DESCRIPTIVE NOTES

INTRODUCTION

This Meadowbank River area map is one of a group of new A-series bedrock geology maps arising from the Woodburn project under the auspices of the Western Churchill NATMAP program. Fieldwork during 1996–2000 addressed the stratigraphic relationships, age, tectonic setting, and deformation history of supracrustal and plutonic rocks in the Churchill Province north of Baker Lake, Nunavut (Fig. 1). The geology of the Meadowbank River map is based primarily on mapping carried out from 1996–2000. The new mapping is supplemented by field observations by J.R. Henderson and M.N. Henderson in 1989–1990 in the southern part of the map area, and by W.W. Heywood and S. Tella in the western part of the map area. Supplementary information on mafic-ultramafic rocks northwest of the Meadowbank River was compiled from Annesley (1989), and south of South Amer lake from Fuller (1977). The Paleoproterozoic Amer group and the area along its southern margin were not mapped to the same level of detail as supracrustal rocks in the rest of the map area. Additional information on the lithological units and structural configuration of the Amer group was compiled from G. Young (unpublished report), Barrett et al. (1978), Tippett and Heywood (1978), Linnen (1979), Patterson (1980, 1986) and Tella (1994). This new A-series map supersedes previously published preliminary Open file maps (Zaleski et al., 1997, 1999b) and Current Research papers (Zaleski et al., 1999a, 2000) on the area.

The informal name 'Woodburn Lake group' was originally used in 1978 for Archean volcanic rocks, including ultramafic flows, and associated sedimentary rocks north of Tehek Lake and near the Meadowbank River (Amer Lake NTS 66H, Ashton, 1988) (Fig. 2). We apply the name 'Woodburn group' to Archean supracrustal rocks from the Meadowbank River to Whitehills Lake. The Woodburn group as defined here comprises a lower volcanic succession, the Meadowbank formation, overlain by an upper succession of dominantly sedimentary rocks subdivided into the Amarulik formation and the Ukalik formation (Table 1). The Meadowbank formation is further subdivided into four assemblages comprising three dated volcanic cycles (Davis and Zaleski, unpublished data): 1) the 2.735 Ga Sanningajukuluk assemblage, 2) the 2.72 Ga Nutiplilik assemblage, 3) the Quggiilik assemblage of unknown age, and 4) the 2.71 Ga Apuqti'naaqtuq assemblage. The Meadowbank River map area is dominantly underlain by plutonic rocks. However, the Woodburn group is well represented by the Nutiplilik and Quggiilik assemblages, the northern Apuqti'naaqtuq assemblage, and the overlying Ukalik formation, including key exposures of the basal unconformity. In the north, the map area encompasses the southeasternmost exposures of the extensive Paleoproterozoic basin deposits of the Amer group (Fig. 2).

As few of the geographic features in the area have formally recognized names, three types of geographic names are shown on the map. Formal geographic names are capitalized (e.g. Meadowbank River). Traditional Inuit names in the Inuktitut language are given in Roman orthography (e.g. Tahirjuaraarjuk), as well as in Inuktitut syllabics. Informal names in use by geologists and exploration companies are indicated by combined upper and lower case (e.g. Pipedream lake).

REGIONAL GEOLOGY

The Woodburn group lies in the Rae Province (Churchill Province), north of the regional geophysical anomaly, the Snowbird tectonic zone (Fig. 1), interpreted by Hoffman (1988) as a major crustal-scale suture. The Woodburn group occupies a central position along a northeasterly trending zone of comparable Neoarchean supracrustal belts that spans the breadth of the Western Churchill Province. These belts have been interpreted as rift-related deposits characterized by ultramafic-mafic rocks, terrigenous sedimentary rocks, and locally recognized sialic basement.

The Woodburn succession comprises multiple cycles of bimodal volcanic rocks, associated felsic to mafic volcaniclastic rocks and iron-formation, overlain by quartzite and wacke. It is part of a belt of deformed supracrustal rocks extending from Schultz Lake to beyond the Meadowbank and Quoich rivers (Fig. 2). The supracrustal rocks are enclosed by a voluminous suite of 2.62–2.60 Ga granite, and intrusive relationships can be demonstrated locally (Ashton, 1988; Roddick et al., 1992; Davis and Zaleski, 1998). Subsequent to the emplacement of Neoarchean granite, four phases of ductile deformation affected the region (Pehrsson et al., 2000; Zaleski et al., 2001). The dominant regional trends are defined by northwest-verging, tight to isoclinal D_2 folds and associated faults that resulted in imbrication of volcanic rocks, basement, and quartzite and greywacke panels. The duration of penetrative ductile deformation in the region is limited by the undeformed deposits and intrusions of the ca. 1.84–1.81 Ga lower Baker Lake Group (Dubawnt Supergroup) (Rainbird et al., 2002).

Northwest of the Woodburn group, deformed and metamorphosed Paleoproterozoic continental basin deposits of the Amer group (Fig. 2, Table 1) locally preserve unconformable relationships to underlying 2.61 Ga granite (Tella et al., 1984; LeCheminant and Roddick, 1991). The Amer group has been interpreted as being equivalent to the Hurwitz Group south of the Snowbird tectonic zone (Young, 1984, 1988).

The volcanic assemblages of the Woodburn group mainly contain greenschist-facies metamorphic parageneses, except for an amphibolite-facies domain encompassing the Quggiilik and northern Apuqti'naaqtuq assemblages north of Quggiilik on the Meadowbank River. The Amer belt contains greenschist-facies parageneses. However, grade increases to the north with sillimanite reported in Amer quartzite (Patterson, 1986) about 10 km north of the map area. Metamorphic grade in the region also increases to the east. Septa of supracrustal rocks extend into the high-grade terrane of the Tehek Lake plutonic complex and the Quoich River gneiss (Fig. 2), the latter interpreted as the high-grade equivalent of supracrustal rocks (Ketyet River group, Heywood and Schau, 1981). Similarly, Fraser (1988) considered paragneiss in the granulite terrane northeast of Woodburn Lake to be derived from Archean supracrustal protolith.

STRATIGRAPHY OF THE MEADOWBANK RIVER AREA

WOODBURN GROUP

Meadowbank formation, Nutiplilik assemblage

The oldest rocks known in the area are those of the Nutiplilik assemblage of the Meadowbank formation, Woodburn group (Table 1) exposed along the Meadowbank River. The Nutiplilik assemblage (2.72 Ga, Davis and Zaleski, unpublished data) is named for the traditional Inuit name for the widening of the Meadowbank River near the central part of the assemblage. West of Nutiplilik, komatiite (unit ĀNkm), komatiitic basalt (unit ĀNkb) and ultramafic schist (unit ĀNkms) derived from komatiitic protolith are interlayered (on a scale of 10–100 m) with quartz-plagioclase porphyritic felsic volcanic rocks (unit ĀNfq) and minor, thin iron-formation (unit ĀNif). Cumulate and spinifex-textured zones can be recognized in komatiite flows, with spinifex sheaves attaining lengths of about 20 cm. Younging directions were interpreted locally based on fining of spinifex sheaves, and contacts between cumulate and spinifex portions of flow units (e.g. Pyke et al., 1973). While primary textures are generally entirely pseudomorphed by serpentine, talc, magnetite, tremolite and chlorite, cumulate-textured zones locally contain minor or trace amounts of olivine and chromite, interpreted as relicts of primary minerals. Komatiitic basalt is typically massive and preserves fine- to coarse-grained, ophitic to subophitic textures pseudomorphed by actinolite, sodic plagioclase, magnetite, chlorite, and epidote. It varies from mesocratic to melanocratic, with about 50 to 80% mafic minerals, respectively. Homoclinal zones of moderately to steeply dipping flows suggest a minimum total thickness on the order of 200–300m.

