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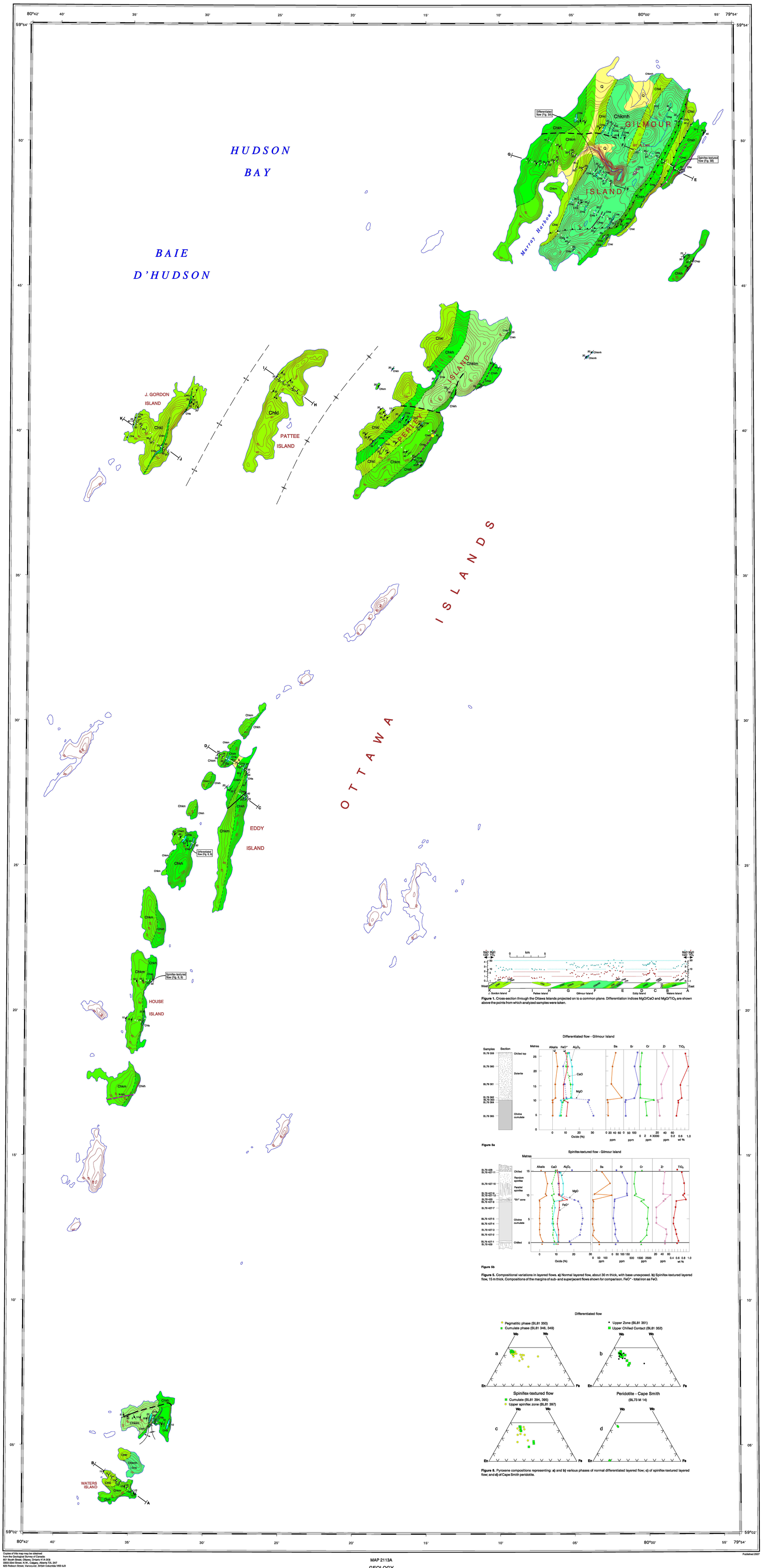

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LOCATION MAP

Author: W.R.A. Baragar

Geology by W.R.A. Baragar and C.G. Lamontagne, 1979; and M. Piché, 1981

Digital cartography by N. Côté, Data Dissemination Division (DDD)

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MAP 2113A

GEOLOGY

OTTAWA ISLANDS
EASTERN HUDSON BAY

NUNAVUT

Scale 1:75 000/Échelle 1/75 000

kilometres 1 0 1 2 3 4 5 6 kilomètres

Universal Transverse Mercator Projection
North American Datum 1983

Projection transverse universelle de Mercator
Système de référence géodésique nord-américain, 1983

