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CHEMICAL ANALYSES OF UPPER CRETACEOUS VOLCANICS AND RELATED(?) SILLS, NORTHWESTERN ELLESMERE ISLAND, DISTRICT OF FRANKLIN

H.P. Trettin[1]

1 Box 96, Mansons Landing, British Columbia V0P 1K0
Thin sections and samples are curated at the Geological Survey of Canada (Calgary)
3303 33 Street N.W., Calgary, Alberta T2L 2A7

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Contents

INTRODUCTION

This Open File lists chemical analyses on 30 samples from the Upper Cretaceous Hansen Point volcanics and on 12 samples from related(?) sills. The source rocks are located in the Yelverton Inlet, Otto Fiord, and Cape Stallworthy map areas (NTS 340 F, 340 C, and 560 D) of northwestern Ellesmere Island. The file also includes chemical classifications of the samples, brief notes on their geological setting, some petrographic observations, and conclusions concerning the tectonic origin and age of the rocks. The petrographic studies were not completed because of my retirement to Cortes Island.

Five samples were collected by T.O. Frisch in 1975 and the rest by me between 1966 and 1992. The analyses were made in laboratories of the Geological Survey at Ottawa and Calgary and by a commercial firm, Elemental Research Incorporated of Vancouver, in the period 1979 to 1993.

I thank the staff of these laboratories for their conscientious work and cooperation. M.G. Bjornerud, T.O. Frisch, Y. Ohta, and K.G. Osadetz contributed to the geology of the Hansen Point volcanics. I have profitted from a discussion with Professor G. Muecke of Dalhousie University, Halifx, N.S. who is leading an on-going research program concerned with the petrology and tectonic significance of the igneous rocks of the Sverdrup Basin.

ANALYTICAL METHODS

Major element analyses obtained from the Ottawa laboratories between 1979 and 1989 (reports 10-79, 57-79, 110-82, 86-83, 96-83, 225-88, and 67-89) were done by wave-length dispersive X-ray fluorescence on fused discs, in combination with rapid analytical techniques for FeO, H_2O, and CO_2, and with optical emission spectography for low values of MnO, MgO, and CaO.

Major element analyses obtained from the Calgary laboratory in 1992 (report 92-XR-49) and from Elemental Research Inc. in 1993 (report 4263) were done by induced coupled plasma mass spectrometry (ICP-MS) and were supplemented by two types of special analyses:

1. CO2 was determined by means of Leco furnace analysis in the Calgary laboratory and subtracted from the total percentage of material lost on ignition (LOI).

2. In the ICP-MS analyses, FeO and Fe2O3 were not distinguished and the total Fe was reported as Fe2O3. Subsequently FeO was determined in the Ottawa laboratory by the Pratt method (report 113-92) or by the Wilson method (report 007-93), and Fe2O3 was recalculated for the remaining fraction of Fe. Note that the sum of FeO and recalculated Fe2O3 is necessarily smaller than the ICP-MS percentage of Fe2O3. All other percentages have been retained as received and therefore the total percentages for individual samples are somewhat smaller than 100: they range from 96.61 to 98.89.

For purposes of rock classification (see below) it was important to acquire relatively reliable data for Nb, Y, Zr, and TiO2, and different methods were used during different years. Regarding Nb, Y, and Zr, energy-dispersive X-ray fluorescence, utilizing Compton scatter, was used for reports 86-83, and 96-83, whereas ICP methods were employed for later reports. Regarding TiO2, three different methods were combined for report 86-83: wave-length dispersive X-ray fluorescence, spectometric analysis, and colorimetric spectography (see Table 3). From the results, a value was chosen that appeared most approriate in view of the observed scatter and the reliability of the methods for certain concentrations. For report 225-88, the Ottawa laboratory reverted to standard major element analysis, i.e. wave-length dispersive X-ray fluorescence on fused disks. Later reports are based on ICP methods.

A variety of methods were applied to determine the remaining trace elements. Prior to 1983, spectometric analysis by means of direct reading of optical emission spectra was employed. From 1983 to 1988, energy-dispersive X-ray fluorescence, using Compton scatter, was applied in conjunction with traditional spectometric analysis. Later reports rely on ICP methods.

Estimates of the reliability of the various methods have changed with time and are difficult to evaluate. Duplicate analyses presented in Tables 2 (# 18-28) and 3 give an impression of the ranges obtained under identical laboratory conditions.

CHEMICAL CLASSIFICATION

In Table 1 the rocks are classified according to a discrimination diagram by Winchester and Floyd (1977, Figure 6). This is a logarithmic plot of Zr/TiO2 versus Nb/Y for the following rock types or groups of rock types: (1) subalkaline basalt, (2) andesite-basalt, (3) andesite, (4) rhyodacite-dacite, (5) rhyolite, (6) alkali basalt, (7) basanite-nephelinite, (8) trachyandesite, (9) trachyte, and (10) comendite-pantellerite. Types (6) to (10) are moderately to highly alkaline in composition.

This method has proven relatively reliable even for highly altered rocks although the elements involved are not entirely immune to alteration (cf. Murphy and Hines, 1986; Brewer and Atkin, 1989; Wang and Glover, 1992; Kuschel and Smith, 1992; Rubin et al., 1993). In the present case, it demonstrates that both volcanics and sills include a significant proportion of alkaline rocks. In contrast, no alkaline rocks were identified by computer analyses based on the major-element classification of Irvine and Baragar (1971). This probably is due to alteration, especially to the addition of quartz, which is evident from X-ray diffractograms and thin sections. The Irvine-Baragar method was applied only to volcanics from the Yelverton Inlet map area (# 1-15), and the results are not listed in Table 1.

GEOLOGICAL NOTES

These notes should be used in conjunction with recent geological maps that are referred to below. The following reports provide overviews for different age spans: Precambrian to Devonian — Trettin, 1996b and in press; Devonian to Permian — Mayr, 1992; Mesozoic — Embry, 1991; Tertiary — Ricketts, 1994.