The felsic rocks are interpreted as lava and pyroclastic flows, including autoclastic breccia, crystal and lapilli tuffs. In the northern part of the assemblage, multiphase monolithic breccias are characterized by abundant angular felsic fragments, including fragments of previously brecciated material, and by internal contacts between phases. Locally, an area interpreted as an autobrecciated felsic dome or volcanic centre is partly encircled by a steeply outward dipping, ultramafic layer, either a subvolcanic intrusion or onlapping komatiite flows (65°19' N, 96°20.5' W). West of the Meadowbank River and along the north shore, felsic rocks are dominantly pyroclastic facies. Locally preserved ptygmatically folded lamellae, visible in thin section, suggest strong welding and the development of flow layering. On one of the large peninsulas extending into the river (65°17' N, 96°16.5' W), lapilli tuff is transitional to reworked volcaniclastic and debris-flow deposits (unit ĀNfb). The volcaniclastic rocks are dominated by felsic volcanic clasts, locally with white cherty clasts, or dark chloritic clasts derived from mafic or altered felsic rocks. Layering is crudely defined by grading with clasts ranging in size from lapilli to breccia. The deposits become generally coarser and more heterolithic toward the south over about 500 m. On the shore (65°17.2' N, 96°16' W), exposures of matrix-supported conglomerate dominated by volcanic and possible chert clasts were interpreted as a debris-flow deposit.

The komatiitic and felsic flows are unconformably overlain by polymictic basal conglomerate and crossbedded quartzite of the Ukalik formation (see below). The best exposures of the contact are west of the Meadowbank River along the northern (65°18.1' N, 96°25.7' W) and southern (65°18' N, 96°25.7' W) margins of the synclinal keel of quartzite. North of the quartzite, komatiite flows show southward younging toward the unconformable contact. At the northern contact, spinifex-textured komatiite is separated from quartzite by about 3 m of chloritic schist with a lensoid structure suggestive of tectonized conglomerate. The schist grades from green and strongly chloritic to buff-coloured and muscovitic toward the contact. On the south side of the synclinal keel, the substrate is quartz-plagioclase porphyritic crystal and lapilli tuff and the unconformity is marked by polymictic conglomerate (see below).

On the large peninsula on the south of Nutiplilik on the Meadowbank River, and south of the River east of Nutiplilik, mafic to intermediate volcanic flows (unit ĀNmi) are intercalated with thin (cm) to thick (50 m) layers of cherty felsic tuff (unit ĀNfc) and iron-formation. The mafic to intermediate rocks are amygdaloidal, and commonly porphyritic with coarse (5–8 mm) plagioclase and amphibole phenocrysts (or amphibole pseudomorphs of clinopyroxene?) in an ophitic matrix. Cherty felsic tuff is typically thinly bedded, and intimately interbedded with banded chert-magnetite iron-formation too thin to show at map scale. West of the Meadowbank River (65°17.25' N, 96°21.9' W), an exposure of mesocratic amygdaloidal pillowed flows below quartzite suggests that the mafic to intermediate flows lie stratigraphically above Nutiplilik bimodal volcanic rocks and below the Ukalik formation. Pillow shapes and concentrations of amygdules near pillow tops indicate upward younging toward quartzite. On an island in the river 700–800 m to the northeast, this interpretation is supported by the presence of massive amphibole-plagioclase porphyritic, possibly subvolcanic, rocks interlayered with quartz-plagioclase porphyritic rocks, and local zones of intermediate hybridized rocks. Hence, mafic to intermediate flows south of Nutiplilik are grouped with the Nutiplilik assemblage. The river itself apparently conceals a fault as upper units of the Ukalik formation are exposed on the western shore and dip eastward toward stratigraphically underlying Nutiplilik rocks exposed on the southern shore (see below).

Bedded cherty felsic tuff with thin iron-formation interbeds continues north of the Meadowbank River east of Nutiplilik. In this area, mafic to intermediate volcanic rocks are present in subordinate amounts. Cherty tuff is associated with felsic to intermediate plagioclase-porphyritic crystal and lapilli tuff, volcanogenic sedimentary rocks (unit ĀNfi), and minor wacke (unit ĀNwk).

Meadowbank formation, Quggiilik assemblage

The Quggiilik assemblage is named for the traditional Inuit name for the widening of the Meadowbank River in the east-central map area. Quggiilik supracrustal rocks are of uncertain age and stratigraphic position, possibly including units correlative with those of the Nutiplilik and Apuqti'naaqtuq assemblages, and/or rocks belonging to some other, thus far undated, volcanic cycle. The assemblage includes recrystallized amphibolite-facies rocks along the Meadowbank River north of Quggiilik, as well as numerous isolated occurrences of supracrustal rocks in the dominantly plutonic terrain south of the Amer group.

Along the Meadowbank River, the Quggiilik assemblage comprises two zones of supracrustal rocks, 100 m to 2 km in map width, interlayered and folded together with Neoarchean granite sheets. The southwestern contact to the Nutiplilik assemblage is mainly defined by high-angle faults that crosscut fabrics and structures associated with ductile deformation. The southeastern limit of the assemblage is placed at the contact to granite. In the northwestern zone of supracrustal rocks, a layer of ultramafic schist (unit ĀQums), 30–250 m in width, can be traced for about 7 km. The schist is porphyroblastic, with local olivine porphyroblasts giving a coarsely knobbly and knotted appearance. Schistosity is most strongly developed adjacent to contacts. Ultramafic schist is associated with gossanous oxide-facies iron-formation (unit ĀQif), metawacke and quartzofeldspathic rocks interpreted as recrystallized tectonized felsic to intermediate volcanic and volcaniclastic rocks (unit ĀQwk), and amphibolite (unit ĀQa). Recrystallization and deformation have obliterated most primary features apart from compositional layering after bedding. However, protoliths appear to be comparable to those found in other assemblages of the Meadowbank formation.

South of the Amer group, supracrustal rocks grouped with the Quggiilik assemblage are present as discontinuous or semicontinuous screens intercalated with and intruded by granitic to gabbroic plutonic rocks. South of the Amer margin in the western part of the map area, massive to foliated ultramafic rocks (unit ĀQum) show polyhedral jointing, but only one instance of possible spinifex was observed. There is southward transition from ultramafic-mafic rocks to mafic to intermediate schist, possibly including units of tuffaceous origin, to intermediate to felsic volcaniclastic rocks and wacke. The ultramafic rocks contain local gossanous sulphide iron-formation and quartz veins associated with carbonate and calc-silicate alteration (including the 'Irv' gold occurrences, no.1-2, Table 2). The ultramafic-mafic suite is truncated a few hundred metres to the east by plutonic rocks. However, about 15 km to the east, screens of massive to schistose ultramafic rocks and interlayered gossanous iron-formation extend over a strike-length of about 7 km. The ultramafic rocks include carbonate-rich schist and massive cumulate-textured rocks with serpentinized pseudomorphs of primary olivine. Schist contains transposed carbonate veins, and sheared surfaces locally show fibres of serpentine asbestos up to 20 cm in length. The iron-formation varies from nearly massive magnetite with minor chert lamellae, to banded iron-formation with alternating lamellae of magnetite and black glassy quartz. The screens are commonly enclosed by massive pyroxenite (unit ĀPpx, see below) with equivocal relationships to the ultramafic rocks and associated iron-formation. Felsic to intermediate supracrustal rocks south of the eastern Amer group mainly consist of quartzofeldspathic wacke containing quartz and plagioclase crystal clasts (0.2–2 mm in diameter).

