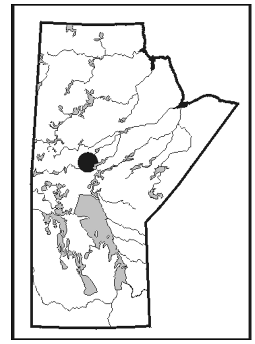
**GS-10**

# STRUCTURAL MAPPING OF THE SETTING LAKE AREA (PARTS OF NTS 63J/15 AND 63O/1, 2)



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## SUMMARY

Mapping in the Setting Lake area has shown that amphibolite (unit Ua; Fig. GS-10-1a, b), derived from mafic flows and sills of uncertain age and stratigraphic affinity, extends from the margin of the Thompson Nickel Belt into the Kisseynew Domain. Pebbly sandstone and conglomerate of the Grass River Group unconformably overlie unit Ua, and grade into finer grained sandstones farther within the Kisseynew Domain. Turbidite of the Burntwood Group, which predominates in the Kisseynew Domain, is faulted against the amphibolite (Ua). Such faults may also juxtapose the Kisseynew stratigraphy with the Ospwagan Group. The faults contain numerous intrusions and were active under changing metamorphic conditions during a proposed structural history of four phases of folding and fabric development in the Proterozoic rocks and the Archean basement.


## INTRODUCTION

The western boundary of the Thompson Nickel Belt (TNB) is a fault zone (Setting Lake Fault Zone) along which the Archean basement gneisses and unconformably overlying Paleoproterozoic Ospwagan Group are truncated against the sedimentary gneisses of the Kisseynew Domain. Remapping of the boundary zone was continued this summer in the Setting Lake area to improve the understanding of the regional structure, particularly of the Ospwagan Group, which hosts the nickel-bearing intrusions in the TNB.

The mapping was extended north to Bah Lake, south to Kiski Lake and east to Highway 6 (Fig. GS-10-1a, b). Areas in the Kisseynew Domain included August, Five-Mile, Fish and Pakwa lakes. Units of the Ospwagan Group on islands in Setting Lake were revisited with Josef Macek of Manitoba Energy and Mines to ascertain their stratigraphic affinity. The mapping and this report focus on: (1) recording the key features of major stratigraphic units; (2) analyzing the large-scale fold pattern; (3) measuring and documenting the various fabric elements in the Proterozoic and Archean rocks; and (4) compiling a Proterozoic structural history of the Setting Lake area.

## STRATIGRAPHY

The stratigraphy in the TNB was subdivided by Macek and Bleeker (1989) and Bleeker (1990). The regional Kisseynew stratigraphy was compiled by Zwanzig (1990), but it is now known that these sedimentary rocks are 1.86-1.83 Ga (Machado et al., submitted manuscript), much younger than the succession in the TNB. The Grass River Group (Zwanzig, 1997), which is very similar to parts of the Kisseynew stratigraphy, is assumed to fall into the range of Kisseynew ages. Although all units in the Setting Lake area are highly metamorphosed, the prefix *meta* is omitted and, where possible, rocks are described as their protolith. Only units affected by the new mapping are discussed in this report.

### Archean reworked migmatite

The basement to the Ospwagan Group along the southeast shore of Setting Lake and the adjacent part of Highway 6 consists of migmatitic gneiss with several leucocratic and mafic components. The darker fractions are medium- to coarse-grained, commonly with 15-50% hornblende, but locally with <10% biotite and no hornblende. The lighter fractions include Archean leucotonalite veins, pink quartz syenite and Proterozoic granite pegmatite (Machado, pers. com., 1997).

### Ospwagan Group sedimentary rocks

The new mapping is consistent with an interpretation that quartz-rich and pelitic sedimentary rocks of the Ospwagan Group underlie much of Setting Lake. Exposures on most islands comprise interbedded quartzite and pelite or quartzose greywacke of the Setting Formation (Zwanzig, 1997). Unusual, garnet-rich semipelite, with interbedded quartzite was assigned to the Setting Formation, whereas minor iron formation and marble were assigned to the Pipe Formation (Macek, pers. com., 1998). The lower part of the Ospwagan Group (Manassan and lower Pipe formations of Bleeker, 1990) is not exposed at Setting Lake but can be inferred to exist between the islands and the basement, which forms the southeast shore (Fig. GS-10-1a, b).

### Amphibolite

Amphibolite derived from mafic flows, dykes and sills forms sheets that are generally less than 500 m thick. These are in contact with a variety of rock types and occur in two or three structural positions. They may form a structural assemblage (mapped as unit Ua; Fig. GS-10-1a, b) that represents more than one stratigraphic unit, possibly including part of the Ospwagan Group and rocks with affinity for the Kisseynew Domain.

