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**VOLCANIC STRATIGRAPHY IN THE HUNTER CREEK FAULT AREA, EAST
OF THE FLAVRIAN PLUTON, ROUYN-NORANDA, QUÉBEC.**

by

GENEVIEVE CAMIRÉ, B.Sc.

A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of the requirements for the degree of
Master of Sciences

Department of Earth Sciences

Carleton University

Ottawa, Ontario

January 1989

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VOLCANIC STRATIGRAPHY IN THE HUNTER CREEK FAULT AREA, EAST
OF FLAVRIAN PLUTON, ROUYN-NORANDA, QUÉBEC

submitted by Geneviève Camiré, B.Sc.

in partial fulfilment of the requirements for
the degree of Master of Sciences

A handwritten signature in dark ink, reading "David H. Wathin", written over a horizontal line.

Thesis Supervisor

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ABSTRACT

The Hunter Creek Fault area, located some 15 km northwest of Rouyn-Noranda in the Archean Abitibi Greenstone Belt, is underlain by volcanic rocks of the Blake River Group and straddles the HCF east of the Flavrian Pluton.

Relatively thin subaqueous flows of felsic and mafic volcanic rocks, metamorphosed to the lower greenschist facies, reflect an upward-shoaling sequence and were intruded by a series of diorite dykes.

Volcanic rocks from the HCF area appear to be of tholeiitic affinity. Slight differentiation is shown by increasing Al_2O_3 content and Zr/Y ratios, and relative fractionation of REE toward the top of the volcanic succession from Rusty Ridge andesite to Newbec andesite.

The HCF has a general trend of N240 to N250/70°NW. It appears to be a reverse fault with minor displacement producing an apparent right-handed movement. Despite the lack of exposure, correlations across the HCF were made for most of the volcanic units.

RÉSUMÉ

La région étudiée se situe à quelques 15 km au nord-ouest de Rouyn-Noranda dans la ceinture archéenne volcano-sédimentaire de l'Abitibi. Elle fait partie intégrale du groupe de Blake River et chevauche la faille Hunter Creek à l'est du pluton de Flavrian.

La séquence volcanique sous-marine est composée d'une succession de coulées mafiques et felsiques relativement minces injectée d'un cortège dioritique. L'ensemble des unités lithologiques semble métamorphisé au faciès des schistes verts inférieurs.

Les roches volcaniques adjacentes à la faille Hunter Creek semblent être d'affinité tholéitique. Une légère différenciation marquée par une augmentation du contenu en Al_2O_3 et des rapports Zr/Y , ainsi que par le fractionnement relatif des patrons des éléments des terres rares est observable de la base vers le sommet de l'empilement volcanique, soit de l'andésite Rusty Edge à l'andésite Newbec.

La faille Hunter Creek semble être une faille inverse à rejet vertical et à déplacement apparent dextre. Elle s'oriente selon un axe N240-N250 et est pentée d'environ 70° vers le nord-ouest.

En dépit du peu d'affleurements et de la piètre qualité de ceux-ci, il a été possible de corréler les différentes unités lithologiques de part et d'autre de la faille Hunter Creek.

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1 INTRODUCTION

1.1 LOCATION

The Hunter Creek Fault area is located some 15 km north-west of Rouyn-Noranda, Québec (79° W, 48° 14' N) in the Abitibi volcanic - sedimentary belt (Fig.: 1 & 2). The area, approximately 7 km by 3 km, straddles the boundary between Duprat and Dufresnoy Townships mainly in Ranges VII and VIII. Access is available through most of the mapped area by drill roads and four-wheel trails.

1.2 PREVIOUS WORK

Little work was done in this part of the Blake River Group. Some detailed mapping along parts of the Hunter Creek Fault (HCF) was pursued by company geologists (Mattinen, 1974, White, 1972), but no detailed work was done over the entire study area. Nevertheless, that did not prevent many authors to include this part of the Blake River Group and, more specifically, the HCF in regional stratigraphic and volcanogenic models.

L'Espérance (1951) was one of the first to note the presence of the Hunter Creek Fault which he described as a

vertical break extending a few miles from the big island of Nora Lake in a north-east direction.

For de Rosen Spence (1976), the HCF was the northern limit of a caldera, or a volcano-tectonic depression, 15 km wide, in the Noranda volcanic complex and bounded in the south by the Quemont feeder dyke. She divided the volcanic strata of the Noranda area into three blocks, that were geologically "distinct" and bounded by major faults. The volcanic strata north of the HCF were included in the North Mine Sequence while those south of the HCF and north of the Horne Creek Fault represent the Central Mine Sequence (Fig.3). The third block, the Southern Mine Sequence, includes volcanic strata south of the Horne Creek Fault and north of the Cadillac-Larder Lake Break. No important modification to de Rosen Spence's stratigraphy was added by subsequent workers in the adjacent areas (Gibson, 1984 (Fig.4); Paradis, in preparation (Fig.5); Péloquin and Verpaelst, 1988). The same interpretation was also adopted by Lichtblau and Dimroth (1980) and Dimroth et al. (1982).

Hubert et al. (1984) considered the HCF as a normal subvertical fault as are the Quesabe, Beauchastel, Horne Creek, Greenwood and Davidson Creek faults, all oriented more or less in a N060-N240 direction.

According to Gélinas et al. (1984), the trace of the HCF coincides with the limit between the prehnite - pumpelleyite metamorphic facies (north side) and the lower greenschist metamorphic facies (south side) in the area north of Rouyn-Noranda. The HCF also constitutes an important boundary for their Dufresnoy tholeiitic unit and Reneault calc-alkaline unit (north side) , and Trémoy tholeiitic unit and Dufault calc-alkaline unit (south side) which abut against it.

1.3 GENERAL GEOLOGY

The HCF area is part of the Archean Abitibi greenstone belt (~2.75 Ga, Krogh and Davis, 1972; Nunes et al., 1978). The Abitibi belt is an east-trending belt about 800 km long and 240 km wide, the largest of the Superior Structural Province and of the Canadian Shield. It is composed of weakly metamorphosed volcanic, sedimentary and plutonic rocks intruded by Proterozoic diabase dyke swarms. Goodwin and Ridler (1970) divided the Abitibi greenstone belt into 11 volcanic complexes; rocks of the area are contained within the Noranda volcanic complex.

Rocks of the Noranda area are a subgroup, the Noranda Subgroup, of the Blake River Group (Goodwin, 1977). Bimodal volcanic rocks of the Blake River Group (BRG) are located between the Cadillac-Larder Lake Break to the south and the

Porcupine-Destor Break to the north. The Rouyn-Noranda mining camp is characterized by abundant accumulations of meta-aluminous rhyolitic lavas and volcanoclastites. Volcanogenic massive sulphide deposits are closely associated with the major rhyolitic centres. In the Rouyn-Noranda area the principal volcanic units of the BRG were divided by Gélinas et al. (1984) on the basis of their geochemistry into 5 tholeiitic units: Rouyn-Noranda, Pelletier, Trémoy, Destor, Dufresnoy, and 4 calc-alkaline units : Duprat-Montbray, Dufault, Cléricy, Reneault.

The volcanic rocks are intruded by a paraconcordant metamorphosed trondhjemite-tonalite suite (e.g.:Flavrian Pluton) and by younger discordant non-metamorphosed granodiorites (e.g.:Lake Dufault pluton).

Two main phases of deformation are recognized in the Rouyn-Noranda area. However, deformation is heterogeneous and volcanic flows have shallow dips and are not much deformed over a large part of the Central Noranda Complex. The first phase of deformation has produced tight to isoclinal folds with axial planes steeply dipping north-east with a NW-SE strike and a weak to moderately developed foliation. These folds were transposed by the second phase of deformation which produced a general east-west tectonic trend and a strongly penetrative foliation (Boivin, 1974; Goulet, 1978; Trudel, 1979; Hubert et al., 1984).

Fig.1 : Generalized geological map of the Abitibi metavolcanic belt
(From Gélinas and Ludden, 1984).

Fig.2 : Geological map of the Blake River Group, Rouyn-Noranda region. Hunter Creek Fault area is framed. (After Célina et al., 1964)

Fig.3 : Geology in the Hunter Creek Fault area east of Flavrian pluton, after de Rosen Spence (1976).

Fig.4 : Geology in the Hunter Creek Fault area, east of Flavrian Pluton, after Gibson, 1984.
(Map covers approximately the present study area).

Fig.5 : Geology in the Hunter Creek Fault area at the boundary between Duprat and Dufresnoy Townships, after Paradis (in preparation).

1.4 GEOLOGY OF THE HUNTER CREEK FAULT AREA EAST OF FLAVRIAN PLUTON

The area overlaps the Hunter Creek Fault east of the Flavrian Pluton. It is composed of a succession of relatively thin flows of felsic and mafic volcanic rocks intruded by syn-volcanic rhyolitic, quartz and feldspar porphyry and andesitic to rhyolitic sills and dykes, and by diorite dykes (Fig.6; in pocket). All rocks appear to be metamorphosed to the lower greenschist facies. No prehnite or pumpelleyite was identified in the mapped area.

Strata are "folded" in an asymmetrical north-east plunging fold, a more or less open flexure with rounded hinge. Average strike and dip range from N000/50 to N260/80. Rocks of the area were affected by at least three phases of deformation. Brittle deformation is best expressed in a corridor subparallel to the N240 trending HCF.

1.5 PURPOSE

The main objectives of this study are:

- 1) To produce a detailed geologic map of the volcanic succession in the Hunter Creek Fault area east of the Flavrian Pluton (principally on the North-East Duprat property of Minnova Inc):.

2) To establish possible correlations across the HCF.

3) To clarify the role of the HCF in the local volcanic stratigraphy. Is the HCF a limit between two geologically "distinct" volcanic blocks ? Is it the northern limit of a caldera, or a volcano-tectonic depression ? Was the HCF a syn-volcanic fault ?

1.6 METHODS

Mapping was pursued for a total of 70 days during the summers of 1987 and 1988. Mapping was done at an original scale of 1 to 2 000 after air photos and grids in the sectors where lines were cut. Air photos, originally at the scale of 1 to 15 000, were enlarged to the scale of 1 to 2 000. Distortion inherent in the air photos and subsequent enlargement required redrawing and measuring many outcrops.

Eight maps at the scale of 1 to 2 000 were initially produced and then reduced to a scale of 1 to 5 000. The final map (Figure 6; in pocket) was then redrawn at a scale of 1 to 5 000. No compiled data are incorporated in the final map.

427 samples were collected and analysed for major elements and some trace elements by Minnova Inc. and Metriclab Inc. 51 other samples were collected and analysed

for major elements and 11 trace elements at the University of Ottawa. From these, 9 samples were also analysed for rare earth elements at the Université de Montréal. Laboratory investigations also included the petrographic examination of a hundred thin sections.

Fig.7 : Summarized lithological map of the Hunter Creek Fault area, east of Flavrian Pluton.

2 LITHOLOGICAL AND PETROLOGICAL DESCRIPTIONS OF MAP UNITS

2.0 INTRODUCTION

Textures and organization of flows indicate that volcanic rocks in the mapped area are subaqueous. Map units were usually not divided into flows because of the lack of exposure. Thus, correlations, flow to flow, were generally not possible. Syn-volcanic quartz and feldspar porphyry, rhyolitic and andesitic dykes, even if they constitute intrusive rocks, will be treated with the mapped unit which they intruded.

Rhyolites and dacitic to rhyodacitic rocks are discussed together. In many cases, the lack of exposure and the altered state of the rocks precluded determination of the original rock type in the absence of trace element data.

All "mafic volcanic rocks" are referred to as andesites.

Map unit names are usually those proposed in previous geological studies. All map names for units exposed on the southern side of the HCF are those used by de Rosen Spence (1976), Gibson, (1984) and Paradis (in preparation). These names were extended for units exposed on the northern side of the fault when the units are considered to be lateral

extensions. Roman numerals used by de Rosen Spence (1976) are indicated at the beginning of each section where possible.

Dufresnoy andesite is used instead of "overlying andesite (XXIV)" and "Fe-Ti rich andesite" (de Rosen Spence, 1976).

The Upper North Duprat andesite was also defined by de Rosen Spence (1976); however, the lower (XI_{UND}) and the upper (XIII_{UND}) members of the Upper North Duprat andesite were not distinguished.

Upper North Duprat rhyolite (X_{UND}:de Rosen Spence, 1976) was not recognized because the central area is very poorly exposed. There is no reason to believe that the rhyolites on the northern side of the HCF in the central area are different from those on the southern side, and different names were not justified.

The main units are described below in their interpreted stratigraphic succession.

2.1.1 NORTH WEST RHYOLITE

(VI_{NW}: south of HCF; VI_{LND}: north of HCF)

The North West rhyolite (NWR) is the lowest stratigraphic unit of the volcanic succession in the mapped area. The

rock is quite fractured and sheared in the area and frequently primary textures are obliterated. Shear planes are emphasized by the development of sericite and more rarely of chlorite. When so, the rock which is usually buff to gray has a more yellowish colour.

Massive and flow-banded lava flows are frequently microporphyritic. Hexagonal and square idiomorphic quartz phenocrysts are almost always resorbed. Their average size varies between 0.2 and 0.7 mm. Feldspar phenocrysts are more frequent but sometimes difficult to identify due to alteration. Near shear zones, feldspar phenocrysts may be totally chloritized but quartz and sericite (and to a lesser extent calcite) are more common alteration products. Average size of feldspar crystals is 0.5 to 1 mm. In any case, the total amount of phenocrysts does not exceed 1 to 3% (visual estimation).

Up to 10% of small spherulites of 0.25 mm diameter were observed in the massive lava flows. They are more common in the flow-banded lavas but are not homogeneously distributed.

Laminations in flow-banded rhyolite are of variable thickness (from a few mm to a few cm). Flow-banded rhyolites may sometimes be more "schistose" than massive flows. They also display abundant amygdules of 1 to 2 mm (up to 20% near

laminae). When the flows are not strongly deformed, amygdules may be elongated parallel to the lamination planes. Elsewhere they are flattened in the foliation plane.

The NWR is crosscut by QFP dykes of a few metres thickness. Percent and size of quartz and feldspar phenocrysts vary from dyke to dyke.

A thin felsic tuff, no more than 25 cm thick, with cherty laminations, outcrops at the top of the NWR a few metres below the contact with the Cranston QFP. This tuff was also observed at the Ansil Mine (M.Labrie, Minnova Inc, pers. comm.).

2.1.2 Andesitic flow in NWR

A 100 m thick andesitic lava flow is contained within the NWR in the mapped area. This andesite is an amygdaloidal flow breccia formed of amoeboid fragments of various sizes. Feldspar phenocrysts of less than 1 mm are easily recognized in thin section, but are present in small quantity. Fragments display microlitic texture, and chlorite, sericite, calcite and opaques as minor phases. Matrix is more chloritic. This andesite also occurs south of the HCF at the Ansil Mine (M. Labrie, pers. comm.).

2.1.3 Cranston rhyolitic quartz and feldspar porphyry

The Cranston QFP is a rhyolitic quartz and feldspar porphyry. It forms a small lava dome in the mapped area (Fig.5). Its apparent thickness decreases rapidly from 500 m to less than 350 m (where not in contact with the diorite that crosscuts it). Flow laminations and autoclastic breccias are common (Fig.8). Where the "paleo" slope is the steepest, a talus breccia is observable (Fig.9). This breccia is built up of mostly angular to sub-angular massive, ribboned and brecciated rhyolitic fragments of various sizes. It is usually not clast-supported. Fragments may exceed one metre. Matrix and fragments display quartz and feldspar phenocrysts. Figure 10 is a stratigraphic log of this talus breccia exposed on the southern side of the dome.

The talus breccia is interpreted as a debris flow. Debris flows occur subaerially and subaqueously in any setting where slopes are relatively high and slope instability prevails (Cas and Wright, 1987). Cohesive debris flow generally involves a cohesive muddy fluid with a strength which is capable of supporting large clasts if available (Hampton 1975, 1979). The muddy fluid would be represented in this case by water-saturated hyaloclastite. The slight inverse sorting, the poorly clast-supported

nature of the breccia and the very coarse to fine sediment involved, suggest a debris flow.

The Cranston QFP contains generally between 8 and 20% of quartz and feldspar phenocrysts 1 to 4 mm large. Hexagonal and square sections of idiomorphic quartz crystals are commonly resorbed. They are often surrounded by a recrystallized quartz halo. Idiomorphic feldspars are frequently imbricated and form small masses of crystals. Besides quartz and feldspar, the QFP contains 1 to 2% chlorite and / or 1 to 5% sericite as alteration products and traces of calcite or epidote. Iron oxides may occur on feldspar if chloritized. Pyrite content may reach 2 or 3%; when weathered, this gives the rock a pinkish colour as a result of hematization.

The size of phenocrysts in the Cranston QFP was considered as characteristic by some geologists. However, size and quantity of phenocrysts are very variable even in one exposure. Size variations in the Cranston QFP may be compared to those in other QFP of the studied area. Figure 11 is a compilation of the five largest quartz and feldspar crystals counted in each thin section of the QFP and the rhyolites exhibiting feldspar phenocrysts in the mapped area. Differences in sizes for feldspar and quartz phenocrysts from the different QFP are small. The best represented unit is the Waite QFP, and the shape of size

distribution would probably be essentially the same for other QFP if they were as well represented. The average phenocryst size is 2 mm and essentially the same for all QFP (except for Dufresnoy QFP, which has smaller crystals in general; feldspar phenocrysts: 1.5 mm, quartz phenocrysts: 1.8 mm). The largest crystals may be considered as not representative of the overall aspect of the QFP. For example, size variation within a sample was higher for the Cranston QFP than for the Waite QFP. Thus it seems hazardous to establish absolute correlations based on that criterion.

2.2 RUSTY RIDGE ANDESITE

(VII_{RR}:south of HCF; VII_{LND}:north of HCF)

The Rusty Ridge andesite (RRA) underlies the Amulet rhyolite and overlies the NWR where Cranston QFP is missing. Flows are gray to brown weathered and only occasionally "rusty" as observed in the southern extension of the RRA. The andesite is usually fairly hard, dark green to almost black, weakly chloritized but frequently silicified.

RRA thickness varies considerably over the mapped area. It is 500 m thick at the boundary of ranges VI and VII but only 20 m over the Cranston QFP dome, and thickens to 150 m at its western extremity (Fig.6). Thus it seems

that the lower part of the RRA abuts against the dome and that the upper part overlapped it.

Some pillow lavas are present in the thicker part of the RRA. Pillows are of various sizes but they are usually smaller than 2 m in diameter with chilled margins 1 to 2 cm thick. Elsewhere, amoeboid flow breccias and hyaloclastite breccias displaying sub-rounded to angular fragments are more frequent. Flow-banding also occurs in massive flows of the RRA and especially towards the top. In the mapped area, this is specific to the RRA. It was not seen anywhere else in andesitic formations. At the top of the RRA, it is possible to see, on one outcrop, discontinuous thin exhalative laminations fragmentated and brecciated which may be the equivalent of the Beecham Breccia (Fig.12).

The western extremity of the RRA is essentially composed of hyaloclastite breccias displaying small fragments, usually less than 15 cm. It is much more fractured and chloritized (up to 50% chlorite). More opaque minerals were also observed and epidote is an important constituent of the rock.

The vesicularity of the RRA is very variable, but up to 30% of amygdules may occur (visual estimation). Amygdules have various sizes and their diameters may easily reach 1 to 2 cm. Amygdules are usually filled with quartz and chlorite

and sometimes with pyrite. Fibro-radiating epidote is also observable in many cases (Fig.13). The presence of numerous veinlets and amygdules filled with epidote is specific to the RRA in the mapped area and it can be seen on both sides of the HCF.

De Rosen Spence (1976) observed that the RRA is mostly aphyric. In the mapped area, the RRA is frequently porphyritic with 1 to 3% of feldspar phenocrysts, 1 to 1.5 mm large (Fig.14).

In thin section, the RRA may be microlitic. Feldspar microlites are 0.1 mm large. In amygdules, calcite may be replacing epidote.

Besides albitization, feldspars display epidote (or calcite) and minor sericite alterations. Up to 5% opaque minerals may also occur.

2.3 AMULET RHYOLITE

(VIII_A: south of HCF, not correlated by de Rosen Spence (1976) on the northern side of HCF).

The Amulet rhyolite (AR) underlies the Waite andesite and overlies the Rusty Ridge andesite.

The Amulet rhyolite formation was divided into two members by Comba (1977) and Gibson (1979) in the Turcotte Lake section. The upper member is composed of andesite and silicified andesite, and the lower member of heterolithic phreatomagmatic breccia (Beecham Breccia) overlain by lava domes of flow-banded and massive spherulitic rhyolite.

In the mapped area, only an equivalent to the lower member outcrops.

2.3.1 Beecham Breccia

The thin boudinaged "exhalative" laminations or fine ash-sediment observed at one location at the top of the RRA may be interpreted as the lateral extension of the "Beecham Breccia" (Fig.12). However no silicified volcanic fragments as described by Gibson (1979) were observed. Its origin is not clear, but it may be correlated with the Beecham Breccia which is a distinct marker unit defining the base of the Amulet Rhyolite Formation (Gibson, 1979).

2.3.2 Lower Amulet rhyolite

The AR has an apparent thickness of 500 m between the RRA and the Waite andesite.

The AR weathers buff to light green-grey. The green colour is attributed to chlorite-sericite alteration.

Massive rhyolite and flow-banded rhyolite are common but few lobes were observed. Rhyolite is frequently spherulitic in various proportions. Contacts between massive and flow-banded rhyolite are not well defined because of the poor quality of exposure. As for other rhyolites it is usually difficult to determine if the massive rhyolite is intrusive or not.

The internal layering of flow-banded rhyolite is recognized on weathered surface. Layering has individual lamellae 2-3 mm to 10 cm thick. The flow-banded rhyolite contains up to 20% elliptical quartz amygdules, more or less aligned, distributed in different amounts in the different laminations. Amygdules may also be absent.

The AR is frequently porphyritic in the mapped area and more rarely microlitic. Feldspar phenocrysts, generally 1 mm large, reach 1 to 2% (Fig.15). The groundmass is composed of recrystallized spherulites, granular quartz, sericite and chlorite. A trace of epidote was also observed.

The AR seems to be intruded by QFP dykes or sills a few metres thick in its upper section. Although QFP "dykes" are intersected in drill holes (DT-43, DT-46, N70-2) and outcrop in a few areas, poor quality and quantity of exposure in the central mapped area makes stratigraphic relations difficult to define. One of these QFP, the

"central QFP" (it outcrops in the central mapped area), seems to be of effusive nature. Weak flow banding is observable at a few places. It was previously correlated with the Cranston QFP (Lichtblau, 1986).

2.4 WAITE ANDESITE

(IX: south of HCF, not mapped by de Rosen Spence (1976) north of HCF)

The Waite andesite (WA) occurs between the Amulet rhyolite and the Waite rhyolite (or Splinter rhyolite, after Paradis, in preparation). It is exposed on the southern side of the HCF and is probably also present on the northern side where there are a few andesitic outcrops that may be related to it (probably also in NV-17, NV-19, DT-54 drill holes).

On the western side of the Dufresnoy diorite, green to dark green andesite displays flow and hyaloclastite breccias and pillows. Pillows are generally smaller than 3 m across and bun or mattress shaped. Chilled margins are thin and rarely exceed 1 cm. Vesicularity is variable. Amygdules 1 to 3 mm large are usually filled with chlorite or quartz and may easily reach 15 to 20%.

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Fig.8 : Flow banding in Cranston QFP.

Fig.9 : Talus breccia in Cranston QFP (southern side of the dome).

Fig.10 : Stratigraphic log of Cranston QFP talus breccia (exposure on the southern side of the dome, Lot 57, boundary between ranges VI and VII, Duprat Township). Each dot represents the average size of the 10 largest fragments measured along a 3 m wide section at every 0.5 m.

Fig.12 : Thin exhalative laminations fragmented and boudined at the bottom of the Amulet rhyolite (Beecham Breccia).

Fig.13 : Amygdaloidal Rusty Ridge andesite. Yellow spots are large amygdules filled mainly with epidote.

Fig.14 : Amygdaloidal Rusty Ridge andesite displaying feldspar phenocrysts half surrounded by chlorite. Black clusters of minerals are fine-grained epidote (151 , plane light).

Fig.15 : Spherulitic Amulet rhyolite displaying weakly chloritized feldspar phenocrysts (214, crossed polars).

On the eastern side of the Dufresnoy diorite, flow breccias displaying whitish amoeboid fragments of a few tens of centimetres are the most common facies. These breccias may be highly silicified, the fragments being generally more altered than the matrix. Highly silicified andesite displaying similar features was observed at one location on the northern side of the HCF.

2.5 WAITE RHYOLITE

(X_W:south of HCF; X_{UND}:north of HCF)

At least four distinct flows may be recognized in the Waite rhyolite (WR) in the mapped area. Each is exposed on both sides of the Hunter Creek Fault. The lowest is an aphyric flow overlying the Waite andesite. It is overlain by a feldspar porphyritic flow which underlies the Upper North Duprat andesite. Three to 50 feldspar phenocrysts, 1 to 2 mm large, may be observable if the rock is not too highly deformed (Fig.11). It is more or less altered depending on the degree of fracturing and shearing. Colour is buff or lightly pinkish due to hematization, or, more commonly, yellow to light green when sericite is developed on cleavage planes. Few lobes were observed.

The third flow is a quartz and feldspar porphyry. The Waite QFP overlies the Upper North Duprat andesite and

underlies the fourth flow of Waite rhyolite or Newbec andesite. Among these four flows, only the QFP outcrops in a continuous fashion on both sides of the HCF. The QFP colour also depends on alteration state and it varies from buff to nearly red. Quartz and feldspar phenocryst sizes are shown on figure 11. Sericite constitutes the main alteration product of the feldspars. The Waite QFP contains between 10 and 15% phenocrysts and is generally spherulitic (Fig.16 and 17). QFP exposures are usually small and because of that, massive lava appears to be the most common facies. Flow banding and autoclastic breccia were also observed in many locations. Small highly sericitized and chloritized sub-rounded fragments 1 to 5 cm large can occur in trace on outcrops and in drill holes. Their degree of vesicularity indicates that they probably come from the underlying Upper North Duprat Andesite.

The fourth flow of the Waite rhyolite is a porphyritic flow displaying approximately 1% feldspar phenocrysts 1 to 1.5 mm large. Its southern extension was mapped by Paradis (in preparation). It is exposed at only one place in the mapped area. A fifth aphyric flow, also identified by Paradis who did very detailed mapping of the Waite rhyolite south of the HCF, appears to overlie the latter. This flow contains abundant amygdules. It is not exposed north of the HCF. Another QFP ("Dufresnoy QFP"), is exposed on the northern side of the Dufresnoy diorite and is in direct

contact with it. It was also crosscut in a few drill holes but quality of outcrops prevents the interpretation of its intrusive or extrusive nature and its relations with other stratigraphic units.

2.6 UPPER NORTH DUPRAT ANDESITE

(XI_{UND}: Lower member north of HCF; XIII_{UND}: Upper member north of HCF; not present south of HCF according to de Rosen Spence, 1976).

The Upper North Duprat andesite (UNDA) occurs between two flows of the Waite rhyolite in the mapped area. The UNDA is almost exclusively composed of flow breccias. Light greenish brown to buff amoeboid fragments are found in a slightly darker matrix on the weathered surfaces. In hand specimen, the andesite is medium to dark green depending on the degree of alteration.

In breccias, fragment sizes vary from a few centimetres to tens of centimetres with average size around 20 to 25 cm. These breccias differ from Dimroth et al. (1978) amoeboid and ellipsoid pillows and from pillow breccias, in that most commonly, matrix and fragments are both amygdaloidal and display microlitic textures in thin section. Fragments are generally widely distributed through the unit even if there is also some more closely packed

breccias displaying hyaloclastite fragments. Where in direct contact with pillow lava, the limit between breccias and pillows is sharp and no reentrant or in situ brecciation or transition between facies was observed.

Less than 10% of the UNDA is pillowed lava in the mapped area. Pillows are usually smaller than 2 m, round or bun-shaped with chilled margins 2 to 4 cm thick. They are closely packed with almost no interpillow hyaloclastite.

The UNDA contains up to 40% amygdules of various sizes from 1 mm to 3 cm, filled with chlorite, calcite or quartz (Fig.18). In flow breccias both matrix and fragments are vesicular with no major differences in proportions. Vesicularity degree is variable but readily observable through the entire unit. Silica alteration halos may occur around amygdules and may be accompanied by some sericite. Feldspar microlites range in size from 0.1 to 0.5 mm. Chlorite and calcite are other major constituents (little epidote was observed), and the lavas generally display between 1 and 3% opaque minerals.

1 mm

Fig.16 : Granophyric texture in recrystallized microspherulitic Waite QFP (126B, crossed polars).

1 mm

Fig.17 : Recrystallized quartz halo around corroded quartz phenocryst in chloritized (dark clusters) Waite QFP (223, plane light).

Fig.18 : Upper North Duprat andesite exhibiting amygdaloidal microclitic texture. Amygdules are infilled with quartz and chlorite. Acicular minerals are microclitic feldspar. Dark gray clusters are chlorite (126A, plane light).

Fig.19 : Microclitic texture in Upper North Duprat andesite. Large white spots are calcite. Also present are chlorite and opaques (0608, crossed polars).

2.7 NEWBEC ANDESITE

(XIII_{NB}:south of HCF).

The Newbec andesite (NA) overlies the Waite rhyolite (mostly Waite QFP in the mapped area) and underlies the Fish Roe rhyolite.

The apparent thickness of the Newbec andesite varies between 400 and 600 m. This andesite is poorly exposed in the Hunter block. The NA is usually light green in fresh samples and this is probably an effect of its slightly higher alumina content. It is light brown to grey on weathered surfaces.

At the bottom, where in contact with the Waite QFP, up to 2% of angular QFP fragments, 1 to 15 cm large, are present in coarse-grained hyaloclastite breccia. These fragments come from the underlying Waite QFP. They are not distributed evenly in the breccia but are easily recognizable. The NA also consists of pillowed lavas more or less vesiculated. Ellipsoidal or bun-shaped pillows closely packed with almost no inter-pillow hyaloclastite have fairly thin chilled margins. Vesicularity reaches 25% in pillowed lava toward the top of the unit and is approximately 10% toward the bottom in breccias and pillowed lavas.

2.8 FISH ROE RHYOLITE

(XV_{FR})

The Fish Roe rhyolite (FRR) is a thin spherulitic flow contained between the Newbec andesite and the Dufresnoy andesite or between the Newbec andesite and the d'Alembert andesite south of the mapped area (d'Alembert andesite is not exposed north of HCF). Apparent thickness is less than 100 m.

The FRR is exposed at only one location in the map area. It is composed of flow-banded rhyolite and autoclastite breccias with some "massive" lava that might be lobes. A few synvolcanic dykes of similar texture and composition intrude the rhyolite. This rhyolite is highly spherulitic with up to 90% spherulites 1 to 2 mm large (Fig.20). Spherulites are commonly surrounded by chlorite. Characteristically, acicular opaque minerals occur within the spherulites. The rhyolite has less than 2% of feldspar phenocrysts 0.5 to 1 mm large.

Fig.20 : Flow-banded Fish Roe rhyolite. All white spots are spherulites or coalesced spherulites.

2.9 DUFRESNOY ANDESITE

(XXIV)

The Dufresnoy andesite (DA) is the best exposed of all units in the mapped area. Weathered surfaces are rusty to greenish brown. Fresh samples are dark to medium green. Volcanic facies are varied but breccias highly dominate. Volcanic rocks of the DA are intruded by several thin synvolcanic dykes and sills of andesitic composition. Only one felsic dyke was identified in the DA volcanic pile.

Pillowed lava flows rarely exceed a few metres thick. They are mostly lenticular. The largest lava flow mapped is 50 m wide by 900 m long. Pillow sizes range from a few tens of centimetres to more than 2 m in cross section. Pillows are subvertically elongated. Large pillows may be decorated by pillow buds and reentrant pillow crust. Small pillows are round or ellipsoidal, whereas large pillows are mattress-shaped or tubes. Different shapes of pillows may be found in the same pillowed flow. Chilled margins rarely exceed 3 to 4 cm, and are more commonly 1 to 2 cm thick. Interpillow hyaloclastite accumulations are fairly common. A few cryptocrystalline massive magnetite fragments, 1 to 3 cm large, are associated with hyaloclastites in pillow triple junctions and in breccias. Pyrrhotite, chalcopyrite and sphalerite were observed in trace amounts in amygdaloid and

pillow rims in a few locations, associated with quartz and epidote veinlets. Acicular amphibole (probably actinolite) is common in pillowed and massive lava (Fig.29). It is usually accompanied by chlorite, epidote, opaque minerals and quartz in the groundmass. Calcite is present in and around amygdules and in veinlets. Crystal size is quite small in other facies and minerals are not readily identified.

Figure 21 is an example of a facies transition between massive lava and pillows and / or breccias. Massive lava is irregular and grades into pillows laterally, but also upward and downward at the top and base of the flow. Unbrecciated quenched contacts exist for some parts of massive lava flow. Breccias are present everywhere, in thin lenses between massive lava flows, but more commonly as flow-top breccia which caps massive and pillowed flows. However, the large quantity of breccia at the base of the DA cannot be explained only by rapid cooling of andesitic lava due to relatively strong interaction with water, and their origin probably differs from the situation exposed in figure 21.

A large amount of hyaloclastite and "coarse-grained" hyaloclastite breccias is present in the mapped section of the DA. Hyaloclastite is mainly sideromelane shard hyaloclastite, characterized by the presence of globules and granules of poorly vesiculated devitrified glass. "Coarse-

grained hyaloclastite" is used instead of "pillow fragments" (forming pillow breccias; Dimroth et al., 1985). They are composed of angular to sub-angular hyaloclastite fragments, 1 to 5 cm across. These coarse-grained hyaloclastite breccias highly dominate facies through the DA.

Hyalotuffs (Fig.22) up to 5 m wide and 120 m long are composed of glass shards and lumps of hyaloclastite (Fig.23). Hyalotuffs are presumed to be generated in very shallow water by lava fountaining (Dimroth et al., 1985). Magmatic volatiles may exsolve, expand, and fragment a magma if hydrostatic pressure is sufficiently low (McBirney and Murase, 1971). Expansion of volatiles that is insufficient to fragment the magma can, nevertheless, cause accelerated effusion or fountaining which results in magma breaking into spatter. Allen (1980), Moore and Fiske (1969) and Moore and Schilling (1973) showed that for tholeiitic basalt magmas, with water contents of up to about 0.5%, the upward transition to fragmental deposits generally occurs at water depths no greater than 100-200 m and is commonly shallower. From theoretical considerations, McBirney (1963) suggested a depth limit to explosive basaltic eruptions near 500 m, but this was based on a low maximum water content of 0.1%. The lack of sorting or bedding in the hyalotuffs indicates that no major transport as in the form of subaqueous mass flows was induced. A thin felsic ash-tuff unit 25 cm thick displaying some pyritic beds was also identified near the

bottom of the DA at one location (Lot 10, Range VIII, Dufresnoy Township).

Besides hyaloclastite and coarse-grained hyaloclastite breccias, some flow breccia composed of amoeboid fragments a few tens of cm large was also mapped. Transition between different types of breccias is usually very rapid and most commonly all types of breccias form a chaotic mixture sometimes associated with pillowed lava and / or massive lava. This can be seen on figures 25 (in pocket) and 26 which represent two stratigraphic logs through a thick sequence of breccias in the DA. On figure 25 slight reverse grading is observed. The thin pillowed flow is used as a marker unit. Transition is noted from underlying breccias to pillows, but the upper contact is mainly sharp. Massive lavas encountered through the section are irregular and discontinuous pods, usually less than 2 m thick in cross section. In this particular case, the pillowed flow represents less than 10 m on a 200 m exposed section of breccias. The situation in figure 26 is more or less the same. A thick sequence of breccias (50 m) overlies a relatively thin pillowed flow 10 m thick. However transition from the upper contact of the pillowed flow into a thin amoeboid breccia followed by coarse grained hyaloclastite breccia is noted in this case.