Meadowbank formation, Apuqti'naaqtuq assemblage

The Apuqti'naaqtuq assemblage is the youngest of the assemblages of the Meadowbank formation of the Woodburn group (Table 1). It underlies the eastern map area south of the Meadowbank River, and extends beyond the map area to west of Pipedream lake and south to Third Portage lake (Fig. 2) (Zaleski et al., in press). The Apuqti'naaqtuq assemblage takes its name from the traditional Inuit name for Third Portage lake. Felsic to intermediate (dacitic) volcanic and subvolcanic rocks of the assemblage have been precisely dated in five locations (south of the map), with all samples giving the same age (within error) of 2.71 Ga (Davis and Zaleski, 1998; unpublished data; Sherlock and Davis, pers. comm., 2003). The assemblage is structurally complex, with fold repetition and imbricated panels of Meadowbank volcanic rocks, Ukalik quartzite and granite. However, deformation tends to be partitioned into high-strain zones so that large tracts show reasonable and, in many cases, remarkable preservation of primary textures and contact relationships.

South of the Meadowbank River, the Apuqti'naaqtuq assemblage is dominated by felsic to intermediate (dacitic) volcaniclastic rocks and volcanogenic wacke, with subordinate ultramafic to mafic rocks and iron-formation. Felsic to intermediate crystal tuff, lapilli tuff, and tuff breccia (unit ĀAfi) are characterized by phenocryst and crystal clast assemblages of plagioclase alone, quartz and plagioclase, or plagioclase and amphibole. Pyroclastic facies are interlayered with coherent flows, the latter containing glomeroporphyritic plagioclase and isolated phenocrysts wrapped by flow layering defined by microlites and deformed amygdules. Between Ukalik lake and Quggiilik, plagioclase-porphyritic pyroclastic rocks commonly preserve textures that indicate welding, for example, compaction fabrics of aligned microlites and flattened amygdules (visible in thin section), and wispy aggregates of mafic minerals possibly replacing altered flattened shards. Northeast of Ukalik lake (65°15' N, 96°00.5' W), exposures of fractured to coarsely brecciated, fine- to medium-grained, tonalite and plagioclase porphyry are interpreted as a lava dome or extrusive centre. Pyroclastic facies are transitional to reworked volcaniclastic rocks and immature volcanogenic wacke (unit ĀAfwk). The transition is typically characterized by increasing proportions of interlayered volcanogenic sedimentary rocks and oxide-facies iron-formation (unit ĀAif), locally with minor carbonate-facies iron-formation (unit ĀAifc). In areas of higher strain and/or poorer exposure, felsic to intermediate volcanic, volcaniclastic and volcanogenic sedimentary rocks were not differentiated during mapping (unit ĀAfivc).

East of the exposures of Ukalik formation on Ukalik lake, modified komatiite flows (unit ĀAkm) are represented by cumulate-textured and recrystallized zones intercalated on metre scale. Recrystallized zones locally contain coarse magnetite sheaves up to 25 cm in length. The relict flows are associated with iron-formation along their southeastern contact. Medium- to coarse-grained, gabbroic to porphyritic mafic rocks (unit ĀAgb) are locally interlayered (on 1–10 metre scale) with felsic to intermediate rocks, or present in larger zones. They were interpreted as volcanic or subvolcanic komatiitic basalt and basalt related to the Apuqti'naaqtuq ultramafic-mafic suite. Fabrics are typically massive, or show strain gradients to mafic schist and amphibolite (unit ĀAma). Schistose porphyroclastic varieties are not easily distinguished from possible volcaniclastic rocks. In the northern Apuqti'naaqtuq assemblage, streaky to weakly layered, porphyroblastic amphibolite was interpreted to be derived from volcanic or volcaniclastic protolith.

Local exposures of ultramafic schist (unit ĀAkms) are present along the komatiite contact east of Ukalik lake, as well as along a high-strain zone 5 km to the southwest (65°11.9' N, 96°01.5' W), possibly representing a faulted continuation of the same schist. Ultramafic schist in an isolated exposure at the southern margin of the map (65°11' N, 95°47' W) lies along-strike from a wider, north to northeasterly trending zone of ultramafic-mafic schist to the south. The zone fingers out in an area dominated by mafic to intermediate wacke (unit ĀAmwk) interlayered with iron-formation. In low-strain zones, the wacke preserves centimetre to metre thick beds, grading from coarse bases with quartz and plagioclase grains in a mafic matrix to fine-grained tops.

Ukalik formation

The Ukalik formation is named for Ukalik lake (informal geographic name used by Ashton, 1988; Inuktitut for 'rabbit') which is centrally located between key exposures of the Ukalik formation in the southern map area where it overlies the 2.71 Ga Apuqti'naaqtuq assemblage. On the Meadowbank River, the Ukalik formation overlies the 2.72 Ga Nutiplilik assemblage. Near the southeastern shore of the Meadowbank River (65°13.7' N, 96°25.2' W), Ashton (1988) documented quartzite inclusions in granite which he correlated with dated Neoarchean granite. Southeast of Ukalik lake (65°11.4' N, 95°59.3' W), Ukalik quartzite is intruded by foliated, 2620 + 3/-2 Ma granite porphyry (unit ĀPp) with apophyses conformable to bedding and bedding-parallel foliation (Davis and Zaleski, 1998). These relationships bracket deposition of the Ukalik formation to < 2.71 Ga and > 2.60 Ga. East of Ukalik lake (65°14.3' N, 95°55.7' W), a quartz-K-feldspar porphyritic tuff in the quartzite (see below) more precisely constrains the depositional age to 2.63 Ga (Davis and Zaleski, unpublished data).

The Ukalik formation is dominated by supermature quartzite (unit ĀUqz) which forms prominent hills 10–100 m higher than the adjacent volcanic rocks. Modified bedding is defined by schistose micaceous and phyllitic layers and bedding-parallel parting. The quartzite is interbedded with oligomictic, pebble to boulder conglomerate (unit ĀUqcg) and black to light grey slate and phyllite (unit ĀUsl). Fuchsite is typically present in quartzite and conglomerate in trace to minor amounts, but local concentrations give a distinct green colour to the rocks. Conglomerate locally contains clasts of green fuchsitic quartzite. Gossanous quartzite exposures in the eastern map area (65°13.7' N, 95°45' W) are remarkable for the abundance of contained fuchsite, pyrite and heavy minerals, and concentrations of fuchsite in part define modified bedding. Quartzite and conglomerate throughout the map area commonly contain small amounts of kyanite. Slate and phyllite interbeds in quartzite typically contain metamorphic parageneses of quartz, chlorite, muscovite, kyanite and chloritoid, indicating a ferruginous-aluminous clay-rich protolith. Modified bedding is defined locally by compositional layering. Feldspar is absent in quartzite and phyllite, with rare exceptions.

East of Ukalik lake (65°14.3' N, 95°55.7' W), quartzite contains a quartz-K-feldspar porphyritic tuff (unit ĀUfkq) interbed. In well preserved local exposures, it contains euhedral to subhedral, embayed quartz phenocrysts, and subhedral K-feldspar phenocrysts in a fine-grained, muscovitic matrix. The phenocryst textures are typical of volcanic origin. At least one contact is transitional to kyanite-muscovite quartzite, which contains quartz crystal clasts similar in size to those in the tuff and, in some cases, preserves relict embayments. The transitional contact suggests either sedimentary reworking of the tuff, or early alkali leaching to produce kaolin, subsequently recrystallized to coarse kyanite blades. Both sedimentary reworking and syngenetic alteration may have been active, as is suggested by the abundance of monocrystalline quartz granules in wacke near or on the fold repetition of same horizon to the south, and by the transition from tuff to kyanite quartz-eye quartzite. Kyanite and quartz-eye muscovite quartzite associated with the tuff are typically 1 to 10 m thick (exaggerated on the map in order to show this important unit), and can be traced intermittently for nearly 3 km along the northern limb and around the hinge of the F_2 fold. The tuff was dated at 2628.7 ± 1.2 Ma, establishing the depositional age of the associated quartzite (Davis and Zaleski, unpublished data).

