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Stratigraphy and structure of the Aylmer Lake volcanic belt and surrounding metasedimentary rocks, Northwest Territories[1]

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Abstract: The Aylmer Lake volcanic belt occurs in the northeastern Walmsley Lake area, southeastern Slave Province. The Aylmer Lake volcanic belt has a granitoid core, rimmed by a volcanic belt composed of a lower, mafic-dominated section of banded amphibolite, pillowed basalt, gabbro sills, and pillowed andesite; an upper compositionally and texturally diverse section; and a transition zone with overlying metaturbidite succession of the Yellowknife Supergroup. The metaturbidite units range from cordierite- to sillimanite-grade, and immediately above the Aylmer Lake volcanic belt contain abundant staurolite. Staurolite-rich rocks are unusual in the Walmsley area and are interpreted to contain a locally derived volcaniclastic component. The metavolcanic rocks preserve an S_1 fabric, in contrast to the overlying metaturbidite units, which were strongly recrystallized during D_2 and preserve an S_2 foliation. In the northwest, the Aylmer Lake volcanic belt and overlying metaturbidite units outline an F_1-F_2, type-II interference pattern, although the overall domal structure is primarily the result of northeast- and northwest-trending upright, F_4 folds.

Résumé : La ceinture volcanique d'Aylmer Lake se situe dans la partie nord-est de la région cartographique de Walmsley Lake, dans le sud-est de la Province des Esclaves. La ceinture volcanique d'Aylmer Lake présente un coeur granitoïde entouré d'une bande de roches volcaniques. La succession volcanique se compose d'une coupe inférieure à prédominance mafique formée d'amphibolite rubanée, de basalte en coussins, de filons-couches de gabbro et d'andésite en coussins; d'une coupe supérieure où la composition et les textures des roches sont variées; et, enfin, d'une zone de transition assurant le passage à la succession sus-jacente de métaturbidites du Supergroupe de Yellowknife. Les métaturbidites affichent un degré de métamorphisme variant de de la zone à cordiérite à la zone à sillimanite et renferment, immédiatement au-dessus de la succession de la ceinture volcanique d'Aylmer Lake, de la staurotide en abondance. Les roches riches en staurotide sont inhabituelles dans la région de Walmsley Lake et leur présence serait liée à l'existence d'une composante volcanoclastique de source locale. La fabrique S_1 a été conservée dans les roches volcaniques métamorphisées, ce qui n'est pas le cas dans les métaturbidites sus-jacentes qui ont été intensément recristallisées pendant la déformation D_2 et exhibent une foliation S_2. Au nord-ouest, les unités de la ceinture volcanique d'Aylmer Lake et les métaturbidites sus-jacentes montrent des figures d'interférence des plis P_1 et P_2 de type II, bien que la structure en dôme d'ensemble résulte principalement de plis droits P_4 montrant des directions nord-est et nord-ouest.

[1] A contribution to the Walmsley Lake Targeted Geoscience Initiative

INTRODUCTION

This study is part of a multidisciplinary geological project in the Walmsley Lake area of the southeastern Slave Province, Northwest Territories. The project is supported by the C.S. Lord Northern Geoscience Centre in Yellowknife and the Geological Survey of Canada, under the Targeted Geoscience Initiative. The aims of the project are to produce integrated 1:125 000-scale digital bedrock and surficial maps for the Walmsley Lake area; use U/Pb geochronology to correlate regional tectonic events throughout the southern Slave Province; and integrate geophysical imaging techniques to link crust and mantle evolution in the southern Slave Province. The stratigraphy, petrography, and geochemistry of the Aylmer Lake volcanic belt reported herein represents part of an M.Sc. thesis project at the University of Western Ontario by the first author, and is jointly supported by the Walmsley Targeted Geoscience Initiative project and Navigator Exploration Corporation. Details of the metamorphism and structure of the Aylmer Lake volcanic belt and surrounding metaturbidite bodies reported herein, is part of an M.Sc. thesis project at the University of Alberta by Scott Cairns. This paper provides a summary of field observations from the 2000–2001 field seasons, and incorporates preliminary geochemical data from samples collected in the 2000 field season.

The Aylmer Lake volcanic belt is located in the northeastern corner of the Walmsley Lake map area, 350 km northeast of Yellowknife (Fig. 1). The Aylmer Lake volcanic belt is a