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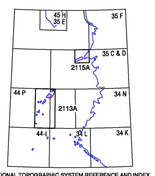
Mean magnetic declination 2007, 18°59' W, decreasing 13' annually. Readings vary from 19°5' W in the SW corner to 19°55' W in the NE corner of the map

Elevations in metres above mean sea level



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

Published 2007

LEGEND

QUATERNARY–RECENT

Q — *Overburden.*

NEOPROTEROZOIC–MESOPROTEROZOIC

N Md — *Diabase dyke.*

PALEOPROTEROZOIC
CHUKOTAT GROUP
KOMATIITIC SUITE VOLCANIC ROCKS (Not necessarily in stratigraphic order)

Chs — *Mafic volcanic schist.*

Chkl — *Low-Mg komatiitic basalts (< 10% MgO). Well formed pillowed and massive, greenish-grey weathering, lavas; abundantly clinopyroxene-phyric, sparsely olivine-phyric. Rarely plagioclase-phyric.*

Chklm — *Undivided low- and medium-Mg komatiitic basalt.*

Chkm — *Medium-Mg komatiitic basalt (MgO 10-15%). Pillowed and massive, buff-weathering lavas, commonly polyhedrally jointed. Moderately olivine-phyric and, in part, also significantly clinopyroxene-phyric.*

Chkmh — *Undivided medium- and high-Mg komatiitic basalt.*

Chkh — *High-Mg komatiitic basalt (MgO > 15%).*

Chla — *Layered flow, komatiitic flow typically comprising a basal olivine cumulate layer overlain by a feldspar-bearing, dolerite-like top.*

Chsp — *Spinifex-textured layered komatiitic flow formed of a basal cumulate layer overlain by a more evolved top containing clinopyroxene and/or olivine spinifex textures.*

Chsh — *Black, interflow shale.*

Geological contact (defined, approximate, interpreted)
Thrust fault (defined, interpreted); teeth on upthrust side
Fault oblique (defined, interpreted)
Bedding, inclined (top unknown) — 60
Pillowed flows, inclined (top known) — 30
Igneous layering, inclined (top undetermined) — 20
Flow contact, inclined (top unknown, top known) — 20, 40
Foliation, inclined (generation unknown) — 20
Shear, inclined (sense unknown) — 20
Lineation, generation unknown
Anticlinal axis (defined with plunge, approximate)
Synclinal axis (defined with plunge, approximate)
Geochemical sampling site (shown in white on map)
Station not otherwise identified (shown in white on map)
Line of section — B A

DESCRIPTIVE NOTES

INTRODUCTION

The Ottawa Islands are underlain by a komatiitic suite of volcanic rocks believed to correlate with the Chukotat Group of the Cape Smith Belt in northern Quebec. They form the outer part of the Paleoproterozoic Circum-Superior Belt that rings the northern margin of the Superior Province. On the inner side is a belt of generally older tholeiitic volcanic rocks, the Povungnituk Group in northern Quebec, and the Flaherty Formation in the Belcher and Sleeper Islands, which are associated with platformal sedimentary rocks marginal to the craton. Relationships between the tholeiitic and komatiitic successions is uncertain. Chukotat rocks structurally overlie the Povungnituk Group and it is intruded by komatiitic sills, but contacts observed are either tectonic or not interpretable. The age of the Chukotat Group is also uncertain, but a precise age of 1918 Ma (Parrish, 1989) on what is believed to be a related sill within the Povungnituk Group of Cape Smith Belt, can be taken to be within its age span. Ages of related rocks from the Circum-Superior Belt of northern Manitoba of about 1883 Ma (Heaman et al., 1986) suggests that that age span of emplacement may have been fairly prolonged.

Field work for this study was done in 1979 and 1981 and preliminary results were published in Baragar and Lamontagne (1980) and Baragar and Piché (1982).

GENERAL GEOLOGY

Exposure of the Chukotat Group on the Ottawa Islands is distributed among several islands so that a continuous sequence can not be observed. A rough cross-section of the Group comprising along-strike projections from the various islands to a common plane is shown in Figure 1. Based on similar projections, estimates of the total thickness of the succession represented is between approximately 9600 m (land-surface measurements only) and 15 300 m (including distances over water with assumed dips of strata). Repetition by thrust faulting is a likely, but unknown factor. Nevertheless, volcanic accumulations of the Chukotat Group are substantial and probably of the order of at least 10 km.