The unconformity at the base of the Ukalik formation is exposed west of Nutiplilik and east of Ukalik lake. West of Nutiplilik on the south side of a synclinal keel of quartzite (65°18' N, 96°25.8' W), the unconformity is marked by polymictic conglomerate (unit ĀUcg) (about 2 m width exposed) with felsic and mafic volcanic clasts, quartzite and banded chert in a matrix rich in muscovite, chloritoid, and tourmaline. The conglomerate contains a varied population of Neoarchean and Mesoarchean detrital zircons, including grains similar in age to the underlying volcanic rocks (Davis and Zaleski, unpublished data). Across a covered interval of about 5 m, polymictic conglomerate gives way to oligomictic conglomerate and crossbedded quartzite that youngs upward (to the north) away from the unconformity. As previously described, the northern quartzite contact is marked by about 3 m of chloritic schist with a lensoid structure, possibly a relict of conglomerate protolith. The unconformity is again repeated to the south across about a kilometre of Nutiplilik felsic volcanic rocks. In the southern area, the contact is not exposed and strain is generally higher. However, local oligomictic conglomerate could be related to the basal conglomerate. Crossbeds in the overlying quartzite (65°17.1' N, 96°21.9' W) show upright southward younging away from the unconformable surface.

East of Ukalik lake, a lenticular unit of polymictic conglomerate in the hinge region of an F_2 fold is interpreted to lie at the base of (on the west side of) quartzite, stratigraphically overlying volcanogenic wacke of the Apuqti'naaqtuq assemblage. The conglomerate contains pebbles and cobbles of tonalite and granite(?), quartzite, plagioclase-porphyritic felsic to intermediate volcanic rocks, chloritic metabasite, and chert, including sulphidic chert. Phyllite interbeds in the quartzite locally show rhythmic compositional grading from light-coloured quartz-rich bases to dark chloritoid-rich (i.e. clay precursor) tops. The grading indicates eastward facing on the S_2 schistosity, and younging away from the polymictic conglomerate (overturned at 65°14.1' N, 96°00' W; eastward facing at 65°14.05' N, 95°56.45' W). Oligomictic conglomerate along the quartzite contact to the west comprises quartz-rich cobbles and boulders in a muscovitic fuchsitic matrix. On the west side of Ukalik lake, polymictic conglomerate adjacent to quartzite has a bimodal clast population comprising quartzite and granodiorite cobbles and pebbles. A sample of quartzite higher in the stratigraphy (65°12' N, 95°58.7' W) contains Mesoarchean and Neoarchean detrital zircons, including grains of similar age to that of the volcanic substrate (Davis and Zaleski, unpublished data). On the east side of the quartzite near Ukalik lake, that is, around the outside of the folded contact, quartzite and quartz wacke are in contact (covered) with komatiite, and felsic pyroclastic and volcaniclastic rocks of the Apuqti'naaqtuq assemblage. The contact seems to be discordant with respect to the stratigraphic units of the Ukalik formation, although this is not well constrained. If this interpretation is correct, it suggests the presence of an early (pre- F_2) fault along the contact (see below).

In the southeastern map area, Ukalik quartzite contains numerous tuffaceous interbeds and possible sills of plagioclase porphyry (unit ĀUfp), with widths varying from approximately 10 to 100 m. Plagioclase porphyry is transitional to, or interlayered with, K-feldspar-quartz porphyritic volcanic rocks similar to those of the distinctive 2.63 Ga tuff layer, suggesting that these are cogenetic. Plagioclase porphyry typically contains 4–5 mm, euhedral to subhedral, plagioclase phenocrysts and local plagioclase porphyritic lapilli or, more rarely, breccia-size fragments. The matrix generally consists of very fine-grained quartz, feldspar, chlorite, micas, epidote and carbonate. Locally, porphyry grades into volcanogenic wacke containing plagioclase crystal clasts. In the absence of quartzite or K-feldspar-quartz porphyritic interlayers, the plagioclase porphyry and its reworked equivalents are not easily distinguished from the volcanic and volcanogenic rocks of the underlying Apuqti'naaqtuq assemblage, introducing possible ambiguity into field interpretations.

Locally preserved sections of the Ukalik formation suggest an upward transition from quartzite to granular and pebbly quartz wacke (unit ĀUqwk), to fine-grained ferruginous sedimentary rocks and minor, banded, oxide-facies iron-formation (unit ĀUif). The best-preserved section lies southwest of Nutiplilik on the Meadowbank River (65°16' N, 96°23' W) and exposes a minimum stratigraphic thickness of approximately 800 m. Although the quartzite is strongly cleaved, local crossbedding defined by dark mineral layers indicates upward younging away from the northern contact with volcanic rocks of the Nutiplilik assemblage. The quartzite (ca. 500 m thick) is overlain by quartz-rich wacke, with minor quartzite and cobble to pebble conglomerate. The wacke is dominated by quartz granules and sand-sized particles in a fine-grained recrystallized matrix of quartz, chlorite, and muscovite, with local chloritoid, pyrite and fuchsite. The clasts are mostly monocrystalline quartz, with a smaller proportion of quartzite and chert clasts. In some cases, monocrystalline quartz granules preserve embayments typical of volcanic phenocrysts suggesting texturally immature volcanic or subvolcanic detritus. Trough-crossbeds are defined by normally graded beds. Minor exposures of chlorite-carbonate schist may represent mafic to intermediate volcanic rocks (unit ĀUm), which appear to retain vestiges of fragmental textures and quartz-carbonate amygdules (65°16.1' N, 96°23.2' W). However, given the abundance of quartz, and their altered character (no identifiable feldspar), they could also be derived from felsic or intermediate volcanic protolith. Near the top of the exposed section, wacke and quartzite are interbedded with chlorite-chloritoid phyllite (too thin to show at map scale) and magnetite-hematite-chert banded iron-formation. The abundance of volcanogenic quartz granules in wacke near the top of the section supports correlation with quartzite, quartz wacke and tuff near Ukalik lake. North of Uiguq&iq on the Meadowbank River, K-feldspar-plagioclase porphyritic rocks that overlie quartzite are interpreted as part of the Ukalik volcanic-subvolcanic suite (unit ĀUfkq). However, strain is relatively high, with porphyroclastic mylonitic fabrics developed near contacts.

The Ukalik formation continues on the southeast side of the Meadowbank River (north of Uiguq&iq). The sequence of lithological units, from quartzite to quartz wacke interlayered with iron-formation, suggests that this may be a fault repetition of the stratigraphy to the north. The presence of concordant mafic intrusions or sills (unit ĀPgb) in both areas tends to support this interpretation, as does an exposure of mafic to intermediate volcanic rocks (tentatively assigned to unit Āum) adjacent to quartzite on the south shore of the river (65°14.9' N, 96°23.5' W). Quartzite west of Uiguq&iq is separated from other quartzite occurrences by Neoarchean granite and younger faults. The quartzite is well exposed as shallowly to moderately dipping beds forming areas of relatively high elevation. However, the adjacent lithological units and contacts are poorly exposed and, hence, relationships and assignment to stratigraphic units is conjectural.

AMER GROUP

The Paleoproterozoic Amer group underlies the northern map area. The Amer group overlies 2.61 Ga granite (see above), and the minimum depositional age is bracketed by massive Paleoproterozoic granite to syenite intrusions, considered to be related to syenite about 10 km to the north, dated at 1849 ± 18 Ma (Tella, 1994). The Amer group is also locally cut by lamprophyre dykes (65°28' N, 96°20.2' W, from Tella and Heywood, unpublished data; Barrett et al., 1978) (see below).

