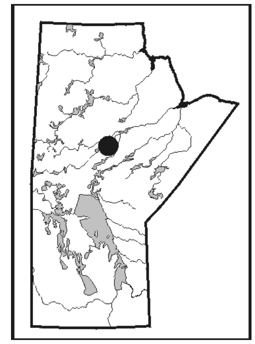
GS-13 **GEOLOGY OF THE NATAWAHUNAN LAKE AREA (PART OF NTS 63P/11)**



by Ch.O. Böhm[1]

Böhm, Ch.O. 1998: Geology of the Natawahunan Lake area; **in** Manitoba Energy and Mines, Geological Services, Report of Activities, 1998, p. 56-59.

SUMMARY

Field relationships, Nd isotopic information and preliminary U-Pb zircon age data for felsic and mafic granulite samples indicate a polyphase, Archean tectonic and metamorphic history of the Natawahunan Lake area. Nd model ages of 3.2-3.5 Ga and a pre-2.9 Ga U-Pb zircon crystallization age component provide evidence for the formation of middle Archean felsic and mafic crust on a regional scale. A younger generation of massive enderbite bodies were intruded prior to, or at, 2.71 Ga and underwent regional high grade metamorphism at around 2.70 Ga and possibly again at 2.67 Ga.

INTRODUCTION

Shoreline exposures on Natawahunan Lake, from Partridge Crop Lake in the southwest to the Grass River at the northeast end of Natawahunan Lake, were mapped during part of the 1997 field season. The main objective of this survey was to map and sample high grade lithological assemblages as part of a geochronology project transecting the northwestern margin of the Superior Province (e.g. Böhm et al., 1997). The corresponding Preliminary Map 1998 T1 (Böhm, 1998) augments earlier mapping by Weber (1978).

The area covered forms part of the Pikwitonei Granulite Domain, where high grade metamorphic rocks are well preserved. Retrogression due to the Hudsonian orogeny partly affected the western Natawahunan Lake/Partridge Crop Lake area and increases towards the Thompson Nickel Belt (Weber, 1978).

The Pikwitonei Granulite Domain is unique among high grade terrains worldwide for the abundance of well preserved granulite facies mineral assemblages that occur in a variety of lithologies (e.g. granodiorite, basalt, etc.). Most of the Natawahunan Lake area consists of meta-igneous units (e.g. enderbites), but remnants of supracrustal rocks such as banded iron formation and paragneiss have been reported (Weber, 1978; Weber, 1983). Estimates of peak pressure/temperature conditions during late Archean granulite facies metamorphism are about 6.7-7.3 kbar and 730-770^{o} C in the Cauchon Lake area and peak at about 7.0-7.8 kbar and 780-840^{o} C in the Natawahunan Lake area (Mezger et al., 1990).

TABLE GS-13-1
Structural and metamorphic evolution of the Natawahunan Lake area

D0	- development of compositional layering and sub-parallel foliation (early fabric) - disruption and flattening of mafic bodies (pancake style deformation) - open-style folding
M0	- amphibolite grade metamorphism (?)
D1	- migmatite formation and fabric development
M1	- amphibolite grade metamorphism (?)
D2	- boudinage, isoclinal intrafolial folding
	- development of mobilizates/melt pods
M2	- granulite grade metamorphism
D3	- transpressional (dextral laterally) shear bands, faulting and c/s fabric
M3	- greenschist to amphibolite grade retrogression

A set of east-northeast-striking cataclastic fault and shear zones that follow Natawahunan Lake intersect the map area. Some of these deformation zones can be traced for several tens of kilometers and are generally subparallel to major fault zones on Sipiwesk and Cross lakes to the south. Dextral transpression affected all lithologies and overprints several phases of deformation (Table GS-13-1).

The new geochronological findings primarily focus on the magmatic and metamorphic history of the granulites and associated supracrustal rocks in the Natawahunan Lake area. Preliminary U-Pb zircon ages and Nd isotopic data are presented in this report and discussed in a regional context.

GENERAL GEOLOGY

The distribution of the major geological domains and their structural subdivisions is illustrated in Figure GS-13-1. A simplified succession of geological events in the map area is summarized in Table GS-13-1.

