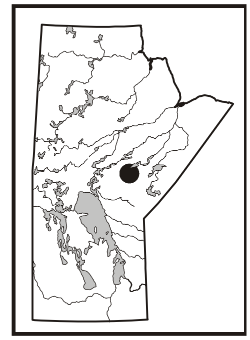
GS-20 SOUTHEAST MAX LAKE AREA (PARTS OF NTS 53L/5NW AND 12SW)



by H.P. Gilbert

Gilbert, H.P. 1999: Southeast Max Lake area (parts of NTS 53L/5NW and 12SW); *in* Report of Activities, 1999, Manitoba Industry, Trade and Mines, Geological Services, p. 84-93.

SUMMARY

1. The Ralph Anderson Lake greenstone belt is a branch of the Archean 'Max Lake belt', and extends from Logan Lake in the west to Aswapiswanan Lake in the east for a distance of ca. 50 km. The monoclinal greenstone belt consists mainly of arc-type mafic volcanic rocks, with subordinate felsic volcanic and sedimentary units.

2. The lower (south) part of the Ralph Anderson Lake belt is intruded by a ca. 1.2 km thick post-volcanic gabbro sill. A series of skialithic enclaves in the gabbro that constitute the lower part of the supracrustal sequence consist of basalt, heterolithologic debris flows and turbidite, and rhyolitic rocks. The overlying main basaltic sequence that constitutes the major part of the belt contains a second gabbro sill in the central zone, and a felsic volcanic formation (together with an associated subvolcanic porphyry sill) close to the north (upper) margin of the belt.

3. The mafic volcanic rocks, which consist mainly of pillowed aphyric basalt, are characterized by widespread sea-floor type hydrothermal alteration. A prominent garnetiferous, silicic alteration zone in the northwest part of the map area is coincident with an oxide-facies iron formation, and is interpreted as a site of early hydrothermal alteration. Alteration associated with later deformation is also widespread in the map area, and is especially conspicuous at the south margin of the main basaltic sequence.

4. Pyritic mineralization occurs in various stratigraphic/structural settings; the best prospect for base-metal exploration appears to be the garnetiferous alteration zone in the northwest part of the map area, which displays extensive surficial iron staining. Sulphide mineralization is also common elsewhere in magnetiferous iron formations, which offer potential base-metal or precious metal exploration targets. Lastly, the conjunction of the volcanic terrane with gabbro at the south margin of the greenstone belt contains sporadic pyritic zones that may represent prospects for economic mineralization.

INTRODUCTION

The southeast Max Lake area is located 120 km east-northeast of Norway House, at the conjunction of the Archean Gods Lake and Molson Lake domains (Manitoba Energy and Mines, 1987). The map area is centered on a series of small lakes immediately southeast of Max Lake, and encompasses part of a 2.5 km wide supracrustal belt (Ralph Anderson Lake belt) that extends from Logan Lake in the west to Aswapiswanan Lake in the east for a strike length of 50 km (Fig. GS-20-1). This belt merges with the northeast-trending Max Lake belt in the west (Hubregtse, 1974); to the east, the belt is on-strike (across a drift-covered area) with supracrustal rocks in the Goose Lake-Beaverhill Lake area (Elbers and Marten, 1973), which are inferred to be laterally continuous with the Ralph Anderson Lake belt.

Previous geological maps in the southeast Max Lake area show only the rudiments of stratigraphic and structural information (Currie, 1961; Elbers, 1973a, b; Schledewitz, 1980). Forest fires in 1989 in the central and west parts of the map area resulted in a significant increase in the amount and quality of bedrock exposure, and thus increased the scope for detailed geological mapping. A one month field mapping program was initiated in 1999, in order to investigate the stratigraphy, structure and volcanic geochemistry of the supracrustal rocks, and to provide a detailed 1:20 000 scale geological map as a base for possible further geological studies. Alteration associated with mineralization, and in particular in a

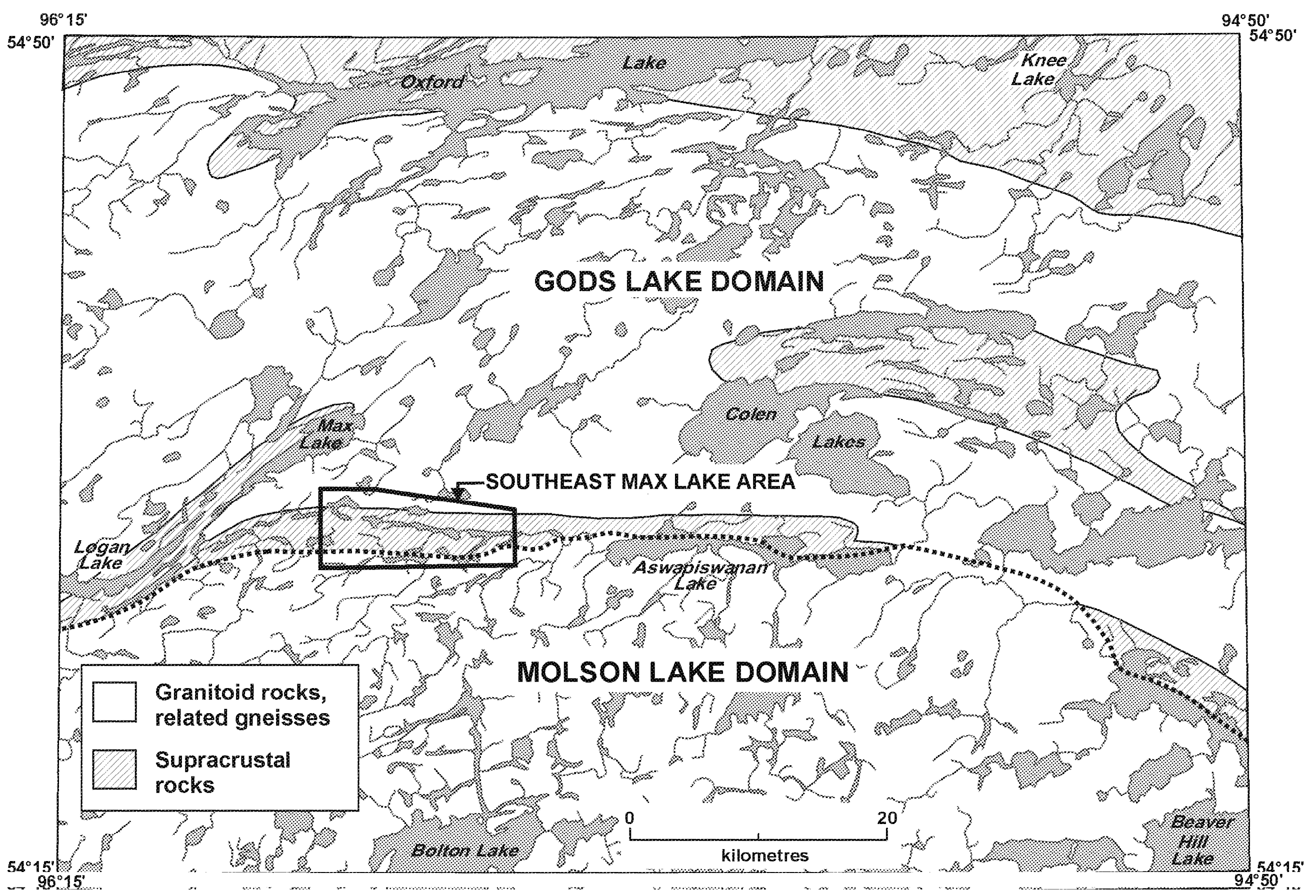


Figure GS-20-1: Regional setting of the southeast Max Lake area.

conspicuous 36 m wide garnetiferous, silicified zone in the northwest part of the map area, were subjects of special attention.

The Ralph Anderson Lake belt consists mainly of basaltic pillow lavas with subordinate felsic volcanic rocks, heterolithologic breccias and epiclastic deposits, flanked by granitoid rocks to the north and a 1.2 km wide gabbroic intrusion (McLeod Narrows gabbro) to the south (Fig. GS-20-2; Table GS-20-1). The supracrustal rocks are provisionally equated with the volcanosedimentary 'Hayes River Group' in the Oxford Lake-Knee Lake-Gods Lake area northeast of Max Lake (see Hubregtse, 1985a, and references therein). The margins of the Ralph Anderson Lake belt are characterized by contact zones in which the supracrustal rocks are intruded by conformable units derived from the flanking plutonic terranes. The granitoid terrane north of the Ralph Anderson Lake belt consists of tonalitic to granodioritic intrusions and related gneisses (Hubregtse, 1985b). The McLeod Narrows gabbro south of the belt contains volcanic and related sedimentary skialithic enclaves (up to 300 m thick) considered to be part of the supracrustal sequence, which is interpreted as monoclinal. Abundant facing directions indicated by pillow structure and sporadic top indicators in epiclastic rocks are almost exclusively to the north. Whereas regional strike-parallel faults have not been identified within the greenstone belt, the effects of possible faulting (i.e., structural hiatus or repetition) cannot be discounted. In this report, lithostratigraphic formations are described in order of decreasing age, beginning with the (inferred) oldest supracrustal enclaves within the McLeod Narrows gabbro.

Table GS-20-1: Table of Formations, southeast Max Lake area.