Hansen Point volcanics

Hansen Point is a cape on the northwestern coast of Ellesmere Island located in the Yelverton Inlet mapa area (NTS 340 F) between Yelverton Bay and Petersen Bay. The informal name, Hansen Point volcanics, was introduced by Trettin and Parrish (1987) for volcanic rocks south of Hansen Point that had yielded a Late Cretaceous zircon age. These rocks were first investigated by Frisch in 1975 (Frisch, 1976; Trettin and Frisch, 1981). Volcanogenic clastic sediments mapped by Christie (1957) in the same general area were also included in this unit, as were relatively undisturbed volcanics southwest of Yelverton Bay mapped by Frisch (1974). More recent investigations have shown that scattered exposures of this unit occur in adjacent parts of the Yelverton Inlet, Otto Fiord, and Cape Stallworthy map areas, between Petersen Bay in the northeast and Nansen Sound in the southwest.

Six separate outcrop areas of the Hansen Point volcanics have been mapped in the Yelverton Inlet area (Trettin and Frisch, 1996), four of which were sampled for chemical analysis.

1. Volcanic and sedimentary strata exposed between Yelverton Bay and Petersen Bay are overthrust by Proterozoic gneiss of Succession 1 of Pearya from the southeast. Seven samples from this area (# 1-7) represent comendite-pantellerite (3), subalkaline basalt (2), rhyolite (1), and rhyodacite-dacite (1). The rocks show varying degrees of alteration. The pyroxene is altered to chlorite and actinolite. The K-feldspar appears to be microcline according to whole-rock XRD analyses, and sanidine is absent. The plagioclase consists mainly of albite, but intermediate to calcic compositions are preserved in two samples. A sample of rhyolite, analyzed by the U-Pb method (Trettin and Parrish, 1987), contained a large proportion of xenocrystic zircon that produced a pronounced discordance on the concordia diagram. The upper intercept age of 1140 +41/-39 Ma indicated derivation from the crystalline basement of Pearya, the lower intercept age of 88 +20/-21 Ma, crystallization in the Late Cretaceous.

2. Volcanic strata exposed on northeastern Wootton Peninsula, southwest of Yelverton Bay, are overthrust from the west-southwest by map units W2 and W3 of Succession 2 of Pearya. Map unit W2 includes metamorphosed diamictite of probable late Neoproterozoic age and other metasediments. Map unit W3 consists of carbonates that are probably Early Cambrian in age. The volcanics were previously assumed to be early Paleozoic in age because they are metamorphosed or altered and because they include lenses of marble (Trettin and Frisch, 1981), but they are similar in composition to the rocks at Hansen Point and in area 3 (see below). The marble probably represents Late Cretaceous land slides of map unit W3. Trace element classifications

are available for six out of eight samples (# 8-15) from this area. They represent comendite-pantellerite (2), rhyolite (2), rhyodacite-dacite (1), and trachyandesite (1). Two samples are probably from cogenetic dykes or sills. The rocks from this area are composed mainly of quartz, K-feldspar (not sanidine), and albite with minor mica, chlorite, and opaque minerals and calcite veins and replacements.

3. Volcanic strata on eastern Wootton Peninsula, southwest of area 2 and separated from it by a northeast and east-flowing glacier, are overthrust from the southeast by Succession 1 of Pearya. Fault blocks or Late Cretaceous land slides of map unit W3 occur in the southwestern part of this area. A stratigraphic section of the Hansen Point volcanics (section EYB in Trettin and Frisch, 1996) has a minimum thickness of 260 m. Its base is concealed and the top coincides with the present erosion surface. Resistant, massive flows alternate with recessive laminated rocks, probably mainly tuffs or welded tuffs. Eleven analyzed samples (# 18-28) are in the compositional fields of comendite-pantellerite (5), rhyolite (3) and trachyandesite (1) or straddle the boundary between rhyolite and trachyandesite (2). Thin section studies and XRD analyses have not been made.

4. Volcanic rocks on an unnamed peninsula southwest of the lower reaches of Phillips Inlet occupy a graben that is bounded by the Danish River Formation and undated carbonates of Succession 2 of Pearya (map unit c). Most of these rocks are fragmental. Two analyzed samples (# 16, 17) are classified as trachyandesite. They are composed mainly of albite, chlorite, and opaque minerals with quartz and calcite veinlets and replacements. Calcic plagioclase is preserved in another sample from this outcrop area that has not been analyzed chemically.

5. An outcrop area in the central part of Wootton Peninsula lies at the southwestern end of the semi-circular structural belt that includes areas 2 and 3. There the Hansen Point volcanics are in fault contact with map unit W2 on the north and with early Paleozoic or older carbonates on the south.
6. A small outcrop area of volcanic rocks and clastic sediments with plant fragments was discovered by Y. Ohta in an area northeast of the central part of Phillips Inlet in 1988 (Ohta and Klaper, 1992). It occurs in a complex graben within the Mitchell Point Fault Zone and is surrounded by strata of Succession 2 of Pearya (Proterozoic to Lower Ordovician). The plant fragments were undiagnostic and no spores were recovered.

Four outcrop areas of the Hansen Point volcanics in the northwestern part of the Otto Fiord map area (Trettin and Mayr, 1996) are in fault contact with the Silurian Lands Lokk Formation, the Carboniferous-Permian Nansen Formation, and locally with the Tertiary Eureka Sound Group. Chemical analyses are listed for two samples of mafic flow rocks (# 29, 30), collected by the writer from the northeasternmost outcrop area in 1977. Special trace element analyses that are suitable for classification have not been made. The lithology, age, and structural setting of the two southwestern areas was clarified by K.G. Osadetz in 1985 (Embry and Osadetz, 1988; Osadetz, pers. com. 1994). In the second area from the southwest, the unit includes sandstone, conglomerate, and mudrock in addition to volcanics. Plant fossils indicated a Late Cretaceous age.

