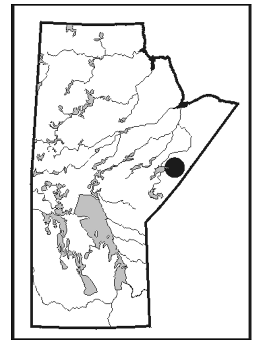
GS-21

GEOLOGY OF THE EDMUND LAKE AREA (NTS 53K/11NW)



by M.T. Corkery and L.M. Heaman[1]

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SUMMARY

Supracrustal rocks in the Edmund Lake area form a westward-thinning, east-plunging, north-facing homoclinal extension of the Stull Lake greenstone belt. They are flanked by felsic intrusive/gneiss terranes to the north, south and west. The most significant observations are that: 1) Hayes River Group basalt forms a thick sequence of tholeiitic basalt with a MORB- like geochemical signature, 2) the geochemical signature of the basalt north of the "Wolf Bay" shear zone indicates affinity to the diverse sequence of the Oxford Lake Group, and 3) the White House tonalite (2734±2 Ma) provides a minimum age of the Hayes River Group, but, more significantly indicates that rocks of Oxford Lake Group age, has geochemistry similar to Oxford Lake Group felsic extrusive rocks in the area and intrudes Hayes River Group rocks.

INTRODUCTION

Manitoba's segment of the Stull Lake map area is being mapped under the auspices of Manitoba's Northern Superior Project and the Western Superior NATMAP project. The Stull Lake area was last mapped in the 1930's (Downie, 1936a, 1936b), and is currently being reexamined to gain a better understanding of, and assess the mineral potential of, greenstone belts in this northern frontier region.

The Stull Lake area straddles the Ontario/Manitoba border between latitudes 54º and 55º north. Cooperative geoscience studies in the area are being carried out by the Geological Survey of Canada, Ontario Geological Survey, Manitoba Geological Services Branch and two universities as part of the Western Superior NATMAP Project. Current projects in this region by Manitoba Geological Services Branch have targeted the Archean greenstone belts (Fig. GS-21-1) at Edmund - Margaret lakes (Corkery, 1996a, b, 1998) and Stull Lake (Corkery et. al., 1997a, b; Corkery and Skulski, GS-22 this volume) in conjunction with more thematic structural studies (Jiang and Corkery, GS 23 this volume).

A program of regional 1:50 000 scale mapping by Denver Stone of the Ontario Geological Survey began in 1995 in the Stull Lake area (Stone and Pufahl, 1995) and has continued with mapping of several 1:50 000 NTS sheets in the region. A shared field camp and mapping program in both 1997 and 1998 have produced a cross-border OGS preliminary series compilation map of the Little Stull Lake area (Stone and Halle, 1997) and joint release of the Stull Lake sheet (53K/9) is planned for January 1998. The Geological Survey of Canada is involved in integrated mapping, geochemical and geochronological programs in both provinces and structural-tectonic studies have been initiated through the University of New Brunswick.

This paper will report on geological mapping in the summer of 1998 in the Edmund Lake (53K/11 NW) area (Fig GS-21-1) and geochronological and geochemical results for the area mapped to the east (53K/11 NE).

GENERAL GEOLOGY

Supracrustal rocks in the Edmund Lake area form a westward-thinning, east-plunging, north-facing homoclinal extension of the Stull Lake greenstone belt (Fig. GS-21-1). The supracrustal rocks are flanked by felsic intrusive/gneiss terranes to the north, south and west. The eastern end of the Gods Lake greenstone belt occurs 10 km to the west along strike. A major linear deformation zone trends 310° across the map area and extends to the southeast into the Little Stull Lake area. This deformation zone ("Wolf Bay" shear zone) divides the belt into Northern and Southern domains. The Southern domain is dominated by pillowed and massive basalt flows that have historically been assigned to the Hayes River Group (Downie, 1937). The basalt is intruded by gabbro and felsic dykes and two small plutons (the White House tonalite and the Margaret Lake granite). The Northern domain consists of more diverse lithologies that consist predominantly of pillowed basalt, mafic volcaniclastic rocks, felsic volcaniclastic rocks, iron formation and sedimentary rocks, that occur sporadically along the northern edge of the "Wolf Bay" shear zone. Downie (1936a) assigned most of these rock types to the Oxford Lake Group. Numerous gossan zones occur both within these units and to the south within the shear zone.

Descriptions of the lithologies that dominate the Edmund Lake area were reported in 1996 (Corkery, 1996b) and new mapping has extended these same units to the west. Only new units and synoptic descriptions required for discussion of the geochemical and geochronological data will be included here.

SUPRACRUSTAL BELT ASSOCIATIONS

The area mapped this summer (53K/11 NW) (Corkery 1998) lies southeast of the "Wolf Bay" shear zone. In the map area, all supracrustal rocks are part of Hayes River Group Southern domain basalts and associated gabbro-diorite intrusions. Supracrustal units belonging to the Oxford Lake Group, mapped to the northeast of the "Wolf Bay" shear zone (Fig. GS-21-2), were absent from this area.

