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PRELIMINARY NOTE ON THE LITHOGEOCHEMISTRY AND PETROGENESIS OF INTRUSIVE ROCK SUITES FROM THE LAC BRÛLÉ REGION (NTS MAP AREA 13D), GRENVILLE PROVINCE, LABRADOR

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ABSTRACT

The Lac Brûlé region of southern Labrador straddles the boundary of three major Grenvillian lithotectonic units: from north to south, parts of the Wilson Lake terrane, the southwest extent of the Mealy Mountains terrane and the northern fringe of the Mecatina terrane. The Wilson Lake terrane consists primarily of late Paleoproterozoic high-grade metasedimentary rocks, and intruded by subordinate diatexite, granitoid orthogneisses and minor gabbroic bodies, all of middle Labradorian age (ca. 1.65Ga). In contrast, the Mealy Mountains terrane is dominated by massive to gneissic, intrusive igneous rocks of the Labradorian Mealy Mountains intrusive suite, which host small and scattered screens of older metasedimentary paragneiss. Farther south, the Mecatina terrane consists primarily of Mesoproterozoic granitoid rocks intrusive in metasedimentary gneisses including quartzite attributed to the early Mesoproterozoic Wakeham Group. Both the Mealy Mountains and the Mecatina terranes are intruded by late- to post-Grenvillian, commonly K-feldspar porphyritic intrusions, chiefly granite and subordinate syenite and monzonite.

Granitoid rocks of Unit P_{WL} grn from Wilson Lake terrane are slightly to moderately peraluminous and contain corundum in the norm. They display a trace-element signature sharing many similarities with I-type volcanic-arc granite. The rocks are, however, lithologically less diverse than volcanic-arc granitoid rocks of an Andean–Cordilleran setting. Their trace-element pattern is indistinguishable from that of the diatexite samples of Unit P_{WL} dxt, a clear indication of the involvement of a high-grade metasedimentary precursor. Although enriched in aluminum, they do not strictly conform to S-type syn-collision granite. The spatially associated gabbroic rocks also exhibit geochemical signatures that set them apart from volcanic-arc gabbroic magmatism. Given the evidence for the close association in space and time between granitoid and mafic plutonism, for crustal involvement in mafic magma generation, and the fact that both suites have geochemical signatures that depart from typical volcanic-arc rocks, a post-collision tectonic regime is suspected.

In the Lac Brûlé area, the Mealy Mountains intrusive suite includes two somewhat contrasting plutonic rock units. The gabbroic rocks of Unit P_{MM} gbr display regionally uniform geochemical characteristics. The trace-element pattern is duplicated in all the analyses, independently of the silica content of the rocks, in accordance with their likely cogenetic origin. The compositional spectrum of the gabbroic suite is attributed to variable degree of fractionation. The granitoid rocks of Unit P_{MM} ggn display significant variability in major- and trace-element compositions. They define a cluster in the metaluminous field with a spread over to peraluminous compositions, as well as a far-reaching trend across the within-plate to volcanic-arc granite fields on an Rb versus Y+Nb discrimination diagram. Given that the rocks appear to be closely related in time, their petrogenesis does not fit any simple model intimating a more complex setting where crustal and mantle interactions occur during magma genesis, differentiation and/or emplacement. Such instances commonly occur in complex settings such as in regions of attenuated continental lithosphere, and collision zones. In the absence of reliable age constraints, the alternative possibility that these rocks pertain to more than one plutonic suite cannot be ruled out.

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Late- to post-Grenvillian granitoid rocks of Units M_{LG} grn and M_{LG} sye are enriched in potassium, plotting above the high-K calc-alkaline and shoshonitic divide in K_2O–SiO_2 space. This peculiar signature can be attributed to K-feldspar fractionation and accumulation in the rock samples, and therefore it does not directly reflect the composition of the parent magma. Most samples cluster in the within-plate granite field on an Rb vs. Nb+Y granite tectonic discrimination diagram, with a few samples in the adjacent volcanic-arc and one in the syn-collision granite fields. The extended trace-element pattern of late- to post-Grenvillian granitoid samples share similarities with those of other granitoid suites from both volcanic-arc and within-plate settings. These patterns are all characterized by a general decrease from Rb to Yb, and by marked enrichments in K, Rb, Th, Ce and Sr, which reflect the importance of crustal involvement in the magma generation. In consideration of the timing of this plutonism relative to peak-Grenvillian regional metamorphism, of the absence of evidence for coeval mafic magmatism, and of the fact that a number of samples plot outside the within-plate granite field, a more complex emplacement regime may be considered e.g., post-collision or far-field subduction-related.

INTRODUCTION AND REGIONAL GEOLOGICAL SETTING

The Lac Brûlé region (NTS map area 13D) of southern Labrador is located in the northeastern Grenville Province and straddles the boundary between the Exterior Thrust Belt and Interior Magmatic Belt (Figure 1; *see* Gower *et al.*,1991). It includes, from north to south, parts of the Wilson Lake terrane (WLT), the southwest extent of the Mealy Mountains terrane (MMT), and the northern fringe of the Mecatina terrane (MET). These Grenvillian structurally stacked terranes consist primarily of late Paleoproterozoic (Wilson Lake and Mealy Mountains terranes) and Mesoproterozoic (Mecatina terrane) crust. The geology and field relationships of the different plutonic rock suites, which underlie most of the region, have recently been described by James and Nadeau (2000a, b) and James *et al (this volume*). Preliminary U–Pb geochronology data are reported by James *et al.* (2001) and James *et al.* (*this volume*). The focus of this complementary note is placed on the whole-rock, major- and trace-element geochemical results obtained from a set of seventy representative rock samples collected during the summers of 2000 and 2001. Readers will benefit from assessing this data in view of the more detailed descriptions of the lithological attributes and field relationships provided in James and Nadeau (*op. cit.*).

The northeastern part of the region (NTS map area 13D/15 and D/16) (Figure 2), part of the WLT, is dominated by high-grade, pelitic and semipelitic metasedimentary gneisses and related diatexite having protolith depositional ages predating ca. 1720 Ma (i.e., pre-Labradorian Orogeny). These are intruded by variably deformed and recrystallized gabbro and granitoid rock bodies provisionally assigned a middle Labradorian age on the basis of overprinting regional metamorphic relationships. Accordingly, these granitoid rocks appear to be closely related in time to high-grade metamorphism and attendant deformation (ca. 1640 Ma; Corrigan *et al.*, 1997). Farther south, most of the study area comprises the southwestern extent of the MMT (Figure 2) (*see* Gower and Owen, 1984; James and Nadeau, 2001, *this volume*). This terrane is underlain mainly by late Paleoproterozoic (Labradorian) plutonic rocks of the Mealy Mountains intrusive suite (MMIS) (*see* Emslie, 1976; Emslie and Hunt, 1990), minor Paleoproterozoic pre-Labradorian crust, and crosscutting Pinwarian (1510 to 1450 Ma) and late- to post-Grenvillian granitoid intrusions (Gower, 1996; James *et al.*, 2001, *this volume*). The MMT and the study area are flanked on the southwest by the Atikonak River anorthosite–mangerite–charnockite–granite (AMCG) complex emplaced ca. 1.13 Ga (Emslie and Hunt, 1990). In contrast, the MET, which extends to the southeastern fringe of the study area (in NTS map 13C/4, 13 D/1 and D/2), is underlain primarily by early Mesoproterozoic, variably foliated and commonly porphyritic, granite and quartz monzonite that are intruded by a few small gabbroic plugs. These rocks intrude metasedimentary rocks, including quartzite and pelitic gneiss, provisionally correlated with the early Mesoproterozoic Wakeham Supergroup. These metasedimentary gneisses are sporadically distributed in the northern Mecatina terrane, outcropping at a sole locality along the southern limit of the study area (NTS map 13D/1). The MET, like the MMT, is intruded by plutons consisting of mostly massive, medium- to coarse-grained granite and K-feldspar porphyritic granite with subordinate quartz monzonite, monzonite and syenite of late- to post-Grenvillian age.

SAMPLING AND ANALYTICAL METHODS

Seventy samples, representative of all major plutonic lithological units (Figure 2), were selected for major- and trace-element analysis on the basis of their mesoscopic textural homogeneity and their representativeness of the outcrop area. None of the samples show field evidence of metamorphic remobilization (e.g., migmatization), fracture related alteration, or weathering. Textures of the rock samples vary from massive, having complete preservation of igneous texture and mineralogy, to metamorphically recrystallized and foliated. Most gabbroic samples are medium to coarse grained, whereas granitic samples vary from coarse grained to K-feldspar porphyritic. With a few exceptions, each sample consisted of over two kilograms of fresh rock.

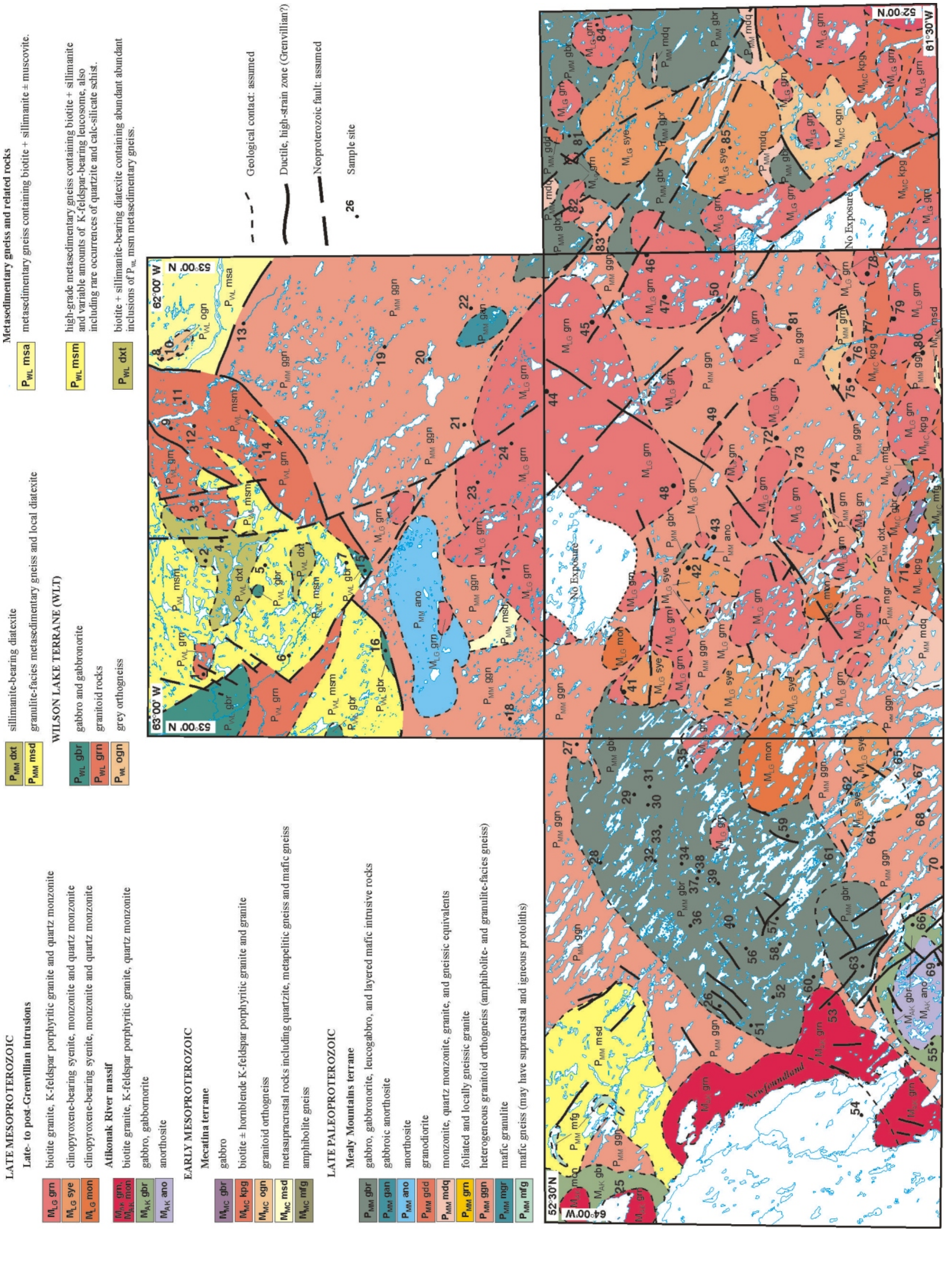

Figure 1. *Generalized geological map of the Lac Brûlé region (including NTS map area 13D/NE, D/SW, D/SE, 13C/4 and C/5). Simplified from James and Nadeau (2001a, this volume).*

Major elements, transition metals (Sc, V, Cr, Co, Ni), and Cu, Zn, Sr and Ba were determined by Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES). Rare-earth-elements (REE), Pb, Y, Hf, Zr, Rb, Ta, and Th were analyzed by Inductively Coupled Plasma–Mass Spectrometry (ICP–MS). Detection limits are given in Tables 1 and 2. Samples were low in volatiles with mean H_2O+CO_2 of 0.43 wt.%, and most totals between 98.5 to 100.3 wt.% (mean = 99.11 wt.%). Norms (CIPW) have been calculated volatile-free to 100% (Table 3). Total iron has been expressed as FeO* using the conversion factor of Irvine and Baragar (1971). Analyses were performed at the geochemistry laboratory of the Quebec Geoscience Centre.

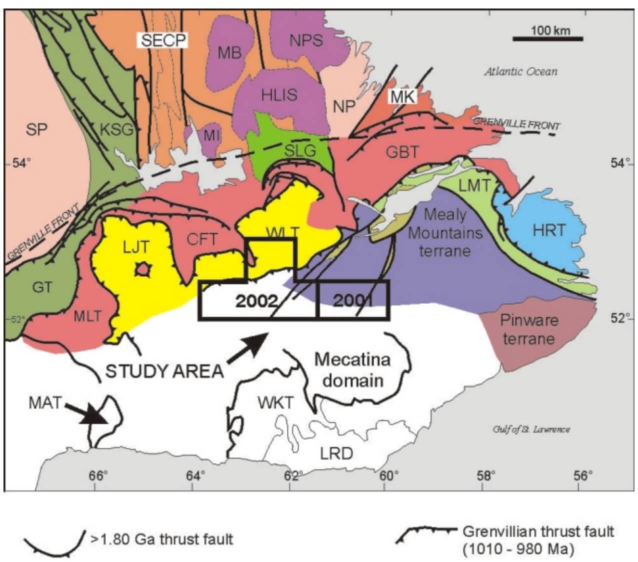

Figure 2. *Location of the Lac Brûlé (this study) and Minipi Lake (Nadeau and James, 2001) regions in relation to the tectonic and major lithotectonic divisions of northeastern Laurentia (modified from Wardle* et al.*, 1997). Grenville Province: HRT - Hawke River terrane, LMT - Lake Melville terrane, GBT - Groswater Bay terrane, WLT - Wilson Lake terrane, CFT - Churchill Falls terrane, LJT - Lac Joseph terrane, MLT - Molson Lake terrane, GT - Gagnon terrane, MAT - Matamec terrane, WKT - Wakeham terrane, LRD - La Romaine terrane. Archean divisions: SP - Superior Province, NP - Nain Province (Hopedale Block). Archean and Paleoproterozoic divisions: MK - Makkovik Province, SECP - Southeastern Churchill Province (Core Zone), KSG - Kaniapiskau Supergroup (2.25 to 1.86 Ga). Mesoproterozoic units: NPS - Nain Plutonic Suite, HLIS - Harp Lake intrusive suite, MB - Mistastin batholith, MI - Michikamau Intrusion, SLG - Seal Lake Group.*

MAJOR PLUTONIC SUITES

WILSON LAKE TERRANE

In the study area, the WLT consists primarily of upper amphibolite to granulite-facies, pelitic and semipelitic metasedimentary gneisses, which host extensive bodies of diatexite, mapped as Unit P_{WL} dxt (Figure 2) (*see* James and Nadeau, 2001). Repeated field observations circumstantiate that the metasedimentary gneisses are gradational, at all scales, into diatexites, which consist of massive to variably foliated, medium- to coarse-grained, equigranular to subporphyritic plutonic rocks of granitic to quartz monzonitic compositions. The diatexite contains abundant biotite, commonly up to 15 percent modal, and widespread sillimanite. In spite of the aluminous character of the rocks, neither garnet nor cordierite have been recognized in the field. Diatexite bodies outcropping in the study area also appear to lack other hallmarks of S-type granite, which characteristically occur as shallow-seated plutons with well-developed contact aureoles (e.g., White and Chappell, 1988). Nevertheless, the field relationships advocate that the petrogenesis of P_{WL} dxt diatexite involved nearly complete *in situ* melting of surrounding pelitic and semipelitic sedimentary precursors.