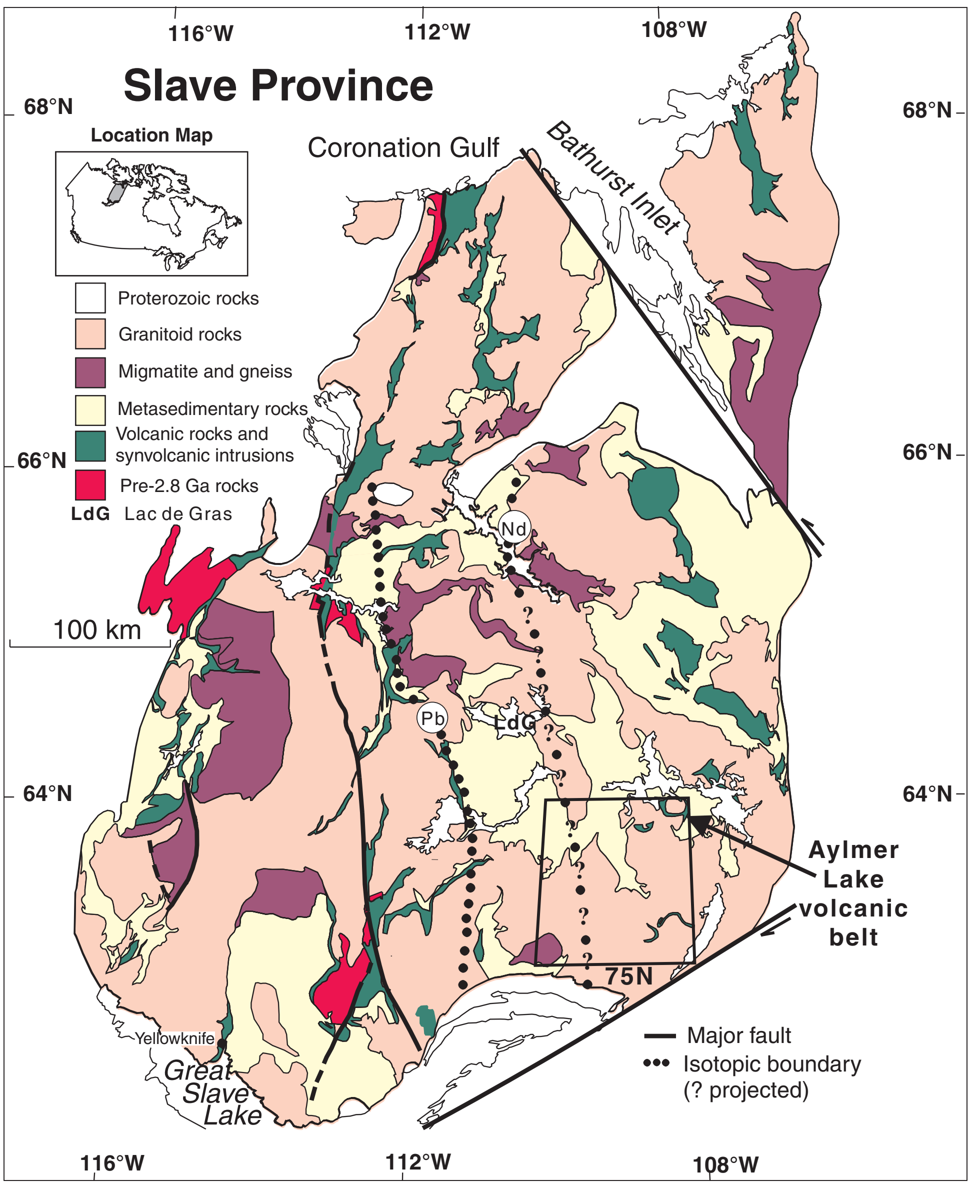

Figure 1. *Simplified geological map of the Slave Province, showing the location of the Aylmer Lake volcanic belt.*

steep-sided outward-facing structural dome cored by granodiorite and overlain by polydeformed metaturbidite of the Yellowknife Supergroup. Outcrop is sparse, especially on the eastern side of the Aylmer Lake volcanic belt. The results presented herein are based on five weeks of field mapping at a scale of 1:30 000, over the 2000–2001 field seasons. Several detailed pseudostratigraphic sections across the belt were constructed to provide details of the volcanic stratigraphy and contact relationships between the volcanic rocks and adjacent granitoid and metaturbidite rocks. High-resolution geophysical data supplied by Navigator Exploration Corporation, provided a means for correlating stratigraphy through areas of sparse outcrop.

Initial maps of the Aylmer Lake area by Folinsbee (1950) showed a domal structure with a granitoid core rimmed by an undifferentiated belt of volcanic rocks, and overlain by turbidite of the Yellowknife Supergroup. Getty Canadian Metals Ltd. mapped the volcanic lithologies in more detail, and drilled a gossanous conductive horizon at the volcanic-metaturbidite interface (J.W. Gill and D.J. Robertson, unpub. internal Getty Mines Ltd. report, 1979). Tyler Resources acquired the claims in 1992 for diamond exploration and carried out detailed airborne geophysical surveys, till sampling, and drilling (D.L. McConnell, unpub. report, 1993). Claims are currently held by Navigator Exploration Corporation (K. Armstrong and R. Hopkins, unpub. report, 1999). The presence of strong EM conductors and coincident gravity highs, favourable volcanic stratigraphy, and the presence of gossanous bolder trains have made the Aylmer Lake volcanic belt a base-metal and lode-gold exploration target for Navigator Exploration Corporation. Previous work in the area has been documented in more detail in Renaud et al. (2001).

ROCK TYPES AND STRATIGRAPHIC RELATIONSHIPS IN THE AYLMER LAKE AREA

The Aylmer Lake volcanic belt defines an upward-facing structural dome, intruded in its core by a number of granitoid plutons (described by MacLachlan et al., 2002). Multiply folded metaturbidite units overlie the volcanic rocks. The volcanic belt is broadly divided into three parts: a lower, mafic-dominated section; an upper, compositionally and texturally diverse section, which unlike the mafic rocks cannot be traced continuously around the dome; and a transition zone with the overlying metaturbidite. Lithological terms used below (basalt, andesite, etc.) are based on geochemical analyses of samples collected in 2000, and on correlations made in the field. Preliminary whole-rock geochemical data from a suite of volcanic rocks collected during the 2000 field season are presented in a subsequent section.

In 2001, several detailed pseudosections (labeled A–F on Fig. 2) were mapped at a scale of 1:100 (Fig. 3A–F). These sections are not true stratigraphic sections because of the high degree of deformation, however, the pseudostratigraphy will henceforth be referred to as stratigraphy. Geophysical data provided a means to trace 'stratigraphy' through areas of sparse outcrop, and facilitated the development a continuous section (Fig. 3). Mapped sections (Fig. 3A–F) show more detail than the simplified lithological descriptions and stratigraphy outlined below.