In the adjacent Cape Stallworthy map area (Trettin, 1996a), the Hansen Point volcanics cover the southwestern part of an unnamed peninsula that is surrounded by Audhild Bay, Emma Fiord, and Nansen Sound. Thorsteinsson (1974), who mapped these strata as unit Cv, established that they overlie the Nansen Formation and consequently are Carboniferous or younger in age. A stratigraphic section on the east side of this outcrop area was investigated by Osadetz (Embry and Osadetz, 1988) and by McRae (1989). It is composed of alkali basalt, trachyte, felsic tuff, conglomerate, mudrock, sandstone, and minor coal and has yielded Maastrichtian palynomorphs and isotopic ages. The stratigraphic top of the unit is not preserved.

Sills

Mafic dykes and sills are common in a lower Paleozoic inlier at Fire Bay, Emma Fiord (Trettin, 1996a, Inset B). The dykes trend in northwesterly, northerly, and northeasterly directions and the most prominent ones are presented on the map as red lines. They appeared to be normal diabases but have not been investigated petrographically or chemically. Sills also are common, especially in an area northeast of Fire Bay that is underlain mainly by the Danish River Formation (map unit S_{DR+}), but are not shown on the map because of space limitations. The sills strike west-southwest and commonly dip in northeasterly directions. A total of nine samples from this area (# 1-2, 6-12) are classified as basanite-nephelinite (3), alkali basalt (3, one transitional to basanite-nephelinite) or subalkaline basalt (3). Preliminary studies of thin sections and whole-rock X-ray diffractograms of two samples of basanite-nephelinite suggested analcite(?), pyroxene, olivine (fosterite), and minor opaque minerals with calcite and chlorite in amygdules and some quartz. The presence of analcite requires confirmation. It was inferred from X-ray diffraction peaks that were tentatively correlated with an isotropic mineral in the groundmass, possibly a replacement. Analcite has never been identified in pre-Carboniferous rocks. If correctly identified, it suggests a relatively young age.

A prominent sill of basanite-nephelinite (# 3-5) also occurs in a fault slice of the Fire Bay Formation (map unit S_{F*}) northeast of Emma Fiord in the Otto Fiord map area (Trettin and Mayr, 1996).

SUMMARY AND DISCUSSION

The classification of the 38 samples for which reasonably reliable trace element analyses are available can be summarized as follows:

Hansen Point volcanics

Normal rocks		Alkaline rocks	
Rhyolite:	6	Comendite-pantellerite:	10
Rhyodacite-dacite:	2	Trachyandesite:	2
Subalkaline basalt:	2		

Transitional rocks

Rhyolite transitional to trachyandesite: 2

Sills

Normal rocks		Alkaline rocks	
Subalkaline basalt:	3	Akali basalt:	2
		Alkali basalt transitional to basanite-nephelinite:	1
		Basanite-nephelinite:	6

These results are not statistically significant because the samples were not collected in a systematic fashion. Nevertheless, they show that the Hansen Point volcanics in the Yelverton Inlet map area are predominantly felsic and only to a minor extent intermediate or mafic in composition.

Statistical information about other areas is not available to me but it appears that felsic volcanics are most abundant in those outcrop areas of the Hansen Point volcanics that are underlain by early Paleozoic or older rocks of Pearya, and this may not be accidental. U-Pb zircon analysis has shown that the felsic components were derived from Middle Proterozoic granitoid gneiss that forms the crystalline basement of Pearya (Trettin and Parrish, 1987). The basement of the other areas is concealed but probably quite different.

Fourteen out of 26 classified samples from the Hansen Point volcanics, i.e. about 54 per cent, are alkaline. This indicates a mildly extensional tectonic regime, in contrast to the rifting regime inferred for the tholeiitic Strand Fiord Formation of Axel Heiberg Island (Ricketts et al., 1985), and for the Wootton Intrusive Complex of the Yelverton Inlet map area. The Strand Fiord Formation is now regarded as late Albian-early Cenomanian in age (Embry, 1991), and the Wootton Complex, which has yielded a U-Pb zircon age of 92 ± 1 Ma (Trettin and Parrish, 1987), as Turonian. Both are significantly older than the Hansen Point volcanics in the Cape Stallworthy map area, for which a Maastrichtian age has been established (McRae, 1989). It is likely that the Hansen Point volcanics of the Yelverton Inlet map area also are Maastrichtian in age and not coeval with the Wootton Intrusive Complex as suggested earlier (Trettin and Parrish, 1987).

The sills at Emma Fiord are related to the Hansen Point volcanics by their partly alkaline composition and geographic proximity. This correlation, however, is not certain because earlier episodes of alkaline magmatism have occurred in the Sverdrup Basin, for example in the Carboniferous (Trettin, 1988).