Subdivision and Stratigraphy of the Chukotat Group

Subdivision of the volcanic succession is enabled by the effect of varying Mg content on the appearance of the rocks. Increased Mg leads to increased fluidity, which in turn imposes distinctive forms and properties upon the resulting lava flows. Three divisions, based upon physical distinctions between low, medium, and high Mg contents, can be separated and mapped. Illustrations of typical lava flows of each division are given in Figure 2 (from Baragar and Piché, 1982).

High-Mg lava flows are relatively thin (3–30 m) and irregularly pillowed, with the pillows being thin-rimmed (≤ 0.5 cm) and irregular in shape. Commonly, they are incomplete with discontinuous pillow rims extending into neighbouring 'pillows', or adjoining or overlying massive zones. Like most of the pillowed lavas of the Circum-Superior Belt, pillows occupy the lower parts of flows with varying thicknesses of massive lava forming the upper parts (Baragar, 1984). High-Mg lava flows typically have a lower proportion of pillows than the less magnesian lavas and the pillows, if present at all, are not uncommonly limited to a few layers at their bases. Drainage cavities tend to be ill-formed and rare, and fillings are poorly defined chloritic or serpentinous material, never quartz. The massive uppermost parts of flows are characteristically finely columnar jointed grading upwards into highly polygonally jointed flow tops. Weathered surfaces are generally orange-brown to brown as opposed to the typical greenish greys of low-Mg flow surfaces.

Low-Mg lavas typically form thick (≥ 100 m), mostly pillowed flows with variable thicknesses of massive tops, and not uncommonly, massive zones within the body of the flow. The pillows are well formed, bulbous masses with thick (> 2 cm) rims and many have one to multiple flat-bottomed, stacked, drainage cavities at their centres. In most places, these, as well as interpillow spaces, are filled with quartz and chloritic materials. Varioliteres are commonly present at, or near, the margins of pillows.

Medium-Mg lavas exhibit properties intermediate between those of the low- and high-Mg lavas. The flows are moderately thick (30 m +) and mostly pillowed. The pillows are well-formed with distinct rims, 1 to 2 cm thick, but are commonly polyhedrally jointed to varying degrees in the interiors. Drainage cavities in pillow centres in medium-Mg flows are more common than in high-Mg flows, and rarely contain quartz. If varioliteres are present they tend to be small and inconspicuous. Weathered surfaces are generally brownish or buff.

Stratigraphic zones of mixed lava types where none are dominant have been mapped as undivided low- to medium-Mg or medium- to high-Mg units.

Layered flows, which are differentiated flows of high-Mg and, less commonly, medium-Mg type, are mapped separately, although most appear within the high-Mg unit.

There is little that is systematic about the distribution of the various units; they interfinger with one another along strike and may be illogically juxtaposed in stratigraphic succession — for example, high-Mg and low-Mg on a flow by flow basis. Nevertheless, many of the units marked by the dominance of one magma type do have continuity for distances of several tens of kilometres and in a stratigraphic sense they show a declining prevalence of high-Mg types upward (Fig. 1).

Unit Compositions

The varying MgO content of all analyzed Chukotat volcanic rocks from the Ottawa and Smith Islands is shown in the frequency-distribution diagram of Figure 3. The samples for the analyses were drawn largely from systematically sampled sections transecting the Chukotat Group in the Ottawa Islands and on Smith Island, and consequently should be fairly representative of the group as a whole. The divisions shown on the diagram of low-, medium-, and high-Mg closely correspond to the field-mapped units and seem to mark out natural divisions of the frequency profile. Accordingly, the compositional divisions of: < 10% MgO (low-Mg), 10–15% MgO (medium-Mg), and > 15% MgO (high-Mg) are limits that can be applied to the subdivision of the volcanic succession. Average full analyses of the three units and average cation normative compositions are given in Table 1. Note in the analyses of Table 1 that in all three divisions TiO_2 and Zr remain low, and Cr high in comparison with levels in tholeiitic or calc-alkaline basaltic series. This underlines their genetic relationships and justifies their categorization as a komatiitic suite. Average normative compositions of all the mapped units are represented in the diagrams of Figure 4 which illustrate that evolution through the suite to slightly quartz-normative compositions is dependant primarily upon withdrawal of olivine (low-Mg to medium-Mg) and in late stages, enrichment in diopside and plagioclase (medium-Mg to high-Mg).