PRECAMBRIAN (ARCHEAN)

INTRUSIVE ROCKS

7	Leucogabbro, diabase
6	Tonalite, granodiorite; minor plagioclase porphyry, pegmatite, aplite; related gneiss
5	Gabbro, minor pyroxenite and hornblendite (Lavigne Lake gabbro; McLeod Narrows gabbro); diabase

VOLCANIC AND SEDIMENTARY ROCKS

4	Rhyolite, massive to fragmental; heterolithologic breccia, minor related sedimentary rocks; plagioclase ± quartz porphyry
3	Heterolithologic volcanic breccia and associated tuff; related sedimentary rocks
2	Sedimentary rocks: oxide-facies iron formation, siltstone, feldspathic greywacke; altered supracrustal rocks
1	Basalt, mainly aphyric and pillowed; related fragmental and intrusive rocks; derived laminated amphibolite, schist and gneiss

STRATIGRAPHY

The basal part of the stratigraphic sequence in the Ralph Anderson Lake belt is represented by supracrustal rocks that occur as skialithic enclaves within the south part of the McLeod Narrows gabbro (Fig. GS-20-2). The southernmost (oldest) supracrustal enclave consists of an aphyric pillowed basalt formation (95 m thick); further north, the gabbro contains an enclave of heterolithologic volcanic breccia and associated sedimentary rocks (up to 300 m thick) and (further north) a felsic volcanic rock formation (up to 85 m thick). Directly north of the McLeod Narrows gabbro, a mafic volcanic sequence extends for up to 1.2 km to the south margin of a gabbro-hornblendite sill in the central part of the belt (Lavigne Lake gabbro). This basaltic section, together with the skialithic enclaves in the McLeod Narrows gabbro, constitute the stratigraphically lower, south part of the greenstone belt.

The north (upper) part of the belt (north of the Lavigne Lake gabbro) is up to 1 km wide and also consists largely of mafic volcanic rocks and related gabbro, together with derived schist and gneiss. A felsic volcanic

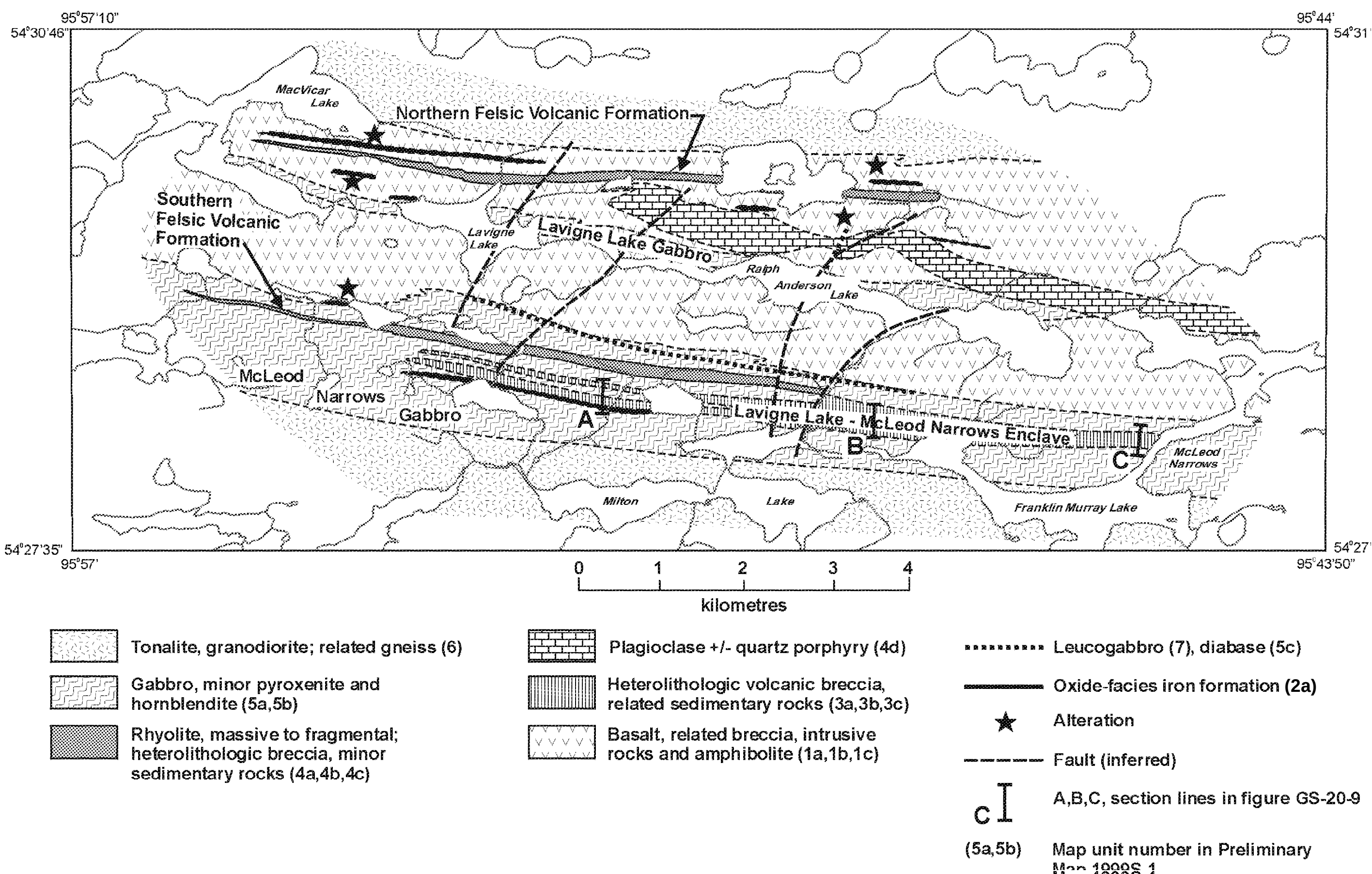


Figure GS-20-2: Simplified geological map of the southeast Max Lake area.

formation (up to 115 m thick) within the northern section extends laterally for at least 7 km along strike; the felsic rocks are interpreted as the extrusive equivalents of a felsic porphyry sill that directly underlies the rhyolite northwest of Ralph Anderson Lake (Fig. GS-20-2). The felsic volcanic formation consists of massive rhyolite and related fragmental rocks, heterolithologic volcanic breccia, and subordinate greywacke-siltstone and conglomerate.

A prominent garnetiferous alteration zone, up to 36 m wide, occurs within mafic volcanic rocks approximately 0.2 km south of the north margin of the greenstone belt. Oxide-facies iron formation is coincident with the garnetiferous zone, and also occurs within the underlying mafic volcanic sequence in the north part of the belt. Similar iron formations occur at the basalt/gabbro contact at the south margin of belt, and in association with supracrustal rocks within the McLeod Narrows gabbro.

Basalt, related fragmental and intrusive rocks; derived laminated amphibolite, schist and gneiss (1)

Aphyric basalt; minor plagioclase-phyric basalt and related gabbro (1a)

Aphyric basalt is the predominant supracrustal lithology in the Ralph Anderson Lake belt. In the south part of the belt, the mafic flows are mainly pillowed, and locally contain irregular pillow-fragment breccia zones. Subordinate non-pillowed basalt flows and gabbroic sills are intercalated with pillowed units at a scale of 2 to 25 m; flow contacts are locally marked by thin (2-5 cm) chilled margins or discrete flow-top breccia units. In the central part of the Ralph Anderson Lake belt, pillows are undeformed or only moderately deformed, whereas toward the north margin of the belt the flows are more attenuated and gradational with intercalated laminated amphibolite and mafic gneiss over a 600 m wide section; attenuation is less pronounced toward the south margin of the belt. Features that distinguish the northern mafic volcanic sequence from that in the south part of the belt are listed in Table GS-20-2.

Pillowed flows in the south part of the Ralph Anderson Lake belt are characterized by ovoid to amoeboid pillows (0.5-2 m in diameter), locally interspersed with large 'mattress' pillows (up to 6 x 2 m) in the lower parts of some flow units. Whereas plagioclase phenocrysts occur in less that 5% of mafic flows, amygdales (with quartz ± plagioclase or rare chlorite fill) are widespread in pillowed flows, randomly distributed or concentrated in the marginal zones of pillows. Ovoid vugs (2-12 cm long), locally filled with carbonate, are common in the central parts of pillows. Basaltic flows are characterized by interpillow hyaloclastite or (less common) carbonate or chert. Rare concentric cooling fractures occur in pillows and analagous parallel fractures occur at the upper margins of some flows, where fracture spacing decreases toward the contact.

Basalt pillow-fragment breccia, flow-top breccia (1b)

Monolithologic volcanic fragmental rocks are intimately intercalated with massive flows and constitute approximately 5-10% of the mafic volcanic sequence in the Ralph Anderson Lake belt. The autoclastic breccias occur in conformable, discontinuous zones typically 1-8 m wide, and as lensoid to irregular deposits up to 35 x 10 m that are interdigital with mafic flows. At one locality just north of the McLeod Narrows gabbro, the pervasive, marginal part of a breccia unit is interstitial to pillows at the edge of an adjacent flow, where pillows are partly detached and incorporated into the fragmental unit (Fig. GS-20-3). Basaltic amoeboid pillow breccia contains angular, tabular or highly irregular, amoeboid pillow fragments up to 30 x 12 cm, in a hyaloclastic matrix; amygdales are ubiquitous in the fragmental deposits. Flow-top breccias, which are relatively thin (0.2-1 m), display gradational contacts with underlying flow units, whereas contacts with overlying units are sharply defined. Flow-top breccias are assumed to be due to localized fragmentation of the chilled upper margins of cooling flows, in contrast to the thicker autoclastic units, which are thought to represent pillowed flow units that were disrupted at a later stage of cooling, possibly due to foundering on inclined slopes. Flow-top breccias are relatively incompetent compared to contiguous massive or pillowed units, and are thus commonly sheared and variously epidotized or silicified.