Metasedimentary gneiss and diatexite of the WLT are intruded by bodies of metamorphosed, foliated to gneissic, lithologically varied granitoid rocks collectively mapped as Unit P_{WL} grn. This extensive unit is made up of a number of plutons consisting mainly of medium- to coarse-grained, K-feldspar porphyritic, biotite- and hornblende-bearing granitic orthogneisses, along with lesser monzonitic rocks, locally porphyritic, and containing sporadic clinopyroxene. The WLT is also punctuated by small bodies of variably deformed and metamorphosed, massive to foliated and locally gneissic, gabbro, gabbronorite and minor clinopyroxenite embodied as Unit P_{WL} grb. These gabbroic rocks are variable to some degree in texture and modal composition, and may contain accessory biotite and quartz. The granitic and gabbroic rocks making up Units P_{WL} grn and PWL gbr are provisionally assigned to middle Labradorian (ca. 1.65 Ga), in view of their crosscutting igneous and overprinting metamorphic relationships, ascribed to the regional high-grade metamorphic culmination (ca. 1640 Ma; Corrigan *et al.*, 1997). The geochemical results for rock samples from the WLT presented and discussed in this study comprise 3 analyses of diatexite (Unit P_{WL} dxt), 6 of granitoid orthogneiss (Unit P_{WL} grn), and 3 of gabbroic rocks (Unit P_{WL} grb) (Tables 1, 2 and 3).

MEALY MOUNTAINS INTRUSIVE SUITE

The Mealy Mountains intrusive suite (MMIS) is generally described as consisting of an older group of anorthositic, leucogabbroic and leucotroctolitic rocks, and a younger group of pyroxene-bearing monzonite and quartz–monzonite. It constitutes one of the most extensive intrusive suites of the Grenville Province in Labrador, underlying most of the region extending from the highlands southeast of Lake Melville, through the Lake Minipi and Lac Brûlé regions, over more than 350 km in the southwestern direction (*cf.* Emslie, 1976; Gower and van Nostrand, 1996; Nunn and van Nostrand, 1996; Gower, 1999; James and Lawlor, 1999, James and Nadeau 2000a, 2001). In the Lac Brûlé region (Figure 2), the MMIS includes two regionally extensive rock units consisting mainly of gabbro and gabbronorite (Unit P_{MM} gbr), and of pyroxene-bearing monzodiorite to monzonite (Unit P_{MM} ggn).

MMIS – Gabbroic Suite (P_{MM} gbr)

As described by James and Nadeau (2000a), MMIS gabbro and gabbronorite (Unit P_{MM} gbr) (Figure 2), vary considerably in composition, textures, structures, and aeromagnetic signatures, possibly indicating that the unit consists of intrusions of different ages. The unit also contains subordinate amounts of leucogabbro, leucogabbronorite, anorthosite, pyroxenite, diorite and very minor amounts of monzogabbro, monzogabbronorite and amphibolite. Rocks consist of varied amounts of clinopyroxene, orthopyroxene and plagioclase; biotite is a common accessory mineral. The rocks are texturally varied, from massive and unrecrystallized, containing preserved igneous mineral textures, to foliated and pervasively recrystallized. Trace amounts to several percent of pyrite are common.

MMIS – Granitoid Orthogneiss Suite (P_{MM} ggn)

James and Nadeau (2000a, 2001) describe the MMIS pyroxene-bearing monzodiorite and monzonite unit (Unit P_{MM} ggn) as a compositionnally and texturally varied unit including monzodiorite, quartz monzodiorite, diorite, granodiorite, quartz monzonite and granite. The unit also includes minor amounts of gabbroic rocks that are correlated with Unit P_{MM} gbr. Rocks are texturally varied, even at the outcrop scale, from massive with complete preservation of igneous textures, to recrystallized and foliated; gneissic varieties also occur. The unit probably consists of distinct intrusions of relatively uniform composition, although it is so poorly exposed that it cannot be subdivided at the scale of mapping. Clinopyroxene, hornblende, biotite and accessory magnetite are common in these rocks. The hornblende–biotite granodiorite orthogneiss (DJ-00-9006a) of Site 22 (Figure 2) has yielded an igneous emplacement age of 1653 ± 5 Ma based on U–Pb dating of zircon (James *et al.*, *this volume*). This age is comparable to the 1659 ± 5 Ma obtained for the igneous crystallization of gneissic monzodiorite from the Minipi Lake region (NTS map area 13C/10) (James *et al.*, 2000).

LATE- TO POST-GRENVILLIAN GRANITOID SUITE (M_{LG} grn, and M_{LG} sye)

The MMT and MET are intruded by plutons of clinopyroxene-bearing syenite, biotite granite, and K-feldspar porphyritic granite defined as Units M_{LG} sye, M_{LG} grn and M_{LG} kpg, respectively. Rocks in the three units are mainly undeformed and massive, although weakly recrystallized and foliated rocks also occur. The emplacement age of an M_{LG} sye clinopyroxene-bearing syenite from the Lac Arvert map area, based on U–Pb dating of zircon, is estimated to be 982 ± 2 Ma (James *et al.*, *this volume*). Based on composition and age, the MLG sye plutons correlate with similar intrusions of an early posttectonic AMCG – mafic magmatic suite defined by Gower *et al.* (2001). The intrusions of granite and K-feldspar porphyritic granite are interpreted to be slightly younger than the syenite intrusions, and form part of a suite of 966 to 956 Ma granite plutons that are widespread in the northeastern Grenville Province (*see* Gower, 1996). An MLG grn intrusion ocurring in the western part of the Fourmont Lake area has an emplacement age of 964 ± 3 Ma, determined by U–Pb geochronology of zircon (James *et al.*, 2001).

RESULTS AND DISCUSSION

It should be emphasized that because of the nature of the field work, accomplished by making helicopter landings on isolated outcrops, contact relationships between the various rock types were infrequently observed, the size and extent of individual plutons could not be delineated, and detailed variations within single plutons cannot be addressed. Nevertheless, individual rock bodies appear to be fairly continuous and extensive at the regional scale, allowing adequate delineation of first-order petrochemical variations. It is also emphasized that most gabbroic to monzodioritic rocks exhibit medium- and coarse-grained igneous or relict igneous textures, locally with a distinct igneous mineral foliation and, more rarely, pronounced compositional layering. Granitic rocks are generally coarse-grained, equigranular or K- feldspar porphyritic, and locally retain a subtle prismatic mineral foliation possibly of igneous origin. These primary igneous textural attributes indicate that some crystal separation and settling occurred during crystallization. Therefore, the geochemistry of the rocks cannot be directly discussed in terms of models applied to lava, considerably limiting the petrogenetic interpretation. Normative mineral mode (CIPW norm; Table 3) and composition dia-

Table 1. *Major-element contents of intrusive rock samples from the Lac Brûlé region*

Site	Sample	UTM	Element	SiO2	TiO2	Al2O3	Fe2O3T	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	Total
			Method	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES		
		Coordinate	Unit	%	%	%	%	%	%	%	%	%	%	%	%
			Limit	0.010	0.0005	0.015	0.00	0.0005	0.0005	0.0015	0.005	0.010	0.025		
Late- to post-Grenvillian granitoid suite: M_{LG}grn and M_{LG}sye															
62	NK-01-3032	492182	6e+06	60.50	1.23	17.30	5.11	0.12	1.25	2.56	4.46	6.36	0.44	0.29	100.30
41	NK-01-3002B	506533	6e+06	62.20	1.22	15.10	6.14	0.12	1.40	3.03	3.68	5.56	0.57	0.55	100.00
85	DJ-00-7049	583279	6e+06	62.47	0.90	16.67	3.43	0.09	0.80	1.22	4.61	6.94	0.15	0.48	98.00
47	NK-00-8127	561750	6e+06	62.75	1.15	14.71	5.77	0.11	1.44	2.61	3.52	4.83	0.67	0.57	98.30
48	NK-01-3005	535411	6e+06	65.20	0.78	15.30	4.07	0.08	0.86	2.72	3.68	5.28	0.40	0.23	99.10
50	NK-00-8132	561290	6e+06	65.36	0.88	14.68	4.83	0.07	1.28	2.30	3.41	5.37	0.40	0.70	99.58
42	NK-01-3007	523900	6e+06	66.10	0.72	14.10	5.19	0.12	1.23	2.65	3.78	4.10	0.22	0.23	98.70
79	NK-00-8135	558792	6e+06	66.55	0.77	13.96	4.24	0.08	0.89	1.90	3.40	5.37	0.30	0.62	98.37
45	NK-00-8149	558350	6e+06	66.92	0.76	14.46	4.72	0.08	1.08	2.01	3.37	5.00	0.43	0.32	99.49
23	NK-00-8030	535732	6e+06	68.43	0.78	14.44	4.08	0.06	1.08	1.50	2.94	5.91	0.30	0.75	100.49
46	NK-00-8126	567967	6e+06	68.45	0.50	14.24	3.62	0.07	0.73	1.18	3.16	5.99	0.19	0.69	98.97
17	NK-00-8059	522615	6e+06	69.42	0.44	14.41	2.87	0.03	0.64	1.49	3.29	5.39	0.22	0.52	98.87
44	NK-00-8140	548500	6e+06	71.23	0.27	14.49	2.03	0.03	0.81	0.79	2.93	6.29	0.11	0.92	100.03
24	NK-00-8028	541183	6e+06	72.45	0.25	13.83	1.93	0.04	0.67	0.78	3.16	5.62	0.08	0.65	99.57
84	DJ-00-7003	600476	6e+06	72.71	0.23	12.80	1.58	0.05	0.28	0.67	3.38	5.49	0.03	0.41	97.65
Mealy Mountains intrusive suite: gabbroic suite, PMMgrb															
Ultramafic															
38	NK-01-3035B	481300	6e+06	41.00	1.25	18.30	14.40	0.13	6.69	13.60	1.77	0.32	0.01	0.17	98.10
38	NK-01-3035A	481300	6e+06	42.70	0.17	7.05	14.40	0.22	23.90	8.44	0.48	0.08	0.02	1.52	99.20
56	NK-01-3047	470357	6e+06	42.80	0.60	12.60	14.90	0.19	14.60	13.30	0.74	0.08	0.03	0.01	100.20
30	NK-01-3031	490602	6e+06	43.20	0.30	10.40	12.90	0.17	18.90	10.70	0.81	0.18	0.05	0.57	98.70
61	NK-01-3027	482306	6e+06	43.20	0.77	13.30	15.70	0.19	11.40	11.60	1.53	0.58	0.17	0.86	99.50
40	NK-01-3021	473685	6e+06	44.60	2.72	15.30	15.70	0.20	5.43	7.58	3.47	1.05	0.84	0.34	97.60
37	DJ-01-1123	480350	6e+06	45.00	1.01	14.50	13.00	0.16	9.08	16.50	1.27	0.25	0.03	0.04	101.00
57	NK-01-3022	474700	6e+06	45.70	2.84	16.00	15.80	0.20	6.56	8.19	3.45	0.78	0.83	-0.02	100.80
Mafic															
59	NK-01-3041B	486350	6e+06	46.20	1.47	15.80	14.00	0.21	7.78	10.20	2.39	0.58	0.12	0.66	99.50
52	NK-01-3062	463578	6e+06	46.30	1.94	16.20	15.00	0.20	7.65	9.73	2.75	0.47	0.23	-0.71	99.90
35	NK-01-3011	496096	6e+06	46.40	1.95	15.30	17.20	0.21	6.88	7.86	2.66	1.13	0.35	-0.53	99.70
31	NK-01-3014	493160	6e+06	46.40	0.69	9.88	14.70	0.26	14.00	10.60	1.68	0.61	0.12	-0.09	99.00
81	DJ-00-7100	585081	6e+06	46.51	1.89	16.38	14.06	0.19	7.07	8.29	3.00	0.79	0.26	1.09	99.66
27	NK-01-3010	499150	6e+06	47.40	0.92	17.60	14.70	0.15	4.18	7.97	3.64	1.92	0.79	1.17	97.10
32	NK-01-3037	482805	6e+06	47.90	1.89	16.00	14.20	0.19	7.29	8.85	2.69	0.83	0.21	-0.26	100.10
36	NK-01-3020	473645	6e+06	47.90	0.72	21.50	9.64	0.12	3.51	10.60	3.60	0.70	0.83	0.27	99.80
51	NK-01-3069	459679	6e+06	48.00	0.95	14.90	12.10	0.22	7.31	10.50	3.03	0.63	0.68	-0.02	98.70
26	NK-01-3061	462428	6e+06	48.20	0.48	21.50	7.46	0.09	3.91	11.30	3.61	0.61	0.93	0.33	98.80
34	NK-01-3036	482392	6e+06	48.50	0.90	10.10	14.80	0.29	11.70	9.58	1.75	1.19	0.24	-0.18	99.10
59	NK-01-3041A	486350	6e+06	48.60	1.43	12.90	13.90	0.21	8.13	10.50	2.29	0.51	0.15	0.19	99.00
28	NK-01-3044	482549	6e+06	48.70	1.09	19.90	9.05	0.13	3.80	9.08	3.84	1.59	0.75	0.54	99.00
29	NK-01-3030	492093	6e+06	51.90	0.69	14.10	10.90	0.21	8.07	8.88	3.01	1.53	0.33	0.14	100.00
Intermediate															
63	NK-01-3054	467911	6e+06	54.00	0.65	18.50	6.40	0.11	2.92	6.61	4.13	3.19	0.67	0.51	98.20
58	NK-01-3048	471061	6e+06	54.20	0.69	17.20	8.10	0.15	4.66	7.62	3.83	2.38	0.50	0.18	99.80
39	NK-01-3042	479598	6e+06	54.70	0.64	16.90	7.73	0.15	4.95	7.33	3.90	2.39	0.45	-0.04	99.50
33	NK-01-3039	487612	6e+06	56.60	0.82	18.10	6.72	0.13	2.36	5.34	4.65	3.93	0.55	-0.01	99.60
Mealy Mountains intrusive suite: granitoid orthogneiss suite: P_{MM}ggn															
Intermediate															
81	NK-00-8134	557400	6e+06	52.46	0.68	17.51	8.81	0.18	5.18	8.00	4.44	1.57	0.46	0.70	100.18
22	DJ-00-9006A	560136	6e+06	58.98	0.65	16.39	6.85	0.14	3.04	4.78	3.72	4.08	0.35	0.63	99.85
19	NK-00-8017A	554682	6e+06	62.91	0.93	15.43	6.81	0.11	2.16	3.32	2.78	4.09	0.25	0.23	99.20
76	NK-00-8145	553210	6e+06	63.00	0.94	13.73	6.45	0.14	1.52	3.08	3.65	3.58	0.37	0.31	97.08
80	NK-00-8144	554100	6e+06	63.77	1.14	14.57	6.33	0.11	1.49	2.68	3.44	5.38	0.49	0.58	100.50
70	NK-01-3051	481760	6e+06	64.70	0.58	15.70	4.70	0.11	1.64	3.61	4.04	3.03	0.25	0.53	99.20
20	NK-00-8025	552990	6e+06	65.99	0.89	14.57	5.96	0.09	0.98	2.90	3.59	4.45	0.30	0.16	100.14
43	NK-01-3004A	528262	6e+06	66.00	0.70	15.20	3.37	0.06	0.66	1.63	3.99	5.98	0.18	0.04	98.10
Felsic															
67	NK-01-3034	493700	6e+06	66.10	0.67	14.20	4.39	0.10	0.58	1.72	3.67	5.70	0.15	0.17	97.90
75	NK-00-8151	550071	6e+06	66.48	0.83	13.88	5.37	0.13	1.20	2.65	3.88	3.81	0.31	0.28	99.07
73	NK-00-8157	538360	6e+06	66.68	0.39	15.33	3.64	0.09	1.13	2.53	4.12	4.27	0.15	0.27	98.75
83	NK-00-8002	571500	6e+06	66.90	0.78	14.41	4.11	0.08	0.88	2.14	3.36	5.52	0.32	0.52	99.28
49	NK-00-8147	543931	6e+06	67.36	0.71	14.55	3.60	0.06	0.81	1.79	3.43	5.97	0.20	0.43	99.11
21	NK-00-8029	543825	6e+06	68.86	0.87	14.60	4.97	0.10	1.36	2.51	2.63	4.19	0.18	0.56	100.98
18	NK-00-8105B	502442	6e+06	69.19	0.39	14.65	2.47	0.03	0.63	1.33	3.12	6.04	0.12	0.71	98.85
68	NK-01-3050	489881	6e+06	69.30	0.24	14.80	2.27	0.07	0.63	2.28	4.43	3.30	0.10	0.29	98.00
64	NK-01-3049	487488	6e+06	70.40	0.11	15.00	1.17	0.03	0.30	1.79	4.41	3.94	0.04	0.20	97.80

