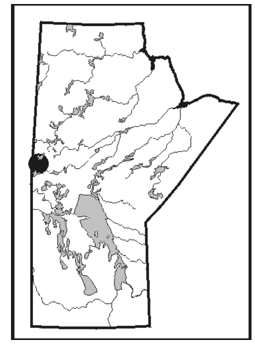
GS-3 GEOCHEMISTRY OF PALEOPROTEROZOIC VOLCANIC ROCKS IN THE LAC AIMÉE AREA, FLIN FLON BELT (PARTS OF NTS 63K/13SE and 63K/14SW)



by H.P. Gilbert

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SUMMARY

New geochemical data in the Lac Aimée area indicate that the Animus Lake block is a highly deformed tectonic wedge of MORB-like basalt, structurally juxtaposed against arc volcanic rocks to the southeast (Lac Aimée block). These contrasting crustal elements are separated by the crustal-scale Lac Aimée Fault Zone. N- and E-type MORB volcanic rock suites in Animus Lake block appear, in part, to be stratigraphically conformable, whereas the contact with arc basalt in the north part of the block is assumed to be faulted. Animus Lake N-type MORB is conspicuously depleted in rare earth elements (REE) and Zr, in contrast to most N-type MORB suites elsewhere in the Flin Flon Belt. Animus Lake block is provisionally interpreted as analogous to ocean floor basalt in the Elbow-Athapapuskow assemblage.

INTRODUCTION

1:20 000 scale mapping (1996-1997) in the Lac Aimée-Naosap Lake area, north-central Flin Flon Belt, identified five tectonostratigraphic volcanic rock assemblages separated by major faults (Fig. GS-3-1, GS-3-2). The map area is transected by the northeast-trending Lac Aimée Fault Zone, a crustal scale fault that marks the boundary between a highly deformed tectonic wedge of MORB-like volcanic rocks to the northwest (Animus Lake block) and arc-type rocks to the southeast (Lac Aimée block).

This report provides a brief summary of geochemical data derived from 1997 mapping. The data confirm field interpretations of the distribution of tectonostratigraphic rock assemblages, and provide details of the compositionally diverse Animus Lake block, which contains no less than three geochemically distinct volcanic rock suites.

VOLCANIC GEOCHEMISTRY

The Lac Aimée area contains parts of five tectonostratigraphic volcanic rock assemblages that include a broad range of geochemical rock suites (Gilbert, 1997a). In the area west of Animus Lake Fault (Fig. GS-3-2), Mikanagan Lake block consists of enriched (E-MORB type) basalt to the north, interpreted as arc-rift in origin, and 'transitional' basalt to the south that is intermediate between MORB- and arc-like