Hayes River Group (Southern domain)

Primary layering and top indicators are rare, similar to the area to the east. However, where present, layering is moderately- to steeply-northeast dipping and northwest trending. This layering is parallel to a weak- to moderately-developed plane of flattening in the basalt. Both the layering and flattening are consistently transected, at an acute clockwise angle, by a strongly developed, west-northwest trending regional fabric parallel to the "Wolf Bay " shear zone. The sole mappable marker horizon in the sequence (plagioclase porphyritic basalt - unit 1d) is not folded (Corkery, 1996a). These relationships indicate that the sequence is homoclinal and northeast-facing.

Gabbro dykes and sills intrude the basalt throughout the Southern domain. In upper part of the section they form only about 10 % of the exposed section, but they increase dramatically down section to the southwest where they commonly comprise over 50 % of the section. Intrusions range from small (1 - 2 m) aphanitic dykes, to sills that are over one hundred metres thick. Feathery, radiating, 3 to 7 mm aggregates of mafic minerals (actinolite?) form mafic clots in thicker sills. Pyroxene (pseudomorphed by amphibole) phyric gabbro with phenocrysts up to 7 mm, forms a minor dyke phase commonly associated with pyroxene phyric basalt.

Based on the presence or absence of phenocrysts, variation in colour of the fresh surface, and the distribution of secondary features such as spherulites pillowed and massive basalt flows in the Southern domain are subdivided into four subunits: 1) dark green- to green-grey, aphyric basalt flows (subunit 1a) are most abundant; they are interlayered with; 2) pale green to blue- green aphyric flows (subunit 1c) that were originally considered to be slightly more siliceous (basaltic andesite); 3) plagioclase phyric flows occur in the upper portion of the section and form a northwest-trending marker that continues into the "Wolf Bay" shear zone (Fig. GS-21-2); and 4) dark green to green-grey pyroxene phyric massive and pillowed basalt flows are rare and show an irregular distribution in the section.

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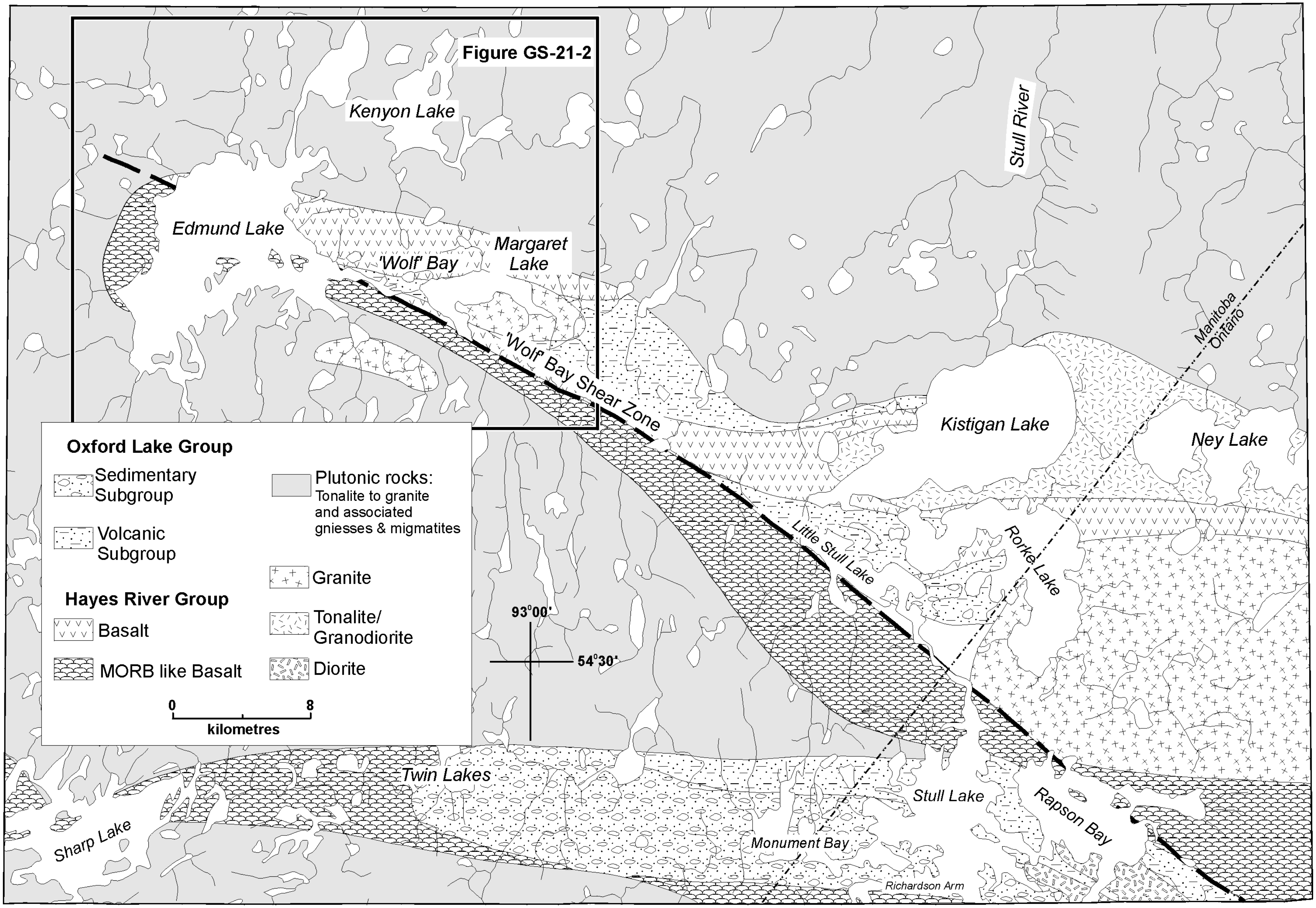