Layered Flows

Layered flows are generally arched lenses that range from 10 to 125 m in maximum thickness. Few have been traced for more than several tens of metres along strike, but probably most of them thin down to normal, non-layered, pillowed-massive flows within 200 to 300 m of the arch. Some are extensive. Arndt (1982) noted one spinifex-textured flow on Gilmour Island that extends for several kilometres and varies little from its average 14 m thickness. Typically, a layered flow is the differentiated top of a pillowed-massive flow wherein an olivine-cumulate base is overlain by an olivine-free (or sparse) top. The two types mapped are those with dolerite- and spinifex-textured tops respectively. Examples of each type with their variations in composition are shown in Figure 5.

The dolerite-textured layered flows (normal layered flows) are characteristically marked by a densely packed olivine cumulate layer that lies just above, and is separated from, its pillowed base by a thin zone of finer grained dolerite. Sparse, ophitic clinopyroxene crystals are typically present throughout the cumulate zone. Upwards, the olivine cumulate zone generally merges into a very thin clinopyroxene-cumulate layer and then passes abruptly into even-grained dolerite that coarsens towards the top of the flow. Near the top it fines to a chilled, complexly jointed, and commonly brecciated top. In the thicker flows, the upper regions may contain pegmatitic zones and even granophyric patches and veinlets. The flow illustrated in Figure 5a is located 2 km due east of the north tip of the harbour of Gilmour Island. Its exposed thickness is just over 25 m, but its base is covered and the probable thickness is 30 m. Of particular interest is the abruptness of the contact between the cumulate and overlying dolerite as reflected in the rapid change in composition shown by the sharp drop in MgO and Cr contents and corresponding jumps in Al_2O_3, CaO, Ba, and Sr concentrations. Other changes are more subdued. This is probably indicative of a mobile rather than a static settling regime and can be attributed to the effect of shear at the contact between flowage regimes of vastly different crystal content, hence viscosity, as represented by the close-packed, olivine cumulate below and the overriding magmatic host. Even the relatively thin dolerite upper part of this flow is itself slightly differentiated as indicated by the minor, but fairly persistent, rise in alkalis, total iron, Zr and TiO_2, and decline in CaO and (partly) MgO upward in the zone. An incipient pegmatitic phase in the mid-upper part of the dolerite-textured zone (BL79 360) distorts the trends to slightly higher values of the more incompatible elements (alkalis, total iron, TiO_2, Zr). Spinifex-textured layered flows are uncommon; the few presently known are on Gilmour, Perley, and House Islands, and on a smaller island about 4 km southeast of Gilmour Island. They tend to be thinner than the normal layered flows and generally less than 20 m thick. In one type the spinifex texture is most conspicuously present as parallel strings of clinopyroxene, roughly orthogonal to the flow contacts, and in places as much as a metre or more long ("string bean", Arndt et al., 1977). This occurs in the lower half of the 'dolerite' upper zone of the layered flow. Above the 'string bean' level, spinifex texture devolves in to randomly-oriented olivine chains a few millimetres in length that persist to the chilled flow top. In the other principal type of spinifex-textured flow, randomly oriented olivine spinifex-type crystals alone dominate the upper 'dolerite' parts of the flow. Still other spinifex-textured flows seem to be hybrids with lenses or thin layers of parallel spinifex texture embedded in a host of randomly oriented spinifex. Typically, all types of spinifex-textured flows contain a foliated zone that lies just above the olivine cumulate layer and parallels the flow margins (B1-equivalent in Archean komatiites). This zone is marked by fairly coarse olivine tablets (e.g.10 x 1 mm) that are oriented in the plane of foliation. Excellent detailed descriptions of various spinifex-textured flows from Gilmour Island were provided by Arndt (1982).

An example of a 'parallel' type of spinifex flow showing some of its principle chemical variations is given in Figure 5b. This section is from a flow of several kilometres length that roughly parallels the northeast coast of Gilmour Island and is about 500 m north of where the flow disappears beneath a small cove near the mid-point of the island. The chemical profiles conspicuously highlight the division of the flow into an extraordinarily thick olivine-cumulate layer, marked in particular by the bulges in MgO and Cr profiles, and an upper spinifex-textured zone with enriched values of alkalis, alumina, Ba, Sr, Zr, and titania. Lime and total iron vary little throughout the flow, except for an extraordinary spike in iron, reflected to lesser degree in titania, at the lower part of the foliated B1 zone. These enrichments might be attributable to the effects of late-stage flowage persisting in this zone after the rear consolidation of both cumulate and spinifex phases (Arndt, 1982). Such flowage, confined to a narrowing "B1" zone, would lead to localized lower pressures that would tend to draw in late-crystallizing fluids from adjoining regions. Even the small increases of Zr, Ba, and alkalis on the upper side of the B1 zone, at the base of the string spinifex, could relate to the same effect. The chilled lower contact of the spinifex flow and those of adjoining flows have MgO contents of about 17%, which is close to maximum value for non-cumulate magmas of the Chukotat Group.