Table GS-20-2: Features that distinguish the mafic volcanic sequence north of the Lavigne Lake gabbro from the basaltic sequence in the south part of the Ralph Anderson Lake belt.

1. Non-pillowed basalt flows appear to be more common than pillowed units; autoclastic breccia and amygdaloidal texture are less widespread. The section includes a flow unit of spherulitic pillowed basalt.
2. Oxide-facies iron formation is more abundant (6 magnetiferous units in the northern mafic volcanic sequence vs. 2 units in the southern sequence). Iron formation is locally coincident with early hydrothermal alteration in a conspicuous garnetiferous zone near the north margin of the belt.
3. Alteration of volcanic rocks consists mainly of epidotization and carbonatization, and occurs typically in concordant, 1-5 m wide zones; concentric, zonal silicic/epidotic alteration of pillows is not characteristic.
4. Deformation is more significant; pillow elongation is typically 4:1 to 10:1. Basalt is locally recrystallized to epidote-amphibole gneiss, or altered to finely laminated amphibolite where the intensity of deformation increases toward the north margin of the belt.

Alteration in massive to fragmental basaltic rocks (1a, 1b)

Syngenetic alteration is widespread in mafic volcanic rocks in the Ralph Anderson Lake belt. The occurrence of altered, silicified flow-top breccia in sharp contact with overlying unaltered basalt suggests alteration was penecontemporaneous with volcanism (Fig. GS-20-4). About one third of pillowed flows have been affected by epidotization and/or silicicification that are interpreted as sea-floor in origin; such alteration is insignificant in non-pillowed flows. Syngenetic alteration was

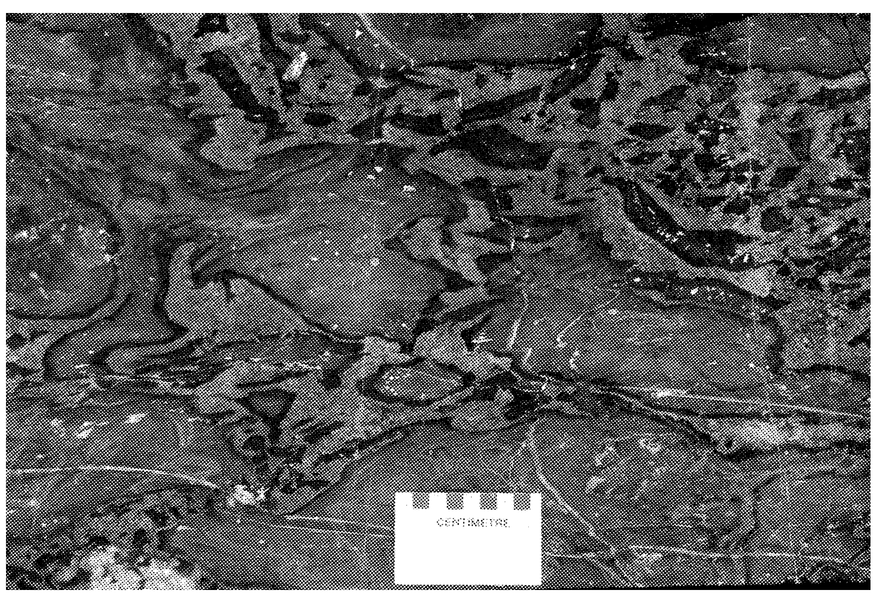


Figure GS-20-3: Aphyric pillowed basalt with pervasive interpillow autoclastic breccia (1b).

Figure GS-20-4: Altered 1 m wide basaltic flow-top breccia (1b). Fragments are spalled from underlying pillows; the top of the pale gray weathering, silicified unit is in sharp contact with overlying dark green, unaltered massive basalt.

initiated by the growth of chlorite + actinolite along radially disposed cooling fractures, followed by epidotization that extended from internal fractures toward pillow cores. Such alteration was commonly accompanied by silicification of pillow margins that resulted in progressive concentric zonation, defined by an outer (pale gray/white) silicified zone, inner (pale yellow) epidosite domain and unaltered, green pillow core (Fig. GS-20-5). More pervasive alteration in a minority of flows resulted in the complete replacement of selected small pillows by silica. Many flows are characterized by variable epidotic alteration in pillow cores, without attendant silicification (Fig. GS-20-6); selective epidote replacement of pillow selvages has also affected some units. In addition to these specific sites of alteration, sporadic epidote pods, stringers and diffuse epidotic domains occur throughout the mafic volcanic section. These features are probably due to both syngenetic and later alteration, associated with hydrothermal processes or regional greenschist facies metamorphism. Minor carbonatization is widespread, commonly selective at pillow selvages, interstitial to pillows, or in the matrix of volcanic breccia. Whereas some carbonatization is syngenetic, this type of alteration is locally postvolcanic, for example, in shear zones, or in a 16 m wide carbonatized zone of highly contorted basalt and post-volcanic diabase that are in contact with the north margin of the McLeod Narrows gabbro, 150 m from the south tip of Lavigne Lake. The basalt/gabbro contact west of this locality is characterized by similar postvolcanic, pervasive alteration (silicification, epidotization, and localized anthophyllite (?) blastesis) accompanied by intense shearing and local pyrite mineralization in a 100 m wide zone at the south margin of the mafic volcanic sequence.

Gabbro, locally plagioclase phyric, megaphyric or glomerophyric; minor hornblendite (1c)

Synvolcanic gabbro constitutes approximately 20% of the mafic volcanic sequence in the Ralph Anderson Lake belt, and ranges from minor intrusive units to sills up to 80 m thick. These massive, homogeneous rocks are mesocratic to melanocratic, and commonly display chilled margins at the contact with mafic volcanic rocks. The rocks are typically medium- to coarse-grained, and commonly 'spotted' due to prominent equant hornblende crystals. Rare porphyritic zones with plagioclase phenocrysts up to 2 cm long occur in some intrusions. One 45 m thick sill that extends for over 2 km along the south shore of Ralph Anderson Lake contains a plagioclase megaphyric to glomerophyric zone.

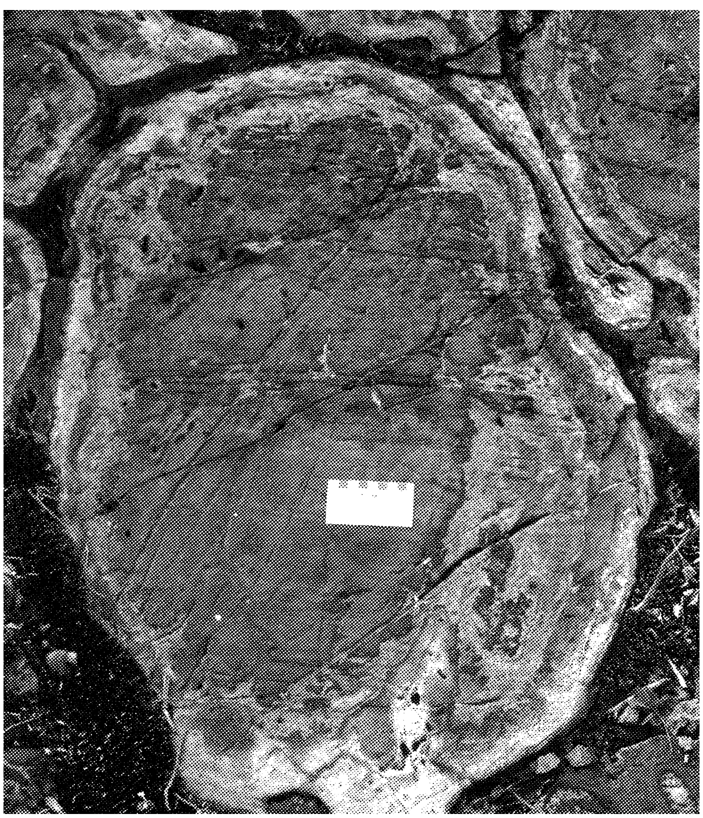


Figure GS-20-5: Zonal alteration of pillows in basalt (1a).