Figure GS-21-1: Regional geologic setting and major subdivisions in the Edmund- Margaret- Stull lakes region.

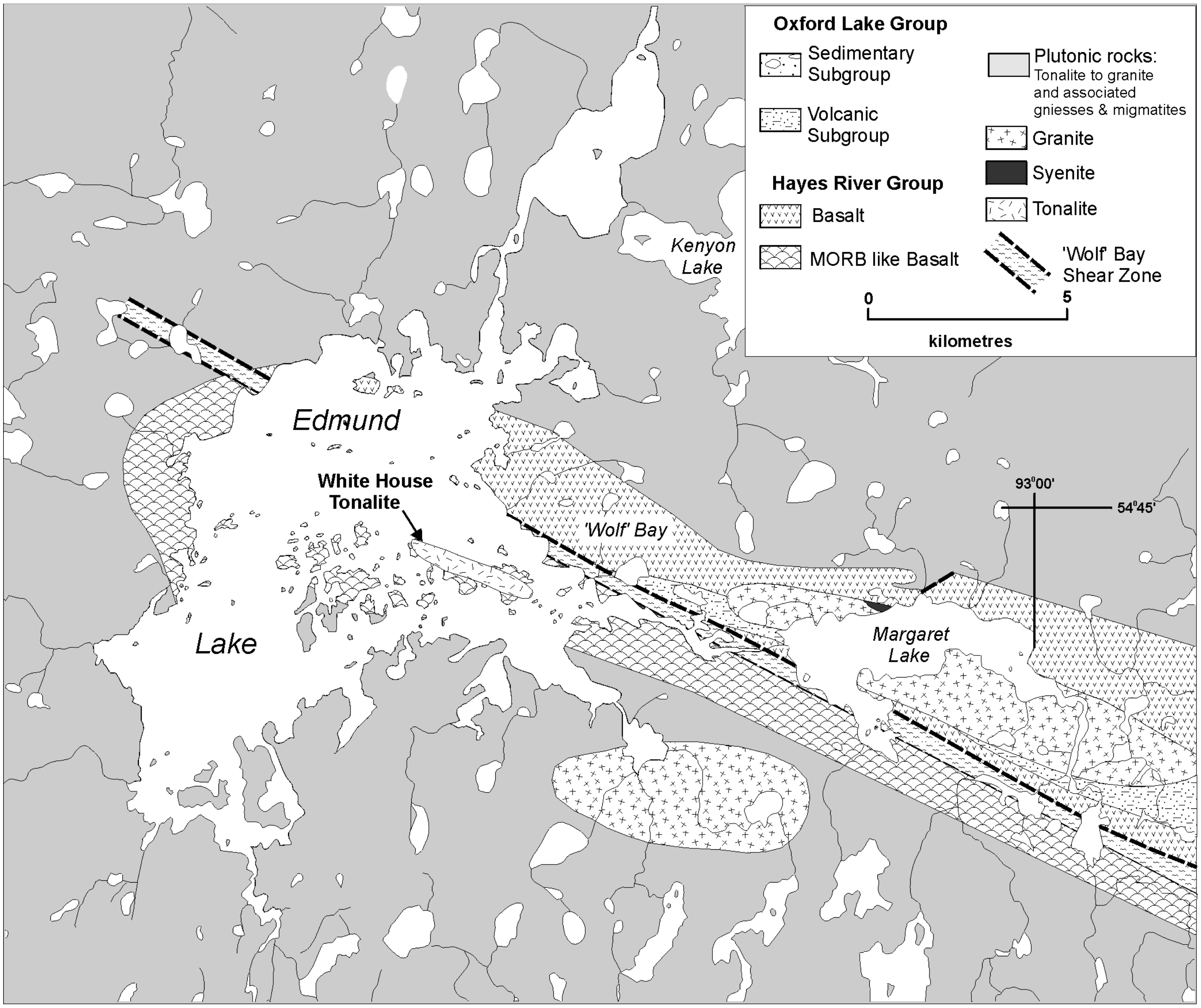

Figure GS-21-2: General geology of the Edmund Lake area.