The only age determined on the volcanic rocks is ca. 2676 Ma (K. MacLachlan and W.J. Davis, unpub. data, 2001) for a rhyolite tuff near the top of the volcanic package. This date is younger than those for rhyolite samples in the Back River (2692 ± 2 Ma, van Breemen et al., 1987) and Hackett River (2690 Ma, Mortensen et al., 1988) areas; however, a comparable age of 2678 ± 13 Ma (Frith et al., 1991) has been determined for the Brislane Lake, and other areas (e.g. *see* Bleeker, 2001).

Lower mafic-dominated section

Banded amphibolite

This unit is approximately 100 m in apparent thickness, occurs immediately adjacent to the biotite-granodiorite in the core, and defines the exposed base of the volcanic section. The gneissosity is defined by variations in the modal abundance of hornblende and plagioclase, and typically dips 50–80° outward from the dome. Mineral assemblages are similar to those in the overlying pillowed basalt units. An increase in strain intensity in the pillows, toward the amphibolite gneiss, suggests that the amphibolite unit may be a highly strained equivalent of the pillowed rocks.

Pillowed basalt units

The pillowed basalt unit is well exposed, and forms a 1 km thick topographic ridge around the core granodiorite. The pillows typically comprise black-weathering, hornblende-rich, cores with 2–3 cm wide, epidote-rich rims, and locally contain quartz-filled amygdales, and eye-brow structures (Fig. 4A). Pillow tops are rarely preserved, but in areas furthest from the granodiorite, pillow tops are consistently outward. In areas proximal to the basal banded amphibolite, the pillows have been flattened from 10:1 to 50:1. Pillowed flows are intercalated with minor massive units that average 15–20 m thick. The tops of pillowed flows locally comprise basaltic clast-supported breccia units with a carbonate matrix, and are interpreted to be flow-top breccia. The ubiquitous pillow structures and presence of amygdales in the basal, basaltic sequence suggests subaqueous eruption in moderate water depths.

Gabbro sills

Gabbro sills 50–100 m thick can be traced semicontinuously over 20 km along strike within the pillowed basalt units in the western part of the belt. A 50 m thick anorthositic gabbro sill can be traced discontinuously for approximately 1 km in the south-central part of the belt. Due to the relatively poor exposure in the eastern segment of the dome, gabbro sills were not noted. The sills generally have a coarse-grained, hornblende+plagioclase interior with fine-grained chilled margins against the pillowed

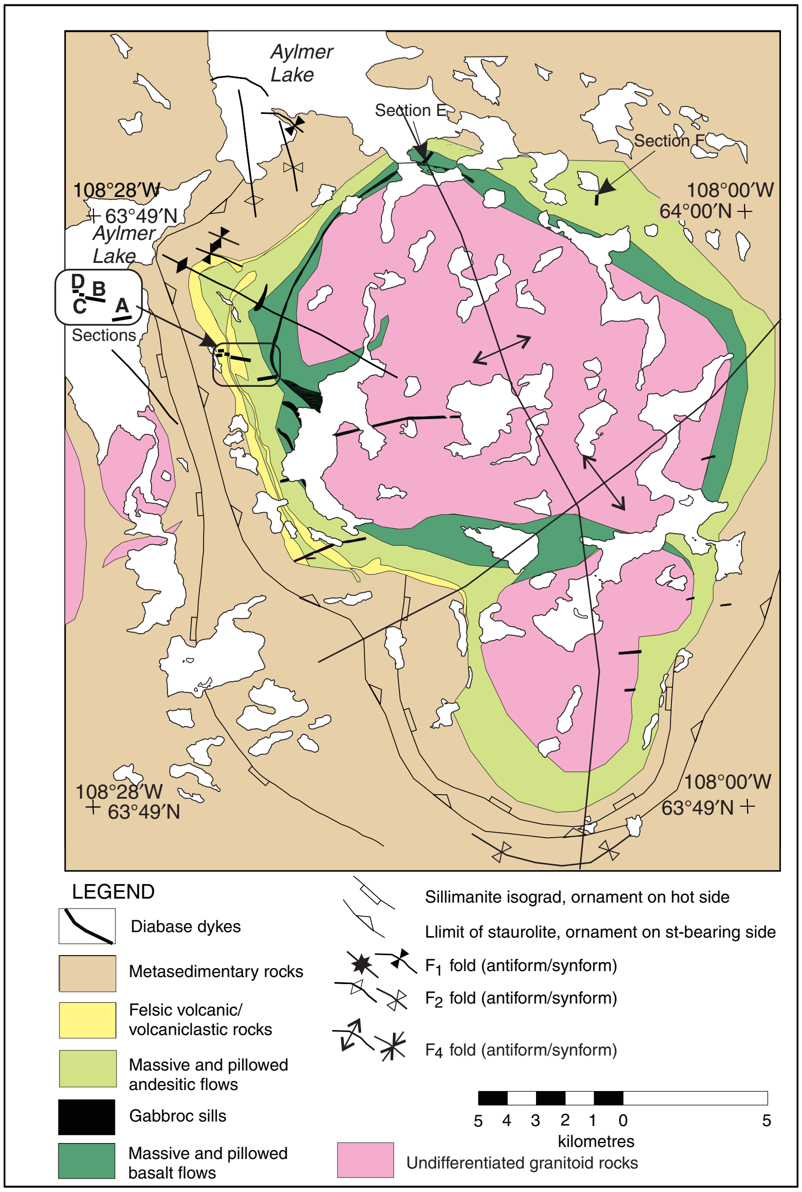

Figure 2.