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Table 1. Sample Information

A. Hansen Point volcanics

Current no.: 1
Location: south of Hansen Point; NTS 340 F; zone 17, 478900E, 9152750N
Field no.: 75FS500-6
Catalogue no.: C054813
Analytical report: GSC Ottawa 86-83-56
Trace element classification: subalkaline basalt

Current no.: 2
Location: see no. 1
Field no.: 75FS500-9
Catalogue no.C054816
Analytical reports: GSC Ottawa 10-79-6, 86-83-40 (TiO2, Nb, Y, Zr)
Trace element classification: subalkaline basalt

Current no.: 3
Location: south of Hansen Point; NTS 340 F; Zone 17, 479500E, 9153300N.
Field no.: 82TM212A1
Catalogue no.: C096616
Analytical reports: GSC Ottawa 110-82-3, 86-83-41 (TiO2, Nb, Y, Zr)
Trace element classification: rhyodacite-dacite

Current no.: 4
Location: see no. 1
Field no.: 75FS500-2
Catalogue no.: C054809
Analytical reports: GSC Ottawa 10-79-7, 86-83-38 (TiO2, Nb, Y, Zr)
Trace element classification: comendite-pantellerite

Current no.: 5
Location: see no. 1
Field no.: 75FS500-1
Catalogue no.: C054808
Analytical reports: GSC Ottawa 10-79-4, 86-83-37 (TiO2, Nb, Y, Zr)
Trace element classification: rhyolite

Current no.: 6
Location: see no. 3
Field no.: 82TM212A2
Catalogue no.: C096617
Analytical reports: GSC Ottawa 110-82-4, 86-83-42 (TiO2, Nb, Y, Zr)

Trace element classification: comendite-pantellerite

Current no.: 7
Location: see no. 1
Field no.: 75FS500-3
Catalogue no.: C054810
Analytical reports: GSC Ottawa 10-79-5, 86-83-39 (TiO2, Nb, Y, Zr)
Trace element classification: comendite-pantellerite

Current no.: 8
Location: northeastern Wootton Peninsula; NTS 340 F; Zone 17, 455400E, 9130700N
Field no.: 88TM103A
Catalogue no.: C097249
Analytical report: GSC Ottawa 225-88
Trace element classification: trachyandesite

Current no.: 9
Location: northeastern Wootton Peninsula; NTS 340 F; Zone 16, 545200E, 9130600N (flow or sill)
Field no.: 75TM226-1
Catalogue no.: CO54326
Analytical report: GSC Ottawa 57-79-11
Trace element classification: no high-precision analyses were made

Current no.: 10
Location: northeastern Wootton Peninsula; NTS 340 F; Zone 17, 462750E, 9138750N
Field no.: 75TM213-2
Catalogue no.: CO54302
Analytical report: GSC Ottawa 86-83-34
Trace element classification: comendite-pantellerite

Current no.: 11
Location: northeastern Wootton Peninsula; NTS 340 F; Zone 17, 464000E, 9137000N
Field no. 75TM214-2
Catalogue no.: C054304
Analytical report: GSC Ottawa 10-79-16
Trace element classification: no high-precision analyses were made

Current no.: 12
Location: northeastern Wootton Peninsula; NTS 340 F; Zone 17, 463000E, 9139300N
Field no.: 75TM212-2
Catalogue no.: CO54297
Analytical report: GSC Ottawa 57-79-8, 86-83-32 (TiO2, Nb, Y, Zr)
Trace element classification: comendite-pantellerite

Current no.: 13
Location: see no. 9
Field no.: 75TM226-3
Catalogue no.: C054328
Analytical reports: GSC Ottawa 10-79-7, 86-83-36 (TiO2, Nb, Y, Zr)
Trace element classification: rhyolite

Current no.: 14
Location: see no. 12
Field no.: 75TM212-4
Catalogue no.: C054297
Analytical reports: GSC Ottawa 57-79-9, 86-83-33 (TiO2, Nb, Y, Zr)
Trace element classification: rhyodacite-dacite

Current no.: 15
Location: see no. 11
Field no.: 75TM214-1
Catalogue no.: C054304
Analytical reports: GSC Ottawa 10-79-15, 86-83-35 (TiO2, Nb, Y, Zr)
Trace element classification: rhyolite (close to comendite-pantellerite and to trachyandesite)

Current no.: 16
Location: unnamed western peninsula southeast of Phillips Inlet; NTS 340 F; Zone 16, 504000E, 9106000N
Field no.: 66TM315E1
Catalogue no.: lacking
Analytical report: GSC Ottawa 96-83-1
Trace element classification: trachyandesite (close to border with trachyte)

Current no.: 17
Location: see no. 16
Field no.: 66TM315E6
Catalogue no.: lacking
Analytical report: GSC Ottawa 96-83-2
Trace element classification: trachyandesite

Current no.: 18, 18a
Location: section on northeastern Wootton Peninsula; NTS 340 F; Zone 17, 460300E, 9133400N
Field no.: 88TM1-38m
Catalogue no.: C171430
Analytical report: GSC Ottawa 67-89-1, 2
Trace element classification: comendite-pantellerite

Current no.: 19, 19a
Location: see no. 18
Field no.: 88TM1-65m
Catalogue no.: C171432
Analytical report: GSC Ottawa 67-89-3, 4
Trace element classification: comendite-pantellerite

Current no.: 20, 20a
Location: see no. 18
Field no.: 88TM1-68m
Catalogue no.: C171433
Analytical report: GSC Ottawa 67-89-5,6
Trace element classification: on boundary rhyolite-trachyandesite

Current no.: 21, 21a
Location: see no. 18
Field no.: 88TM1-84.5m
Catalogue no.: C171434
Analytical report: GSC Ottawa 67-89-7, 8
Trace element classification: on boundary rhyolite-trachyandesite

Current no.: 22, 22a
Location: see no. 18
Field no.: 88TM1-110m
Catalogue no.: C171436
Analytical report: GSC Ottawa 67-89-9, 10
Trace element classification: rhyolite

Current no.: 23, 23a
Location: see no. 18
Field no.: 88TM1-117m
Catalogue no.: C171437
Analytical report: GSC Ottawa 67-89-11, 12
Trace element classification: trachyandesite

Current no.: 24, 24a
Location: see no. 18
Field no.: 88TM1-131m
Catalogue no.: C171438
Analytical report: GSC Ottawa 67-89-13, 14
Trace element classification: rhyolite

Current no.: 25, 25a
Location: see no. 18

Field no.: 88TM1-150m
Catalogue no.: C171440
Analytical report: GSC Ottawa 67-89-15, 16
Trace element classification: rhyolite (close to boundary with trachyandesite)