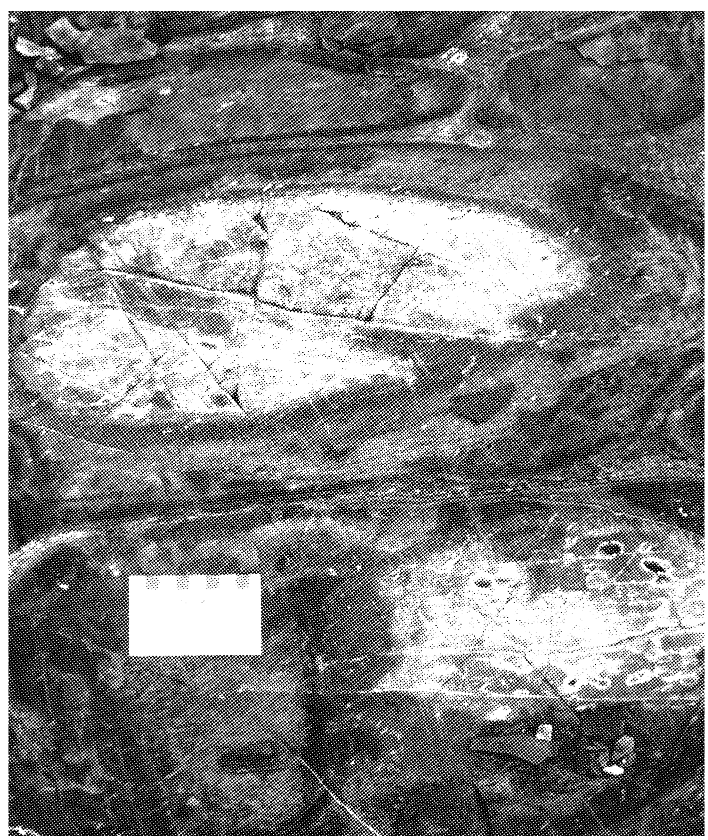


Figure GS-20-6: Epidotization of pillow cores in amygdaloidal basalt (1a).

The north (upper) part of the sill is characterized by conspicuous pseudohexagonal plagioclase megacrysts and glomerocrysts up to 13 cm across (Fig. GS-20-7), and hornblende pseudomorphs after pyroxene (2-15 mm) that each constitute up to 20% of the rock. The plagioclase megacrysts, which are partly saussuritized, diminish in size and abundance southwards toward a basal zone of melanocratic gabbro and hornblendite. Some basaltic flows that are contiguous with porphyritic gabbro units display analagous plagioclase phyric textures, suggesting they are the extrusive counterparts of the mafic sills.

Sedimentary rocks: oxide-facies iron formation, feldspathic greywacke, siltstone; altered supracrustal rocks (2)

Most fine grained sedimentary rocks in the map area occur in association with volcanic fragmental debris flows (3) or with detrital components in felsic volcanic rock formations (4). Other sedimentary deposits include iron formations (2a) that occur at 5 stratigraphic horizons within the greenstone belt, and several greywacke-siltstone units (2b) that occur in the south part of the belt. Strongly deformed and altered rocks in a prominent garnetiferous zone (2c) close to the north margin of the belt are also, in part, of sedimentary origin.

Oxide-facies iron formation (2a)

Magnetiferous iron formations occur at 3 stratigraphic horizons in the north part of the Ralph Anderson Lake belt. The iron formations, which extend for at least 6 km along strike, occur within basaltic flows and derived amphibolite both above and below the northern felsic volcanic formation (Fig. GS-20-2). The northernmost oxide iron formation, ca. 150 m above the felsic volcanic rocks, consists of 2 'banded' magnetite/chert units (1.3 m and 1 m thick, respectively), separated by up to 10 m of laminated amphibolite; these units occur a few metres north of a prominent garnetiferous alteration zone (2c) close to the northeast corner of MacVicar Lake. The alteration zone itself contains 2 thin (<1 m thick) magnetite/chert units. Similar oxide-facies iron formations occur (i) 200 m and (ii) 400 m below the felsic volcanic formation.

The iron formations consist of massive magnetite and chert laminae (± very fine grained, chloritic amphibolite), typically 2-20 mm thick (locally up to 6 cm). Both chert and amphibolite laminae contain subordinate magnetite; in some units, thin chloritic partings occur in place of amphibolite laminae. Siliceous siltstone or intermediate, garnetiferous siltstone are associated with several magnetiferous units. The iron formations are locally highly contorted, with steeply plunging, partly disrupted folds. Surficial iron staining due to alteration of pyritic zones within the magnetiferous rocks is widespread.

In the south part of the Ralph Anderson Lake belt, oxide iron formations occur (i) 1 km south of MacVicar Lake, close to the base of the mafic volcanic sequence, and (ii) at the base of the Lavigne Lake-McLeod Narrows supracrustal enclave that extends through the central part of the McLeod Narrows gabbro (Fig. GS-20-2). The iron formation south of MacVicar Lake is thin (30 cm) and of limited lateral extent, in contrast to the formation at the base of the supracrustal enclave, which consists of 4 magnetiferous units (0.5-1.5 m wide) intercalated with siltstone over a 14 m wide section. The magnetiferous units consist of intercalated 2-30 mm thick laminae of magnetite-chlorite rock, chert, siltstone (± garnet) and very fine grained amphibolite. The intervening well laminated siltstone beds contain anthophyllite (?) porphyroblasts (as small 1-3 mm lenticles and elongate blasts up to 3 cm long) in strata-bound zones 20-80 cm wide. The iron formation is locally tightly folded and partly disrupted.

Siltstone, feldspathic greywacke (2b)

A 20 m thick siltstone unit occurs 0.8 km south of the east part of MacVicar Lake, at the south margin of the mafic volcanic terrane (Fig. GS-20-2). The siltstone is porphyroblastic in a 3 m wide zone at the northern margin, where ovoid andalusite (?) blasts constitute up to 40% of the rock. The siltstone/basalt contact displays extensive surficial iron staining due to the weathering of a 2 m wide zone of disseminated pyrite mineralization. Felsitic rocks of probable intrusive origin occur to the south, between the sedimentary rocks and the north margin of the McLeod Narrows gabbro.

Feldspathic greywacke, pebbly wacke and siltstone occur in several narrow (ca. 20 m) skialithic enclaves within the McLeod Narrows gabbro, 600 m north of the west end of Milton Lake (Fig. GS-20-2). The rocks are characterized by well defined, locally graded beds (10-70 cm thick) consistent with a turbidite origin. Stratigraphically equivalent rock units at the narrows between Milton and Franklin Murray lakes contain porphyroblasts provisionally identified as cordierite and sillimanite. These sedimentary units, together with aphyric basalt in contiguous enclaves in the south part of the gabbro sill, comprise the basal part of the supracrustal sequence in the Ralph Anderson Lake belt.

Altered garnetiferous supracrustal rocks (2c)

A conspicuous 36 m wide zone of silicified supracrustal rocks, including magnetiferous iron formation, occurs within massive basalt and related laminated amphibolite close to the northeast corner of MacVicar Lake. This zone extends laterally for approximately 1.5 km, close to the shore of the lake. Four magnetiferous units (30-80 cm thick) occur (i) within the altered zone and along the north margin of the zone, and (ii) within adjacent amphibolite to the north. Stratigraphically equivalent oxide-facies iron formation, on-strike to the east, extends through the north part of the map area for over 5.5 km.

The altered supracrustal rocks have been extensively recrystallized to coarse grained garnetiferous gneiss, which was strongly deformed and partly disrupted by sinistral strike-slip movement. The zone is characterized by extensive surficial iron staining due to the weathering of disseminated pyrite. Siliceous rocks, which constitute 20-40% of the zone, can mostly be traced to basalt precursors, which occur as irregular, dark green massive to laminated remnants within the altered rocks (Fig. GS-20-8), and as intercalated concordant units. Horizons of intense alteration and deformation are characterized by pervasive quartz veins, sporadic garnets (up to 2 cm), blastic garnetiferous trails and massive garnetite layers up to 15 cm thick, which are highly contorted. Minor disrupted plagioclase porphyry and siltstone units occur in the alteration zone along strike to the west, where brittle deformation has locally resulted in the

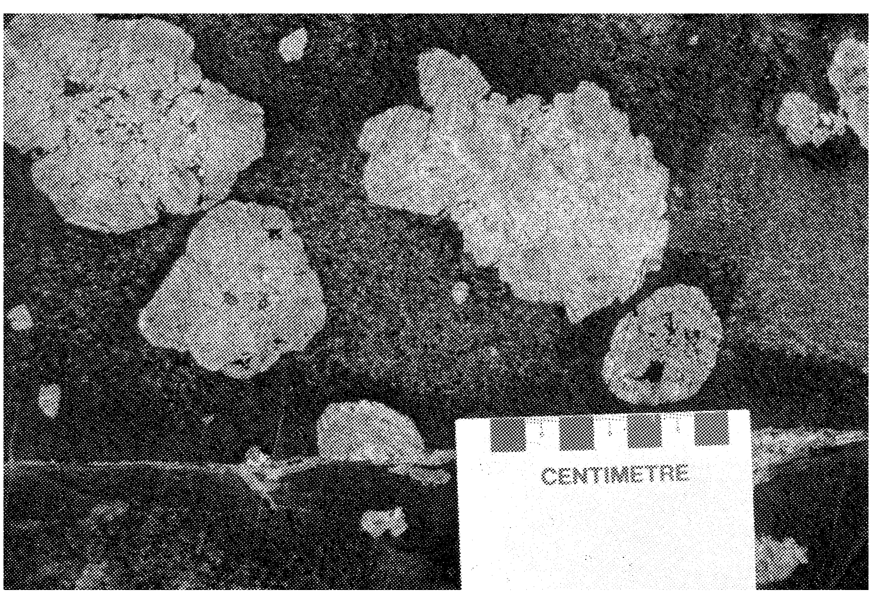


Figure GS-20-7: Pseudohexagonal plagioclase glomerocrysts in megaphyric gabbro (1c).