Vesicularity is variable in the DA, but generally less strongly developed than in all other andesitic lavas of the mapped area. Massive lavas are always more vesiculated than pillowed flows and breccias, displaying up to 20% and sometimes more amygdules. Other flows exhibit usually less than 10% amygdules. Only very small amygdules (<1mm) were observed in the hyaloclastite.

Environment

Not all shallow marine mafic lava is highly vesiculated; the vesiculation also depends on the degree to which volatiles exsolved and were lost before the solidification of the lava. Variations in the numerous inter-related parameters that influence the growth of vesicles and the strength of the magma might be responsible for differences in the vesiculation depth between magmas of similar volatile contents.

Despite the low degree of vesicularity of lavas from the DA, the high proportion of brecciated and quenched lava is probably diagnostic of shallow marine environments. Correlations between the depth of the transition to fragmental deposits and volatile content can be poor, and vesiculation may not be marked at the level of the transition (Kokelaar, 1986).

Dimroth et al. (1985) considered a large ratio, 1:1 or greater, of brecciated to massive or pillowed lava to be characteristic of shallow environments. In the case of the DA, the ratio seems to be fairly high. As a volcanic pile is built to shallower water depths the site of extrusion ultimately reaches a level where one or more explosive clast-forming processes is facilitated. Lava fountaining will begin at the level of onset of rapid exsolution of magmatic volatiles. The transitional deposits are likely to be a chaotic mixture of lava flow units (pillow), lava breccia, and ragged lava fragments, with moderately vesicular fragments, splinters and cracked globules of glass (Kokelaar, 1986). Because of the enclosing water, ballistic dispersal of clastic materials is very restricted.

The predominance of brecciated over massive or pillowed lava in shallow marine environments may be attributed to explosive release of magmatic volatiles, explosive expansion and collapse of steam formed at magma-water contact surfaces, explosive expansion of steam following enclosure of water in magma, and cooling-contraction (Kokelaar, 1986). The volume of water vapour is greater in shallow than in deep water. Even though pyroclastites were not identified (with the exception of a thin ash tuff unit), phreatomagmatic processes are interpreted to be active during the extrusion of the DA in

the mapped area, and the volcanic succession represents an upward-shoaling sequence.

2.9.2 Rhyolitic feldspar porphyry dome in Dufresnoy andesite

A small rhyolitic feldspar porphyry dome is exposed in Ranges VIII and IX at the boundary between Lupiat and Dufresnoy Townships. The weathered alteration surface is generally buff to light grey. Pinkish colour may be seen, reflecting weak hematization, but rhyolite is dark to medium grey in fresh samples. This rhyolite has 3 to 5% of feldspar phenocrysts 1 to 3 mm large. It is relatively weakly altered, and feldspars are easily identified. Some idiomorphic pyrite was noted.

The dome is very massive and no flow textures were observed. However, it does not seem (at least entirely) to be intrusive, since fragments of rhyolitic feldspar porphyry were found in the DA (Fig.28). Up to 15% of angular fragments of similar composition, 3 to 30 cm large (with a few exceptions up to 100 cm), were identified in hyaloclastite and flow breccias on both sides of the dome as far as 600 m away. The proportion of rhyolitic fragments increases toward the dome. On its eastern side, rhyolitic fragments occur in two breccia units separated by a pillowed flow, suggesting that the dome was eroding during the extrusion of lavas from the LA.

2.10 DIORITES

Diorite dykes constitute more or less one fifth of the HCF area. They display some zonation, especially emphasized by the presence or absence of quartz. Compositions range from quartz and hornblende diorite, clinopyroxene and quartz diorite, to quartz-free diorite and gabbro.

Grain size is fine to coarse with some pegmatitic sections. Granophyric textures are common. Primary, dark green amphibole crystals (hornblende) up to 15 cm long occur in pegmatitic sections. They are generally altered to some late acicular amphibole and epidote. Amphibole is also an alteration product of clinopyroxene. Feldspar crystals are commonly strongly saussuritized. Chlorite is also a major constituent. Magnetite crystals up to 1.5 mm occur in parts of the diorite. Other common minor and trace minerals are pyrite, calcite, sericite and apatite.

2.11 CONCLUSION

The volcanic succession reflects in a broad manner an upward-shoaling sequence. Vesicularity slightly increases toward the top of the sequence, at least up to the UNDA. Dufresnoy andesite is poorly vesiculated but highly brecciated. No difference in degree of vesicularity was noted on

either side of the HCF through a particular unit or through the entire volcanic succession.

Volcanic facies are essentially similar on both sides of the HCF. There is no marked change in volcanic facies near or across the HCF. Volcanic facies are highly dominated by flow breccias which is not indicative of proximity to volcanic centres.

No indication of slumping, megabreccia, talus or sedimentary breccia, or abrupt termination of flow indicating collapse, subsidence or any major difference in level was observed in the field or in drill holes along or near the HCF. There is no abrupt change in the thickness of the volcanic units near the HCF.

The trace of the HCF is not marked by any specific alteration halo indicating more or less intense hydrothermal alteration from the circulation of fluids through the fault.

From field and drill holes correlation, the HCF does not seem to be intruded by "feeder" dykes.

From volcanogenic features, there is no specific indication to suggest that the HCF is a syn-volcanic fault.

Table 1 : Summary of particular volcanic textures and features found in units correlated across the Hunter Creek Fault.

	NORTH OF HCF	SOUTH OF HCF
DA	-Poorly vesiculated. -Highly brecciated. -Abrupt transition between volcanic facies. -Rusty weathered surfaces	-Poorly vesiculated. -Highly brecciated. -Abrupt transition between volcanic facies. -Rusty weathered surfaces.
FRR	-Highly spherulitic rhyol. flow (up to 90%). -Acicular opaque minerals within spherulites. -Feldspar phenocrysts.	-Highly spherulitic rhyol. -Acicular opaque minerals within spherulites. -Feldspar phenocrysts (Paradis, pers.comm.).
NA	-Light green pillowed lava and flow breccias with thin chilled margins. -Rare hyaloclastite (brec. or interpillow). -Amygdules <10% at bottom, reach 20% toward the top.	-Light green pillowed lava and flow breccias with thin chilled margins. -Rare hyaloclastite (brec. or interpillow). -Amygdules <10% at bottom, reach 20% toward the top.
UNDA	-Almost entirely composed of highly amygdaloidal (up to 40%) amoeboid flow breccias.	-The few exposures are amygdaloidal (20%) flow breccias.
WR	-Succession of flows: aphyric rhyo.-FP rhyo.-QFP-FP rhyolite.	-Succession of flows: aphyric rhyo.-FP rhyo.-QFP-FP rhyolite.
WA	-Whitish amoeboid highly silicified flow breccia fragments (L58, RVIII, Duprat T.).	-Whitish amoeboid highly silicified flow breccia fragments (L1, RVII, Dufresnoy T.).
AR	-1 mm large feldspar phenocrysts (~5%).	-1 mm large feldspar phenocrysts (~5%).
RRA	-Epidote in amygdules and veinlets (only observed in the RRA). -Feldspar phenocrysts (east of diorite dyke, L55, RVII, Duprat T.). Strongly altered feldspar phenocryst relics (west of diorite dyke, L55, RVII, Duprat T.).	-Epidote in amygdules. -Feldspar phenocrysts.

Fig.21 : Organization of Dufresnoy andesite flows (eastern extremity of HCF area, boundary between ranges VII and VIII, Dufresnoy Township).

Fig.22 : Sharp sub-vertical contact between
hyalotuff (right) and overlying pillow
lava (left) in Dufresnoy andesite.

Fig.23 : Hyalotuff of the Dufresnoy andesite.

Fig.24 : Hyaloclastite breccia in Dufresnoy andesite displaying some pillow fragments.

Fig.26 : Stratigraphic log of Dufresnoy andesite, western side of the rhyolite feldspar porphyry dome and variation in size of breccia fragments. Each dot represents the average size of the 10 largest fragments measured along a 3 m wide section at every 0.5 m (Range IX, Lot 54, Duprat Township).

Fig.27 : Termination of massive andesitic flow forming coarse-grained hyaloclastite lava also displaying small amoeboid fragments (Dufresnoy andesite).

Fig.28 : Rhyolitic feldspar porphyry fragments in andesite breccia found near the contact with the small feldspar porphyry dome in Dufresnoy andesite.

0.1 mm

Fig.29 : Acicular amphiboles in massive lava flow from Dufresnoy andesite. Groundmass is quartz (white), epidote, chlorite, and opaques (171C, plane light)

3 S T R U C T U R A L G E O L O G Y

3.0 INTRODUCTION

Two main deformation phases are recognized in the Rouyn-Noranda area. However, deformation is heterogeneous and volcanic flows have shallow dips over a large part of the Central Noranda Complex. The first deformation phase has produced tight to isoclinal folds (F_1) with axial planes steeply dipping northeast with a NW-SE strike, and a weak to moderately developed foliation (S_1). These folds were transposed by the second phase of deformation (D_2) which produced a general east-west tectonic trend, and a strongly penetrative S_2 foliation (Goulet, 1978; Trudel, 1979; Hubert *et al.*, 1984).

The mapped area does not constitute an ideal site for structural studies. Rock exposures are discontinuous and of relatively poor quality. The best exposed areas are apparently the least deformed. However, many structural elements allowing a better understanding of the local geology, were identified during field work.

The different lithological units exposed in the mapped area are mainly affected by shear zones, spaced cleavage, joints, and faults displaying minor displacement.

Two deformation corridors were identified in the HCF area. The first has a N260/N270 trend and is approximately located on the boundary between Ranges VII and VIII. This corridor formed during D₂. All earlier structural elements were more or less transposed sub-parallel to it. Foliation (S₂) is fairly well developed and many small shear zones of similar orientation were mapped, but the corridor is not by itself a broad "shear zone". Lineations resulting from elongated amygdules or fragments are steeply dipping and were reoriented in S₂ planes. This corridor is more or less 1 km wide.

The second corridor is oriented in a N240 trend and is parallel to the trace of the Hunter Creek Fault. It is characterized by heterogeneous brittle deformation. Some shear zones were observed, but foliation parallel to the N240 direction is poorly developed.

The maximum of deformation (and the minimum of rock exposures) is located at the intersection of these two corridors. Other structural elements identified in the field, and resulting from subsequent phases, were preferentially formed inside these corridors.

3.1 STRATIFICATION (S₀)

In the mapped area stratification and polarity were mainly determined from pillows; only two tuffaceous units were identified. Lithological units always dip towards the north or the northeast. Dips vary from more or less 50° at the boundary between Ranges VI and VII, Lots 56 and 57, to 75° to 80° in the northern part of the mapped area. Gradual change in dip is accompanied by gradual change in orientation (Fig.30). The latter is NNW-SSE south of the HCF and is progressively upright in a more E-W trend toward the D₂ corridor of deformation. Away from this corridor, stratification is progressively restored in its NW-SE orientation but dips are steeper than south of the HCF (Fig.31). There is one anomalous sector in the southwest corner of the mapped area. The stratification, marked by the attitude of the small andesitic flow in the NW rhyolite, is transposed in a SW-NE trend. This area is the most deformed one along the HCF. Stratification is distorted and reoriented toward a N240 trend. Lithology may have been dragged into such trending structures and may be fault-bounded.

○ mean lineation vector 079/81

Fig.30 : Stereographic plots of poles to stratification (S_0), and stretching lineations (L_x) defined by elongated amygdulites.

Fig.31 : Steeply dipping pillowed lava ($S_0:290/75$)
in Dufresnoy andesite.

3.2 FOLIATION (S_1 , S_2 , S_x)

The volcanic rocks of the HCF area were mainly subjected to brittle deformation and foliation is not strongly penetrative in the mapped area. When present, it is emphasized by the development of chlorite and / or sericite oriented in foliation planes. Foliation plots are shown on figure 32. S_2 is best developed and has an average value of N258/76. S_1 is subparallel to S_0 and also reoriented in a more east-west trend. S_1 and S_2 are usually related to the development of axial plane foliation. S_x comprises all post- D_2 foliations. Among those, N240/060 and N220/040 foliations can be identified, the latter usually crosscutting the former. S_x appears to be related to the development of conjugate faults and locally to the development of kink bands.

3.3 SHEAR ZONES

Shear zone measurements are plotted on figure 33. According to their orientation and their crosscutting relationships, D_1 , D_2 and later phase shear zones were identified. Among the latter, N240 and N220 shear zones are the more common. Shear zones are usually local and not much larger than a few tens of centimetres. When developed in andesites, they are generally highly chloritized and may display calcite-quartz veining. When developed in rhyolites,

they are usually chloritized and sericitized. Hematization is also a common alteration in both kinds of rock near shear zones. The largest shear zone mapped is located within the NW rhyolite in the southwestern corner of the map area (Fig.34). This N240/80 trending shear zone is more than 5 m wide and parallel to the HCF. Another major shear zone of probable N270 orientation (after field and drill hole correlations), emphasized by a well developed schistose fabric and a very strong sericitization, was observed in DT-52 drill hole.

3.4 SPACED CLEAVAGE

Spaced cleavage is very well developed in the mapped area. Spaced cleavage resembles a very closely spaced, planar, parallel jointing (Fig.35). Spaced cleavage and jointing are distinctly different from the point of view of strain. It can often be shown that spaced cleavages are discontinuities along which significant volumes of host rock have been removed by pressure solution during the compression - induced shortening that accompanied the folding (Davis, 1984). Spaced cleavage reflects compressional events. It is better developed, than is foliation, for post-D₂ systems. This is readily seen on figure 32, 33 and 36 for N240/060 and N220/040 systems. It is also interesting to note that maxima of spaced cleavage are almost opposite to those of joint distribution maxima.

Fig.32 : Stereographic projections of poles to foliation (S₁,S₂,S_x)
The largest is a compilation of all measurements

Fig.33 : Stereographic projections of poles to shear zone, spaced cleavage and joint.

Fig.34 : Major N240/80 shear zone in North
West rhyolite north of HCF.
(L52, RVII, Duprat T.).

Fig.35 : N240/75 spaced cleavage infilled by
quartz and epidote veinlets, in Rusty
Ridge andesite.
(L54, RVII, Duprat T.).

3.5 STRETCHING LINEATIONS (L_x)

Stretching lineations are mostly defined by elongated amygdules in the mapped area (Fig.37). They are usually steeply dipping and plunge towards the east-northeast (mean lineation vector is N079/81, Fig.30). They are generally included in S_2 planes. The dispersion of the L_x lineations is probably the combined result of D_1 and D_2 deformations. They reflect in a broad manner the position of the stretching component (σ_3) and the orientation of the fold axis of the asymmetrical open fold (F_2) defined by the stratification (in the HCF area) close to the D_2 corridor of deformation.

3.6 INTERSECTION LINEATIONS (L^0_1 , L^0_2 , L^1_2)

Intersection lineations shown on figure 38 were all calculated. L^0_1 represents the intersection of the stratification surface (S_0) and the S_1 foliation surface and so on for other lineations. The axis of the F_2 fold and the lineation L^0_2 are contained within the surface S_2 . From L^1_2 distribution we can see that the open fold F_2 plunges steeply towards the NE-E.

3.7 JOINTS

The expression of jointing in the volcanic flows and intrusive rocks of the mapped area range from simple, systematic patterns to complicated patterns of interfering non-systematic jointing. Joints were compiled on stereographic projection (Fig.33), rose diagram (Fig.36) and frequency diagram. Since most joints are steeply inclined, trends of dominant joint sets are more readily apparent in the latter diagrams.

3.8 FOLDS

Besides the broad flexural fold (F_2) defined by the attitude of the stratification, few folds were observed in the HCF area. Small isoclinal folds with axial planes dipping N270/85 were observed in two locations in the NW rhyolite north of the Hunter Creek Fault. Dextral kink folds with axial plane ~N220/85 and sub-vertical fold axis were also observed in the NW rhyolite (Fig.40). When developed, they fold the S_2 surface.

3.9 FAULTS

Measured fault data are compiled on figure 41. Most right-handed faults are small scale features and were observed in diorite dykes. A few sub-vertical N000 right-

handed strike-slip faults were observed in the HCF area. They appear to be very late features and are probably related to a set of faults and airphoto lineaments. These are well defined on Landsat photographs and crosscut all other structural and lithological elements including sediments of the Proterozoic Cobalt Group and the post-metamorphic syenites of the BRG. A few reverse faults occur in the mapped area. Perverse faults with minor oblique displacement were always left-handed. Reverse faults comprise some low-angle faults with dips around 15° to 20° , which are related to D_1 and D_2 . Such reverse faults are poorly documented in the Rouyn-Noranda area. These faults are rather rare in the HCF area but they are very common in the Harvie shaft area in Clérice Township (Camiré, 1988) and near the Mourun Mine in Dufresnoy Township. Contemporaneous or later left-handed strike-slip faults are also related to N015 N105 systems.

Volcanic formations are generally considered to be up-thrusted along the eastern margin of the moderately dipping diorite dykes south of the mapped area (Wilson, 1941). However, such thrusting is not apparent over the entire mapped area (especially where diorite dykes are EW trending north of HCF) and where contacts are exposed, diorite dykes are steeply dipping ($\sim 85^{\circ}$). Diorite dykes display many small scale faults; among those, a more or less well developed conjugate system of left-handed ($\sim$ N030) and right-handed

(~N330) strike-slip faults is probably related to a late D₂ compression (Fig.42). They can be the result of changes in the state of stress, σ_3 being sub-horizontal instead of sub-vertical. Very few structures oriented N270-090 were observed in diorites.

3.9.1 Hunter Creek Fault

The Hunter Creek Fault, a major structure more than 30 km long, crosscuts the study area. On the geological map (Fig.6, in pocket), the trace of the HCF was determined from drill holes and airphoto lineament. It is the direct continuation of the HCF as located on the western side of the Flavrian Pluton and follows the same airphoto lineament. However other lineaments of similar trend are also observable on airphotos, and were indicated on the geological map. They may represent faults as does the HCF. But, since there is almost no rock exposure and no drill holes providing information on them, they were only indicated as lineaments.

The HCF does not appear to be a single break. It forms instead a fault zone composed of probably subparallel spaced fault surfaces (observable in drill holes, Fig.39). Based on field and drill hole correlations, the HCF appears to be a reverse-slip fault with an apparent right-handed displacement. The fault has a general trend of N240-N250 and dips

toward the northwest. Dip is estimated to be approximately 70°NW. The apparent right-handed displacement is an effect of the dip of the lithological units towards the north-northeast.

Reverse faults are not easily explained by the Anderson model of faulting and the Mohr-Coulomb theory. Two explanations might be advanced. Reverse faulting may take advantage of preexisting high-angle weakness in the crust, such as ancient faults and shear zones. Where reverse faulting is a result of fault reactivation, the dip of the reverse-slip fault is inherited from a previous event.

Another explanation of reverse faulting is that orientation of the principal stress directions may be inclined. Stress trajectories become inclined and / or curved as the result of changes in the state of stress laterally and vertically. Hafner (1951) demonstrated that the dissipation of horizontal compressive stresses can result in a strain field marked by curved stress trajectories. Curved compressive stress trajectories give rise to continuously curved faults, parts of which are thrust-slip faults, but parts of which are reverse-slip faults (Fig.43). In contrast, other workers (Stearns 1978, Friedman et al., 1976) have demonstrated experimentally that differential vertical uplift, involving no compression, can produce upper level thrusts that steepen downward into reverse-slip faults (Fig.44).The

problem is in part to determine if moderately dipping faults steepen with depth to form high-angle reverse-slip faults, or whether they shallow with depth into pure thrust-slip faults.

In the mapped area, structural features such as shear zones and spaced cleavage of similar trend, suggest that N240-N060 faults are an effect of compressive stresses. Furthermore, low-angle N240-N060 "thrust" faults were mapped in adjacent areas, at the Harvie shafts (Camiré, 1988), at the Mine d'Étain (Fig.45) where N240 faults appear to be part of the Greenwood Fault system, at the Yvan Vézina Mine and at the Davangus Gold Prospect (M.Laflèche, pers.comm.).

N240-N060 faults and shears appear to be late structures. They crosscut D_1 and D_2 structural features and are themselves crosscut by N220-N040, N000 and N015 structures.

3.10 CONCLUSION

D_1 , the first phase of deformation has given a NW-SE tectonic trend in the area (Fig.46). S_0 and S_1 are subparallel. D_1 faults are usually reverse and left-handed if their displacement is oblique. Many of these faults are low-angle faults. D_1 faults are rare in the relatively poorly

exposed HCF area but are common in other areas such as the Harvie shafts area (Cléricy Township).

In the HCF area, major north-south compression during D_2 has produced a transposition of previous structural elements in a more EW trend (Fig.46). Subvertical stretching lineations suggest that the minimal stress (σ_3) was subvertical. Faults associated with D_2 are also reverse and left-handed if their displacement is oblique. Conjugate reverse faults produced during the peak of deformation are EW trending and usually low-angle. Conjugate left-handed (N030) and right-handed (N330) strike-slip faults seem also to be an effect of NS compression. They were probably formed under a greater rock thickness than EW low-angle faults with the minimal stress constraint (σ_3) being sub-horizontal instead of sub-vertical.

Later phases of deformation are mainly characterized by the development of spaced cleavages. N060-N240 and N220-040 structures crosscut D_2 structures. The HCF appears to be a reverse-slip fault with minor displacement producing an apparent right-handed movement. Minor displacement is in agreement with mapping done by Leduc (1986) on the western side of the Flavrian Pluton. Leduc (1986) has also reported the development of N060 foliation in sediments of the Cobalt Group in the area of the Lac Dasserat in Québec. Reinterpretation of Leduc's (1986) structural data suggests that the

N240-N060 trending structures are very late. Faults of trend similar to the HCF are not strictly confined to the Blake River Group. They are also observable in other areas such as in the Kinojévis Group in the area of Kirkland Lake and in the Hunter Mine Group in Ontario (MERQ-OGS, 1984).

Fig.36 : a) Rose and frequency diagrams of joint orientation data.

b) Spaced cleavage rose diagram.

Fig.37 : Stretching lineations defined by sub-vertical elongated vesicles in Upper North Duprat andesite. Attitude of the surface photographed is N000/90.
(L59, RVIII, Duprat T.).

Fig.38 : a) Stereographic diagram of pole isocontours of all planar structures including joints, spaced cleavages, foliation, faults, stratification. Diagram shows that planar structures are mainly oriented in a west to northwest direction.

b) Stereographic diagram of calculated L_0^1 lineations.

c) Stereographic diagram of calculated L_2^0 lineations.

d) Stereographic diagram of calculated L_2^1 lineations.

Fig.39 : Drill core section "across" the Hunter Creek Fault. Drill hole DT-52, 1368-1405 ft.

Fig.40 : N220 dextral kink folds in the North West rhyolite, north of the Hunter Creek Fault.

Fig 41 : Stereographic projection of poles to fault plane.

Fig.42 : Right-handed and left-handed faults mapped in the Lake Dufault diorite. Shaded areas represent rock exposures where faults were measured. The situation is similar for diorites exposed in the Hunter Creek Fault area.

2

MicroD

Fig.43 : a) Pattern of stress trajectories that would be produced in a block subjected to strong horizontal compressive stresses that die out laterally.

b) The pattern of curved faults that would emerge within the field of curved stress trajectories.
 (From Hafner, 1951).

Fig.44 : Curved reverse-slip faults produced by differential vertical uplift in deformation experiment.
 (From Sanford, 1959).

Fig.45 : Major structural elements mapped at the Mine d'Etain. Well developed low-angle reverse N235 trending faults crosscut N265 shear zones. (Southeast corner of Dufresnoy Township at the boundary with Rouyn Township; Laflèche and Camiré).

Fig.46 : Synoptic stereographic diagrams of D_1 and D_2 structural elements.

4 G E O C H E M I S T R Y

4.0 INTRODUCTION

Laboratory analytical methods and determination of least altered rocks are described respectively in Appendices 1 and 2. All geochemical data with sample descriptions are listed in Appendix 3.

4.1 ALTERATION

The least altered rocks in the area have been metamorphosed to lower greenschist facies. It is typified in the andesites by chlorite-actinolite-albite-epidote-quartz-sphene / leucoxene assemblages. Spilitization (seawater-basalt reaction) may also produced such assemblages. Although regional metamorphism has changed the mineralogy, it has not obviously affected the chemistry of least altered rocks (Gibson et al., 1983). However, some of the least altered rocks have their compositions slightly modified by alteration processes and some of those display weak silicification.

According to Gibson (1979), epidotization-silicification and albitization-silicification alteration facies are collectively referred to as silicification. Silicification is not a pervasive alteration in the mapped area. It

manifests itself in andesite mostly as halos mantling amygdules and more rarely as irregular white patches as described by Gibson (1979). Both andesites and rhyolites display silicification. Rusty Ridge andesite is generally more silicified than other mafic volcanics.

Chloritization and sericitization were also recognized in some areas. They are mostly associated with shear zones; chloritization is more common in andesites and sericitization in rhyolites. Geochemical changes accompanying these alteration facies are described by Gibson et al. (1983) and Lesher et al. (1986). Relative to least altered andesite, epidotized-silicified andesite is enriched in Ca-Sr-Eu and depleted in Mg and divalent first transition series metals (FTSM), whereas albitized-silicified andesite is strongly enriched in Na, and depleted in K-Rb and some FTSM.

In order to determine qualitatively the chemical changes produced by the regional alteration in the volcanic rocks, a chemical alteration index (A.I.) has been used to qualify the degree of alteration of the samples (Hashiguchi et al., 1983). It mainly reflects the changes caused by feldspar alteration and is based on the alkalis, CaO and MgO. According to Hashiguchi, the least altered rocks should have approximate values of A.I. = 50. Values < 50 indicate sodium enrichment, whereas values > 50 correspond to

magnesium-potassium enrichment. However, rocks from the Blake River Group are generally depleted in K_2O relative to modern volcanic rocks with K_2O content generally below 1 wt% (Gélinas, 1984). Thus, the alteration index for the least altered rocks is mainly affected by the relative Na and K contents and falls between 30 and 40 (Table 2). Altered glassy and microlitic lava flows do not display any significant difference in geochemistry; for example glassy and microlitic andesites have similar K_2O contents.

From figure 48, it appears that the most altered rocks from the Hunter Creek Fault area display K + Mg enrichment, but Na enrichment is also developed in many rocks. Rocks with high loss on ignition (L.O.I.) values are not necessarily much more altered than those with low L.O.I. Mafic (high TiO_2 content) and felsic (low TiO_2 content) volcanic rocks display in a broad manner the same kind of alteration, but strong K and Mg enrichment is preferentially found in rhyolites. The bulk of selected least altered rocks plots between A.I. = 30 and A.I. = 40. The alteration index does not seem to be affected by a modification in the chemistry of the rock in terms of Ca and Mg contents. An enrichment in Ca and a depletion in Mg would reflect epidotization-silicification. Almost all selected least altered rocks plotted on figure 47 fall within the "not altered" field. Thus, the lower A.I. calculated for some least altered rocks is attributed to Na enrichment which

accompanied spilitization. From figure 48 it can also be seen that felsic volcanics are relatively more altered than mafic volcanics.

On figure 50, ranges of abundances for selected trace elements are mostly similar for "all rocks" and least altered rocks with the exception of Rb which is a more mobile element. The strong K-Rb enrichment relative to least altered rocks would be characteristic of sericitization. The trivalent REE and high field-strength elements (HFS) are mostly immobile and retain their original abundances (Leshner et al., 1985).

Table 2 : Calculated A.I. for andesites from the Blake River Group.

	BRG ¹	BRG ²	BRG ³	BRG ⁴	BRG ⁵	BRG ⁶
SiO ₂	55.3	54.9	58.8	57.32	57.59	61.98
TiO ₂	1.7	1.2	1.3	1.57	1.25	1.16
Al ₂ O ₃	14.8	17.4	15.8	15.14	15.88	14.53
FeO	11.8	10.7	7.9	11.25	8.22	8.36
MgO	6.7	5.4	4.0	4.55	4.37	3.38
CaO	5.3	4.7	6.4	4.37	6.94	1.93
Na ₂ O	3.8	4.4	5.4	4.64	3.74	4.43
K ₂ O	0.2	0.9	0.3	0.47	0.81	0.7
P ₂ O ₅						0.33
A.I.*	43	41	27	36	33	39

1 , 2, 3 From Gélinas *et al.* (1984)

1 Representative Dufresnoy andesite

2,3 Representative Renault-Dufault andesite

4 , 5 From de Rosen Spence (1976)

4 Mean of 12 analyses from Rusty Ridge andesite

5 Mean of 19 analyses from Amulet andesite

6 From table 3, in Leshner *et al.* (1986)

Mean of 5 least altered andesite analyses from Amulet formation, upper member, Turcotte Lake section. In Gibson *et al.* (1983), it is considered that least altered andesite from Amulet Rhyolite formation were affected by early alkali metasomatism and then was more altered than andesites from Amulet and Rusty Ridge formations (4 & 6).

* Calculated from 100% volatile free analyses.

Fig.47 : (CaO/Al₂O₃)-(MgO/10)-(SiO₂/100) alteration diagram, after Davis et al. (1978). Only least altered rocks are plotted. (100% volatile free).

Fig.48 : L.O.I. and TiO₂ as a function of alteration index as defined by Hashiguchi et al. (1983).

$$A.I. = [(MgO + K_2O) / (Na_2O + K_2O + CaO + MgO)] \times 100.$$

All rocks plotted (100% volatile free).

Fig. 49 : SiO₂, TiO₂ and Al₂O₃ as a function of alteration index. A.I. = $[(\text{MgO} + \text{K}_2\text{O}) / (\text{Na}^+ + \text{K}_2\text{O} + \text{CaO} + \text{MgO})] \times 100$. Least altered rocks. (100% volatile free).

Fig.50 : Histograms of Zr, Y, Sr and Rb for least altered rocks and "all rocks" analyzed for trace elements.

4.2 GENERAL POINTS

Volcanic rocks from the Hunter Creek Fault area are sub-alkaline and meta-aluminous (Fig.51). On major elements vs SiO_2 diagrams, they form a bimodal sequence with most data grouped around the basalt-andesite pole and around the rhyolite pole (Fig.52). This is less obvious when MgO is used as a discriminant (Fig.53). However, intermediate compositions are also observable as shown by the distribution of trace elements on figure 54. Bimodality will be discussed in chapter 5.

On the Irvine and Baragar $\text{FeO}^*-(\text{Na}_2\text{O}+\text{K}_2\text{O})-\text{MgO}$ diagram (1971), mafic rocks are distributed between calc-alkalic and tholeiitic fields (Fig.55). However, almost all mafic volcanics plot in the tholeiitic field on the Jensen ($\text{FeO}^*+\text{TiO}_2$)- $\text{Al}_2\text{O}_3-\text{MgO}$ diagram (1974) on figure 56. Thus, the least altered mafic volcanics may be classified as tholeiitic volcanics. The differences observed from the results of those two diagrams may be explained by the high mobility of alkali elements during secondary processes.

4.3 MAFIC VOLCANIC ROCKS

From major element compilation for least altered mafic rocks, (table 3 and figure 57), andesitic "formations" do not exhibit significant chemical differences. Chemical

analyses from rocks on the southern side of the HCF in adjacent areas are mostly similar to those from the northern side within a particular "formation" (table 4).

RRA has a higher content of SiO_2 but this reflects weak silicification of least altered samples. NA and WA have higher Al_2O_3 content whereas DA displays the lowest. The highest values of TiO_2 are encountered for the Dufresnoy andesite but all mafic volcanics are iron and titanium rich.

Zirconium and yttrium abundances range respectively from 85 to 188 and 25 to 51 ppm (Table 5). From Rusty Ridge andesite to Newbec andesite, Zr/Y ratios increase in a broad manner towards the top of the volcanic succession as does the La/Yb ratio which is 1.73 for the RRA and 2.71 for the NA. However Dufresnoy andesite has a different trace element signature and exhibits the lowest Zr/Y ratios and the least fractionated REE pattern which is almost flat.

Mafic volcanic rocks of the HCF area were divided by Gélinas et al. (1982) into calc-alkalic and tholeiitic volcanic series. According to Gélinas, the RRA, WA and NA would then be part of the Dufault calc-alkalic unit, and the DA, part of the Dufresnoy tholeiitic unit. From major and trace element data, such a distinction is not obvious for andesites of the HCF area. As mentioned above, almost all least altered mafic rocks of the mapped area fall within the

tholeiitic field as proposed by Jensen (1974). Comparison between trace and rare earth elements in table 6 does not indicate a strong affinity of mafic volcanic rocks of the mapped area to calc-alkalic units. Zirconium to yttrium ratios are much smaller than those determined by Ludden et al. (1982) for Reneault and Dufault calc-alkalic units as are La/ Yb and La/Sm ratios. In fact, they are more like those determined by Ludden et al. (1982) for Trémoy and Dufresnoy tholeiitic units. The most fractionated of mafic volcanic rocks is the Newbec andesite and the least, the Dufresnoy andesite (Fig.59). However, it is not obvious whether or not the Newbec andesite is a true calc-alkalic andesite. Even if La/Sm ratio for the NA (2.08) is close to those determined for Reneault and Dufault calc-alkalic units (2.4 and 2.12), La/Yb (2.71) and Zr/Y (4.28) ratios are much smaller (respectively 4.43 and 5.15 for Reneault, and 3.04 and 5.43 for Dufault).

On the other hand, Ujike and Goodwin (1987) employed the $[La/Yb]_N$ ratio = 2.2 as the upper boundary limit of the tholeiitic series relative to the calc-alkalic series. However, this particular ratio is questionable and not universally applicable for magma series identification. For example, in the Izu-Bonin arc, tholeiitic basalts in the inner volcanic zone have higher $[La/Yb]_N$ ratios than calc-alkalic andesites in the outer volcanic zone (Miyashiro, 1975). In table 6, average $[La/Yb]_N$ for tholeiites in the

Rouyn-Noranda area is less than 2.2 but close to it, whereas $[La/Yb]_N$ for average calc-alkalic rocks is much higher than 2.2 . If we consider the $[La/Yb]_N$ ratio = 2.2 as a limit, UNDA and NA would be considered as calc-alkaline and RRA and DA as tholeiitic, even if all other factors indicate that they are all tholeiites. A slight shift of composition toward the calc-alkalic field may be explain in different ways. It can be the result of a liquid formed by a low degree of mantle melting (Ujike and Goodwin,1987; this liquid would be richer in water and could have a high oxygen fugacity. Apparent calc-alkalic composition may be the result of fractional crystallization at high fO_2 conditions where Fe-Ti oxides precipitate. Grove and Baker (1984) have also shown that tholeiitic and calc-alkalic differentiation trends may be generated from a common basaltic parent melt and that a continuum of differentiation series intermediate between the calc-alkalic and tholeiitic trend may be produced.

Table 3 : Mean of major oxide contents for least altered andesites.

[illegible]

Table 4 : Comparison of chemistry between rocks from northern and southern sides of the HCF.