The main lithologies in the map area are migmatitic felsic gneisses that contain variable proportions of mafic granulite and ultramafic inclusions (Fig. GS-13-2). Although no clear contacts were found in the field, two main types of closely associated felsic granulite can be distinguished: (1) tonalitic to granodioritic migmatitic gneiss interlayered with mafic granulite; and (2) younger, more uniform bodies of enderbite and minor opdalite. In addition, garnet gneisses and supracrustal assemblages, including banded iron formation, form discrete rafts within the granulites.

The following descriptions of the main rock types are given from oldest to youngest, according to observed or inferred age relationships.

Meta-pyroxenite commonly forms relatively coarse grained, uniform, anhedral to lensoid, centimeter- to decimeter- sized bodies and fragments. Contacts with the felsic granulite gneisses are sharp. The meta-pyroxenitic inclusions most likely represent relic sills of ultramafic composition (orthopyroxene, clinopyroxene, ±hornblende, olivine, plagioclase).

Mafic granulites usually form layers and/or lensoid bodies within felsic granulite gneisses (Fig. GS-13-3). Composition of the massive to layered mafic granulites is typically amphibolitic to gabbroic/noritic (plagioclase, clinopyroxene, hornblende, ±orthopyroxene, biotite, garnet, magnetite, quartz). A common feature is the formation of agmatitic structure with coarse grained mobilizate/leucosome (pyroxene, plagioclase, ±quartz, hornblende, garnet, magnetite) in the felsic granulites and along the rims of the mafic lenses (Fig. GS-13-4).

Internal structures, such as foliation and intrafolial folding in meta-pyroxenitic and noritic lenses, are commonly crosscut by foliation and metamorphic layering in the felsic granulite host gneisses. In addition, foliation and layering in the felsic granulites are crenulated and folded around the mafic and ultramafic lenses and layers. Occasionally, interlayered felsic and mafic granulites are folded around meta-pyroxenitic lenses.

Garnet-bearing gneisses are felsic to intermediate in composition (garnet, plagioclase, ±biotite, sillimanite). They tend to form discrete belts associated with supracrustal components such as quartzitic, mafic, or ultramafic (meta-pyroxenite) rocks, iron formation, and skarn (calc-silicate rocks).

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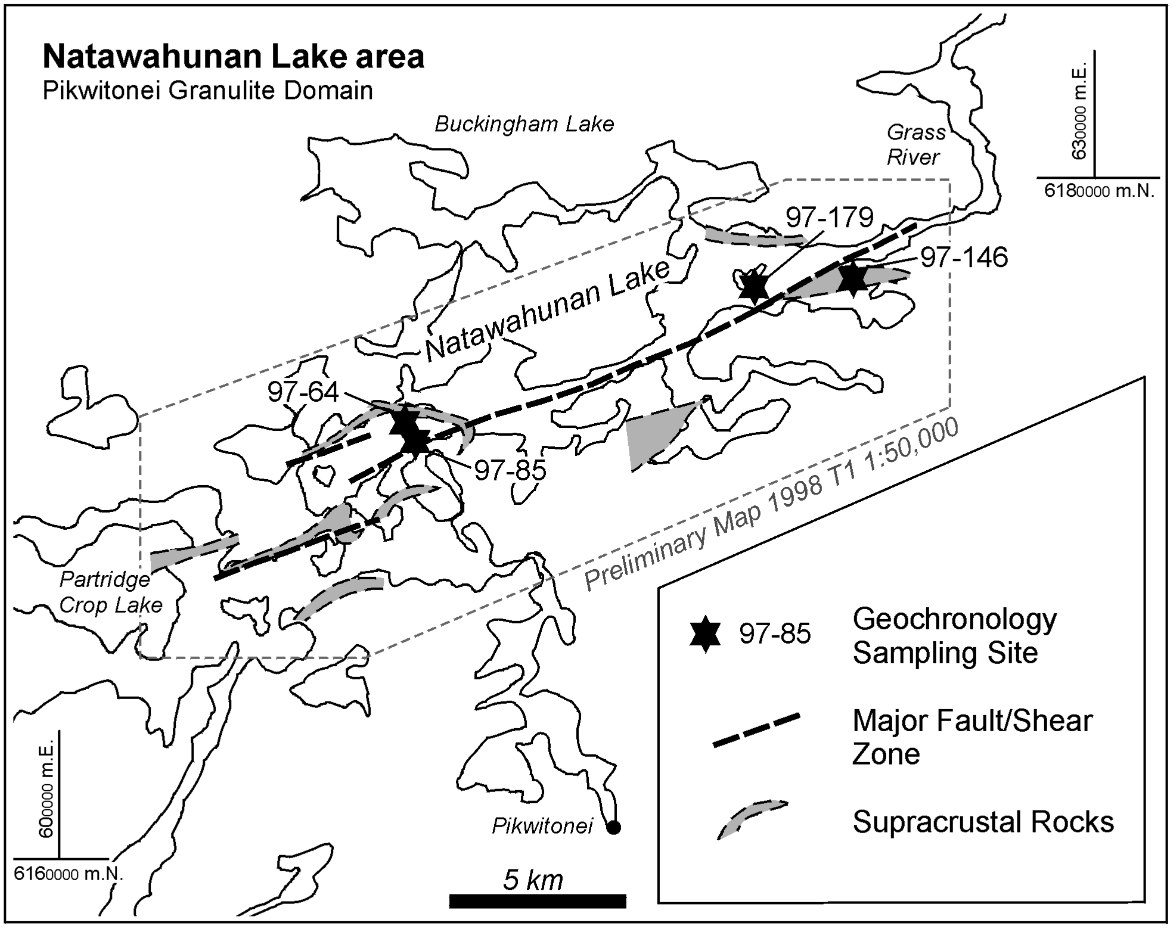