The cumulative stratigraphic thickness of the Amer group was estimated by Patterson (1986) to be a maximum of 2300 m. Quartzite and associated conglomerate generally form prominent, nearly continuous ridges and plateaus 50–100 m higher in elevation than the surroundings. The southern contact of the Amer group is marked by a steep scarp sloping toward the south, interrupted by valleys along late, high-angle faults. The contact is covered, but basal oligomictic conglomerate (unit PAcg) is exposed intermittently along the south side of the quartzite. The conglomerate contains closely packed, flattened, lenticular boulders, cobbles and pebbles of quartzite and vein quartz, with minor jasper and chert and rare fuchsitic clasts, in a muscovite-rich schistose matrix. Rare muscovite-rich clasts with embayed monocrystalline quartz grains resemble altered felsic volcanic rocks. The quartzite (unit PAqz) is typically supermature, homogeneous, massive and monotonous, except for metre-scale interbeds of oligomictic conglomerate. The intraformational conglomerate is dominated by quartz-rich clasts including minor banded oxide-facies iron-formation and jasper. Quartzite is overlain by poorly exposed siliciclastic sedimentary rocks (unit PAs) comprising feldspathic quartzite and arkose, in some cases containing quartzite lenses, green to buff wacke and black slate. Siliceous dolomitic marble (unit PAdl) comprises pink carbonate with quartz-rich laminae and layers, as well as high-angle veins.

Mafic to intermediate volcanic rocks (unit PAmf) are typically strongly schistose, chloritic with white-grey streaks of quartz and possibly sodic plagioclase, as well as brown weathering carbonate and minor pyrite. The volcanic rocks contain relict quartz-carbonate amygdules up to 1 cm in diameter, and plagioclase phenocrysts up to 1 cm in length. The major element geochemistry is similar to that of continental tholeiites (Linnen, 1979). The volcanic rocks form a zone in quartzite along the southern margin of the Amer group. Contact relationships are generally covered. However, in an area of near-continuous outcrop southeast of South Amer lake (65°26.5' N, 96°35' W), the volcanic rocks are flanked on both sides by 100 m of siliciclastic sedimentary rocks (unit PAs) and, on the south side, about 100 m of intervening siliceous dolomite (unit PAdl).

The mafic to intermediate volcanic rocks have been variously interpreted as part of the Amer stratigraphic sequence (Barrett et al., 1978; Young, 1984, 1988; Patterson, 1986), or as a structurally emplaced panel of Archean rocks (Tippett and Heywood, 1978; Tella and Heywood, 1983; Tella, 1994). Young (1984, 1988) proposed correlations between the basal quartzite of the Amer group and the Kinga Formation (Hurwitz Group) and between the volcanic rocks in the Amer group and the Happotiyik member of the Ameto Formation (Hurwitz Group). Deposition of the Lower Hurwitz Group is broadly bracketed to < 2.45 Ga by a baddeleyite age from Kaminak dykes in underlying basement (Heaman, 1994), and > 2111 ± 1 Ma based on baddeleyite from gabbro sills (Patterson and Heaman, 1991; Heaman and Lecheminant, 1993) that cut lithified rocks of the Ameto Formation (Aspler et al., 2001). In addition, the volcanic unit in the Amer group is remarkably similar lithologically and in its associations to plagioclase-porphyritic mafic to intermediate volcanic rocks intercalated with the < 2.5 Ga > 2.0 Ga Whitehills quartzite (Table 1) in the Half Way Hills-Whitehills Lake map area (Zaleski and Pehrsson, in press), although a carbonate unit is not known in that area. The Whitehills volcanic rocks (Pehrsson et al., 2002), like the Happotiyik member of the Ameto Formation (Hurwitz Group) (Hemmingway and Sandeman, 1999) and the Amer volcanic rocks (see above) show geochemical compositions consistent with continental tholeiite. In contrast, Archean mafic-ultramafic volcanic rocks of the Woodburn group generally show komatiitic to tholeiitic affinities, and volcanic rocks immediately south of the Amer margin comprise ultramafic cumulate and schist, associated with iron-formation. These considerations, together with the absence of an obvious structural break in the well-exposed part of the Amer section southeast of South Amer lake, support the interpretation of previous workers who viewed the volcanic rocks intercalated with the Amer group as part of the Paleoproterozoic stratigraphic succession. Additional structural, stratigraphic, geochemical and geochronological studies may contribute to unambiguously resolving this issue.

The youngest stratigraphic unit of the Amer group in the map area comprises rather poorly exposed, commonly calcareous, arkose, siltstone and slate (unit PAf). Bedding ranges from millimetre-scale laminated slate to 5–50 cm interbeds of arkose and siltstone. With recent geochronological work in the Hurwitz Group resulting in the recognition of a > 200 million year disconformity within the Hurwitz stratigraphy (Davis et al., 2000; Aspler et al., 2001), stratigraphic correlation between the Amer and Hurwitz groups has major implications for the timing of deposition and deformation of the Amer group. The Amer group has not been dated directly, but unit-by-unit stratigraphic comparisons (Young, unpublished report) suggest that the youngest unit of the Amer group in the map area could be equivalent to the upper < 1.9 > 1.83 Ga upper Hurwitz Group.

PLUTONIC AND RELATED ROCKS

Plutonic rocks in the map area are dominated by the 2.62–2.60 Ga Neoarchean granite suite. Granite (unit Āgt) varies from equigranular to porphyritic, with variably developed tectonic fabrics ranging from massive unfoliated to strongly foliated and locally mylonitic. A distinctive and common textural phase contains microcline megacrysts or augen up to 5 cm in length. Intrusive relationships to intermediate wacke are exposed in the eastern Apuqti'naaqtuq assemblage (65°11.6' N, 95°40.6' W). Foliated augen granite grades over about 5 m to quartz-feldspar porphyry adjacent to the contact. Mesoscale granitic apophyses extend into the host rock and are transposed into the parallelism with the host schistosity. The granite contains small (< 0.5 m) inclusions of wacke. Both the wacke and the granite are recrystallized, with the granite containing metamorphic epidote, biotite, magnetite and muscovite. Titanite is present both as recrystallized and relict igneous grains. Granite sampled at the site gave an age of 2610 + 3/-2 Ma (Davis and Zaleski, 1998). Nine kilometres to the north, the contact (covered) between granite and supracrustal rocks is partly marked by a wide (200 m) zone of coarse-grained actinolite-carbonate-biotite skarn (unit Ācs). The area north of the Apuqti'naaqtuq assemblage is dominated by homogeneous medium- to coarse-grained biotite-magnetite granite, and similar granite is interlayered with the Quggiilik assemblage on the Meadowbank River. The granite is present as sheets, approximately 1000 m wide in map view, folded (F_2 and F_3) together with amphibolite-facies supracrustal rocks. A strong subhorizontal L > S lineation, coaxial with the dominant folds, is defined by quartz and feldspars. Granite collected west of the river (65°20.1' N, 96°25.2' W) gave an age of 2613 ± 2 Ma (Davis and Zaleski, unpublished data). Northwest of the Quggiilik assemblage, fine- to medium-grained granite is more heterogeneous, including enclaves of quartz-feldspathic paragneiss (unit Āgtb). Fine- to medium-grained, massive to foliated granite containing recrystallized biotite, epidote and titanite is present at the western contact of the Apuqti'naaqtuq assemblage. Ashton (1988) reported an age of 2599 ± 5 Ma for similar granite from an island nearby in Pipedream lake (65°11.1' N, 96°12.6' W, not shown on map). Between the Apuqti'naaqtuq and Nutiplilik assemblages, Neoarchean granite is more heterogeneous, including diffuse amphibole-rich enclaves and hybrid granite and diorite (unit Āgtdt). Massive to foliated, coarse-grained granite dominates the area between the Nutiplilik assemblage and the Amer group.

Fine- to medium-grained quartz-feldspar porphyry (unit Āpp) belonging to the Neoarchean granite suite is present as minor intrusions in supracrustal rocks. The best exposure is in the southern map area, where a 60-metre wide porphyry dyke intrudes quartzite of the Ukalik formation (65°11.5' N, 95°59.2' W). Apophyses several metres in width penetrate the quartzite along bedding planes and parallel to bedding-parallel schistosity. Schistosity and S_3 crenulations in the apophyses are concordant with those in quartzite. A sample of the dyke gave an age of 2620 + 3/-2 Ma (Davis and Zaleski, 1998), also constraining the minimum depositional age of the Ukalik formation (see above). The dyke is likely itself an apophysis of microcline augen granite 500 m to the west, which lies along-strike of granite on southern Pipedream lake (Zaleski et al., in press) dated by Ashton (1988) at 2621 ± 2 Ma.

