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ARCHEAN BASEMENT UNDERLYING PALEOPROTEROZOIC CAPE SMITH BELT: PART OF POVUNGNITUK MAP AREA NTS 35-C

INTRODUCTION

Field work for this report was done in 1985 as part of a project that was intended to clarify the relationship of the Cape Smith Belt to its encompassing tectonic setting. Accordingly, a strip of 1 degree longitude width (approximately 105 km) was to be mapped from south of the Cape Smith Belt to the coast of Hudson Strait. Due to unfortunate circumstances only one summer's field work was completed when the project was cancelled. A preliminary map and report of the work completed that summer with few details was published earlier (Baragar et al., 1986). The present map represents that portion of the summer's field work that lies south of the Cape Smith Belt. Work done on the north side of the Belt is represented in a separate report and map; the Kovik Bay Map Area 35F (Baragar, 2015).

A summary map of the area is shown in Fig. 1 as well as in the 1:250 000 scale geology map (accompanying pdf) where northward Archean trends can be seen to be truncated by rocks of the east-northeastward trending Paleoproterozoic Cape Smith Belt. Within this area most of the contact between the stratified rocks of the Cape Smith Belt and underlying Archean basement is clearly unconformable (Baragar et al. 2001). In places it is obscured or replaced by south-verging thrust faults that roughly parallel the trend of the belt. In this report only the geology of the Archean rocks will be addressed in detail. The geology of the Cape Smith Belt immediately to the north is covered in such publications as: Baragar and Scoates, 1987; Moorehead, 1988; Picard, 1989; and Baragar et al., 2001.

The Archean geology has been subdivided into four units but as shown in the legend of Fig.1 probably only two of them are to be regarded as primary lithologies; the trondhjemite-tonalite and the megacrystic granite gneisses. Gneisses of the mafic margins and of the migmatites seem to be, at least in part, phases of the megacrystic granite gneisses. The trondhjemite-tonalite unit is interpreted as being the older but relationships between the various units are not well defined and the interpretation depends on less direct evidence and, to a degree, intuition. This will be discussed further in the descriptions of units that follow.

Cross cutting the Archean gneissosity and widely distributed within the map area (Fig.1 and accompanying pdf) are two sets of dolerite dykes, of probable Proterozoic age, trending respectively, northward and westward. For most of the dykes, relatively short lengths were all that were observed but in each set at least one major dyke exists that can be traced through a number of traverse intersections and on air photographs for distances of 22 km (northward set) and 9 km (westward set) respectively.