The basaltic rocks in the Southern domain are all geochemically similar. They plot in the tholeiitic field in tight clusters on major element plots (AFM (Irving and Baragar, 1971), Jensen (1976) ternary cation plot and SiO_2 vs. FeO*/MgO) (Fig. GS-21-3a, 3b, 3c). The most abundant aphyric flows of units 1a and 1c are indistinguishable on both rare earth element (REE) and incompatible element primitive mantle normalized diagrams (Fig GS-21-4a and 4b). In general they have depleted light rare earth element (LREE) and large ion lithophile (LIL) profiles and relatively flat heavy rare earth element (HREE) profiles. Some variations are apparent between the aphyric and the phyric basalt units of the Southern domain. The plagioclase-bearing basalt flows have a slightly elevated light rare earth profile (Fig. GS-21-4c) and have relative enrichment of La > Th > Nb. (Fig. GS-21-4d). The only analysis of the pyroxene phyric basalt displays a depleted LREE profile, and flat HREE profile (Fig. GS 21-4d), and strongly depleted LIL with Th< Nb < La. This analysis also shows significantly elevated Sr common to all the basalt in the region. Elevated Sr may be the result of a regionally extensive alteration event.

North of the "Wolf Bay" shear zone, the basalt of the Northern domain have similar outcrop characteristics to the Southern domain basalt. These aphyric basalt flows (unit 1e) are dark-grey to black, on the fresh surface, and grade to the north into amphibolite derived from pillowed and massive basalt flows (unit 1f). These rocks were interpreted to be higher metamorphic grade equivalents of unit 1a (Corkery, 1996b). However, they are geochemically distinct: they plot in the calc-alkaline field on a SiO_2 vs. FeO*/MgO diagram (Fig. GS-21-5). The Northern domain basalt have strongly enriched LREE patterns compared to units 1a and 1b (Fig. GS-21-6a) and high Th/Nb ratios (Fig. GS-21-6b). These features are similar to the patterns described for basalt flows on the south shore of Kistigan Lake north of the "Wolf Bay" shear zone in the Little Stull Lake area (Corkery and Skulski, GS 22 this volume) and further interpretation of the significance of these geochemical patterns and their interpretations are made in that report.

Oxford Lake Group

A highly diverse sequence of volcaniclastic and sedimentary rocks forms a narrow discontinuous band up to 500 m wide along the north flank of the "Wolf Bay" shear zone in the Margaret Lake area. They pinch out to the west along the north edge of the "Wolf Bay" shear zone and are intruded to the east by the Margaret Lake granite. In general these rocks are strongly flattened, foliated and transposed parallel to the shear zone. However, some outcrops retain delicate primary depositional features. In close proximity to the "Wolf Bay" shear zone, Oxford Lake Group rocks are commonly strongly altered, producing a light grey and black mottled fresh surface, with muscovite and sulphides along fractures and significant sulphide-bearing gossan zones.

Massive and fragmental felsic volcanic rocks are the dominant lithologies in this group, including pale green to light green-beige weathering aphyric dacite to rhyolite. A felsic fragmental rock (Fig. GS-21-7) was sampled for geochronology and geochemistry.