Gabbro (unit ĀPgb) intrudes the Meadowbank and Ukalik formations, as well as Neoarchean granite. In the Ukalik formation, gabbro is present as sills up to 500 m in width with locally developed fabrics concordant to those in the host rock. In the Meadowbank formation, contacts are obscured, but massive to foliated gabbro apparently cuts across lithological units. The gabbro is typically characterized by 1–2 cm oikocrysts comprising amphibole pseudomorphs of clinopyroxene. The presence of primary, interstitial or micropoikilolitic quartz distinguishes the gabbro from gabbroic-textured rocks belonging to the komatiitic suite. Spotted porphyroblastic amphibolite (unit ĀPsa) associated with Apuqti'naaqtuq volcanic rocks and iron-formation in the eastern map area may be a more strongly recrystallized equivalent of gabbro. In two locations (65°18.8' N, 96°20.3' W; 65°18.5' N, 96°20' W), komatiite in the Nutiplilik assemblage is cut by quartz diabase dykes (unit ĀPdb dyke symbols). Strain in the area is generally low, and the dykes are massive. The medium-grained, subophitic textures are pseudomorphed by greenschist-facies parageneses consistent with those in the host rocks. The evidence of metamorphism suggests that the dykes are older than the Paleoproterozoic diabase dykes in the Amarulik-Tehek lakes (Zaleski et al., in press) and Half Way Hills-Whitehills Lake (Zaleski and Pehrsson, in press) map areas to the south. Fine- to medium-grained, weakly foliated to massive, pink granite (unit ĀPgd) and lithologically similar dykes may postdate the Neoarchean granite suite.

In the northern map area adjacent to the Amer group, ultramafic rocks and iron-formation are associated with pyroxenite and gabbro (unit ĀPpx). The pyroxenite is generally massive, except for mylonitic and schistose fabrics exposed near the contact to the Amer group south of South Amer lake. Pyroxenite is characterized by poikilitic clinopyroxene enclosing serpentinized olivine, and coarse poikilitic brown amphibole, up to 2 cm in diameter, enclosing fine-grained (1–2 mm) clinopyroxene and serpentinized olivine. Relationships to olivine cumulate and ultramafic schist grouped with the Quggiilik assemblage (unit ĀQum) are obscured by lichen and suboptimal exposure. Intercalation on a 10 metre scale locally gives the impression that pyroxenite and ultramafic rocks may be phases of a layered intrusion, and the presence of local diffuse lamellae of magnetite suggest igneous layering. However, the difference in strain between pyroxenite and ultramafic schist may indicate that the pyroxenite is considerably younger. Ultramafic rocks and iron-formation are apparently intruded by medium- to coarse-grained, massive to foliated and porphyroclastic, monzodiorite to monzonite (unit ĀPd), although contacts were not observed. Euhedral to subhedral plagioclase is commonly associated with coarse poikilitic microcline, and minor (10–20%) micropoikitic and interstitial quartz. In outcrop and hand samples, the quartz has the appearance of blue eyes. Mafic minerals include amphibole and biotite, commonly altered to chlorite.

Massive gabbro sills (unit Pgb) in the Amer group, and massive to weakly foliated gabbro and pegmatitic gabbro (unit Pgbpg) to the south are interpreted to be Paleoproterozoic intrusions, as is a dyke of massive orbicular diorite (unit Pdto) in granite southeast of Nutiplilik. North of Uiguq&iq on the Meadowbank River, the Ukalik formation and the Nutiplilik assemblage are intruded by massive deep pink granite (unit PNgt) grouped with the ca. 1.76 Ga Nueltin suite (Peterson et al., 2002). The granite cuts across the folded unconformity at the base of the Ukalik formation, and across tectonic fabrics in quartzite. Foliation is locally developed within a few centimeters adjacent to contacts. Massive unmetamorphosed lamprophyre dykes (unit PMlm) that crosscut the Amer group as well as Archean rocks are interpreted to be associated with the 1.84–1.81 Ga, Christopher Island Formation (Baker Lake Group, Dubawnt Supergroup) (Rainbird et al., 2002). Most dykes are narrow (metre-scale) and could not be traced between exposures. However, west of Nutiplilik (65°18.4' N, 96°27' W), two subparallel dykes up to 40 m in width can be traced for several hundred metres.

STRUCTURAL INTERPRETATION

Four main phases of ductile deformation (D_1–D_4) are recognized on the basis of fabric orientations and overprinting relationships, relationships between fabrics and metamorphic mineral assemblages, correlations to macroscopic structures, and interpretation of the map pattern. Each of the main deformation events produced folds and related fabrics. The dominant fabrics in the area are S_1 and S_2 mineral schistosities. S_1 is typically subparallel to bedding (S_0), and S_1 and S_0 together define mesoscopic and macroscopic F_2 folds. S_1 schistosity is widely preserved, although in many areas, especially on the limbs of F_2 folds, the distinction between S_1 and S_2 is not clear. S_2 is commonly a composite fabric comprising transposed S_1 or a differentiated crenulation cleavage axial planar to F_2 folds. S_3 and S_4 are typically crenulation cleavages associated with mesoscopic and macroscopic, west-trending F_3, and north-northeast- to north-northwest-trending F_4 folds, respectively.

Evidence of D_1 deformation is mainly preserved in fabrics and mesoscopic structures, for example local intrafolial, hook-shaped or isoclinal F_1 folds in iron-formation and other strongly layered rocks. Just 200 m south of the map area (south, at 95°47' W), facing reversals (i.e. grading reversals in normally graded bedding) along the axial planar schistosity of isoclinal F_2 folds in mafic wacke suggest the presence of F_1 folds. In the Meadowbank River and Ukalik lake areas, the development of axial planar crenulation cleavage and local preservation of folded S_1 schistosity in volcanic rocks and quartzite indicate that the east- to northeast-trending folds are D_2 structures. The fabric relationships also confirm that the Meadowbank formation and the younger Ukalik formation have D_1 and subsequent deformation in common. Neoarchean granite also contains locally preserved S_1 schistosity deformed by macroscopic F_2 folds (e.g. east of Quggiilik, 65°20' N, 95°43' W). Ambiguity remains in the interpretation of macroscopic D_1 structures. For example, east of Quggiilik on the Meadowbank River, normal grading in felsic to intermediate wacke indicates eastward facing (65°18' N, 95°49' W and 65°16.9' N, 95°46.5' W) with respect to the macroscopic F_2 fold and, hence, overturned bedding younging toward the granite contact. The observations suggest the presence of a cryptic, eastward-verging, overturned F_1 syncline between the graded wacke occurrences and the granite contact. The possible presence of additional cryptic F_1 folds is suggested locally by symmetry of lithological units along F_2 traces (e.g. quartzite and volcanic rocks, 65°12.4' N, 95°48' W). However, in the absence of younging indicators, these are difficult to distinguish from stratigraphic accumulations. The configuration of the F_2 fold trace near Ukalik lake can be interpreted as either a refolded F_1 syncline cored by quartzite, or an eastward younging, stratigraphic section (with 2.63 Ga tuff near the top of the section) truncated by a D_1 fault that juxtaposed quartzite and volcanic rocks, or some combination of these scenarios. The presence of a D_1 fault is supported by the apparent discordance of the contact with respect to the stratigraphic units of the Ukalik formation.

