phase to pluton, typically quartz and feldspar porphyritic.

7 — MOUNT NANSEN VOLCANICS: 7a, andesite to latite massive flows and feeders; 7at, tuff, tuffaceous sediments, in part laharic; 7b, leucocratic latite to rhyolite; 7bt, welded vitric tuff, tuffaceous sediments; 7bx, lapilli tuff, pyroclastics; 7c, felsic dome-commonly flow-banded, quartz and feldspar porphyry.

EARLY CRETACEOUS

DAWSON RANGE PLUTONIC SUITE

5 — DAWSON RANGE BATHOLITH: 5a, Casino granodiorite; 5c, Coffee Creek granite.

EARLY JURASSIC

4 — MOUNT FREEGOLD META-PLUTONIC SUITE: 4a, orthoclase-hornblende porphyritic syenite; 4b, plagioclase-hornblende monzonite; 4c, hornblende segregations in subunit 4a.

3 — KLOTASSIN META-PLUTONIC SUITE: 3a, foliated hornblende-biotite granodiorite; 3b, leucogranodiorite.

PALEOZOIC AND OLDER

BASEMENT METAMORPHIC COMPLEX

2 — SCHIST AND GNEISS UNITS: 2a, hornblende-biotite-feldspar gneiss, grades locally to unit 3; 2b, pink granite gneiss; 2c, schist-gneiss subunit includes biotite-quartz-feldspar schist, feldspar augen gneiss, amphibolite and minor quartzite and marble; 2d, amphibolite.

1 — METASEDIMENTARY UNIT: 1a, quartzite, micaceous quartzite; 1b, quartz-feldspar-mica schist, quartzofeldspathic gneiss; 1L, limestone.

SYMBOLS

Outcrop and felsenmeer
Geological boundary (defined, assumed)
Bedding
Schistosity, foliation (inclined, vertical)
Minor fold axis, lineation
Joints (inclined, horizontal, vertical)
Faults, sense of movement unknown (observed, assumed)
Mineral deposit or prospect, reference number ●24
Intrusive breccia

MINERAL OCCURRENCES

Name (Commodity)	YEX Number
KLAZAN (Cu, Mo, Au, Ag)	115 I – (24)
COM (Cu)	115 I – (25)
REVENUE (Cu)	115 I – (26)
COMBO (Pb, Zn)	115 I – (27)
BOW (NEWKIRK) (Cu, Mo)	115 I – (28)
CARIBOU CREEK (Au, Ag)	115 I – (30)
KOOK (CAR, CASTLE) (Cu)	115 I – (31)
RED FOX (Ag, Pb)	115 I – (32)
GUDER (MARGARETE AUGUSTA) (Au, Ag)	115 I – (33)
LAFORMA (Au, Ag)	115 I – (34)
EMMONS HILL (DART) (Au, Ag, Sb)	115 I – (35)
TINTA HILL (Cu, Au, Ag, Pb, Zn)	115 I – (37)
NUCLEUS (Au)	115 I – (64)
ZIT (Cu, Au)	115 I – (69)
GOLDY (WHALE) (Au)	115 I – (83)
VERLENE (Cu)	115 I – (97)
ANTONIUK (Au, Ag)	115 I – (98)

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Yukon Region

GEOLOGICAL MAP OF STODDART CREEK MAP AREA (115 I-6)

to accompany

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