Table 1. Continued

Site	Sample	UTM	Element	SiO2	TiO2	Al2O3	Fe2O3T	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	Total
			Method	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES		
		Coordinate	Unit	%	%	%	%	%	%	%	%	%	%	%	%
			Limit	0.010	0.0005	0.015	0.00	0.0005	0.0005	0.0015	0.005	0.010	0.025		
Wilson Lake terrane granitoid suite: P_{WL}grn															
12	NK-00-8024	543453	6e+06	56.36	1.31	17.95	9.23	0.15	2.83	5.02	3.55	2.95	0.39	0.25	100.26
11	NK-00-8023	546760	6e+06	57.73	1.28	16.95	8.93	0.15	2.71	4.40	3.35	3.13	0.43	0.63	99.91
9	NK-00-8031	543169	6e+06	61.55	0.89	15.75	7.02	0.12	2.13	3.58	3.21	3.30	0.18	0.37	98.26
3	NK-00-8044	532442	6e+06	63.00	0.61	16.49	6.44	0.08	2.28	2.34	3.06	3.34	0.10	0.36	98.31
14	NK-00-8036	539254	6e+06	66.77	0.68	15.02	5.06	0.07	1.44	2.44	2.87	4.29	0.08	0.23	99.08
1	NK-00-8120	508642	6e+06	67.21	0.64	14.91	5.15	0.08	1.64	2.43	2.97	3.68	0.08	0.42	99.37
Wilson Lake terrane diatexite: P_{WL}dxt															
2	NK-00-8080	524625	6e+06	60.70	0.76	17.10	7.62	0.11	3.32	2.59	3.27	2.43	0.08	0.34	98.50
4	NK-00-8084	527366	6e+06	64.52	0.68	15.76	5.81	0.13	2.34	3.63	3.08	2.69	0.06	0.14	98.95
5	NK-00-8066	524021	6e+06	61.98	0.71	17.80	6.42	0.11	2.04	1.49	2.61	3.67	0.09	0.33	97.40
Wilson Lake terrane gabbro and gabbronorite: P_{WL}grb															
16	NK-00-8087	512031	6e+06	46.10	1.33	15.94	12.40	0.17	8.55	10.53	2.14	0.26	0.11	-0.05	97.57
6	NK-00-8102	511354	6e+06	46.81	3.80	11.92	18.50	0.27	5.03	9.14	2.52	0.94	0.38	-0.36	99.19
15	NK-00-8063	523336	6e+06	49.28	0.82	13.84	10.07	0.18	10.96	7.67	2.02	1.33	0.21	1.94	98.48

grams are used to characterize the rocks and to emphasize their similarities and differences.

WILSON LAKE TERRANE INTRUSIVE SUITES

Granitoid orthogneiss samples from the WLT (Unit PWL grn) have major-element compositions typical of granite (*s.s.*) and quartz monzonite, except for two samples of pronounced monzonitic affinity (Tables 1 and 3). The SiO_2 contents range between 56.36 to 67.21 wt.% (mean = 62.1 wt.%), K_2O between 2.95 and 4.29 wt.% (mean = 3.45 wt.%), Na_2O + CaO between 8.57 and 5.31 wt.% (mean = 6.54 wt.%), and Al_2O_3 between 14.91 and 17.95 wt% (mean = 16.18 wt.%). They define an array extending across the boundary between the granite and quartz monzonite fields on a normative quartz–K-feldspar–plagioclase ternary diagram (Figure 3a) and have MgO + MnO + Fe_2O_3 (as total iron) ranging between 6.87 and 12.21 wt.% (mean = 9.25 wt.%), and contain 9.0% to 16.7% (mean = 13.3%) hypersthene in the norm. The samples have high K_2O / Na_2O ratios (mean = 1.1), plot in the high-K calc-alkaline field (Figure 3b), are enriched in aluminum with elevated Al_2O_3 / (Na_2O + K_2O) (mean = 2.4), and contain in average 1.6% (up to 3.9%) corundum in the norm. Accordingly, the rocks are slightly to moderately peraluminous, except for one sample crossing the metaluminous devide (Figure 3c).

In spite of their marked aluminum enrichment and peraluminous signature, granitoid rocks of the WLT display extended trace-element patterns characterized by enrichments in K_2O, Rb, Ba, Th, Ce and Sm relative to Ta, Nb, Hf, Y, and Yb that are typical of volcanic-arc granite (Figure 4a). Indeed, their mean trace-element pattern displays very close similarities with the pattern of the Chilean volcanic-arc granitoid rocks (Figure 4c). The mean Wilson Lake granitoid pattern differs a little, however, from that of the volcanic-arc granite reference line in showing i) a less-pronounced fractionation slope from the large ion lithophile elements (Rb and Th) to the high-field strength element (Nb, Hf and Zr) and the rare-earth-elements, ii) an enrichment in Zr relative to Hf and Sm, and iii) no negative Ba spike (Figure 4a and c). These differences in pattern can be attributed to the presence of accessory phases (e.g., zircon and allanite) in the rocks sampled, and to their porphyritic texture which is indicative of K-feldspar accumulation.

In spite of these differences, the PWL grn granitoid plot with typical I-type Andean–Cordilleran granites in the volcanic-arc field on the Rb versus Y+Nb tectonic discrimination diagram of Pearce *et al*. (1984) (Figure 3d). However, the PWL grn granitoid samples display several features that set them apart from typical granitoid rocks of this group. First, they are lithologically much less diverse than volcanic-arc granitoid suite of Andean–Cordilleran setting. Indeed, P_{WL} grn samples appear to define a trend from the quartz monzonite to the granite (*s.s.*) fields on Streckeisen (1973) classification triangle (Figure 3a) that is quite distinct from the quartz diorite–tonalite–granodiorite–granite trend typical of Andean–Cordilleran suites. Second, it is emphasized that the P_{WL} grn granitoid are mildly to moderately peraluminous (mean Al_2O_3 / (CaO + Na_2O + K_2O) = 1.61) and present elevated K_2O/Na2O ratios (0.83 to 1.49). Accordingly, PWL grn granitoid are corundum normative, in departure from granitoids of Andean–Cordilleran, suites which usually contain diopside in their norm. Such geochemical features are generally attributed to the assimilation by the magma of sedimentary precursor (e.g., Patino Douce, 1999). In this respect, it is striking and significant that samples from diatexite (Unit P_{WL} dxt) display extended trace-element patterns undistinguishable from those of P_{WL} grn

Table 2. *Transition metal and trace-element contents of intrusive rock samples from the Lac Brûlé Minipi region*

	ELEMENT	Cr	Ni	Co	Cu	Zn	Pb	Sc	V	Rb	Sr	Ba	Nb	Zr	Y	Th
	Method	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-MS	ICP-AES	ICP-AES	ICP-MS	ICP-AES	ICP-AES	ICP-MS	ICP-MS	ICP-MS	ICP-MS
	Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SITE	Limit	10	37.5	15	15	37.5	0.005	1	10	0.003	0.5	1	0.020	0.010	0.020	0.002
Late- to post-Grenvillian granitoid suite: M_{LG}grn and M_{LG}sye																
62	NK-01-3032	32	-	-	-	133	35.2	9	37	72	777	4682	17.0	851	33	4.85
41	NK-01-3002B	84	-	-	-	127	32.4	9	55	133	708	2744	36.0	629	50	9.57
85	DJ-00-7049	70	-	-	-	73	37.2	11	21	81	163	1150	25.8	1395	48	11.80
47	NK-00-8127	103	-	-	41	113	36.0	7	61	221	431	1244	80.5	524	90	26.27
48	NK-01-3005	133	-	-	11	112	32.6	7	31	162	649	2331	34.0	655	43	17.00
50	NK-00-8132	100	-	-	13	104	47.0	6	53	211	541	1780	46.6	652	45	29.50
42	NK-01-3007	113	-	-	13	98	17.3	13	46	120	295	1533	14.0	278	57	6.56
79	NK-00-8135	97	-	-	-	91	36.6	8	24	139	372	2037	36.7	806	54	14.82
45	NK-00-8149	95	208	-	74	94	41.4	6	47	271	446	1327	57.6	623	64	28.12
23	NK-00-8030	120	-	-	21	93	47.0	6	33	210	317	1397	42.1	794	29	27.01
46	NK-00-8126	118	16	-	33	86	53.1	6	30	273	248	989	39.5	649	48	121.58
17	NK-00-8059	161	12	-	215	57	54.4	3	33	187	299	969	12.0	508	17	130.82
44	NK-00-8140	97	-	-	57	51	47.5	4	28	262	266	972	23.2	233	20	52.31
24	NK-00-8028	139	12	-	7	55	41.1	4	15	266	378	1007	20.9	209	9	41.06
84	DJ-00-7003	133	-	-	17	33	44.4	2	-	234	88	323	40.7	260	40	27.60
Mealy Mountains intrusive suite: gabbroic suite, P_{MM}grb																
Ultramafic																
38	NK-01-3035B	14	53	45	1168	94	2.4	43	622	2	1536	229	0.6	11	11	-
38	NK-01-3035A	1037	387	109	24	106	-	33	75	1	449	79	0.1	4	4	-
56	NK-01-3047	426	109	73	191	102	0.6	56	298	1	895	122	0.3	14	7	-
30	NK-01-3031	2498	609	73	96	162	-	38	167	2	479	137	0.2	9	7	0.08
61	NK-01-3027	168	81	63	70	114	1.4	39	408	12	1148	380	1.2	26	11	0.50
40	NK-01-3021	36	66	49	53	131	2.7	23	254	9	765	1112	5.8	157	35	0.41
37	DJ-01-1123	42	173	43	93	91	0.7	61	528	2	1087	152	0.4	13	13	0.08
57	NK-01-3022	50	102	53	38	118	0.8	21	273	6	864	1020	5.3	141	29	0.37
Mafic																
59	NK-01-3041B	150	128	59	84	123	5.4	36	260	24	211	99	6.1	81	23	0.52
52	NK-01-3062	123	125	59	117	126	0.5	31	230	9	277	149	8.7	113	28	0.80
35	NK-01-3011	24	116	64	92	159	3.8	25	207	23	328	541	4.6	86	26	1.72
31	NK-01-3014	513	157	64	36	123	1.5	48	290	12	716	457	1.4	38	17	0.79
81	DJ-00-7100	119	100	53	71	100	11.3	25	173	12	298	279	6.4	105	24	0.63
27	NK-01-3010	18	-	23	389	109	9.8	22	234	45	1489	1388	1.7	27	21	0.57
32	NK-01-3037	201	134	53	138	130	4.3	29	215	22	278	243	10.0	150	29	2.23
36	NK-01-3020	21	-	24	102	86	2.4	15	223	9	2409	974	1.2	9	15	0.27
51	NK-01-3069	152	40	35	124	135	4.6	36	285	6	1581	941	0.8	20	21	0.28
26	NK-01-3061	40	27	25	608	68	4.1	13	230	9	2325	702	0.9	11	9	0.66
34	NK-01-3036	420	123	53	16	151	3.4	45	315	18	695	805	2.6	62	25	1.03
59	NK-01-3041A	249	94	54	101	116	2.2	47	286	14	199	154	7.9	101	27	1.18
28	NK-01-3044	30	-	21	150	100	4.7	20	234	32	2003	2121	2.8	22	17	0.46
29	NK-01-3030	280	81	39	93	115	6.5	33	204	26	888	1154	2.8	50	20	1.30
Intermediate																
63	NK-01-3054	71	24	14	259	77	9.7	13	194	65	1612	2654	2.2	34	16	1.27
58	NK-01-3048	126	39	24	135	90	6.5	22	190	35	1120	1735	3.2	36	19	1.38
39	NK-01-3042	169	40	22	104	89	8.1	21	182	31	1211	1652	2.1	42	18	0.69
33	NK-01-3039	46	-	11	118	87	11.3	15	144	60	972	1978	7.9	123	23	0.51
Mealy Mountains intrusive suite: granitoid orthogneiss suite: P_{MM}ggn																
Intermediate																
81	NK-00-8134	89	63	28	32	97	19.0	23	204	62	976	309	7.6	126	22	2.76
22	DJ-00-9006A	41	-	18	82	73	24.8	17	141	140	633	811	17.6	211	26	13.48
19	NK-00-8017A	124	26	16	106	83	25.0	15	100	117	295	1276	12.4	432	25	7.06
76	NK-00-8145	58	-	-	14	103	23.1	16	72	65	360	1880	13.1	357	46	2.20
80	NK-00-8144	124	77	-	-	127	37.8	12	43	120	688	3295	43.1	946	59	11.32
70	NK-01-3051	68	-	-	13	78	10.2	10	70	60	662	1477	8.5	239	20	1.79
20	NK-00-8025	116	-	-	26	99	23.3	17	49	102	190	1909	35.9	718	47	0.65
43	NK-01-3004A	121	-	-	6	85	34.1	4	20	142	425	1861	37.0	574	75	11.00
Felsic																
67	NK-01-3034	70	-	-	19	75	19.6	11	9	93	165	2639	12.0	645	19	0.62
75	NK-00-8151	66	-	-	-	93	25.6	14	48	77	277	1562	13.4	337	41	2.49
73	NK-00-8157	85	-	-	-	51	26.6	7	53	110	529	1216	9.8	194	20	11.36
83	NK-00-8002	111	-	-	24	101	40.1	6	39	240	465	1793	53.0	756	55	33.74
49	NK-00-8147	82	-	-	9	74	49.9	6	28	212	390	1561	54.1	590	69	20.27
21	NK-00-8029	121	16	-	-	64	29.2	13	66	148	265	1339	17.4	384	36	7.04
18	NK-00-8105B	90	-	-	53	46	42.7	3	27	235	365	1438	15.7	386	11	51.65
68	NK-01-3050	134	-	-	18	55	16.3	3	14	76	699	1755	6.1	139	9	5.88
64	NK-01-3049	94	-	-	-	24	20.5	2	1	50	529	2594	2.1	82	4	1.77