PETROCHEMISTRY

PETROGRAPHY

Alteration within the Chukotat volcanic rocks is variable, but persistent. Fresh olivine is rare, but fresh clinopyroxene is present in most specimens examined and the region as a whole should probably be classified as subgreenschist facies. Secondary minerals are most commonly serpentine (after olivine), chlorite, tremolite-actinolite (after olivine and clinopyroxene), epidote-zoisite (after plagioclase), and sphene (after magnetite). Deformation is essentially absent, except for a few narrow zones, and igneous textures are reasonably well preserved in all but the most altered rocks. Accordingly, the primary mineralogy can generally be interpreted from the forms preserved in secondary minerals.

The high-Mg rocks contain abundant olivine phenocrysts that range from 22 to 45% and average about 35% of the rocks. Only 20% of these high-Mg rocks are also clinopyroxene-phyric and they typically contain 10 to 15% clinopyroxene phenocrysts. Skeletal olivine and clinopyroxene are commonly present in a groundmass that is similarly characterized by quench-textured clinopyroxene and, presumably plagioclase. Chromite is recognized in all three divisions, but is most common in the high-Mg category. It typically occurs as tiny octahedra in the groundmass and in olivine pseudomorphs, but in at least two places was present as a phenocryst phase.

All medium-Mg rocks are olivine-phyric with only about 25% also clinopyroxene-phyric. Olivine phenocrysts constitute from 5 to 22% of the rocks with most in the 14 to 18% range. In at least half the rocks examined, olivine is also a skeletal groundmass phase where it is commonly associated with skeletal clinopyroxene. Thus, both appear to have been liquidus minerals at the time of consolidation. The remaining groundmass generally comprises a quench-texture of finely acicular clinopyroxene interleaved with what is presumed to be (or to have been) plagioclase.

In the low-Mg division, 69% of the rocks examined are barely olivine-phyric (1 to 10% olivine phenocryst content) and about half of these also contain from 10 to 35% phenocrysts of clinopyroxene. Of the olivine-free rocks, most are clinopyroxene-phyric and only one — on Pattie Island — is primarily plagioclase-phyric. Typically, the groundmass is dominated by clinopyroxene, commonly in a quenched mode of patches, plumes, and whorls of finely acicular parallel growth with what is probably plagioclase. Magnetite, now mainly sphene, is present as discrete grains in coarser grained rocks — from 1 to 9% — but in finer grained or quenched rocks is manifested as a brownish screen that pervades the groundmass and is concentrated in interstices.

Within the Chukotat Group of the Cape Smith Belt the rocks are subdivided on the basis of phenocryst type into olivine-phyric, pyroxene-phyric, and plagioclase-phyric types (Francis, et al., 1983). Here, the subdivision on this basis is not as readily applicable as is evident from the overlapping variety of phenocrysts in each of the categories. Moreover, most phenocrysts are microphenocrysts and not readily discernable in hand specimen. Hence, subdivision by physical characteristics (dependent on Mg content), as done here, was found to be a more workable field method than by phenocryst type.

MINERALOGY

Microprobe analyses were performed on minerals from two layered flows where fresh olivine is preserved. One is a 125 m thick differentiated flow on an island just west of the southern leg of Eddy Island and the other is a spinifex-textured flow on the east side of House Island.

The differentiated flow comprises a thick olivine cumulate base capped by a thin pyroxenite layer and overlain by a subordinate dolerite top with minor pegmatitic phases at mid-levels. Analyses were done on olivine, clinopyroxene, and chromite in specimens from the mid-cumulus zone (BL81 346), the pyroxenite layer (BL81 349), the dolerite pegmatite (BL81 350), the upper dolerite (BL81 351), and the upper chilled zone (BL81 352). Additionally, some feldspar, chlorite, and epidote grains were also analyzed.