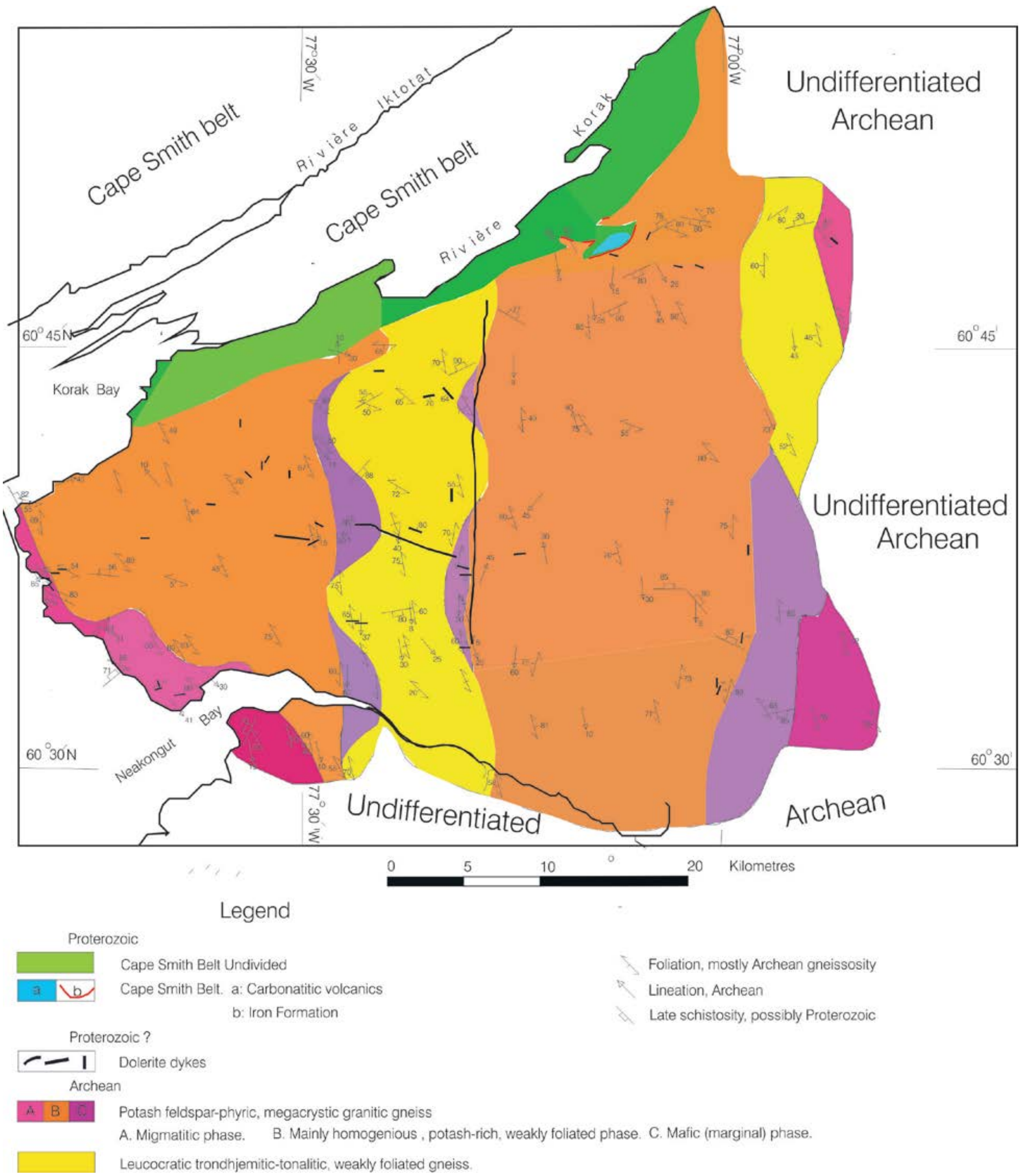

Figure 1. Sketch map of the Povungnituk area covered in this report.

DESCRIPTIONS OF LITHOLOGICAL UNITS

Trondhjemite-tonalite gneisses

The trondhjemite-tonalites are typically white- to light-grey weathering, leucocratic rocks of medium to fine grain, commonly with a sucrose texture. They are present mainly in two major belts that parallel the north-south trend of the foliation but similar rocks also occur within the regions dominated by the other lithologies. This leaves the impression that the trondhjemite-tonalite was the foundation lithology into which megacrystic granite was emplaced. Contacts between the major units are not well defined but local, small scale veining of trondhjemite-tonalite by granitic rock is present in a number of places.

The trondhjemite-tonalites are characterized by a very low mafic mineral content, generally 10 per cent or less, composed of biotite, or more rarely, hornblende. The foliation is generally weak and is marked by discontinuous folia of biotite and by elongated lenses or pods of quartz and feldspar. Most commonly these rocks contain 20 to 40 per cent of quartz, 40 to 50 per cent of plagioclase, and less than 10 per cent of potash feldspar but in places the latter can range up to 25 %. Accessory minerals include an opaque mineral, sphene, apatite, epidote, and in a few places white mica. Thus, the dominant lithology is tonalitic, ranging in places to granodioritic, but because of the commonly very low mafic mineral content the rocks can also be appropriately designated as trondhjemite.

Within the trondhjemite-tonalite masses are many enclaves of more mafic gneisses occurring both as shreddy layers or lenses paralleling the regional foliation and as sharp-walled inclusions. Some of the latter appear to be tightly-folded paragneiss. Stings of amphibolite inclusions observed in a few places may represent early mafic dykes disrupted and partly digested by a late remobilization of the trondhjemite-tonalite.

The boundaries of the trondhjemite-tonalite masses are generally abrupt but in places along the western side of the western belt the trondhjemite-tonalite is increasingly interlayered with mafic-rich, locally megacrystic gneisses, as one passes westward into quartz diorites of the mafic margin. These may be interpreted as intrusions into the trondhjemite-tonalite “basement” by an early, mafic phase of the succeeding megacrystic granites.