Table 2 suite. *Transition metal and trace-element contents of intrusive rock samples from the Lac Brûlé Minipi region*

SITE	ELEMENT	La	Ce	Hf	Nd	Sm	Eu	Tb	Yb	Gd	Dy	Ho	Er	Tm	Ta	Lu
Method	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	
	Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Limit	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.002	0.005	0.002	0.0001	0.002	0.0005	0.0005	0.0005
Late- to post-Grenvillian granitoid suite: M_{LG}grn and M_{LG}sye																
62	NK-01-3032	123.0	259	15.00	114	18.00	5.65	1.32	1.92	12.00	6.69	1.13	2.86	0.34	0.75	0.29
41	NK-01-3002B	127.0	272	15.00	115	18.00	3.94	1.61	3.76	13.00	9.12	1.65	4.46	0.60	1.89	0.57
85	DJ-00-7049	377.4	728	26.34	286	35.67	5.05	2.05	3.92	23.51	10.76	1.82	4.77	0.64	1.03	0.65
47	NK-00-8127	162.3	414	11.45	181	27.32	3.23	2.47	9.57	18.41	15.04	2.98	9.52	1.49	5.57	1.43
48	NK-01-3005	115.0	253	15.00	103	17.00	3.20	1.44	3.29	12.00	8.07	1.46	3.95	0.54	2.27	0.47
50	NK-00-8132	142.2	323	14.53	125	18.72	2.86	1.47	3.77	12.38	8.50	1.56	4.31	0.60	2.58	0.57
42	NK-01-3007	53.0	113	6.64	55	10.00	1.99	1.39	5.08	9.42	9.04	1.90	5.57	0.82	0.70	0.79
79	NK-00-8135	106.6	267	17.79	115	19.22	3.71	1.79	4.52	14.34	10.50	1.91	5.37	0.75	1.72	0.69
45	NK-00-8149	143.4	318	13.19	116	18.97	2.37	1.31	6.36	12.39	9.67	1.93	6.09	0.97	3.68	0.99
23	NK-00-8030	125.7	273	14.96	99	14.99	2.42	1.11	1.72	10.04	5.74	0.96	2.46	0.31	1.56	0.25
46	NK-00-8126	245.6	524	15.58	185	26.18	2.23	1.81	3.91	16.67	9.99	1.76	4.85	0.66	1.65	0.58
17	NK-00-8059	85.6	181	10.53	63	8.72	1.62	0.58	1.08	5.22	3.11	0.55	1.48	0.19	0.49	0.16
44	NK-00-8140	92.0	220	6.29	80	13.02	1.49	0.89	1.28	8.19	4.52	0.71	1.76	0.22	1.19	0.20
24	NK-00-8028	38.8	79	5.16	32	5.10	1.08	0.34	0.80	3.27	1.68	0.29	0.81	0.12	1.00	0.14
84	DJ-00-7003	83.2	168	7.38	62	10.28	0.85	1.25	3.83	8.31	7.31	1.42	4.20	0.63	2.12	0.56
Mealy Mountains intrusive suite: gabbroic suite, P_{MM}grb																
Ultramafic																
38	NK-01-3035B	3.6	10	0.43	10	2.79	1.20	0.37	0.73	2.88	2.22	0.40	1.05	0.13	0.03	0.10
38	NK-01-3035A	1.6	4	0.15	4	0.96	0.44	0.12	0.30	0.94	0.77	0.15	0.38	0.05	-	0.04
56	NK-01-3047	3.8	10	0.54	8	2.00	0.75	0.25	0.56	1.88	1.50	0.28	0.76	0.10	0.02	0.08
30	NK-01-3031	2.5	6	0.33	5	1.24	0.48	0.21	0.57	1.43	1.30	0.26	0.72	0.10	0.01	0.08
61	NK-01-3027	8.5	19	0.81	14	3.13	0.98	0.35	0.85	2.85	2.10	0.40	1.05	0.14	0.06	0.13
40	NK-01-3021	22.0	53	3.79	35	7.64	2.65	1.01	2.70	7.66	6.33	1.20	3.40	0.45	0.39	0.41
37	DJ-01-1123	3.5	10	0.56	11	3.10	1.27	0.43	0.89	3.30	2.54	0.48	1.23	0.15	0.02	0.13
57	NK-01-3022	18.0	43	3.36	30	6.75	2.42	0.88	2.19	6.51	5.37	1.02	2.81	0.38	0.37	0.33
Mafic																
59	NK-01-3041B	6.2	15	2.17	11	3.14	1.18	0.62	2.20	3.84	4.15	0.86	2.49	0.35	0.42	0.32
52	NK-01-3062	9.6	24	3.03	16	4.25	1.58	0.76	2.61	5.11	5.05	1.03	2.84	0.41	0.67	0.38
35	NK-01-3011	13.0	29	2.26	17	4.14	1.57	0.66	2.22	4.62	4.32	0.87	2.50	0.35	0.29	0.34
31	NK-01-3014	9.8	24	1.11	17	4.13	1.16	0.50	1.38	3.81	3.04	0.59	1.61	0.23	0.07	0.21
81	DJ-00-7100	8.6	21	2.33	14	3.72	1.49	0.65	2.28	4.21	4.34	0.87	2.57	0.36	0.33	0.35
27	NK-01-3010	31.0	67	0.81	39	7.09	1.98	0.67	1.60	5.76	3.98	0.76	2.05	0.27	0.07	0.23
32	NK-01-3037	15.0	34	3.81	19	4.45	1.50	0.76	2.64	5.09	4.93	1.02	2.97	0.41	0.65	0.39
36	NK-01-3020	23.0	48	0.31	27	5.20	1.72	0.48	0.98	4.12	2.70	0.52	1.37	0.17	0.05	0.14
51	NK-01-3069	22.0	51	0.76	32	6.86	2.02	0.72	1.71	5.69	4.21	0.80	2.13	0.29	0.04	0.26
26	NK-01-3061	16.0	35	0.35	20	3.83	1.38	0.34	0.70	3.07	1.98	0.35	0.92	0.12	0.13	0.11
34	NK-01-3036	18.0	43	1.75	29	6.80	1.54	0.80	2.44	6.10	5.03	0.96	2.82	0.40	0.14	0.37
59	NK-01-3041A	9.3	23	2.70	14	3.73	1.28	0.72	2.54	4.45	4.78	1.00	2.83	0.41	0.56	0.38
28	NK-01-3044	25.0	55	0.60	31	5.79	1.91	0.56	1.18	4.78	3.15	0.58	1.55	0.20	0.12	0.17
29	NK-01-3030	21.0	47	1.42	26	5.43	1.59	0.60	1.71	4.64	3.54	0.70	1.95	0.28	0.14	0.27
Intermediate																
63	NK-01-3054	30.0	61	0.89	31	5.67	1.73	0.53	1.34	4.39	3.14	0.58	1.64	0.22	0.13	0.21
58	NK-01-3048	29.0	61	1.10	31	5.93	1.76	0.61	1.69	4.75	3.61	0.71	1.91	0.27	0.16	0.25
39	NK-01-3042	26.0	54	1.09	28	5.40	1.62	0.57	1.51	4.47	3.18	0.63	1.79	0.25	0.11	0.24
33	NK-01-3039	40.0	85	2.67	41	7.29	1.87	0.70	1.97	5.71	4.19	0.81	2.26	0.32	0.33	0.31
Mealy Mountains terrane intrusive suite: granitoid orthogneiss suite: PMMggn																
Intermediate																
81	NK-00-8134	24.5	54	2.63	28	6.12	1.78	0.53	2.09	5.40	3.82	0.74	2.20	0.31	0.46	0.35
22	DJ-00-9006A	44.4	93	4.84	42	7.32	1.45	0.75	2.50	6.03	4.49	0.86	2.58	0.38	0.65	0.39
19	NK-00-8017A	49.6	108	8.14	43	7.22	1.80	0.76	1.71	6.12	4.40	0.83	2.21	0.29	0.36	0.27
76	NK-00-8145	41.2	91	7.69	46	9.22	2.48	1.21	4.29	8.91	8.12	1.63	4.81	0.68	0.53	0.67
80	NK-00-8144	161.5	353	18.74	155	25.09	5.51	2.16	4.49	18.23	12.12	2.14	5.68	0.76	1.82	0.67
70	NK-01-3051	37.0	73	5.98	33	5.61	1.46	0.58	1.77	4.58	3.54	0.70	1.99	0.27	0.36	0.27
20	NK-00-8025	49.8	107	13.86	50	9.52	2.71	1.28	4.10	8.89	7.88	1.59	4.68	0.66	1.70	0.64
43	NK-01-3004A	119.0	278	15.00	136	24.00	3.52	2.30	5.57	17.00	14.00	2.49	6.85	0.95	3.20	0.77
Felsic																
67	NK-01-3034	24.0	42	13.00	21	4.06	3.02	0.52	1.96	3.92	3.34	0.69	2.01	0.30	0.47	0.34
75	NK-00-8151	36.4	82	7.36	40	8.09	2.43	1.04	4.32	7.51	7.15	1.48	4.48	0.68	0.51	0.69
73	NK-00-8157	41.1	84	4.80	37	6.20	1.15	0.60	2.05	4.68	3.65	0.72	2.14	0.31	0.37	0.32
83	NK-00-8002	143.9	330	14.63	134	21.18	3.34	1.77	4.44	14.19	10.35	1.88	5.14	0.72	3.35	0.66
49	NK-00-8147	122.8	285	13.24	127	22.73	3.04	2.16	5.93	16.81	13.14	2.42	6.94	0.98	4.62	0.84
21	NK-00-8029	46.8	96	7.43	43	7.80	2.05	0.96	2.90	7.19	6.07	1.19	3.32	0.46	0.95	0.45
18	NK-00-8105B	137.7	273	8.05	78	9.55	1.43	0.46	0.76	5.43	2.17	0.35	0.95	0.13	0.43	0.12
68	NK-01-3050	38.0	67	3.33	23	3.16	0.73	0.28	0.83	2.21	1.52	0.31	0.84	0.13	0.27	0.15
64	NK-01-3049	34.0	52	1.96	14	1.45	0.70	0.12	0.54	0.91	0.73	0.14	0.45	0.07	0.19	0.09

Table 2. Continued

SITE	ELEMENT	Cr	Ni	Co	Cu	Zn	Pb	Sc	V	Rb	Sr	Ba	Nb	Zr	Y	Th
	Method	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-MS	ICP-AES	ICP-AES	ICP-MS	ICP-AES	ICP-AES	ICP-MS	ICP-MS	ICP-MS	ICP-MS
	Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Limit	10	37.5	15	15	37.5	0.005	1	10	0.003	0.5	1	0.020	0.010	0.020	0.002
Wilson Lake terrane granitoid suite: P_{WL}grn																
12	NK-00-8024	86	26	20	49	105	20.2	19	126	50	450	1961	12.8	580	23	0.32
11	NK-00-8023	97	26	20	52	102	18.5	18	125	55	390	1641	16.9	525	37	0.62
9	NK-00-8031	101	24	16	73	82	25.5	16	103	83	322	1196	14.0	450	28	17.36
3	NK-00-8044	216	41	18	39	88	27.2	10	82	75	563	1432	10.9	290	20	10.85
14	NK-00-8036	100	26	12	39	71	32.5	12	69	99	271	1154	10.5	291	15	12.15
1	NK-00-8120	131	20	11	94	67	29.6	12	65	82	292	1130	10.1	357	37	17.57
Wilson Lake terrane diatexite: P_{WL}dxt																
2	NK-00-8080	278	62	18	-	78	25.9	15	89	47	564	1171	12.9	322	19	9.84
4	NK-00-8084	134	36	16	10	75	22.8	18	76	78	316	915	11.6	288	27	33.58
5	NK-00-8066	155	29	15	-	85	32.1	11	73	107	400	1299	17.4	409	29	15.82
Wilson Lake terrane gabbro and gabbronorite: P_{WL}grb																
16	NK-00-8087	259	176	58	84	81	8.5	34	227	6	189	70	6.0	92	22	0.66
6	NK-00-8102	88	45	49	87	148	10.3	44	440	24	182	208	26.2	311	61	2.73
15	NK-00-8063	761	296	49	-	90	11.8	29	171	106	408	430	7.8	114	25	0.29

granitoid (Figure 4b). Indeed, strongly peraluminous granite are commonly assumed to be largely derived from the anatexis of sedimentary rocks (e.g., Patino Douce, 1999). Plotting in the volcanic-arc field on Rb versus Y+Nb discrimination diagrams (Pearce *et al., op. cit.*), the P_{WL} grn samples, however, are well set apart from S-type granites, which characteristically plot in the syn-collisional granite field.

The major petrochemical departures between the Andean–Cordilleran volcanic-arc granitoid suites and the P_{WL} grn granitoids suggest that the latter are not directly subduction related nor mantle derived, and that a metasedimentary precursor was involved in their petrogenesis. It is noteworthy that, as pointed out by Pearce *et al*. (1984), neither the extended trace-element patterns nor the Rb versus Nb+Y discrimination diagram allow the separation of post-collision from volcanic-arc granites. Indeed, post-collision granites commonly lie with I-type granites in the volcanic-arc granite field and, as illustrated by the post-collision granites from Oman, they could exhibit extended trace-element patterns indistinguishable from volcanic-arc granites (Figure 4c). The characteristics of post-collision granites arise from the fact that they result both from melting of the lower crust due to thermal relaxation following collision and from melting of lithospheric mantle due to adiabatic decompression that accompanies post-collision deep crustal exhumation, uplift and erosion (Harris *et al.*, 1993). The fact that Unit PWL grn contain ubiquitous metasedimentary inclusions and are intimately associated in space and time with both high-grade metasedimentary rocks and diatexites are consistent with their emplacement in a post-collision setting.