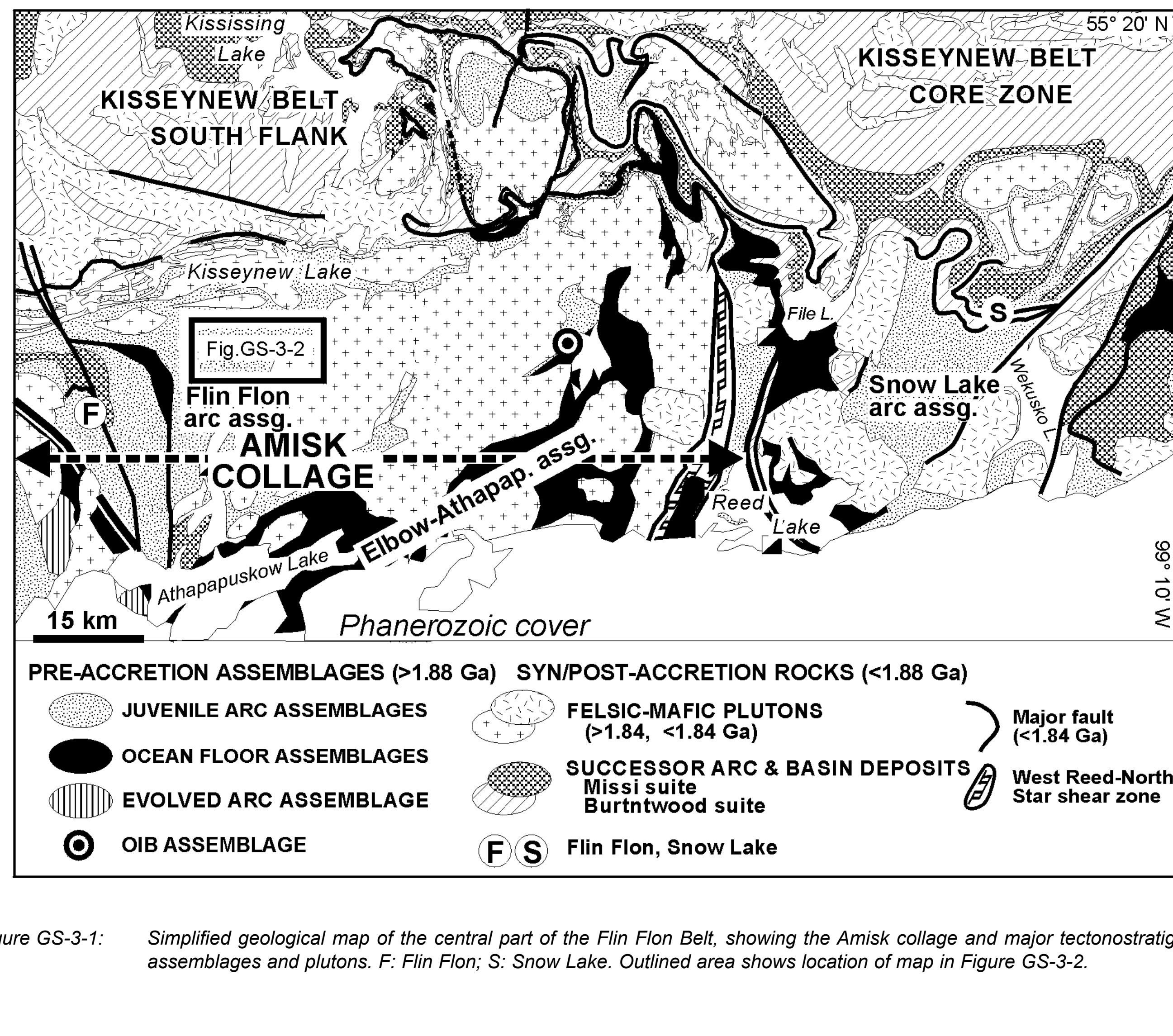

Figure GS-3-1: Simplified geological map of the central part of the Flin Flon Belt, showing the Amisk collage and major tectonostratigraphic assemblages and plutons. F: Flin Flon; S: Snow Lake. Outlined area shows location of map in Figure GS-3-2.