The House Island spinifex flow is just 1.3 m thick and is one of a package of five such flows all less than 3 m thick (Baragar and Piché, 1982). Typically they consist of an olivine cumulate base, an overlying foliated zone parallelling the margins (B1 zone), and a randomly oriented, spinifex-textured top. Analyses, done primarily on olivine, clinopyroxene, chromite, and mesostasis (presumably residual magma), are from specimens of the lower (BL81 394), and mid-cumulate (BL81 395) zones, and the upper spinifex zone (BL81 397).

In addition, minerals from a specimen of peridotite from the Chukotat Group of the Cape Smith Belt were also analyzed and the olivine and chromite compositions compared with those obtained from this region.

Olivine

Olivine compositions are summarized in Figure 6 where distinctions between olivine in the spinifex-textured flow and the normal layered flow can be seen to be significant. Olivine from the lower part of the cumulate zone of the spinifex flow range between Fo_{90} and Fo_{82} whereas those from the mid-upper part of the flow are somewhat more fayalitic at $Fo_{84.5}$ to Fo_{68}. In contrast, cumulate olivine of the normal layered flow have compositions ranging between $Fo_{84.5}$ and $Fo_{68.5}$ and those from the Cape Smith peridotite between Fo_{92} and $Fo_{80.5}$, both considerably more evolved than the spinifex cumulate olivine. Arndt et al. (1987) determined olivine compositions from a spinifex-textured flow on Gilmour Island where they found two distinct compositions; $Fo_{~92}$ for olivine megacrysts and $Fo_{~75}$ for normal olivines of the cumulate zone. They suggested that the megacrysts may have been cognate xenocrysts developed in an earlier-formed magma chamber and brought to the surface to mix with olivines developing at the time of eruption. Based on the megacryst compositions the earlier magma was calculated to have had 22% MgO in comparison with 17 to 18% for magma in equilibrium with normal cumulate olivine. The implication is that the primary magma of the Chukotat assemblage was somewhat more primative than is indicated by the most magnesian of the phenocryst-free lava samples that had been analyzed (Arndt et al., 1987). Nevertheless, the spinifex-textured flow represented in Figure 6 and the one analyzed by Arndt et al. (1987) are close to primary magmas, in contrast to the other two examples and this suggests that the bulk of Chukotat magmatism may have undergone significant fractionation before eruption.

Chromite

Chromite from the two layered flows and from the Cape Smith peridotite are compared with the compositional fields of chromite from a variety of tectonic settings on a traditional chromite diagram shown in Figure 7. The diagram, with its various outlined fields, is adapted from Baragar et al. (2001) where the significance of the compositional trends is discussed in more detail. Briefly stated, the trends of the fields of 'abyssal basalts' (4) and 'ultramafic xenoliths from kimberlites' (2) at the Mg-rich side of the region of chromite compositions, roughly parallel the projections of chromite-olivine equilibrium surfaces (Irvine, 1965). Along their Mg-rich edge, chromites are in equilibrium with olivine of roughly mantle composition (Fo_{90-92}) (Basu and MacGregor, 1975). Declining magnesian/iron ratios in the chromite fields should be indicative first of their derivation from increasingly fractionated magmas, and eventually, their alteration. The extended arms of the fields of the 'Circades fracture zone' (6) and central Manitoba (1) as well as the low-Mg phase of the 'Josephine Ophiolite' (5) define the region of altered chromite. Chromite analyses from the two layered flows and the Cape Smith peridotite mostly occupy distinct and separate fields. For the spinifex-textured flow, the chromite field is in the region of primary magmas whereas that of the differentiated flow is in a region indicative of more evolved magmas. The Cape Smith peridotitic chromite appears to belong to the same cluster as those of the differentiated flow, but some are altered and distinctly offset into the region ascribed to alteration. Interestingly, the cluster of spinifex chromite analyses lies within the field of chromite representing the Lac Leclair carbonatitic volcanic complex at the southern margin of the Cape Smith Belt (Baragar et al., 2001). Both of the chromite clusters lie within the field of chromite compositions of the 2–3 ultramafic sill and related rocks of eastern Cape Smith Belt (Miller, 1977).