Beside the above considerations, it is noteworthy that the three analyses of gabbroic rocks from Unit PWL grb show significant variability in trace-element contents and do not define a systematic distribution pattern (Tables 1, 2 and 3). Assuming that these rocks are genetically related, the geochemical differences could be attributed to crustal contamination, as suggested by the fact that the samples display elevated Ti/Zr, Zr/Y, Nb/Y and Ce/Y ratios relative to primitive mantle, N-MORB and E-MORB, which are intermediate to values typical for continental crust (Table 4). In addition, the analysed samples plot either or both, along or outside the 10 percent probability ellipse for volcanic-arc and within-plate basalts fields on an Hf–Th–Ta discrimination diagram (Wood *et al.*, 1979; Pearce, 1996) (Figure 4d). They all plot, however, well within the broader 10 percent probability field for gabbroic rocks emplaced in attenuated continental lithosphere (Pearce, 1995). Given the distinctive geochemical signatures of P_{WL} grb gabbroic rocks, which suggests crustal involvement, and the evidence for their close association in space and time with P_{WL} grn granitoid plutonism, the data is further consistent with plutonic emplacement in a post-collision tectonic regime.

MEALY MOUNTAINS INTRUSIVE SUITE

Rock samples of the MMIS selected in this study typify the two most important lithological units that make up the MMT in the Lac Brûlé region (Figure 2). Map Unit P_{MM} gbr comprises a variety of coeval and petrogenetically related chiefly gabbroic, along with rare dioritic, rocks. In contrast, Unit P_{MM} ggn consists of more felsic and diverse gneissic and foliated granitoid rocks, mainly granite, quartz monzonite and quartz monzodiorite. Representative samples from these two units differ in major- and trace-elements composition, intimating that the two rock groups are not directly related through simple magmatic process (e.g., fractional crystallization) and differ significantly in their petrogenesis. Relative age constraints based on field and overprinting metamorphic relationships suggest, however, that the two rock groups have middle Labradorian (ca. 1650 Ma)

Table 2 suite. Continued

SITE	ELEMENT	La	Ce	Hf	Nd	Sm	Eu	Tb	Yb	Gd	Dy	Ho	Er	Tm	Ta	Lu
Method	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	
	Unit	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Limit	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.002	0.005	0.002	0.0001	0.002	0.0005	0.0005	0.0005
Wilson Lake terrane granitoid suite: P_{WL}grn																
12	NK-00-8024	40.4	83	10.70	38	6.56	2.62	0.70	1.79	5.88	4.14	0.79	2.13	0.28	0.37	0.29
11	NK-00-8023	41.1	86	9.83	46	7.88	2.25	0.85	3.46	6.73	5.21	1.10	4.16	0.63	0.77	0.51
9	NK-00-8031	71.9	158	8.57	60	9.32	1.84	0.86	1.98	7.32	4.80	0.92	2.44	0.33	0.48	0.32
3	NK-00-8044	49.9	108	5.76	41	6.60	1.57	0.62	1.60	5.02	3.57	0.67	1.83	0.26	0.51	0.27
14	NK-00-8036	49.1	98	5.83	40	5.97	1.79	0.47	1.62	4.29	2.55	0.47	1.41	0.23	0.48	0.28
1	NK-00-8120	60.1	125	8.19	53	9.21	1.63	0.98	3.08	8.12	5.97	1.17	3.49	0.49	0.28	0.48
Wilson Lake terrane diatexite: P_{WL}dxt																
2	NK-00-8080	44.1	89	6.27	37	6.27	1.35	0.61	1.50	4.85	3.54	0.66	1.78	0.24	0.64	0.24
4	NK-00-8084	78.6	186	5.75	73	11.96	1.93	1.06	1.81	8.92	5.68	0.97	2.42	0.30	0.39	0.29
5	NK-00-8066	57.2	119	7.87	50	8.49	1.60	0.87	1.87	6.74	5.04	0.95	2.48	0.32	0.83	0.29
Wilson Lake terrane gabbro and gabbronorite: P_{WL}grb																
16	NK-00-8087	5.6	14	2.08	10	2.89	1.14	0.57	2.06	3.65	3.89	0.79	2.31	0.32	0.32	0.31
6	NK-00-8102	20.4	51	7.20	32	8.63	2.56	1.58	5.29	10.33	10.50	2.09	6.10	0.86	1.39	0.81
15	NK-00-8063	18.4	44	2.32	24	4.98	1.34	0.70	2.25	4.62	4.26	0.85	2.49	0.36	0.30	0.35

emplacement ages, as determined by U–Pb zircon dating of monzodioritic orthogneiss bodies from Site 22 (Figure 2) (James *et al.*, *this volume*) and from the Lake Minipi region (James *et al.*, 2000).

MMIS – Gabbroic Unit (P_{MM} gbr)

Rocks mapped as Unit P_{MM} gbr comprise two major intrusive bodies consisting of locally massive, but generally variably deformed and metamorphosed, biotite gabbro, gabbro, gabbronorite locally displaying metre-scale layering including subordinate ultramafic facies, and rare diorite. Rocks of this unit extend easterly throughout much of the Minipi Lake region (NTS map 13D) displaying the same field, mesoscopic and geochemical characteristics (*see* Nadeau and James, 2001). Mesoscopic examination of (Unit P_{MM} gbr) gabbroic to dioritic samples indicates that they are essentially composed of plagioclase, clinopyroxene, orthopyroxene, accessory hornblende and biotite, and up to a few percent sulphides and Fe–Ti oxides. Olivine is rare and has been recognized only sporadically in the field. Dioritic and monzodioritic samples are distinguished by ubiquitous K-feldspar and by greater abundances of biotite and hornblende, locally porphyritic, at the expense of pyroxenes.

Analyzed gabbroic to dioritic samples of Unit P_{MM} gbr (Tables 1 and 2) have SiO_2 contents ranging from 41.00 to 56.60 wt.%. Three subgroups are distinguished in Figures 5, 6 and 7; ultramafic (SiO_2<46 wt.%), mafic (46 to 52 wt.% SiO_2), and intermediate (SiO_2>52 wt.%). The mafic and ultramafic subgroups have mean CaO of 10.41 wt.% (7.58 to 16.5 wt.%), Na_2O of 2.27 wt.% (0.48 to 3.84 wt.%), K_2O of 0.67 wt.% (0.08 to 1.92 wt.%), MgO of 9.65 wt.% (3.51 to 23.90 wt.%), and total iron expressed as Fe_2O_3 of 13.79 wt.% (9.05 to 15.8 wt.%). The four monzodioritic samples of the intermediate subgroup are very similar in composition. They have SiO_2 ranging from 54.00 to 56.60 wt.% (mean=54.88), and are set apart from the mafic subgroup by their higher mean K_2O at 2.97 wt.%, Na_2O at 4.13 wt.%, and lower mean CaO of 6.73 wt.%, MgO of 3.72 wt.%, and total iron as Fe_2O_3 of 7.24 wt.%. The mafic and ultramafic samples are also markedly enriched in Al_2O_3 (mean=14.65 wt.%) and deficient in TiO_2 (1.22 wt.%) compared to mantle plume related gabbroic plutonism, e.g., the Mackenzie dyke swarm (Al_2O_3 =13.86 wt.%; TiO_2= 2.47 wt.%), to the Columbia River basalts (Al_2O_3=14.34 wt.%; TiO_2= 2.33 wt.%), and to ocean-island basalts (Al_2O_3=12.80 wt.%; TiO_2=2.57 wt.%). This is consistent with crystal fractionation and accumulation.

All the analyzed Unit P_{MM} gbr gabbroic to dioritic samples are silica-saturated (olivine and hypersthene in the norm) or silica-undersaturated (olivine and nepheline in the norm) (Table 3). They can be described as transitional to alkaline because they straddle the alkaline–subalkaline dividing line on (Na_2O + K_2O) vs SiO_2 diagram (Figure 5a). On an AFM diagram (Figure 7a), they straddle the tholeiitic–calc-alkaline divide of Irvine and Baragar (1971). The abundance of normative olivine contrasts with its scarcity in the field. This results essentially from the anhydrous nature of the norm. The abundance of primary hornblende and biotite, which are common accessory minerals in these rocks, was likely essentially controlled by the availability of deuteric water during crystallization.

That Unit P_{MM} gbr gabbroic to dioritic samples are essentially mixtures of plagioclase, pyroxenes and olivine is well illustrated in the ACF and normative plagioclase–pyroxenes–olivine diagrams (Figures 5b, d). Normative plagioclase content of the ultramafic, mafic and intermediate

Table 3. *Table of the CIPW norm of intrusive rock samples from the Lac Brûlé region*

SITE	Normative mineral / LITHOLOGY	Q	C	or	ab	an	ne	Di	Di (wo)	Di (en)	Di (fs)	Hy	Hy (en)	Hy (fs)	Ol	Ol (fo)	Ol (fa)	mt	il	ap
Late- to post-Grenvillian granitoïd: M_{LG}grn and M_{LG}sye																				
62	porphy epi-neph? sye	2.5	-	38.0	38.1	8.4	-	1.5	0.8	0.3	0.4	6.7	2.8	3.9	-	-	-	1.4	2.4	1.0
41	porphy hb mon/sye	10.8	-	33.4	31.6	8.3	-	3.0	1.5	0.6	0.9	7.8	3.0	4.8	-	-	-	1.6	2.4	1.3
85	monzonite	4.8	-	42.3	40.2	4.4	-	0.8	0.4	0.2	0.2	4.5	1.9	2.6	-	-	-	1.0	1.8	0.3
47	biotite granite	15.8	0.4	29.4	30.6	9.3	-	-	-	-	-	9.1	3.7	5.4	-	-	-	1.6	2.2	1.5
48	bio-hb monzonite	16.4	-	31.9	31.7	9.8	-	1.4	0.7	0.2	0.4	5.4	2.0	3.4	-	-	-	1.1	1.5	0.9
50	hbl-bio granite	17.5	-	32.4	29.4	9.0	-	0.2	0.1	0.0	0.1	7.8	3.2	4.6	-	-	-	1.3	1.7	0.9
42	porphy mon+modio ogn	20.0	-	24.8	32.7	9.6	-	2.2	1.1	0.4	0.7	7.6	2.8	4.8	-	-	-	1.3	1.4	0.5
79	bio-qtz syenite	20.5	-	32.7	29.6	7.1	-	0.6	0.3	0.1	0.2	6.1	2.2	3.9	-	-	-	1.1	1.5	0.7
45	bio-granite	2.6	0.8	30.0	28.9	7.6	-	-	-	-	-	7.5	2.7	4.7	-	-	-	1.2	1.5	1.0
23	bio granite	23.1	1.1	35.2	25.0	5.7	-	-	-	-	-	6.5	2.7	3.8	-	-	-	1.1	1.5	0.7
46	aplitic granite	22.8	0.8	36.2	27.3	4.9	-	-	-	-	-	5.7	1.9	3.8	-	-	-	0.9	1.0	0.4
17	bio granite	25.3	0.9	32.5	28.4	6.2	-	-	-	-	-	4.5	1.6	2.9	-	-	-	0.7	0.8	0.5
44	bio granite	26.9	1.7	37.6	25.1	3.3	-	-	-	-	-	4.2	2.0	2.1	-	-	-	0.5	0.5	0.2
24	bio granite	29.6	1.3	33.7	27.1	3.4	-	-	-	-	-	3.8	1.7	2.1	-	-	-	0.5	0.5	0.2
84	granite	30.4	0.1	33.4	29.4	3.2	-	-	-	-	-	2.4	0.7	1.7	-	-	-	0.4	0.4	0.1
Mealy Mountains intrusive suite: Gabbroic group, P_{MM}grb																				
Ultramafic rocks																				
38	layered gab/ultramaf	-	-	2.0	3.2	42.6	6.7	22.7	11.5	5.7	5.5	-	-	-	16.8	8.2	8.7	3.5	2.5	0.0
38	layered gab/ultramaf	-	-	0.5	4.2	17.5	-	20.7	10.8	7.6	2.3	7.9	6.0	1.9	45.6	34.0	11.6	3.3	0.3	0.0
56	mela-gabbronorite	-	-	0.5	3.0	31.2	1.8	28.8	14.8	9.3	4.6	-	-	-	30.1	19.4	10.7	3.4	1.2	0.1
30	porphy meta-cpxenite	-	-	1.1	7.1	25.0	-	23.8	12.4	8.5	2.9	0.9	0.7	0.2	38.4	27.9	10.6	3.0	0.6	0.1
61	hb mela-gabbro	-	-	3.5	8.7	28.5	2.5	24.3	12.4	7.1	4.7	-	-	-	26.9	15.6	11.4	3.7	1.5	0.4
40	oli?-hb mela-gab	-	-	6.5	30.4	24.1	0.1	8.4	4.2	2.0	2.2	-	-	-	19.0	8.6	10.4	4.2	5.4	1.9
37	layered gabbro	-	-	1.5	3.0	33.2	4.2	39.8	20.4	11.7	7.7	-	-	-	13.3	7.7	5.6	3.1	1.9	0.1
57	porphy bio mela-gabbro	-	-	4.7	29.4	26.1	-	8.3	4.2	2.1	1.9	0.1	0.0	0.0	20.1	10.1	10.0	4.1	5.4	1.8
Mafic rocks																				
59	frsh gabbronorite	-	-	3.5	20.7	31.4	-	16.2	8.2	4.5	3.5	5.0	2.8	2.2	16.6	8.9	7.7	3.4	2.9	0.3
52	fresh massive gabbro	-	-	2.8	23.4	30.7	-	13.7	7.0	3.7	3.0	2.9	1.6	1.3	18.6	9.8	8.8	3.7	3.7	0.5
35	frsh fg bio-gabbro	-	-	6.8	22.8	26.8	-	8.9	4.5	2.1	2.3	9.5	4.6	4.9	16.4	7.5	8.9	4.2	3.8	0.8
31	cpx-hb-bio meta-gabbro	-	-	3.7	14.5	18.0	-	28.4	14.7	9.1	4.7	3.9	2.6	1.3	26.4	16.9	9.5	3.4	1.3	0.3
81	mela-gabbro	-	-	4.8	26.1	29.7	-	9.1	4.6	2.5	2.0	5.9	3.2	2.6	16.7	8.8	7.9	3.6	3.7	0.6
27	px-hb-bio dioritic ogn	-	-	12.0	29.9	27.5	1.4	7.9	4.0	1.8	2.1	-	-	-	14.9	6.5	8.4	2.7	1.8	1.8
32	frsh gabbronorite	-	-	5.0	23.0	29.4	-	11.3	5.7	3.1	2.5	12.6	7.0	5.6	11.1	5.9	5.2	3.5	3.6	0.5
36	cpx? meta dio-gab	-	-	4.2	29.5	41.1	0.8	6.2	3.1	1.4	1.7	-	-	-	12.7	5.3	7.4	2.3	1.4	1.8
51	frsh gabbronorite	-	-	3.8	26.3	25.8	-	19.3	9.8	5.4	4.1	4.0	2.3	1.8	14.4	7.8	6.6	2.9	1.8	1.6
26	metagabbro	-	-	3.7	29.5	41.7	1.0	8.5	4.3	2.2	2.0	-	-	-	10.9	5.5	5.4	1.8	0.9	2.1
34	bio-meta-gabbronorite	-	-	7.2	15.1	16.5	-	24.9	12.8	7.6	4.6	16.2	10.1	6.1	14.3	8.6	5.7	3.5	1.8	0.5
59	frsh gabbronorite	-	-	3.1	19.9	24.0	-	23.4	11.9	6.6	4.9	17.8	10.2	7.6	5.3	2.9	2.4	3.4	2.8	0.3
28	bio meta-gabbro	-	-	9.7	30.3	33.3	1.7	7.1	3.6	1.8	1.8	-	-	-	11.9	5.6	6.3	2.3	2.1	1.7
29	cpx-hb-bio monzodiorite	-	-	9.2	25.8	20.7	-	17.9	9.2	5.3	3.4	13.9	8.5	5.4	7.9	4.6	3.3	2.6	1.3	0.7
Intermediate rocks																				
63	frsh bio-gabbro	-	-	19.5	36.1	23.2	-	5.5	2.8	1.4	1.3	8.7	4.4	4.3	2.5	1.2	1.3	1.6	1.3	1.5
58	ol? gabbronorite	-	-	14.3	32.8	23.0	-	10.1	5.2	2.8	2.2	13.4	7.4	5.9	2.1	1.1	1.0	1.9	1.3	1.1
39	monzogabbro ogn	-	-	14.4	33.5	21.8	-	10.2	5.2	2.9	2.1	14.8	8.6	6.2	1.3	0.7	0.6	1.8	1.2	1.0
33	px? qtz-mon ogn	-	-	23.6	39.8	17.1	-	5.4	2.7	1.2	1.5	7.0	3.2	3.8	2.6	1.1	1.5	1.7	1.6	1.2
Mealy Mountains terrane orthogneiss suite: Granitoide orthogneiss suite: P_{MM}ggn																				
Intermediate rocks																				
81	dioritic ogn	-	-	9.4	38.0	23.5	0.0	11.5	5.9	3.2	2.5	-	-	-	-	7.0	6.1	2.1	1.3	1.0
22	granodiorite gneiss	5.7	-	24.5	32.0	16.2	-	4.8	2.4	1.2	1.2	13.2	6.5	6.6	-	-	-	1.7	1.3	0.8
19	bio-granite	18.5	0.9	24.6	23.9	15.3	-	-	-	-	-	12.7	5.5	7.2	-	-	-	1.7	1.8	0.6
76	bio-hbl granodioritic ogn	18.5	-	22.1	32.2	10.9	-	2.3	1.2	0.4	0.8	9.7	3.5	6.1	-	-	-	1.7	1.9	0.8
80	bio granitic ogn	14.3	-	32.2	29.4	8.5	-	1.7	0.9	0.3	0.5	9.0	3.4	5.5	-	-	-	1.6	2.2	1.1
70	strky bio-hb granitic ogn	18.3	-	18.3	34.8	16.0	-	0.6	0.3	0.1	0.2	9.0	4.0	5.0	-	-	-	1.2	1.1	0.6
20	hbl-qtz monz/gra ogn	19.1	-	26.5	30.6	10.5	-	1.9	0.9	0.3	0.7	7.6	2.2	5.4	-	-	-	1.5	1.7	0.7
43	dio ogn+porph mon-sye	15.2	-	36.3	34.6	6.0	-	1.0	0.5	0.2	0.3	4.3	1.5	2.8	-	-	-	0.9	1.4	0.4
Felsic rocks																				
67	augen bio granitic ogn	17.8	-	34.8	32.0	5.6	-	2.0	1.0	0.2	0.8	5.0	1.2	3.8	-	-	-	1.1	1.3	0.3
75	granodioritic ogn	21.1	-	23.0	33.4	9.3	-	1.9	0.9	0.3	0.6	7.6	2.7	4.9	-	-	-	1.4	1.6	0.7
73	hbl-bio granodioritic ogn	18.4	-	25.8	35.5	10.9	-	0.8	0.4	0.2	0.2	6.6	2.7	3.9	-	-	-	0.9	0.8	0.3
83	bio-granitic ogn	20.0	-	33.3	28.9	8.0	-	0.7	0.4	0.1	0.2	5.8	2.1	3.7	-	-	-	1.1	1.5	0.7
49	bio-granitic ogn	19.1	-	36.0	29.5	6.7	-	0.9	0.5	0.2	0.3	4.9	1.9	3.1	-	-	-	1.0	1.4	0.4
21	bio-granitic ogn	28.4	1.5	24.8	22.3	11.4	-	-	-	-	-	8.2	3.4	4.8	-	-	-	1.3	1.7	0.4
18	bio-granodioritic gne	23.9	0.8	36.5	27.0	6.0	-	-	-	-	-	4.1	1.6	2.5	-	-	-	0.6	0.8	0.3
68	porphy bio-granitic ogn	24.9	-	20.1	38.5	11.0	-	0.0	0.0	-	-	4.2	1.6	2.6	-	-	-	0.6	0.5	0.2
64	bio aplitic granite	25.7	0.3	24.0	38.4	8.9	-	-	-	-	-	2.1	0.8	1.4	-	-	-	0.3	0.2	0.1