Figure GS-20-8: Disrupted garnetiferous amphibolite in zone of silicic alteration, northeast MacVicar Lake (2c).

development of tectonic breccia.

The alteration is interpreted as a result of early hydrothermal activity and sulphide mineralization, possibly contemporaneous with volcanism and related felsic porphyry intrusions. Garnet porphyroblastesis and subsequent disruption of the altered rocks is attributed to later regional metamorphism and deformation.

Heterolithologic volcanic breccia and associated tuff; related sedimentary rocks (3)

Heterolithologic volcanic fragmental rocks (3) occur as skialithic enclaves within the McLeod Narrows gabbro in the south part of the Ralph Anderson Lake greenstone belt. The most conspicuous formation extends for at least 8 km through the central part of the gabbro (Lavigne Lake-McLeod Narrows enclave, Fig. GS-20-2); the 200-300 m thick formation consists mainly of mafic to felsic volcanic fragmental detritus, together with reworked sedimentary deposits (Fig. GS-20-9). Unsorted heterolithologic breccias (3a, 3b) within the enclave are interpreted as debris flows, possibly initiated by the slumping of unconsolidated volcanic fragmental detritus on unstable slopes. Well layered and locally graded sedimentary rocks in the central part of the section northwest of Milton Lake (section A in Fig. GS-20-9) are interpreted as turbidites (3c). A basal 14 m thick unit of oxide iron formation (unit 2a) underlies volcanic breccia in the same section, whereas further east the basal unit consists of graded and laminated fine grained sedimentary rocks (sections A and B, respectively, in Fig. GS-20-9). In addition to the main breccia formation, several minor volcanic fragmental units up to 20 m thick also occur within the McLeod Narrows gabbro.

Heterolithologic volcanic breccia and tuff, mafic to felsic fragments (3a); heterolithologic volcanic breccia and tuff, felsic and minor intermediate fragments (3b); volcanic-derived conglomerate, greywacke and siltstone (3c)

Heterolithologic volcanic breccia consists of diverse volcanic fragments (with variously porphyritic, aphyric or rare amygdaloidal textures) in a tuffaceous matrix (Table GS-20-3); the map unit is subdivided into breccia with mafic to felsic fragments in a mafic volcaniclastic matrix (3a), and breccia with predominantly felsic fragments in a felsic to intermediate matrix (3b). Clasts are generally strongly attenuated (elongation ratios are typically 5:1 to 20:1) but original, mainly angular fragment shapes are locally preserved. Depositional units up to 35 m wide are typically devoid of sorting or only very poorly sorted; for example, one felsic unit is characterized by a lower 10 m zone of coarse breccia, gradational to an upper vaguely sorted 12 m zone of alternating breccia and lapilli tuff. More typically, sporadic large (mostly felsic) blocks (up to 1.85 x 0.5 m in size) are distributed randomly within breccia that consists of smaller fragments, mostly 5-30 cm long (Fig. GS-20-10). Rarely, conspicuous large blocks are disposed along specific horizons in otherwise unsorted volcanic breccia. Tuff and lapilli tuff intercalations comprise approximately 10% of the section.

In the area northwest of Milton Lake (Fig. GS-20-2), the Lavigne Lake-McLeod Narrows enclave contains a ca. 20 m section of greywacke, siltstone and conglomerate (3c) within the central part of the supracrustal sequence (section A in Fig. GS-20-9). The sedimentary rocks are gradational with and compositionally similar to the underlying breccia (3a), but are distinguished by well-defined layering and locally graded bedding that indicate a turbidite origin (Table GS-20-3). These turbidites are characterized by cyclic units (10-55 cm thick) that consist of basal conglomerate overlain by pebbly greywacke, and uppermost fine grained greywacke or siltstone. The north margin of the turbidite section is intruded by a 90 m thick gabbro sill, and the upper (north) part of the supracrustal sequence consists of greywacke, laminated porphyroblastic siltstone and subordinate conglomerate that are devoid of graded bedding. Similar sedimentary rocks have not been recognized in the equivalent part of the sequence elsewhere in the Lavigne Lake-McLeod Narrows enclave (Fig. GS-20-9).

Rhyolite, massive to fragmental; heterolithologic breccia, minor related sedimentary rocks; related plagioclase ± quartz porphyry (4)

Rhyolite, massive to fragmental (4a); heterolithologic volcanic breccia and tuff (4b); volcanic-derived conglomerate, feldspathic greywacke and siltstone (4c)

Two felsic volcanic rock formations located close to the south and north margins, respectively, of the Ralph Anderson Lake belt are characterized by lithologically similar rock assemblages; these consist of massive to fragmental rhyolite flows (4a), heterolithologic volcanic breccia (4b), minor related sedimentary rocks (4c) and felsic porphyry intrusions (4d). The southern felsic volcanic formation consists of a supracrustal enclave within the McLeod Narrows gabbro, whereas the northern felsic volcanic formation occurs within the predominantly basaltic north part of the Ralph Anderson Lake belt (Fig. GS-20-2).

The rhyolitic rocks are mostly well attenuated, and original flow structures are generally not preserved; however, the southern formation is relatively undeformed due south of Lavigne Lake, where it consists of a fragmental lava flow with remnant layers and irregular lobes of massive rhyolite. The northern formation consists of a more homogeneous, massive extrusive unit, overlain by unsorted heterolithologic breccia with mainly felsic volcanic fragments. Both rhyolite formations contain volcaniclastic rocks that are interpreted to include both debris flows and turbidite-type deposits (4b, 4c). For the most part, the volcaniclastic rocks either overlie or are laterally equivalent to the massive rhyolite components. Massive flows are thickest in the central parts of both the northern and southern formations, i.e., at Lavigne Lake in the north and at a small lake directly south of Lavigne Lake in the south. Whereas volcaniclastic rocks extend laterally for over 7 km throughout both formations, the massive components are more restricted in their lateral extent (ca. 3.5 km).

The northern and southern felsic volcanic formations, which have similar strike length and thickness (maximum ca. 115 m and 85 m respectively), are assumed to be stratigraphically distinct, but they may represent the same rock formation that was structurally repeated due to major strike-parallel faulting. Although evidence for such structures has

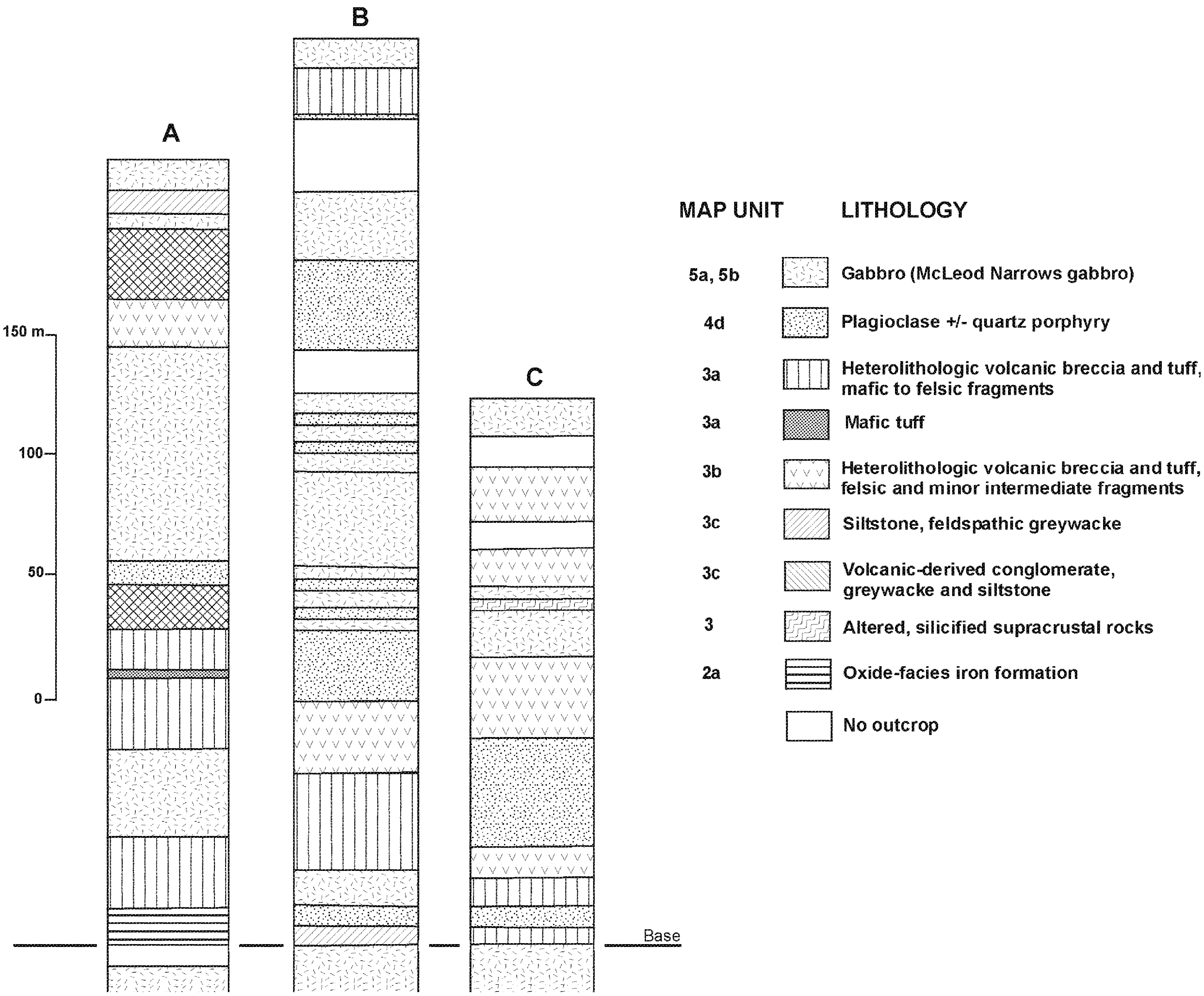


Figure GS-20-9: North-south stratigraphic sections through the Lavigne Lake-McLeod Narrows enclave (Fig. GS-20-2). (A) northwest of Milton Lake (305 m section); (B) north of the west end of Franklin Murray Lake (355 m section); (C) at McLeod Narrows (195 m section). Section lines are shown in Figure GS-20-2.