Current no.: 26, 26a
Location: see no. 18
Field no.: 88TM1-175m
Catalogue no.: C171445
Analytical report: GSC Ottawa 67-89-17, 18
Trace element classification: comendite-pantellerite (close to boundary with trachyte)

Current no.: 27, 27a
Location: see no. 18
Field no.: 88TM1-239m
Catalogue no.: C171450
Analytical report: GSC Ottawa 67-89-19, 20
Trace element classification: comendite-pantellerite

Current no.: 28, 28a
Location: see no. 18
Field no.: 88TM1-255m
Catalogue no.: C171451
Analytical report: GSC Ottawa 67-89-21, 22
Trace element classification: comendite-pantellerite

Current no.: 29
Location: south of Phillips Inlet; NTS 340 C; UTM zone 16, 528400E, 9082600N
Field no.: 77TM334D1 (C075373)
Catalogue no.: CO75373
Analytical report: GSC Ottawa 57-79-21
Trace element classification: no high-precision analyses were made

Current no.: 30
Location: see no. 29
Field no.: 77TM334D2
Catalogue no.: C075374
Analytical report: GSC Ottawa 57-79-20
Trace element classification: no high-precision analyses were made

B. Sills

Current no.: 1

Location: northeast of Fire Bay (in map unit S_{DR}+); NTS 560 D; UTM zone 16, 470200E, 9045800N
Field no.: 90TM111A1
Catalogue no.: C194692
Analytical reports: GSC Calgary 92-XR-49, GSC-Ottawa 113-92 (FeO), Elemental Research Inc. 2130 (Ti, Nb, Y, Zr)
Trace element classification: basanite-nephelinite

Current no.: 2
Location: northeast of Fire Bay (in map unit S_{DR}+); NTS 560 D; UTM zone 16, 9046000N, 470000E
Field no.: 90TM112B
Catalogue no.: C194695
Analytical reports: GSC Calgary 92-XR-49, GSC-Ottawa 113-92 (FeO), Elemental Research Inc. 2130 (Ti, Nb, Y, Zr)
Trace element classification: basanite-nephelinite

Current no.: 3
Location: northeast of major bend in Emma Fiord (red line in map unit S_F*); NTS 340 C; UTM ZONE 16, 487700E, 9055700N
Field no.: 90TM114B1
Catalogue no.: C194705
Analytical reports: GSC Calgary 92-XR-49, GSC-Ottawa 113-92 (FeO), Elemental Research Inc. 2130 (Ti, Nb, Y, Zr)
Trace element classification: basanite-nephelinite

Current no.: 4
Location: northeast of major bend in Emma Fiord (red line in map unit S_F*); NTS 340 C; UTM ZONE 16, 487250E, 9055600N
Field no.: 90TM125C1
Analytical reports: GSC Calgary 92-XR-49, GSC-Ottawa 113-92 (FeO), Elemental Research Inc. 2130 (Ti, Nb, Y, Zr)
Trace element classification: basanite-nephelinite

Current no.: 5
Location: see no. 4
Field no.: 90TM125C2
Analytical reports: GSC Calgary 92-XR-49, GSC-Ottawa 113-92 (FeO), Elemental Research Inc. 2130 (Ti, Nb, Y, Zr)
Trace element classification: basanite-nephelinite

Current no.: 6
Location: northeast of Fire Bay (in map unit S_{DR}+); NTS 560 D; UTM zone 16, 469800E, 9045700N

Field no.: 92TM134C1
Catalogue no.: C242845
Analytical reports: Elemental Research Inc. 4263, GSC-Ottawa 007-93 (FeO), GSC Calgary 21/4/93 (CO2)
Trace element classification: basanite-nephelinite

Current no.: 7
Location: see no. 6
Field no.: 92TM134C2
Catalogue no.: C242846
Analytical reports: Elemental Research Inc. 4263, GSC-Ottawa 007-93 (FeO), GSC Calgary 21/4/93 (CO2)
Trace element classification: alkali basalt

Current no.: 8
Location: see no. 6
Field no.: 92TM134C3
Catalogue no.: C242847
Analytical reports: Elemental Research Inc. 4263, GSC-Ottawa 007-93 (FeO), GSC Calgary 21/4/93 (CO2)
Trace element classification: alkali basalt (close to boundary with basanite-nephelinite)

Current no.: 9
Location: northeast of Fire Bay (in map unit S_{DR}+); NTS 560 D; UTM zone 16, 470600E, 9047100N
Field no.: 92TM143A2
Catalogue no.: C242878
Analytical reports: Elemental Research Inc. 4263, GSC-Ottawa 007-93 (FeO), GSC Calgary 21/4/93 (CO2)
Trace element classification: alkali basalt

Current no.: 10
Location: northeast of Fire Bay (in map unit S_{DR}+); NTS 560 D; UTM zone 16, 470200E, 9045750N
Field no.: 92TM146A2
Catalogue no.: C242881
Analytical reports: Elemental Research Inc. 4263, GSC-Ottawa 007-93 (FeO), GSC Calgary 21/4/93 (CO2)
Trace element classification: subalkaline basalt

Current no.: 11
Location: northeast of Fire Bay (in map unit S_{DR}+); NTS 560 D; UTM zone 16, 471200E, 9045250N
Field no.: 92TM146B

Catalogue no.: C242882
Analytical reports: Elemental Research Inc. 4263, GSC-Ottawa 007-93 (FeO), GSC Calgary 21/4/93 (CO2)
Trace element classification: subalkaline basalt

Current no.: 12
Location: northeast of Fire Bay (in map unit S_{DR}+); NTS 560 D; UTM zone 16, 471000E, 9045700N
Field no.: 92TM146C1
Catalogue no.: C242883
Analytical reports: Elemental Research Inc. 4263, GSC-Ottawa 007-93 (FeO), GSC Calgary 21/4/93 (CO2)
Trace element classification: subalkaline basalt

Table 2. Chemical Analyses

Bold entries designate relatively precise determinations used for chemical classification according to Winchester and Floyd (1977, Fig. 6).