Table 3. Continued

SITE	Normative mineral / LITHOLOGY	Q	C	or	ab	an	ne	Di	Di (wo)	Di (en)	Di (fs)	Hy	Hy (en)	Hy (fs)	Ol	Ol (fo)	Ol (fa)	mt	il	ap
Wilson Lake terrane granitoid suite, P_{WL}grn																				
12	porphy pyx-hbl monzo	6.2	0.6	17.6	30.3	22.9	-	-	-	-	-	16.7	7.2	9.5	-	-	-	2.3	2.5	0.9
11	porphy hbl-bio monzo	9.9	1.0	18.8	28.8	19.7	-	-	-	-	-	16.2	6.9	9.3	-	-	-	2.3	2.5	1.0
9	K-feld augen granite	17.0	0.8	20.1	27.9	17.2	-	-	-	-	-	13.1	5.5	7.6	-	-	-	1.8	1.7	0.4
3	granite/qtz monzo	21.6	3.9	20.3	26.6	11.4	-	-	-	-	-	13.2	5.9	7.4	-	-	-	1.6	1.2	0.2
14	K-feld augen gra ogn	24.5	1.4	25.8	24.7	11.8	-	-	-	-	-	9.0	3.7	5.3	-	-	-	1.3	1.3	0.2
1	porphy bio-granite	26.4	1.8	22.1	25.5	11.8	-	-	-	-	-	9.7	4.2	5.5	-	-	-	1.3	1.2	0.2
Wilson Lake terrane diatexite P_{WL}dxt																				
2	s-type qtz monzo/grn	18.8	4.7	14.8	28.4	12.7	-	-	-	-	-	17.2	8.5	8.6	-	-	-	1.9	1.5	0.2
4	s-type granite	22.7	1.3	16.2	26.5	18.0	-	-	-	-	-	12.4	6.0	6.4	-	-	-	1.4	1.3	0.1
5	bio-sil granite	24.5	7.3	22.5	22.9	7.1	-	-	-	-	-	12.5	5.3	7.2	-	-	-	1.6	1.4	0.2
Wilson Lake terrane gabbro and gabbronorite P_{WL}grb																				
16	gabbro	-	-	1.6	18.7	34.3	-	15.6	8.0	4.7	3.0	11.1	6.8	4.3	12.6	7.5	5.2	3.1	2.6	0.2
6	amphibolite/meta gbr	0.3	-	5.7	21.8	18.8	-	21.1	10.6	4.6	6.0	19.2	8.3	10.9	-	-	-	5.0	7.4	0.8
15	meta gabbro	-	-	8.2	17.9	25.9	-	10.2	5.3	3.5	1.5	26.4	18.6	7.8	6.8	4.7	2.2	2.5	1.6	0.5

subgroups averages 40%, 46%, and 57% respectively. Orthose contents of intermediate samples average 18%, in contrast to the 5.7% and 2.5% means for the mafic and ultramafic subgroups respectively. Mean anorthite content in plagioclase decreases from ~An_{54} in mafic samples to ~An_{38} in intermediate samples. Except for 3 samples with normative plagioclase < An_{50}, the rocks of the mafic subgroups can be described as olivine-gabbronorite. Giving their high normative Or and K_2O contents, intermediate samples are best described as olivine-monzodiorite. The trend of decreasing normative anorthite in plagioclase is reflected in the ACF and Na_2O–CaO–(FeOT +MgO) diagrams (Figures 5b, c), which also illustrate the compositional variability and the continuous nature of the suite.

The principal features of the trace-element patterns for the three subgroups are shown in N-MORB normalized extended elemental plots (Figure 6). It is emphasized that the elemental abundances and distribution patterns are indistinguishable from those presented for the MMIS gabbroic rocks of the Minipi Lake region (*see* Nadeau and James, 2000). The patterns of the three subgroups are remarkably similar, largely overlapping each others. The patterns show a marked enrichment in high-field-strength-elements (HFSE) relative to N-MORB, and a fairly flat heavy-REE distribution somewhat below the normalizing values. As expected, the samples of the intermediate subgroup are depleted in transition metals relative to the more mafic rock, and the rare-earth-element mean concentrations increase from the ultramafic toward the more felsic subgroups (Figure 6d). Along with the field relationships, the close similarities displayed in the trace-element patterns provide strong support to the hypothesis that these rocks are genetically related. Accordingly, the cross-over in the heavy-REE abundances between the mafic and intermediate subgroups can be attributed to hornblende fractionation. The most notable features of the patterns are given by the well-defined negative Th, Nb, Zr, and Hf anomalies, which are coupled with a positive Sr spike. Ti also defines a small negative anomaly (relative to Eu and Gd) that is more pronounced in the intermediate samples. The absence of Eu anomaly (relative to Sm and Gd) is also notable. Such patterns emphasize the importance that fractional crystallization could have played in the petrogenesis of the suite. Given the compatibility of Sr in plagioclase, the latter, cotectically crystallizing with olivine and (or) pyroxenes, maintains nearly constant Sr in magma as elements highly incompatible in plagioclase, olivine, and pyroxenes gradually increase concentration in residual melt.

MMIS – Granitoid Orthogneiss Suite (P_{MM} ggn)

Granitoid rocks of Unit P_{MM} ggn comprise an assortment of locally massive with preserved igneous textures, commonly foliated and gneissic amphibolite-facies orthogneisses, mainly derived from biotite ± hornblende ± clinopyroxene granite, granodiorite, quartz–monzonite, quartz monzodiorite, and rare diorite. Accordingly, the representative rock samples selected for analysis tend to plot near the common boundary between these rock types on the Streckeisen (1976) classification diagram. The unit consists of distinct intrusions of variable sizes which appear to be relatively uniform in composition. Although lithologically composite, it is emphasized that all major plutonic rock bodies comprised in Unit P_{MM} ggn appear to be closely related in age (middle Labradorian) as evidenced from their field association and from regional metamorphic overprinting relationships. These rocks generally contain from 5 to 15 percent ferromagnesian minerals.

Except for one dioritic sample likely affiliated with Unit PMM gbr, the 16 remaining samples have SiO_2 contents from between 58.98 and 70.40 wt.% (mean= 66.04 wt.%), K_2O between 3.03 and 6.04 wt.% (mean = 3.45 wt.%), CaO between 1.33 and 4.78 wt.% (mean = 2.55 wt.%), Na_2O between 2.63 and 4.43 wt.% (mean = 3.64 wt.%), MgO between 0.03 and 3.02 wt.% (mean = 1.19 wt.%), and total Fe as tFe_2O_3 between 1.17 and 6.85 wt.% (mean = 4.53wt.%). Contents in TiO_2, tFe_2O_3, MgO, CaO, MnO, and P_2O_5 show a negative correlation with SiO_2 that is compensated by less systematic increases in Al_2O_3, K_2O and Na_2O contents. Felsic (SiO_2 > 66 wt.%) are distinguished

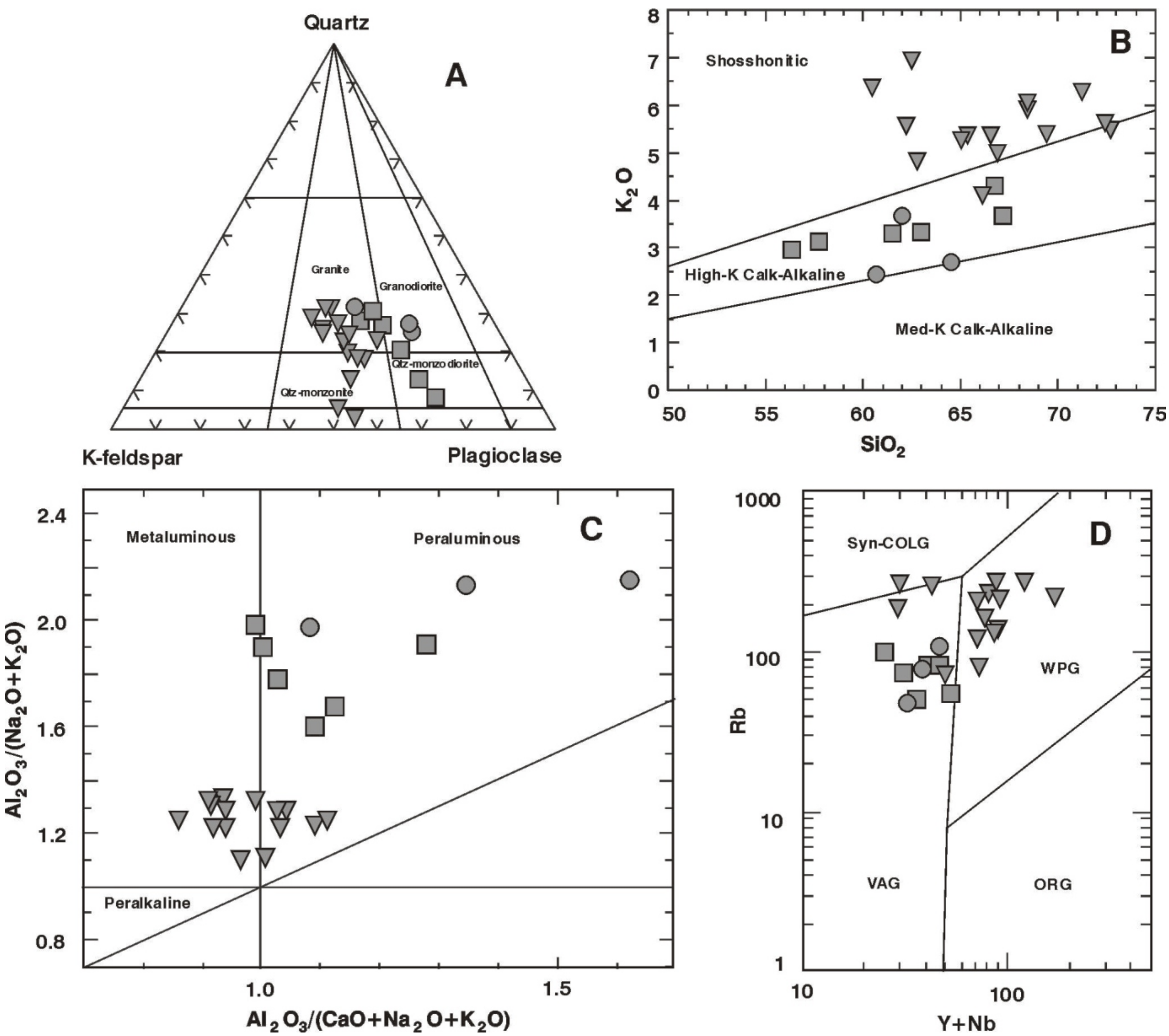

Figure 3. *Selected normative, major- and trace-element composition diagrams of granitoid samples from the WLT granitoid map units, and from the late- to post-Grenvillian intrusions. Legend: square - P_{WL} grn; circle - P_{WL} dxt; triangle - M_{LG} grn and M_{LG} sye. (A) Ternary plot of normative quartz, K-feldspar, and plagioclase; rock name and subdivisions after Streckeisen (1976). (B) Plot of K_2O vs SiO_2 with the limits of the shoshonitic, high-K calc-alkaline and med-K calc-alkaline fields. (C) Alumina saturation diagram with the limits of the metaluminous, peraluminous and paralkaline fields. The Al_2O_3 / (Na_2O+K_2O) and AL_2O_3 / (CaO+Na_2O+K_2O) ratios are calculated from molar values. (D) Rb vs (Y+Nb) tectonic discrimination diagram of Pearce* et al., (op. cit.). *WPG - within-plate granite; ORG - ocean-ridge granite; VAG - volcanic-arc granite; Syn-COLG - syn-collision granite.*