Geological map of the Aylmer Lake volcanic belt and surrounding metaturbidite units.

basalt. Sill contacts are locally gossanous and contain elevated nickel contents (407 ppm) and disseminated chalcopyrite and pyrrhotite.

Pillowed and massive andesite

Above the black, pillowed basalt package is a thin unit of carbonate-bearing, biotite schist which separates the basalt from a sequence of fine- to medium-grained, grey-green-weathering pillowed volcanic rocks with andesitic compositions (*see below*). The majority of the andesite pillows are strongly flattened, variably carbonated, and are locally garnetiferous. Pillow tops generally cannot be determined due to the extreme flattening (Fig. 4B). Intercalated with the pillowed andesite units are 5 to 10 m thick, fine-grained, pale greenish-grey plagioclase+hornblende-bearing units, with andesitic bulk compositions. These massive units typically exhibit a moderate foliation parallel to flattening in the pillowed andesite, but lack internal compositional layering, and are therefore interpreted as massive flows. Pillowed andesite comprises approximately 40% of the volcanic belt, forming a ring approximately 2 km thick dipping between 65–80° outward. The predominance of pillows indicates that the andesitic succession was also erupted subaqueously.

Upper, compositionally and texturally diverse section

This package comprises a mixture of pillowed andesite, rhyolitic to dacitic tuffs, and medium- to coarse-grained intermediate and mafic-felsic fragmental units (Fig. 3).

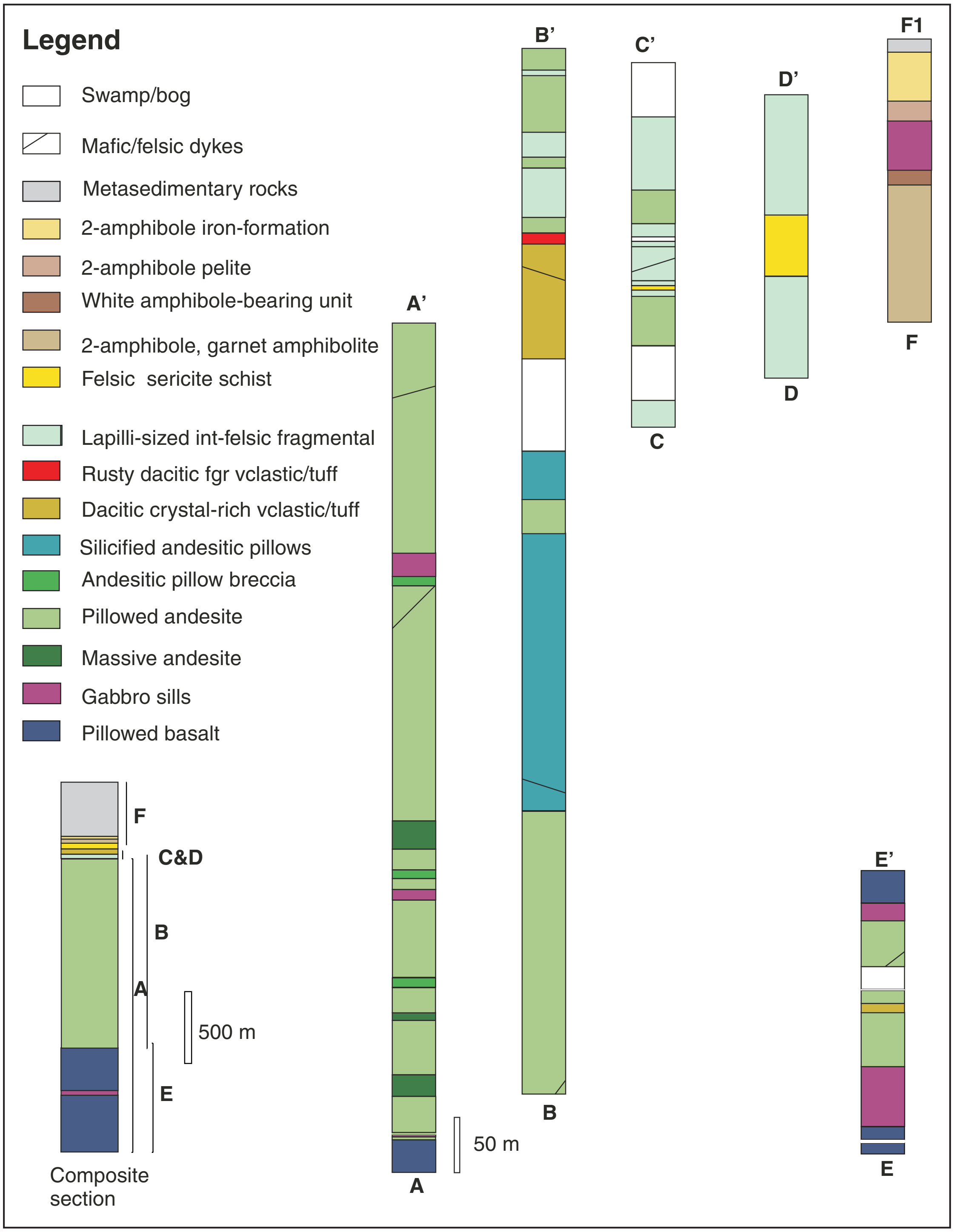

Figure 3. Detailed stratigraphic sections across the Aylmer Lake volcanic belt. See *Figure 2 for locations. amph=amphibole, fmn=formation, int=intermediate, fgr=fine-grained, vclastic=volcaniclastic*