A. Hansen Point volcanics

Nr.	1	2	3	4	5	6	7
SiO2 %	40.3	48.4	64.1	69.4	72.3	72.8	79.2
Al2O3	15.0	14.9	11.3	13.9	13.7	12.3	10.4
TiO2	**3.1**	**2.24**	**0.42**	**0.39**	**0.44**	**0.57**	**0.14**
Fe2O3	5.7	2.9	0.0	3.9	3.2	2.7	0.0
FeO	7.7	8.6	2.9	1.1	0.2	1.2	2.0
MnO	0.22	0.20	0.26	0.06	0.02	0.04	0.03
MgO	1.7	6.52	0.55	0.14	0.11	0.19	0.12
CaO	12.8	10.90	7.49	0.42	0.77	1.16	0.43
Na2O	1.9	2.4	1.1	3.8	3.4	2.2	2.0
K2O	0.34	0.41	4.47	4.83	4.96	4.77	3.61
P2O5	0.40	0.27	0.12	0.02	0.04	0.14	0.0
CO2	7.4	0.3	5.4	0.4	0.0	0.5	0.1
H2O	3.7	3.1	1.9	1.2	0.9	1.3	1.0
Total	100.2	101.1	100.1	99.5	100.0	99.9	98.9
As ppm	11	16.5	5.5	21	9	11.5	6.5
B		<50	29	<50	<50	15	<50
Ba	200	92	690	1100	920	750	51
Be							
Br	0	3.5	2.5	4	2	0	6
Co		56	<7	14	19	<7	11
Cr		160	67	9	12	85	<5
Cu		69	9	19	17	10	12
La		<100	80	<100	<100	45	<100
Mo	0	0	0.5	0	0	0	0
Nb	**22**	**7.5**	**24**	**86**	**56.5**	**29**	**122**
Ni		70	<10	<10	<10	<30	<10
Pb	21.5	22.5	22	24	23.5	25	41.5
Rb	6	14	148.5	185	175.5	180	231
Sr	231	275	72.5	89	78	78.5	10
Th	4.5	8	22	25.5	24	19	39
U	0	0	11	12	7	5.5	11.5
V		300	21	23	40	21	<20
Y	**45.5**	**31.5**	**76**	**102.5**	**76**	**90**	**147**
Yb		<4	5.6	12	10	<2	13
Zn		60	70	130	50	<20	90

Zr	**185.5**	**129.5**	**355.5**	**785.5**	**579**	**447.5**	**396.5**

Nr.	8	9	10	11	12	13	14
SiO2 %	69.3	65.8	70.0	71.4	72.0	73.5	74.2
Al2O3	13.2	14.7		13.9	13.9	12.0	11.6
TiO2	**0.58**	0.82	**0.32**	0.34	**0.35**	**0.33**	**0.71**
Fe2O3	4.0	4.4		2.8	3.1	2.4	5.2
FeO	1.3	1.9		0.3	0.2	0.2	0.9
MnO	0.08	0.07		0.07	0.07	0.06	0.14
MgO	0.47	0.78		0.30	0.15	0.21	0.27
CaO	1.24	2.02		0.52	0.31	1.03	0.28
Na2O	3.8	5.1		3.7	3.0	4.5	0.51
K2O	4.45	3.89		4.43	5.97	3.65	2.89
P2O5	0.11	0.15		0.04	0.03	0.03	0.17
CO2	0.9	0.2		0.2	0.1	0.8	0.2
H2O	1.0	0.6		1.0	1.1	0.6	3.6
Total	100.5	100.5		98.9	100.3	99.3	100.7

As ppm	<2000	33.5		<2000	4.5	10	14
B		<50		<50	<50	<50	
Ba	745	1000		1120	480	660	380
Be	3.8						
Br			0.5		7.5	2.5	1.5
Co	7	<10		15	<10	19	<10
Cr	13	7		11	5	10	<20
Cu	18	21		18	15	17	9
La	77	89		<100	76	120	55
Mo		<50	0	<50	0	0	0.5
Nb	**69**		**81.5**		**78.5**	**77.5**	**31**
Ni	8	<10		<10	10	<10	<10
Pb		<700	32.5	<700	24.5	18	7.5
Rb	156	<20	213	110	246	135.5	135.5
Sr	69	96	86.5	63	32.5	42.5	20.5
Th			31		38.5	28.5	15.5
U			6.5		9	11	6.5
V	19	19		30	100	28	220
Y	**81**	77	**91.5**	<40	**73.5**	**99.5**	**63**
Yb	7.9	6.4		8.7	4.6	13	3.8
Zn	51	<200		40	<200	50	<200
Zr	**545**	510	**614.5**	410	**490**	**593**	**373.5**

Nr.	15	16	17
SiO2 %	74.4	53.4	53.4
Al2O3	12.6	12.9	16.1
TiO2	**0.37**	**1.04**	**0.99**
Fe2O3	3.1	3.7	4.7
FeO	0.1	3.1	0.6
MnO	0.04	0.27	0.15
MgO	0.27	2.07	2.21
CaO	0.33	8.15	4.62
Na2O	1.9	4.5	5.1
K2O	4.91	1.43	3.87
P2O5	0.02	0.23	0.23
CO2	0.1	6.3	3.5
H2O	1.4	1.8	1.5
Total	99.5	98.9	99.0
As ppm	24	12	6
B	<50		
Ba	680		
Be			
Br	2	5	5
Co	<10		
Cr	<5		
Cu	11		
La	<100		
Mo	0	0	0
Nb	**54**	**110**	**150**
Ni	<10		
Pb	14	0	12
Rb	197.5	42	86
Sr	61	270	280
Th	24	24	31
U	7	9	16
V	<20		
Y	**60.5**	**44**	**66**
Yb	5.3		
Zn	30		
Zr	**470**	**400**	**630**