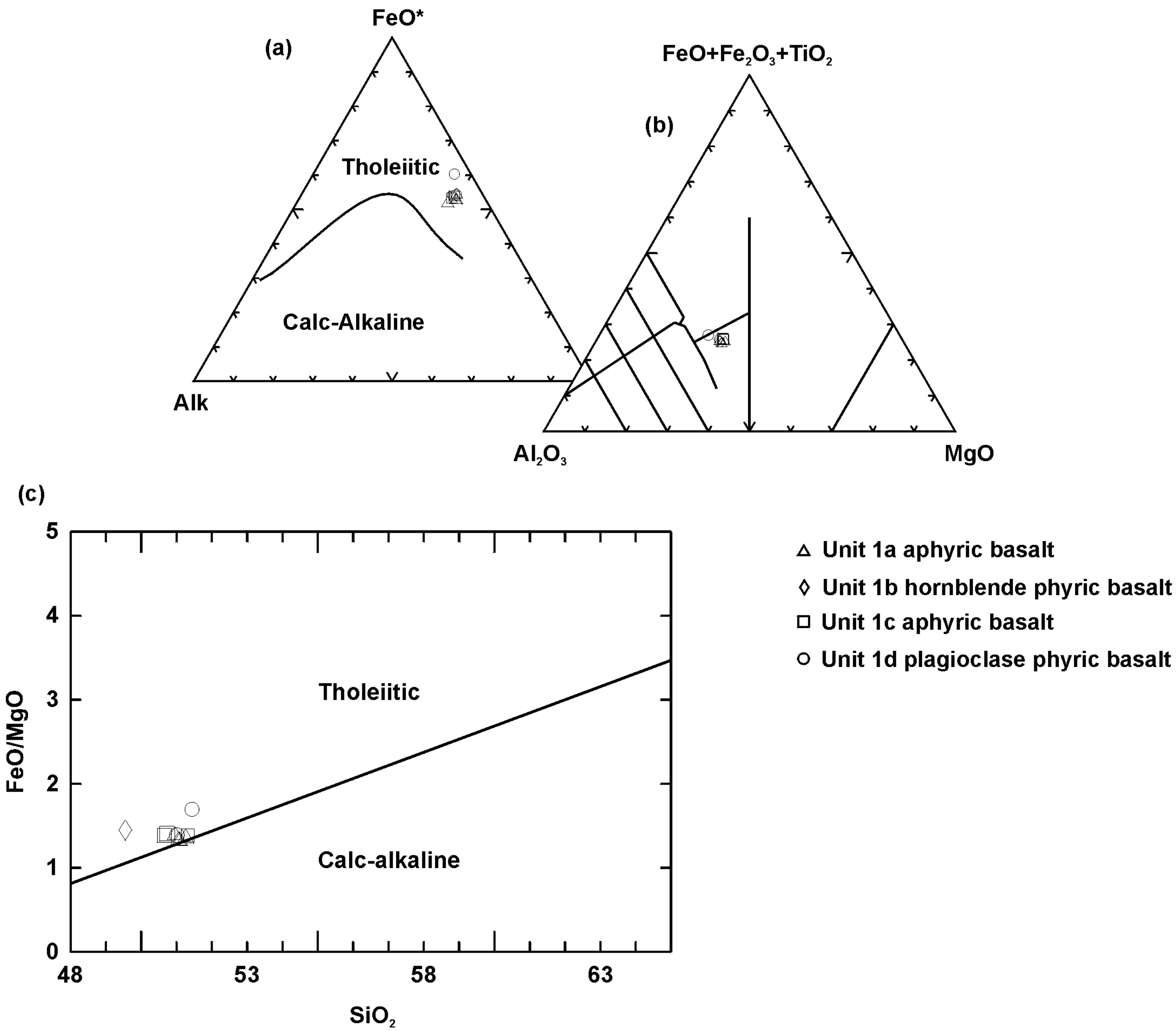

Figure GS-21-3: Major element plots for all subunits of the Hayes River Group basalts in the Southern domain. All analyses plot in a tight cluster in the tholeiitic field on a) AFM (Irving and Baragar 1971), b) Jensen (1976) ternary cation plot and c) SiO_2 vs. FeO/MgO).*