The dominant structural trends in the map area are defined by transposed bedding and contacts (S_0) and bedding-parallel schistosity (S_1), associated with north-verging, overturned, tight to isoclinal, F_2 folds, as well as faults and high strain zones mainly localized on F_2 fold limbs. In some cases, faults associated with F_2 folds thrust older rocks over younger rocks. West of Nutiplilik, the unconformable contact between the Ukalik formation and the underlying komatiite and felsic volcanic rocks of the Nutiplilik assemblage is repeated by an easterly trending, F_2 synform-antiform pair. Crossbeds in Ukalik quartzite change younging direction across the area, consistently younging upward away from the folded contact. The folds reorient bedding-parallel S_1 schistosity and are associated with development of axial planar S_2 crenulation cleavage. Plunge is mainly toward the west, although the occurrence of quartzite near Nukiplilik on the Meadowbank River suggests doubly-plunging fold axes. However, west of the quartzite, a 500-metre wide zone of intensely developed schistosity is exposed on the small peninsulas along the shore. The outline of the peninsulas, crudely cruciform with several arms extending to east and west, is controlled by differential erosion along the fabric of the schist zone. In the zone, felsic rocks are transitional to quartz-eye muscovite schist, and carbonatized komatiite is transitional to ultramafic schist characterized by talc, tremolite, serpentine, magnetite and Fe-carbonate. Compositional layering is strongly transposed and attenuated. West of Nutiplilik, F_2 folds are reoriented by a north-northeast-trending F_4 fold, and truncated by crosscutting Nueltin granite. The macroscopic F_4 fold is associated with mesoscopic folds and S_4 crenulation cleavage, the latter resulting in locally strong pencil intersection lineation.

As previously discussed, the sequence of lithological units in the Ukalik formation southeast of the Meadowbank River (north of Uiguq&iq) suggests a repetition of the stratigraphy to the north. In addition, the upper stratigraphic units (i.e. the enveloping surface of the F_4 folds) exposed along the western shore of the river generally dip moderately to the southeast, apparently underneath the Nutiplilik assemblage on the south side of the river. These observations suggest the presence of a D_2 fault, largely obscured by the river, juxtaposing older rocks over younger rocks. High-strain zones exposed discontinuously on the shores of the river may be related to the fault or fault system. On the large peninsula that extends south into the Meadowbank River, felsic volcanic rocks of the Nutiplilik assemblage on the south shore (65°16.9' N, 96°18' W) are transitional to schist with recessive weathering carbonate streaks. To the southwest, sheared rocks are also locally exposed on the west side of the large peninsula that extends north into the river (65°16.1' N, 96°20.6' W).

South of Quggiilik, the Apuqti'naaqtuq assemblage and Ukalik formation are repeated and imbricated by F_2 folds and associated high-strain zones that also involve Neoarchean granite (65°11' N, 96°02' W). F_2 folds are defined by the northernmost occurrences of the Ukalik formation east of Ukalik lake, and in the eastern map area (65°15' N, 95°40' W). Folded surfaces are traced by curved quartzite ridges, visible on aerial photographs. The shape of the folds can also be seen in drainage patterns, as in the crescent-shaped lake that outlines part of the F_2 fold east of Ukalik lake. On the ground, units of the Ukalik formation can be traced around the hinge region of the fold. The dominant foliation visible on outcrop can be seen in thin section to be an S_2 crenulation cleavage of S_1 schistosity (Zaleski et al., 1999b). The vergence of S_0/S_2 changes systematically across the fold hinge. To the south, iron-formation and wacke of the Apuqti'naaqtuq assemblage, and the contact to the Ukalik formation, are deformed by numerous macroscopic and mesoscopic, tight, F_2 folds. Associated high-strain zones are marked by strongly developed schistosity and local ultramafic schist (65°11.9' N, 96°01.5' W).

In the southeastern map area, F_2 folds are increasingly attentuated and sheared limbs disrupt stratigraphic continuity. In addition, large areas of little or no exposure introduce ambiguities into the mapping of units. In particular, an area of low ground covered by Quaternary deposits and overlooked on the west by high knolls of quartzite extends from about 5 km southeast of Ukalik lake to the southern limit of the map. While the topography and outcrop pattern resembles that of folded quartzite to the north, quartzite and interleaved porphyry 1.5–2 km to the east suggest that the quartzite continues through the covered area, in part along high-strain zones on strongly attenuated fold limbs.

D_3 structures comprise east- to east-northeast-trending, shallowly to moderately dipping, south-verging folds with associated axial planar crenulation cleavage. Subhorizontal to shallowly plunging L_3 intersection lineations are near-ubiquitous on S_1 and S_2 schistosity surfaces throughout the map area. In the Nutiplilik assemblage along the northern shore of the Meadowbank River, interlayered ultramafic and felsic schist and iron-formation show extensive development of mesoscopic recumbent tight F_3 folds and axial planar crenulation cleavage. South of Quggiilik, D_2 structures are overprinted by shallowly plunging, F_3 folds at all scales, with surface traces subparallel to those of F_2 folds. On the northern limb of the F_2 fold east of Ukalik lake, and in the Ukalik formation to the southeast, mesoscopic F_3 folds and associated fabrics are prevalent. Locally, open to close F_3 folds result in domains of alternating shallow and steeply dipping schistosity, for example, along the ridge of Ukalik formation 10 km east-southeast of Ukalik lake. The eastern end of the ridge terminates in a domain of subhorizontal to moderately dipping bedded quartzite, interpreted as the short limb and hinge region of a macroscopic F_3 fold. Tight F_3 folds result in domains in which the dominant schistosity is transposed and dips toward the north. Near the southeastern contact of the Apuqti'naaqtuq assemblage with Neoarchean granite, northwest-dipping S_1 and S_2 schistosities are reoriented by F_3 folds. Similarly, in the amphibolite-facies domain of the southern Quggiilik assemblage on the Meadowbank River and the northernmost Apuqti'naaqtuq assemblage, northwest-dipping S_1 and S_2 schistosities are associated with F_3 folds. East of Quggiilik, mesoscopic F_3 folds have the style typical of F_3 folds, with steep, long limbs and subhorizontal or shallowly dipping short limbs. Changes between Z and S asymmetry indicate the presence of macroscopic folds. West of Quggiilik, poles to schistosity and bedding about the F_3 fold of interleaved supracrustal rocks and granite define a girdle about an axis of 240/06. The amphibolite-facies domain is characterized by subhorizontal to shallowly southwest-plunging L > S fabrics in both supracrustal rocks and granite. The lineations (peak distribution of 231/08) comprise composite transposed L_2 and L_3 mineral and stretching lineations subcoaxial with F_3 folds.

D_4 structures comprise north-northeast to north-northwest-trending, moderately dipping to subvertical, chevron and kink folds with associated axial planar crenulation cleavage. Locally, mesoscopic F_4 folds form kink bands (S_4) and, in some cases, a conjugate set of kink bands. The best constrained macroscopic F_4 folds are west of Nutiplilik, associated with mesoscopic F_4 folds and S_4 crenulation cleavage. In this area, moderately dipping, tight, overturned F_4 folds plunge shallowly toward the south.

The Amer group is involved in northwest-vergent folding and thrust imbrication (Barrett et al., 1978; Tippett and Heywood, 1978; Patterson, 1986), comparable in style and orientation to D_2 structures in the Woodburn group (Ashton, 1988; Zaleski and Davis, 1999; Zaleski et al., 2001). This has generally been interpreted as the first deformation in the Amer group (ibid.), requiring that the first foliation is S_2 associated with D_2 folds and faults. However, this interpretation needs to be reevaluated, as locally in hinge regions of F_2 folds, the dominant foliation is oriented at high angle to fold axial planes, suggesting a pre-existing folded foliation (65°29' N, 96°12' W). In recognition of this lingering ambiguity, we show the dominant foliation in the Amer group as S_1.