Pillow basalt is relatively uniform in well-preserved areas of unit Ua. It is dark green and has a high content of hornblende (50-75%). Selvages have a thin plagioclase-rich core and hornblende-rich margins. Inner rinds are rarely amygdaloidal or spherulitic. Ubiquitous lenses of calc-silicate alteration are rich in epidote on Setting Lake and near Bah Lake, but contain epidote-diopside on Fish Lake. A gradation from pillow basalt and gabbro at Bah Lake to layered amphibolite along strike at the south end of Fish Lake represents increased deformation and metamorphic grade.

Fine- to coarse-grained, layered, hornblende-diopside gneiss on Five-Mile and August lakes is interpreted as a highly metamorphosed variety of unit Ua. At the southeast end of Setting Lake, pillow basalt forms parts of large amphibolite rafts in granodiorite, one of which contains part of a sheeted dyke complex. This observation, the uniform appearance of the basalt and the absence of clastic sedimentary rocks make the mafic sequence similar to part of an ophiolite succession. Pebbles and cobbles of ferruginous chert in the overlying polymictic conglomerate of the Grass River Group may have been eroded from unit Ua (Zwanzig, 1997).

Initially, pillow basalt and sills on Setting Lake were interpreted to form the upper part of the Ospwagan Group (Zwanzig, 1997). However, they are preserved in structural lenses separated by mafic tectonite and are therefore designated here as unit Ua with uncertain stratigraphic affinity. Only the sills intruding the Setting Formation are tied to the Ospwagan Group. The new mapping indicates that unit Ua extends north into the hinge zone of a large northeast-plunging antiform near Bah Lake and continues in a southwest-tapering belt for 20 km, to the south end of Fish Lake (Fig. GS-10-1b). The tapering belt lies in the northwest limb of the large antiform and is therefore most likely part of the same folded sheet as the amphibolite (Ua) on Setting Lake, which lies in the southeast limb of the antiform. The amphibolite in this sheet is interpreted to be unconformably overlain by the Grass River Group, which belongs to the Kisseynew Domain.

### Burntwood Group

West of Setting Lake a unit of greywacke-mudstone turbidite (at higher grade, layered garnet±cordierite-biotite gneiss and migmatite) underlies the amphibolite (Ua). The rock is identical to the Burntwood Group throughout the rest of the Kisseynew Domain (Zwanzig, 1990). It contains cordierite, abundant biotite (10-30%), garnet (~15%), very little K-feldspar or sillimanite, and a high ratio of plagioclase to quartz. This mineral content and uniform bedding distinguish the Burntwood Group from the turbidite in the Setting Formation of the Ospwagan Group.

A 100-400 m wide belt of the Burntwood Group extends from the southwest shore of Setting Lake for a distance of least 15 km to the southwest shore of Kiski Lake (Fig. GS-10-1a). Compositional grading (greywacke-mudstone) is well preserved in large rafts in granodiorite on Setting Lake. A 1.5 km wide belt of the Burntwood Group extends along

Fish Lake, where the unit grades from well preserved turbidite to migmatite and rafts in granodiorite. Porphyroblasts of fresh blue or purple, and altered grey to green, cordierite are common at the margin of leucosomal veins at Fish Lake. A large area of Burntwood Group migmatite is exposed northwest of August Lake.

The contacts between the Burntwood Group and the amphibolite (Ua) are interpreted as a series of faults. Elongate stocks of gneissic granite to monzodiorite or younger leucogranodiorite generally intrude the faults.

### Grass River Group

The Grass River Group is a sedimentary succession of: (1) deformed conglomerate; (2) intermediate to mafic clastic rocks (sandstone and possible tuff); (3) pebbly sandstone; and (4) quartzofeldspathic rock derived from crossbedded arkose (Zwanzig, 1997). The most widely recognizable characteristic of the group is the presence of hornblende porphyroblasts near the base, and quartz-sillimanite knots in the upper half (Albino and Macek, 1981). The Grass River Group is part of the sedimentary succession of the Kisseynew Domain. It occurs in belts, up to 3 km wide, with symmetrically disposed units defining folds with axial traces extending up to 20 km. A narrow belt of Grass River Group has been newly identified along Highway 6 east of Kiski Lake (Fig. GS-10-1a).

The possibility of an unconformity between the Grass River Group and the underlying amphibolite (Ua), suggested by Zwanzig (1997), has been made more plausible by the presence of sheared basal conglomerate exposed on the logging road south of Bah Lake (Fig. GS-10-1b). The amphibolite unit is typically overlain by 50-200 m of hornblende-bearing units of the Grass River Group that young away from the amphibolite, toward the sillimanite-bearing unit. This relationship is consistent with a widespread unconformity at the base of the Grass River Group.

Units of fine grained, pink to buff, felsic gneiss occur near the base of the Grass River Group on Five-Mile and August lakes (Fig. GS-10-1b). They resemble felsic volcanic gneiss in the Missi Group (Zwanzig and Schledewitz, 1992) and may have been derived from felsic tuff. Cordierite-sillimanite±garnet-bearing pelite (Gp) is associated with the felsic gneiss. This rock (Gp) resembles pelite in the Sickle Group (McRitchie, 1977). The migmatitic sandstones on Five-Mile and August lakes are rarely pebbly and were probably derived from finer grained facies than those on Setting Lake.