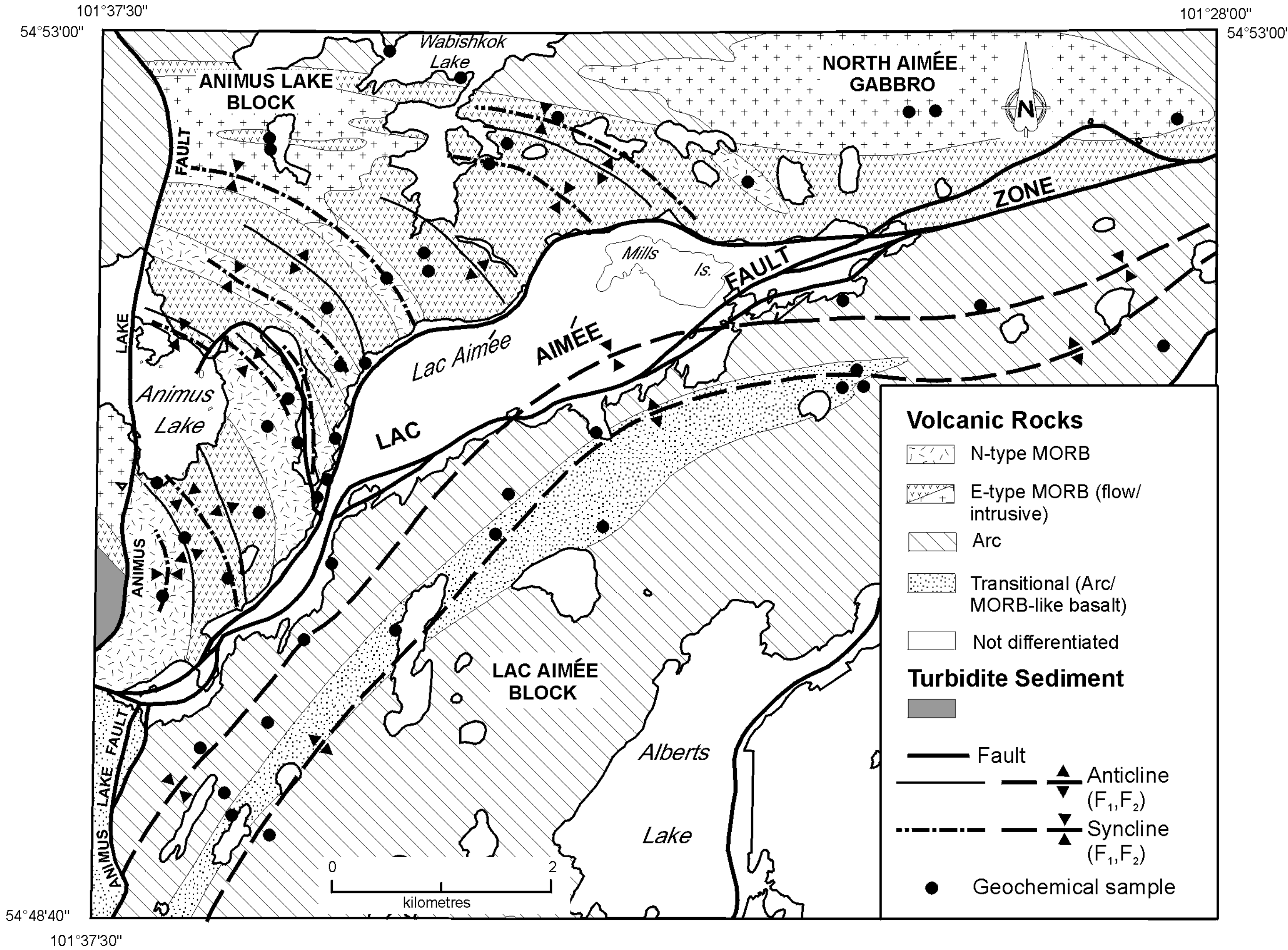

Figure GS-3-2: Map showing geochemically distinct volcanic rock suites and major structural features in the Lac Aimée area.

basalt (low-HFSE group, Gilbert, 1997a; Gilbert, 1996; 1998, paper in review). Mikanagan Lake block basalts are pillowed, aphyric and devoid of fragmental and sedimentary intercalations. Rocks of volcanic arc affinity southeast of Lac Aimée are stratigraphically more diverse, and include basalt, volcanic fragmental rocks, and subordinate felsic volcanic and sedimentary rocks. Within this arc assemblage, a transitional (MORB-like/arc) basalt unit up to 600 m wide extends for 8 km along the hinge-line of Lac Aimée anticline (Gilbert, 1997a, b).

Northwest of Lac Aimée, Animus Lake block consists almost exclusively of basalt and related gabbro, interpreted as E-MORB type rocks of arc-rift origin (Gilbert, 1997a). New geochemical data show that Animus Lake block in fact contains three distinctive volcanic rock suites (Fig. GS-3-2, GS-3-3). E-type and N-type MORB occupy the central and south parts of the block, whereas arc-type basalt occurs in the area north of Lac Aimée. Contacts between N- and E-type MORBs appear to be largely conformable, although the N-type/E-type MORB contact at the lake east of Animus Lake is coincident with a major fault. N-type MORB (Fig. GS-3-4) occupies the cores of major synclinal folds, and thus overlies the E-type MORB. The contact between MORB-like basalt to the south and arc-type basalt to the north is not clearly marked by either a structural or stratigraphic discontinuity. The contact is provisionally interpreted here as an early fault, only because arc and MORB-like volcanic suites elsewhere in the Flin Flon Belt are typically separated by major faults (Syme, 1995; Lucas et al., 1996). The relative ages of arc and MORB-like basalts in Animus Lake block are not known. Synvolcanic intrusive rocks suggest these geochemical rock suites are, in part, coeval: an arc-type basalt dyke intrudes E-type MORB flows close to the south extremity of Wabishkok Lake, whereas the North Aimée gabbro, which is geochemically akin to and assumed comagmatic with E-type MORB, is emplaced within arc volcanic rocks in the north part of Animus Lake block (Fig. GS-3-2).