Figure GS-13-1: Geological sketch map of the Natawahunan Lake area showing main lithological boundaries, deformation zones and geochron sampling sites.

Figure GS-13-2: Granulite grade migmatitic felsic gneiss containing layers and lenses of mafic granulite and mobilizate, station 97-85, southwest Natawahunan Lake.

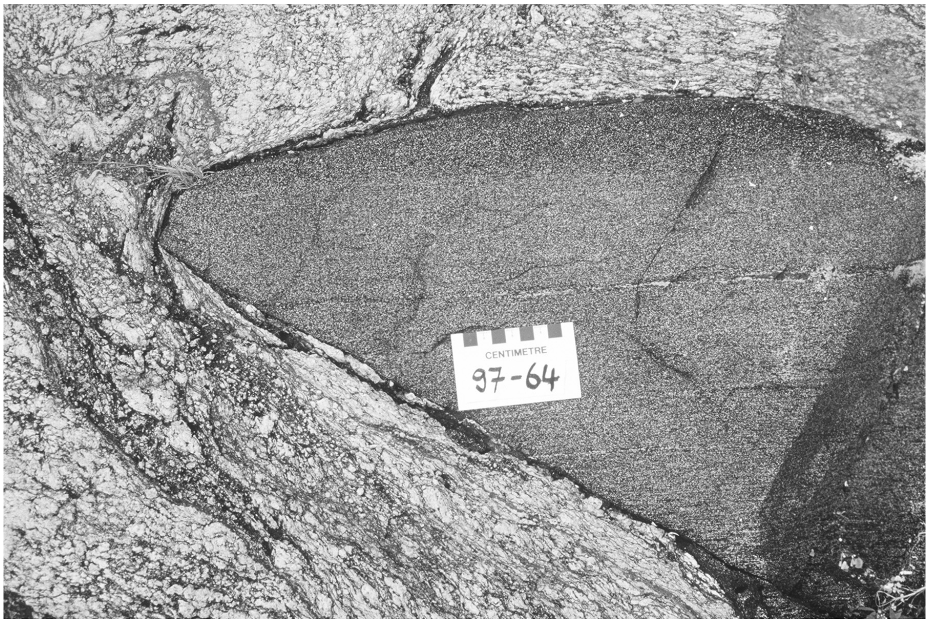

Figure GS-13-3: Noritic lens in opdalite gneiss, station 97-64, southwest Natawahunan Lake.