Megacrystic granite

The megacrystic granite unit is typically pink or grey coloured rock containing up to 60 per cent, but more commonly 10 to 20 per cent, megacrysts of pink potash feldspar in a groundmass of predominantly quartz and feldspar. Locally the quartz is a distinctive bluish colour. Biotite is the common mafic mineral and ranges from 5 to 30 per cent. The megacrysts are typically 1 to 3 cm long and are very commonly oriented with their long axes in the foliation plane. The foliation is mostly weak to distinct but in places it is pronounced and the rock appears as an augen gneiss. The megacrystic granites may be quite variable in both phenocrystic and mafic content. Along the eastern side of the eastern belt the megacrystic content is sufficiently low that the rock is essentially a granite or granodiorite with only rare potash feldspar megacrysts.

Throughout both belts more mafic phases of the rock are present, seemingly interdigitated with the normal granitic gneisses. In such places the mafic minerals may compose as much as 25 to 30 per cent of the rock and they include both hornblende and biotite but generally only sparse potash feldspar megacrysts are present. Enclaves of trondhjemite-tonalite are found within both belts of megacrystic granites but their relationship to their host is unclear.

In thin section the groundmass of the megacrystic granite is seen to be composed typically of 25 to 30 per cent quartz, 15 to 30 per cent potash feldspar (microcline, in places perthitic), 30 to 40 per cent plagioclase and 5 to10 per cent of generally olive-green biotite. In the more mafic phases, up to 20 to 25 per cent of deep green hornblende is present. Accessory minerals include apatite, opaque/sphene, and white mica. The megacrysts are typically Carlsbad-twinned crystals of microcline that is commonly perthitic. The texture of the rock can generally be described as hypidiomorphic-granular. Quartz, plagioclase and microcline grains of the ground mass are mostly 1 to 2 mm in size, commonly equant or, in the case of plagioclase, partially tabular, and all tend to show mutually intergrown boundaries. Microcline has a tendency to be interstitial to plagioclase whereas quartz commonly forms elongate bulbous lenses that mark the foliation plane. Plagioclase is invariably clouded with minute crystals of what is probably white mica. Interestingly, where the plagioclase margin adjoins microcline the boundary zone is generally free of inclusions and slightly more albitic. Similarly, many of the microcline grains, including the megacrysts, contain rounded plagioclase inclusions with unclouded, albitic margins. In places, plagioclase inclusions within a microcline crystal have a common optical orientation as if microcline were replacing an earlier plagioclase. Potash feldspar of the groundmass is a late, crystallizing constituent judging from its interstitial habit, and may have been a mobile reactant until just prior to consolidation of the rock or it may have been remobilized during the subsequent deformation and metamorphism of the region. That some of the potash feldspar megacrysts appear as porphyroblasts in the more mafic enclaves and margins provides some supporting evidence for this point of view.

Mafic margins

The rocks of this unit are assumed to be a marginal phase of the megacrystic granites because they generally contain some aspect of the latter within the unit. Although the rocks are commonly mafic gneisses, with moderate amounts of hornblende and/or biotite, they are interspersed with pink granitic gneisses, in part with megacrystic, potash feldspar or augen. In places the mafic rocks are invaded, lit par lit fashion, by granites with, seemingly, an attendant development in the mafic part of the rock of potash feldspar megacrysts or possibly porphyroblasts. Rocks of this unit are typically quartz diorite or granodiorite gneisses with 20 to 30 per cent mafic (hornblende and/or biotite) minerals but they range in lithologies from biotite schist and amphibolite to leucocratic granodiorite and tonalite. Present in a few places are agmatites showing sharply bounded blocks of amphibolite in a granodiorite matrix, possibly representing disrupted remnants of earlier dyking.

In thin sections, typical mafic margin gneiss can be seen to contain 25 to 35 per cent quartz, minor to 25 per cent potash feldspar, 10 to 15 per cent amphibole, and 5 to 15 per cent biotite. Opaque minerals may form as much as 10 per cent of the rock and apatite is a common accessory. Minor, but varying amounts of chlorite and epidote-zoisite are invariably present. In the eastern mafic margin belt clinopyroxene relicts in hornblende are commonly present and may form up to 25 per cent of the rock. These occurrences would seem to indicate increasing metamorphic grade to the east.