UNIT	RRA		UNDA		NA		DA	
	N	S	N	S	N	S	N	S
N.A.	4	4	17	1*	4	5	21	18
SiO ₂	62.2	62.1	57.01	58.55	57.42	56.54	58.6	57.87
TiO ₂	1.54	1.26	1.65	1.5	1.3	1.07	1.83	1.51
Al ₂ O ₃	13.87	13.55	14.4	14.71	15.59	15.68	12.83	13.07
FeO*	7.89	7.02	8.61	10.68	7.61	6.31	8.41	7.3
MnO	0.18	0.2	0.2	0.22	0.15	0.11	0.22	0.21
MgO	3.39	3.73	4.82	4.92	3.83	5.03	4.26	4.14
CaO	3.38	3.93	4.82	4.92	6.57	6.14	5.9	6.4
Na ₂ O	5.13	4.44	4.44	2.77	3.8	3.69	4.07	4.0
K ₂ O	0.54	1.01	0.62	0.3	0.32	0.79	0.46	0.28
TOTAL	98.12	97.24	95.32				96.58	94.76
N.A.	2		5	1	1	5	3	5
P ₂ O ₅	0.47		0.47	0.57	0.1	0.15	0.09	0.05
Cr	78		64	101	19		26	27
Ni	45		21	80	10		22	14
V	99		142	156	245		406	384
Nb	6.5		7		0	22	2.3	2.2
Zr	111		97	98	107	65	123	115
Y	33		30	25	25	18	44	41
Sr	124		94	134	178	120	79	119
Rb	24		5	4	0	30	3	1
Ba	214		92	70	202	120	164	159
N.A.	1		2	1	1		1	
La	10.2		10.7	9.26	11.9		9.1	
Ce	24		25	21.8	28		22	
Nd	16		15	14.6	13.5		16.5	
Sm	4.64		4.3	4.17	3.48		4.63	
Eu	1.2		1.34	1.66	0.85		1.04	
Ho	1.3		1.3	1.01	1.2		1.8	
Yb	3.9		2.9	2.35	2.9		4.2	
Lu	0.59		0.43	0.38	0.41		0.61	
Sc	24.92		57.96	33	27.01		44.81	
Co	32.6		25.85	27	32.2		33	
As			0.95				52.4	
Sb	0.09		0.12		0.15		1.9	
Hf	3.8		2.85	2.4	3.2		3.5	
Ta	1		0.51		0.6		0.6	
W	170		39.5		68		50	
Th	1.3		1.3	0.9	1.5		1	
U	0.32		0.26	0.3	0.35		0.25	

N : Northern side of HCF

S : Southern side of HCF

N.A.: Number of analyses (least altered rocks for major elements)

RRA, UNDA and DA : all data are from the mapped area

UNDA (S. of HCF): analysis is andesite No.9 from Ujike and Goodwin (1987); *:100% volatile-free

NA (S. HCF): data are from Paradis (in preparation) a few hundreds metres south of the mapped area (427-86, 428-86, 429-86, 432-86, 433-86).

Table 4 (continuation)

UNIT	WQFP		WR		SR	
	N	S	N	N	S	S
N.A.	6	1	4	1	1	
SiO ₂	79.1	77.3	76.5	68.6	63.6	
TiO ₂	0.26	0.25	0.36	0.7	0.71	
Al ₂ O ₃	10.17	11.4	10.93	13.72	13.4	
FeO*	2.23	1.36	2.77	4.89	8.9	
MnO	0.05	0.04	0.08	0.02	0.12	
MgO	0.78	0.26	0.64	2.88	2.1	
CaO	1.42	0.67	2.09	0.7	2.92	
Na ₂ O	4.1	4.78	4.18	2.21	4.0	
K ₂ O	1.24	2.92	1.16	3.0	1.25	
TOTAL	99.35	98.98	98.71	96.72	97.0	
N.A.	4	1	3	1	1	
P ₂ O ₅	0.01	0.04	0.03	0.23	0.26	
Cr	10		19	29		
Ni	5		3	0		
V	6		7	19		
Nb	11	30	8	5	30	
Zr	308	340	232	207	210	
Y	60	80	51	49	20	
Sr	84	40	43	23	130	
Rb	44	70	54	73	30	
Ba	376	590	353	617	300	
N.A.	1					
La	26.6					
Ce	60					
Nd	33.5					
Sm	8.97					
Eu	1.62					
Ho	2.8					
Yb	7.1					
Lu	1.02					
Sc	5.96					
Co	45.8					
As	0.8					
Sb	0.15					
Hf	8.9					
Ta	2.1					
W	332					
Th	3.8					
U	0.9					

N : Northern side of HCF

S : Southern side of HCF

N.A.: Number of analyses (least altered rocks for major elements)

WQFP and WR : all data are from the mapped area

WQFP tr.elem.:098-129-132-223 (N.of HCF)

WQFP (S.of HCF): analyse is 384-86 from Paradis (in preparation).

WR tr.elem.:104-105-137

SR (Splinter rhyolite) southern side of the fault: analysed is 392-86 from Paradis (in preparation) and is from a few hundreds metres south of the mapped area

SR northern side of the HCF is sample 048 in central mapped area

Table 5 : Selected trace element abundances for mafic
volcanics of the Hunter Creek Fault area.

		Zr	Y	Sr	Rb	Ba	Zr/Y
RRA	151C	128	38	61	7	266	3.37
	242	94	28	187	<10	120	3.36
UNDA	063	157	37	54	31	287	4.24
	071	109	32	99	0	74	3.41
	079	102	27	111	6	124	3.78
	135	77	31	105	0	65	2.48
	52-02	85	28	88	<10	110	3.04
NA	163	107	25	178	0	241	4.28
DA	171B	110	41	140	0	49	2.68
	171C	107	37	127	0	89	2.89
	174	144	50	100	6	324	2.88
	186	104	38	103	0	154	2.74
	196A	111	42	57	0	164	2.64
	196B	107	39	82	4	163	2.74
	202	153	51	97	6	144	3.00

RRA Rusty Ridge andesite
 UNDA Upper North Duprat andesite
 NA Newbec andesite
 DA Dufresnoy andesite

transported in aqueous fluids, except perhaps when these fluids contain high activities of certain complexing agents such as F^- , and tend to remain unaffected in rocks which have suffered metasomatic alteration.

1.1 PETROGENETIC PROCESSES

Previous workers in the Rouyn-Noranda area have proposed several distinct petrogenetic processes and models to explain the characteristics of the volcanic sequence.

Felsic magmas in the Rouyn-Noranda area were attributed to direct melting of older sialic crust by Baragar (1969), Gélinas and Ludden (1984), and Gélinas et al. (1984). Ludden et al. (1982) proposed that the calc-alkaline andesite series had a petrogenetic history different from that of the tholeiitic lavas. They suggested the presence of a preexisting felsic crust below the Blake River Group and argued that the most likely origin for the calc-alkaline andesitic magma was contamination of a tholeiitic magma by sialic crust.

On the other hand, felsic volcanic rocks were ascribed to fractional crystallization of mantle-derived mafic magmas by Capdevila et al. (1982), Ujike and Goodwin (1987) and Latfèche and Ludden (in press).

Fig.51 : a) Alkali- SiO_2 diagram and division between alkalalic and subalkalic fields. Dashed line is from Mac Donald (1968); solid line is from Irvine and Baragar (1971). Least altered rocks (100% volatile free).

b) Al_2O_3 vs $(\text{Na}_2\text{O} + \text{K}_2\text{O} + \text{CaO})$ diagram and division between per-aluminous and meta-aluminous fields (after Lafleche and Ludden, in press). Least altered rocks (100% volatile free).

Fig.52 : Major element - SiO_2 variation diagrams. Least altered rocks (100% volatile free).

Fig. 53 : Major element -MgO variation diagrams. Least altered rocks (100% volatile free).

Fig.54 : Trace elements (Y, Rb, Sr, Nb) and TiO_2 and Al_2O_3 vs Zr and SiO_2 variation diagrams.

Fig.55 : Irvine and Baragar (1971) FeO*-(Na₂O+K₂O)-MgO diagram for least altered mafic volcanics. FeO* as total iron. (100% volatile free).

Fig. 56 : Jensen ($\text{FeO}^* + \text{TiO}_2$)- Al_2O_3 - MgO diagram for mafic volcanic rocks (1974). FeO^* as total iron (Least altered mafic volcanics, 100% volatile free).

Fig. 57 : Histograms of Al_2O_3 , TiO_2 , FeO^* and MgO for the least altered rocks from Rusty Ridge, Waite, Upper North Duprat, Newbec and Dufresnoy andesites (100% volatile free).

Fig.58 : Location of rocks analyzed for rare earth elements.

Fig.59 : Rare earth element patterns for rhyolites and andesites of the Hunter Creek Fault area. (Values normalized to Leedy chondrite).

Fig.60 : Comparative rare earth element patterns from the mapped area and REE patterns from rocks exposed south of the Hunter Creek Fault area. (Filled symbols for samples north of HCF, open symbols south of HCF).

4.4 FELSIC VOLCANIC ROCKS

Felsic volcanism in the Blake River Group has been the subject of many publications in the past. Many of the analysed rhyolites were from zones of hydrothermal alteration. Nevertheless, Campbell et al. (1982;1984), Leshner et al. (1985) and Laflèche and Ludden (in press) using REE and HFS elements developed some geochemical subdivisions of rhyolitic lavas which may be related to their petrogenesis.

According to Laflèche and Ludden (in press), three groups of Archean felsic volcanic rocks may be defined based on Al_2O_3 , REE and Zr/Y . These groups are : (1) high Al_2O_3 , Zr/Y , and LREE/HREE; (2) intermediate Al_2O_3 , intermediate Zr/Y , fractionated LREE and unfractionated HREE; (3) low Al_2O_3 , CaO and high FeO^* , and unfractionated REE and Zr/Y . Felsic volcanic rocks from the Hunter Creek Fault area, as other felsic volcanic rocks from the BRG, are considered to be low Al_2O_3 rhyolites of the third group.

Leshner et al. (1985) have divided the felsic metavolcanic rocks in the Superior Province into three major groups on the basis of trace element abundances and ratios. Felsic volcanics from the BRG in the Rouyn-Noranda area are rhyolites and high-silica rhyolites from FIII felsic rock type. They are characterized by relatively flat REE

patterns. Furthermore, FIII felsic rocks were subdivided into two types; FIIIa and FIIIb.

According to Leshner et al. (1985), FIIIa rhyolites are characterized by moderately negative Eu anomalies ($Eu/Eu^* = 0.37-0.94$), high abundances of Sc and intermediate abundance of HFS with Zr/Y ratios between 4 and 7. Whereas, FIIIb felsic rocks exhibit pronounced negative Eu anomalies ($Eu/Eu^* = 0.20-0.61$), low abundances of Sc and Sr and high abundances of HFS elements with Zr/Y ratios between 2 and 6. According to Leshner et al. (1985), Waite and Amulet rhyolites would be of FIIIa type and North West rhyolite of FIIIb type.

Rhyolites in the HCF area will not be subdivided in FIIIb and FIIIa types. From comparison of trace element abundances in NWR and Cranston QFP and NWR data from Knuckey and Watkins (1982), it does not appear that data presented here fit in the FIIIb felsic rock type as defined by Leshner et al. (1985). Furthermore, it is not obvious that the NWP (NOR-55) itself is really representative of the FIIIb felsic rock type as shown by comparison of compiled data in table 6. NWR and Cranston QFP do not appear to differ in any significant way from other rhyolites in the mapped area. Differences between compiled REE data and REE data presented here are not significant and not more important for the NWP and the Cranston QFP than they are for the Waite and Amulet rhyolites. It appears that all rhyolites from the HCF area

could be classified as FIIIa type as defined by Leshar et al. (1985).

According to Ujike and Goodwin (1987), rhyolites with $[La/Yb]_N$ ratio smaller than 2.2 are considered as tholeiitic and those with ratio higher than 2.2 as calc-alkalic. The NWR would then be tholeiitic and the Cranston QFP calc-alkalic even if their REE patterns show perfect parallelism, suggesting that the Cranston QFP is consanguinous with the NWR. They also classified the rhyolites of the Mine rhyolite zone into two groups: those without quartz phenocrysts having $[La/Yb]_N \sim 2.6$, and those with quartz phenocrysts having $[La/Yb]_N \leq 1.5$. This limit is also questionable since $[La/Yb]_N$ ratios for Waite QFP and Cranston QFP are respectively 2.47 and 2.39.

Table 7 : Comparison between some selected trace elements for felsic metavolcanic rocks.

	NWR 259	CRANSTON 219	QFP NOR-55	NWR WAITE 098	QFP AMULET 151A	FIIIIa	FIIIIb
Zr/Y	4.67	4.18	3.8	4.72	4.61	4-7	2-6
Sr	30	32	8	35	33	16-61 [^]	7-88 [']
Sc	13.14	8.09	11.1	5.96	13.37	9.5-19.8 [^]	1.5-8.3 [']
Eu/Eu*	0.48	0.43	0.43	0.53	0.6	0.37-0.94	0.20-0.61
[La/Yb] [°]	2.01	2.31	1.4	2.47	3.03	1.5-2.8 [^]	1.1-2.9 [']

NOR-55 from Knuckey and Watkins (1982).

FIIIIa and FIIIIb from Leshner *et al.* (1985).

- * Interpolated between chondrite-normalized Sm and Tb for data from Leshner *et al.* (1985).
Interpolated between chondrite-normalized Sm and Ho for other data.
- ° Chondrite-normalized ratio.
- ^ Range of Sr, Sc and [La/Yb] values for FIIIIa felsic rocks from table 4, Leshner *et al.* (1985).
- ' Range of Sr, Sc and [La/Yb] values for FIIIIb felsic rocks from table 5, Leshner *et al.* (1985). NOR-55 excluded.

Table 8 : Comparison for some selected trace elements for felsic metavolcanics of the Hunter Creek Fault area.

		Zr/Y	Sr
NW rhyolite	255	4.38	19
	259	4.69	30
Cranston QFP	217	4.43	25
	219	4.18	32
Amulet rhyolite	151A	4.61	33
	214	4.46	35
Waite rhyolite	098	4.73	35
	104	4.55	49
	105	4.74	39
	137	4.28	41
	140	4.66	35
	132	4.46	50

4.4.1 Fish Roe rhyolite

No significant geochemical differences are exhibited among North West, Amulet and Waite rhyolites. Nevertheless, the Fish Roe rhyolite has very characteristic TiO_2 contents of 0.89 wt% and 1.29 wt% TiO_2 for respectively 78.1 wt% SiO_2 , 9.44 wt% Al_2O_3 and 67.1 wt% SiO_2 , 12.22 wt% Al_2O_3 (Table 9). Although few data are available; it is suggested that the Fish Roe rhyolite is the result of immiscibility processes. By comparison with work done by Philpotts (1982) on immiscible liquids preserved as two phase glassy globules in tholeiitic basalt, the FRR could represent the Si-rich liquid which is produced by immiscibility in tholeiitic basalt or andesite. On figure 61, the least altered sample from FRR plots near the average of 15 immiscible Si-rich glasses analyzed and compiled in tholeiites by Philpotts. Andesite analyses are those of least altered Newbec andesite which directly underlies the FRR. Andesitic units would more or less plot the same since they are all tholeiites. According to Philpotts (1982), regardless of whole rock composition, immiscible liquids fall within rather restricted compositional ranges, one fraction having approximately 73% silica, the other only 43%. Aluminium, potassium, and sodium preferentially enter the silica-rich liquid, whereas the HFS cations enter the silica-poor one.

The immiscibility field in natural rocks is similar to

that in the system Fayalite-Leucite-Silica (Roedder, 1951), and tie lines between conjugate liquids are essentially parallel in both. The miscibility gap is slightly wider in natural rocks than in the synthetic system, a result possibly of lower temperatures of formation (Philpotts, 1979).

Table 9 : Analyses of Fish Roe rhyolite

	18549	18550*	18551	18553	18554	18555
(wt%)						
SiO ₂	72.8	73.4	68.4	78.1	71.8	67.1
TiO ₂	1.18	1.13	1.22	0.89	1.26	1.29
Al ₂ O ₃	9.70	11.79	11.28	9.44	10.29	12.22
FeO*	5.87	3.64	7.19	1.26	2.09	4.99
MnO	0.11	0.09	0.13	0.04	0.07	0.10
MgO	1.26	1.00	2.89	0.62	1.99	2.27
CaO	5.05	1.76	2.65	1.63	4.52	4.32
Na ₂ O	1.68	4.73	1.15	3.96	1.61	0.96
K ₂ O	0.22	0.96	1.70	1.53	0.69	2.17
L.O.I.	1.63	1.06	2.99	1.00	2.21	2.39
Total	99.50	99.43	99.80	99.30	99.43	99.52

* Least altered rhyolite

Fig. 61 : Philpotts (1982) diagram showing average iron-rich (filled star) and silica-rich (open star) immiscible glasses in tholeiites. Rocks are plotted in wt%. Fish Roe rhyolite falls near the average silica-rich glass for tholeiites. The immiscibility field is included for the system fayalite-leucite-silica (Roedder, 1951).

- Hunter Mine Group, Gagnon, 1981
- Blake River Group, Ujike & Goodwin, 1987
- this study

Fig. 62 : Zr/Y variation diagram showing a trend of fractional crystallization for volcanic rocks of the Blake River Group (including the Hunter Creek Fault area).

By comparison with work done by Philpotts (1982) on immiscible liquids found in tholeiites, and although geochemical data available are limited, immiscibility processes are proposed for the formation of the titanium-rich Fish Roe rhyolite.

5 PETROGENESIS

5.0 INTRODUCTION

Association between distinct geochemical characteristics of volcanic rocks and specific tectonic environment of origin have been recognized by many workers. However, the available data seem to indicate that in many cases the major element geochemistry is similar irrespective of the exact locus of melting, and it is only with respect to detailed minor element, trace element and isotopic characterization that subtle differences appear from one tectonic environment to another.

For a given trace element to be reliable as a genetic and tectonic indicator, the measured abundances must reflect those of unaltered magmas. For example, this assumption is probably valid for REE, is not valid for Rb, and is suspect for Sr and Ba. The significance of ratios of the latter elements is also questionable.

The most successful discrimination on trace element grounds depends on the relative fractionation of the alkaline earths and high-field-strength (HFS) elements to elements such as Nb, Ta, Zr and Th. HFS elements have a high charge / radius ratio and as a result, they are not usually

transported in aqueous fluids, except perhaps when these fluids contain high activities of certain complexing agents such as F^- , and tend to remain unaffected in rocks which have suffered metasomatic alteration.

2.1 PETROGENETIC PROCESSES

Previous workers in the Rouyn-Noranda area have proposed several distinct petrogenetic processes and models to explain the characteristics of the volcanic sequence.

Felsic magmas in the Rouyn-Noranda area were attributed to direct melting of older sialic crust by Baragar (1968), Gélinas and Ludden (1984), and Gélinas et al. (1984). Ludden et al. (1982) proposed that the calc-alkaline andesite series had a petrogenetic history different from that of the tholeiitic lavas. They suggested the presence of a preexisting felsic crust below the Blake River Group and argued that the most likely origin for the calc-alkaline andesitic magma was contamination of a tholeiitic magma by sialic crust.

On the other hand, felsic volcanic rocks were ascribed to fractional crystallization of mantle-derived mafic magmas by Capdevila et al. (1982), Ujike and Goodwin (1987) and Laflèche and Ludden (in press).

5.1.1 Bimodality

Bimodal volcanism is defined as the scarcity of volcanic rocks representing magmatic liquids of intermediate composition. According to Thurston et al. (1985), bimodal volcanism implies the eruption of separate mafic and felsic magmas, the felsic magma being likely produced by anatexis. If the bimodal sequences originated by fractional crystallization, steadily decreasing proportions of the more siliceous derivatives should be present.

On the other hand, Grove and Donnelly-Nolan (1986) demonstrated that the compositional gap between andesite and rhyolite at Medicine Lake Volcano, California, has been generated by fractional crystallization at shallow crustal levels. The changes in the slope of liquidus and solidus paths might lead to the rarity of intermediate rocks in mafic-felsic suites. The liquidus surface has a shallow composition-temperature slope in the andesite-rhyolite range and the residual liquids produced over this part are less likely to be sampled than liquids on the evolved side where the composition-temperature slope steepens. A large percentage of crystals is removed over a small temperature interval, evolved liquids are sampled, and substantial amounts of gabbroic cumulates are generated. Thus, a bimodal volcanic assemblage may be produced by low pressure fractional crystallization.

The constancy in trace element ratios and the overall geochemical characteristics of the volcanic sequence suggesting that rhyolites and andesites of the HCF area are cogenetic, may favor such an origin. Detailed mapping of many of the rhyolitic complexes of the BRG has not revealed granulitic or amphibolitic xenoliths of crustal origin. In addition, geochronological studies do not reveal the existence of inherited zircons (Mortensen, 1987). The low concentration in LIL elements also mitigates against the hypothesis of partial melting, but attention has to be paid to such consideration since many LIL elements such as K and Rb are mobile, and their concentrations may decrease during alteration. Despite the general lack of cumulus phases from the HCF area, olivine pseudomorphs were observed in tholeiites of the BRG by Ludden et al. (1982), as were primary clinopyroxene microphenocrysts by Gélinas et al. (1977).

5.1.2 Fractional crystallization

The trend defined by the volcanic sequence of the HCF area and of the BRG in general on figure 62 is subparallel to the Zr axis. Modelling of the Zr/Y ratio suggested that this variation could be generally explained simply in term of fractional crystallization. Usually, partial melting will fractionate the Zr/Y ratio more effectively than fractional

crystallization which is ineffective in comparison with this process; some partial melting processes may also produce trends that are subparallel to the Zr axis. In order to determine the precise explanation, other elements, particularly Cr and Ni, must be considered.

Within volcanic suites, increase in Zr is accompanied by decrease in Cr. Since Cr is strongly partitioned into mafic phases, Cr concentration in the melt should vary little during partial melting but decrease rapidly during fractional crystallization (Pearce and Norry, 1979). This is the case for the volcanic sequence of the HCF area. From figure 63 such a decrease in Cr+Ni+V values is observable from mafic to felsic volcanics, and indicates fractional crystallization processes. The break in the fractionation trend on (Cr+V+Ti)-TiO₂ diagram may be explained by crystallization of Fe-Ti oxides. An almost continuous trend is shown between andesites and rhyolites of the HCF area. However, it does not seem from this diagram that the Dufresnoy andesite is directly related to the rhyolites. Somehow, it seems to show independant evolution.

The variation in the Ti, Zr, Y and Nb contents of a magma as it evolves to more siliceous compositions by fractional crystallization can be interpreted in terms of the nature and proportion of crystallizing phases, factors which are also indirectly related to the tectonic setting in

which the magma is generated. Following Pearce and Norry (1979), Y-Zr, Ti-Zr and Nb-Zr diagrams were used to investigate these variations (Fig.64). In order to interpret correctly the fractionation trend, it is necessary that the observed and theoretical trends should match on all variation diagrams.

On a Y-Zr diagram, the volcanic sequence exhibits a fractionation trend with slope slightly less than unity, corresponding to a combination of olivine-plagioclase-clinopyroxene $\pm$ orthopyroxene as crystallizing phases (equivalent to modelled trends 1 and 2).

According to Pearce and Norry (1979), tholeiitic fractionation trends both in island arcs and within-plate settings are characterized by crystallization of olivine, clinopyroxene and plagioclase throughout the fractionation sequence. However, in lavas from calc-alkaline volcanic arcs and some alkalic within-plate volcanoes, amphibole has been reported as a crystallizing phase at intermediate and siliceous compositions. The trend followed by the volcanic sequence in the HCF area differs from the trend followed by these volcanoes where Y decreases as Zr increases.

The mineral vectors on Ti-Zr diagram show that biotite, amphibole and magnetite (and ilmenite) can cause Ti to decrease during fractional crystallization. The observed

trend, for the volcanic sequence in the HCF area, shows increasing Ti and Zr with slopes close to unity for most mafic rocks, consistent with a crystallizing assemblage of olivine-clinopyroxene-plagioclase (trend 1). The subsequent decrease in Ti can be attributed to incoming of magnetite as a crystallizing phase.

On figure 64, the concentrations of Nb and Zr increase throughout the fractionation sequence. This is also consistent with trends observed in Y-Zr and Ti-Zr diagrams. The three variation diagrams follow modelled trends 1 and 2 in which feldspars, clinopyroxene (+/-opx), olivine and magnetite are the main residual crystallizing phases.

It appears likely that the rhyolites are derived from andesitic magmas by fractional crystallization. The HCF area comprises several andesite and rhyolite flows. Both lava sequences have similar enough ratios between incompatible elements such as Th/Zr and $[La/Yb]_N$, to suggest that they are mutually consanguineous (Table 9). According to Wood *et al.* (1979), the coefficient D_{La} is somewhat smaller than D_{Yb} during common magmatic processes, and therefore a magma derived by fractional crystallization should have a higher $[La/Yb]_N$ ratio than parental magma. However, some magmatic processes as thermodiffusion are poorly understood and partition coefficients may vary considerably depending on

the composition in silicic magmas (Mahood and Hildreth, 1983) .

Even if volcanics from the HCF area seem to be consanguinous, Dufresnoy andesite is somehow different. The DA is at the top of the stratigraphic sequence but is the least differentiated of all volcanic formations (Fig.59 & 63). Its composition is similar in many aspects to gabbrodiorite compositions (high Cr, Ni, V contents; low P_2O_5 content). It may come from a different reservoir depleted in P_2O_5 or be the result of an open system allowing the influx of new mafic parental magma.

- Hunter Mine Group, Gagnon, 1981
- Blake River Group, Ujiie & Goodwin, 1987
- this study

Fig. 62 : Zr/Y variation diagram showing a trend of fractional crystallization for volcanic rocks of the Blake River Group (including the Hunter Creek Fault area).

Fig. 63 : (Cr+V+Ni) vs Zr, Y, TiO₂ and P₂O₅ showing fractional crystallization trend for rocks of the Hunter Creek Fault area.

Fig.64: Observed fractionation trends on Y-Zr, TiO₂-Zr and Nb-Zr diagrams (after Pearce and Norry, 1979). Modelled fractionation vectors (all for F=0.5, 50% fractional crystallization) are:

- 1 : Pl 0.5, Cpx 0.3, Ol 0.2 (mafic magma)
- 2 : Pl 0.5, Cpx 0.3, Ol 0.2, Mt 0.05 (intermediate magma)
- 3 : Pl 0.6, Am 0.35, Mt 0.05 (intermediate magma)
- 4 : Pl 0.55, Am 0.2, Cpx 0.2, Mt 0.05 (intermediate magma)
- 5 : (Ksp, Pl) 0.6, Bio 0.15, Am 0.2, Mt 0.05 (felsic magma)
- 6 : Pl 0.6, Cpx 0.2, Am 0.15, Mt 0.05 (felsic magma)

B : mafic; **I**: intermediate; **A**: felsic melt composition. Am: amphibole, Ap: apatite, Bio: biotite, Cpx: clinopyroxene, Ol: olivine, Opx: orthopyroxene, Or: orthoclase, Pl: plagioclase, Mt: magnetite, Zr: zircon.

Fig. 64

Table 10 : $[La/Yb]_N$ and $100x(Th/Zr)$ ratios for volcanic rocks of the Hunter Creek Fault area.

	Number	$[La/Yb]_N$	$100x(Th/Zr)$
NWR	259	2.01	0.97
CrQFP	219	2.39	1.09
RRA	151C	1.73	1.02
RRA	1*	1.68	0.9
AR	151A	3.03	0.85
AR	2*	2.17	0.9
UNDA	52-05	2.19	1.29
UNDA	071	2.66	1.38
UNDA	9*	2.60	0.9
WQFP	098	2.47	1.22
WR	6*	2.69	0.9
NA	163	2.71	1.4
DA	196	1.43	1.08
Mean rhyolite		2.5	1.02
Mean andesite		2.14	1.19
PM		0.97	0.9
AAUC		6.6	4.6
AALC		12.10	0.21
AATC		4.4	2.9

* From Ujike and Goodwin (1987)

NWR North West rhyolite

CrQFP Cranston QFP

RRA Rusty Ridge andesite

AR Amulet rhyolite

UNDA Upper North Duprat andesite (9* is the equivalent of 071)

WQFP Waite QFP

WR Waite rhyolite

NA Newbec andesite

DA Dufresnoy andesite

PM Primordial mantle, after Taylor and McLennan (1985)

AAUC Average Archean upper crust, after Taylor and McLennan (1981)

AALC Average Archean lower crust, after Weaver and Tarney (1984)

5.1.3 Origin of parental magma

In their model calculation of fractional crystallization for the Waite rhyolite, Ujike and Goodwin (1987) assumed that the composition of the "Waite andesite" no.9 (UNDA in this study) was the parental magma as being the most primitive andesite in the formation. From the results presented in the previous section, this andesite might itself be related to more primitive andesites such as the Rusty Ridge andesite exposed near the bottom of the volcanic sequence in the HCF area. Ujike and Goodwin (1987) also used the ratio Th/Zr as a crude petrogenetic tracer. In this regard, it is significant that the studied rocks have $(\text{Th}/\text{Zr}) \times 100$ (and $[\text{La}/\text{Yb}]_N$) close to that estimated in primordial mantle (Table 9).

Hygromagmatophile element (HYG) contents in mean andesite and mean rhyolite, from the HCF area, normalized to the primordial mantle are plotted on figure 65. The elements have been arranged in order of increasing distribution coefficient values (Wood et al., 1979).

The patterns for mean rhyolite and mean andesite are broadly similar in shape, suggesting that they are cogenetic. They show depletion of the more HYG refractory elements relative to other HYG elements. They differ mainly in the absolute abundance of the elements. Despite the fact

that mean rhyolite and mean andesite display higher abundances of trace elements than primordial mantle, their patterns are not much fractionated. Fractional crystallization can under certain circumstances, have a major effect on the shapes of the patterns; for example, depletion of Ti can be explained for andesites and rhyolites by crystallization of magnetite-ilmenite. The mantle source may also be enriched in some incompatible elements relative to the primordial mantle.

Crustal contamination

It has been advocated that the likely origin of Noranda calc-alkalic lavas is contamination of tholeiitic magma by sialic crust enriched in incompatible elements such as LREE and Zr (Gélinas and Ludden, 1984). The Archean upper crust does not appear as a possible contaminant in the generation of the felsic volcanics of the HCF area. The trace element signature is too different. Figure 66 also demonstrates that volcanic rocks from the HCF area do not have Zr and Th concentrations close to the Archean average total crust. Crustal material of known composition is unlikely to have contributed appreciably in the origin of the felsic and andesitic magmas through assimilation or remelting processes. However, it is possible that a particular crust, significantly different in composition from the average Archean crust and having Th/Zr ratios and

Th-Hf-Ta relations similar to the primitive mantle composition, was involved in the petrogenesis of the volcanic sequence in the HCF area.

5.2 COMPARISON WITH MODERN TECTONIC SETTINGS.

Different tectonic models were proposed by previous workers to explain the particular features of the Rouyn-Noranda and adjacent areas.

Dimroth et al. (1982,1983) considered the Abitibi belt to be the Archean analog of an immature island-arc of Cenozoic age. This tectonic model involves a north-dipping subduction zone through the mantle below Rouyn-Noranda. Gélinas and Ludden (1984) suggested that the BRG, and probably the entire southern Abitibi belt, represents the vestiges of an Archean continental rift zone. Ludden and Hubert (1986) proposed that the volcanic rocks of the Timmins and Val d'Or region as those of Rouyn-Noranda were also erupted in a series of rift basins. For Ujike and Goodwin (1987), the Archean felsic volcanism occurred in a back-arc-type spreading setting. For Laflèche and Ludden (in press), the southern Abitibi belt represents a series of volcanic assemblages that were related to plate convergence (Hunter Mine Group and Misema Sub-group) which in the final stage of evolution were rifted as a result of back arc extension or the propagation of a ridge axis. The

consequences of this rifting episode were the eruption of extensive mafic and ultramafic lava (the Kinojévis Group) and fractionation of mafic magmas in shallow reservoirs to form the bimodal assemblages of the Blake River Group.

Many studies were carried out concerning trace elements and tectonic setting discrimination. Most of the discriminant diagrams were built with data from Phanerozoic volcanic environments. There is a certain danger of assuming that the diagnostic trace element discriminants employed for these volcanics can be used unambiguously for older suites, especially those of Archean age. There is also some ambiguity about the uniqueness of tectonic association with certain geochemical signatures. Mixed signals are not rare in magmatic environments. However, careful consideration of these discriminant factors may help in the recognition of ancient tectonic environments.

According to Pearce et al. (1984), Y (or Yb) and Nb (or Ta) are likely to be effective elements for tectonic discrimination of granites and rhyolites. On figure 67a most of the rhyolites from the HCF area fall within the Ocean Ridge granite field. This group encompasses granitic rocks that either belong to the oceanic crust itself or form part of layered ophiolite sequences. On Yb-Al₂O₃ diagram, these rocks also fall within the oceanic field and are considered as low-Al₂O₃ rhyolites. However the boundaries between these

fields should not be considered sharp since rocks from the mature stages of island arc development and those in the early stages of continental margin development should show values which are transitional between the two groups.

Hf/3-Th-Ta diagram was also used to discriminate between magma series erupted in different tectonic settings. The advantage of this diagram is that silicic magmas plot reasonably close to their mafic parents and can therefore also be discriminated (Fig.68).

Felsic rocks from the HCF area fall within the E-Type MORB field whereas some mafic rocks fall between the destructive plate margins field and the E-Type MORB field.

According to Wood et al. (1979), E-Type MORB are extruded at ridge segments with positive residual gravity. Depth and heat flow anomalies are often associated with "hot spots", which generate basalts enriched and more rarely depleted in the more HYG elements. E-Type MORB consists predominantly of tholeiitic basalts but shows greater variation in HYG element and radiogenic isotope ratios than N-Type MORB. The volcanic rocks from the HCF area would fall within the E-Type MORB field. However utilization of Hf/3-Th-Ta ternary diagram is suspect since a Ta-tungsten carbide shat-

ter box was used in the rock powder preparation, causing possible Ta contamination. On Hf-Th diagram (Fig.69), rocks of the Rouyn-Noranda area also follow the E-MORB (Famous Red Sea) fractional crystallization trend as defined by Treuil and Varet (1973).

All these discrimination diagrams indicate the possible association of the volcanic rocks of the HCF area with oceanic type of setting when compared with modern tectonic setting. They may be related to a rifting episode of a basaltic crust allowing the ascent of mafic magma from a deep mantle-source.

5.3 CONCLUSION

Despite the lack of cumulus phases in the lava flows, it appears likely that cogenetic felsic and mafic rocks of the HCF area could have been derived by fractional crystallization of a mafic primitive mantle magma source in shallow-level magma chambers leaving clinopyroxene (+/- orthopyroxene), olivine and magnetite (ilmenite) in the residual liquid. Crustal material of known composition is unlikely to have contributed appreciably to the origin of the felsic magmas through assimilation or remelting processes. Comparison with modern tectonic settings indicate a possible association of the volcanic rocks of the HCF area

with an ensimatic type of setting. They may be related to the rifting of a mafic crust resulting from an episode of back arc extension.

Fig.65 : Hypermagmatic element concentrations in mean rhyolite and mean andesite normalized to primordial mantle. Data is from Taylor and McLennan (1985).

Fig. 66 : Zr-Th variation diagram. Primordial mantle plots near the origin. AATC: Average Archean total crust, from Taylor and McLennan (1985). AALC: Average Archean lower crust, from Weaver and Tarney (1984). AAUC: Average Archean upper crust, from Taylor and McLennan (1981). Compiled data from Blake River Group (BRG) are from: Ujike and Goodwin (1987); Ujike (1983); Leshner *et al.* (1986); Verpaelst (1985) and Laflèche (1986).

Fig.67 a) Nb-Y discriminant diagram for granitic rocks. After Pearce et al. (1984).

b) Yb-Al₂O₃ diagram discriminating between low-Al₂O₃ (oceanic) and high-Al₂O₃ (continental) granitic rocks. After J.G. Arth (1979).

Fig.68 : Hf/3-Th-Ta diagram to discriminate between magma series erupted in different tectonic settings (after Wood et al., 1979).

Fig.69 : Hf-Th variation diagram. N-MORB and Famous Red Sea trends from Treuil and Varet (1973).

6 LITHOSTRATIGRAPHIC CORRELATION

6.0 INTRODUCTION

Stratigraphic correlations in the HCF area were established previously by de Rosen Spence (1976) after Spence and Karis (1967), by Gibson (in preparation) and by Paradis (in preparation).

The proposed correlations by de Rosen Spence (Fig.70) implied a westward disappearance of about 850 m of volcanics across the HCF. She suggested the disappearance of the Amulet rhyolite (VIII_A), the Waite andesite (IX) and the lower flows (X_{W1} and X_{W2}) of the Waite rhyolite on the northern side of the HCF and other units. The upper part of the succession on either side of the fault was mainly established using the unusual features of the Fish Roe rhyolite (XV_{FR}). De Rosen Spence also stated that the Upper North Duprat rhyolite flows west of the Dufresnoy Diorite were not the continuation of the Waite rhyolite flows but that both rhyolites were erupted contemporaneously from two distinct centres.