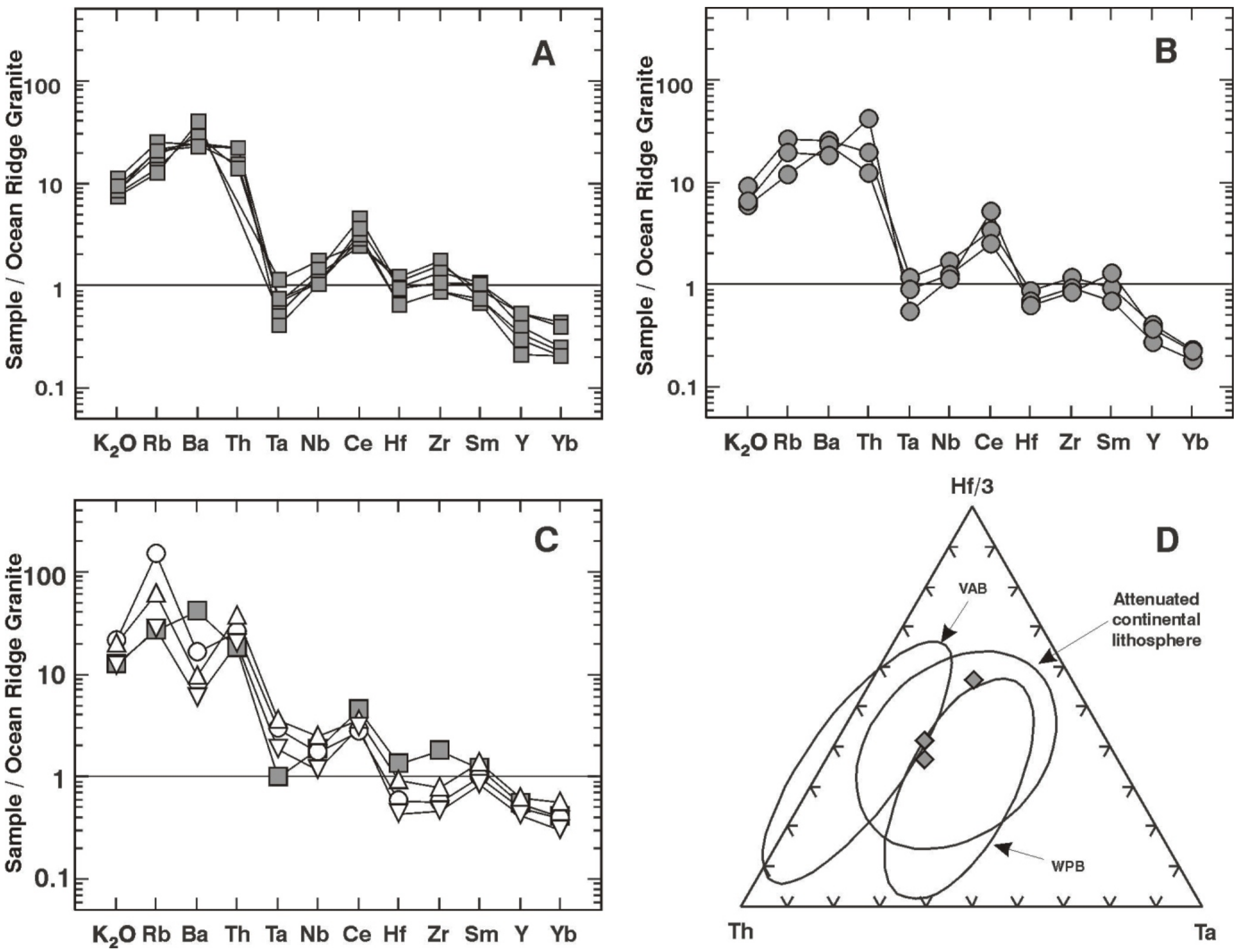

Figure 4. *Comparative ocean-ridge granite normalized incompatible trace-element patterns of granitoid and diatexite samples of WLT, and Hf-Th-Ta ternary plot of associated gabbroic samples. (A) Granitoid samples of Unit P_{WL} grn. (B) Diatexite samples of Unit P_{WL} dxt. (C) Average composition of Unit PWL grn granitoid samples - shaded square, compared to post-collision granitoids of Bolivia - circle and Oman - inverted triangle, and to volcanic-arc granitoids of Chile - upright triangle (after Pearce* et al., *1984). (D) Hf-Th-Ta tectonic discrimination diagram (Wood* et al., *1979) for gabbroic samples of Unit P_{WL} gbr. The diagram emphasizes the fact the WLT gabbroic samples plot near or outside the 10 percent probability ellipses for volcanic-arc (VAB) and within-plate (WPB) basalts, well within the field of basalts emplaced in attenuated continental lithosphere (Pearce, 1996).*

from intermediate samples in Figures 5a and 7 for comparative purpose. The samples define a trend below the calc-alkaline-tholeiitic divide of Irvine and Baragar (1971) on AFM plots (Figure 7a). They are subalkaline (Figure 5a), with Al_2O_3 / (Na_2O+K_2O) <1.75 (Figure 7b). They define a cluster centered in the metaluminous field and spreading over the devide to the peraluminous field on aluminum saturation diagram (Figure 7b). Along with these compositional hallmarks, 11 and 3 of the samples contain respectively diopside and corundum in the norm.

It is significant that as a group, the samples are not clustered, and define a far-reaching trend across the within-plate to volcanic-arc granite fields on Rb versus Y+Nb discrimination diagram of Pearce *et al.* (1984) (Figure 7c). It is also noteworthy that at any given Y+Nb content, felsic samples tend to be enriched in Rb compared to intermediate samples, hence suggesting that the two groups are genetically related. In addition, the extended trace-element spectrum (not plotted) for the rocks of this unit does not fit any simple pattern, beside the fact that their patterns do not closely fit those

Table 4. *Trace-element ratios indicative of continent-crust contribution in PWL gbr gabbroic samples. Data for Primitive Mantle, N-MORB, and E-MORB from Sun and McDonough (1989), and for BCC - bulk continental crust, UCC - upper continental crust, and LCC - lower continental crust from Taylor and McLennan (1985)*

	Ti/Zr	Zr/Y	Nb/Y	Ce/Y
Site 16	86	4.2	0.28	0.64
Site 6	73	5.1	0.43	0.84
Site 15	43	4.6	0.31	1.76
Primitive mantle	116	2.5	0.16	0.39
N-MORB	110	2.6	0.08	0.27
E-MORB	139	3.3	0.38	0.68
BCC	54	5.0	0.55	1.65
UCC	16	8.6	1.14	2.90
LCC	86	3.7	0.31	1.21

identified by Pearce *et al.* (*op. cit.*) for volcanic-arc and within-plate granite. Given that these rocks appears to be closely related in time, magma generation, differentiation and final emplacement has likely involved complex crustal and mantle interactions. The present data does not allow further petrogenetic interpretations. It is noted however that such instances commonly occur in complex settings, e.g., region of attenuated continental lithosphere and collision zones, and that transitional within-plate to volvanic-arc characteristics are most common in collision zones. The alternative possibility that these rocks pertain to more than one plutonic suite cannot be ruled out.

LATE- TO POST-GRENVILLIAN GRANITOID SUITE

Late- to post-Grenvillian age intrusions of biotite granite, K-feldspar porphyritic granite and quartz monzonite defined as Unit M_{LG} grn, and clinopyroxene-bearing syenite defined as Unit M_{LG} sye, have SiO_2 content between 60.50 and 72.71 wt.% (mean=66.72 wt.%) (Table 1), and Al_2O_3 ranges from 12.80 to 17.30 wt.% (mean=14.70 wt.%). They have mean MgO of 0.96 wt.% (0.28 to 1.44 wt.%), MnO of 0.77 wt.% (0.03 to 0.12 wt.%), and total iron expressed as tFe_2O_3 of 3.97 wt.% (1.58 - 6.14 wt.%.). K_2O contents are high varying from 4.10 to 6.94 wt.% (mean=5.57 wt.%), with means CaO of 1.83 wt.% (0.67 to 3.03 wt.%) and Na_2O of 3.52 wt.% (2.93 to 4.46 wt.%).

These plutonic rocks are calc-alkaline according to the AFM criterion and subalkaline according to the normative nepheline–olivine–quartz criterion of Irvine and Baragar (1971). The samples plot above the boundary between high-K calc-alkaline and shoshonitic series in K_2O–SiO_2 space (Figure 3b), and straddle the boundary between the metaluminous and peraluminous fields on aluminum saturation diagram (Figure 3c). The enrichment in potassium of the rocks may be attributed to the porphyritic texture, which is indicative of K-feldspar fractionation. Therefore, the shoshonitic signature of the rocks is unlikely to reflect directly the K_2O and major-element contents of the parent magma. In accordance with their geochemical signature, the samples plot predominantly in the field of granite (*s.s.*) and define an array that extends to the quartz monzonite and monzonite fields on a quartz–plagioclase–K-feldspar ternary classification diagram (Figure 3a). Of the 15 samples analyzed, 8 are corundum normative (up to 1.66%) whereas 7 contain normative 2 diopside (up to 95%). Normative orthopyroxene ranges from 2.18 to 9.12% (mean=5.83%), with mean magnetite+ilmenite content of 2.45% generally increasing up to 3.97% in monzonitic samples. These rocks have modal biotite ± hornblende as dominant ferromagnesian minerals.

On the Rb vs Nb+Y granite discrimination diagram (Figure 3d) of Pearce *et al*. (1984), most samples cluster in the within-plate granite field, with three samples in the adjacent volcanic-arc and one in the syn-collision granite fields. Among them, three data points correspond to the most silica enriched (SiO_2 > 69.42 wt.%) and one to the most silica-depleted (SiO_2 = 60.50 wt.%) samples. Ocean-ridge granite normalized extended trace-element patterns for the late- to post-Grenvillian granitoid samples are displayed in Figure 8a. In addition, the pattern derived from averaging the trace-element abundances for the group of samples is reported in Figure 8b, together with the reference patterns from Pearce *et al.* (*op. cit.*) for continental margin volcanic-arc granite (Chile), and within-plate granite (Sabaloka) emplaced in continental crust of normal thickness. The late- to post-Grenvillian granite patterns and the reference lines reported for the volcanic-arc and within-plate granite types are characterized by a general decrease in normalized abundance from Rb to Yb, and by marked enrichments in K, Rb, Ba, Th, Ce and Sm relative to Ta, Nb, Hf, Zr, Y and Yb. According to Pearce *et al*. (*op. cit.*) such selective enrichments can be attributed to crustal involvement, and the resulting distribution pattern could be described as crust-dominated. Late- to post-Grenvillian granite patterns differ from the reported reference lines essentially in having no large negative Ba anomaly. As pointed out by Pearce *et al*. (*op. cit.*), the Ba negative spikes may not be apparent, however, in rocks of intermediate compositions. In addition, the Ba abundance is similar to within-plate granite emplaced in attenuated continental lithosphere (e.g., Mull and Skaergaard) reported by Pearce *et al.* (*op. cit*.). The elevated Ba abundances can be attributed to the combined effects of Ba substitution in K-feldspar and to K-feldspar accumulation as suggested by the porphyritic texture.