Migmatites

The migmatite unit could be considered as a variant of the mafic margin unit as it, too, is generally mafic but contains variable amounts of embedded megacrystic granite enclaves, layers, and veins. Typically the rocks are mixed leuco and melanocratic, mostly sharply differentiated from one another as layered gneisses or as blocky fragments of amphibolite or quartz diorite in a granitic or tonalitic matrix, commonly in proportions of about 40 to 60 respectively. In most places the leucosome of the rock is pink granite but not uncommonly may also be a megacrystic granite of the type that forms the major masses. One discrete, mapable layer of megacrystic granite within the western migmatite belt, adjoining the Hudson Bay coast, is as much as 300 metres wide. Some of the blocky amphibolite fragments in granitoid matrix can be interpreted as disrupted and partially digested early dykes. On the whole the migmatites are a more intimately mixed assemblage of lithologies, mostly mafic-felsic, than in the mafic margin units and are generally complexly foliated.

Dolerite dykes

Relationships and Descriptions

Age relationships between the northerly and westerly trending dykes have not been determined but both sets cut all other lithologies and are assumed to be Proterozoic. All have a similar appearance; aphyric, dark greenish grey, mafic rocks of fine- to medium- grain size. Where boundaries were observed they are chilled against the country rock. Dyke widths range from 1 to 75 m across with average widths for the northerly trending set being 30 m and for the westerly trending set 17 m. Major dykes of 50 or more metres thick and, as noted above, strike lengths of many kilometres, occur in each set. Overall the strike directions of the dykes are somewhat variable: the average for the northerly-trending set (22 dykes) is 003 degrees and for the westerly-trending set (34 dykes) 282 degrees with standard deviations of 12 and 18 degrees respectively. Dips for the westward-trending dykes range from 58 degrees north to 77 degrees south and for the northward set from 78 degrees east to 79 degrees west. The major northward dyke in the centre of the map area dips consistently 80 degrees west.

The dykes are generally undeformed but all are metamorphosed to greenschist facies grade. Plagioclases are commonly heavily saussuritized or charged with discrete epidote/zoisite crystals. In places they are clouded with a fine micaceous intergrowth. The mafic minerals are actinolite/hornblende and brownish biotite and the opaque minerals are mostly replaced by sphene. Rarely, clinopyroxene relicts are found within amphibole grains. Textures are predominantly metamorphic but most specimens show a vestige of their primary doleritic or gabbroic texture.

In the few thin sections examined no significant difference could be detected between the petrography of the northward- and westward- trending dykes. Plagioclase and hornblende in mutually intergrown, equant to blocky, patches, and generally present in similar amounts, form the bulk of the rock in most dykes. Minor biotite and opaque/sphene (5 per cent or less) are invariably present and in many specimens minor interstitial quartz is a constituent. Also, commonly present in interstitial patches, are intergrowths of chlorite, epidote and apatite with the two latter, in places, forming the cores of pleochroic halos. In one specimen of the major northward-trending dyke (BL85-49), what seems to be a successor generation of distinctive purplish-blue, acicular amphiboles in random alignment, overgrow the earlier metamorphic fabric. They could represent an annealing episode that succeeded the peak of dyke metamorphism.

One northward-trending dyke in the western block of megacrystic granite, just south of the Cape Smith Belt (UTM coordinates X359518 Y6733137), is petrographically distinctive in that biotite is the sole mafic mineral and minor orthoclase appears to be present. The rock contains about 60 per cent plagioclase, 30 per cent biotite and 5 to 10 per cent sphene/opaque.

Chemical relationships

Seven chemical analyses of the dolerite dykes are presented in Table 1; two from the major northward-trending dyke shown in Figure 1 and five from westward-trending dykes, including one from the major dyke of this swarm. The data are indicative of distinct compositional differences between the two dyke swarms and they are suggestive of a possible relationship between the dykes and the principal magmatic formations of Cape Smith Belt (Povungnituk and Chukotat formations) and the islands of eastern Hudson Bay (Flaherty and Chukotat formations).

TABLE 1. COMPOSITION OF DOLERITE DYKES, POVUNGNITUK MAP AREA

Station	Dyke Set	Spec_Num.	SIO2 %	AL2O3 %	FE2O3 %	FEO %	MGO %	CAO %	NA2O %	K2O %	TIO2 %
5B-2	Major N-S	BL85 49	51.8	14.2	3.3	5.8	8.0	7.64	3.0	1.25	0.64
2B-07	Major N-S	BL85 5	52.7	15.2	2.6	6.2	7.2	8.79	2.9	1.28	0.51
3B-13	E-W	BL85 22	53.2	14.7	4.0	10.2	2.5	5.89	4.2	0.69	1.53
4B-5	E-W	BL85 33	49.6	13.3	4.8	10.6	5.7	8.42	1.8	1.54	1.41
4B-6	E-W	BL85 35	49.1	14.7	4.6	10.4	4.8	9.76	2.2	0.40	1.39
3B-20	Major E-W	BL85 84	50.4	14.1	2.7	12.7	5.3	7.19	3.2	0.76	1.53
3B-31	E-W	BL85 91	50.1	14.3	3.4	12.1	4.9	9.38	2.5	0.46	1.42