Stratigraphic correlations made by Gibson (1984) in the HCF area were mainly those of de Rosen Spence (1976). He

correlated the Lower North Duprat andesite (VI_{LND}) north of HCF to the Rusty Ridge andesite (VII_{RR}) south of the HCF. Following de Rosen Spence, he suggested the disappearance of the Amulet rhyolite and of the Waite andesite in the Hunter block. Gibson correlated the Upper North Duprat rhyolite north of HCF with the Waite rhyolite, south of HCF. He also suggested the presence of Newbec and d'Alembert andesites on both sides of the HCF.

Paradis (in preparation) suggested that the extension of the Newbec andesite was exposed on the northern side of the HCF.

6.1 LITHOSTRATIGRAPHIC CORRELATION ACROSS THE HUNTER CREEK FAULT

Due to the lack of exposures, it is usually impossible to make flow to flow correlation in the HCF area. From the bottom to the top of the stratigraphic sequence, the following correlations are made across the HCF :

The North West rhyolite (VI_{NW}) is found on both sides of the fault, but its thickness is not defined in the mapped area. It was previously correlated with the Lower North Duprat rhyolite (VI_{LND}) north of the HCF by de Rosen Spence (1976). The thin exhalative tuff unit exposed near the top of the NWR on the southern side of the fault was not

identified on the northern side. A thin andesitic flow breccia unit is contained within the NWR on the northern side of the fault and does not outcrop on the southern side of the HCF. However, a similar andesitic unit was observed near the top of the MWR at the Ansil Mine (M. Labrie, Minnova Inc. geologist, pers. comm.). The Cranston QFP is exposed on both sides of the HCF (Fig. 6) but it is not exposed on the western side of the diorite dyke in Lot 55, Range VII, Duprat Township.

The Rusty Ridge andesite (VII_{RR}) is exposed on both sides of the HCF, and ends on the northern side within the mapped area. Its thickness is very variable. The Rusty Ridge andesite was not recognized by de Rosen Spence (1976) north of the HCF.

The Amulet rhyolite (VIII_A, lower member) is best exposed on the southern side of the HCF. West of the diorite dyke (Lot 55, Range VII), highly fractured and poorly exposed rhyolite overlying the RRA may be related to the AR. The AR is intruded by a few QFP dykes or sills on both sides of the HCF. Such QFP dykes or sills are also encountered in drill holes crosscutting the AR.

The Waite andesite (IX) is best exposed on the southern side of the HCF. A few isolated andesite exposures are found in the Hunter block in the central part of the

mapped area. This part of the mapped area was previously correlated with the Upper North Duprat rhyolite (X_{UND}) by de Rosen Spence (1976), in which no andesitic unit was identified. Nonetheless, a few andesitic outcrops were actually mapped and andesite was also encountered in drill holes DT-53 and DT-54. This andesite may be correlated with the WA. The Upper North Duprat rhyolite (X_{UND}) was not recognized in the central area. However, of interest is the presence of lava flows of intermediate composition ($\sim 65\%$ SiO_2 , $\sim 0.4-0.73$ TiO_2) mapped in the field and seen in drill holes DT-53 and DT-54. These rhyolites might be correlative with the Splinter rhyolite which is also a volcanic unit of general intermediate composition. The Splinter rhyolite was defined by Paradis (in preparation) on the southern side of the HCF where it is mainly contained within the WA. South of the HCF, the thickness of the WA rapidly decreases on both sides of the Splinter rhyolite toward the fault in such a way that no important difference in the thickness of the WA is evident north of the HCF.

The Waite rhyolite (X_W) overlies the Waite andesite and is exposed on both sides of the HCF. However, all flows are unevenly exposed and some flows end in the Hunter block. The WR is thicker on the southern side of the HCF, but no abrupt change in thickness is observable. WR is easily correlated by the QFP flow well exposed on both sides of the HCF.

Upper North Duprat andesite was subdivided by de Rosen Spence (1976) into a lower (XI_{UND}) and an upper member (XIII_{UND}) which were not recognized in the HCF area. The Upper North Duprat andesite is underlain and overlain by the WR. Its thickness rapidly decreases from the north-west toward the HCF. However a few outcrops correlated with the UNDA are found on the southern side of the HCF where it was correlated with the New Vauze andesite by Paradis (in preparation).

Newbec andesite (XIII_{NB}) overlies the Waite QFP and is also exposed on both sides of the fault. Near its contact with the latter, rhyolitic QFP fragments are found within the breccias exposed at the based of the NA. The thickness of the NA seems to be similar on both sides of the HCF with respect to the change in dips. Newbec andesite was previously correlated by de Rosen Spence (1976) with the Upper member (XIII_{UND}) of the Upper North Duprat andesite. She stated that the upper member of the UNDA was directly overlain by the Fish Roe rhyolite (XV_{FR}). However, the UNDA is directly overlain by the Waite rhyolite (QFP member) which is up to 100 m thick north of the HCF. In fact, the Fish Roe rhyolite should be separated from the UNDA by approximately 500 m.

Fish Roe rhyolite (XV_{FR}) is exposed on both sides of the HCF. Its high titanium content and particular spherulitic texture make correlation possible even if there is a real lack of exposure. FRR exposures in the Hunter Block are separated by some 6 km from FRR outcrops in the southern block. Its apparent thickness is about 80 m in the mapped area but less than 20 m south of the mapped area (S.Paradis, pers. comm.).

D'Alembert andesite (XVI_{DL} and XX_{DL}) is not exposed on either sides of the fault in the mapped area.

The thickness of the Dufresnoy andesite (XXIV) is undetermined, only the lower part being exposed in the mapped area. It is well exposed on both sides of the HCF. A small rhyolitic feldspar porphyry dome was mapped within the DA. This dome is not correlated with any other rhyolitic unit in the mapped area.

6.3 CONCLUSION

Despite the poor exposure in the central area of the map, correlations were made for most of the volcanic units in the mapped area. The HCF does not seem to represent a syn-volcanic structure, and no major displacement is apparent along it. Variation in thicknesses may be explained in many cases by other topographic features.

Fig.70 : Lithostratigraphic correlation between Hunter block and part of Flavrian block. From de Rosen Spence (1976). Legend on next page.

1

INTENSIVE ROSES

INTRUSIVE FORMATIONS

Figures refer to internal equivalents within formation

Range number : formation number, Arabic number : flow number

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V2 **Quartzite**
 V3 **Dacite**
 V6 **Andesitic to dacitic tuffaceous**
 1 **Fine tuff**
 2 **Explosive tuff, light to orange**
 3 **Abundant angular clay breccia**
 4 **Phagocytes in sand / silt, clay**
 5 / 6 **Quartzite / dacite stone**
 7 **Sandstone, calcareous**
 8 **Magnetite crystallization**
 9 **Chert**
 10 **Sandstone other than 9**
 11 **Gravelly sandstone or silt**
 12 **Full**

Fig.70 (continuation)

Fig.71 : Lithostratigraphic correlation across the Hunter Creek Fault.

7 CONCLUSIONS

The subaqueous volcanic succession in the Hunter Creek Fault area reflects in a broad manner an upward-shoaling sequence. Volcanic facies are essentially similar on both sides of the HCF. There is no marked change in volcanic facies near or across the HCF. No indication of slumping, megabreccia, talus or sedimentary breccia, or abrupt termination of flow indicating collapse, subsidence or any difference in level was observed along or near the HCF. The trace of the HCF is not marked by any specific alteration assemblages indicative of more or less intense hydrothermal alteration from the circulation of fluids through a fault zone. It does not appear to be intruded by "feeder" dykes. From volcanic features, there is no specific indication to suggest that the HCF is a syn-volcanic fault.

In the HCF area, strata are folded in an asymmetrical north-east plunging fold, a more or less open flexure with rounded hinge. Average strike and dip range from N000/50 to N260/80. Two deformation corridors were identified; the first corridor is approximately 1 km wide, has a N250-N270 trend and formed during D₂. All earlier structural elements were more or less transposed subparallel to it. The second corridor is oriented N240 and is parallel to the trace of the HCF, which is a major structure, more than 30 km long.

The HCF appears to be a reverse-slip fault with minor displacement producing an apparent right-handed movement. The fault has a general trend of N240-N250 and dips approximately at 70° toward the northwest. N240 and N060 trending structures clearly crosscut D₂ east-west structures.

Despite the poor exposure in the central part of the HCF area, correlations across it were made for most of the volcanic units. The North West rhyolite (VI_{NW}), the Rusty Pidge andesite (VII_{RR}) and the Amulet rhyolite (VIII_A) are found on both sides of the HCF. Two thin andesitic flows exposed on the northern side of the HCF and separated by a lava flow of intermediate composition are correlated with the Waite andesite (IX); the intermediate flow is correlated with the Splinter rhyolite as defined by Paradis (in preparation) south of the HCF. The Waite rhyolite (X_W) overlies the Waite andesite and is exposed on both sides of the HCF. The Waite rhyolite is thicker on the southern side of the HCF, but no abrupt change in thickness is observable. Waite rhyolite is correlated by the QFP flow well exposed on both sides of the fault and by its overall succession of flows similar south and north of the HCF. The Upper North Duprat andesite is underlain and overlain by the Waite rhyolite. Its thickness rapidly decreases from the northwest toward the HCF. However, a few outcrops correlated with the UNDA are found on the southern side of the HCF. Newbec

andesite has a slightly higher aluminum content and is the most fractionated of all andesites; it is exposed on both sides of the HCF as are the Fish Roe rhyolite (XV_{FR}) and the Dufresnoy andesite (XXIV). The high titanium content and particular spherulitic texture of the Fish Roe rhyolite make correlation possible despite the lack of exposure. The Dufresnoy andesite is well exposed on both sides of the HCF, whereas D'Alembert andesite (XVI_{DL} and XX_{DL}) is not at all.

Volcanic rocks from the HCF area are sub-alkaline and meta-aluminous. They form a bimodal sequence. All mafic volcanic rocks appear to be of tholeiitic affinity and no calc-alkaline unit is defined in the mapped area. Slight differentiation is shown by increasing Al₂O₃ content and Zr/Y ratios, and relative fractionation of REE toward the top of the volcanic succession from Rusty Ridge andesite to Newbec andesite. Dufresnoy andesite has a different chemical signature, emphasized by its low Al₂O₃ content and Zr/Y and by unfractionated REE pattern. Despite the fact that no cumulate inclusions were identified in the lava flows, the constancy in trace element ratios and the overall geochemical characteristics of the volcanic sequence suggest that rhyolites are derived from andesitic magma by fractional crystallization.

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A P P E N D I C E S

APPENDIX 1 : LABORATORY ANALYTICAL METHODS

All samples with numbers in the GX 17000 series were analysed for SiO_2 , Al_2O_3 , TiO_2 and Au at Metriclab by X-ray fluorescence or atomic absorption and for FeO, MgO, CaO, Na_2O , K_2O , Cu, Zn and Ag at Minnova Inc. laboratory by atomic absorption spectrophotometry. All samples with numbers in the GX 18000 and LDX series were analyzed at Metric Lab by X-ray fluorescence or atomic absorption for SiO_2 , Al_2O_3 , TiO_2 , FeO, MnO, MgO, CaO, Na_2O , K_2O , Au, Ag, Cu, Zn and Ni. L.O.I. determination for these samples were also done at Metric Lab.

51 samples (with numbers smaller than 1 000) were selected for major and trace elements analysis. They were analysed at the University of Ottawa using a fused pellet X-ray fluorescence technique for 10 major oxides : SiO_2 , TiO_2 , Al_2O_3 , Fe_2O_3 , MnO, MgO, CaO, Na_2O , K_2O , P_2O_5 , and 11 trace elements : S, Ba, Cr, Zr, Sr, Rb, Y, Nb, Zn, Ni, V. Sample pellets were analysed by a Phillips PW 1410 X-ray spectrometer. The pellets consisted of 1.5 g of sample powder fused together with 0.5 g of lithium carbonate (Li_2CO_3) and 4.5 g of lithium tetraborate ($\text{Li}_2\text{B}_4\text{O}_7$). L.O.I. determination was also determined at the University of Ottawa.

Nine samples out of the 51 (same powder) were also analysed for rare earth elements by instrumental neutron activation at the Université de Montréal. The following elements were determined : La, Ce, Nd, Sm, Eu, Ho, Yb, Lu, Sc, Cr, Co, As, Sb, Ba, Hf, Ta, W, Th, U. Irradiation of sample powders was four hours long and carried out in a SLOWPOKE 2 nuclear reactor under a 10^{12} neutrons / cm^2 . sec

flux. Two counts were done, the first one after 30 days and the second one after 60 days. G.Gauthier was in charge of the analyses at J.Ludden laboratory at the Université de Montréal. Detailed experimental method description is found in Paradis (1984).

Table 11 : Rare earth element duplicate analyses

	1-196A	196A
La	9.30	9.10
Ce	23.00	22.00
Nd	14.80	16.50
Sm	4.82	4.63
Eu	1.09	1.04
Ho	1.70	1.80
Yb	4.00	4.20
Lu	0.64	0.61
SUM	59.35	59.88
Sc	44.90	44.81
Cr	30.00	33.00
Co	52.40	52.40
As	nd	1.90
Ba	175	186
Hf	3.80	3.50
Ta	0.60000	0.60000
W	48.00	50.00
Th	1.20	1.00
U	0.30000	0.25000

Table 12 : Trace and major elements duplicates (same powders)

	063	063D	189	189D	196A	196A-D
SiO ₂	63.18	63.36	54.91	55.31	52.70	52.73
TiO ₂	0.83	0.83	1.46	1.46	1.34	1.34
Al ₂ O ₃	13.00	13.01	13.65	13.73	14.59	14.54
Fe ₂ O ₃	9.38	9.43	10.35	10.41	11.61	11.62
MnO	0.20	0.20	0.21	0.21	0.24	0.24
MgO	2.61	2.64	3.74	3.89	6.93	6.69
CaO	3.15	3.16	7.59	7.64	6.36	6.37
Na ₂ O	3.39	3.44	3.30	3.24	4.49	4.84
K ₂ O	1.09	1.10	0.40	0.40	0.38	0.39
P ₂ O ₅	0.32	0.34	0.07	0.04	0.05	0.05
S	0.05	0.04	0.05	0.06	0.03	0.03
Ba	287	294	178	218	164	164
Cr	24	29	18	21	32	42
Zr	157	162	111	113	111	110
Sr	54	52	127	124	57	57
Rb	31	32	0	0	0	1
Y	37	38	41	43	42	39
Nb	6	6	3	3	0	3
Zn	77	97	85	83	118	124
Ni	0	4	18	11	34	25
V	21	6	414	428	412	401
L.O.I.	4.60	4.64	5.32	5.24	2.87	2.70
total	101.8	102.19	101.6	101.54	101.59	101.54

	202D	202
SiO ₂	57.26	57.12
TiO ₂	1.60	1.60
Al ₂ O ₃	14.46	14.60
Fe ₂ O ₃	9.37	9.20
MnO	0.19	0.17
MgO	4.92	4.93
CaO	5.93	5.92
Na ₂ O	4.35	4.31
K ₂ O	0.52	0.52
P ₂ O ₅	0.14	0.18
S	0.03	0.03
Ba	144	144
Cr	15	13
Zr	154	153
Sr	99	97
Rb	7	6
Y	52	51
Nb	6	4
Zn	80	77
Ni	8	16
V	382	375
L.O.I.	2.61	2.76
TOTAL	101.38	101.34

Table 13 : Major elements duplicates (same rock sample)

186 = GX17434 188 = GX17436 196A = GX17449

SiO ₂	76.23	77.7	53.3	54.2	52.70	56.5
Al ₂ O ₃	10.36	10.65	12.88	12.44	14.59	13.98
TiO ₂	0.43	0.47	1.36	1.38	1.34	1.52
FeO	2.65	4.95	9.26	7.33	10.44	5.05
MgO	1.25	2.50	3.77	3.50	6.93	5.63
CaO	1.79	0.89	9.17	8.56	6.36	6.88
Na ₂ O	0.78	0.51	3.66	3.00	4.49	4.36
K ₂ O	3.37	2.41	0.17	0.19	0.38	0.27
TOTAL	96.86	100.0	93.57	90.6	97.23	94.19

196B = GX17453 214 = GX17618 217 = GX17620

SiO ₂	52.03	54.10	73.55	74.80	77.80	79.10
Al ₂ O ₃	13.99	12.90	11.43	11.31	11.71	9.18
TiO ₂	1.40	1.58	0.33	0.55	0.19	0.26
FeO	12.80	8.62	4.28	3.92	2.55	2.35
MgO	6.40	5.43	0.87	1.02	1.07	1.06
CaO	6.69	7.16	1.40	1.03	0.22	0.33
Na ₂ O	3.09	2.31	5.44	4.96	3.95	3.50
K ₂ O	0.48	0.31	0.35	0.31	1.75	1.34
TOTAL	96.88	92.41	97.65	97.9	99.24	97.12

219 = GX17623

SiO ₂	76.92	79.10
Al ₂ O ₃	11.82	11.28
TiO ₂	0.18	0.26
FeO	2.80	2.57
MgO	0.72	0.96
CaO	0.32	0.39
Na ₂ O	4.56	4.04
K ₂ O	1.53	1.49
TOTAL	98.85	100.09

Table 14 : Accuracy of analysis from U. of Ottawa Lab.

(Based on 10 fusions of felsic standard SY-2, all run once.)

Oxide	$\bar{x}$	s.d	R.V.
SiO ₂	60.18	0.168	60.09
Al ₂ O ₃	12.23	0.103	12.15
Fe ₂ O ₃ *	6.25	0.036	6.29
MgO	2.69	0.047	2.61
CaO	7.96	0.059	8.00
Na ₂ O	4.37	0.067	4.35
K ₂ O	4.52	0.04	4.51
TiO ₂	.14	0.005	0.15
P ₂ O ₅	0.43	0.015	0.42
MnO	0.33	0.000	0.32
S	0.017	0.12	0.01
Ba	467	5.17	460
Cr	9.8	8.1	10
Zr	269	3.67	270
Sr	256	7.15	270
Rb	222	3.92	220
Y	123	2.53	130
Zn	239	31.66	250
Ni	2.1	3.2	10

$\bar{x}$: mean
s.d.: standard deviation
R.V.: reference value

Table 15 : Leedy chondrite values used in normalization of REE.

La	0.315 (ppm)
Ce	0.813
Pr	0.116
Nd	0.597
Sm	0.192
Eu	0.072
Gd	0.259
Tb	0.049
Dy	0.325
Ho	0.073
Gr	0.213
Tm	0.030
Yb	0.208
Lu	0.0323 (after, Masuda <u>et al.</u> , 1973)

APPENDIX 2 : DETERMINATION OF LEAST ALTERED ROCKS

The least altered samples used in major elements diagrams were determined as follow:

- 1) No anomalous normative minerals (CIPW norm)
 Normative corundum < 1.0
 No normative wollastonite
 No normative nepheline
- 2) Na_2O (wt%) > 3.20
- 3) K_2O (wt%) < 3.00
- 4) Volatile < 3.8 wt% , except for highly vesiculated andesitic lava, volatile < 6.00 wt%

Parameters are mostly those of Gélinas et al., (1977, 1982). Less than 1.0 normative corundum was allowed instead of 0% normative corindon as suggested by Gélinas. Normative corindon is mostly found in rhyolites. This amount is in agreement with the amount of normative corindon allowed by Chappell and White (1974) for I-type granites and rhyolites (< 1%). Up to 6 wt% volatile was allowed for highly vesiculated lava when all other parameters were respected.

Table 16 : Distribution of least altered samples.

North West Rhyolite

GX 18510

Andesite flow in NWR

260 GX 17658 GX 17662

Rusty Ridge andesite

151C	242	GX 17397	GX 17398	GX 18526
GX 18534	GX 18538	GX 18541	GX 18543	

Amulet Rhyolite

214 GX 18527 GX 18528 GX 18531 GX 18478

Waite andesite

GX 18519 GX 18520 GX 18522 GX 18521 GX 18523

Central QFP

GX 17209

Waite rhyolite

098	104	GX 17244	GX 17248	GX 17172	GX 17174
GX 17190	GX 17198	GX 17414	GX 17186		

Dufresnoy QFP

GX 17403

Upper North Duprat andesite

71	52-05	GX 17234	GX 17326	GX 17236
GX 17151	GX 17156	GX 17157	GX 17194	GX 17385
GX 17194	GX 17353	GX 17354	GX 17365	GX 18460
GX 17628	GX 17638	GX 18458	GX 18459	GX 18461
GX 18465	GX 18467			

Newbec andesite

163 GX 17408 GX 18558 GX 18560

Fish Roe rhyolite

GX 18550

Dufresnoy andesite

171C	174	196	202	GX 17415	GX 17425
GX 17426	GX 17444	GX 17457	GX 17458	GX 17460	GX 17466
GX 17467	GX 17474	GX 17477	GX 17485	GX 17489	GX 17492
GX 17493	GX 17462	GX 17465	GX 17416	GX 17418	GX 17423
GX 17427	GX 17429	GX 17438	GX 17440	GX 17442	GX 17449
GX 17454	196B	GX 18603	GX 18604	GX 18605	GX 18609
GX 18612	GX 18614	GX 18625			

Feldspar porhyry dome in Dufresnoy andesite

GX 18617

Diorites

19-01

Others

GX 17172	GX 18472	GX 18473	GX 18474	GX 18475
GX 18476	GX 18455			

APPENDIX 3 : GEOCHEMICAL DATA

Common abbreviations used for sample descriptions

amygd.	amygdaloidal
and.	andesite
band.	banding or banded
Cp	chalcopyrite
fl.	flow
felds.	feldspar
fragm.	fragment
gr.	grain or grained
hyalo.	hyaloclastite
interm.	intermediate
mas.	massive
min.	mineralized
phenocr.	phenocryst
Po	pyrrhotite
porp.	porphyry
Py	pyrite
QFP	rhyolitic quartz and feldspar porphyry
qz	quartz
rhyo(l).	rhyolite
Sp	sphalerite
spherul.	spherulitic
volc.	volcanic

	NUMBER	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O	Au	Ag	Cu	Zn	total	sample description
1	GX 17201	46.8	2.50	12.23	9.77	4.57	8.23	1.81	10	5	1.5	48	96	86.01	diorite
2	GX 17202	52.4	2.40	12.19	8.74	3.71	7.73	2.43	39	5	7.0E-1	39	72	89.99	diorite
3	GX 17203	54.5	.64	16.19	3.86	6.23	8.85	2.80	27	6	7.0E-1	28	52	93.34	and. dyke in diorite
4	GX 17204	52.6	1.04	14.37	4.37	6.17	7.56	3.88	19	5	7.0E-1	50	80	90.18	diorite
5	GX 17205	52.8	1.32	13.59	7.14	5.57	8.62	2.37	27	5	1.7	110	86	91.68	diorite
6	GX 17206	55.5	1.27	15.44	6.36	5.37	5.04	2.83	96	6	1.4	10	67	92.77	and. breccia
7	GX 17207	76.2	.54	12.22	2.85	1.13	1.01	4.48	1.35	9	7.0E-1	42	41	99.78	mas. QFP
8	GX 17208	60.7	.66	18.17	3.28	1.19	1.40	9.06	.11	11	1.0	6	66	94.57	mas. QFP
9	GX 17209	62.0	.62	16.81	4.09	1.29	1.90	7.66	.43	6	1.0	4	65	94.80	rhyolite
10	GX 17210	80.2	.39	10.89	1.77	.40	.67	5.12	.43	7	7.0E-1	33	28	99.87	rhyolite
11	GX 17211	80.2	.29	11.40	1.57	1.76	.84	.49	2.89	8	3.0E-1	5	28	99.44	QFP
12	GX 17212	81.7	.27	10.61	1.76	.60	.73	5.23	.12	7	3.0E-1	5	19	101.02	QFP
13	GX 17213	85.7	.24	7.86	1.58	.35	.14	2.59	1.23	5	7.0E-1	13	10	99.69	min. QFP (28 Py)
14	GX 17214	83.0	.23	10.33	1.18	1.69	.39	2.86	.60	7	1.0	6	16	100.28	min. QFP (28 Py)
15	GX 17215	82.7	.26	10.69	.58	1.09	.20	4.58	.34	9	3.0E-1	11	14	100.44	QFP
16	GX 17216	84.3	.30	10.78	2.06	.23	8.00E-2	.35	3.08	5	7.0E-1	4	11	101.18	min. QFP (28 Py)
17	GX 17217	83.1	.31	11.17	1.38	.20	.10	.40	3.18	7	1.4	5	9	99.84	min. QFP
18	GX 17218	80.5	.39	10.65	3.60	1.06	.42	2.05	1.64	10	7.0E-1	14	17	100.31	min. QFP (28 Py)
19	GX 17219	81.3	.37	10.62	3.47	1.09	.45	2.10	1.54	6	7.0E-1	16	20	100.94	rhyolite
20	GX 17220	80.2	.22	9.68	6.94	.46	2.46	2.00	1.69	6	1.0	30	23	103.65	min. QFP (38 Py)
21	GX 17221	74.9	.51	12.03	3.15	1.52	.98	.73	3.13	6	1.0	75	272	96.95	felsic dyke
22	GX 17222	72.3	.66	11.94	4.69	1.96	.50	2.97	1.23	6	1.0	18	110	96.25	intern. volcanic
23	GX 17223	71.4	.61	13.92	2.73	1.49	.73	1.94	3.37	7	7.0E-1	13	85	96.19	intern. volcanic
24	GX 17224	75.2	.51	12.61	2.85	1.46	.70	1.94	3.28	8	7.0E-1	13	74	98.55	intern. volcanic
25	GX 17225	75.0	.57	12.16	3.66	1.36	1.23	2.00	2.84	6	7.0E-1	14	66	98.82	intern. volcanic
26	GX 17226	54.3	1.94	14.22	9.19	5.44	2.18	2.16	1.59	5	1.7	11	90	91.02	and. dyke
27	GX 17227	81.7	.35	11.05	2.38	.43	.78	2.97	1.83	6	7.0E-1	32	122	101.49	QFP flow
28	GX 17229	81.8	.31	10.84	1.54	.13	.39	5.34	.65	7	7.0E-1	25	85	101.00	QFP flow
29	GX 17230	61.6	1.69	12.71	5.04	2.65	6.55	5.23	.14	5	1.0	45	149	95.61	amyl. and. pillow
30	GX 17231	51.0	1.66	12.96	11.32	4.44	6.22	3.67	5.00E-2	7	2.0	55	162	91.32	amyl. and. pillow
31	GX 17232	54.6	1.54	13.91	8.74	4.04	4.93	2.64	2.07	10	1.4	8	60	92.47	mas. andesite
32	GX 17233	49.1	1.19	14.49	6.17	8.29	7.39	2.53	.72	7	1.0	100	113	89.88	diorite

	NUMBER	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O	Au	Ag	Cu	Zn	total	sample description
1	GX 17234	61.9	1.60	13.72	6.88	2.65	3.53	4.31	1.16	8	1.0	35	122	96.75	amyl. and. flow brec.
2	GX 17235	59.5	1.27	11.82	8.10	2.78	7.17	3.45	.34	7	1.4	44	106	94.43	amyl. and. flow brec.
3	GX 17236	59.5	1.92	14.49	5.34	2.39	4.59	4.31	1.49	7	1.0	18	70	94.03	and. fragm. in flow brec.
4	GX 17237	32.8	1.86	13.82	18.39	7.56	6.10	.32	.14	6	3.1	123	245	80.99	and. matrix in flow brec.
5	GX 17238	57.0	1.75	13.30	7.97	3.65	4.07	2.86	1.06	6	1.4	32	95	92.46	amyl. and. flow brec.
6	GX 17239	47.9	1.88	13.18	10.03	4.77	7.11	3.07	.39	7	2.0	45	106	88.33	amyl. and. flow brec.
7	GX 17240	56.9	1.28	17.04	6.11	3.98	1.01	6.20	1.06	7	1.4	88	77	93.58	mass. amyl. and. flow brec.
8	GX 17243	78.0	.30	10.69	2.64	.40	1.46	3.29	1.59	6	7.0E-1	33	82	90.57	QFP flow
9	GX 17244	81.1	.22	9.84	2.29	.36	1.57	3.77	1.04	7	3.0E-1	22	62	100.19	QFP
10	GX 17245	54.6	1.37	12.63	7.20	3.71	7.73	3.83	.14	7	1.7	45	100	91.21	amyl. and. flow brec.
11	GX 17246	55.7	1.97	15.90	5.40	2.72	4.70	6.69	.36	9	1.7	28	78	93.44	amyl. and. flow brec.
12	GX 17247	53.0	2.27	16.08	8.94	6.10	2.24	5.01	5.00E-2	6	2.0	41	147	93.69	amyl. and. flow brec.
13	GX 17248	78.4	.30	10.58	2.12	.40	.78	4.58	1.69	7	7.0E-1	23	92	98.85	QFP flow
14	GX 17249	59.7	1.10	10.64	8.55	2.65	7.06	3.24	.10	9	2.4	110	89	93.04	amyl. and. flow brec.
15	GX 17250	59.7	1.90	16.46	6.11	2.65	1.96	3.77	2.51	10	1.3	17	68	95.26	amyl. and. flow brec.
16	GX 17151	57.5	1.77	14.49	8.42	2.95	4.03	4.85	.29	0	3.0E-1	37	108	94.30	amyl. and. flow brec.
17	GX 17152	41.1	1.26	12.18	20.58	6.23	2.91	.65	.36	0	2.0	130	175	85.27	amyl. and. flow brec.
18	GX 17153	78.6	.33	10.20	3.99	1.13	.17	1.89	1.83	6	1.0	31	54	98.14	min. QFP
19	GX 17154	79.4	.29	10.75	2.76	.73	.39	3.83	1.25	5	5.0E-1	14	120	99.40	QFP
20	GX 17155	57.5	1.82	14.00	7.59	3.85	3.36	4.64	.24	5	1.5	8	97	93.00	amyl. and. flow brec.
21	GX 17156	59.4	2.03	14.56	8.36	3.05	3.30	5.07	.34	5	1.5	17	100	96.11	amyl. and. flow brec.
22	GX 17157	58.3	1.92	14.72	6.94	3.12	3.36	5.01	.67	6	1.3	10	93	94.04	amyl. and. flow brec.
23	GX 17158	71.5	.57	11.99	5.14	1.92	.73	2.43	1.49	8	1.0	83	190	95.77	intern. volcanic
24	GX 17159	58.6	1.78	17.64	6.56	2.32	1.18	1.56	3.71	7	1.2	123	118	93.35	amyl. and. flow brec.
25	GX 17160	56.1	1.87	19.54	6.69	2.52	.56	1.19	4.29	6	1.0	30	150	92.76	sheared amyl. and.
26	GX 17161	65.7	.73	11.38	9.64	.90	1.34	1.13	2.80	6	1.5	50	107	93.57	andesite
27	GX 17162	69.0	1.83	13.83	4.31	1.33	.84	5.82	.29	5	7.0E-1	72	94	97.25	amyl. and. flow brec.
28	GX 17163	59.6	1.60	13.61	6.94	2.12	5.32	5.66	.19	6	1.2	72	130	95.11	amyl. and. flow brec.
29	GX 17164	56.4	1.60	13.56	8.87	3.12	4.31	3.29	1.11	5	2.0	65	122	92.26	amyl. and. flow brec.
30	GX 17165	49.9	1.82	13.35	12.22	3.98	3.86	2.96	.48	5	2.3	80	360	88.57	amyl. and. flow brec.
31	GX 17166	46.7	.38	7.11	9.64	10.48	10.64	.11	.14	6	2.0	17	185	85.20	sheared rhyolite
32	GX 17167	77.1	.41	10.37	1.48	.99	.45	4.31	1.25	5	3.0E-1	14	102	96.36	rhyolite

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MICROD

	NUMBER	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O	Au	Ag	Cu	Zn	total	sample description
1	GX 17168	80.3	.46	10.98	.51	.66	.28	.11	3.66	5	3.0E-1	10	38	96.96	rhyolite
2	GX 17169	70.2	.62	11.25	4.89	2.25	1.68	4.04	.77	5	7.0E-1	95	595	95.70	interm. volcanic
3	GX 17170	72.7	.42	13.17	4.44	1.26	.34	3.13	1.74	9	1.0	360	1580	97.20	rhyolite flow
4	GX 17171	75.8	.41	11.60	4.50	1.46	.28	3.83	.96	5	3.0E-1	50	215	98.84	rhyolite flow
5	GX 17172	75.9	.39	10.56	2.89	.86	1.85	3.56	1.46	5	3.0E-1	230	150	97.47	rhyolite
6	GX 17173	74.9	.42	11.17	4.01	1.59	.78	3.88	.87	5	3.0E-1	55	225	97.62	rhyolite
7	GX 17174	81.0	.28	8.77	1.99	.80	2.27	4.15	.22	6	3.0E-1	42	119	99.48	rhyolite
8	GX 17175	65.1	.48	15.10	6.30	3.32	.59	3.77	1.54	6	7.0E-1	17	110	96.20	amygd. andesite
9	GX 17176	54.4	2.03	17.27	7.07	3.38	1.15	5.61	1.21	5	1.0	19	102	92.12	andesite
10	GX 17177	78.0	.45	11.20	3.29	.83	.36	5.34	.29	6	3.0E-1	13	37	99.76	rhyolite
11	GX 17178	79.2	.41	10.49	3.66	1.13	.17	3.72	.72	5	3.0E-1	21	36	99.50	min. rhyolite
12	GX 17179	79.9	.45	11.46	3.73	.73	.31	2.48	1.83	5	3.0E-1	75	49	100.89	rhyolite
13	GX 17180	76.7	.44	11.51	5.98	.23	.11	3.29	1.78	7	3.0E-1	58	68	100.04	sheared rhyolite
14	GX 17181	61.6	1.14	11.74	7.33	2.32	5.66	2.32	1.28	5	1.5	20	138	93.39	and. flow brecc.
15	GX 17182	70.3	1.32	10.40	5.72	1.49	3.08	1.59	2.46	5	5.0E-1	56	79	96.36	and. flow brecc.
16	GX 17183	76.2	.85	11.11	4.56	.56	.92	4.31	1.16	5	3.0E-1	10	72	99.67	andesite
17	GX 17184	78.8	.34	10.33	2.89	.43	.98	3.61	2.41	5	3.0E-1	25	115	99.79	rhyolite
18	GX 17185	73.6	.52	11.84	5.01	.66	1.04	3.77	1.49	5	3.0E-1	16	56	97.93	QFP flow
19	GX 17186	79.5	.29	10.18	1.86	.36	1.12	4.80	.80	6	3.0E-1	16	59	98.91	QFP flow
20	GX 17187	78.9	.34	10.64	1.35	.36	.67	4.04	2.02	11	3.0E-1	8	26	98.32	QFP flow
21	GX 17188	78.8	.27	11.00	2.31	.30	.84	3.67	2.60	6	3.0E-1	20	75	99.79	QFP flow
22	GX 17189	79.5	.26	10.08	1.99	.60	1.34	3.40	1.78	5	3.0E-1	25	46	98.95	QFP flow
23	GX 17190	81.3	.24	9.45	2.08	.36	1.57	3.83	.92	6	5.0E-1	14	39	100.25	QFP flow
24	GX 17191	78.3	.26	9.79	3.37	.70	1.57	2.00	2.31	4	5.0E-1	18	66	98.90	QFP flow
25	GX 17192	77.7	.37	12.68	1.52	.50	.67	2.86	3.37	5	3.0E-1	20	40	99.67	QFP flow
26	GX 17193	56.1	1.62	14.11	6.82	3.78	6.16	4.83	7.00E-2	5	1.0	61	111	93.49	amygd. mas andesite
27	GX 17194	55.3	1.89	15.45	7.65	4.38	4.59	5.45	5.00E-2	5	1.0	48	122	94.76	amygd. mas andesite
28	GX 17195	76.3	.40	11.84	4.01	1.06	2.35	1.56	2.65	5	5.0E-1	31	74	100.17	rhyolite
29	GX 17196	77.0	.45	10.77	3.77	1.03	1.62	3.18	2.12	6	3.0E-1	30	106	99.94	rhyolite
30	GX 17198	75.9	.43	11.64	2.98	.63	2.52	4.15	1.49	5	1.0	44	58	99.74	rhyolite
31	GX 17199	74.6	.43	12.53	4.24	1.06	1.46	2.53	2.22	5	5.0E-1	37	80	99.07	sheared rhyolite
32	GX 17200	75.8	.45	11.28	4.10	1.33	1.88	1.62	2.46	6	5.0E-1	12	92	98.92	rhyolite