not been recognized, contacts between the felsic volcanic rocks and flanking units are not exposed, and thus their identity (i.e., whether or not they are faulted) is not known. Evidence in support of a structural repetition model is provided by the similar lithology and stratigraphic setting of the rhyolite formations, in particular the fact that they both consist of massive and fragmental flows with associated volcaniclastic rock units.

Southern felsic volcanic formation

The southern felsic volcanic formation, near the south margin of the belt, is truncated to the east by a fault in the area northeast of Milton Lake (Fig. GS-20-2); the west end of the formation appears to wedge out in the area south of MacVicar Lake. Porphyritic rhyolite and related monolithologic breccia (4a) up to 85 m thick are well preserved at a small lake south of Lavigne Lake, where massive rhyolite occurs as concordant

Table GS-20-3: Lithology and stratigraphic association of volcanic fragmental rocks (3a, 3b) and associated conglomerate (3c) at the south margin of the Ralph Anderson Lake greenstone belt.

Rock type (map unit)	Fragment type	Fragment shape & size	Clast/ matrix	Sorting	Matrix type	Associated clastic units	Inferred origin
Heterolithologic volcanic breccia, (3a)	Felsic to mafic (aphyric to porphyritic)	Angular or tabular to flattened (up to 1.85 x 0.5 m)	20-75% typically > 50 %	Unsorted to rarely sorted; rarely graded	Mafic-intermediate tuff, crystal tuff	Tuff & lapilli tuff (<10 % of map unit)	Mass flow, subaqueous
Heterolithologic volcanic breccia (3b)	Felsic, minor intermediate (mainly pg±qz phyric)				Felsic-intermediate tuff, crystal tuff		
Polymictic conglomerate (3c)	Felsic to mafic (aphyric to porphyritic)	Subangular to subrounded, flattened, pebble- to cobble-size	35-75%	Well sorted; locally graded, with cyclic bedding	Greywacke-siltstone	Greywacke, pebbly greywacke, siltstone	Reworked by water (below storm-wave base)

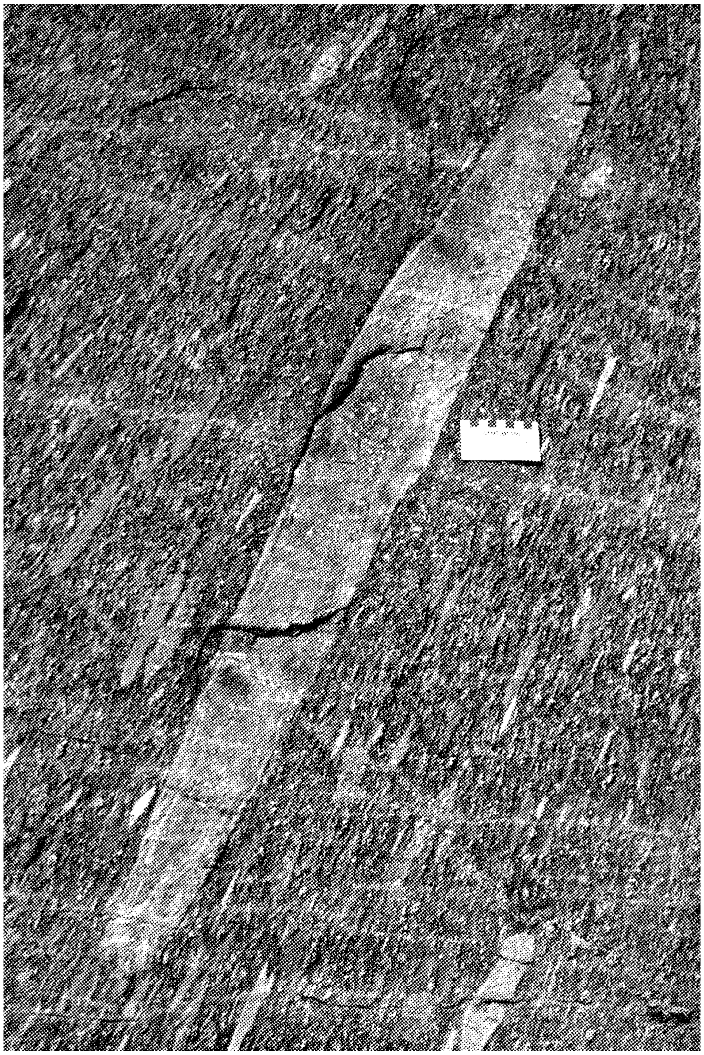


Figure GS-20-10: Heterolithologic volcanic breccia (3a) contains unsorted, sporadic large blocks within less coarse volcanic detritus.

layers (typically 1 to 3 m thick) and sporadic lenses and lobes (up to 9 x 2.5 m) within the breccia. Massive units display both sharp and gradational contacts with the associated fragmental rocks (4a), which comprise approximately 85% of the formation at that locality. Massive rhyolite is white to cream-gray weathering, in contrast to felsic clasts in associated breccia, which range from white to gray or beige (probably due to secondary epidote or carbonate content). The breccia is characterized by unsorted 10-30 cm long clasts and sporadic blocks up to 1.5 x 0.5 m; the felsic tuff/crystal-tuff matrix constitutes 25-70% of the rock. Rhyolite fragments are moderately to strongly attenuated (elongation ratios are 4:1 to >20:1) but angular clast shapes are locally preserved. Both massive and fragmental units contain ubiquitous plagioclase phenocrysts (0.5-3.0 mm long; 5-20% of the rock).

The southern felsic volcanic formation at a locality north of the narrows between Milton and Franklin Murray lakes consists of a 90 m thick section of massive to fragmental, locally porphyroblastic rhyolite (4a), stratigraphically equivalent to the (above described) rhyolite south of Lavigne Lake, 3.5 km to the west. A 30 m wide zone at the north margin of the formation is characterized by subhedral to elongate anthophyllite (?) porphyroblasts assumed to be due to contact metamorphism by the adjacent gabbro. The porphyroblasts (0.5-3.0 cm long) and sporadic anthophyllite aggregates (up to 11 cm across) comprise 5-30% of the rock; a 1 m thick unit of densely porphyroblastic felsic rock at the rhyolite/gabbro contact zone contains 70-80% epidotized anthophyllite porphyroblasts.

Between the above two massive rhyolite localities, the felsic volcanic formation consists of ca. 120 m of volcanic-derived conglomerate, feldspathic greywacke and siltstone (4c), with subordinate (<10%) massive rhyolite flow/sill units up to 8 m thick (4a). The sedimentary rocks are intercalated at a scale of 1 to 12 m, and are interpreted as reworked, subaqueous mass flow deposits. The conglomerate contains strongly attenuated pebble- to boulder-sized clasts (up to 1.85 x 0.1 m) that locally display traces of original subangular shapes; lithologic types consist of aphyric and sparsely to densely plagioclase phyric rhyolite. The fragments are unsorted, except for rare, narrow (0.5 m) pebbly horizons within coarser conglomerate. The sedimentary deposits are porphyroblastic in the south (lower) part of the section, where lenticular to elongate strata-bound cordierite (?) blasts up to 2 x 5 cm comprise 10-50% of the rock in zones up to 2.5 m wide. Ovoid anthophyllite rosettes (1-2 cm) are less widespread. The porphyroblastesis is attributed to hornfelsing by the contiguous gabbro; the sedimentary rocks are also characterized by epidotic alteration that postdates the porphyroblastesis.

Northern felsic volcanic formation

The northern felsic volcanic formation is especially well exposed at the north shore of Lavigne Lake, where massive and fragmental rocks are intimately intercalated. The formation at that locality consists of a lower 50 m thick predominantly massive rhyolite unit (4a) overlain by a mainly fragmental upper unit (>65 m thick) of coarse volcanic breccia with predominantly felsic fragments (4b). The (lower) massive rhyolite unit locally contains subparallel, evenly spaced chlorite-filled fractures that may be due to thermal stress during cooling. Minor fragmental zones within the massive rock are attributed to flow brecciation. The rocks contain sparse to abundant plagioclase phenocrysts (3-25%), and are locally characterized by fine tectonic laminae (1-5 mm) or diffuse concordant stringers/zones of recrystallized plagioclase and hornblende.