Figure 4. ***A)*** *Pillowed basalt with well preserved selvedges;* ***B)*** *Strongly flattened pillowed andesite;* ***C)*** *Flattened, intermediate volcaniclatic fragmental;* ***D)*** *Felsic fragmental with a more mafic matrix;* ***E)*** *Dacitic crystal-rich volcaniclastic horizon;* ***F)*** *Rhyolite volcaniclastic horizon;* ***G)*** *Gossanous weathering of silicate-sulphide iron-formation; and* ***H)*** *stromatolitic carbonate.*

Mixed mafic and felsic volcaniclastic breccia and agglomerate

Detailed stratigraphic sections (Fig. 3A–F) across the compositionally and texturally diverse package show interbedded, intermediate volcaniclastic and pillowed units and mixed mafic and/or felsic breccia near the base of the section. The intermediate volcaniclastic horizons are up to 30 m thick and are comprised of monolithic, lapilli-sized (2–64 mm), biotite-bearing, felsic fragments in a matrix of similar, but slightly more mafic composition (Fig. 4C). The fragments comprise up to 30% of the rocks and are typically flattened parallel to the regional foliation. Discontinuous units of coarse-grained, poorly sorted fragmentals, with 4–5 cm, angular, intermediate and felsic clasts in a more mafic matrix (Fig. 4D) also occur in this package. These breccia units are interpreted as proximal, subaqueous mass-flow deposits derived through slumping and/or redeposition of volcaniclastic material. These medium- to coarse-gained agglomerate units are interbedded with andesitic, pillowed flows.

Crystal-rich dacitic unit

Above the mixed intermediate unit in the northern, northwestern, and western parts of the belt is a 50 m thick, dacitic (*see* 'Geochemistry' section) unit. This greenish-white-weathering, medium-grained unit is equigranular to porphyritic, thinly banded and contains quartz eyes (Fig. 4E). Interlayered within it are rusty, pyrite+pyrrhotite horizons that correspond with EM conductors and positive gravity anomalies.

Crystal-rich rhyolitic unit

The uppermost volcanic unit is fine grained, light greyish-white weathering, faintly banded, and moderately foliated, with greyish-blue quartz eyes up to 5 mm in diameter and white-weathering, subhedral feldspar crystals. The matrix is comprised of fine-grained, recrystallized quartz and feldspar with minor muscovite and biotite. The presence of abundant angular quartz and feldspar crytals, and lack of abundant micaceous minerals suggest, respectively, that this unit has not experienced significant reworking or mixing during deposition, and likely represents a primary volcanic composition. This unit varies from 20–100 m thick and dips up to 85° outward (Fig. 4F).

Volcanic-sediment transition zone

The transition zone comprises a basal, iron-rich pelite, which grades up into a central, sulphide-rich, mixed volcaniclastic and/or siliciclastic unit. These rocks are capped by an upper carbonate-rich unit.

The basal section of the transition zone consists of a white amphibole-bearing, biotite-rich, pelitic unit that locally contains trace amounts of pyrrhotite. On the northern segment of the dome, where it is best exposed, this unit is approximately 5 m thick. It is interlayered with the overlying, gossanous, siliciclastic unit, suggesting a conformable contact.

The central section of the transition zone is a 50 m thick, sulphide-bearing (pyrrhotite>pyrite), iron-rich (up to 30% FeO_3) horizon (Fig. 4G) that can be traced continuously around the entire dome (Fig. 2). It consists of coarse-grained, two-amphibole+quartz layers alternating with thin bands of biotite+pyrrhotite+pyrite. Where the unit is not exposed in outcrop, it can be traced using its high positive, total-field magnetic signature and the occurrence of distinct, orange-brown rubble crop (Fig. 4G). Although it does not have the well layered appearance of a banded iron-formation, the iron content is well above that expected in iron-formation (15%, James (1966)), and thus this unit is interpreted as a silicate-facies iron-formation.

A recessively weathered, approximately 10 m thick, carbonate-rich unit of mixed siliciclastic and volcanogenic material occurs at the contact of the volcanic belt with the overlying metaturbidite. This unit is comprised of quartz+carbonate+epidote, and is best exposed on the northeastern segment of the dome. Along the eastern margin of the dome, a carbonate unit with 2–5 cm layers with millimetre-scale wavy laminations (Fig. 4H), local onlapping surfaces, and dark carbonaceous material are interpreted as microbial mats. The fine, wavy laminations contain fenestrae typical of *Stratifera* forms (Lambert, 1998) and are interpreted to be stromatalitic in origin, suggesting that the entire carbonate unit could be primary, and implying a shallow-marine environment. The microbial mats are overlain by a centimetre-thick, medium-grained, quartz-rich layers. This sequence could be interpreted to record successive growth of stromatalite mounds and termination by an influx of clastic material.

Metaturbidite

The transition-zone sediments grade upwards into iron-rich, staurolite-bearing metaturbidite units (*see* below), which grade upwards into turbidite units with a bulk composition more typical of the Yellowknife Supergroup. The metaturbidite units form 10 cm to 5 m thick composite beds, typically consisting of 70% psammite at the base, overlain by 25% semipelitic mudstone, commonly, but not always, with a pelitic top. These cordierite-grade metaturbidite units preserve abundant primary sedimentary features including graded bedding, crossbedding, rip-up clasts, scoured bed tops, and flame structures.