NUMBER	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MgO	CaO	Na ₂ O	K ₂ O	Au	Ag	Cu	Zn	Total	sample description
1	GX 17488	49.9	1.70	12.76	10.42	6.82	6.88	67	1.27	6	2.0	85	90	90.42 and breccia
2	GX 17489	63.9	1.87	12.15	4.37	2.45	7.28	3.39	45	8	1.0	50	76	95.86 and breccia
3	GX 17490	56.4	1.55	12.61	7.33	4.83	6.34	2.26	21	7	1.0	90	83	93.53 and breccia
4	GX 17491	66.8	76	13.22	5.85	1.39	2.01	4.04	1.47	7	1.0	10	88	95.54 mas andesite
5	GX 17492	64.8	2.12	11.94	8.87	1.98	3.58	3.82	31	8	1.3	25	120	97.42 and breccia
6	GX 17493	62.9	1.99	11.62	8.87	2.65	4.25	3.72	9.00E-2	8	1.3	28	124	96.09 and flow breccia
7	GX 17618	74.8	55	11.31	3.92	1.02	1.03	4.96	31	5	3.0E-1	7	26	97.90 rhyolite
8	GX 17619	82.3	24	8.31	1.29	59	33	1.24	2.79	5	3.0E-1	75	12	97.09 QFP breccia
9	GX 17620	79.1	26	9.18	2.35	1.06	33	3.50	1.34	5	3.0E-1	5	20	97.12 QFP breccia
10	GX 17621	77.9	25	10.31	1.97	1.59	58	2.42	2.69	8	7.0E-1	5	25	97.71 QFP breccia
11	GX 17622	80.1	27	10.33	1.90	72	72	3.61	1.54	6	3.0E-1	7	18	99.19 QFP
12	GX 17623	79.1	26	11.28	2.57	96	39	4.04	1.49	8	7.0E-1	6	22	100.09 flow band QFP
13	GX 17624	51.6	1.46	13.35	6.43	6.03	9.96	1.77	9.00E-2	5	1.3	128	62	90.69 diorite
14	GX 17625	60.1	70	17.26	3.66	2.45	10.08	2.42	24	5	1.3	72	50	96.91 fragm. in and. brec
15	GX 17626	47.1	72	17.44	7.97	7.35	8.06	62	62	5	2.0	79	142	89.88 matrix in and. brec
16	GX 17627	84.8	25	9.00	1.77	36	4.64	62	1.15	6	3.0E-1	15	35	102.59 QFP
17	GX 17628	63.9	1.50	15.08	5.46	1.92	4.42	4.58	1.27	5	7.0E-1	45	70	98.13 amyg. and flow brec
18	GX 17629	49.8	1.82	15.79	10.35	4.37	5.60	3.99	3.00E-2	5	1.0	38	105	91.75 amyg. and flow brec
19	GX 17630	85.9	76	8.22	1.29	33	3.08	3.01	24	6	3.0E-1	51	17	102.83 fragm. in and flow brec
20	GX 17631	71.2	1.20	12.77	4.69	1.52	4.03	4.09	24	5	7.0E-1	95	47	99.74 matrix in and flow brec
21	GX 17632	65.5	1.27	13.48	6.56	1.59	3.47	4.31	1.08	5	1.0	14	93	97.26 matrix in and flow brec
22	GX 17633	63.2	1.48	14.74	6.94	2.25	3.08	4.36	89	5	1.0	24	94	96.94 amyg. and.
23	GX 17634	48.9	98	14.96	5.21	8.48	8.73	2.80	12	6	1.0	17	70	90.18 diorite
24	GX 17635	57.3	2.17	14.94	8.49	3.51	4.25	3.66	67	5	1.4	28	163	94.99 min. amyg. and.
25	GX 17636	49.0	1.66	16.20	7.65	8.08	2.91	3.07	2.41	5	1.7	22	73	90.98 mas. andesite
26	GX 17638	58.5	1.57	12.85	5.08	2.18	8.00	4.31	65	5	1.4	47	71	93.14 amyg. and flow brec
27	GX 17639	51.5	1.32	16.41	6.56	7.42	2.35	4.63	2.00E-2	5	1.4	59	80	90.21 andesite
28	GX 17640	52.5	1.16	16.62	5.92	7.95	4.31	2.48	45	5	1.0	81	82	91.39 amyg. andesite
29	GX 17641	50.7	1.78	12.98	9.84	4.83	5.65	2.96	1.08	5	1.4	86	132	89.82 andesite
30	GX 17642	64.2	1.29	12.43	1.36	3.44	13.60	1.07	6.00E-2	6	3.0E-1	48	15	97.51 and hyalo. breccia
31	GX 17643	55.5	1.89	14.52	9.45	5.10	3.13	4.36	25	5	1.4	11	46	94.20 and hyalo breccia
32	GX 17644	76.6	55	10.87	4.56	1.65	1.28	2.58	1.06	5	7.0E-1	30	155	99.15 qz porp. rhyolite
33	GX 17645	77.7	49	12.36	4.56	66	89	1.24	2.12	5	3.0E-1	7	76	100.02 rhyolite
34	GX 17646	55.2	1.72	14.83	6.88	4.90	4.64	5.01	20	5	1.0	52	54	93.38 amyg. and. breccia

	NUMBER	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MgO	CaO	Na ₂ O	K ₂ O	Au	Ag	Cu	Zn	total	sample description
1	GX 17386	50.2	1.83	13.06	11.64	4.71	5.82	2.00	.92	6	1.7	54	128	90.18	amygd. and flow brecc.
2	GX 17387	50.1	1.79	13.21	12.09	4.71	5.71	2.00	.94	5	20.0	55	132	90.55	amygd. and flow brecc.
3	GX 17388	52.9	2.08	15.39	9.71	3.98	2.07	5.01	.10	6	1.4	33	110	91.24	amygd. and flow brecc.
4	GX 17389	74.2	.41	10.58	3.54	.86	2.86	2.53	1.59	5	3.0E-1	19	133	96.57	rhyolite
5	GX 17390	74.8	.42	11.57	3.79	1.23	1.79	2.70	1.64	5	3.0E-1	15	95	97.94	rhyolite
6	GX 17391	71.9	.50	11.75	3.67	1.66	.20	3.24	1.74	5	3.0E-1	8	44	94.66	rhyolite
7	GX 17392	74.5	.43	11.34	3.86	.86	1.40	4.26	1.11	9	3.0E-1	10	40	97.76	felds.porp.rhyol. flow
8	GX 17393	74.1	.49	12.33	4.18	.93	.42	4.74	1.11	8	3.0E-1	7	35	98.30	felds.porp.rhyol. flow
9	GX 17394	73.9	.37	11.68	5.79	.90	.62	3.83	2.17	8	3.0E-1	12	41	99.26	felds.porp.rhyol. flow
10	GX 17395	74.6	.46	11.77	4.37	.70	.31	3.61	2.94	7	3.0E-1	60	70	98.76	felds.porp.rhyol. flow
11	GX 17396	73.5	.41	12.41	4.18	1.03	1.34	4.31	2.65	5	7.0E-1	10	97	99.83	felds.porp.rhyol. flow
12	GX 17397	65.5	1.76	13.17	6.88	2.78	2.41	5.28	.48	7	7.0E-1	15	86	98.26	amygd. flow band. and
13	GX 17398	65.7	1.72	13.19	7.59	2.19	2.24	5.66	.48	7	7.0E-1	13	90	98.77	amygd. flow band. and
14	GX 17399	51.2	1.25	14.84	6.04	5.30	9.35	2.37	.22	8	7.0E-1	88	73	90.57	diorite
15	GX 17400	49.9	1.93	12.06	9.45	6.36	9.69	1.13	5.00E-2	6	1.0	203	67	90.57	diorite
16	GX 17401	53.8	1.97	12.01	13.12	3.98	4.37	3.45	5.00E-2	7	1.7	47	98	92.75	diorite
17	GX 17402	76.9	.31	11.30	1.29	1.23	1.06	2.00	2.80	10	3.0E-1	12	50	96.89	QFP
18	GX 17403	79.1	.25	8.58	1.57	1.09	1.23	4.10	.84	7	3.0E-1	15	26	96.76	QFP
19	GX 17404	52.3	.87	15.01	5.02	6.03	9.52	2.26	.22	5	7.0E-1	133	80	91.23	diorite
20	GX 17405	52.1	.65	14.39	4.12	7.03	10.14	1.94	.48	7	7.0E-1	140	46	90.85	diorite
21	GX 17406	53.4	1.25	16.03	5.40	5.44	9.58	1.94	.24	7	1.4	45	66	93.28	diorite
22	GX 17407	48.7	1.58	16.38	9.65	6.17	4.98	2.43	.39	9	1.7	121	95	90.28	amygd. andesite
23	GX 17408	58.9	1.40	16.12	5.02	4.18	6.66	3.24	.46	6	1.4	77	67	95.98	amygd. andesite
24	GX 17409	74.3	.38	10.66	3.63	1.69	2.30	1.40	2.31	7	1.0	38	135	96.67	rhyolite
25	GX 17410	51.4	1.31	15.91	6.30	6.23	6.27	3.67	.21	8	1.4	46	100	91.30	diorite
26	GX 17411	52.2	1.31	15.36	5.40	5.90	3.98	5.12	.84	7	1.0	88	88	90.11	and breccia
27	GX 17412	52.8	1.44	15.52	7.27	6.10	4.93	3.29	6.00E-2	7	1.4	80	107	91.41	mas amygd andesite
28	GX 17413	82.1	.27	9.09	2.83	1.03	1.51	.24	2.65	9	7.0E-1	30	173	99.72	QFP
29	GX 17414	77.7	.29	10.14	2.64	2.80	2.02	3.72	1.35	8	3.0E-1	12	90	100.66	QFP
30	GX 17415	59.1	1.53	11.93	7.39	4.97	5.66	3.61	7.00E-2	12	1.0	95	85	94.26	and breccia
31	GX 17416	58.1	1.41	12.16	7.07	3.98	7.84	3.34	2.00E-2	9	1.4	86	94	93.92	and pillow
32	GX 17417	56.2	1.73	12.92	10.48	5.44	4.59	2.80	6.00E-2	14	2.4	80	110	94.22	and pillow
33	GX 17418	61.3	1.52	10.26	8.74	2.85	6.16	3.40	.27	20	1.7	55	77	94.50	and breccia
34	GX 17419	50.9	1.96	12.49	13.18	5.30	4.20	2.21	5.00E-2	15	2.7	64	125	90.29	and breccia

	NUMBER	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O	Au	Ag	Cu	Zn	total	sample description
1	GX 17420	55.2	1.60	12.32	10.61	3.85	7.50	2.32	19	10	2.1	92	94	93.59	and hyalo breccia
2	GX 17421	51.1	1.48	11.99	9.97	5.04	8.96	2.32	34	21	2.4	93	94	91.20	and pillow
3	GX 17422	54.9	1.67	12.86	7.72	4.97	7.67	2.97	3.00E-2	7	1.4	95	90	92.79	and breccia
4	GX 17423	58.1	2.10	13.46	7.46	3.45	4.48	4.80	19	10	1.4	75	265	94.04	and flow breccia
5	GX 17424	53.8	1.48	13.53	7.71	5.24	9.30	62	75	7	1.4	131	167	92.43	and breccia
6	GX 17425	63.1	1.58	12.38	4.18	3.65	6.27	4.31	31	7	6.9E-1	82	110	95.78	and pillow (Po, Cp)
7	GX 17426	57.6	1.52	13.89	4.44	5.64	6.61	3.94	77	12	1.0	125	88	94.41	and flow breccia
8	GX 17427	58.2	1.52	13.62	4.76	4.51	7.84	3.50	13	6	1.4	130	190	94.08	mas. andesite
9	GX 17428	57.8	1.42	11.60	5.53	5.77	11.14	16	34	6	1.4	80	86	93.76	and breccia (Po, Sp)
10	GX 17429	57.8	1.76	13.36	5.27	4.77	5.88	4.69	46	7	1.0	70	78	93.99	and breccia (Po)
11	GX 17430	52.6	1.18	11.90	5.92	2.98	12.21	4.37	11	6	2.1	97	64	91.27	and flow breccia
12	GX 17431	52.8	1.89	14.11	9.39	6.36	4.59	3.61	2.00E-2	6	2.1	103	180	92.77	and pillow
13	GX 17432	61.8	.98	15.94	5.59	2.65	2.41	7.01	5.00E-2	6	1.0	12	77	96.43	and breccia
14	GX 17433	49.0	1.66	12.68	12.47	7.95	4.36	1.72	22	9	2.0	81	130	90.06	and breccia
15	GX 17434	77.7	.47	10.65	4.95	2.50	.89	.51	2.41	10	1.0	12	63	100.08	min felsic tuff (exhal.)
16	GX 17435	77.3	.35	11.76	4.11	1.85	.28	6.00E-2	4.20	8	7.0E-1	26	30	99.91	min. felsic tuff (exhal.)
17	GX 17436	54.2	1.38	12.44	7.33	3.50	8.56	3.00	19	5	1.3	86	99	90.60	and hyalo. breccia
18	GX 17437	54.5	1.74	14.01	9.77	4.30	5.43	3.50	43	6	1.7	84	125	93.68	mas. andesite
19	GX 17438	60.7	1.62	12.93	6.82	3.64	7.40	3.18	28	6	1.7	86	74	96.57	and pillow
20	GX 17439	58.6	1.37	12.79	7.59	4.50	7.84	2.10	4.00E-2	6	1.7	102	100	94.83	mas. andesite
21	GX 17440	58.2	1.52	12.64	7.33	5.17	5.65	3.60	27	5	7.0E-1	84	77	94.38	and flow breccia
22	GX 17441	49.2	1.67	13.89	10.74	5.17	7.22	2.00	33	11	1.4	89	120	90.22	mas. andesite
23	GX 17442	58.7	1.55	13.10	6.30	4.04	7.05	3.34	14	5	1.0	83	82	94.22	and pillow
24	GX 17443	57.5	1.32	12.99	9.64	5.03	4.08	3.40	3.00E-2	7	1.4	79	125	93.99	and pillow
25	GX 17444	59.0	1.70	13.31	8.49	2.78	4.42	4.70	72	7	7.0E-1	64	115	95.12	and pillow
26	GX 17445	58.2	1.60	13.37	7.52	3.24	8.28	2.64	57	9	1.0	78	84	95.42	and pillow
27	GX 17446	57.0	1.58	12.85	7.72	3.24	9.30	2.04	8.00E-2	9	1.0	88	95	93.81	and pillow
28	GX 17447	51.7	1.77	12.76	12.22	5.50	6.60	1.21	3.00E-2	6	1.4	78	122	91.79	and pillow
29	GX 17448	55.8	1.45	12.32	8.49	3.97	9.90	1.56	1.00E-2	7	1.0	85	107	93.50	and pillow
30	GX 17449	56.5	1.52	13.98	5.05	5.63	6.88	4.36	.27	11	1.4	345	98	94.19	and breccia
31	GX 17450	58.4	1.67	12.01	6.24	4.37	6.04	3.82	40	54	1.4	1260	140	92.95	and breccia
32	GX 17451	55.3	1.81	13.54	6.69	5.10	6.32	3.71	43	8	1.0	142	70	92.90	and breccia
33	GX 17452	53.2	1.74	13.69	9.26	5.10	8.68	.37	53	11	1.4	150	120	92.57	and breccia
34	GX 17453	54.1	1.58	12.90	8.62	5.43	7.16	2.31	31	5	1.4	172	105	92.41	and breccia

	NUMBER	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MgO	CaO	Na ₂ O	K ₂ O	Au	Ag	Cu	Zn	total	sample description
1	GX 17454	60.8	1.59	12.96	6.49	4.70	6.83	2.70	20	7	1.4	115	84	96.27	and breccia
2	GX 17455	56.6	1.62	12.78	9.13	4.10	6.68	1.18	24	5	1.7	90	82	93.33	and breccia
3	GX 17456	58.7	1.46	11.90	5.14	5.10	7.33	3.00	62	7	1.0	97	43	93.25	and breccia
4	GX 17457	61.7	2.11	13.20	5.01	2.85	5.25	4.70	58	5	7.0E-1	90	98	95.40	coarse gr. hyalo. brec.
5	GX 17458	62.8	2.16	13.28	5.08	3.04	4.67	4.79	48	6	7.0E-1	88	69	96.50	coarse gr. hyalo. brec.
6	GX 17459	56.0	1.99	12.56	8.23	3.44	6.49	3.72	38	6	7.0E-1	75	139	92.81	and breccia
7	GX 17460	60.2	1.65	11.62	5.27	4.57	6.55	3.77	67	6	3.0E-1	165	60	94.30	and pillow
8	GX 17461	55.5	1.62	13.45	6.24	5.37	9.01	2.21	12	5	7.0E-1	112	540	93.52	and flow breccia
9	GX 17462	59.1	1.74	12.71	5.59	4.77	7.78	3.01	38	7	1.0	123	65	95.08	and flow breccia
10	GX 17463	50.7	1.79	12.91	10.29	7.35	5.65	67	163	7	1.0	91	87	90.99	and flow breccia
11	GX 17464	52.4	1.68	13.35	7.65	4.77	10.02	1.45	74	7	1.0	92	57	92.06	and flow breccia
12	GX 17465	58.8	1.86	13.47	4.69	4.57	5.99	4.58	74	6	7.0E-1	95	75	94.70	and flow breccia
13	GX 17466	61.8	1.70	12.78	4.76	3.77	6.88	3.82	57	8	7.0E-1	92	82	96.08	andesite
14	GX 17467	60.4	1.97	12.38	6.11	3.84	5.82	4.20	24	7	7.0E-1	81	67	94.96	andesite
15	GX 17468	59.5	1.67	12.68	6.43	2.65	8.96	3.45	24	7	1.0	92	86	95.58	and hyalo. breccia
16	GX 17469	59.4	1.58	10.86	9.13	5.50	5.09	2.15	24	5	1.3	65	85	93.95	and hyalo. breccia
17	GX 17470	58.0	1.67	12.37	5.57	4.50	7.16	3.23	48	5	1.0	87	68	92.98	and flow breccia
18	GX 17471	60.3	1.78	13.13	3.34	3.97	5.71	5.71	24	7	7.0E-1	83	50	94.18	and flow breccia
19	GX 17472	55.0	1.79	13.28	6.62	4.90	6.44	4.15	17	7	7.0E-1	138	70	92.35	and syn-volc. dyke
20	GX 17473	55.2	1.72	13.44	7.20	4.90	7.72	2.85	14	8	1.3	122	85	93.17	and flow breccia
21	GX 17474	59.2	1.72	13.94	5.33	4.57	5.62	3.99	48	6	7.0E-1	92	495	94.85	and syn-volc. dyke
22	GX 17475	54.3	1.40	12.93	6.30	6.23	7.95	3.07	19	9	1.3	115	75	92.37	and breccia
23	GX 17476	52.0	1.44	14.42	6.24	6.82	7.61	3.01	80	7	1.0	115	87	92.34	and syn-volc. dyke
24	GX 17477	58.0	1.78	13.06	6.11	5.56	5.71	4.09	43	7	1.0	92	62	94.74	and syn-volc. dyke
25	GX 17478	57.5	1.82	12.78	7.59	4.77	6.49	2.53	19	9	1.0	74	75	93.67	and hyalo. breccia
26	GX 17479	56.7	1.61	12.57	5.53	5.03	8.28	2.48	52	7	1.0	98	80	92.72	and flow breccia
27	GX 17480	57.2	1.95	13.93	5.40	3.84	6.16	5.01	28	5	1.0	80	109	93.77	and hyalo. breccia
28	GX 17481	82.4	4.3	9.04	58	15	1.56	4.31	127	5	3.0E-1	16	15	99.74	hyol frag in and brec
29	GX 17482	54.4	1.70	12.56	7.91	4.37	7.39	3.23	9.00E-2	5	1.0	135	115	91.65	diorite
30	GX 17483	53.3	1.47	14.09	7.72	4.83	10.92	5.6	1.00E-2	5	1.3	60	85	92.90	and flow breccia
31	GX 17484	54.7	1.59	14.85	6.81	4.11	8.28	3.45	1.00E-2	5	1.0	84	100	93.80	and pillow
32	GX 17485	58.9	1.94	12.92	9.39	3.24	5.82	3.50	3.00E-2	9	1.7	47	95	95.74	and syn-volc. dyke
33	GX 17486	53.1	1.55	15.18	6.88	3.31	9.91	2.85	1.00E-2	8	1.3	80	86	92.79	and pillow
34	GX 17487	54.3	1.78	13.80	5.72	4.70	8.96	3.77	1.00E-2	6	1.7	82	88	93.04	and pillow

	NUMBER	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MgO	CaO	Na ₂ O	K ₂ O	Au	Ag	Cu	Zn	total	sample description
1	GX 17488	49.9	1.70	12.76	10.42	6.82	6.88	6.7	1.27	6	2.0	85	90	90.42	and breccia
2	GX 17489	63.9	1.87	12.15	4.37	2.45	7.26	3.39	45	8	1.0	50	76	95.86	and breccia
3	GX 17490	56.4	1.55	12.61	7.33	4.83	8.34	2.26	21	7	1.0	90	83	93.53	and breccia
4	GX 17491	66.8	76	13.22	5.85	1.39	2.01	4.04	1.47	7	1.0	10	88	95.54	mas andesite
5	GX 17492	64.8	2.12	11.94	8.87	1.98	3.58	3.82	31	8	1.3	25	120	97.42	and breccia
6	GX 17493	62.9	1.99	11.62	8.87	2.65	4.25	3.72	9.00E-2	8	1.3	28	124	96.09	and flow breccia
7	GX 17618	74.8	55	11.31	3.92	1.02	1.03	4.96	31	5	3.0E-1	7	26	97.90	rhynolite
8	GX 17619	82.3	24	8.31	1.29	.59	33	1.24	2.79	5	3.0E-1	75	12	97.09	QFP breccia
9	GX 17620	79.1	26	9.18	2.35	1.06	33	3.50	1.34	5	3.0E-1	5	20	97.12	QFP breccia
10	GX 17621	77.9	25	10.31	1.97	1.59	58	2.42	2.69	8	7.0E-1	5	25	97.71	QFP breccia
11	GX 17622	80.1	27	10.33	1.90	.72	.72	3.61	1.54	6	3.0E-1	7	18	99.19	QFP
12	GX 17623	79.1	26	11.28	2.57	.96	.39	4.04	1.49	8	7.0E-1	6	22	100.09	flow band QFP
13	GX 17624	51.6	1.46	13.35	6.43	6.03	9.96	1.77	9.00E-2	5	1.3	128	62	90.69	diorite
14	GX 17625	60.1	.70	17.26	3.66	2.45	10.08	2.42	.24	5	1.3	72	50	96.91	fragm. in and. brec
15	GX 17626	47.1	.72	17.44	7.97	7.35	8.06	.62	.62	5	2.0	79	142	89.88	matrix in and. brec
16	GX 17627	84.8	.25	9.00	1.77	.36	4.64	.62	1.15	6	3.0E-1	15	35	102.59	QFP
17	GX 17628	63.9	1.50	15.08	5.46	1.92	4.42	4.58	1.27	5	7.0E-1	45	70	98.13	amygd and flow brec
18	GX 17629	49.8	1.82	15.79	10.35	4.37	5.60	3.99	3.00E-2	5	1.0	38	105	91.75	amygd. and. flow brec
19	GX 17630	85.9	.76	8.22	1.29	.33	3.08	3.01	.24	6	3.0E-1	51	17	102.83	fragm. in and. flow brec.
20	GX 17631	71.2	1.20	12.77	4.69	1.52	4.03	4.09	.24	5	7.0E-1	95	47	99.74	matrix in and. flow brec.
21	GX 17632	65.5	1.27	13.48	6.56	1.59	3.47	4.31	1.08	5	1.0	14	93	97.26	matrix in and. flow brec.
22	GX 17633	63.2	1.48	14.74	6.94	2.25	3.08	4.36	.89	5	1.0	24	94	96.94	amygd. and.
23	GX 17634	48.9	.98	14.96	5.21	8.48	6.73	2.80	12	6	1.0	17	70	90.18	diorite
24	GX 17635	57.3	2.17	14.94	8.49	3.51	4.25	3.66	.67	5	1.4	28	163	94.99	min. amygd. and.
25	GX 17636	49.0	1.66	16.20	7.65	8.08	2.91	3.07	2.41	5	1.7	22	73	90.98	mas. andesite
26	GX 17638	58.5	1.57	12.85	5.08	2.18	8.00	4.31	.65	5	1.4	47	71	93.14	amygd and flow brec
27	GX 17639	51.5	1.32	16.41	6.56	7.42	2.35	4.63	2.00E-2	5	1.4	59	80	90.21	andesite
28	GX 17640	52.5	1.16	16.62	5.92	7.95	4.31	2.48	.45	5	1.0	81	82	91.39	amygd andesite
29	GX 17641	50.7	1.78	12.98	9.84	4.83	5.65	2.96	1.08	5	1.4	86	132	89.82	andesite
30	GX 17642	64.2	1.29	12.43	1.36	3.44	13.60	1.07	6.00E-2	6	3.0E-1	48	15	97.51	and hyalo. breccia
31	GX 17643	55.5	1.89	14.52	9.45	5.10	3.13	4.36	.25	5	1.4	11	46	94.20	and hyalo breccia
32	GX 17644	76.6	.55	10.87	4.56	1.65	1.28	2.58	1.06	5	7.0E-1	30	155	99.15	qz porp. rhynolite
33	GX 17645	77.7	.49	12.36	4.56	.66	.89	1.24	2.12	5	3.0E-1	7	76	100.02	rhynolite
34	GX 17646	55.2	1.72	14.83	6.88	4.90	4.64	5.01	.20	5	1.0	52	54	93.38	amygd and. breccia

NUMBER	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O	Au	Ag	Cu	Zn	total	sample description	
1	GX 17647	57.7	1.42	12.98	4.44	4.77	8.51	2.48	43	5	7.0E-1	53	58	92.73	amygd andesite
2	GX 17648	75.4	43	10.82	3.60	86	1.51	3.88	1.08	5	3.0E-1	7	34	97.58	rhyolite
3	GX 17649	48.6	1.09	14.05	6.49	7.42	8.96	2.69	2.00E-2	5	1.0	178	115	89.32	diorite
4	GX 17650	73.2	44	11.42	5.01	69	33	4.09	1.44	5	3.0E-1	10	45	96.62	rhyolite
5	GX 17651	78.5	26	10.12	4.44	59	1.73	1.86	1.83	7	3.0E-1	17	58	99.33	rhyolite
6	GX 17652	80.8	32	10.47	2.44	66	1.28	3.50	1.20	7	3.0E-1	10	27	100.67	QFP dyke
7	GX 17653	76.6	60	11.67	4.69	1.25	28	91	2.31	5	3.0E-1	12	88	98.31	qz porp. rhyolite
8	GX 17654	75.9	58	11.65	4.95	96	1.42	4.52	53	6	3.0E-1	67	77	100.51	qz porp. rhyolite
9	GX 17655	84.1	39	8.81	3.47	76	24	3.12	57	6	3.0E-1	15	57	101.46	rhyolite
10	GX 17656	54.1	1.27	12.43	6.74	4.30	5.99	1.29	2.07	6	1.4	81	113	90.19	diorite
11	GX 17657	77.8	47	10.35	4.11	1.06	50	3.66	91	8	3.0E-1	31	104	98.86	rhyolite
12	GX 17658	62.6	1.48	13.73	7.72	1.85	3.69	5.39	13	7	1.0	13	102	96.59	and. flow breccia
13	GX 17659	76.5	82	11.83	3.92	1.12	1.09	4.85	74	7	7.0E-1	12	68	100.87	qz porp. rhyolite
14	GX 17660	54.6	2.00	14.79	9.32	3.64	4.03	5.01	68	5	1.7	38	102	94.07	diorite
15	GX 17661	75.6	52	11.05	4.50	1.02	1.34	4.31	67	6	1.0	12	100	99.01	rhyolite
16	GX 17662	62.6	1.17	15.43	3.60	3.58	5.65	5.06	60	6	3.0E-1	57	60	97.69	andesite
17	GX 17663	61.9	29	8.82	2.85	29	1.40	4.31	60	7	3.0E-1	81	58	100.46	amygd rhyolite
18	GX 17664	68.2	71	12.71	7.07	2.58	1.37	4.58	72	5	7.0E-1	41	44	97.94	mas. and
19	GX 17665	77.2	56	10.39	4.27	82	28	3.28	1.63	6	3.0E-1	17	26	98.43	felsic dyke
20	GX 17666	77.3	40	12.14	3.54	82	30	1.75	3.18	5	7.0E-1	14	29	99.43	rhyolite
21	GX 17667	73.4	35	11.79	1.68	2.32	61	2.91	2.98	6	3.0E-1	5	30	96.04	rhyolite

	NUMBER	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	Ni	Au	Ag	Cu	Zn	LOI	total	sample description
1	6X 18621	70.9	20	12.72	4.07	9.00E-2	66	1.29	1.83	5.96	3	4	3.0E-1	2	101	1.71	99.43	mass rhyol felds phen
2	6X 18622	73.0	27	13.84	3.10	9.00E-2	64	1.05	5.46	94	2	3	3.0E-1	1	71	1.42	99.81	mass rhyol felds phen
3	6X 18623	74.0	26	13.03	3.25	10	45	1.28	5.50	49	3	4	7.0E-1	1	52	1.43	99.79	mass rhyol felds phen
4	6X 18624	50.2	1.10	16.28	9.38	25	5.34	8.88	2.68	40	43	3	7.0E-1	68	61	4.90	99.44	mass andesite
5	6X 18625	56.4	1.74	12.93	10.94	23	4.21	6.02	3.95	34	18	3	8.0E-1	51	100	2.90	99.66	and pillow
6	6X 18626	54.0	71	17.37	6.24	11	4.97	9.31	2.08	13	118	3	5.0E-1	73	150	4.93	99.60	and pillow

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[illegible]

	NUMBER	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	Ni	Au	Ag	Cu	Zn	L.O.I.	total	sample description
	1	GX 18483	54.2	1.22	15.46	8.24		5.52	4.65	.74	21	4	7.0E-1	47	116	6.36	99.77	amylid. and
	2	GX 18484	79.0	23	9.27	3.53	6.00E-2	65	1.36	3.31	51	4	7.30E-1	17	62	1.80	99.72	GFP syke
	3	GX 18485	50.3	1.06	19.02	5.74	.15	6.78	4.35	3.20	24	5	4.0E-1	85	95	7.31	99.52	amylid. and.
	4	GX 18486	71.6	34	11.94	3.82	.10	3.62	.22	3.34	3	4	2.0E-1	9	47	4.18	99.76	rhyo. flow
	5	GX 18487	72.6	33	11.55	6.37	8.00E-2	87	1.14	1.54	2.33	4	5.30E-1	3	60	2.75	99.56	amylid flow band rhyolite
	6	GX 18488	73.0	26	11.20	3.44	5.00E-2	40	3.61	2.17	1.99	3	4.20E-1	18	16	3.56	99.68	GFP syke
	7	GX 18489	76.0	27	11.53	4.36	3.00E-2	80	.49	1.65	2.57	4	4.30E-1	28	25	1.96	99.66	n. band rhyo. (qz-f phenocr.)
	8	GX 18490	72.6	40	12.97	6.22	1.00E-2	1.09	9.00E-2	3.39	1.04	12	4.30E-1	70	55	1.90	99.71	rhydlite
	9	GX 18491	71.8	47	12.85	5.30	5.00E-2	1.49	.59	2.84	1.82	3	4.30E-1	35	60	2.20	99.41	rhydlite
	10	GX 18492	72.7	49	12.28	4.63	9.00E-2	83	.50	3.64	1.66	3	4.10E-1	23	53	2.66	99.48	rhydlite
	11	GX 18493	65.6	1.25	13.57	4.59	.10	2.09	1.51	4.51	.30	7	5.50E-1	38	139	2.88	99.40	and breccia
	12	GX 18494	75.2	54	12.23	3.98	1.00E-2	80	.18	3.91	1.12	3	5.20E-1	31	63	1.85	99.82	rhydlite
	13	GX 18495	71.4	44	11.06	6.80	6.00E-2	86	.42	2.09	1.51	5	4.30E-1	7	124	4.81	99.45	rhydlite
	14	GX 18496	51.0	1.37	15.15	10.56	.16	4.49	5.87	3.40	.61	25	4.90E-1	51	103	7.24	99.85	rhydlite
	15	GX 18497	73.5	51	12.18	3.29	2.00E-2	1.04	1.67	4.34	.75	9	4.30E-1	11	47	2.22	99.52	GFP
	16	GX 18498	47.2	1.57	15.80	11.64	.17	4.73	5.23	2.49	1.64	27	5.1.1	54	133	8.98	99.45	diorite
	17	GX 18499	77.9	45	10.47	4.27	6.00E-2	1.03	.12	3.61	.53	5	5.30E-1	84	71	1.22	99.66	sheared rhyolite
	18	GX 18500	77.8	38	10.12	3.32	8.00E-2	.89	1.36	3.21	.76	8	4.20E-1	9	55	1.92	99.84	amylid spherul rhyolite
	19	GX 18501	74.7	35	11.44	5.15	5.00E-2	1.46	.63	2.76	.94	5	4.40E-1	84	61	2.08	99.56	rhydlite
	20	GX 18502	74.7	42	11.61	4.84	3.00E-2	.82	.29	3.34	1.04	4	7.20E-1	25	36	2.67	99.76	min rhyolite
	21	GX 18503	79.7	39	10.54	1.99	3.00E-2	.79	.20	3.09	1.61	1	5.10E-1	3	16	1.36	99.70	rhydlite
	22	GX 18504	77.0	43	11.75	3.32	2.00E-2	.86	.12	3.74	1.07	3	4.10E-1	7	84	1.58	99.89	n. band rhyo (qz-f phenocr.)
	23	GX 18505	62.3	1.36	14.46	8.39	6.00E-2	3.29	1.31	5.35	.16	16	9.40E-1	9	41	2.90	99.58	and flow breccia
	24	GX 18506	76.6	35	9.24	4.15	7.00E-2	.49	2.84	1.70	1.23	4	4.20E-1	7	80	2.95	99.62	rhydlite
	25	GX 18507	59.9	1.54	14.84	9.36	.10	1.86	3.35	4.91	.16	12	4.60E-1	12	123	3.79	99.81	mas and
	26	GX 18508	59.1	1.31	13.52	7.98	.17	2.07	4.81	4.63	.40	8	4.70E-1	8	122	5.73	99.72	mas and (fields phenocr.)
	27	GX 18509	72.2	43	12.35	4.82	9.00E-2	.59	1.45	4.80	.81	4	4.30E-1	3	102	2.26	99.80	sheared rhyolite
	28	GX 18510	72.3	38	11.39	4.50	.11	.77	2.12	4.20	.93	4	45.30E-1	10	81	2.73	99.43	rhydlite
	29	GX 18511	60.7	1.69	13.97	9.27	.15	2.33	3.14	4.54	.37	8	4.80E-1	6	112	3.29	99.45	amylid and flow brec
	30	GX 18512	71.2	94	10.56	5.95	.11	.94	3.23	4.55	.16	7	4.40E-1	26	56	1.93	99.57	amylid and flow brec
	31	GX 18513	67.2	97	10.05	5.97	.15	1.69	3.92	4.30	.40	6	4.60E-1	34	62	5.15	99.79	amylid and flow brec
	32	GX 18514	76.5	38	11.27	3.32	6.00E-2	.12	.95	4.15	.13	4	4.10E-1	3	45	1.86	99.74	rhydlite
	33	GX 18515	72.2	43	12.50	4.75	8.00E-2	.45	1.20	4.85	.87	5	5.20E-1	120	70	2.28	99.61	rhydlite
	34	GX 18516	72.4	44	12.51	5.06	4.00E-2	1.53	.68	4.01	.26	4	4.40E-1	9	43	1.94	99.97	rhydlite