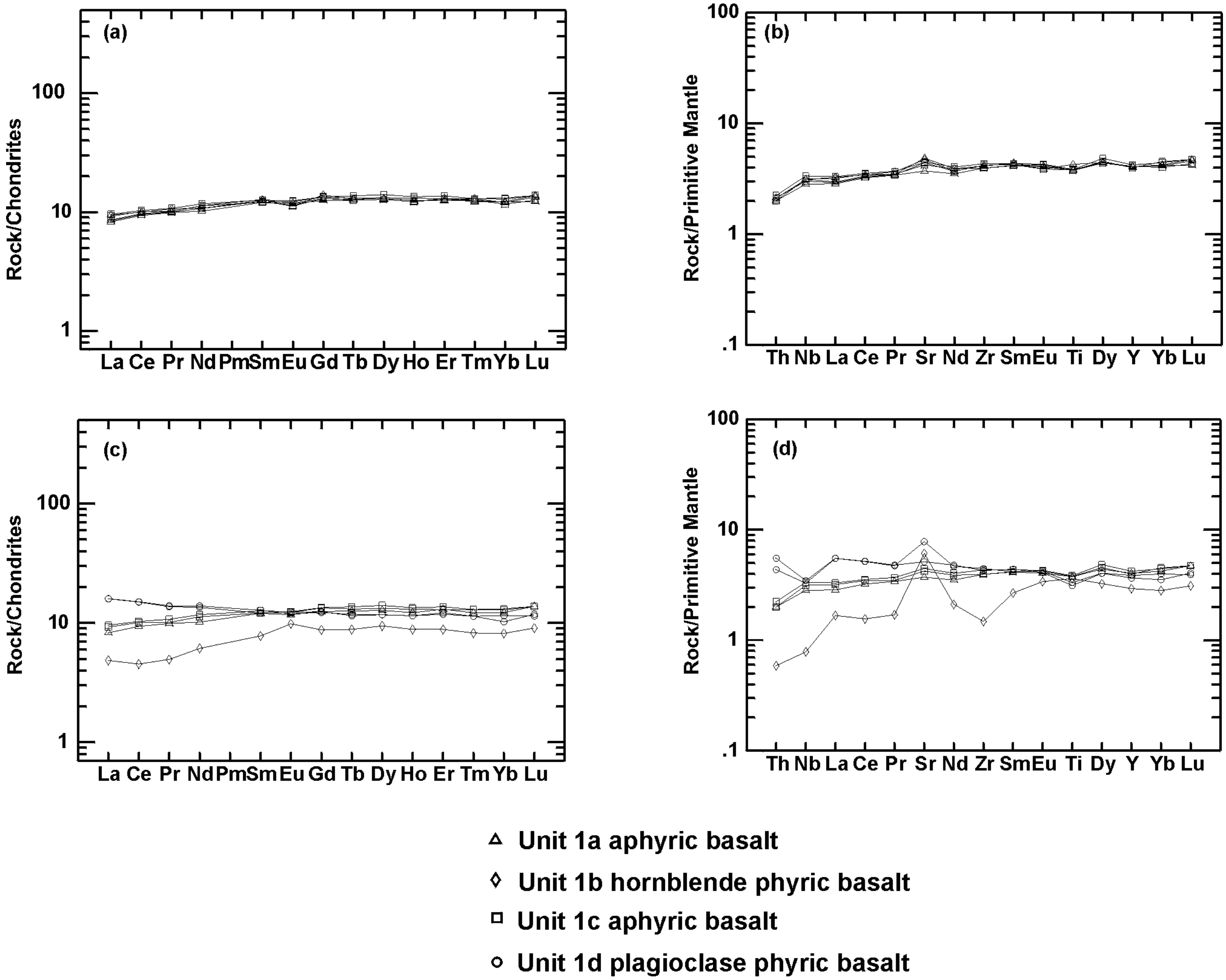

Figure GS-21-4: Chondrite-normalized REE plots and primitive mantle normalized trace element profiles of Hayes River Group basalts (normalization factors from Sun and McDonough, 1989). Plots a and b are aphyric basalt, c and d are plagioclase and pyroxene phyric basalt.

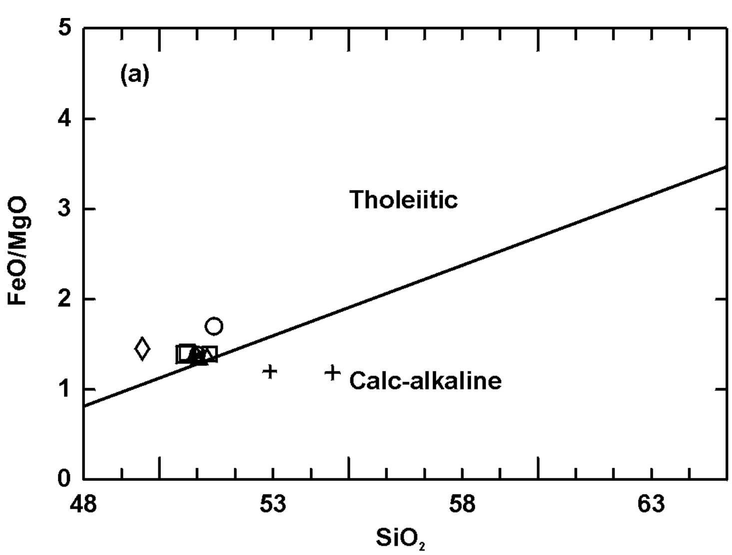

Figure GS-21-5: SiO_2 vs. FeO/MgO plot comparing tholeiitic Southern domain basalts to calc-alkaline Northern domain basalt.*