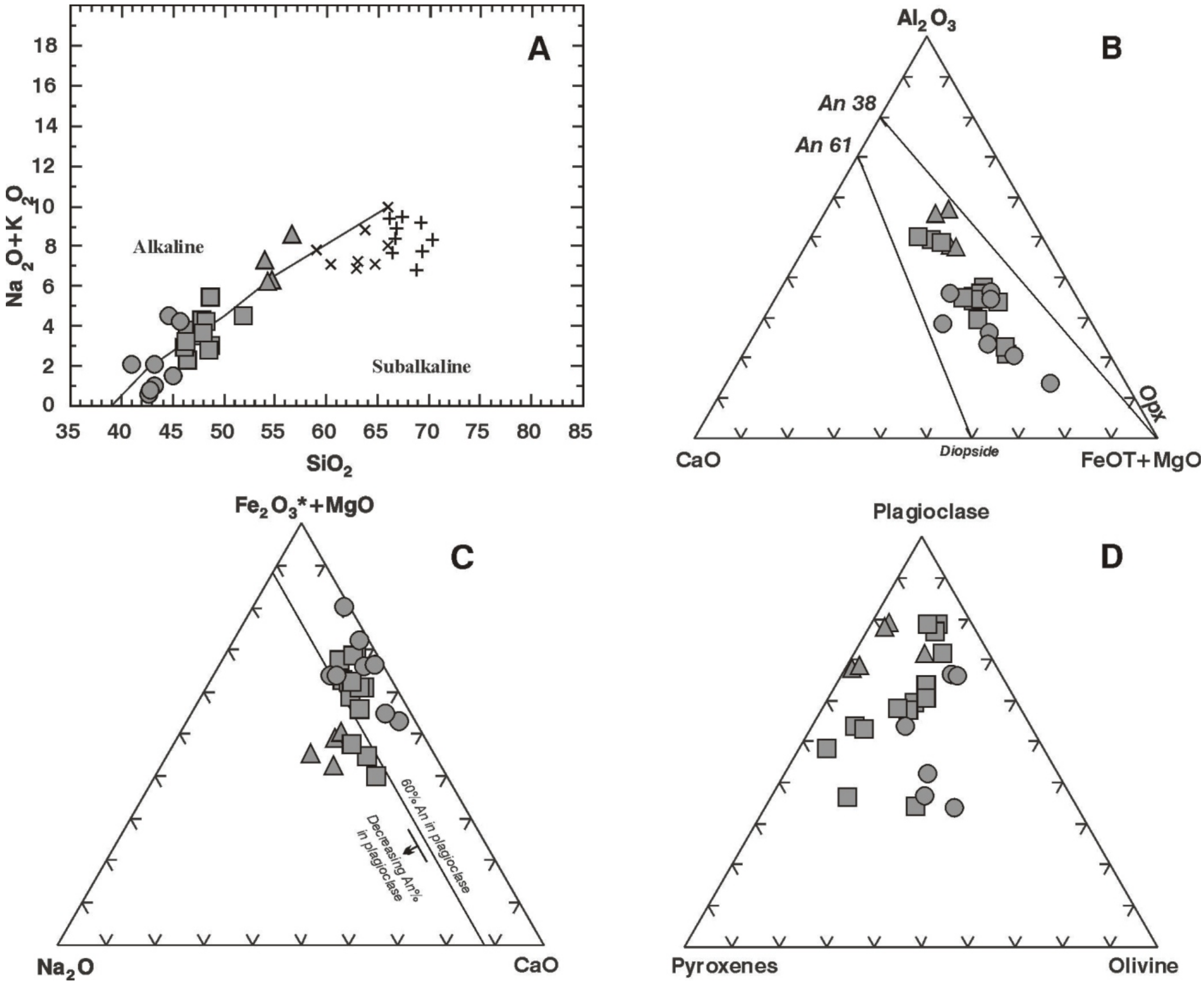

Figure 5. *Major-element and normative composition diagrams of the MMIS samples. Legend: circle - Unit P_{MM} gbr ultramafic rock (SiO_2<46 wt.%); square - Unit P_{MM} gbr mafic rock (46-52 wt.% SiO_2); triangle - Unit P_{MM} gbr intermediate rock (SiO_2>52 wt.%); diagonal cross - Unit P_{MM} ggn intermediate rock (58-66 wt.% SiO_2); upright cross - Unit P_{MM} ggn felsic rock (SiO_2>66 wt.%). (A) Plot of total alkali vs. silica showing the alkaline-subalkaline boundary of Irvine and Baragar (1971). (B) ACF diagram. (C) FNC diagram. (D) Ternary plot of normative plagioclase, pyroxenes (diopside+hypersthene), and olivine.*

Continental within-plate granites are generally affiliated with extensional tectonic regimes. They are commonly related to rifting, driven by mantle plume or convection, where they are accompanied by coeval gabbroic magmatism in bimodal association. It is noteworthy however that there is no significant mafic magmatism coeval with late- to post-Grenvillian granitoid plutonism. At least two tentative and somewhat contrasting petrogenetic models can be proposed: 1) the generation of granitic magma may have been triggered by decompression melting enhanced by heat transfer from the mantle, both consequences of thinning of over-thickened Grenvillian collisional crust, and 2) given the high-K calc-alkaline to shoshonitic signature of the group and the close similarities in the trace-element spectrum with some Andean–Cordilleran type granites, the late- to post-Grenvillian intrusions may represent a far-field intracratonic plutonic manifestation related to the establishment of a flat subduction regime that was established on the Laurentian margin following Grenvillian collision.

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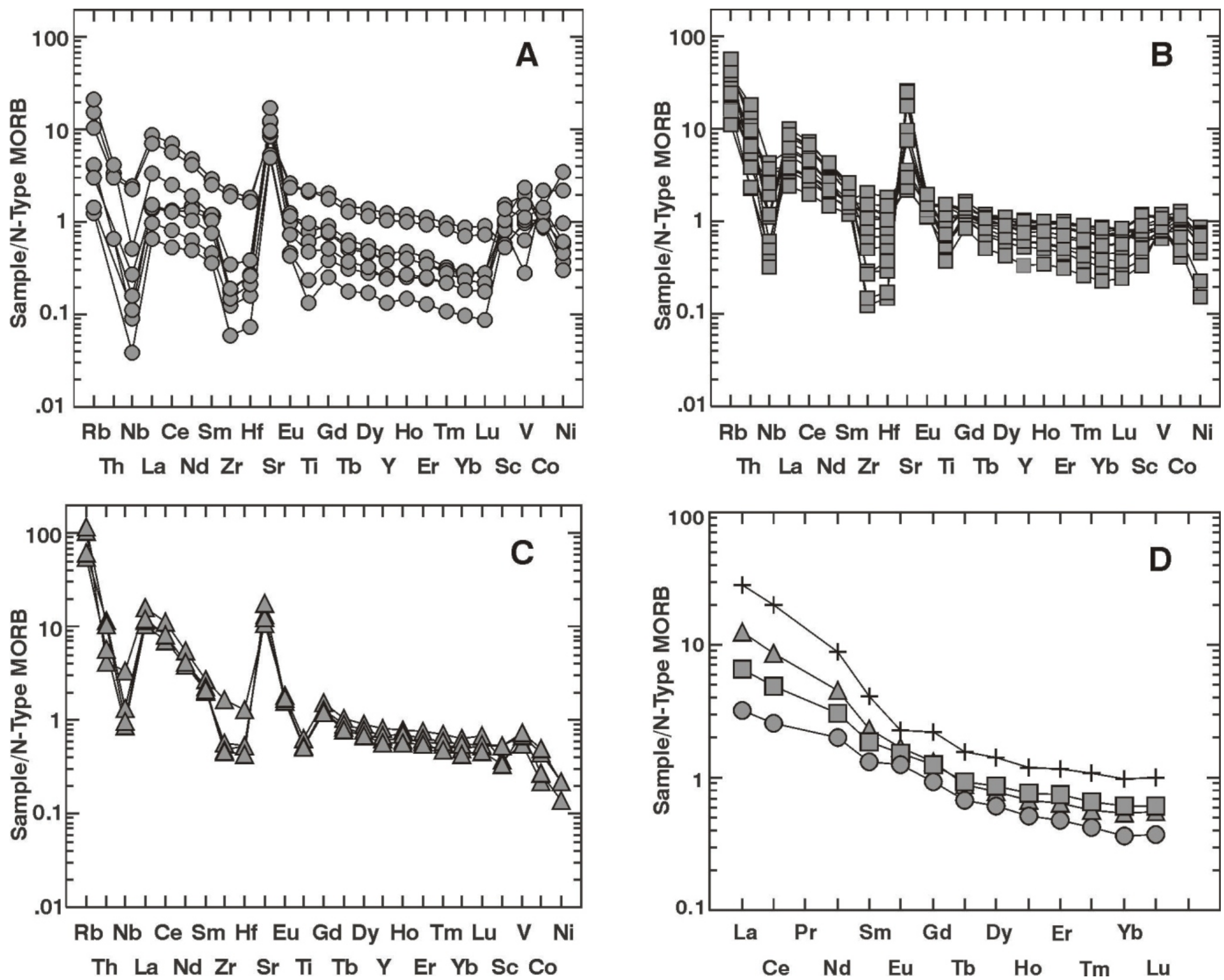

Figure 6. *N-MORB normalized incompatible trace-element diagrams of the MMIS samples. (A) Unit P_{MM} gbr, ultramafic samples (SiO_2<46 wt.%). (B) Unit P_{MM} gbr, mafic samples (46-52 wt.% SiO_2). (C) Unit P_{MM} gbr, intermediate samples (SiO_2>52 wt.%). (D) Comparative rare-earth-element diagram of mean compositions of Unit P_{MM} ggn and Unit P_{MM} gbr samples. Legend: circle - Unit P_{MM} gbr ultramafic; square - Unit P_{MM} gbr mafic; triangle - Unit P_{MM} gbr; cross - Unit P_{MM} ggn samples.*

(GSC 2001173) to a larger, on-going GSNL-GSC-MRNQ, Targeted Geoscience Initiative (TGI Project 000019) to better understand the geological development of the eastern Grenville Province.

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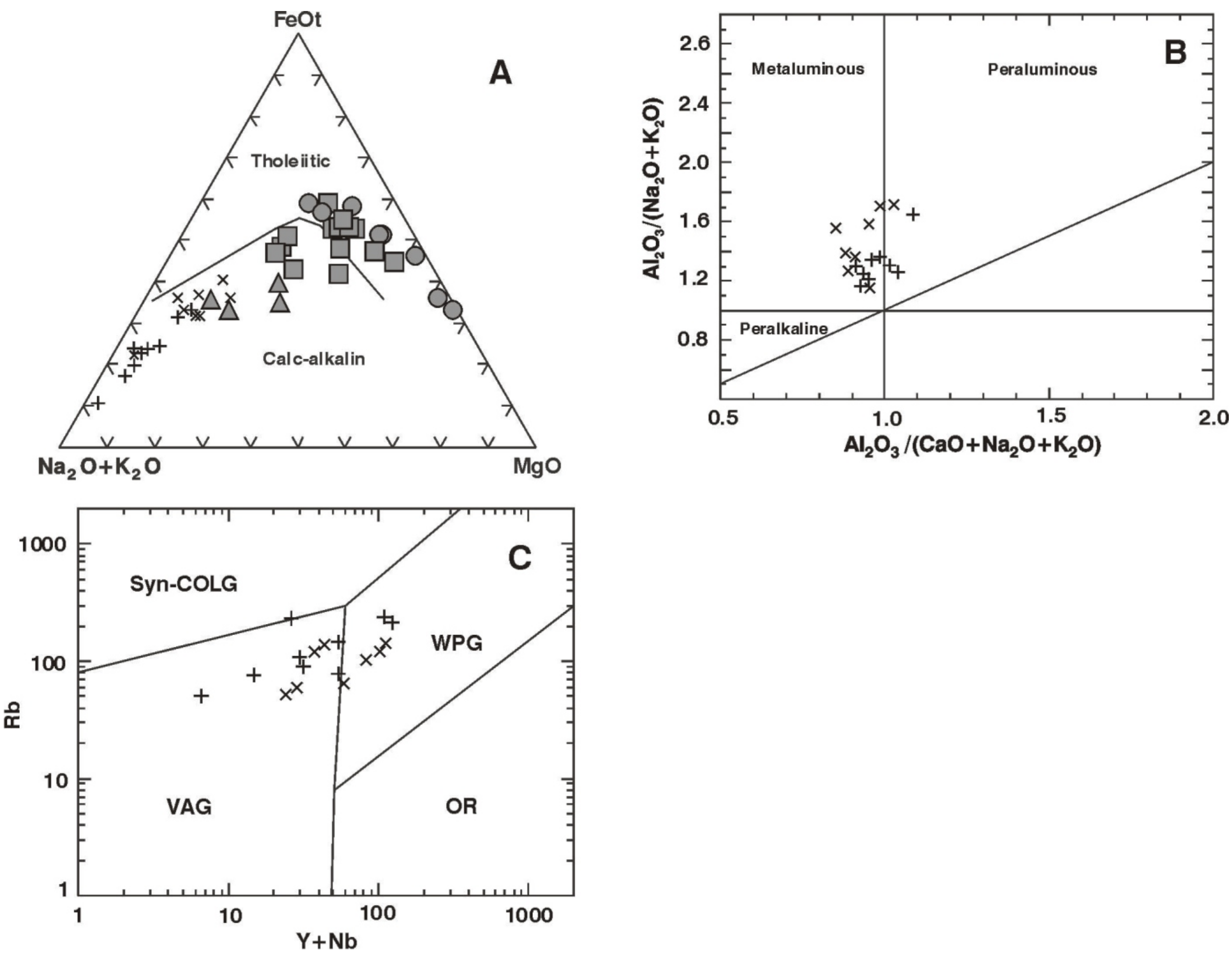

Figure 7. *Major- and trace-element composition diagrams of MMIS samples from Unit P_{MM} ggn. Legend: circle - Unit P_{MM} gbr ultramafic rock (SiO_2<46 wt.%); square - Unit P_{MM} gbr mafic rock (46-52 wt.% SiO_2); triangle - Unit P_{MM} gbr intermediate rock (SiO_2>52 wt.%); diagonal cross - Unit P_{MM} ggn intermediate rock (58-66 wt.% SiO_2); upright cross - Unit P_{MM} ggn felsic rock (SiO_2>66 wt.%). (B) Alumina saturation diagram with the limits of the metaluminous, peraluminous and paralkaline fields. The Al_2O_3 / (Na_2O+K_2O) and AL_2O_3 / ($CaO+Na_2O+K_2O$) ratios are calculated from molar values. (C) Rb vs (Y+Nb) tectonic discrimination diagram of Pearce* et al., (op. cit.). *WPG - within-plate granite; OR - ocean-ridge granite; VAG - volcanic-arc granite; Syn-COLG - syn-collision granite.*

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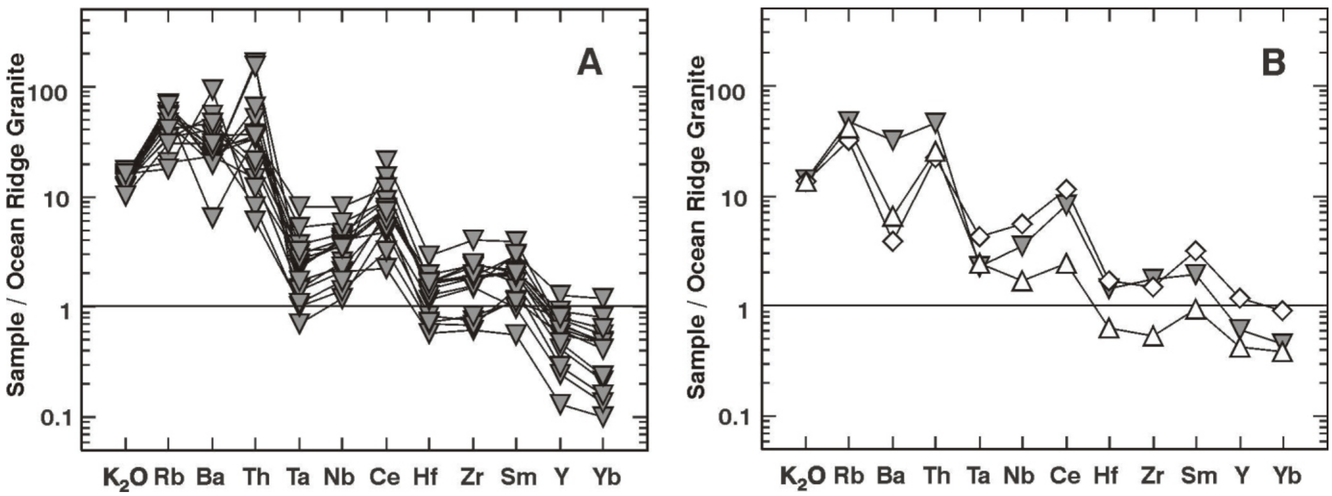

Figure 8. *Comparative ocean-ridge granite normalized incompatible trace-element patterns of late- to post-Grenvillian granitoid samples. (A) Unit M_{LG} grn and M_{LG} sye samples. (B) Comparative diagram of trace-element patterns for mean late- to post-Grenvillian granitoid composition - inverted shaded triangle, volcanic-arc granitoids of Chile - triangle, and within-plate granitoids of Sabaloka - diamond (after Pearce* et al., *1984).*

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