DISCUSSION

Geochemical distinctions between volcanic rock suites in the Lac Aimée area are shown in Figure GS-3-3 and Table GS-3-1. High field strength elements (HFSE) Ti, Zr and Nb are typically lower in arc than MORB-like basalt; this is generally attributed to the refractory nature of the source regions of magmas. 'Transitional' basalts are characterized by HFSE levels intermediate between arc and MORB. Arc basalts are also distinguished from E-type MORB by higher levels of Th and, by association, large ion lithophile elements (LILE). Conspicuous Th enrichment relative to N-MORB is a hallmark of modern arc magmas, and is variously attributed to contamination of source magmas by sial or subducted sediments, or mixing of the source with metasomatized sub-arc mantle wedge (Stern et al., 1995a, b; Sinton and Fryer, 1987; Hawkesworth et al., 1994). Moderate Th enrichment is also characteristic of E-type MORB in the Lac Aimée area (Table GS-3-1), but notably not Animus Lake N-type MORB, in which Th (average=0.08 ppm) is depleted relative to N-MORB (average=0.12 ppm; Sun and McDonough, 1989). Elsewhere in the Flin Flon Belt, depletion of Th is displayed only by Moen Bay N-type MORB in the Elbow-Athapapuskow ocean floor assemblage (Stern et al., 1995b); all other MORB-like and arc volcanic rocks show moderate to strong Th enrichment. Low levels of Th and REE, and low Th/Nb in Animus and Moen Bay N-type MORB suites suggest the source magmas were not subjected to either metasomatism or mixing/contamination by subduction-related magmas; strong positive ε_{Nd} values for Moen Bay basalt are consistent with this interpretation (Stern et al., 1995b). Animus Lake N-type MORB is distinguished by conspicuously low Zr, and lower HFSE than other MORB-like rock suites in the Flin Flon Belt. This pattern may be due to mantle heterogeneity and/or remelting of the mantle source, during which incompatible elements become depleted in the refractory source (Jenner, 1996).