NUMBER	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	Ni	Au	Ag	Cu	Zn	LOI	total	sample description
1	76.7	37	10.25	4.33	6.00E-2	1.16	97	3.34	6.4	5	5	2.0E-1	40	69	1.89	99.71	hyolite
2	76.18	1.09	17.38	11.47	9.00E-2	6.45	3.19	2.08	2.40	8	4	1.0	3	87	7.68	99.43	and dyke
3	76.19	1.24	15.36	9.01	14	4.18	7.71	3.46	3.9	26	4	3.0E-1	15	44	1.95	99.74	and. hyalo brecc.
4	76.20	1.33	15.46	9.45	13	5.55	6.77	3.76	7.2	15	6	4.0E-1	5	41	1.72	99.69	amygd. mas andesite
5	76.21	1.25	15.42	8.71	13	5.69	6.49	4.00	4.9	16	5	2.0E-1	2	27	1.01	99.49	and. breccia
6	76.22	1.36	15.13	9.21	15	5.16	6.99	3.56	4.8	20	4	4.0E-1	8	53	1.74	99.78	and. breccia
7	76.23	1.38	14.91	7.77	14	6.63	4.64	4.20	5.6	33	6	4.0E-1	2	87	2.58	99.71	amygd. and. pillow
8	76.24	3.8	11.85	3.72	2.00E-2	1.65	5.1	4.75	5.1	4	4	3.0E-1	2	50	1.43	99.42	flow band rhyo (qz phenocr.)
9	76.25	2.4	9.74	2.09	6.00E-2	.92	.11	3.67	2.41	3	4	2.0E-1	2	27	.94	99.58	GP flow
10	76.26	1.21	12.74	7.43	15	2.20	2.70	4.03	1.83	4	3	4.0E-1	19	82	1.93	99.62	amygd. and. (felds. phenocr.)
11	76.27	4.8	11.11	4.59	10	1.04	1.70	4.03	1.75	6	4	2.0E-1	11	62	1.46	99.76	amygd. rhyolite flow
12	76.28	3.0	9.62	3.03	11	.41	1.87	4.45	3.2	8	4	2.0E-1	4	49	1.00	99.41	flow band rhyo. (felds. ph.)
13	76.29	3.9	11.23	4.42	11	.75	.88	2.40	4.70	3	3	3.0E-1	5	62	1.49	99.77	flow band rhyo. (felds. phen.)
14	76.30	6.2	12.28	5.90	15	.95	1.77	3.87	2.42	4	3	3.0E-1	9	83	1.30	99.46	and. breccia (felds. phenocr.)
15	76.31	3.2	9.42	6.8	5.00E-2	.14	1.31	5.43	4.2	2	3	1.0E-1	151	4	.98	99.25	flow band. rhyolite
16	76.32	5.0	10.93	4.39	10	.61	1.34	4.54	.82	3	3	2.0E-1	7	55	1.40	99.13	amygd. fl. band. and. (felds. ph.)
17	76.33	5.0	11.55	4.69	16	.86	2.45	3.94	.90	4	4	4.0E-1	83	153	1.63	99.58	amygd. fl. band. andesite
18	76.34	7.6	11.89	6.79	14	3.07	2.24	4.37	1.0	4	4	4.0E-1	15	88	2.29	99.55	amygd. and. (felds. phenocr.)
19	76.35	1.21	14.18	.04	26	3.27	4.58	4.09	1.03	7	3	7.0E-1	6	125	4.85	99.91	andesite
20	76.36	5.6	14.49	6.41	7.00E-2	3.34	.21	.37	4.16	3	3	4.0E-1	2	102	3.47	99.68	rhyolite
21	76.37	3.9	10.35	3.77	5.00E-2	.88	1.08	4.35	1.11	2	4	2.0E-1	19	25	1.38	99.66	rhyo. breccia
22	76.38	1.75	14.95	7.19	20	5.10	5.35	3.89	1.74	27	4	4.0E-1	27	37	3.36	99.94	amygd. and. breccia
23	76.39	1.86	10.57	1.38	2.00E-2	.39	2.74	4.97	1.22	5	4	1.0E-1	13	16	.67	99.42	and. flow breccia
24	76.40	7.2	12.28	3.81	7.00E-2	.74	1.08	5.93	.29	2	3	3.0E-1	9	39	.91	99.93	and. flow breccia
25	76.41	7.5	11.23	6.14	16	.86	3.55	3.68	1.58	3	3	4.0E-1	24	80	3.03	99.68	amygd. and. brecc (felds. ph.)
26	76.42	1.49	13.72	7.07	9.00E-2	2.67	2.88	4.89	.60	3	6	4.0E-1	14	52	2.55	99.76	amygd. andesite
27	76.43	1.32	14.61	6.67	32	4.54	5.41	5.47	3.9	53	5	3.0E-1	18	70	2.07	99.50	and. pillow (felds. phenocr.)
28	76.44	.25	9.52	5.36	3.00E-2	.29	5.00E-2	.13	2.45	2	3	6.0E-1	2	14	1.55	99.53	and. fl. breccia (felds. ph.)
29	76.45	.43	12.76	6.97	5.00E-2	1.17	1.00	4.23	1.94	2	3	1.0	1	14	1.54	99.79	GP talus brecc
30	76.46	.65	11.12	12.29	9.00E-2	1.78	1.92	1.90	1.20	11	24	8.0E-1	18	27	2.32	99.77	enhal. felsic tuff
31	76.47	.35	11.12	4.76	4.00E-2	.60	1.55	4.35	.51	2	4	2.0E-1	1	10	1.01	99.99	hyolite
32	76.48	1.16	9.52	5.86	11	1.29	5.02	1.79	.24	4	3	2.0E-1	6	82	1.71	99.00	and dyke in rhyolite
33	76.49	1.18	9.70	5.87	11	1.26	5.05	1.68	.22	4	3	3.0E-1	7	87	1.63	99.50	spherul. rhyo mas flow
34	76.50	1.13	11.79	3.64	9.00E-2	1.00	1.76	4.73	.96	11	4	3.0E-1	7	77	1.06	99.43	spherul. rhyo mas flow

NUMBER	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	Ni	Au	Ag	Cu	Zn	L.O.I.	total	sample description	
1	GX 18551	68.4	1.22	11.28	7.19	.13	2.89	2.65	1.15	1.70	1	5	4.0E-1	20	284	2.99	99.80	spherul.rhyo. breccia
2	GX 18553	78.1	.89	9.44	1.26	4.0E-2	.62	1.63	3.96	1.53	4	3	2.0E-1	5	39	1.00	99.30	spherul.rhyo. flow breccia
3	GX 18554	71.8	1.26	10.29	2.09	7.00E-2	1.99	4.52	1.61	.69	4	4	3.0E-1	8	88	2.21	99.43	spherul. rhyo. flow
4	GX 18555	67.1	1.29	12.22	4.99	.10	2.27	4.32	.96	2.17	4	4	3.0E-1	8	93	2.39	99.52	spherul. rhyo. breccia
5	GX 18556	54.3	1.29	15.98	7.04	.14	3.79	5.85	5.10	.67	26	3	5.0E-1	48	53	5.27	99.43	amygd. and pillow
6	GX 18557	57.0	1.06	15.13	6.33	.10	4.32	5.94	4.81	.20	60	3	5.0E-1	40	46	4.91	99.80	amygd. and pillow
7	GX 18558	56.3	1.40	15.54	9.83	.15	3.21	6.50	3.52	.10	11	4	5.0E-1	17	74	3.00	99.55	amygd. mas andesite
8	GX 18559	51.0	1.38	16.97	7.46	.17	5.29	6.35	4.30	.57	30	3	6.0E-1	26	49	6.26	99.75	amygd. and pillow
9	GX 18560	56.7	1.30	14.99	7.35	.15	4.01	6.23	4.57	.34	18	4	4.0E-1	49	67	3.70	99.34	hyalo and brec. & rhyo fragm.
10	GX 18561	47.0	1.10	15.89	11.82	.25	8.98	5.95	3.13	2.22	43	4	4.0E-1	94	37	3.20	99.54	hyalo and brec. & rhyo fragm.
11	GX 18562	47.5	1.08	14.55	11.06	.22	8.62	10.21	2.52	.83	41	4	4.0E-1	119	33	2.82	99.41	rhyo fragm in and. hyalo. brec.
12	GX 18563	75.0	.38	11.85	1.35	2.00E-2	.45	.88	.52	8.60	2	5	1.0E-1	4	14	.45	99.50	hyalo and brec. & rhyo fragm.
13	GX 18564	55.7	1.87	11.98	12.11	.20	3.34	10.21	.32	17	17	3	5.0E-1	42	148	3.55	99.45	hyalo. and brec.
14	LDX 536	54.6	1.26	13.38	9.97	.16	3.33	5.89	.95	2.77	31	4	9.0E-1	8	118	7.12	99.43	and. brec.
15	LDX 536	55.2	1.47	13.56	9.48	.11	4.13	5.36	1.01	2.88	9	4	8.0E-1	11	98	6.54	99.74	and. brec.
16	LDX 536	55.4	1.40	13.71	9.59	.11	2.71	5.82	4.31	.75	8	4	1.0	12	75	5.54	99.34	and. brec.
17	GX 18603	59.8	1.63	12.16	9.41	.15	3.88	6.96	3.95	.49	11	3	2.0E-1	41	36	1.27	99.70	and pillow
18	GX 18604	58.4	1.82	12.36	9.90	.19	4.15	5.79	5.06	.37	14	4	3.0E-1	66	67	1.74	99.76	and pillow
19	GC 18605	52.0	1.75	13.47	12.48	.22	6.73	5.54	4.14	.49	19	3	4.0E-1	50	70	2.70	99.52	and hyalo brec
20	GX 18606	53.8	1.70	13.38	11.97	.21	5.47	7.60	2.61	.32	21	3	3.0E-1	66	63	2.70	99.76	and pillow
21	GX 18607	53.9	1.69	11.29	13.48	.28	6.01	6.85	2.30	.14	18	3	8.0E-1	44	89	3.52	99.46	and. pillow
22	GX 18608	59.3	1.84	11.72	8.82	.18	3.04	6.57	3.80	.52	13	4	4.0E-1	34	115	3.81	99.60	and hyalo brec
23	GX 18609	56.4	2.01	12.33	11.28	.24	4.95	5.74	4.40	.40	14	3	3.0E-1	42	63	1.84	99.59	and. pillow
24	GX 18610	55.1	1.61	12.55	10.86	.22	3.93	8.23	2.31	.37	18	3	5.0E-1	54	98	4.30	99.48	and pillow
25	GX 18611	52.6	1.60	11.88	13.52	.33	5.70	7.15	3.11	.92	16	3	4.0E-1	64	48	2.49	99.63	and hyalo brec
26	GX 18612	59.7	2.17	12.96	7.82	.18	3.90	5.07	5.55	.52	12	3	3.0E-1	51	60	1.85	99.72	and hyalo brec
27	GX 18613	54.0	1.58	12.21	13.20	.23	4.57	7.98	1.15	.29	24	3	8.0E-1	67	85	4.42	99.63	and hyalo brec
28	GX 18614	55.6	1.78	12.84	11.28	.22	4.74	6.62	4.12	.57	19	3	7.0E-1	67	55	2.06	99.83	and pillow
29	GX 18615	73.6	.29	13.00	3.03	.10	.52	1.64	4.83	.86	2	3	2.0	1	70	1.94	99.81	mass rhyol felds, phenoc
30	GX 18616	73.8	.25	13.53	2.56	.10	.41	1.39	4.16	1.53	1	4	1.6	1	52	1.94	99.67	mass rhyol felds phenoc
31	GX 18617	73.4	.23	13.07	3.05	.10	.64	2.76	4.66	.39	2	3	5.0E-1	1	49	1.56	99.86	mass rhyol felds phenoc
32	GX 18618	73.7	.27	12.85	3.57	.10	.67	.96	5.68	.28	2	3	2.0E-1	2	56	1.33	99.41	mass rhyol felds phenoc
33	GX 18619	75.6	.25	12.70	2.59	.60E-2	.68	.71	5.83	.34	2	3	1.0E-1	2	50	.93	99.59	mass rhyol felds phenoc
34	GX 18620	73.3	.27	13.62	3.01	.80E-2	.74	.90	5.52	.72	2	3	2.0E-1	1	81	1.31	99.47	mass rhyol felds phenoc

NUMBER	SiO2	Al2O3	FeO	MnO	MgO	CaO	Mg2O	P2O5	S	Ba	Cr	Zr	Sr	Y	Yb	Ni	V	Zn	LOI	Total	La	Ce	Md	Sm	Eu	Mn	Vb	Lu
1	217	77.8	19	11.71	255	4.00E-2	1.07	22	3.95	1.75	3.00E-2	4.00E-2	4.00E-2	25	36	19	11	0	20	170	101.05							
2	213	76.9	18	11.82	260	3.00E-2	32	4.96	1.53	1.00E-2	4.00E-2	5.00E-2	5.93	16	322	32	77	10	0	7	136	100.29	30.10	88.00	38.00	10.41	1.34	2.90
3	223	76.8	18	11.14	318	7.00E-2	17	4.46	95	1.40	0	3.00E-2	6.37	3	314	237	52	10	0	74	143	99.77						
4	242	51.5	144	16.29	1022	22	8.25	6.31	4.73	20	54	2.00E-2	120	149	94	187	46	10	0	132	376	101.49						
5	259	79.8	24	9.72	330	3.00E-2	44	11	3.43	68	8.00E-2	5.00E-2	135	123	228	19	11	52	10	0	87	151	99.32					
6	259	73.2	29	11.54	450	12	99	1.06	4.14	93	3.00E-2	3.00E-2	223	23	300	30	14	64	11	0	108	293	99.49	21.60	83.50	28.50	1.48	2.50
7	260	57.3	104	14.56	876	12	187	4.74	5.73	24	52	2.00E-2	239	4	152	103	46	10	0	104	541	100.34						
8	2704	74.8	24	11.82	305	4.0E-2	16	1.02	4.98	77	3.00E-2	4.00E-2	108	22	264	17	12	59	10	0	92	221	96.56					
9	2708	67.1	52	13.35	707	8.0E-2	235	99	4.99	61	9.00E-2	8.00E-2	96	21	192	47	11	36	10	0	99	28	277	99.86				
10	105	66.8	32	11.84	484	15	124	2.65	1.75	124	3.00E-2	5.00E-2	592	18	223	39	63	10	0	97	434	99.89						
11	1265	66.5	145	11.87	13.1	25	5.06	6.09	4.00E-2	2.35	64	15	608	100	79	90	70	28	10	0	111	106	819	98.66				
12	129	76.0	28	10.93	419	4.00E-2	1.56	12	3.09	1.31	4.00E-2	4.00E-2	242	21	277	13	32	29	10	0	10	33	173	98.70				
13	132	75.2	20	11.46	789	8.00E-2	63	319	75	2.80	0	4.00E-2	326	14	330	50	52	74	10	0	10	80	433	99.74				
14	19-61	68.9	102	15.26	1.46	19	8.20	9.05	3.21	3.00E-2	0	2.00E-2	35	57	56	199	10	29	10	112	295	43	318	100.40				
15	19-07	64.1	100	14.94	7.91	11	3.49	99	5.46	26	46	5.00E-2	64	23	188	41	10	44	10	10	19	96	311	101.84				
16	19-08	75.2	44	12.95	3.25	4.00E-2	94	82	5.44	99	10	5.00E-2	287	17	271	59	17	45	10	0	25	43	230	102.42				
17	51-07	64.5	157	15.54	15.70	13	8.44	2.93	1.66	56	74	9.00E-2	116	103	84	52	10	48	116	153	664	100.49						
18	51-09	33.2	223	12.93	14.94	27	3.03	432	3.05	1.42	14	18	214	13	159	103	19	58	10	0	320	79	274	98.48				
19	52-05	50.4	154	15.49	11.19	29	4.06	5.77	4.64	8.00E-2	70	4.00E-2	110	112	85	98	10	28	10	42	121	120	567	101.60				
20	52-08	68.8	121	12.13	9.65	19	1.61	6.54	8.00E-2	1.72	56	5.00E-2	214	93	66	43	41	50	10	39	100	81	1183	100.11				
21	53-15	56.9	128	14.97	9.53	11	3.81	3.57	3.52	1.37	47	4.00E-2	106	87	146	52	29	37	10	143	132	563	100.96					
22	53-21	55.4	137	15.63	8.70	14	3.83	4.13	3.63	4.13	79	7.00E-2	33	103	69	104	10	31	10	40	114	91	524	101.46				
23	53-28	68.8	157	13.69	12.33	16	3.69	7.48	2.13	1.88	6.00E-2	11	46.3	20	131	93	44	52	10	17	457	171	932	98.48				
24	53-07	71.5	38	13.27	4.20	3.00E-2	1.50	1.02	5.16	87	9.00E-2	11	215	1	264	62	16	41	10	10	28	273	100.87					
25	53-08	70.9	37	13.20	4.97	3.00E-2	2.23	90	3.64	173	7.00E-2	6.00E-2	348	18	260	37	42	58	10	10	10	61	308	100.80				
26	53-13	65.9	68	16.88	7.64	19	6.06	5.54	4.00	1.77	12	5.00E-2	352	125	152	40	17	10	94	150	87	1010	100.89					

NUMBER	1102	AI1203	FeO	MnO	MgO	CaO	Mg2O	P2O5	S	Ba	Cr	Zr	Sr	Y	Yb	Ni	V	Zn	LOI	Total	La	Ce	Md	Sm	Eu	Mn	Vb	Lu
1 028	745	31	12.48	294	8.00E-2	111	20	5.47	71	6.00E-2	230	20	237	24	12	44	6	0	19	38	182	99.49						
2 048	686	70	13.72	480	2.00E-2	2.88	70	2.21	3.00	29	5.00E-2	617	29	207	23	73	49	5	0	19	16	310	100.13					
3 063	632	83	13.00	843	20	2.61	315	339	1.09	32	5.00E-2	287	24	157	54	31	37	6	0	21	77	460	100.85					
4 071	554	118	12.92	914	23	2.77	7.25	4.24	9.00E-2	24	5.00E-2	117	6	109	99	0	32	4	0	163	63	839	99.81	12.10	28.00	14.90	4.19	1.20
5 078	562	111	11.64	824	26	2.30	7.34	4.05	38	21	5.00E-2	124	17	102	111	6	27	3	0	136	59	771	99.51					
6 096	783	19	10.88	239	3.00E-2	43	1.48	3.75	1.65	0	7.00E-2	301	3	312	35	39	66	12	0	6	96	225	99.42	28.60	60.00	33.50	8.97	1.62
7 104	732	32	12.73	523	8.00E-2	27	1.71	4.66	1.45	4.00E-2	5.00E-2	214	22	241	49	32	53	7	0	5	38	250	100.44					
8 135	555	139	14.21	571	22	2.42	7.22	6.24	10	65	5.00E-2	65	110	77	105	0	31	0	35	93	48	680	100.35					
9 137	685	35	11.21	518	11	1.48	3.23	17	3.02	2.00E-2	7.00E-2	464	18	231	41	64	54	6	0	6	96	605	99.38					
10 140	734	30	11.76	436	7.00E-2	66	1.37	4.39	110	2.00E-2	5.00E-2	260	24	312	35	22	67	8	0	0	20	252	100.03					
11 151A	678	41	14.44	650	15	1.36	62	5.24	2.20	10	4.00E-2	554	3	370	33	62	12	0	0	116	187	100.53	42.20	81.00	49.80	14.31	2.63	
12 151C	662	124	12.92	609	14	2.35	2.84	4.83	1.01	39	3.00E-2	308	2	128	61	7	38	3	0	53	98	227	100.84	10.20	24.00	16.00	4.64	1.20
13 153	518	115	14.64	1194	25	5.98	8.08	3.65	26	2.00E-2	7.00E-2	174	27	85	129	0	34	3	0	20	53	289	101.08	11.90	28.00	13.50	3.46	65
14 163	578	109	15.68	822	15	3.91	6.78	3.85	38	10	3.00E-2	202	19	107	170	0	25	0	10	20	53	289	101.08	11.90	28.00	13.50	3.46	65
15 1718	328	134	13.45	1122	25	4.90	6.97	2.90	2.00E-2	5.00E-2	4.00E-2	46	26	110	140	0	41	2	25	365	113	610	100.03					
16 171C	328	130	13.58	1223	21	5.03	5.84	4.93	3.00E-2	9.00E-2	5.00E-2	69	32	107	127	0	37	0	10	494	100	382	99.92					
17 174	560	127	12.78	1050	19	4.91	7.94	3.70	79	5.00E-2	6.00E-2	324	34	144	100	6	50	6	4	336	62	182	99.91					
18 175	742	19	11.25	216	4.00E-2	2.24	1.59	4.47	86	1.00E-2	4.00E-2	292	35	344	66	17	63	13	0	0	33	332	100.22					
19 186	762	43	10.34	265	8.00E-2	1.25	1.79	78	3	10	3.00E-2	704	29	346	4	129	61	13	0	0	45	288	100.03					
20 188	533	136	12.88	926	20	3.77	9.17	3.66	17	0	4.00E-2	154	23	104	103	0	58	0	14	390	94	630	100.31					
21 189	548	146	13.85	950	21	3.74	7.59	3.30	40	7.00E-2	5.00E-2	178	18	111	127	0	41	3	18	414	65	533	100.01					
22 198	327	134	14.59	1044	24	6.93	6.36	4.49	36	5.00E-2	3.00E-2	163	31	107	82	0	42	0	34	412	118	287	100.42	9.10	22.00	18.50	4.03	1.04
23 198B	320	140	15.84	1260	27	6.40	6.68	3.69	48	5.00E-2	6.00E-2	185	33	107	82	4	39	3	16	431	102	348	100.72					
24 202	371	160	14.60	827	17	4.03	5.92	4.31	52	18	3.00E-2	144	13	153	97	6	51	4	16	375	77	276	100.41					
25 214	33	33	11.43	426	10	87	1.40	5.44	35	5.00E-2	3.00E-2	153	26	290	35	4	65	11	0	0	32	243	100.26					

[illegible][illegible]

Table 17 : Distribution of the 478 analyses

Andesite flow in NW rhyolite	10	(1)
Pasty Ridge andesite	23	(2)
Waite andesite	14	(2)
Upper North Suprat andesite	77	(7)
Newbec andesite	13	(1)
Dufresnoy andesite	105	(10)
North West rhyolite	36	(2)
Cranston QFP	9	(2)
Amulet rhyolite	30	(2)
Waite rhyolite	28	(4)
Waite QFP	32	(4)
Spherulitic rhyolite	6	
Rhyolitic feldspar porphyry dome in Dufresnoy andesite	9	
Diorites	26	(4)
Others	60	(10)
<hr/>		
	478	(51)

() : number of trace elements analysis

Table 18 : Summarized descriptions of selected thin sections.

#	FM	AN	FL	MAS	PIL	BC	BD	HVA	AMY	SP	MC	PP	OZ	FP	SI	FD	AM	CA	EP	CL	SE	AP	OP	DVK
251	NWR	17053	X							X		X	m	3%	X			X		X				X
253A	NWR	17053	X				X			X		X	m	3%	X			X		X				X
255A	NWR	17055	X						X	X		X		3%	X			tr		X	X		X	
255B	NWR	255B	X						X	X		X	m	2%	X			X		X	X			
266	NWA	17662	X			X			X		X	X		1%	X	X		X		X	X			X
268	NWA	17662	X			X			X		X	X		4%	X	X	X	X	X	tr	X			
217	CrO	217	X			X			X		X		1%	3%	X			tr		X	X			X
219	CrO	219	X			X			X		X		4%	3%	X			X		X	X			X
151C	RRA	151C	X			X			X		(x)	X		<1%	X	X		tr	X	X	tr			X
242	RRA	242	X			X		X	X		(x)				X			X	X	X				X
151B	AR	151B	X			X			X	tr	X	X		1%	X	X		tr	X	X	X			X
214	AR	214	X						X	X	X	X		4%	X	X		X		X	X			X
071	UNDA	071	X			X			X		X				X	X		X		X	X			X
067	UNDA	17247	X			X			X						X			X		X	X			X
116	UNDA	17358	X			X		X	X		(x)				X	X		X		X	X			X
116E	UNDA	17359	X			X			X	X					X	X		X		X	X			X
126A	UNDA	17366	X			X			X		X				X	X		X		X	X			X
239B	UNDA	17639	X			X			X		X				X	X		X	X	X				X
096A	WOFP	17185	X			X			X		X		4%	3%	X			X		X	X			X
098	WOFP	098	X	X					X		X		3%	4%	X			X		X	X			X
123B	WOFP	17245	X						X		X		4%	3%	X			X		X	X			X
128	WOFP	17368	X						X		X		4%	3%	X			X		X	X			X
223	WOFP	17627	X						X		X		4%	3%	X		(x)		tr	X	X			X
236	WOFP	17413	X			X			X	X	X		4%	3%	X			X		X	X			X
140	WR	140	X						X		X			4%	X			X		X	X			X
253	WR		X	X					X		X			tr	X			X		X	X			X
253B	WR		X			X			X		X			2%	X			X		X	X			X
139B	DOFP	17381	?						X		X		3%	2%	X			tr		X	X			X
52-14	DOFP		?						X		X		4%	3%	X			X		tr	X			X
52-17	DOFP		?						X		X		1%	2%	X			X		X	X			X
205	DIO	17202											X	X	X	X	Ac	X	X	X	X		X	X
209	DIO												X	X	X	X	Hy-Ac	X	X	X	X			X
155	DIO	17400											X	X		X	Hb-Ac	X	X	X	tr	tr	X	X
162B	DIO	17406													X	X	Ac	X						X
241	COFP	17220							X						X				tr					X
128a	COFP	028	?	X						X	X		6%	X	X			X		X	X			X
128b	COFP	17208	?	X							X		3%	2%	X			tr		X	X			X
133	COFP	17211	?	X					X		X		5%	5%	X			X		X	X			tr
135	COFP	17215	?	X					X		X		5%	4%	X			X		X	X			X
7212	COFP	17212	?	X					X		X		4%	3%	X			X		X	tr			X
53B	DOFP	17403	?	X						X		X	3%	tr	X			X		X	X			X
50B	AR	17394	X	X					X		X		5%	X				X		X	X			X
82	UNDA	18455	X								X	X		3%	X	X	X	X	X	X	X		X	X
11	DA	17489	X		X				X		X				X		X	X	X	X				X
09B	DA	17487	X			X									X		X	X	X	X				tr
86	DA	186	X		X										X			X		X	X			X
71C	DA	171C	X	X							X				X	X	X	X	X	X				X
96A	DA	196A	X		X						X	(x)		tr		X	X	tr	X	X				tr
90	DA	17441	X	X					X		X				X	X	X	X	X	X				X
85	DA	17433	X		X				X		X				X	X	X	X	X	X				X
71B	DA	171B	X		X				X		X				X		X	tr	X	X				X
71A	DA	171A	X					X	X						X		X	X	X	X				X
51A	NWR									X		X	4%					X		X	X			X
51	WR		X			X	X			X					X			X		X	X			X
52	WR		X			X				X					X			X		X	X			X
198	CrO	17623	X				X			X		X	4%	3%	X			tr		X	X			tr
22	WOFP	18466	X						X		X		5%	3%	X	X		X		X	X			tr
26B	WOFP		X						X		X		4%	3%	X				tr	X				X
25	DIO													X	X		Ac	X	X	X				X
26	WA	17638	X			X			X						X		X	tr	X	X				tr
20B	UNDA	17236	X			X			X		X				X	X		X		X	X			X
2-05	UNDA	52-05	X						X	X	X				X	X	X	X	X	X				X
13	WR	17154							X		X				X	X		X		X	X			X
17	DA	17465	X			X										X	X	X	X					X
11	DA	17442	X		X						X				X	X	X	tr	X					X
1	DA	17430	X			X		X	tr						X		X	X	X	X				tr
5	DA	17448	X		X						X				X		X	X	X	X				X
-15	CR														X				X	X				X
3	NA	18560	X			X			X		(x)				X	X		X	X	X				tr
5	CR	275	?	X											X					X				tr
6	NWR	18484								X		X	5%	3%	X			X		X				tr
3A	DOFP	17402	?	X					X		X		4%	2%	X			X		X				X
3A	UNDA	17364	?	X						(x)					X	X		X		X	X			X

	#	FM	AN	FL	MAS	PIL	BC	BD	HYA	AMY	SP	MC	PP	OZ	FP	SI	FD	AM	CA	EP	CL	SE	AP	OP	DYK
74	62-20	WA	62-21							X		X				X	X		X		X			X	
75	209	DA	17407	X		X										X		?	X	X				X	
76	163	NA	163	X		X				X		X				X	X	X		X	X			tr	
77	244	RRA	17646	X			X			X						X			X	X	X			tr	
78	18556	NA	18556	X		X				X		X				X	X		X	X	X			X	
79	18550	FRP	18550	X	X						X		X		3%	X			X	X	X	A		X	
80	460	FDDA	18620	X	X							X			10%	X			X		A	A		X	
81	414	RRA	18544	X				X			X		X	5%		X					X	X		X	
82	479	FRP	18643	X			X				X		X		3%	X			X	X	X	X		X	

ABBREVIATIONS

Ac	Actinolite	AM	Amphibole	
AMY	Amygdaloidal	AN	Chemical analyse	
AP	Apatite	BC	Breccia	
BD	Banded	CA	Carbonate	
CL	Chlorite	DYK	Dyke	
EP	Epidote	FD	Feldspar in the groundmass	
FL	Flow	FP	Feldspar phenocryst	
FM	Formation	Hb	Hornblende	
HY	Hypersthene	HYA	Hyaloclastite	
MAS	Massive	MC	Microlitic	
OP	Opaque minerals	PIL	Pillowed	
PP	Porphyritic	QZ	Quartz phenocryst	
SE	Sericite	SI	Quartz in the groundmass	
SP	Spherulitic			
X	Major component			
x	Minor component (<10%)			
tr	Trace			
AR	Amulet rhyolite	OQFP	Central QFP	
CR	Central rhyolite	CrQ	Cranston QFP	
DA	Dufresnoy andesite	DIO	Diorite	
DQFP	Dufresnoy QFP	FRR	Fish Roe rhyolite	
FDDA	Feldspar porphyry dome in DA	NA	Newbec andesite	
NWR	North West Rhyolite	RRA	Rusty Ridge andesite	
UNDA	Upper North Duprat andesite	WA	Waite andesite	
	WQFP	Waite QFP	WR	Waite rhyolite

APPENDIX 4 : NORM CALCULATION

The C.I.P.W. norm was calculated using GPF computer program for all analyses with the following assumptions :

$$1) \frac{\text{FeO}}{\text{Fe}_2\text{O}_3} = 0.701 \quad , \quad \text{for mafic volcanics}$$

$$2) \frac{\text{FeO}}{\text{Fe}_2\text{O}_3} = 0.214 \quad , \quad \text{for felsic volcanics}$$

Least altered samples are marked by * in the following table.