Spec_Num.	P205 %	MNO %	S %	CO2 %	H2O %	RB ppm	BA ppm	NB ppm	SR ppm	ZR ppm	Y ppm
BL85 49	0.11	0.14	999	0.3	2.5	59	56	6	306	94	12
BL85 5	0.09	0.14	999	0.1	2.1	47	396	5	327	71	8
BL85 22	0.46	0.22	0.15	0.1	3.0	33	258	24	210	223	54
BL85 33	0.13	0.24	0.04	999	3.2	51	531	11	350	86	18
BL85 35	0.14	0.22	0.09	0.1	2.7	13	170	12	162	88	24
BL85 84	0.16	0.21	999	999	2.6	44	157	14	112	106	24
BL85 91	0.13	0.23	0.07	999	1.8	37	126	11	100	87	24

Spec_Num.	LA ppm	YB ppm	ZN ppm	BE ppm	MO ppm	CU ppm	V ppm	CO ppm	NI ppm	CR ppm	TOTAL
BL85 49	18	1.2	74	0.8	4	82	160	50	170	520	98.90
BL85 5	14	0.8	65	0.7	4	34	140	48	140	310	101.00
BL85 22	21	4.6	86	2.0	4	130	110	30	26	8	101.00
BL85 33	9	2.1	160	1.2	2	250	310	50	77	61	100.90
BL85 35	8	1.8	110	1.0	5	220	290	51	53	34	100.50
BL85 84	8	2.2	140	0.9	5	130	310	48	58	39	101.00
BL85 91	7	2.0	200	0.9	6	96	310	52	60	40	100.90

Note: 999 = no data

In the AFM diagram of Figure 2 (Jensen diagram - Jensen, 1976) individual analyses of dykes of the two swarms are shown in relation to the distribution fields of analyses of the two major suites (tholeiitic and komatiitic) of the Cape Smith Belt and the islands of eastern Hudson Bay respectively (cf. Baragar and Scoates, 1987). Analyses of the Cape Smith Belt represent the Povungnituk (tholeiitic) and Chukotat (komatiitic) formations, and for the islands of eastern Hudson Bay, the Flaherty (tholeiitic) and Chukotat formations, respectively. For this report we