Nr.	18	18a	19	19a	20	20a	21
SiO2 %	71.8	71.6	73.1	72.8	71.7	72.0	71.8
Al2O3	13.8	13.6	14.1	14.1	12.9	12.8	13.7
TiO2	**0.27**	**0.28**	**0.29**	**0.33**	**0.48**	**0.48**	**0.50**
Fe2O3	4.2	4.2	0.7	0.7	4.3	4.2	3.3
FeO	0.4	0.4	0.4	0.4	0.8	0.8	0.8
MnO	0.01	0.01	0.00	0.00	0.02	0.02	0.01
MgO	0.23	0.22	0.31	0.30	0.33	0.34	0.34
CaO	0.17	0.17	0.19	0.20	0.43	0.42	0.53
Na2O	3.6	3.5	2.0	1.9	3.1	3.1	3.2
K2O	4.18	4.16	7.94	7.84	4.06	4.04	4.90
P2O5	0.04	0.04	0.04	0.04	0.07	0.08	0.10
CO2(T)	0.1	0.1	0.1	0.1	0.2	0.2	0.2
H2O(T)	1.2	1.2	1.4	1.4	1.5	1.5	1.3
Total	100.0	99.5	100.5	100.0	99.9	99.9	100.6
As ppm							
B							
Ba	637	592	1017	990	514	553	573
Be	4.0	4.1	2.7	2.6	4.1	4.1	3.9
Br							
Co	3	3	3	4	4	4	4
Cr	11	12	5	5	11	15	10
Cu	9	8	6	6	9	10	14
La	96	96	94	86	82	81	88
Mo							
Nb	**81**	**81**	**75**	**73**	**58**	**56**	**65**
Ni	6	7	7	7	6	9	11
Pb							
Rb	141	141	194	200	147	144	173
Sr	41	38	71	75	38	44	51
Th							
U							
V	4	4	0	0	8	9	6
Y	**68**	**71**	**94**	**88**	**64**	**64**	**73**
Yb	7.8	8.3	9.1	8.7	6.4	6.5	7.9
Zn	110	100	64	43	87	75	95
Zr	**624**	**565**	**581**	**578**	**576**	**590**	**635**

Nr.	21a	22	22a	23	23a	24	24a
SiO2 %	71.3	70.4	70.5	71.9	72.3	74.0	73.2
Al2O3	13.6	12.8	12.7	13.6	13.5	13.5	13.4
TiO2	**0.49**	**0.46**	**0.46**	**0.48**	**0.49**	**0.44**	**0.46**
Fe2O3	3.2	4.7	4.7	3.0	3.1	1.2	1.3
FeO	0.8	0.7	0.7	0.5	0.5	0.6	0.6
MnO	0.01	0.22	0.21	0.01	0.01	0.02	0.01
MgO	0.33	0.28	0.28	0.28	0.28	0.46	0.44
CaO	0.54	0.28	0.28	0.28	0.27	0.84	0.84
Na2O	3.2	4.8	4.8	2.9	2.8	4.5	4.4
K2O	4.92	3.04	3.06	5.72	5.66	2.02	2.00
P2O5	0.10	0.10	0.10	0.08	0.08	0.07	0.07
CO2(T)	0.2	0.5	0.5	0.1	0.1	0.5	0.5
H2O(T)	1.3	1.7	1.7	1.3	1.3	1.9	1.9
Total	99.9	100.0	100.1	100.2	100.4	100.0	99.1
As ppm							
B							
Ba	586	1152	1166	698	689	350	316
Be	3.9	2.5	2.5	4.2	4.1	3.9	3.9
Br							
Co	4	4	5	3	3	3	3
Cr	11	16	16	10	11	8	8
Cu	19	12	13	14	14	13	10
La	86	88	88	69	68	73	74
Mo							
Nb	**64**	**62**	**57**	**37**	**43**	**40**	**45**
Ni	11	8	7	5	6	6	6
Pb							
Rb	177	81	78	204	209	111	120
Sr	48	104	109	41	51	125	135
Th							
U							
V	6	8	8	8	8	6	6
Y	**74**	**83**	**83**	**47**	**47**	**59**	**59**
Yb	8.1	8.6	8.5	4.7	4.7	6.3	6.2
Zn	100	71	68	58	42	86	53
Zr	**528**	**618**	**616**	**419**	**442**	**433**	**465**

Nr.	25	25a	26	26a	27	27a	28
SiO2 %	61.4	61.5	69.3	69.4	70.3	70.3	70.7
Al2O3	10.9	10.9	12.8	12.9	13.3	13.3	13.1
TiO2	**0.35**	**0.33**	**0.41**	**0.41**	**0.39**	**0.39**	**0.38**
Fe2O3	6.9	7.0	6.5	6.5	4.9	4.8	4.0
FeO	2.3	2.3	0.4	0.4	0.3	0.3	0.7
MnO	1.21	1.23	0.02	0.02	0.10	0.11	0.09
MgO	0.36	0.36	0.27	0.28	0.27	0.29	0.33
CaO	4.96	5.02	0.50	0.51	0.23	0.23	0.26
Na2O	3.4	3.4	3.0	3.1	3.8	3.8	3.4
K2O	2.01	2.03	5.27	5.30	4.52	4.57	5.23
P2O5	0.06	0.06	0.05	0.05	0.05	0.05	0.05
CO2(T)	4.1	4.1	0.4	0.4	0.1	0.1	0.2
H2O(T)	2.1	2.1	1.2	1.2	1.8	1.8	1.5
Total	100.2	100.3	100.2	100.5	100.1	100.1	100.0