GEOCHEMISTRY

During the 2000 field season 59 samples were collected for whole-rock analysis. Table 1 is a list of representative samples spanning the compositional spectrum and stratigraphic sequence observed in the belt.

Volcanic rocks

On a major element AFM diagram (Fig. 5A), basalt, andesite, and associated gabbro sills plot close to the tholeiitic–calc-alkaline boundary, whereas the felsic volcanic rocks from the overlying, mixed, intermediate to felsic section plot in the calc-alkaline field. The most felsic samples plot close to the alkali apex, possibly as a result of extensive fractionation (Fig. 5A). The major oxides CaO, TiO_2, Fe_2O_3, MnO, and P_2O_5 all show compatible behaviour, and correlate negatively with SiO_2 content, which is also compatible with crystal fractionation in calc-akaline rocks. Trace element plots (e.g. Fig. 5B) confirm classifications of the volcanic rocks based on major element oxides.

Chondrite-normalized REE plots show a range of patterns with the degree of LREE-enrichment increasing from mafic to more felsic compositions (Fig. 5C). The pillowed basalt units have slightly LREE-enriched patterns, as does the banded amphibolite, supporting the interpretation based on field observations, that the amphibolite units are highly deformed pillows. The gabbro units show almost horizontal, MORB-like patterns, and may not be genetically related to the pillowed rocks. The andesitic pillows have slightly higher overall REE concentrations and greater LREE-enrichment than the basalt. Rocks with dacitic major element compositions have similar REE-abundances to the andesite, but with stronger LREE-enrichment. The rhyolite has the greatest degree of LREE-enrichment, but HREE contents similar to the andesite and dacite. Two samples of mixed mafic-felsic fragmentals show different REE patterns. One sample of matrix only has a flat, MORB-like pattern, whereas the other, which is dominated by felsic clasts, has LREE-enrichment. A unit mapped as pillowed dacite by Getty Canadian Metals Ltd. (in 1979) has REE contents similar to the andesitic samples, suggesting that it may, in fact, be a silicified andesite.

The change in major element composition from mafic to felsic is accompanied by a change from flat to LREE-enriched, chondrite-normalized REE patterns. This change correlates with stratigraphic position suggesting an increasing calc-alkalic signature towards the top of the volcanic belt. This could be the result of an assimilation-crystal fraction process.

Mineralized samples

Table 1 lists the metal concentrations of eight samples selected to represent the volcanic stratigraphy, and two of the more altered and/or gossanous samples from the Aylmer Lake volcanic belt. Most samples analyzed showed Cu, Zn, Pb, Ni, and Au contents above the detection limit, with maximum values of 356 ppm, 1780 ppm, 35 ppm, 407 ppm, and 22 ppb, respectively. Co-enrichment in Cu and Zn, and the fact that the sulphide-rich gossans are associated with calc-alkalic felsic volcanic rocks is compatible with a VMS-style of mineralization (Padgham, 1992). The iron-formation at the volcanic-sediment interface has the potential to act as a chemical site for gold mineralization (Padgham, 1985). The presence of elevated nickel contents in gabbro sills suggests some potential for hydrothermal PGE mineralization.

STRUCTURAL AND METAMORPHIC ELEMENTS OF THE NORTHEAST WALMSLEY LAKE AREA

Structure

Within cordierite- and sillimanite-grade metaturbidite, inclusion trails in porphyroblasts predate the main foliation defined by aligned metamorphic minerals, and therefore the peak metamorphic fabric is designated S_2. F_1 folds in the turbidite units were recognized by reversals in younging direction, where S_2 transects, and therefore postdates, both limbs. Although both premetamorphic (i.e. 'D_1') folds (F_1) and foliation (S_1) have been observed in the metaturbidite units, it is not possible to demonstrate a definitive genetic link between them, due to overprinting and recrystallization.

Table 1. Whole-rock analyses of a representative selection of rocks types from the Aylmer Lake volcanic belt.

Sample number	Pillowed basalts		Pillowed andesites		Dacitic rocks		Rhyolitic rocks		Altered/gossanous samples	
	6396	6055A	8375	6075	6056	6389	6461	6192	6382	6398
(wt %)										
SiO_2	53.26	56.77	58.64	60.91	63.86	64.27	73.43	73.18	38.78	29.7
Al_2O_3	17.39	14.9	16.41	12.37	15.49	12.98	14.38	15.34	16.28	6.21
Fe_2O_3	2.17	2.35	9.64	1.29	0.82	8.65	0.82	0.38	7.8	38.23
MnO	0.153	0.178	0.14	0.2	0.057	0.1	0.04	0.024	0.131	0.09
MgO	3.57	5.21	3.17	4.88	1.43	3.66	0.29	0.29	2.26	1.29
CaO	10.48	6.39	6.88	7.06	3.36	4.34	2.99	1.38	4.91	2.35
Na_2O	3.2	3.33	3.66	1.31	3.05	3.51	5.26	6.09	2.36	0.66
K_2O	0.71	0.81	0.51	0.65	3.06	0.14	0.83	1.38	3.56	1.06
TiO_2	1.28	1.098	1.24	1.273	0.557	1.24	0.37	0.154	3.41	1.17
P_2O_5	0.2	0.19	0.22	0.24	0.18	0.31	0.1	0.03	0.9	0.36
L.O.I.	0.8	1.14	0	0.54	1.87	0.79	1.79	0.78	9.63	18.88
TOTAL	99.76	100	100.51	98.1	98.13	99.99	100.3	100.26	98.53	100
(ppm)										
Cu	33	38	72	72	ND	20	5	ND	ND	109
Pb	ND	ND	5	ND	ND	5	35	8	7	14
Zn	99	120	105	104	67	109	7	88	619	1780
Ni	44	36	28	52	407	ND	10	ND	31	64
Rb	17	20	318	16	59	294	231	32	97	100
Sr	143	79	15	82	77	3	20	507	384	41
Zr	144	135	217	161	253	199	260	88	350	170
Y	29	23.6	36	26.7	28.2	33	19	3.3	45	25
Nb	6.2	5.3	11	6.2	7.4	11	9	1.5	27.3	18