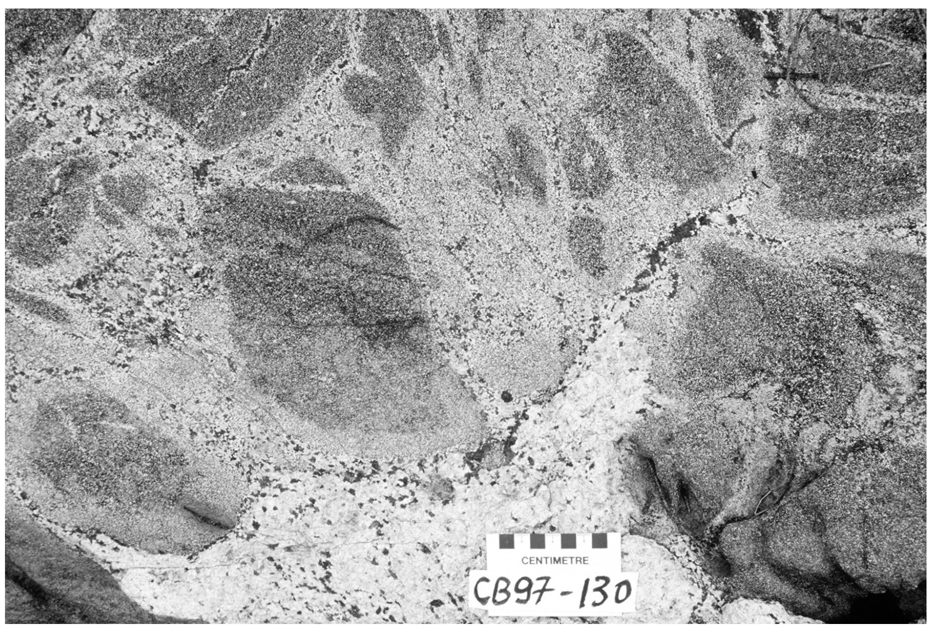

Figure GS-13-4: Granulite grade schollen enderbite with abundant mobilizate and pegmatitic injection, central Natawahunan Lake.

Iron formation is banded silicate (garnet-pyroxene±quartzite) and/or oxide (magnetite/quartzite) facies zones (Weber, 1978) within the supracrustal gneiss and granulite assembly. Iron formation-bearing zones occur as bodies and rafts in enderbitic gneiss, and are commonly associated with mafic granulites, ultramafic/meta-pyroxenitic zones, quartzite, garnet gneiss and minor skarn.

Enderbite (hypersthene tonalite) forms the predominant gneissic lithology in the map area. Typical colours are honey green to grey; the texture varies from massive to layered. The following types of enderbite can be distinguished in the field:

- **Schollen enderbite** contains abundant schollen and rafts of mafic granulite, enderbitic gneiss, and minor meta-pyroxenite (Fig. GS-13-4). The mafic inclusions originally formed larger bodies that have been partially disrupted, boudinaged and assimilated within the tonalite host rock.
- **Enderbitic gneiss**, the most abundant type of felsic granulite on Natawahunan Lake, generally is foliated and layered with variable amounts of paleosome, segregation, injection and mobilizate phases (plagioclase, pyroxene, ±biotite, quartz) (Fig. GS-13-2). Based on composition and structure, enderbitic gneiss most likely represents a highly metamorphosed equivalent of the abundant migmatite gneisses in adjacent Archean basement segments, i.e., in the Gods Lake Domain to the southeast of the Pikwitonei Granulite Domain.
- **Augen gneiss** represents a cataclastic-mylonitic, sheared (±retrogressed), type of enderbitic gneiss containing plagioclase and quartz porphyroblasts.

Opdalite (hypersthene granodiorite) forms honey-grey-beige to pink coloured, leucocratic bodies and gneiss complexes similar to enderbite.

- **Schollen opdalite** contains abundant inclusions of mafic granulite and minor meta-pyroxenite.