Heterolithologic volcanic breccia (4b) that directly overlies the massive rhyolite unit contains aphyric to plagioclase phyric volcanic fragments, typically 5 to 40 cm long, together with sporadic large blocks up to 1.3 m x 15 cm. Clasts are predominantly felsic but include subordinate (<15%) intermediate rock types. The fragments are moderately to strongly flattened, but traces of original angular shapes are locally preserved. The breccia matrix is tuffaceous and similar to rare felsic tuff and lapilli tuff layers (ca. 1 m thick) that occur within the fragmental unit. The breccias are generally unsorted but locally characterized by vague grading in the area west of Lavigne Lake, where a 3.5 m wide zone of lapilli tuff occurs at the upper margin of the (generally coarser) fragmental unit.

The northern felsic volcanic formation thins rapidly over a distance of only 1.5 km from the Lavigne Lake locality (115 m thick) west to the northeast part of MacVicar Lake (Fig. GS-20-2), where it is represented by a 42 m thick heterolithologic volcanic breccia deposit (4b). The breccia contains approximately equal amounts of felsic and intermediate fragments with minor (5%) mafic types, within a tuffaceous matrix. Clasts (mainly 5-25 cm long) are subangular to strongly flattened; blocks up to 80 x 25 cm occur sporadically within the breccia, which is unsorted in units up to 10 m thick. Subordinate tuff and lapilli tuff units that comprise ca. 20% of the formation at that locality are moderately well layered (at a scale of 20 cm to 1.5 m) and locally graded, possibly due to reworking by subaqueous turbulent density currents.

Approximately 1 km west of the heterolithologic breccia deposit at northeast MacVicar Lake, a stratigraphically equivalent unit of a rhyolite cobble conglomerate and laminated greywacke-siltstone (4c) constitutes the most western observed part of the felsic volcanic formation. The 50 m thick sedimentary unit is characterized by locally pervasive porphyroblastic zones with hornblende ± garnet. A similar sedimentary unit (>18 m thick) directly north of Lavigne Lake forms the upper part of the felsic volcanic formation, whereas 2 km east of Lavigne Lake, feldspathic greywacke, siltstone and conglomerate constitute a 25 m thick basal unit in the formation. The heterolithologic breccia and sedimentary rock units (4b, 4c) are interpreted as subaqueous mass flows and related turbidite deposits, penecontemporaneous with felsic volcanism, which was initiated close to the end of the mafic volcanic episode represented by the basaltic, main part of the greenstone belt.

Plagioclase ± quartz porphyry (4d)

A prominent plagioclase ± quartz porphyry sill (4d), up to 480 m thick and at least 6 km long, extends from the area north of Ralph Anderson Lake for an unknown distance to the east, beyond the northwest shore of Franklin Murray Lake (Fig. GS-20-2). The felsic sill, which is oblique to the basalt/rhyolite contact at the south side of the northern felsic volcanic formation, is interpreted as a subvolcanic intrusion related to the extrusive rocks to the north; the west end of the sill appears to extend directly into the rhyolitic rock formation (Gilbert, 1999). The porphyry is massive, homogeneous, and contains 10-20% plagioclase phenocrysts (1-3 mm long). Ovoid to subhedral epidote pseudomorphs after feldspar (0.5-3.0 cm across) constitute up to 20% of the rock in irregular zones in ca. 15% of the intrusion; rare quartz phenocrysts (1-2 mm) also occur in the sill.

Plagioclase ± quartz porphyry dykes up to 11 m thick occur thoughout the map area, but are most abundant in the central and north parts of the greenstone belt. The dykes, which trend mainly east/west, include several texturally distinct types. Plagioclase phenocrysts (typically 1-3 mm long) constitute 10-40% of the dykes; some porphyries are relatively more coarse grained, with feldspars up to 1 cm. Quartz phenocrysts, where present, are subordinate to plagioclase and are typically 1-2 mm across (rarely, up to 8 mm). The felsic dykes are provisionally interpreted as synvolcanic, because of their textural similarity and local proximity to some rhyolitic units (4).

INTRUSIVE ROCKS

Gabbro, minor pyroxenite and hornblendite (Lavigne Lake gabbro; McLeod Narrows gabbro); diabase (5)

Gabbro, mesocratic to melanocratic (5a); pyroxenite, hornblendite (5b); diabase (5c)

Mafic sills in the central and south parts of the Ralph Anderson Lake belt (Lavigne Lake gabbro and McLeod Narrows gabbro, 0.3 km and 1.2 km thick respectively; Fig. GS-20-2) consist mainly of massive, homogeneous mesocratic gabbro to melagabbro (5a), with minor (<5%) altered pyroxenite and hornblendite (5b). The McLeod Narrows gabbro is mesocratic to leucocratic near the north (upper) margin, and locally contains various subordinate intrusive phases in the area to the south. For example, the predominant massive equigranular gabbro phase locally contains enclaves of an older plagioclase phyric gabbro; these rock types both predate younger dykes of very coarse grained porphyritic gabbro that contain plagioclase and hornblende crystals up to 1.5 cm. Magnetiferous quartz diorite to diorite (up to 35 m thick) that occurs at the north margin of the sill in the west part of the map area is interpreted as a hybrid intrusive phase that was contaminated by oxide iron formation from the adjacent supracrustal section to the north. Elsewhere, the intrusion contains inclusions of mafic volcanic rocks, which are variously metasomatized and recrystallized to coarser grained amphibolite. Igneous layering defined by variable feldspar/hornblende ratio (at a scale of 2-25 cm) is commonly preserved in the McLeod Narrows gabbro but is rare in the Lavigne Lake gabbro.

Pyroxenite and related hornblendite occur in a >5 m thick unit at the north margin of the Lavigne Lake gabbro, close to the shore of MacVicar Lake. The ultramafic rocks locally display igneous layering, defined by alternating medium grained and very coarse grained units at a scale of 1-20 cm. The occurrence of layered ultramafic rocks at the north (upper) margin of the mafic intrusion is enigmatic; this anomaly may be explained if the ultramafic rocks are interpreted as a separate intrusive phase emplaced at the margin of the gabbro sill. The occurrence of pyroxenite dykes within gabbro elsewhere at the north margin of the mafic sill is consistent with this model. Minor gabbroic pegmatite intrusions also occur locally at the north margin of the intrusion.

The McLeod Narrows gabbro sill is interpreted to postdate the first regional deformation phase (F_1) and associated metamorphic events in the southeast Max Lake area, because highly attenuated supracrustal enclaves within the (typically massive) intrusion were apparently foliated and deformed prior to gabbro emplacement. The gabbro sill was, however, affected by subsequent deformation phases: marginal zones are locally strongly foliated (S_2), and minor tectonic breccia associated with epidotic alteration within the mafic sill is attributed to late (F_3) brittle deformation. The age of the Lavigne Lake gabbro is not known, but the intrusion is provisionally interpreted as contemporaneous with the McLeod Narrows gabbro, on the basis of it's compositional and textural similarity with the latter intrusion.

A prominent altered diabase dyke (5c) that extends for at least 4 km along strike intrudes the north margin of the McLeod Narrows gabbro, and locally follows the contact between the gabbro and mafic volcanic rocks to the north (Fig. GS-20-2). The 2-9 m thick dyke is largely altered to amphibolite and chloritic schist and is deeply weathered, resulting in a pronounced topographic lineament. The mafic dyke displays chilled margins, and is locally deformed and partly disrupted by mesoscopic (F_2) folds and later (F_3) internal crenulations associated with fracture cleavage. The diabase is locally intruded by felsitic veins, and is pervasively carbonatized at the westernmost exposure (175 m from the south tip of Lavigne Lake).

Tonalite, granodiorite; minor plagioclase porphyry, pegmatite, aplite; related gneiss (6)

Gneissoid tonalite to granodiorite and related gneisses (6) in the granitoid terranes north and south of the Ralph Anderson Lake belt are variously biotite ± hornblende-bearing, white to pale or medium gray, and characterized by diffuse 30 cm - 10 m scale layering, due to minor compositional variations that are probably the result of contamination by supracrustal rocks. Subordinate concordant intrusive components (10 cm to 2 m thick), which are also gneissoid, include white alaskite and plagioclase porphyry, and pink pegmatite and aplite. Some pegmatite dykes are massive and undeformed in the granitoid terrane south of the greenstone belt. These rock types occur both within the granitoid terranes, and as dykes in the contact zone at the north margin of the Ralph Anderson Lake belt.

Leucogabbro, diabase (7)

Massive, post-tectonic leucogabbro (7) occurs in an ovoid 25 x 40 m stock at the north-central shore of Ralph Anderson Lake; a zoned, 8 m thick dyke that extends north from the stock intrudes the felsic porphyry sill (4d) in that area (Fig. GS-20-2). The north-northeast-trending dyke is characterized by a 4 m wide leucogabbro core, flanked by 2 m wide plagioclase phyric diabase zones that grade outwards to aphyric margins. Leucogabbro is medium-grained and subophitic, with ca. 25% hornblende and 65% plagioclase; sporadic xenoliths of plagioclase porphyry and medium grained tonalite occur locally in the dyke. Several sparsely porphyritic diabase dykes are adjacent and parallel to the zoned intrusion. Quartz-feldspar-carbonate veins emplaced at a diabase dyke margin represent the latest intrusive phase recognized in the map area.