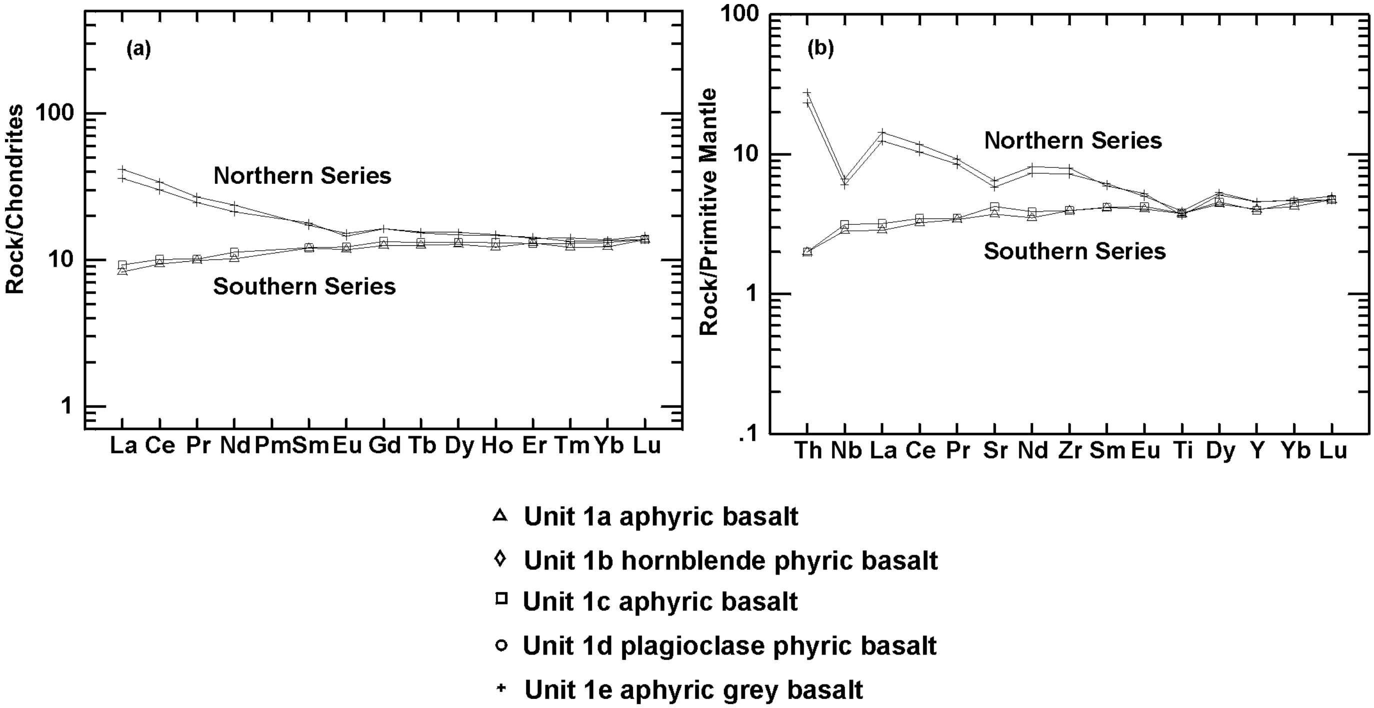

Figure GS-21-6: Chondrite-normalized REE plots and primitive mantle normalized trace element profiles of Southern domain and Northern domain basalt.

Figure GS-21-7: Photograph of rhyolite fragmental rock with interbedded oxide facies iron formation at the location sampled for geochronology and geochemistry.

Two analyses of White House tonalite are included in Figure GS-21-8 and display similar trace element abundance and patterns to the Oxford Lake Group felsic fragmental rocks described above. This tonalite intrudes the Hayes River Group in the central Edmund Lake area (Fig. GS-21-2). It is a strongly foliated and recrystallized intrusion, dominated by light grey weathering, fine grained, equigranular biotite tonalite. Along the southern margin, the main phase is intruded by a younger plagioclase ± quartz porphyritic biotite tonalite. Both phases show variable alteration of the biotite to chlorite, with significant epidotization of the adjacent feldspars.

Both the Oxford Lake Group felsic fragmental rocks and the White House tonalite are HREE depleted with a high $[La/Yb]_n$ ratio (Fig. GS-21-8a). Trace element analyses of these rocks have primitive mantle normalized profiles with high Th/Nb ratios and minor Ti depletion, most apparent in the rhyolite fragmental rock (Fig. GS-21-8b). The geochemical similarity of the tonalite and felsic volcanic rocks suggests that they are cogenetic.

The White House tonalite has been dated at 2734±2 Ma (Heaman, internal report). Although there was a small amount of zircon in the felsic volcaniclastic sample, the results have been ambiguous and result in several discordant $^{207}Pb/^{206}Pb$ model ages ranging from 2741 to 2779 Ma (Heaman, internal report). Several more analyses are underway on this sample to better constrain the age of felsic volcanism. However, the 2728 ± 2 Ma age for the Margaret Lake Granite (Heaman, internal report), a pluton that intrudes Oxford Lake Group iron formation and sandstone at the west end of Margaret Lake, provides a minimum age for this sequence.

MAJOR GRANITIC TERRANES

The supracrustal belt is flanked to the north and south by plutonic terranes. On the south, the Wapawaka Intrusive Complex (Corkery, 1996b) is everywhere in fault contact with the supracrustal belt. The dominant intrusive phases that were observed near the supracrustal belt include coarse- grained, sparsely porphyritic, leucocratic- biotite tonalite, intruded by medium- to coarse- grained, light grey weathering, biotite tonalite. In a 100 - 300 m thick zone along the margin of the supracrustal belt these rocks are strongly foliated, and have an augen fabric. To the southwest of the tonalites, a medium- grained biotite granodiorite (Fig. GS-21-9) with 1 - 4 %, 2 - 4 cm tabular poikilitic microcline intrudes the tonalites. Several phases of late aplitic to pegmatitic dykes intrude the complex.