6396 - Basal banded amphibolite
6055A - Pillowed basalt
8375, 6075-Pillowed andesite
6056, 6389-Dacite tuffs
6461 - Rhyolite tuff
6192 - Feldspar porphyry dyke
6382 - Gossanous and may represent intermediate to felsic tuff with a carbonate matrix
6398 - Volcanic/sediment interface iron-formation
ND - not detectable

In contrast, field relationships suggest that the main fabric preserved in the metavolcanic rocks is S_1. The tight fold on the northwestern edge of the Aylmer Lake volcanic belt is a fold of bedding, which in the hinge area preserves a strong axial-planar fabric defined by flattened pillows and aligned amphibole crystals. On the limbs of the fold, this flattening fabric is parallel to bedding. In the overlying turbidite units, bedding youngs in opposite directions on each limb of this fold; however, the main S_2 foliation in the metaturbidite transects both limbs, indicating it is an early (F_1) fold. Thus, the fold and flattening fabric in the volcanic rocks are designated F_1 and S_1, respectively. In the metaturbidite north of the Aylmer Lake volcanic belt, chevron-style, F_1 folds are refolded by tight, F_2 folds with an axial-planar cleavage defined by the metamorphic minerals. The resultant fold pattern is a classic type-II, mushroom interference pattern (Ramsey, 1967); however, the fold closure at the southeast end of the belt refolds S_2 and F_2 folds in the surrounding metaturbidite units and therefore must be an F_3 or F_4 fold. Since this is an upright, open fold, it is more characteristic of regional F_4 folds (MacLachlan et al., 2002) and is interpreted as such. The same argument can be made for gentle folds on the southwest side of the dome. Thus, although F_1 and F_2 are locally prominent, upright, northeast- and northwest-trending F_4 folds (MacLachlan et al., 2002) have contributed to the overall domal nature of the Aylmer Lake volcanic belt.

Metamorphism

Three regional isograds were mapped in the metaturbidite units in the Walmsley Lake area (Fig. 2). The sillimanite-in isograd is defined by the first appearance of sillimanite in pelitic layers and occurs in the northeastern part of the Walmsley Lake area, just west of the Aylmer Lake volcanic belt. The melt-in isograd is defined as the first appearance of in situ leucosome in pelitic beds, and is characterized by centimetre-scale granitic blebs with biotite-rich selvedges. A third isograd delineating the appearance of iolite in pelitic rocks is restricted to a small zone in the southwestern part of the Walmsley Lake area and occurs in rocks exhibiting a high percentage of in situ leucosome. Iolite first appears in an assemblage of biotite±muscovite±sillimanite±garnet, in the leucosome. The restitic phase contains sillimanite±biotite ±garnet. Up grade of the iolite-in isograd, K-feldspar porphyroblasts were observed at the restite-leucosome interface. Co-existence of K-feldspar, garnet, and sillimanite suggests granulite-facies conditions; however, petrographic work is required to determine whether these minerals define an equilibrium assemblage.

Immediately above the Aylmer Lake volcanic belt, cordierite-grade metaturbidite units contain the assemblage cordierite+staurolite+biotite+muscovite±garnet±andalusite. Two generations of staurolite are present: large porphyroblasts contain and are elongate parallel to the main (S_2) foliation, but are locally overgrown by cordierite south of the belt; and smaller, euhedral crystals of staurolite that overgrow the S_2