Mafic and ultramafic dykes, formerly known as Molson dykes, represent the youngest igneous activity on Natawahunan Lake. They occur in the entire map area but form a north-to northeasterly-trending swarm of mostly fresh, ultramafic dykes in the western part of Natawahunan Lake. Composition of the dykes varies from amphibolitic to gabbroic or diabasic (orthopyroxene, clinopyroxene, olivine, hornblende, plagioclase). Dyke margins are commonly fine-grained (i.e., chilled), and cores vary from fine- to coarse-grained. Most dykes are less than one metre wide; few reach several tens of metres. Mafic dykes are generally deformed, and display internal foliation and occasionally folding and/or boudinage, whereas ultramafic dykes are mostly massive. Correspondingly, at least two ages of mafic dyke emplacement at 2092 Ma (Halls and Heaman, 1997) and 1883 Ma (Heaman et al., 1986b) are currently recognized in the Pikwitonei Granulite Domain.

PRELIMINARY U-PB ZIRCON AGE DETERMINATIONS AND GEOLOGICAL CONSEQUENCES

Previously determined field relationships, petrography and U-Pb geochronology indicate at least two high grade Archean deformational and metamorphic episodes in the Pikwitonei Granulite Domain (Weber and Scoates, 1978; Heaman et al., 1986a; Mezger et al., 1990). For example, two distinct events of metamorphic zircon growth at ca. 2685 and 2640 Ma are recorded in the Cauchon Lake area with initiation of granulite conditions occurring as early as 2695 ±2 Ma (Heaman et al., 1986a).

The new geochronological investigations in the Natawahunan Lake area apply Nd isotopic tracing and U-Pb zircon dating. Geochron sampling locations are shown in Figure GS-13-1.

Nd model ages for three felsic granulite samples (97-64a, 97-85a, 97-179a) from Natawahunan Lake indicate mantle separation ages of ca. 3.3-3.5 Ga. Similar Nd model ages exist in other parts of the Pikwitonei Granulite Domain and in the Split Lake Block, suggesting regional formation of middle Archean crust. In addition, a garnet-bearing paragneiss sample from northwest Natawahunan Lake (97-146; similar to sample B in Mezger et al., 1989) shows a slightly younger Nd model age of 3.2 Ga. Since the garnet-bearing gneisses on Natawahunan Lake form highly deformed rafts within the granulite gneisses, a Mesoarchean origin is also suggested for (part of) the paragneisses and associated supracrustal rocks.

Preliminary U-Pb zircon ages are available for two felsic granulite samples (97-85a and 97-179a) and one sample from a mafic granulite lens (97-64). Sample 97-85a represents the felsic portion of a layered enderbite (above type (1) felsic paleosome) (Fig. GS-13-2). Most of the enderbite zircons are slightly discordant, show pink to brown colour and $^{207}Pb/^{206}Pb$ ages scatter around 2.70 Ga. Younger zircon growth at around 2.67 Ga is indicated by colourless grains. All 2.67-2.70 Ga zircons are characterized by relatively high Th/U ratios that range from 0.7-2.8. In contrast, an irregular fragment of a larger zircon shows a significantly older $^{207}Pb/^{206}Pb$ age of 2973 Ma and a distinct, lower Th/U ratio of 0.3. The pre-2.9 Ga minimum age for this zircon fragment is currently interpreted to represent the primary age for the felsic precursor of enderbite sample 97-85a. Consequently, zircon growth at around 2.70 Ga and possibly also at 2.67 Ga might indicate the M1 and M2 stages of medium to high grade metamorphism as listed in Table GS-13-1.

Sample 97-179a comes from a uniform enderbite body (above type (2)). Similar to the previous enderbite sample, $^{207}Pb/^{206}Pb$ zircon ages range from ca. 2.66 to 2.71 Ga (Th/U = 0.05-1.3). In addition, a colourless, equant zircon has a concordant age of 2701 Ma (Th/U= 1.7). Based on zircon morphologies, Th/U ratios, U-Pb ages and field relationships, the 2701 Ma zircon age is interpreted as the timing of metamorphism (M1?), subsequent to type (2) enderbite emplacement at or before 2.71 Ga.

Compared to the felsic granulite samples, zircons from a noritic lens (97-64) in an opdalite gneiss (97-64a) are much less abundant (Fig. GS-13-3). A concordant age of 2696 Ma for a mafic granulite zircon is interpreted as indicating metamorphic zircon growth and substantiates ca. 2695 Ma regional high grade metamorphism in the Pikwitonei Granulite Domain (Heaman et al., 1986a) and in the Split Lake Block (Böhm et al., 1997).

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