	ANIMUS LAKE	LAC AIMÉE	MIKANAGAN LAKE
N-type MORB	●		
E-type MORB	○		+
ARC	◐	◩	
TRANSITIONAL (ARC/MORB-like BASALT)		□	✱

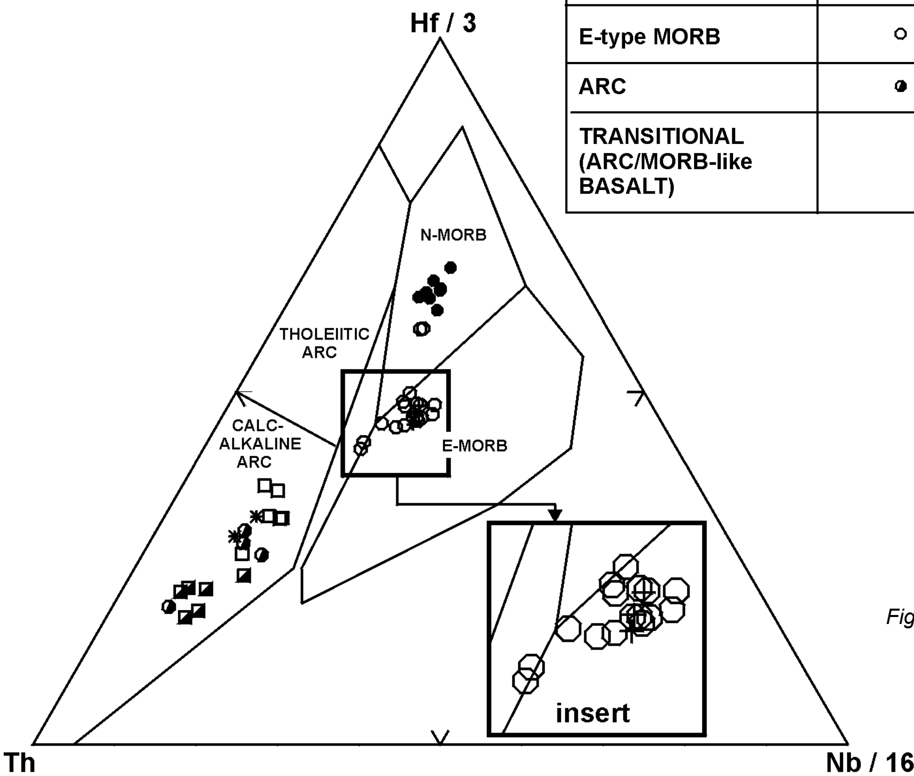

Figure GS-3-3: *Th-Hf-Nb ternary plot of mafic volcanic rocks in the Lac Aimée area. Compositional fields of modern volcanic rocks after Wood (1980).*

Figure GS-3-4: *Aphyric pillowed basalt of N-type MORB affinity close to the south end of Wabishkok Lake.*

The N-type/E-type MORB volcanic association in Animus Lake block suggests this highly deformed tectonic wedge may be related to the Elbow-Athapapuskow ocean floor assemblage, which extends through the south-central part of the Flin Flon Belt 20 km south of Lac Aimée (NATMAP Working Group, 1998). The ocean floor assemblage is characterized by structural juxtaposition of contrasting N- and E-type MORB volcanic rock suites, in contrast to Animus Lake block, in which these rock types appear, in part, to be stratigraphically conformable. Alternatively, enriched MORB-like basalts in Animus Lake block may represent arc-rift volcanics, which are typically associated with arc volcanic rocks in modern volcanic sequences. The tectonic interpretation of Animus Lake block is economically important, in view of the direct association of base-metal mineralization with arc and arc-rift volcanic rock suites in the Flin Flon Belt (Syme and Bailes, 1993; Syme et al., 1996). The tectonic setting of volcanic components in the Lac Aimée area will be the subject of an open file report, scheduled for publication early in 1999, which will include the geochemical database.

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Table GS-3-1
TiO_2 (%) and selected REE data (ppm) and element ratios of volcanic rock suites in the Lac Aimée area. Normalizing values from Sun and McDonough (1989).

Fault block	Geochemical suite	TiO_2 average (range)	Zr average (range)	Th average (range)	Nb average (range)	Th/Nb average (range)	$(La/Yb)_{ch}$ average (range)
Animus Lake	E-type MORB	1.61 (1.33-2.04)	80 (54-109)	0.53 (0.24-0.83)	6.14 (3.14-9.27)	0.09 (0.07-0.13)	1.60 (0.95-1.93)
Animus Lake	N-type MORB	0.62 (0.52-0.72)	17 (12-23)	0.08 (0.05-0.11)	1.09 (0.94-1.32)	0.07 (0.05-0.08)	0.36 (0.20-0.58)
Animus Lake	Arc	0.51 (0.48-0.57)	22 (21-32)	0.78 (0.51-1.46)	1.94 (1.51-2.40)	0.39 (0.25-0.66)	3.10 (2.21-5.23)
Lac Aimée	Arc	0.57 (0.27-0.86)	45 (26-64)	1.30 (0.62-2.32)	3.01 (1.36-4.98)	0.45 (0.28-0.61)	4.40 (1.89-5.53)
Lac Aimée	Transitional (arc/MORB-like)	1.07 (0.93-1.24)	53 (43-77)	0.93 (0.63-1.48)	3.39 (2.13-5.50)	0.27 (0.23-0.33)	2.20 (1.37-4.19)
Mikanagan Lake	Transitional (arc/MORB-like)	1.46 (0.73-2.03)	79 (30-131)	1.63 (0.30-2.90)	4.90 (4.00-5.80)	0.34 (0.31-0.38)	2.50 (1.02-3.59)
Mikanagan Lake	E-type MORB	1.81 (1.60-2.02)	43 (90-112)	0.56 (0.50 - 0.71)	7.58 (7.06-8.89)	0.08 (0.07-0.08)	1.80 (1.43-2.05)

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