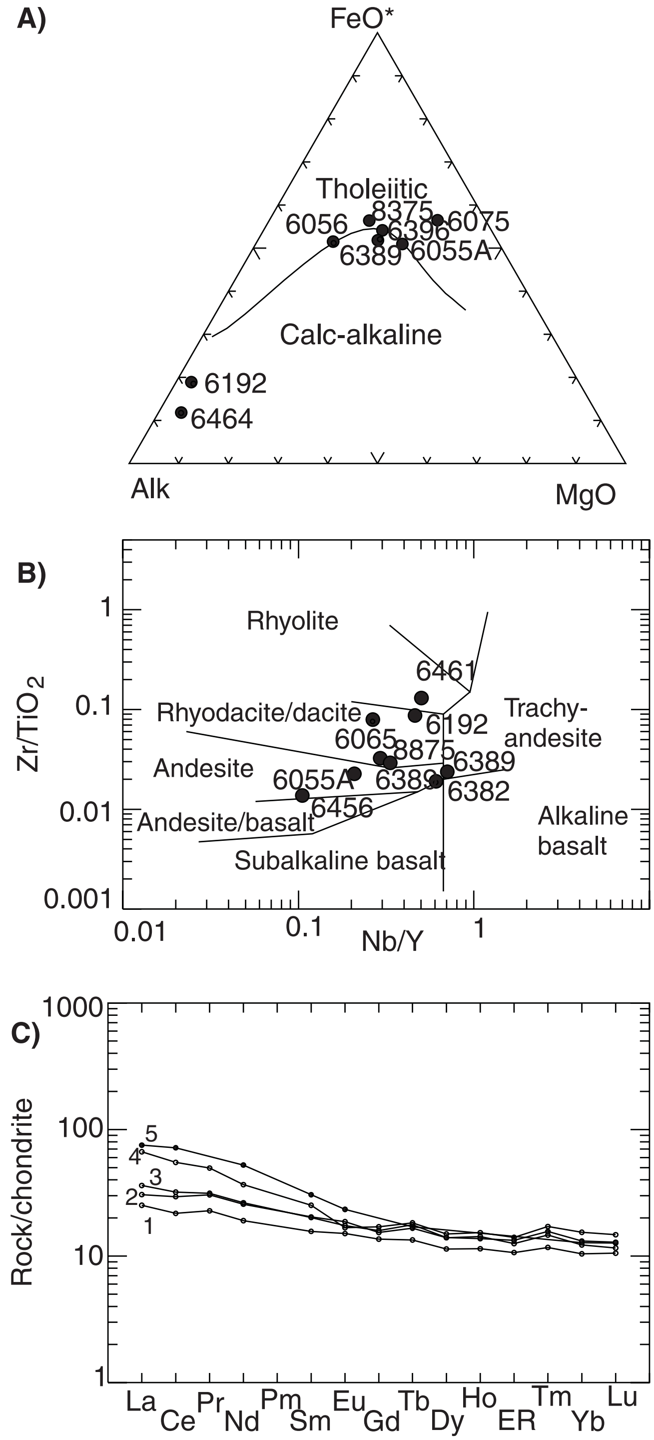

Figure 5. *Geochemical plots of selected whole-rock analyses of volcanic rocks from the Aylmer Lake volcanic belt:* ***A)*** *FeO-MgO-total alkalies (Alk) ternary diagram (*after *Irvine and Baragar, 1971);* ***B)*** *Zr/TiO_2 versus Nb/Y discrimination diagram (*after *Winchester and Floyd, 1997); and* ***C)*** *chondrite-normalized REE plot (normalizing values of Nakamura (1974)); 1, banded amphibolite; 2, pillowed basalt; 3, pillowed andesite; 4, dacite tuff; 5, rhyolite tuff.*

fabric. Staurolite is present above the volcanic-metaturbidite contact for a distance of 800–1000 m (true thickness), beyond which it disappears from the rocks. The presence of staurolite in the metaturbidite is unusual in the Walmsley Lake area, and reflects atypical, iron-rich, bulk compositions, likely the result of a locally derived volcaniclastic component.

The sillimanite-in isograd occurs west of the Aylmer Lake volcanic belt, with hot side to the west, and transects bedding and the S_2 foliation. The sillimanite-in isograd roughly parallels the eastern extent of an area of large peraluminous, granitic bodies separated by narrow septa of metaturbidite units, to the west of the Aylmer Lake volcanic belt, and a large composite pluton mapped by Folinsbee (1950) to the south of the belt. The spatial association of sillimanite-bearing rocks and large volumes of granitic material suggest a contact metamorphic relationship, as proposed elsewhere in the Slave Province (e.g. Bethune et al., 1999)

Within the volcanic lithologies, the assemblage hornblende+plagioclase±garnet prevails, and is consistent with the lower amphibolite conditions present in the surrounding metaturbidite units.

DISCUSSION

The Aylmer Lake volcanic belt ranges from pillowed tholeiitic basalt at the base, through pillowed andesite, to felsic tuffs with a calc-alkaline geochemical signature towards the top. The volcanic rocks have a gradational contact with the overlying turbidite units of the Yellowknife Supergroup. The sequence dips and youngs outward on all sides and forms a structural dome with granodiorite in the core. The base of the Aylmer Lake volcanic belt consists of a sequence of banded amphibolite that is interpreted to be a highly strained equivalent of the overlying pillow basalt units. This suggests that there may have been some movement along the contact between the volcanic belt and the granodiorite core, although there are no constraints on the timing or magnitude of this displacement.

The volcanic package evolved from tholeiitic basalt erupted at moderate water depths, to more felsic calc-alkaline rocks, which are interpreted to have been partially erupted subaerially. This suggests a decrease in water depth with time, probably as a result of building up of the volcanic edifice. The presence of a stromatolitic unit at the top of the volcanic pile indicates that the volcanic pile locally built up above wave base. The change to turbidite deposition at the top indicates subsequent deepening, possibly due to collapse of the volcanic system. The iron-rich compositions of the turbidite units immediately overlying the volcanic rocks suggest that the volcanic edifice was being eroded and supplied detritus to the turbidite basin.

The volcanic rocks have anomalous base-metal contents (Cu, Pb, Zn, Ni), and sulphide horizons are spatially associated with the felsic volcanic rocks, suggesting the potential for VMS-style mineralization. Gossanous units within the volcanic stratigraphy and at the volcanic-metaturbidite interface are coincident with positive magnetic and gravity anomalies.

Structural and metamorphic relationships in metaturbidite units surrounding the Aylmer Lake volcanic belt are consistent with the structural styles and metamorphic conditions found throughout the Walmsley Lake map area (*see* MacLachlan et al., 2002). The metavolcanic rocks preserve an S_1 fabric, whereas the metaturbidite typically recrystallized during peak metamorphism and D_2 deformation, and preserve an S_2 fabric. The overprinting of F_1 folds by F_2 structures locally produced type-II (mushroom) interference patterns, although upright, northeast- and northwest-trending F_4 folds have contributed to the overall domal nature of the Aylmer Lake volcanic belt.

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