The scarp marking the southern contact of the Amer group has been interpreted as a steep, south-side-up, reverse fault (Patterson, 1986). However, this conflicts with C-S fabrics and shear bands observed in several locations that consistently indicate north-side-up relative motion, despite variations in attitude from moderately north-dipping to steeply south dipping. The presence of mesoscopic F_3 folds and fabrics suggests that the variations in dip are due to local reorientation by D_3 structures.

METAMORPHISM

Metamorphic parageneses in the map area range from greenschist and, possibly, subgreenschist facies to upper amphibolite facies. Strain is typically strongly partitioned, so that supracrustal rocks commonly show excellent preservation of primary textures pseudomorphed by metamorphic minerals. The exception is the Quggiilik assemblage along the Meadowbank River, which is strongly recrystallized to parageneses characteristic of upper amphibolite facies. Ultramafic schist in the Quggiilik assemblage contains coarse (up to 1 cm) porphyroblasts of olivine, together with tremolite, chlorite, magnesiohornblende and magnetite (L'Heureux, 2003). Silicate-facies iron-formation contains andesine/labradorite, tschermakite, garnet and cummingtonite (ibid.). Semipelite along the northern Meadowbank River locally contains K-feldspar-sillimanite-muscovite-quartz, without evidence of leucosome development. These observations imply temperatures of about 600°–670°C and pressures of 2–5 kb, depending on the activity of H_2O and departures from pure mineral compositions (Spear, 1993 and references therein). Thermobarometric results of ca. 610°C and 3.2 kb from semipelite, and 620°–670°C and 4–5 kb from silicate iron-formation (L'Heureux, 2003) are in broad agreement with petrogenetic grid constraints. Intermediate wacke throughout the Meadowbank River part of the Quggiilik assemblage is characterized by hornblende and andesine/labradorite. Assemblages in the northernmost Apuqti'naaqtuq assemblage include local biotite, andalusite, sillimanite and garnet (without muscovite), along with pale yellow staurolite (S. Pehrsson, pers. comm., 2001), indicating temperatures > ca. 600°C and pressures below that of the aluminosilicate triple point. The transition to low-grade rocks is apparently abrupt, with greenschist parageneses (chlorite-sodic plagioclase-epidote-actinolite) in metabasite in the Apuqti'naaqtuq and Nutiplilik assemblages to the south. Amphibole-absent metabasite (chlorite-albite-carbonate) indicates either lowermost greenschist facies or high CO_2 during metamorphism (Spear, 1993 and references therein). The amphibolite to greenschist transition coincides with a structural change from composite L_3/L_2 > S to S > L fabrics, suggesting that the metamorphic isograds were structurally telescoped during D_3 deformation.

The Ukalik formation contains chloritoid (± kyanite) in phyllite, and kyanite in quartzite, characteristic of greenschist facies, and consistent with chlorite-sodic plagioclase-epidote-actinolite in associated gabbro (unit ĀPgb) and in metabasite in the adjacent Meadowbank formation. The kyanite is interpreted to be derived from pyrophyllite decomposition (Ashton, 1988; this study), constraining temperatures to ca. 400°–500°C and pressures to ca. 2.7–3.6 kb (Spear, 1993 and references therein). Actinolite ± hornblende and chlorite-absent assemblages in metabasite in the northwestern Nutiplilik assemblage, and in mafic wacke the southeastern Apuqti'naaqtuq assemblage, suggest transitional greenschist-amphibolite facies. Neoarchean granite contains metamorphic epidote, biotite, magnetite, muscovite, and titanite consistent with the grade of the adjacent supracrustal rocks.

Metamorphic grade is poorly constrained in supracrustal rocks south of the Amer group, but Quggiilik wacke commonly preserves relict clastic textures suggesting only minor recrystallization. To the north, actinolite and local cummingtonite in iron-formation, and serpentine, chlorite and tremolite in ultramafic schist are consistent with greenschist facies, as are assemblages in metabasite in the Amer group itself.

In general in greenschist-facies rocks, phyllosilicate minerals and amphibole define S_1 schistosity and S_2 foliation or crenulation cleavage. Porphyroblastic kyanite both overgrows S_2 crenulation and is wrapped by S_2 schistosity in the matrix. Kyanite is typically randomly oriented on the S_2 foliation surface. Phyllosilicate minerals and kyanite are kinked and crenulated by F_3 and F_4 microfolds, and kyanite commonly shows associated retrogression. In amphibolite-facies areas, high-grade minerals, including aluminosilicate minerals, typically define the dominant foliation and lineation, and relict intrafolial microfolds indicate that this is an S_2 fabric. Staurolite in the northern Apuqti'naaqtuq assemblage is both wrapped by the dominant foliation, and contains inclusion trails subparallel to the matrix fabric (S. Pehrsson, pers. comm., 2001). The dominant fabric is deformed or transposed by D_3 structures. These observations suggest that the main regional metamorphism is broadly syn-D_2 and, hence, bracketed to < 2.0 Ga by the syntectonic Tasirjuak conglomerate (Zaleski and Pehrsson, in press; Davis and Zaleski, unpublished data), and > 1.835 Ga by crosscutting granite dykes (Roddick et al., 1992).

ECONOMIC GEOLOGY

The map area encompasses 10 known mineral occurrences (Table 2). Five kilometres south of South Amer lake, ultramafic-mafic rocks grouped with the Quggiilik assemblage are host to two gold occurrences (Irv showings, no.1–2) associated with iron-formation, carbonate-actinolite and silicic alteration, and sulphidation. Surface samples from the 'Main' showing (no.1) returned assays of up to 21.7 g/t Au (Wollex Exploration, 1990). The limited extent of the mineralized zones, which are truncated to the east by plutonic rocks, apparently hindered further investigation. However, numerous screens of massive to schistose ultramafic rocks and interlayered gossanous iron-formation continue 15 km to the east, in part associated with pyroxenite. Gossan zones are extensively developed, especially in iron-formation, accompanied by iron carbonate alteration in ultramafic-mafic schist. Prior to our most recent field work, this area had not apparently been thoroughly prospected (Zaleski et al., 2000). Interestingly, along the northern Meadowbank River, although ultramafic-mafic rocks and iron-formation in the amphibolite-facies Quggiilik assemblage are commonly gossanous, no mineral occurrences have been reported. The Nutiplilik assemblage is host to three occurrences of gold, base metal and polymetallic type (no.3–5), associated with deformed quartz-carbonate veins and pods in ultramafic schist. Metavolcanic and associated rocks of the Apuqti'naaqtuq assemblage south of Quggiilik are host to five gold occurrences (no. 6–10). In part these lie on the northeastern end of a belt of mineral occurrences of various types that extends southwest beyond Pipedream lake (Kjarsgaard et al., 1997; Kerswill et al., 1998).

ACKNOWLEDGMENTS

The Woodburn Project was initiated by Jack and Mariette Henderson to follow up on previous reconnaissance mapping. Although Jack was not able to return to the field himself, he was a continuing source of support and inspiration until he passed away in 1997. The results of the Woodburn Project are dedicated to his memory.

Wouter Bleeker, Paul Budkewitsch, David Corrigan, Bill Davis, Norm Duke, Erika Greiner, John Kerswill, Rob L'Heureux, Sally Pehrsson and Lori Wilkinson contributed to the mapping and interpretation of the Meadowbank River area map. Bill Davis derived the U-Pb ages reported here, except where otherwise indicated. Subhas Tella facilitated access to unpublished theses and to field data collected by previous GSC mapping teams. Mapping between Uiguq&iq and Nutiplilik on the Meadowbank River was aided by the generosity of Gerry Harron, who supplied detailed aeromagnetic data and unpublished reports (McChip Resources Inc.). The field program operated out of the Meadowbank camp of Cumberland Resources Ltd., and Brian Alexander, Gord Davidson, Roger March and other Cumberland employees are gratefully acknowledged for their co-operation and logistical help during the field seasons. Subhas Tella and Karen Fallas reviewed the map and manuscript, and their comments greatly improved the final version.

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