As ppm							
B							
Ba	584	609	524	535	828	783	909
Be	3.0	3.1	4.5	4.5	4.0	4.0	3.8
Br							
Co	8	9	5	4	4	4	4
Cr	34	35	15	14	13	14	14
Cu	21	20	11	11	21	10	10
La	67	68	78	76	91	90	87
Mo							
Nb	**50**	**52**	**51**	**47**	**66**	**67**	**65**
Ni	12	12	8	7	10	9	9
Pb							
Rb	72	74	207	204	159	153	158
Sr	132	127	47	47	59	57	56
Th							
U							
V	8	8	10	10	4	4	4
Y	**59**	**59**	**42**	**45**	**86**	**85**	**70**
Yb	6.5	6.5	3.9	4.1	10	9.5	7.8
Zn	81	78	100	89	100	87	130
Zr	**442**	**441**	**505**	**497**	**563**	**562**	**554**

Nr.	28a		29	30
SiO2 %	70.8		43.5	44.4
Al2O3	13.1		14.6	14.6
TiO2	**0.38**		1.41	1.14
Fe2O3	4.0		4.0	3.7
FeO	0.7		5.5	4.9
MnO	0.09		0.17	0.13
MgO	0.32		7.76	9.75
CaO	0.26		12.89	9.95
Na2O	3.4		2.5	2.4
K2O	5.25		1.20	1.89
P2O5	0.05		0.43	0.47
CO2(T)	0.2	CO2	3.5	0.4
H2O(T)	1.5	H2O	2.9	6.2
Total	100.2		100.4	100.2
As ppm				
B				
Ba	871		880	960
Be	3.7		<3	<3
Br				
Co	5		42	40
Cr	15		320	470
Cu	9		83	68
La	85		68	74
Mo			<50	<50
Nb	**64**			
Ni	7		150	210
Pb				
Rb	153			
Sr	62		640	520
Th				
U				
V	4		240	180
Y	**69**		32	30
Yb	7.7		4.3	4.4
Zn	120		<200	<200
Zr	**572**		130	140

B. Sills

Nr.	1	2	3	4	5	6	7
SiO2 %	32.56	31.10	45.98	49.57	44.10	41.02	42.41
Al2O3	10.96	10.56	16.65	14.65	11.21	12.91	14.79
TiO2	**1.39**	**2.07**	**1.49**	**1.44**	**1.22**	**1.48**	**1.37**
Fe2O3	2.49	2.08	1.41	2.03	2.10	3.20	2.69
FeO	3.97	4.75	6.79	5.04	4.54	6.2	6.3
MnO	0.11	0.12	0.08	0.11	0.15	0.13	0.14
MgO	7.27	7.97	10.06	7.54	6.64	13.69	9.93
CaO	20.75	21.25	2.73	9.24	15.55	8.44	9.40
Na2O	2.06	1.60	1.90	3.47	2.34	0.35	2.31
K2O	0.26	1.46	3.49	0.62	1.45	2.06	1.43
P2O5	0.67	1.31	1.62	1.08	0.96	0.59	0.48
CO2(T)	9.85	6.40	0.64	1.18	5.66	0.62	1.48
LOI	6.15	7.00	5.26	2.92	2.94	6.49	4.31
Total	98.49	97.67	98.1	98.89	98.86	97.18	97.04
Nb	**93**	**150**	**81**	**100**	**81**	**100**	**65**
Y	**18**	**19**	**20**	**24**	**18**	**28**	**24**
Zr	**140**	**170**	**180**	**230**	**180**	**150**	**130**

Nr.	8	9	10	11	12
SiO2 %	44.81	46.70	47.80	47.58	46.54
Al2O3	13.92	17.60	14.42	15.10	13.85
TiO2	**1.65**	**1.57**	**1.37**	**1.48**	**2.00**
Fe2O3	2.54	1.69	3.69	4.10	4.78
FeO	6.1	8.1	8.4	8.4	8.2
MnO	0.10	0.10	0.21	0.21	0.21
MgO	9.51	7.81	6.45	5.39	6.22
CaO	8.37	4.13	11.05	10.64	10.97
Na2O	2.13	2.72	2.30	2.68	2.60
K2O	1.31	1.40	0.38	0.40	0.43
P2O5	0.50	0.33	0.18	0.19	0.19
CO2(T)	1.50	1.14	0.34	0.34	0.41
LOI	4.39	5.00	0.02	1.12	1.64
Total	96.83	98.29	96.61	97.63	98.04
Nb	**71**	**25**	**15**	**17**	**19**
Y	**24**	**29**	**36**	**33**	**38**
Zr	**140**	**130**	**110**	**110**	**120**

Table 3.

Multiple analyses of TiO2, Nb, Y, and Zr that are averaged in Table 2 (Henson Point volcanics)

Nr.	1	2	3	4	5	6	7
TiO2	3.09	2.23	0.40	0.37	0.42	0.58	0.11
		1.93		0.36	0.42		0.13
	3.30	2.25	0.44	0.42	0.46	0.57	0.17
Nb	19	6	26	85	58	27	122
	25	9	22	87	55	31	122
Y	42	30	79	97	72	91	145
	49	33	73	108	80	89	149
Zr	176	125	366	793	582	446	394
	195	134	345	778	576	449	399

Nr.	10	12	13	14	15
TiO2	0.30	0.33	0.3	0.68	0.37
	0.30	0.28	0.3	0.57	0.36
	0.34	0.38	0.36	0.74	0.38
Nb	80	81	78	32	54
	83	76	77	30	54
Y	90	73	101	63	58
	93	74	98	63	63
Zr	615	499	587	373	466
	614	480	594	374	474

TiO2: the first line indicates results from wave length dispersive X-ray fluorescence on fused discs; the second, from spectometric analysis using direct reading of emission spectra; the third, from colorimetric spectroscopy.