Pyroxenes

Pyroxene compositions for the various parts of the layered flows are summarized in the basic En-Wo-Fs (normative) triangles of Figure 8 and the Al_2O_3 frequency distribution diagrams of Figure 9. The clinopyroxene in both types of layered flows show a significant range of compositions beginning with a tight grouping of highly diopsidic pyroxene, primarily from the cumulate zone. The differentiated flow then follows an expected course of evolution marked by increasing Fs ratio in the pegmatitic phase and a return to mostly diopsidic pyroxene in the upper doleritic and chilled-margin zones. The more extreme ferrosilitic pyroxenes are those that are most characteristic of the pegmatite phase; elongated, curved crystals and crystals graphically intergrown with plagioclase. Even the highly magnesian spinifex-textured flow shows a marked increase in the Fs content of the spinifex-zone clinopyroxene compared with that of the cumulate zone. The three cumulate-zone analyses at the more evolved end of the Fs enrichment trend are from highly quenched groundmass and may represent inequilibrium compositions. The Cape Smith peridotite provides the only orthopyroxene analyses among the pyroxenes analyzed and tends to corroborate the petrographic observations that low-calcium pyroxenes were either rarely formed or failed to survive alteration.

The varying alumina content of the pyroxenes analyzed is illustrated in the frequency distribution diagram of Figure 9. The alumina content can be regarded as a surrogate for the degree of substitution in the pyroxene structure by non-traditional elements including ferric iron, titanium, and chromium, and it signifies some departure from ideal crystallization conditions. Note in Figure 9 that the clinopyroxene of the alumina-deficient, spinifex textured flow are, paradoxically, higher in alumina than are those of the normal differentiated flow. Amongst the former, the quenched interstitial pyroxene of the cumulate zone are highest in alumina content (> 5.5% Al_2O_3) and the more fully crystallized pyroxene of the spinifex zone are the lowest (< 8% Al_2O_3). Hence, the alumina content appears to be a measure of the disequilibrium induced by rapid crystallization. In the differentiated flow, the alumina content seems to increase with rising stratigraphic level as if related to increasing alumina content, but this may be misleading in that the spike of lowest alumina content in the cumulate zone represents settled clinopyroxene whereas the others are ophites of the olivine zone. Probably, the more nearly equilibrium conditions of clinopyroxene settling resulted in lesser Al_2O_3 substitution. In the pegmatitic zone, higher concentrations of volatiles should have lead to more nearly equilibrium crystallization, but it would also have had to have been an environment richer in alumina. In the upper zone, most of the pyroxenes analyzed are semi-quenched, skeletal crystals and the higher alumina content probably again reflects disequilibrium crystallization.

Other Components

Feldspar is a major component of the upper part of the differentiated flow and is all but absent as a discrete phase in the spinifex flow. The primary plagioclase of the dolerite, preserved in its upper chilled zone, is mainly labradorite ($An_{~50-55}$), but within the pegmatitic phase it has evolved to albite - oligoclase ($An_{~10}$). In the cumulate zone, feldspar was observed only within the pyroxenite layer where it occurs as albitic quench-like fibres in the interstices. In the spinifex flow, indeterminant mesostasis (presumably magmatic residue) in the interstices of both cumulate and overlying spinifex zones is generally rich in a feldspar component; in the cumulate zone, normative 34 to 45% feldspar and in the spinifex zone, 42 to 80%. Their compositions range mostly from An_{30} to An_{70}, although in the spinifex zone a few are albite to oligoclase.

STRATIGRAPHIC VARIATION IN COMPOSITION

The geochemistry of the Chukotat Group was discussed in some detail by Francis et al. (1983), Baragar and Scoates (1987), and Arndt et al. (1987). Variation in composition is primarily due to olivine and, to much lesser degree, clinopyroxene fractionation. Effective measures of the fractionation are given by MgO/CaO and MgO/TiO_2 ratios and these are plotted above the cross-section of the Ottawa Islands in Figure 1. Olivine separation alone produces a range of variation in the MgO/CaO ratio of from about 3 to 1, where it is commonly joined by clinopyroxene. For TiO_2/MgO the olivine range is generally 50 to 20, with clinopyroxene becoming increasingly important at lower ratios and plagioclase at ratios below about 8 to 10. In Figure 1 these ratios can be seen to mark out units of differing MgO content as well as showing both short- and long-range systematic variations in composition. The short-range variations presumably denote limited regimes of fractionation, probably related, at least partly, to olivine and clinopyroxene settling within the layered flows (Baragar and Scoates, 1987). The long-range variation, represented by overall decline through the succession, must be related to a more fundamental cause, possibly fractionation in deep-crustal or upper-mantle magma chambers. Such variation in composition is similar to that recorded from the Cape Smith Belt, but here the range is limited to the more mafic part of the spectrum whereas in Cape Smith it reaches feldspathic (feldspar-phyric) compositions.