STRUCTURE AND GEOLOGICAL HISTORY

A protracted history of deformation is recognized in the Ralph Anderson Lake greenstone belt, beginning with crustal-scale folding (inferred from the subvertical attitude of the monoclinal greenstone belt), and finishing with brittle deformation along northeast-trending fault planes. Structural features and phases of deformation are described in the following summary geological history of the southeast Max Lake area.

(a) Mafic to felsic arc-type volcanism and emplacement of related intrusive rocks (1, 3 and 4); associated sedimentation (2), including subaqueous debris flows and turbidites ('Hayes River Group'; Hubregtse, 1985a). Volcanism was locally associated with hydrothermal alteration and sulphide mineralization (see unit 2c description).

(b) F_1 major folding resulted in the subvertical, east-southeast-trending strike of the volcanosedimentary sequence; only rare, disrupted F_1 fold remnants (with unknown plunge) are preserved. F_1 resulted in regional S_1 foliation and associated planar features, such as clast flattening in fragmental rocks, and lamination in amphibolite derived from basaltic rocks. Associated M_1 metamorphism resulted in the alteration of pyroxene to amphibole in mafic rocks, and development of euhedral to elongate porphyroblasts in sedimentary and altered volcanic rocks including garnet, anthophyllite, cordierite, andalusite, sillimanite, and staurolite; also garnetite laminae in the alteration zone at northeast MacVicar Lake. Note that some blasts may be due to contact metamorphism by gabbro (5) or later (M_2) regional metamorphism; also the identification of some porphyroblastic minerals is not yet confirmed.

(c) Emplacement of mafic sills - Lavigne Lake and McLeod Narrows gabbros (5).

(d) Emplacement of a diabase dyke (5c) at the north margin of the McLeod Narrows gabbro.

(e) Pervasive intrusion of granitoid rocks (6) at the margins of the greenstone belt.

(f) F_2 folding of F_1 planar elements by regional sinistral movement parallel to S_1 (F_2 folds have steep to subvertical, southeast to east-southeast plunge). Refolding of F_1 folds (Fig. GS-20-11). Folding and disruption of gneissic laminae and early quartz veins in garnetiferous alteration zone (2c). Folding of diabase dyke (5c) at outcrop scale; associated S_2 foliation in diabase and in gabbro at the north margin of the McLeod Narrows intrusion (possibly S_2 is of regional extent, reinforcing S_1). Rotation and crenulation of M_1 porphyroblasts. Associated M_2 alteration of pyroxene to amphibole in gabbro and pyroxenite (5a, 5b).

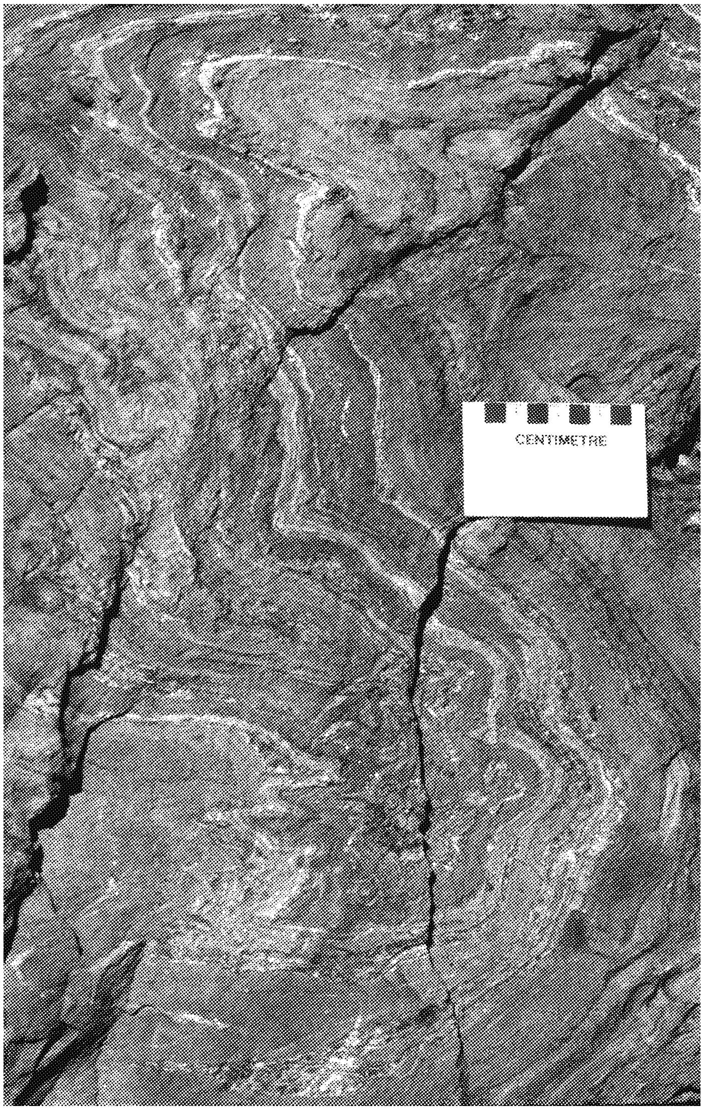


Figure GS-20-11: F_1/F_2 fold interference pattern in alteration zone in the northeast part of the map area.

(g) F_3 discrete shear zones throughout the greenstone belt (locally at incompetent horizons such as brecciated basalt flow contacts, alteration zones or thin sedimentary rock units). Strongly sheared contact between the McLeod Narrows gabbro and mafic volcanic rocks to the north (includes local mylonite). Folding of S_2 foliation and associated S_3 strain-slip cleavage in diabase (5c). Alteration associated with F_3 includes (i) localized chloritization in sporadic shear zones within the supracrustal sequence; (ii) silicification, carbonatization and epidotization at the south margin of the mafic volcanic sequence; (iii) epidote alteration in minor tectonic breccia zones within gabbro (5a).

(h) F_4 north-northeast- to northeast-trending, high angle faults (displacement on order of 10's of metres) transect the greenstone belt. Late leucogabbro (7) was possibly emplaced at this time.

ECONOMIC GEOLOGY

Surficial iron staining due to the oxidation of localized pyrite occurrences is common throughout the Ralph Anderson Lake belt. Disseminated to stringer pyrite is locally preserved, but mostly the sulphide is completely altered. The best prospects for base-metal or precious metal exploration include the hydrothermal alteration zone (2c) close to the northeast corner of MacVicar Lake, and related magnetiferous iron formations that display extensive surficial iron staining. Other potential targets include pyritic zones at the conjunction of the mafic volcanic terrane and gabbro intrusion at the south margin of the greenstone belt, and altered sulphide showings elsewhere at basalt/gabbro contacts.

Specific sites of sulphide mineralization, in order of relative importance, are summarized as follows:

(i) The hydrothermal alteration zone with pervasive garnet porphyroblastesis, near the northeast corner of MacVicar Lake.

(ii) Oxide-facies iron formations (locally coincident with basalt/gabbro contacts).

(iii) The conjunction of the McLeod Narrows gabbro and the basaltic sequence to the north; associated variously with either siltstone or altered basalt and protomylonite in the contact zone.

(iv) Gabbro/basalt contacts (locally coincident with felsic porphyry dykes).

(v) Discrete shear zones in volcanic or sedimentary rocks.

(vi) Felsic porphyry dykes within mafic volcanic rocks.

(vii) Mafic volcanic rocks: as irregular zones within pillowed flows, interstitial to pillows, or in related breccia units.

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REFERENCES

Currie, K.L. 1961: Oxford House, Manitoba; Geological Survey of Canada, Map 21-1961, scale 1:250 000.

Elbers, F.J. 1973a: Bolton Lake (NTS 53L/5, north half); Manitoba Mines, Resources and Environmental Management, Preliminary Map 1973H-10, scale 1:50 000.

1973b: Joint Lake (NTS 53L/6, north half); Manitoba Mines, Resources and Environmental Management, Preliminary Map 1973H-11, scale 1:50 000.

Elbers, F.J. and Marten, B.E. 1973: Kanuchuan Rapids (NTS 53L/7); Manitoba Mines, Resources and Environmental Management, Preliminary Map 1973H-12, scale 1:50 000.

Gilbert, H.P. 1999: Geology of the Max Lake area (parts of NTS 53L/5NW, L/12SW); Manitoba Industry, Trade and Mines, Preliminary Map 1999S-1, scale 1:20 000.

Hubregtse, J.J.M.W. 1974: The Max Lake Greenstone Belt; *in* Summary of Geological Fieldwork 1974, Manitoba Department of Mines, Resources and Environmental Management, p. 33-34.

1985a: Geology of the Oxford Lake-Carrot River area; Manitoba Energy and Mines, Geological Report GR83-1A, 73 p.

1985b: Geology of the Oxford Lake-Carrot River area; Manitoba Energy and Mines, Geological Report GR83-1A, Windy Lake, Map GR83-1-10, scale 1:50 000.

Manitoba Energy and Mines. 1987: Oxford House; Manitoba Energy and Mines, Geological Services, Bedrock Geology Compilation Map Series, NTS 53L, scale 1: 250 000.

Schledewitz, D.C.P. 1980: Oxford House Southwest; Manitoba Energy and Mines, Mineral Resources Division, Preliminary Map 1980K-3, scale 1:100 000.