Normative minerals abbreviations

Ab	Albite
An	Anorthite
Ap	Apatite
C	Corindon
Di	Diopside
Hm	Hematite
Hy	Hypersthene
Il	Ilmenite
Mt	Magnetite
Ne	Nepheline
Ol	Olivine
Or	Orthoclase
Q	Quartz
Ru	Rutile
Tn	Sphene
Wo	Wolastonite

	NUMBER	Il	Mt	Or	Ab	An	Di	Hy	C	Q	Hm	Wo	Ru	Ap	TOTAL
1	GX 17207	1.02	98	7.94	37.74	4.99	•	1.84	3.09	40.99	1.17	•	•	•	99.78
2	GX 17208	1.27	1.03	65	77.18	6.99	•	1.96	1.21	2.83	1.44	•	•	•	94.57
3	GX 17209*	1.19	1.89	2.57	65.57	9.54	•	2.14	58	9.93	1.39	•	•	•	94.80
4	GX 17210	.74	.45	2.53	43.16	3.31	•	.65	1.56	46.62	.84	•	•	•	99.87
5	GX 17211	.53	.54	16.35	3.97	3.99	•	2.76	11.39	59.31	.61	•	•	•	99.44
6	GX 17212	.51	.80	.71	44.27	3.62	•	.98	1.10	48.43	.60	•	•	•	101.02
7	GX 17213	.45	.71	7.15	21.55	.68	•	.56	3.96	64.10	.52	•	•	•	99.69
8	GX 17214	.43	.38	3.45	23.54	1.88	•	2.69	8.31	59.12	.49	•	•	•	100.28
9	GX 17215	.34	•	1.98	38.18	.98	•	1.76	4.78	51.98	.37	•	•	•	100.44
10	GX 17216	.54	.92	17.10	2.78	.37	•	.35	12.66	65.83	.63	•	•	•	101.18
11	GX 17217	.55	.32	17.60	3.17	.46	•	.31	12.92	63.87	.62	•	•	•	99.84
12	GX 17218	.72	2.02	9.35	16.74	2.01	•	1.68	9.16	57.78	.87	•	•	•	100.31
13	GX 17219	.68	1.97	8.79	17.16	2.16	•	1.73	9.05	58.59	.82	•	•	•	100.94
14	GX 17220	.42	5.63	10.05	17.04	12.29	•	.76	18.00	56.60	.67	•	•	•	103.65
15	GX 17221	.93	1.29	17.72	5.92	4.66	•	2.39	10.86	62.10	1.08	•	•	•	96.95
16	GX 17222	1.22	2.23	7.06	24.40	2.41	•	3.12	9.36	45.03	1.43	•	•	•	96.25
17	GX 17223	1.11	.65	19.05	15.71	3.47	•	2.34	11.02	41.60	1.25	•	•	•	96.19
18	GX 17224	.94	1.04	18.77	15.90	3.36	•	2.32	8.91	46.23	1.08	•	•	•	98.55
19	GX 17225	1.06	1.59	16.41	16.55	5.97	•	2.18	6.97	46.84	1.23	•	•	•	98.82
20	GX 17227	.65	1.09	10.57	24.57	3.78	•	.69	5.41	53.95	.76	•	•	•	101.49
21	GX 17229	.59	.48	3.82	44.97	1.93	•	.21	1.28	47.05	.67	•	•	•	101.00
22	GX 17243	.57	1.49	9.35	27.72	7.21	•	.65	1.80	48.89	.68	•	•	•	98.37
23	GX 17244*	.42	1.42	6.16	31.96	6.87	.83	.37	•	51.65	.52	•	•	•	100.19
24	GX 17248*	.57	1.03	10.02	38.88	3.33	.49	.53	•	43.33	.67	•	•	•	98.85
25	GX 17153	.61	2.53	10.43	15.42	.81	•	1.79	9.27	56.53	.76	•	•	•	98.14
26	GX 17154	.54	1.61	7.27	31.88	1.90	•	1.18	4.70	49.66	.66	•	•	•	99.40
27	GX 17158	1.05	2.86	8.52	19.91	3.51	•	3.05	9.80	45.80	1.27	•	•	•	95.77
28	GX 17167	.78	.14	7.37	36.39	2.23	•	1.62	2.21	44.76	.87	•	•	•	96.36
29	GX 17168	.28	•	20.40	.88	1.31	•	1.02	11.96	60.51	.31	•	.29	•	96.96
30	GX 17169	1.20	2.63	4.62	34.73	8.47	•	3.75	1.46	37.43	1.42	•	•	•	95.70
31	GX 17170	.77	2.65	9.85	25.39	1.62	•	1.98	10.59	43.40	.95	•	•	•	97.20
32	GX 17171	.76	2.78	5.54	31.69	1.36	•	2.34	7.34	46.07	.95	•	•	•	98.84
33	GX 17172*	.75	1.47	3.69	30.35	8.59	.59	1.26	•	44.89	.88	•	•	•	97.47
34	GX 17173	.79	2.36	5.10	32.55	3.84	•	2.58	4.82	44.62	.96	•	•	•	97.62
35	GX 17174	.53	.97	1.29	34.92	4.63	4.90	•	•	51.17	.62	.45	•	•	99.48
36	GX 17175	.89	4.13	8.83	30.96	2.84	•	5.28	11.97	30.18	1.13	•	•	•	96.20
37	GX 17177	.85	1.64	1.70	44.93	1.78	•	1.35	2.88	43.62	1.00	•	•	•	99.76

NUMBER	II	Mt	Cr	Ab	An	Di	Hg	C	Q	Hm	Wo	Ru	Ap	TOTAL
39	GX 17179	.82	1.96	10.40	20.18	1.48	•	1.15	9.31	54.60	.98	•	•	100.89
40	GX 17180	.81	3.95	10.17	26.92	.53	•	.36	7.69	48.57	1.04	•	•	100.04
41	GX 17184	.65	1.61	14.31	30.71	4.89	•	.71	•	46.13	.78	•	•	99.79
42	GX 17186*	.55	.83	4.73	40.61	3.87	1.51	.19	•	45.99	.64	•	•	98.91
43	GX 17187	.65	.22	11.90	34.10	3.32	•	.59	1.18	45.64	.72	•	•	98.32
44	GX 17188	.51	1.29	15.32	30.98	4.16	•	.49	1.24	45.19	.61	•	•	99.79
45	GX 17189	.50	1.04	10.57	28.91	6.68	•	.99	.25	49.44	.59	•	•	98.95
46	GX 17190*	.46	1.17	5.43	32.39	5.87	1.71	.14	•	52.54	.55	•	•	100.25
47	GX 17191	.49	2.26	13.60	16.86	7.76	•	1.14	2.28	53.88	.63	•	•	98.90
48	GX 17192	.69	.28	19.40	23.58	3.24	•	.80	6.07	44.85	.77	•	•	99.67
49	GX 17195	.75	2.41	15.50	13.07	11.54	•	1.72	4.23	50.02	.92	•	•	100.17
50	GX 17196	.86	2.09	12.62	27.12	8.10	•	1.70	.60	45.80	1.03	•	•	99.94
51	GX 17198*	.82	1.42	8.79	35.05	8.72	3.36	.14	•	40.50	.96	•	•	99.74
52	GX 17199	.80	2.50	13.43	20.97	7.10	•	1.70	6.28	45.41	.98	•	•	99.17
53	GX 17200	.85	2.34	14.36	13.55	9.22	•	2.15	5.01	50.41	1.02	•	•	98.92
54	GX 17351	.95	2.06	15.05	19.23	6.81	•	2.14	6.56	41.85	1.13	•	•	95.77
55	GX 17352	.78	1.80	9.37	26.43	9.41	•	1.31	2.17	46.79	.93	•	•	98.88
56	GX 17358	1.40	1.94	11.86	20.43	8.28	•	1.30	3.13	45.85	1.62	•	•	95.85
57	GX 17363	.49	1.49	18.64	9.07	8.56	•	1.07	2.92	55.85	.60	•	•	98.68
58	GX 17367	.48	1.29	13.62	19.59	8.02	•	.87	1.49	53.86	.57	•	•	99.79
59	GX 17368	.72	.90	7.88	27.10	3.58	•	2.20	4.79	51.55	.82	•	•	99.55
60	GX 17369	.29	•	12.29	22.83	3.02	•	.21	3.96	54.78	.33	13	•	97.73
61	GX 17370	.65	2.72	13.14	10.77	15.61	•	1.53	1.66	50.26	.82	•	•	97.15
62	GX 17371	.61	.80	16.82	8.36	7.78	•	1.16	7.53	53.76	.70	•	•	97.52
63	GX 17372	1.14	1.83	8.67	24.50	15.63	3.13	2.63	•	37.19	1.33	•	•	96.05
64	GX 17373	1.20	2.15	14.78	2.28	22.74	9.36	1.18	•	39.76	1.40	•	•	94.84
65	GX 17378	.99	1.83	19.00	1.80	7.76	•	1.84	8.95	53.24	1.17	•	•	96.57
66	GX 17380	.85	2.58	10.82	14.27	2.85	•	2.12	7.68	55.70	1.04	•	•	97.92
67	GX 17381	.65	1.11	14.50	17.04	2.72	•	1.17	5.79	53.56	.76	•	•	97.23
68	GX 17382	.75	3.02	14.68	14.49	11.83	•	2.04	4.69	45.67	.94	•	•	98.11
69	GX 17383	.81	2.45	17.45	13.48	8.39	•	1.89	7.93	42.52	.99	•	•	95.92
70	GX 17389	.79	2.00	9.45	21.54	12.90	1.23	1.09	•	46.63	.94	•	•	96.57
71	GX 17390	.79	2.16	9.61	22.65	8.81	•	2.00	4.17	46.80	.96	•	•	97.94
72	GX 17391	.93	1.79	10.01	26.69	.97	•	2.65	8.14	42.39	1.09	•	•	94.66
73	GX 17392	.82	2.22	5.58	36.19	6.97	•	1.41	1.18	41.39	.99	•	•	97.76
74	GX 17393	.92	2.29	6.46	39.49	2.05	•	1.50	5.06	39.42	1.10	•	•	98.30
75	GX 17394	.70	4.09	12.72	32.16	3.05	•	1.46	3.78	40.38	.92	•	•	99.26
76	GX 17395	.97	2.55	17.15	30.17	1.52	•	1.13	4.12	40.19	1.05	•	•	99.76

	NUMBER	Il	Mt	Or	Ab	An	D ₁	H _g	C	Q	Hm	W ₀	Ru	AP	TOTAL
77	GX 17396	79	2.59	15.83	36.88	6.72	•	1.71	3.00E-2	34.30	.97	•	•	•	99.83
78	GX 17402	58	.25	16.21	16.59	5.15	•	1.98	5.99	49.49	.65	•	•	•	96.89
79	GX 17403*	48	.68	4.97	34.74	2.53	3.19	.94	•	48.67	.55	•	•	•	96.76
80	GX 17409	72	2.15	13.64	11.84	11.41	•	2.77	3.35	49.90	.88	•	•	•	96.67
81	GX 17413	50	1.72	15.33	1.99	7.34	•	1.65	6.04	64.52	.62	•	•	•	99.72
82	GX 17414*	56	1.55	8.12	32.05	7.11	2.76	3.94	•	43.88	.68	•	•	•	100.66
83	GX 17435	64	2.55	23.67	.48	1.33	•	2.89	12.62	54.94	.80	•	•	•	99.91
84	GX 17618	105	1.92	1.83	42.04	5.12	•	1.67	1.89	41.15	1.23	•	•	•	97.90
85	GX 17619	45	.45	16.13	10.27	1.60	•	.95	5.19	61.54	.51	•	•	•	97.09
86	GX 17620	49	1.35	7.89	29.51	1.63	•	1.73	2.74	51.19	.60	•	•	•	97.12
87	GX 17621	47	1.03	15.74	20.28	2.85	•	2.58	4.69	49.50	.56	•	•	•	97.71
88	GX 17622	51	.91	9.03	30.32	3.55	•	1.17	2.81	50.28	.60	•	•	•	99.19
89	GX 17623	49	1.53	8.68	33.72	1.91	•	1.55	4.57	47.04	.60	•	•	•	100.09
90	GX 17627	47	.86	6.78	5.23	18.34	2.21	•	•	67.24	.56	.90	•	•	102.59
91	GX 17644	103	2.46	6.17	21.51	6.26	•	2.63	6.22	51.62	1.23	•	•	•	99.15
92	GX 17645	88	2.53	11.86	9.94	4.18	•	1.02	12.15	56.39	1.07	•	•	•	100.02
93	GX 17648	82	1.99	6.41	32.97	7.52	•	1.42	1.05	44.42	.98	•	•	•	97.58
94	GX 17650	82	3.16	8.36	34.03	1.61	•	1.11	4.99	41.50	1.03	•	•	•	96.62
95	GX 17651	49	3.19	10.63	15.55	8.48	•	.96	3.83	55.49	.66	•	•	•	99.33
96	GX 17652	61	1.26	7.06	29.49	6.32	•	1.08	2.17	51.97	.72	•	•	•	100.67
97	GX 17653	108	2.33	12.88	7.27	1.31	•	1.93	13.54	56.69	1.28	•	•	•	98.31
98	GX 17654	110	2.76	3.13	38.27	7.05	•	1.57	2.12	43.18	1.32	•	•	•	100.51
99	GX 17655	73	1.95	3.31	25.94	1.17	•	1.22	5.16	61.10	.88	•	•	•	101.46
100	GX 17657	88	2.29	5.31	30.57	2.45	•	1.71	4.81	49.78	1.06	•	•	•	98.86
101	GX 17659	156	1.14	4.38	41.08	5.41	•	1.84	2.14	41.54	1.77	•	•	•	100.87
102	GX 17661	99	2.54	3.97	36.59	6.67	•	1.68	1.60	43.77	1.19	•	•	•	99.01
103	GX 17663	55	1.71	3.54	36.44	2.95	1.78	•	•	51.98	.67	.83	•	•	100.46
104	GX 17664	136	4.32	4.29	39.05	6.85	•	4.26	3.84	32.30	1.67	•	•	•	•
105	GX 17665	105	2.17	9.46	27.26	1.36	•	1.32	5.35	49.22	1.24	•	•	•	•
106	GX 17666	73	1.93	17.99	14.18	1.43	•	1.29	10.11	50.90	.88	•	•	•	•
107	GX 17667	66	.49	17.49	24.47	3.01	•	3.78	5.31	40.09	.75	•	•	•	•
108	028	58	2.51	4.12	45.50	.59	•	1.79	4.91	37.43	.59	•	•	.13	98.15
109	098*	36	2.26	9.75	31.73	7.34	•	.69	.43	44.44	.36	•	•	•	97.37
110	104*	61	2.91	8.56	41.09	8.22	•	.44	30	35.44	.59	•	•	9.00E-2	98.25
111	137	66	5.04	17.69	1.43	15.76	•	2.40	3.65	46.52	.66	•	•	4.00E-2	93.84
112	140	57	4.19	6.46	36.94	6.63	•	1.08	1.80	39.62	.62	•	•	4.00E-2	97.95
113	151A	77	6.40	12.78	43.61	2.38	•	2.19	5.02	25.24	.73	•	•	22	99.35
114	175	37	2.00	5.15	38.35	6.93	•	3.72	94	39.25	.38	•	•	2.00E-2	97.10

	NUMBER	II	Mt	C-	Ab	An	D1	Hg	Cl	C	Q	Hm	Tn	Yo	Ne	Ap	TOTAL
115	GX 18475*	2.19	3.73	1.42	50.72	21.31	9.46	6.78	•	•	1.93	•	•	•	•	•	97.55
116	GX 18476*	3.04	4.83	95	50.53	23.15	5.32	9.17	•	•	37	•	•	•	•	•	97.35
117	GX 18483	2.44	4.38	4.59	41.30	20.08	7.42	5.76	•	•	7.44	•	•	•	•	•	93.41
118	GX 18485	2.01	2.90	18.85	31.09	22.86	9.07	•	2.40	•	•	•	•	•	3.04	•	92.21
119	GX 18493	2.42	3.91	1.80	38.85	7.63	•	5.22	•	6.28	30.40	•	•	•	•	•	96.52
120	GX 18496	2.84	5.81	3.92	31.27	26.39	4.51	9.68	•	•	8.19	•	•	•	•	•	92.61
121	GX 18498	3.31	6.52	10.72	23.30	28.70	•	11.71	•	93	5.29	•	•	•	•	•	90.47
122	GX 18505	2.67	4.38	98	46.73	6.71	•	7.48	•	6.42	21.31	•	•	•	•	•	96.68
123	GX 18507	3.09	4.99	1.00	43.74	17.50	•	5.40	•	1.05	19.26	•	•	•	•	•	96.02
124	GX 18508	2.58	4.18	2.44	40.52	15.44	7.82	3.43	•	•	17.57	•	•	•	•	•	93.99
125	GX 18511	3.40	4.96	2.31	40.60	16.46	•	6.14	•	83	21.46	•	•	•	•	•	96.16
126	GX 18512	1.82	3.06	96	39.12	7.99	6.90	1.26	•	•	36.52	•	•	•	•	•	97.62
127	GX 18513	1.87	3.06	2.39	36.85	7.03	10.74	1.49	•	•	31.21	•	•	•	•	•	94.64
128	GX 18518	2.20	6.16	15.05	18.68	16.80	•	14.43	•	11.82	6.62	•	•	•	•	•	91.75
129	GX 18519*	2.48	4.78	2.42	30.71	26.47	11.74	6.47	•	•	12.73	•	•	•	•	•	97.79
130	GX 18520*	2.71	5.12	4.55	34.05	24.81	9.63	9.67	•	•	7.42	•	•	•	•	•	97.97
131	GX 18521*	2.55	4.72	3.10	36.20	24.25	8.83	9.91	•	•	8.92	•	•	•	•	•	98.48
132	GX 18522*	2.75	4.96	3.02	32.04	25.41	9.92	8.76	•	•	11.18	•	•	•	•	•	98.04
133	GX 18523*	2.87	4.29	3.61	38.76	22.00	2.71	13.00	•	•	9.90	•	•	•	•	•	97.13
134	GX 18526*	1.76	2.67	11.27	37.73	11.75	1.77	9.77	•	•	23.29	•	•	•	•	•	100.00
135	GX 18530	90	2.11	14.88	36.16	9.14	•	6.70	•	9.00E-2	30.03	•	•	•	•	•	100.00
136	GX 18533	73	1.69	5.55	36.95	11.67	82	5.29	•	•	37.30	•	•	•	•	•	100.00
137	GX 18534*	1.10	2.44	62	40.95	11.60	•	13.30	•	59	29.40	•	•	•	•	•	100.00
138	GX 18535	1.80	3.32	6.49	39.14	18.43	4.63	13.20	•	•	13.00	•	•	•	•	•	100.00
139	GX 18536	84	2.37	26.44	3.57	1.12	•	14.39	•	10.56	40.70	•	•	•	•	•	100.00
140	GX 18538*	2.48	2.52	20.17	35.50	13.62	10.68	12.31	•	•	2.73	•	•	•	•	•	100.00
141	GX 18539	1.42	•	7.39	45.77	3.00	2.21	4.08	•	•	36.60	32	1.85	2.04	•	•	100.62
142	GX 18540	1.02	1.33	1.74	54.10	5.44	•	4.08	•	27	32.01	•	•	•	•	•	100.00
143	GX 18541*	1.11	2.25	9.91	35.10	10.05	6.93	3.12	•	•	31.53	•	•	•	•	•	100.00
144	GX 18543*	1.97	2.34	2.35	50.01	14.42	10.33	11.35	•	•	7.34	•	•	•	•	•	100.00
145	GX 18548	1.74	2.18	1.53	17.33	18.59	6.62	3.73	•	•	48.29	•	•	•	•	•	100.00
146	GX 18549	1.76	2.17	1.39	16.19	19.62	5.82	3.99	•	•	49.06	•	•	•	•	•	100.00
147	048	1.31	3.01	17.41	18.37	1.55	•	6.11	•	12.31	36.84	•	•	•	•	63	97.53
148	063	1.67	5.57	6.80	30.27	14.29	•	7.61	•	2.71	27.50	•	•	•	•	74	97.15
149	071*	2.31	5.89	55	36.93	16.42	15.95	3.78	•	•	12.14	•	•	•	•	54	94.50
150	079	2.14	5.22	2.27	34.66	12.66	19.08	1.80	•	•	14.39	•	•	•	•	47	92.68
151	135	2.63	3.55	59	52.55	10.42	17.95	89	•	•	4.33	•	•	•	•	1.42	94.34
152	151C*	2.48	4.52	6.26	42.86	10.54	•	6.16	•	41	25.18	•	•	•	•	90	99.31

	NUMBER	Il	Mt	Or	Ab	An	Di	Hy	C	O	Hm	Yo	Ru	Ap	TOTAL
153	GX 18499	93	2.56	3.05	29.75	59	•	1.64	7.29	51.75	88	•	•	•	98.34
154	GX 18500	72	2.12	4.46	26.99	6.71	•	1.45	3.07	51.71	68	•	•	•	97.92
155	GX 18501	65	3.65	5.38	22.61	3.03	•	2.32	9.18	49.94	73	•	•	•	97.48
156	GX 18502	77	3.11	5.93	27.28	1.39	•	1.30	8.63	47.79	90	•	•	•	97.09
157	GX 18503	72	73	9.27	25.47	.97	•	1.26	6.54	52.62	76	•	•	•	98.34
158	GX 18504	79	10	6.11	30.61	.58	•	1.36	8.18	48.04	89	•	•	•	98.31
159	GX 18506	67	2.96	7.31	14.48	14.04	13	77	•	55.63	68	•	•	•	96.67
160	GX 18509	82	3.37	4.78	40.56	7.18	•	97	1.88	37.18	81	•	•	•	97.54
161	GX 18510*	73	3.32	5.53	35.79	9.55	93	102	•	39.16	66	•	•	•	96.70
162	GX 18514	71	2.05	6.59	34.69	4.66	•	19	2.95	45.31	73	•	•	•	97.88
163	GX 18515	81	3.25	5.10	40.73	5.91	•	73	2.78	37.18	93	•	•	•	97.33
164	GX 18516	82	3.34	7.32	33.35	3.32	•	2.46	6.52	39.87	94	•	•	•	97.93
165	GX 18517	70	2.97	3.74	27.96	4.76	•	1.88	4.55	50.52	74	•	•	•	97.82
166	GX 18524	72	2.28	2.98	39.81	2.51	•	2.68	5.07	41.12	83	•	•	•	97.99
167	GX 18525	46	96	14.24	31.05	.55	•	1.51	1.79	47.27	81	•	•	•	98.64
168	GX 18527*	92	2.17	10.43	34.40	7.12	1.24	1.39	•	38.85	1.77	•	•	•	98.30
169	GX 18528*	57	1.61	1.89	37.60	5.32	2.52	•	•	47.41	1.03	47	•	•	98.41
170	GX 18529	75	2.33	27.86	20.38	4.38	•	1.23	1.19	38.63	1.52	•	•	•	98.28
171	GX 18531*	42	•	2.48	45.86	9.00E-2	86	•	•	45.72	48	2.12	•	•	98.03
172	GX 18537	75	1.69	6.62	37.17	5.41	•	1.46	6.00E-2	43.60	1.52	•	•	•	96.28
173	GX 18544	45	2.95	13.64	1.04	.23	•	.45	12.38	65.31	1.53	•	•	•	97.96
174	GX 18545	82	3.79	11.41	35.65	4.94	•	1.91	3.76	33.69	2.29	•	•	•	98.25
175	GX 18547	67	2.46	3.02	36.89	7.71	•	.99	1.19	44.38	1.68	•	•	•	98.98
176	GX 18549	2.24	.99	1.30	14.19	18.25	6.04	.46	•	50.93	3.47	•	•	•	97.87
177	GX 18550*	1.86	•	5.73	40.41	8.18	6.00E-2	1.64	•	37.61	2.61	•	•	•	98.50
178	GX 18551	2.33	1.86	10.07	9.75	13.18	•	4.75	5.48	45.37	3.83	•	•	•	96.61
179	GX 18553	.65	•	8.99	33.34	3.45	2.42	.37	•	46.03	89	•	•	•	97.47
180	GX 18554	1.11	•	4.12	13.77	19.01	1.11	3.00	•	49.01	1.50	•	•	•	94.32
181	GX 18555	2.50	3.00E-2	13.07	8.28	21.85	•	3.79	89	41.41	3.59	•	•	•	95.42
182	GX 18563	.66	•	1.00	4.42	4.38	•	.74	17	36.68	.96	4.00E-2	•	•	99.05
183	GX 18615	.55	1.57	5.05	40.66	8.09	•	.85	2.27	37.77	1.05	•	•	•	97.87
184	GX 18616	.47	1.34	8.86	34.49	6.76	•	.66	4.91	39.39	85	•	•	•	97.73
185	GX 18617*	.44	1.78	2.32	39.72	13.69	9.00E-2	1.03	•	38.27	95	•	•	•	98.30
186	GX 18618	.51	2.00	1.64	47.74	4.73	•	1.09	2.90	36.33	1.14	•	•	•	98.09
187	GX 18619	.47	1.25	1.99	48.97	3.50	•	1.11	2.88	37.62	96	•	•	•	98.76
188	GX 18620	.51	1.54	4.20	46.09	4.41	•	1.20	4.20	34.98	1.05	•	•	•	98.16
189	GX 18621	.38	2.53	35.18	15.47	6.40	•	1.08	1.83	33.71	1.14	•	•	•	97.72
190	GX 18622	.51	1.63	5.49	45.65	5.15	•	1.04	3.82	34.07	1.05	•	•	•	98.39

	NUMBER	II	Mt	Or	Ab	An	Di	Hj	Ol	C	Q	Y _o	Ap	TOTAL
1	GX 17415*	3.11	2.20	.44	32.64	17.25	10.95	8.72	•	•	18.93	•	•	94.26
2	GX 17416*	2.78	2.04	.12	29.25	18.76	18.35	4.73	•	•	17.89	•	•	93.92
3	GX 17417	3.75	3.32	.40	26.94	25.59	.25	14.65	•	•	19.30	•	•	94.22
4	GX 17418*	3.03	2.55	1.67	30.13	13.53	15.49	4.49	•	•	23.98	•	•	94.86
5	GX 17419	4.31	4.25	.34	21.60	24.06	•	16.04	•	2.69	17.00	•	•	90.26
6	GX 17420	3.30	3.21	1.22	21.27	24.53	13.26	8.03	•	•	18.77	•	•	93.59
7	GX 17421	3.01	2.97	2.15	20.99	22.78	21.02	7.71	•	•	10.56	•	•	91.20
8	GX 17422	3.37	2.28	.19	26.62	22.96	14.89	7.70	•	•	14.78	•	•	92.79
9	GX 17423	4.23	2.20	1.19	43.00	15.48	6.87	6.70	•	•	14.37	•	•	94.04
10	GX 17424	3.02	2.30	4.74	5.62	34.17	13.06	8.88	•	•	20.63	•	•	92.43
11	GX 17425*	3.04	1.18	1.85	36.81	13.65	15.47	3.07	•	•	20.72	•	•	95.78
12	GX 17426*	3.00	1.29	4.72	34.61	18.62	13.50	7.33	•	•	11.34	•	•	94.41
13	GX 17427*	2.96	1.36	.79	30.30	21.56	15.87	4.84	•	•	16.41	•	•	94.08
14	GX 17428	2.77	1.58	2.06	1.39	30.66	22.57	5.68	•	•	27.07	•	•	93.76
15	GX 17429*	3.47	1.52	2.81	41.05	14.53	13.61	6.07	•	•	10.93	•	•	93.99
16	GX 17430	2.22	1.64	.64	36.62	12.41	27.41	•	•	•	3.92	6.42	•	91.27
17	GX 17431	4.08	2.97	.13	34.67	25.24	.52	15.55	•	•	9.60	•	•	92.77
18	GX 17432*	1.99	1.66	.31	63.11	12.64	7.00E-2	6.85	•	•	9.80	•	•	96.43
19	GX 17433	3.72	4.10	1.53	17.14	25.47	•	21.28	•	3.97	12.85	•	•	90.06
20	GX 17434	.90	1.38	14.24	4.32	4.42	•	6.22	•	11.19	57.42	•	•	100.08
21	GX 17436	2.71	2.11	1.16	26.15	20.25	19.73	3.70	•	•	14.52	•	•	90.60
22	GX 17437	3.65	3.00	2.80	32.62	23.41	5.31	10.47	•	•	12.42	•	•	93.68
23	GX 17439	3.20	1.97	1.71	27.88	20.91	14.64	4.84	•	•	21.41	•	•	96.57
24	GX 17439	2.77	2.25	.25	18.89	26.96	12.30	7.73	•	•	23.67	•	•	94.83
25	GX 17440	3.11	2.20	1.71	32.71	18.83	9.69	9.43	•	•	16.70	•	•	94.38
26	GX 17441	3.57	3.36	2.19	18.98	31.34	7.49	12.31	•	•	10.99	•	•	90.22
27	GX 17442	3.07	1.83	.86	29.43	21.18	13.10	5.72	•	•	19.02	•	•	94.22
28	GX 17443	2.84	3.04	.20	32.49	22.70	14	13.65	•	•	18.93	•	•	93.99
29	GX 17444	3.44	2.52	4.52	42.30	13.93	7.89	6.14	•	•	14.38	•	•	95.12
30	GX 17446	3.11	2.23	.49	17.84	26.53	17.91	3.93	•	•	21.99	•	•	93.81
31	GX 17447	3.89	3.93	.20	11.79	33.75	3.36	15.13	•	•	19.75	•	•	91.79
32	GX 17448	2.88	2.47	6.00E-2	13.78	27.76	19.95	5.12	•	•	21.47	•	•	93.50
33	GX 17449*	3.01	1.47	1.66	38.37	18.49	14.84	7.30	•	•	9.05	•	•	94.19
34	GX 17450	3.31	1.91	2.46	33.64	15.03	13.93	5.95	•	•	16.92	•	•	92.95
35	GX 17451	3.65	1.98	2.69	33.25	20.15	11.29	8.20	•	•	11.70	•	•	92.30
36	GX 17452	3.63	2.83	3.43	3.43	37.43	8.36	10.80	•	•	22.65	•	•	92.57
37	GX 17453	3.27	2.62	1.99	21.27	26.03	10.81	10.42	•	•	16.00	•	•	92.41
38	GX 17454*	3.20	1.91	1.25	24.14	23.94	10.23	7.80	•	•	23.81	•	•	96.27

	NUMBER	li	Mt	Or	Ab	An	Di	H ₂	Ol	C	Q	Wo	Ap	TOTAL
39	GX 17455	3.34	2.76	1.54	1.65	36.14	8.91	8.75	•	•	30.25	•	•	93.33
40	GX 17456	2.86	1.48	3.77	26.14	17.68	17.19	•	•	•	18.35	•	•	93.25
41	GX 17457*	4.08	1.42	3.48	40.39	13.41	11.28	•	•	•	18.37	•	•	95.40
42	GX 17458*	4.20	1.45	2.90	41.42	13.61	9.60	•	•	•	19.57	•	•	96.50
43	GX 17459	3.97	2.40	2.35	32.97	17.23	13.99	•	•	•	14.63	•	•	92.81
44	GX 17460*	3.21	1.50	4.05	32.61	13.09	17.48	•	•	•	17.67	•	•	94.30
45	GX 17461	3.22	1.82	7.4	19.51	27.57	16.51	•	•	•	17.11	•	•	93.52
46	GX 17462*	3.41	1.60	2.31	26.20	20.62	16.56	•	•	•	18.94	•	•	95.08
47	GX 17463	3.96	3.34	11.19	6.59	31.85	62	•	•	•	15.07	•	•	90.99
48	GX 17464	3.33	2.22	4.56	12.79	28.91	19.64	•	•	•	14.69	•	•	92.06
49	GX 17465*	3.63	1.34	4.48	39.68	14.35	14.05	•	•	•	12.02	•	•	94.70
50	GX 17466*	3.28	1.35	3.41	32.75	16.25	15.92	3.41	•	•	19.71	•	•	96.08
51	GX 17467*	3.87	1.76	1.46	36.68	14.68	13.04	4.94	•	•	18.52	•	•	94.96
52	GX 17468	3.18	1.80	1.42	29.24	18.43	22.14	83	•	•	18.53	•	•	95.58
53	GX 17469	3.33	2.82	1.57	20.17	21.37	5.66	12.39	•	•	26.64	•	•	93.95
54	GX 17470	3.27	1.60	2.92	28.14	18.37	15.78	5.23	•	•	17.67	•	•	92.98
55	GX 17471	3.39	.93	1.42	48.26	9.48	16.59	2.65	•	•	11.47	•	•	94.18
56	GX 17472	3.58	1.94	1.05	36.88	17.97	13.46	7.18	•	•	10.28	•	•	92.35
57	GX 17473	3.46	2.12	87	25.48	24.80	13.48	7.59	•	•	15.36	•	•	93.17
58	GX 17474*	3.43	1.56	2.97	35.40	19.62	8.35	7.28	•	•	16.22	•	•	94.85
59	GX 17475	2.81	1.85	1.18	27.41	22.10	46.94	8.71	•	•	11.36	•	•	92.37
60	GX 17476	2.94	1.87	5.07	27.30	25.16	13.31	10.82	•	•	5.87	•	•	92.34
61	GX 17477*	3.58	1.80	2.69	36.58	16.92	11.31	8.67	•	•	13.19	•	•	94.74
62	GX 17478	3.72	2.27	1.20	22.96	24.62	8.51	8.95	•	•	21.43	•	•	93.67
63	GX 17479	3.16	1.59	3.17	21.63	22.29	17.40	5.72	•	•	17.76	•	•	92.72
64	GX 17480	3.80	1.54	1.69	43.37	15.03	14.07	4.24	•	•	10.03	•	•	93.77
65	GX 17482	3.41	2.33	.56	28.80	20.56	15.44	6.55	•	•	14.00	•	•	91.65
66	GX 17483	2.95	2.27	6.00E-2	5.00	37.90	16.51	7.14	•	•	21.06	•	•	92.90
67	GX 17484	3.16	1.98	6.00E-2	30.45	26.09	14.37	5.77	•	•	11.91	•	•	93.30
68	GX 17485*	3.96	2.81	.19	31.75	20.86	8.50	7.17	•	•	20.52	•	•	95.74
69	GX 17486	3.03	1.97	6.00E-2	24.75	29.35	17.97	3.45	•	•	12.22	•	•	92.79
70	GX 17487	3.44	1.62	6.00E-2	32.42	21.04	20.93	4.11	•	•	9.41	•	•	93.04
71	GX 17488	3.70	3.32	8.57	6.47	32.05	5.94	15.84	•	•	14.54	•	•	90.42
72	GX 17489*	3.54	1.21	2.64	28.49	16.49	16.77	.61	•	•	26.12	•	•	95.86
73	GX 17490	3.10	2.15	1.30	20.11	24.86	16.01	6.96	•	•	19.03	•	•	93.53
74	GX 17491	1.51	1.70	9.05	35.61	10.39	•	4.85	•	2.77	29.66	•	•	95.54
75	GX 17492*	4.30	2.64	1.95	34.47	15.48	2.87	5.95	•	•	29.75	•	•	97.42
76	GX 17493*	4.05	2.64	.57	33.61	15.74	5.68	6.51	•	•	27.29	•	•	96.09

NUMBER	II	MI	OR	AB	AN	DI	HY	OI	C	Q	Hm	Tn	Yo	Ne	AP	TOTAL
1	GX 17201	4.94	5.13	61	15.90	25.91	14.32	5.66	•	13.53	•	•	•	•	•	86.01
2	GX 17202	4.66	4.51	2.35	20.95	24.61	15.17	3.56	•	17.19	•	•	•	•	•	89.99
3	GX 17203	1.27	2.04	1.66	24.68	32.10	12.03	8.33	•	11.23	•	•	•	•	•	93.34
4	GX 17204	2.04	2.28	1.16	33.90	21.92	14.82	7.30	•	6.75	•	•	•	•	•	90.18
5	GX 17205	2.61	3.75	1.66	20.84	26.65	15.53	6.94	•	13.70	•	•	•	•	•	91.68
6	GX 17206	2.59	3.45	6.08	25.67	26.80	•	10.75	•	16.19	•	•	•	•	•	92.77
7	GX 17226	3.81	4.80	9.69	18.85	11.15	•	10.95	•	10.29	21.49	•	•	•	•	91.02
8	GX 17230	3.17	2.51	81	43.53	10.62	18.37	•	•	16.44	•	•	16	•	•	95.61
9	GX 17231	3.37	6.11	32	33.12	19.99	11.07	7.66	•	9.67	•	•	•	•	•	91.32
10	GX 17232	3.13	4.72	13.04	23.81	21.31	4.11	7.93	•	14.43	•	•	•	•	•	92.47
11	GX 17233	2.45	3.38	4.60	23.16	28.19	10.11	13.36	•	4.62	•	•	•	•	•	89.88
12	GX 17234*	3.17	3.63	7.14	37.97	15.27	2.56	5.10	•	20.92	•	•	•	•	•	95.75
13	GX 17235	2.45	4.15	2.03	29.57	15.97	17.14	2.05	•	21.06	•	•	•	•	•	94.43
14	GX 17236*	3.71	2.74	8.94	37.03	16.03	6.21	2.85	•	16.51	•	•	•	•	•	94.03
15	GX 17237	4.20	11.04	98	3.21	35.90	•	20.25	•	4.87	53	•	•	•	•	80.99
16	GX 17238	3.52	4.26	6.61	25.55	21.45	3.51	6.93	•	20.64	•	•	•	•	•	92.46
17	GX 17239	3.77	5.35	2.43	27.38	22.17	12.97	7.01	•	7.25	•	•	•	•	•	88.33
18	GX 17240	2.48	3.15	6.37	53.38	5.10	•	7.80	•	7.45	•	•	•	•	•	93.58
19	GX 17245	2.64	3.68	84	32.74	17.03	18.80	2.73	•	12.76	•	•	•	•	•	91.21
20	GX 17246	3.78	2.76	2.14	57.07	12.39	9.76	2.42	•	3.11	•	•	•	•	•	93.44
21	GX 17247	4.52	4.73	31	44.34	11.62	•	11.94	•	7.77	8.45	•	•	•	•	93.69
22	GX 17249	2.13	4.39	60	27.82	14.40	17.96	1.91	•	23.83	•	•	•	•	•	93.04
23	GX 17250	3.16	3.09	14.81	31.86	9.71	•	5.42	•	7.95	18.81	•	•	•	•	95.26
24	GX 17151*	3.55	4.48	1.80	43.19	17.80	2.79	6.02	•	14.67	•	•	•	•	•	94.30
25	GX 17152	2.72	11.80	2.41	6.23	16.36	•	18.09	•	12.32	15.33	•	•	•	•	85.27
26	GX 17155	3.69	4.09	1.51	41.79	17.74	100E-2	8.07	•	16.12	•	•	•	•	•	93.00
27	GX 17156*	4.08	4.47	2.12	45.29	16.86	37	6.64	•	16.29	•	•	•	•	•	96.11
28	GX 17157*	3.83	3.68	4.15	44.43	16.45	89	6.18	•	14.43	•	•	•	•	•	94.04
29	GX 17159	3.21	3.15	20.77	12.51	5.55	•	4.52	•	16.91	26.73	•	•	•	•	93.35
30	GX 17160	3.28	3.12	23.33	9.27	2.56	•	4.63	•	21.97	24.56	•	•	•	•	92.76
31	GX 17162	3.46	2.16	1.70	48.84	4.13	•	2.38	•	4.80	29.77	•	•	•	•	97.25
32	GX 17164	3.24	4.77	6.97	29.57	20.13	2.21	6.80	•	18.58	•	•	•	•	•	92.26
33	GX 17165	3.78	6.75	3.09	27.32	20.39	•	10.11	•	20.6	14.57	•	•	•	•	88.57
34	GX 17166	7.5	5.25	89	1.00	19.92	32.22	13.15	•	11.98	•	•	•	•	•	95.20
35	GX 17181	2.23	3.82	7.79	20.20	13.36	8.98	3.23	•	28.73	•	•	•	•	•	93.39
36	GX 17182	2.59	2.98	4.45	13.95	14.39	1.15	3.24	•	43.20	•	•	•	•	•	96.36
37	GX 17183	1.53	2.33	6.92	36.94	4.61	•	1.85	•	2.21	43.27	•	•	•	•	99.67
38	GX 17193	3.16	3.53	42	41.55	17.01	12.43	4.30	•	10.79	•	•	•	•	•	93.49