SUMMARY AND CONCLUSIONS

The Chukotat Group in the Ottawa Islands forms a generally westerly dipping succession of volcanic rocks, some 10 000 + m thick. All are part of an interrelated komatiitic suite of rocks divisible on the basis of physical characteristics into low- (< 10% MgO), medium- (10–15% MgO), and high- magnesian (> 15% MgO) units. The volcanic flows are typically composed of variable proportions of pillowed bases and massive tops. Thickened lenses within the massive tops of many of the flows in the high- and medium-Mg units in particular are markedly differentiated into olivine cumulate bases surmounted by thick dolerite cappings. In places with pegmatitic segregations. These are called layered flows and are generally of limited lateral extent. A few have a spinifex-textured upper zone in place of the normal dolerite. The layered flows probably served as conduits through which lava was distributed over the surface and may have been responsible for much of the local variation of lava compositions evident in the stratigraphy.

Through the succession overall, the lavas seem to evolve upward towards less magnesian compositions as manifested by increasing incidence of medium- and low-Mg flows from east to west across the islands. Chemically this is marked by a general decline in fractionation indicies such as MgO/CaO and MgO/TiO_2. Such a broad change in composition is most likely attributable to fractionation in large, long-lived crustal or upper-mantle magma chambers. The contrasting compositions of olivine and spinel in each of a spinifex-textured and a normal layered flow, respectively, shows a measure of fractionation even within the most primitive parts of the sequence. In the spinifex-textured flow both minerals have attributes consistent with their derivation from a primary (or near primary) magma, whereas in the normal layered flow their compositions show significant fractionation. Since both flows are interlayered within the same high-Mg member they must have been almost simultaneously available at the time of extrusion. Hence, one might speculate that during magma-chamber initiation, mantle-derived magma could bypass the magma chamber and reach the surface coincident with magma from the chamber itself but with its extension with time, the mantle source would be blocked. In any event, it can be concluded that the bulk of Chukotat magma has undergone fractionation to a varying degree.

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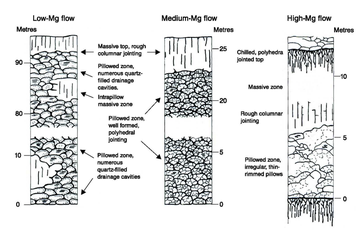

Figure 2. Sketch sections showing typical characteristics of the three subdivisions of the Chukotat Group; high-, medium-, and low-Mg basalts of the komatiitic suite.

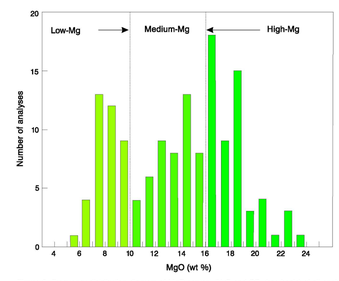

Figure 3. Frequency-distribution diagram of MgO content (H_2O and CO_2-free basis) of all analyzed volcanic rocks of the Chukotat Group on the Ottawa Islands and Cape Smith Island. Note the divisions into low-, medium-, and high-Mg categories.

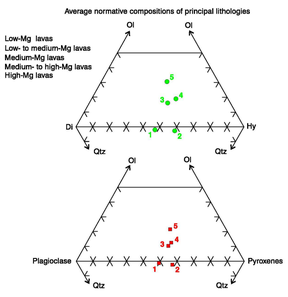

Figure 4. Normative olivine-hypersthene-diopside and olivine-pyroxene-plagioclase plots showing average normative compositions of each of the major mapping units. Apart from the mixed units 2 and 4 (which appear more heavily weighted in mafic components) fractionation is driven by olivine extraction and in late stages by enrichment in diopside and plagioclase.

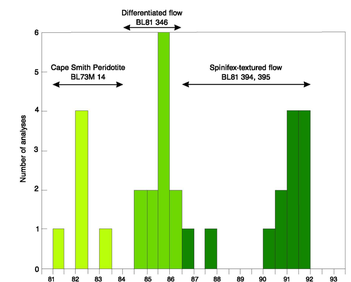

Figure 6. Frequency-distribution diagram comparing olivine compositions of spinifex-textured and normal (differentiated) layered flows from the Ottawa Islands and of a peridotite from western Cape Smith Belt.