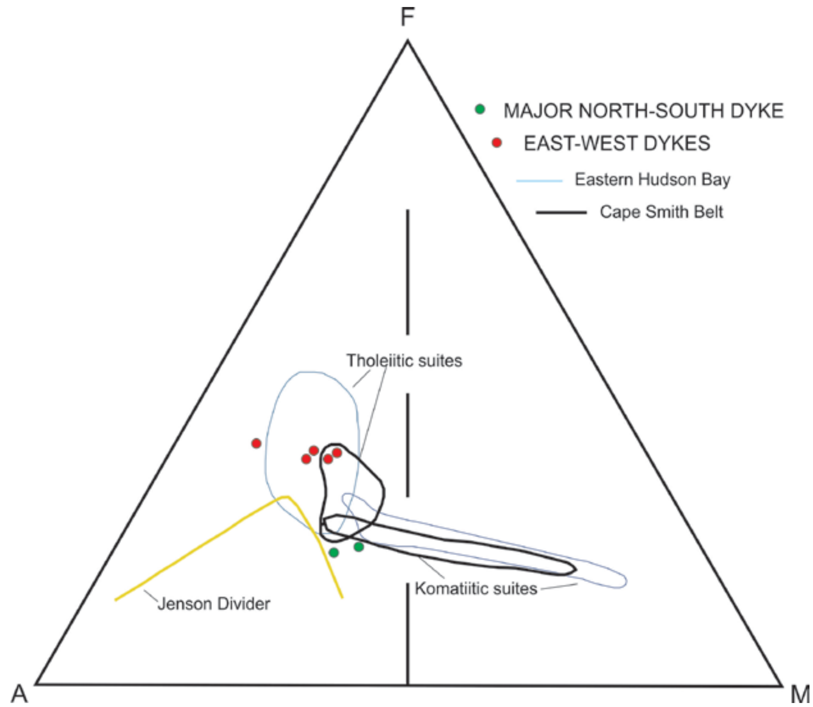

Figure 2. AFM diagram (cation plot after Jensen, 1976) showing plots of dolerite dykes of the Povungnituk area in relation to distribution fields of tholeiitic and komatiitic suites of the islands of eastern Hudson Bay and of Cape Smith Belt. The formations represented in eastern Hudson bay are the Flaherty (tholeiitic) and the Chukotat (komatiitic) and in Cape Smith Belt, the Povungnituk (tholeiitic) and the Chukotat (komatiitic). Parameters: A = Al_2O_3, F = FeO + Fe_2O_3 + TiO_2, M = MgO.

are mainly concerned with the compositions of the Cape Smith Povungnituk and Chukotat formations which are proximal to the dykes of this area and might reasonably be considered their surface equivalents. Clearly the compositions of the two sets of dykes in Figure 2 are distinctive and each is within or associated with one or other of the major suites: the east-west trending dykes with the tholeiitic and the north-south dyke with the komatiitic suite. Similarly, in the plots of other diagnostic chemical constituents in Figures 3, and 4 analyses of the east-west and north-south dykes are within or associated with the tholeiitic and komatiitic fields respectively of Cape Smith Belt and Islands of eastern Hudson Bay.

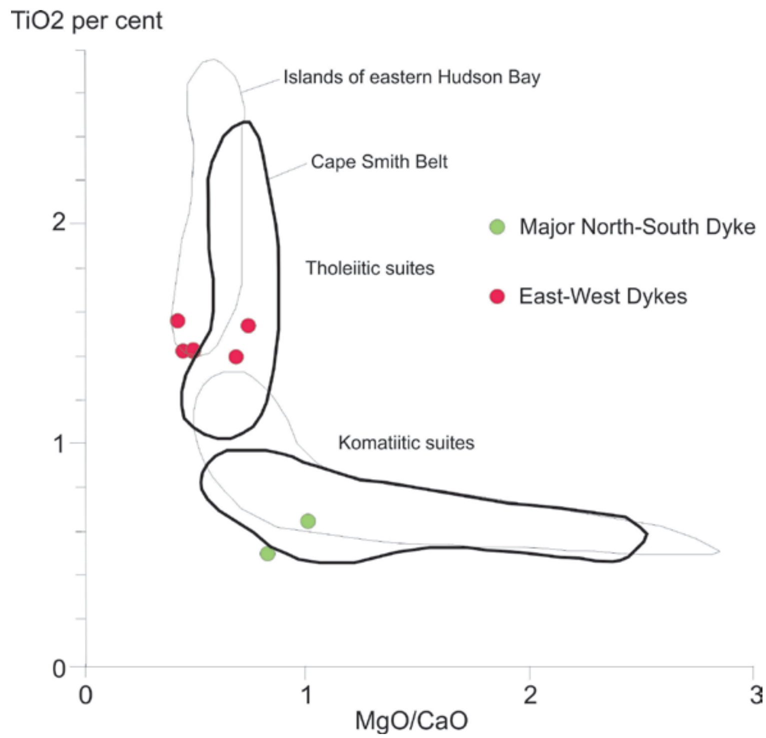

Figure 3. MgO/CaO vs TiO_2 plot showing Povungnituk dykes in relation to distribution fields of analyses of the tholeiitic and komatiitic suites of the Islands of eastern Hudson Bay and of Cape Smith Belt.