CONCLUSIONS

Hayes River Group basalt form a thick sequence of tholeiitic basalt with a MORB-like signature (see Corkery and Skulski, GS 22 this volume). The basalt is intruded by the White House tonalite (2734 ±2 Ma), which is geochemically similar to the Oxford Lake Group extrusive felsic fragmental rocks (Fig. GS-21-8). We suggest that the intrusive and extrusive rocks were comagmatic, implying that Hayes River Group rocks formed the basement, at 2734 Ma, for Oxford Lake Group arc-like felsic magmatism. This suggestion provides an important tectonic constraint on the relationship between the two groups.

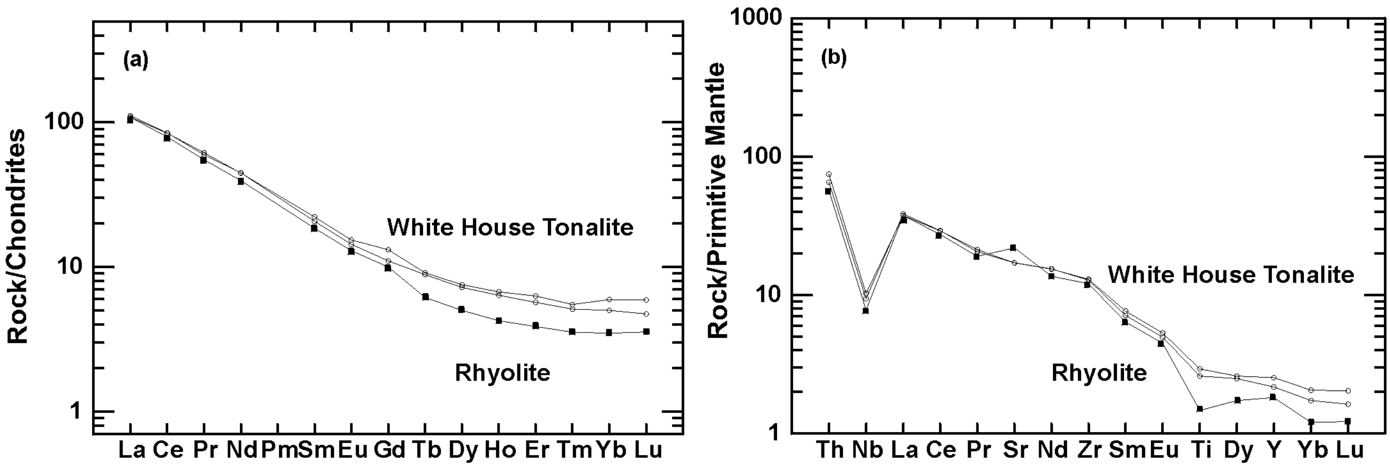

Figure GS-21-8: Chondrite-normalized REE plots and primitive mantle normalized trace element profiles of Oxford Lake Group rhyolite fragmental rock and White House tonalite.

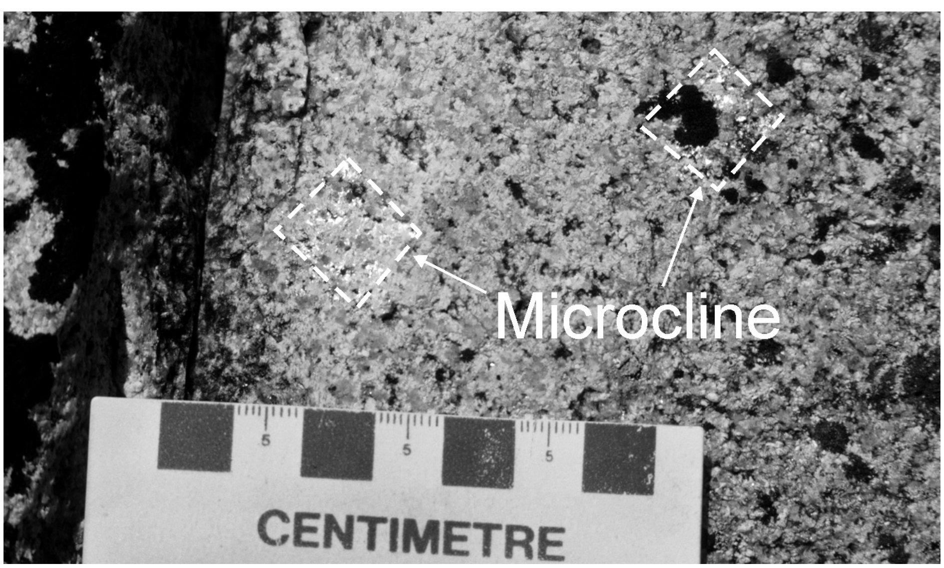

Figure GS-21-9: Typical texture of the medium- grained biotite granodiorite with 1 - 4 %, 2 - 4 cm tabular poikilitic microcline.

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