	NUMTEP	1	Mt	Or	Ab	An	Di	Hy	Cl	C	Q	Hm	Tn	Wo	Ne	Ap	TOTAL
39	GX 17194*	3.79	4.08	31	48.61	18.49	4.80	7.63	•	•	7.04	•	•	•	•	•	94.76
40	GX 17353*	3.69	4.72	3.92	43.72	18.12	2.27	5.64	•	•	12.41	•	•	•	•	•	94.49
41	GX 17354*	2.74	3.52	1.15	46.14	12.76	8.49	2.59	•	•	17.28	•	•	•	•	•	94.67
42	GX 17355	2.31	3.30	8.19	35.01	22.14	3.95	9.21	•	•	6.17	•	•	•	•	•	90.28
43	GX 17356	2.65	3.77	1.19	35.87	15.34	•	8.08	•	49	26.59	•	•	•	•	•	93.98
44	GX 17357	1.86	2.64	17.84	8.86	19.11	•	5.29	•	3.07	35.37	•	•	•	•	•	94.03
45	GX 17358	1.42	2.33	12.03	20.72	8.40	•	2.32	•	3.37	45.36	•	•	•	•	•	95.95
46	GX 17359	1.78	2.87	5.34	36.19	9.09	5.35	1.27	•	•	35.99	•	•	•	•	•	97.89
47	GX 17360	3.94	5.86	5.89	31.66	22.67	5.94	9.93	•	•	2.89	•	•	•	•	•	78.92
48	GX 17362	2.17	2.93	87	23.61	27.81	14.91	9.04	•	•	10.07	•	•	•	•	•	88.78
49	GX 17364	2.61	2.44	20.72	24.43	20.68	1.69	10.69	•	•	7.22	•	•	•	•	•	90.47
50	GX 17365*	3.43	4.39	44	45.95	17.63	4.66	8.14	•	•	10.32	•	•	•	•	•	94.96
51	GX 17366	3.48	4.61	4.18	28.41	19.51	6.22	7.03	•	•	18.98	•	•	•	•	•	92.41
52	GX 17374	2.87	3.71	11.93	24.35	19.41	1.30	5.26	•	•	25.40	•	•	•	•	•	94.22
53	GX 17375	1.68	2.68	13.80	25.34	16.85	•	3.25	•	67	31.44	•	•	•	•	•	95.71
54	GX 17376	3.42	4.47	62	44.74	16.70	•	6.61	•	74	17.52	•	•	•	•	•	94.81
55	GX 17377	3.93	7.38	1.53	32.52	17.41	•	14.90	98	9.39	•	•	•	•	•	•	88.03
56	GX 17379	3.15	2.30	7.73	32.17	13.79	1.33	3.27	•	•	32.71	•	•	•	•	•	96.45
57	GX 17384	4.08	6.69	1.74	31.90	25.00	2.78	9.99	•	•	9.53	•	•	•	•	•	91.71
58	GX 17385*	3.35	4.90	44	45.68	17.67	7.76	6.74	•	•	7.27	•	•	•	•	•	93.80
59	GX 17386	3.80	6.43	5.93	18.46	26.12	4.62	10.02	•	•	14.80	•	•	•	•	•	90.18
60	GX 17387	3.74	6.71	6.09	18.57	26.65	3.79	10.48	•	•	14.51	•	•	•	•	•	90.55
61	GX 17388	4.11	5.10	61	44.02	10.66	•	8.62	•	6.81	11.29	•	•	•	•	•	91.24
62	GX 17397*	3.56	3.63	2.96	46.61	11.29	1.03	5.60	•	•	23.61	•	•	•	•	•	98.29
63	GX 17398*	3.41	4.00	2.95	49.85	9.54	1.73	4.68	•	•	22.60	•	•	•	•	•	98.77
64	GX 17399	2.45	3.15	1.34	20.66	30.08	15.50	6.07	•	•	11.32	•	•	•	•	•	90.57
65	GX 17400	3.85	5.01	31	10.01	28.99	18.60	7.95	•	•	15.86	•	•	•	•	•	90.57
66	GX 17401	4.09	7.24	32	31.83	18.68	4.21	9.24	•	•	17.13	•	•	•	•	•	92.75
67	GX 17404	1.71	2.63	1.35	49.79	31.22	15.52	7.25	•	•	11.76	•	•	•	•	•	91.23
68	GX 17405	1.28	2.15	2.92	16.92	30.03	19.23	7.74	•	•	10.58	•	•	•	•	•	90.95
69	GX 17406	2.47	2.83	1.47	17.02	35.58	12.03	7.06	•	•	14.83	•	•	•	•	•	93.28
70	GX 17407	3.23	5.24	2.47	22.05	26.49	•	13.07	•	6.24	11.50	•	•	•	•	•	90.28
71	GX 17408*	2.77	2.64	2.83	28.53	29.23	4.53	6.69	•	•	18.75	•	•	•	•	•	95.98
72	GX 17411	2.67	2.93	5.31	46.37	17.61	3.11	10.49	•	•	1.63	•	•	•	•	•	90.11
73	GX 17412	2.96	3.97	38	30.03	26.39	•	12.30	•	2.33	13.05	•	•	•	•	•	91.41
74	GX 17624	2.85	3.34	55	15.37	28.96	19.09	6.30	•	•	14.23	•	•	•	•	•	90.69
75	GX 17625	1.33	1.85	1.42	20.50	35.56	12.62	1.46	•	•	22.16	•	•	•	•	•	96.91
76	GX 17626	1.52	4.47	4.06	5.82	44.36	•	15.67	•	2.43	11.54	•	•	•	•	•	89.88

	NUMBER	II	Mt	Or	Ab	An	Di	Hy	Qt	C	Q	Hm	Tn	Yn	Ne	Ap	TOTAL
77	GX 17628*	2.91	2.82	7.66	39.55	17.19	4.49	2.87	•	•	20.65	•	•	•	•	•	98.13
78	GX 17629	3.75	5.67	.19	36.56	27.16	2.51	9.44	•	•	6.46	•	•	•	•	•	91.75
79	GX 17631	2.32	2.41	1.44	35.21	16.05	3.69	2.34	•	•	36.27	•	•	•	•	•	99.74
80	GX 17632	2.50	3.43	6.59	37.64	14.71	2.60	3.36	•	•	26.44	•	•	•	•	•	97.26
81	GX 17633	2.92	3.63	5.44	38.16	15.81	•	5.14	•	2.08	23.76	•	•	•	•	•	96.94
82	GX 17634	1.99	2.81	.76	25.24	29.72	14.48	12.10	•	•	3.08	•	•	•	•	•	90.18
83	GX 17635	4.36	4.54	4.18	32.69	22.26	•	7.49	•	.99	18.49	•	•	•	•	•	94.99
84	GX 17636	3.39	4.15	15.28	27.87	15.49	•	15.70	•	6.98	2.11	•	•	•	•	•	90.98
85	GX 17638*	2.95	2.54	3.79	36.02	13.63	15.97	•	•	•	15.21	•	•	•	•	•	93.14
86	GX 17639	2.63	3.48	.12	41.04	12.21	•	14.06	•	9.44	7.22	•	•	•	•	•	90.21
87	GX 17640	2.33	3.16	2.80	22.11	22.53	•	14.94	•	8.90	14.65	•	•	•	•	•	91.36
88	GX 17641	3.62	5.32	6.81	26.75	20.23	8.39	8.44	•	•	1.25	•	•	•	•	•	89.82
89	GX 17642	1.71	•	.34	8.79	28.24	20.56	•	•	•	31.13	.46	.86	5.41	•	•	97.51
90	GX 17643	3.85	5.12	1.58	39.52	16.64	•	10.90	•	2.97	13.61	•	•	•	•	•	94.20
91	GX 17646	3.46	3.68	1.25	44.76	18.36	5.20	8.29	•	•	8.38	•	•	•	•	•	93.38
92	GX 17647	2.72	2.26	2.56	21.12	23.16	17.07	3.89	•	•	19.95	•	•	•	•	•	92.73
93	GX 17649	2.19	3.46	.12	24.00	27.63	16.89	9.85	•	•	5.17	•	•	•	•	•	89.32
94	GX 17656	2.58	4.71	13.02	11.62	23.44	7.07	7.80	•	•	19.95	•	•	•	•	•	90.12
95	GX 17658*	2.91	4.04	.79	47.15	13.32	4.75	3.51	•	•	20.10	•	•	•	•	•	96.59
96	GX 17660	4.04	5.00	4.26	44.93	16.81	3.77	7.16	•	•	8.10	•	•	•	•	•	94.07
97	GX 17662*	2.26	1.85	3.60	43.44	17.88	9.33	3.91	•	•	15.42	•	•	•	•	•	97.69
98	GX 18455*	2.25	4.51	5.82	39.01	23.03	4.24	10.92	•	•	6.38	•	•	•	•	•	96.15
99	GX 18456	2.16	4.47	11.85	27.67	24.59	9.16	8.44	•	•	8.87	•	•	•	•	•	97.21
100	GX 18457	3.04	4.23	34.61	13.35	20.06	2.74	9.87	•	•	8.70	•	•	•	•	•	96.60
101	GX 18458*	3.66	4.27	8.71	33.28	18.75	6.27	6.17	•	•	15.91	•	•	•	•	•	97.01
102	GX 18459*	2.91	8.75	3.95	30.66	24.44	5.84	11.46	•	•	9.16	•	•	•	•	•	97.16
103	GX 18460*	2.48	4.04	8.18	30.68	24.95	5.12	7.25	•	•	12.96	•	•	•	•	•	95.66
104	GX 18461*	3.28	4.27	5.85	36.88	16.74	6.13	5.12	•	•	18.49	•	•	•	•	•	96.76
105	GX 18462	3.78	7.01	.90	27.34	30.29	13.23	10.76	•	•	3.51	•	•	•	•	•	96.82
106	GX 18463	2.48	1.89	3.45	28.75	9.54	3.38	1.27	•	•	47.63	•	•	•	•	•	98.39
107	GX 18464	2.69	4.61	1.09	36.35	24.93	•	13.21	•	2.22	11.28	•	•	•	•	•	96.37
108	GX 18465*	2.79	5.06	5.68	30.75	20.42	9.10	9.08	•	•	13.29	•	•	•	•	•	96.18
109	GX 18467*	2.99	4.05	2.71	37.72	15.21	8.11	5.42	•	•	18.57	•	•	•	•	•	95.79
110	GX 18468	3.44	7.01	2.75	27.04	28.11	13.04	9.53	•	•	2.39	•	•	•	•	•	93.21
111	GX 18469	2.11	3.33	7.42	44.88	21.15	8.30	6.32	•	•	1.28	•	•	•	•	•	94.78
112	GX 18472*	2.25	4.02	3.41	42.48	21.23	9.28	6.64	•	•	7.15	•	•	•	•	•	96.47
113	GX 18473*	2.71	4.14	2.24	49.54	18.39	6.50	7.51	•	•	6.92	•	•	•	•	•	97.26
114	GX 18474*	2.24	3.49	.54	47.25	23.56	12.92	3.96	•	•	3.76	•	•	•	•	•	97.72

	NUMBER	II	Mr	C	Ab	An	D1	Hy	Cl	C	Q	Hm	Tn	Wo	Ne	Ap	TOTAL
115	GX 18475*	2.19	3.73	1.42	50.72	21.31	9.46	6.78	•	•	1.93	•	•	•	•	•	97.55
116	GX 18476*	3.04	4.83	95	50.53	23.15	5.32	9.17	•	•	37	•	•	•	•	•	97.35
117	GX 18483	2.44	4.38	4.59	41.30	20.08	7.42	5.76	•	•	7.44	•	•	•	•	•	93.41
118	GX 18485	2.01	2.90	18.85	31.09	22.86	9.07	•	2.40	•	•	•	•	•	3.04	•	92.21
119	GX 18493	2.42	3.91	1.80	38.85	7.63	•	5.22	•	6.28	30.40	•	•	•	•	•	96.52
120	GX 18496	2.84	5.81	3.92	31.27	26.39	4.51	9.68	•	•	8.19	•	•	•	•	•	92.61
121	GX 18498	3.31	6.52	10.72	23.30	28.70	•	11.71	•	93	5.29	•	•	•	•	•	90.47
122	GX 18505	2.67	4.38	98	46.73	6.71	•	7.48	•	6.42	21.31	•	•	•	•	•	96.68
123	GX 18507	3.09	4.99	1.00	43.74	17.50	•	5.40	•	1.05	19.26	•	•	•	•	•	96.02
124	GX 18508	2.58	4.18	2.44	40.52	15.44	7.82	3.43	•	•	17.57	•	•	•	•	•	93.99
125	GX 18511	3.40	4.96	2.31	40.60	16.46	•	6.14	•	83	21.46	•	•	•	•	•	96.16
126	GX 18512	1.82	3.06	96	39.12	7.99	6.90	1.26	•	•	36.52	•	•	•	•	•	97.62
127	GX 18513	1.87	3.06	2.39	36.85	7.03	10.74	1.49	•	•	31.21	•	•	•	•	•	94.64
128	GX 18518	2.20	6.16	15.05	18.68	16.80	•	14.43	•	11.82	6.62	•	•	•	•	•	91.75
129	GX 18519*	2.48	4.78	2.42	30.71	26.47	11.74	6.47	•	•	12.73	•	•	•	•	•	97.79
130	GX 18520*	2.71	5.12	4.55	34.05	24.81	9.63	9.67	•	•	7.42	•	•	•	•	•	97.97
131	GX 18521*	2.55	4.72	3.10	36.20	24.25	8.83	9.91	•	•	8.92	•	•	•	•	•	98.48
132	GX 18522*	2.75	4.96	3.02	32.04	25.41	9.92	8.76	•	•	11.18	•	•	•	•	•	98.04
133	GX 18523*	2.87	4.29	3.61	38.76	22.00	2.71	13.00	•	•	9.90	•	•	•	•	•	97.13
134	GX 18526*	1.76	2.67	11.27	37.73	11.75	1.77	9.77	•	•	23.29	•	•	•	•	•	100.00
135	GX 18530	90	2.11	14.88	36.16	9.14	•	6.70	•	9.00E-2	30.03	•	•	•	•	•	100.00
136	GX 18533	73	1.69	5.55	36.95	11.67	82	5.29	•	•	37.30	•	•	•	•	•	100.00
137	GX 18534*	1.10	2.44	62	40.95	11.60	•	13.30	•	59	29.40	•	•	•	•	•	100.00
138	GX 18535	1.80	3.32	6.49	39.14	18.43	4.63	13.20	•	10.56	40.70	•	•	•	•	•	100.00
139	GX 18536	84	2.37	26.44	3.57	1.12	•	14.39	•	•	•	•	•	•	•	•	100.00
140	GX 18538*	2.48	2.52	20.17	35.50	13.62	10.68	12.31	•	•	2.73	•	1.85	2.04	•	•	100.62
141	GX 18539	1.42	•	7.39	45.77	3.00	2.21	4.08	•	•	36.60	32	•	•	•	•	100.00
142	GX 18540	1.02	1.33	1.74	54.10	5.44	•	4.08	•	27	32.01	•	•	•	•	•	100.00
143	GX 18541*	1.11	2.25	9.91	35.10	10.05	6.93	3.12	•	•	31.53	•	•	•	•	•	100.00
144	GX 18543*	1.97	2.34	2.35	50.01	14.42	10.33	11.35	•	•	7.34	•	•	•	•	•	100.00
145	GX 18548	1.74	2.18	1.53	17.33	18.59	6.62	3.73	•	•	48.29	•	•	•	•	•	100.00
146	GX 18549	1.76	2.17	1.39	16.19	19.62	5.82	3.99	•	•	49.06	•	•	•	•	•	100.00
147	048	1.31	3.01	17.41	18.37	1.55	•	6.11	•	12.31	36.84	•	•	•	•	63	97.53
148	063	1.67	5.57	6.80	30.27	14.29	•	7.61	•	2.71	27.50	•	•	•	•	74	97.15
149	071*	2.31	5.89	55	36.93	16.42	15.95	3.78	•	•	12.14	•	•	•	•	54	94.50
150	079	2.14	5.22	2.27	34.66	12.66	19.08	1.80	•	•	14.39	•	•	•	•	47	92.68
151	135	2.63	3.55	59	52.55	10.42	17.95	89	•	•	4.33	•	•	•	•	1.42	94.34
152	151C*	2.48	4.52	6.26	42.86	10.54	•	6.16	•	41	25.18	•	•	•	•	90	99.31

	NUMBER	II	Mt	Or	Ab	An	Di	Hy	Ol	C	Q	Hm	Tn	Wo	Ne	Ap	TOTAL
153	153	2.36	8.04	1.65	33.23	24.59	16.59	10.79	•	•	1.89	•	•	•	•	5.00E-2	99.18
154	163*	2.19	5.42	2.37	34.32	25.72	8.19	7.46	•	•	13.08	•	•	•	•	.23	98.99
155	242*	2.88	6.71	1.24	41.97	23.73	7.82	8.62	5.37	•	•	•	•	•	•	•	98.32
156	260*	2.07	5.74	1.48	50.73	13.92	5.93	4.75	•	•	10.08	•	•	•	•	1.20	95.90
157	126S	3.12	9.19	17.01	38	33.87	•	14.34	•	.11	12.16	•	•	•	•	1.59	91.78
158	19-01*	2.02	7.48	.18	28.30	28.28	16.09	9.01	7.11	•	•	•	•	•	•	•	98.49
159	19-07	1.93	5.03	1.56	46.95	1.94	•	8.41	•	10.13	22.59	•	•	•	•	1.03	99.57
160	51-07	3.20	10.51	3.54	15.02	10.48	•	20.43	•	18.44	10.19	•	•	•	•	1.74	93.53
161	51-09	4.67	10.27	9.22	28.37	18.24	•	10.58	•	.65	14.05	•	•	•	•	1.79	97.84
162	52-05*	3.22	7.69	.52	44.95	22.29	3.50	12.06	•	•	.64	•	•	•	•	1.69	96.55
163	52-09	2.62	6.86	11.54	.58	31.53	1.02	17.51	•	•	16.46	•	•	•	•	1.40	89.51
164	52-21	3.21	5.84	.25	53.08	16.44	•	9.62	•	.74	6.08	•	•	•	•	1.86	97.13
165	GX 18556	2.56	3.71	4.12	44.91	19.49	9.26	5.66	•	•	4.45	•	•	•	•	•	94.16
166	GX 18557	2.10	3.34	1.23	42.44	19.92	9.39	6.42	•	•	10.05	•	•	•	•	•	94.89
167	GX 18558*	2.83	5.28	.63	31.63	27.94	5.37	6.72	•	•	16.15	•	•	•	•	•	96.55
168	GX 18559	2.81	4.04	3.60	38.90	27.07	5.75	9.51	•	•	1.82	•	•	•	•	•	93.49
169	GX 18560*	2.58	3.87	2.09	40.25	20.18	10.37	5.86	•	•	10.44	•	•	•	•	•	95.64
170	GX 18561	2.00	5.71	12.52	24.52	21.72	5.60	•	23.87	•	•	•	•	•	.41	•	96.34
171	GX 18562	2.06	5.61	4.91	21.36	25.98	21.48	4.66	•	•	•	•	•	•	•	•	96.59
172	GX 18564	3.77	5.01	1.06	2.87	32.54	17.66	5.46	•	•	27.53	•	•	•	•	•	95.90
173	GX 18603*	3.23	3.83	3.01	34.77	14.57	18.16	5.01	•	•	15.85	•	•	•	•	•	98.43
174	GX 18604*	3.64	4.06	2.29	44.93	10.41	16.80	6.01	•	•	9.90	•	•	•	•	•	98.04
175	GX 18605*	3.73	5.47	3.24	39.26	18.74	10.32	14.32	•	•	1.73	•	•	•	•	•	96.82
176	GX 18606	3.54	5.12	2.07	24.17	26.10	12.91	10.82	•	•	12.32	•	•	•	•	•	97.06
177	GX 18607	3.59	5.88	.92	21.72	22.40	13.19	12.76	•	•	15.47	•	•	•	•	•	95.94
178	GX 18608	3.61	3.55	3.17	33.13	13.79	16.77	3.51	•	•	18.26	•	•	•	•	•	95.79
179	GX 18609*	4.11	4.74	2.54	40.00	13.66	14.43	8.77	•	•	9.51	•	•	•	•	•	97.75
180	GX 18610	3.26	4.51	2.32	20.76	24.19	16.20	6.50	•	•	17.44	•	•	•	•	•	95.18
181	GX 18611	3.33	5.78	5.95	31.84	15.60	19.67	10.37	•	•	4.60	•	•	•	•	•	97.14
182	GX 18612*	4.27	3.15	3.17	48.49	9.22	14.43	4.93	•	•	10.28	•	•	•	•	•	97.87
183	GX 18613	3.32	5.70	1.89	10.75	30.15	11.44	10.37	•	•	21.60	•	•	•	•	•	95.21
184	GX 18614*	3.62	4.72	3.60	37.29	15.89	16.34	8.01	•	•	8.31	•	•	•	•	•	97.77
185	GX 18624	2.27	3.99	2.56	24.60	33.86	11.91	10.03	•	•	5.33	•	•	•	•	•	94.54
186	GX 18625*	3.56	4.60	2.15	35.92	17.78	12.13	8.10	•	•	12.51	•	•	•	•	•	96.76
187	GX 18626	4.44	2.52	.52	13.75	40.13	7.93	9.69	•	•	14.44	•	•	•	•	•	94.62

	NUMBER	Il	Mt	Or	Ab	An	Di	Hy	C	Q	Hm	Yo	Ru	Ap	TOTAL
191	GX 18623	49	1.81	2.88	46.29	6.32	•	.73	2.24	36.56	1.04	•	•	•	98.36

	NUMBER	Il	Mt	Or	Ab	An	Di	Hy	Ol	C	Q	Yo	Ap	TOTAL
77	189	3.10	4.39	2.63	31.10	23.67	14.93	7.57	•	•	12.44	•	.17	100.00
78	171B	3.03	5.56	.14	28.71	27.64	10.46	12.74	•	•	11.59	•	.13	100.00
79	171C*	3.00	5.90	.20	47.57	16.95	12.94	12.51	•	•	.69	•	.23	100.00
80	174*	2.60	4.78	5.02	34.38	16.69	21.44	8.36	•	•	6.63	•	.12	100.00
81	188	2.84	4.30	1.10	33.95	19.97	25.13	4.92	•	•	7.80	•	•	100.00
82	196*	2.79	4.83	2.45	41.47	20.23	11.81	11.02	5.27	•	•	•	.12	100.00
83	196B*	3.09	6.28	3.29	30.29	26.51	9.76	16.53	•	•	4.12	•	.13	100.00
84	202*	3.34	3.84	3.37	39.96	20.77	8.63	10.36	•	•	9.30	•	.43	100.00

APPENDIX 5 : SUMMARIZED DRILL CORE LOGS

Summarized drill core logs of a few selected holes located near the trace of the Hunter Creek fault. All holes were drilled by Minnova Inc. They are sub-vertical (90° at collar). Their position is indicated on the geological map (Fig.: 6, in pocket).

DRILL HOLE DT-51 (depth : 1083 ft.)

12'-601' Sheared and altered QFP (0° to 20 ° c.a.). Intense
 sericite alteration.
140'-144' fault (20° c.a.)

601'-695' Amygdaloidal pillowed and flow breccia andesite .
 Strongly altered until 623' (sericite, hematite).
628'-668' diorite dyke
695' fault (40° c.a.)

695'-1083' Diorite intruded by felsic dykes

(90° at collar , 54° at 865')

DRILL HOLE DT-52 (depth : 2193 ft)

12'-181'	Diorite
181'-187'	QFP breccia
187'-806'	Amygdaloidal sheared andesite (0° to 30° to 0° c.a.)
451'-627'	diorite dyke
451'-627'	strong chlorite-sericite alteration
806'	minor fault (5° c.a.)
806'-842'	Rhyolite (feldspar phenocrysts)
819'-830'	mafic dyke
842'-1036'	QFP
852'	minor fault (5° c.a.)
863'	minor fault (20° c.a.)
934'-972'	mafic dyke
979'-1027'	strong hematite alteration
1036'-1212'	Amygdaloidal andesite
1212'-1282'	Rhyolite
1274'	minor fault
1282'	fault

1282'-1296' Amygdaloidal pillowed andesite
 1288' sheared and sericitized (25° - 60° c.a.)

1296'-1412' Rhyolite (quartz and feldspar phenocrysts)
 1302' minor fault (70° c.a.)
 1302.5' minor fault
 1304' minor fault (20° c.a.)
 1386'-1392' major fault
 1397' fault
 1412' fault (20° c.a.)

1412'-1532' QFP
 1451' minor fault (35° c.a.)
 1458' minor fault

1532'-1651' Andesite (pillowed ?)
 1532'-1582' with feldspar phenocrysts
 1601'-1649' diorite dyke

1651'-2193' Rhyolite (quartz phenocrysts) intruded by andesitic dykes
 1651'-1676' breccia
 1718'-1755' feldspar porphyre andesite dyke
 1764'-1782' andesite dyke
 1800'- breccia , strong sericite alteration (more developed in fragments)
 1977'-1988' andesite dyke (?)
 1993'-2012' andesite dyke (?)
 (90° at collar , 75° at 1582')

DRILL HOLE NV-10 (depth : 588 m)

5-13 m Diorite

13-139.3m Rhyolite flows and breccias
 45-47 m diorite dyke

139.3-163.2m QFP dyke

163.2-200m Rhyolite flow

200-259m QFP and rhyolite dykes
 224 m minor fault

259-267m Rhyolite
 267-333m QFP dyke
 308-314 m diorite dyke , sheared contact

333-433m Rhyolite , massive flow, predominantly breccia below
 390 m

433-588m QFP , predominantly breccia
 445-452 m strongly chloritized
 456-461 m sheared amygdaloidal andesite dyke

461-554 m chloritized
554.5-555.7 cherty tuff

(90° at collar , 87° at 588 m)
(after A. Lichtblau, 1986)

DRILL HOLE NV-17

(depth : 2002 ft)

19'-38' Diorite

38'-141' Andesite
 38'-110' silicified andesite
 62'-82' diorite dyke
 110'-121' diorite dyke
 121'-141' sheared andesite (35° c.a.)

141'-243' Rhyolite (quartz and feldspar phenocrysts)

243'-267' Massive andesite , amygdaloidal
 255' minor fault (35° c.a.)

267'-422' Rhyolite (few quartz phenocrysts)
 287' fault (45° c.a.)
 335'-340' minor faults

422'-504' Massive andesite (feldspar phenocrysts)
 locally highly fractured
 465' minor fault (35° c.a.)

504'-536' Rhyolite flow

536'-683' Massive andesite , fractured
 545'-673' QFP dyke

683'-939' Rhyolite intruded by dykes
 721'-722' sheared zone
 779' minor fault (35° c.a.)
 798' minor fault
 818' minor fault
 833'-839' QP dyke
 839'-860' diorite dyke
 866'-910' diorite dyke
 939'-1078' QFP dyke , hematized
 1041'-1078' fractured
 1059' fault

1078'-1129' Rhyolite , local feldspar phenocrysts , highly
 fractured
 1121' fault (50° c.a.)

1129'-1223' (Q)FP dyke (?) , hematized
 1138'-1140' fractured, ground

1223'-1734' Rhyolite , few feldspar phenocrysts

1734'-2002' QFP
 1923' fault

(90° at collar , 80° at 2000')

(after P. Bertrand , 1987)

DRILL HOLE NV-19

(depth : 1540 ft)

5'-146' Diorite
82' fault (0° c.a.)

146'-528' Rhyolite , more or less chloritized and seritized
321'-344' andesitic dyke
384'-420' andesitic dyke
423'-519' quartz and feldspar phenocrysts , some strongly
hematized sections

528'-637' Pillowed andesite , locally sheared , locally
amygdaloidal

637'-927' QFP , fractured , locally sheared
713'-773' andesitic dyke
805' fault (45° c.a.)
819' fault (50° c.a.)
857'-858' ground rock
889'-890' ground rock
896' minor fault
899'-900' minor fault
902' minor fault
925' minor fault (50° c.a.)

927'-1192' Andesite (pillowed)
926'-938' diorite dyke
930' ground rock
939'-949' felsic dyke
940' ground rock
1092'-1100' diorite dyke
1160' ground rock
1170' ground rock

1192'-1396' QFP (dyke) , locally hematized
1361'-1371' andesite
1370'-1371' sheared zone
1371' ground rock , minor fault
1371'-1375' andesite

1396'-1540' Dacite breccia
1396' ground rock

(90° at collar , 75.5° at 1500')

DRILL HOLE DT-53

(depth : 1117 feet)

23'-38' Pillowed andesite

38'-297' Rhyolite (with few andesite)
105'-116' andesite

297'-495' Andesite
399'-442' FP dyke

495'-630' Rhyolite (with few andesite)
 630'- Rhyolite with QP sections
 1064' 671' minor fault (70°c.a.)
 1064'-1117' Gabbro with magnetite grains
 (90° at collar, 84° at 1100')
 (after P. Bertrand, 1987)

DRILL HOLE PT-54 (depth : 508 m)

16.5-27.2m Rhyolite (0-5% quartz phenocrysts 1 to 2 mm large)
 27.2-27.9m Mafic dyke
 27.9-66.1m Rhyolite , hematite alteration
 66.1-181m Silicified andesite (magnetic sections)
 74 m-91 m andesite breccia
 138 m-181m pillowed andesite
 181-203m Massive rhyolite
 203-477m Andesite
 259 m fault
 423 m-477m silicified andesite
 477-508m Gabbro
 (90° at collar, 84.3° at 500 m)
 (after P. Bertrand, 1987)

c.a. : core angle
 QFP : rhyolitic quartz and feldspar porphyry
 QP : rhyolitic quartz porphyry

APPENDIX 6 : STRATIGRAPHIC LOGS : METHODS

The stratigraphic logs done in Cranston QFP breccia and in Dufresnoy andesite breccias were built as follow :

- 1) Logs were measured on sections perpendicular to the stratigraphy (S_0).
- 2) The five largest fragments in 1.5 m on each side of the section were measured at every 0.5 m.
- 3) The mean was calculated out of the ten fragment measurements obtained, and reported on the diagrams.

Fig.25 : Stratigraphic log in Dufresnoy andesite, eastern side of the rhyolitic feldspar porphyry dome (Range VIII, Lot 6, Dufresnoy Township), and variation in size of breccia fragments. Each dot represents the average size of the 10 largest fragments measured along a 3 m wide section at every 0.5 m.

R IX
R VIII

FISH

VF, Δ

V6 Δ with up to 10%
V2E⁺ ang frag (2-100 cm)

79°02'43"

48°24'17"

(NOT MAPPED)

DUFRESNOY
andesite

LEGE

EGEND

STRUCTU

- geological co
- bedding: incli
- foliation (S
- foliation (S
- foliation (S
- long axis of

long cycle of

Figure 6a
GEOLOGY OF THE
HUNTER CREEK FAULT
AREA

STRUCTURE

geological contact: defined, inferred
 dipping: inclined, vertical, normal polarity
 dip (S₁): defined dip
 dip (S₂): defined dip
 dip (S_x): defined dip
 axis of elongated amygdulites

VOLCANIC

V 2	rhyolite
V 6	andesite
V 9	tuff
VI 2	hyalotuff

INTRUSIVE

2D	quartz diorite to quartz
----	--------------------------

COMPOSITION

α	felsic
β	mafic

TEXTURES

⊙	amygdaloidal
◻	porphyritic
*	spherulitic
⊖	pillowed
⊕	flow-banded

VOLCANIC ROCKS

V2	rhyolite
V6	andesite
V9	tuff
V12	hyalotuff

INTRUSIVE ROCKS

2D	quartz diorite to gabbro
----	--------------------------

COMPOSITION

α	felsic
β	mafic

TEXTURES

⊙	amygdaloidal
□	porphyritic
*	spherulitic
⊕	pillowed
⦶	flow-banded

△	brecciated
△	hyaloclastite b
△	flow breccia
■	massive

ALTERATIO

σ	quartz
ϵ	epidote
ϕ	chlorite
λ	sericite
η	carbonate
ρ	hematite

MINERALS

am	amphibole
c	carbonate
cf	iron carbonate
cl	chlorite

LEGEND

ite breccia
cia

ATION

LS

nate

e epidote
f feldspar
q quartz
Cp chalcopyrite
Hm hematite
Mt magnetite
Po pyrrhotite
Py pyrite
Sp sphalerite

GRAIN SIZE

f.g. fine grained
mg. medium grained
c.g. coarse grained
peg pegmatitic

ABBREVIATIONS

ang. angular
dyk dyke
frag. fragment
tal. talus
tr trace
v. vein

be
foliated
foliated
foliated
long d
v
space associated
joints oolite
quartz breccia
dyke
fault
inclined
strike
fault vein
gote
shear zone
pegmatite
axial zone
folded

NERA
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ERATION

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ERALS

ool
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- e epidote
- f feldspar
- q quartz
- Cp chalcopryrite
- Hm hematite
- Mt magnetite
- Po pyrrhotite
- Py pyrite
- Sp sphalerite

GRAIN SIZE

- f.g. fine grained
- mg. medium grained
- c.g. coarse grained
- peg pegmatitic

ABBREVIATIONS

- ang. angular
- dyk dyke
- frag. fragment
- tal. talus
- tr trace
- v. vein

- geological con
- bedding: inclin
- foliation (S)
- foliation (S)
- foliation (S)
- long axis of el

with angl

- spaced cleava
- joints: incline
- quartz vein:
- dyke: inclined
- fault (undeter
- inclined fault
- strike slip fau
- fault with stric

(U:up , D

- shear zone: in
- presumed fau
- axial plane
- fold

HUNTER CREEK FAULT AREA

contact: defined, inferred

inclined, vertical, normal polarity

(S₁): defined dip

(S₂): defined dip

(S_x): defined dip

of elongated amygdules

angle of plunge

average: inclined, vertical

lined, vertical

in : inclined, vertical

ned, vertical

etermined)

ult

fault : right-handed, left-handed

striae : normal, reverse

, D: down)

: inclined, undetermined dip

fault

;

trench

outcrops: large, small

sample location
(least altered rocks)

drill hole with first lithologic
unit encountered

creek with swampy ground
ponded water

road

trail

power line

airphoto lineament

0

500 m

scale 1: 5 000

mapped and drawn by Geneviève Camiré
-1988-

4 of /de 4

MINI-DIGITAL SYSTEM
MICRO
DIGITAL SYSTEM

R IX

R VIII

• 184160

• 846

• 18457

• 18458

• 1845

• 18456

• 18455

• 18451

• 18450

• 18472

• 18474

• 18475

• 18476

• 18473

Fig.28

Δ 8603
• 8604

Fig.20

Δ 8603
• 8604

Fig.17

Δ 7627
• 7628
• 7629
• 7630

• 8467
• 8471
• 8470

• 8467 • 8458

• 8464 • 8463

• 8460 • 8461

• 8462

Fig.28

Δ 2551
• 2552

Fig.20

Δ 2551
• 2552

• 2551
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• 2553

• 18516

• 18511

• 18512

• 18511

• 18510 • 18511

• 18511

• 18511
• 18512
• 18513

• 18511 • 18512

Fig.37

• 17357 • 17358

• 17356 • 17181 • 17164 • 17165

• 17182 • 17180 • 17176 • 17177

• 17184 • 17183 • 17179 • 17172

• 17176 • 17178 • 17170 • 17171

• 17177 • 17173 • 17174 • 17175

• 17177 • 17174 • 17175

• 17177 • 17174 • 17175

• 17177 • 17174 • 17175

R IX

R VIII

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18614

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DUFRESNOY

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17401

Fig.22 & 23

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R VIII
R VII

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Fig.25 & 31

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Fig.29
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Figure 6b : Sample

Fig.25 & 31

Fig.29
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Figure 6b: San

Sample and figure location.

Fig.15

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Fig.8Δ

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Fig.9 & 10

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Fig. 9 & 10

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Fig.12

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SAMPLE LOCATION

SMALL LAKE OR SWAMP

ROAD

FIGURE LOCATION

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SAMPLE LOCATION

SMALL LAKE OR SWAMP

ROAD

FIGURE LOCATION

SCALE 1: 5 000

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END

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