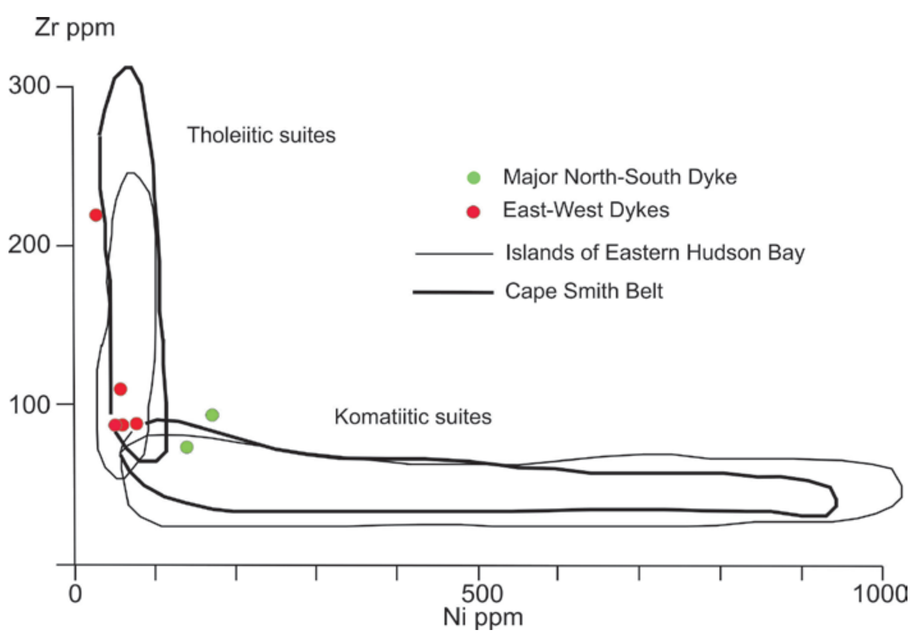

Figure 4. Ni vs Zr plot of Povungnituk dykes in relation to the distribution fields of analyses of the tholeiitic and komatiitic suites of the Islands of eastern Hudson Bay and of Cape Smith Belt.

Assessment of dyke relationships

Both sets of dykes post-date Archean deformation and are probably Proterozoic in age. Their greenschist facies metamorphism matches that of the magmatic rocks of the Cape Smith Belt just to the north (Moorhead, 1988) which might signify an emplacement age within the same metamorphic time frame as the Cape Smith rocks. Limited chemical data are suggestive of petrogenic affinities between the northward- trending dykes and the Chukotat komatiitic suite and the westward-trending dykes and the Povungnituk tholeiitic suite. It seems entirely possible, therefore, that these dykes are feeders to the magmatic formations (Povungnituk and Chukotat) of the Cape Smith Belt.

Structural Elements of the Povungnituk Map-area

Structural characteristics of the Archean gneisses are represented in the stereonet plot of Figure 5 where poles to the planes of the major gneissosity indicate a regional strike of about 350 degrees and, given the approximate balancing of eastward and westward dips, nearly vertical (on average) axial planes of folding. Fold axes and mineral lineations are both predominantly southeastward plunging at moderate to shallow angles.

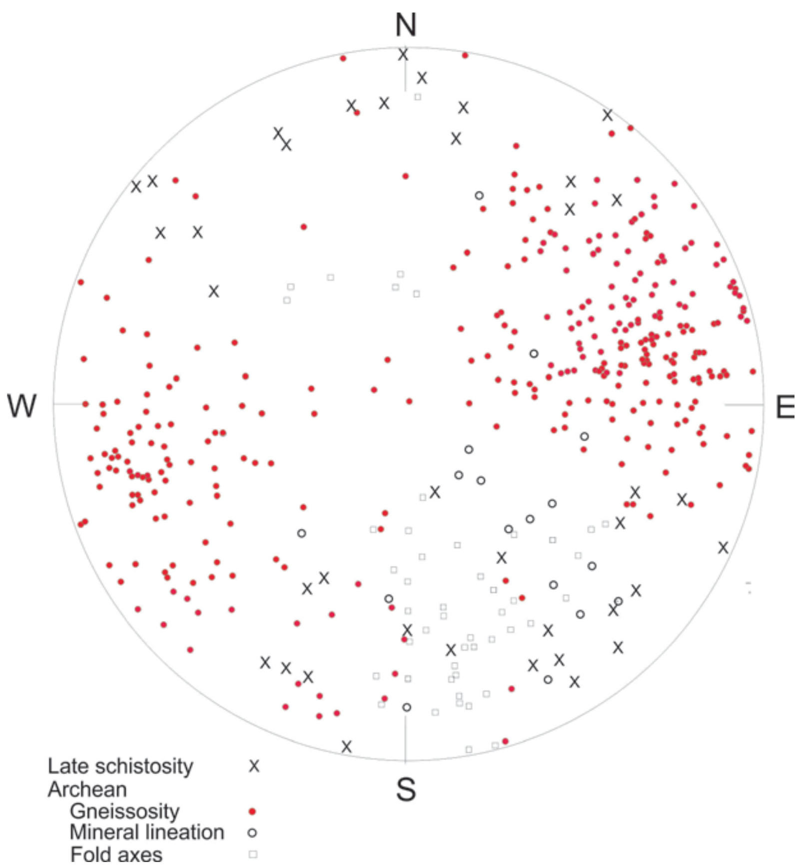

Figure 5. Stereonet plot of the structural elements of the Povungnituk map area.

The Hudsonian deformation of the Cape Smith Belt may be represented within the Archean basement by a late schistosity which occurs in the northern part of the Archean terrane and is marked by micaceous fractures and shears that crosscut Archean structures and in places the dolerite dykes. Poles to the schistosity planes of the late shears are shown on the stereonet of Figure 5 where it can be seen that the schistosity roughly parallels the east- northeastward strike of the Cape Smith Belt and dips both northward and southward. The distribution, orientation, and timing of these structures would be entirely consistent with their origin as outlying elements of the Hudsonian deformation and they would indicate that its effects did not penetrate far into the foreland.

SUMMARY AND CONCLUSIONS

Archean basement unconformably underlying the Paleoproterozoic Cape Smith Belt in this area comprises northward-trending, alternating belts of trondhjemite-tonalite and megacrystic (potash feldspar) granite; the latter, bounded in places, by mafic phases of what is interpreted to be, its mafic margins. Migmatites along the western side of the area are mafic gneisses extensively interspersed with layers and enclaves of megacrystic granitoid rocks and interpreted also as a phase of the megacrystic granites. The relationship between the two principal units is not well defined but enclaves of trondhjemite-tonalite found within megacrystic granite masses and small scale granitic intrusions cutting trondhjemite-tonalite are suggestive of an earlier age for the latter.

Two sets of dolerite dykes, northward and westward trending respectively, cut all other rocks of the Archean terrane and are assumed to be Proterozoic. Although of greenschist facies metamorphism they are generally undeformed and show chilled relationships towards their hosts. The two sets of dykes are chemically distinct from one another and each shows a chemical affinity with one or other of the major magmatic suites of the Cape Smith Belt: the westward trending dykes with the tholeiitic (Povungnituk) suite and the major northward trending dykes with the komatiitic (Chukotat) suite.

The Archean gneisses have been folded generally about north- northeastward trending, roughly vertical, axial planes with axes predominantly south-southeastward plunging. In detail the structural patterns can be variable and complex. Unrelated to the Archean deformation is a late schistosity that develops intermittently across the northern part of the Archean terrane and crosscuts all other rocks, including the dolerite dykes. These structures, comprising micaceous schists and shears, strike east-northeastward, roughly parallel to the stratigraphy of the Cape Smith Belt and dip variably north and south. They are probably outliers of the Hudsonian thrusting that deformed the Cape Smith Belt just to the north.

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REFERENCES

Baragar, W.R.A.
2015: Geology of part of Kovik Bay map area (NTS 35-F); Geological Survey of Canada, Open File 7846, 1 .zip file. doi:10.4095/296431

Baragar, W.R.A. and Scoates, R.F.J.
1987: Volcanic geochemistry of the northern segments of the Circum-Superior Belt of the Canadian Shield; *in* Geochemistry and mineralization of Proterozoic volcanic suites. (eds.) T.C, Pharaoh, R.D. Beckinsdale, and D. Rickard. Geological Society Special Publication v. 33**,** p, 113-131.

Baragar, W.R.A., Mader, U., and LeCheminant, G.M.
2001: Paleoproterozoic carbonatitic ultrabasic volcanic rocks (meimechites?) of Cape Smith Belt, Quebec. Canadian Journal of Earth Sciences, v. 38, p. 1313-1334.

Baragar, W.R.A., Hervet, M., and Charland, M.
1986: Structural character and plutonic setting at the west end of the Ungava Trough; *in* Exploration en Ungava; Données récentes sur la géologie et la gîtologie, (eds.) D. Lamothe, R. Gagnon, and T. Clark. Séminaire d'information, Ministère de l'Energie et des Ressources, Québec. v. 16, p.41-43.

Jensen, L.S.
1976: A new cation plot for classifying subalkaline volcanic rocks. Ontario Division of Mines, Miscellaneous Paper 66.

Moorehead, J.
1988: Géologie de la région du Lac Vigneau, Nouveau Québec. Ministre de l'Énergie et des Ressources du Québec, DP 88-05.

Picard, C.
1989: Pétrologie et volcanologie des roche volcanique de la partie centrale de la fosse de l'Ungava. Ministére de l'Énergie et des Ressources du Québec, ET 87-07.