## PROTEROZOIC INTRUSIVE ROCKS

A wide variety of pre- to late-tectonic intrusions occur in the Setting Lake area. Some of these have been previously described, including early mafic to intermediate and felsic dykes in the Grass River Group (Zwanzig, 1997). Plutons re-examined in 1998 are summarized, from oldest to youngest, below.

### Hornblende quartz diorite (Pqd)

A large body of quartz diorite intrudes the Archean basement gneisses east of the southern half of Setting. Locally, the quartz diorite is gneissic along the contact. The rock contains <5 mm hornblende porphyroblasts and, rarely, larger grains with a core of orthopyroxene in a finer-grained matrix dominated by plagioclase. Quartz diorite is intruded by the youngest granitoid phases: leucogranodiorite (Pld) and pegmatite.

### Granodiorite gneiss (Pgn)

The felsic to intermediate intrusive complex that extends from the north end of Setting Lake for 35 km southwest to Pakwa Lake (Fig. GS-10-1a, b) had no relative age assigned in the original mapping (Albino and Macek, 1981; Zwanzig, 1997). The complex is pre-metamorphic and has an early gneissic foliation cut by narrow foliated mafic-ultramafic dykes. Abundant screens include garnet-hornblende-bearing gneiss of unknown origin. The granodioritic phase also contains rafts of Grass River Group and probable screens of Burntwood Group, and thus must postdate these units. Similar gneissic granodiorite forms the felsic phase of the early dykes in the Grass River Group on Setting Lake (Zwanzig, 1997).

### Gneissic porphyritic granite to monzodiorite (Ppg)

Complexes of porphyritic granite, augen gneiss and medium grained granite extend for >20 km along Pakwa Lake, and along the west shores of Setting and Kiski lakes (Fig. GS-10-1a). This granite appears to intrude the granodiorite gneiss (Pgn) at the north end of Pakwa Lake. The granite grades into hornblende syenite and quartz diorite with alkaline-calc-alkaline geochemical affinity (Zwanzig, 1997). Augen texture is most prominent at Pakwa Lake, and dykes occur in the contact zone with the Grass River Group on Setting Lake.

### Gneissic granite to leucogranite (Plg)

Another granite complex extends from the west shore of Fish Lake for 15 km to the west half of Five Mile Lake. The granite intrudes the Grass River Group in the north, and its southeast contact is a major shear zone. Sheets of granite, ~200 m wide, occupy shear zones on Five-Mile and August lakes.

### Leucogranodiorite (Pld)

The youngest plutons in the map area are sheets that generally intrude major faults and shear zones. They consist of distinctive, white weathering, leucogranodiorite and leucogranite that generally contain garnet ±muscovite or cordierite and are locally pegmatitic. The largest bodies intrude the Ospwagan Group directly east of the Setting Lake Fault Zone. They form raft complexes (large-scale agmatite) and smaller bodies that represent a late pulse of leucosome in the migmatites of the Kisseynew Domain. Composition, texture and orientation of the layering in the country rocks was little disturbed in the agmatization.

## STRUCTURE

The Setting Lake area straddles the boundary between the Thompson Nickel Belt (TNB) and the Kisseynew Domain. The eastern margin of the Kisseynew Domain constitutes an elongate, fault-bounded block, the Setting Lake Fault Zone (SFZ). This structural framework divides the Setting Lake area into three zones.

The first zone comprises TNB basement and cover, with prominent dome structures and complex fabrics. This zone occupies the main part of Setting Lake–underlain by the Ospwagan Group–and areas to the southeast, which are underlain by complexly migmatized Archean basement gneisses. The basement contact with the Ospwagan Group is not exposed but is inferred to be a sheared unconformity.

The second structural zone underlies the northwest bay in Setting Lake and extends west to the shore of Fish Lake, northeast beyond Bah Lake and southwest beyond Kiski Lake (SFZ; Fig. GS-10-1a, b). In this belt, pebbly facies of the Grass River Group unconformably overlie the amphibolite (Ua). These supracrustal rocks occupy large recumbent folds that are refolded in a late anticline with a core of granodiorite gneiss (Pgn). The southwestern part of the SFZ is largely replaced by syntectonic intrusions. All units are at uppermost amphibolite grade, but volcanic rocks south of Bah Lake and adjacent sedimentary rocks have a slightly lower grade, and some late granodiorite (Pld) is at greenschist facies. Retrogression to greenschist facies is common in shear zones. Outside the shear zones, primary features are better preserved in the SFZ than in the main part of the Kisseynew Domain.

The third (northwestern) zone includes the Fish Lake-August Lake area and is dominated by sediment-derived migmatites and folded sheets of granite typical of the Kisseynew Domain. Pelitic rocks have the assemblage cordierite-sillimanite-garnet in this area. The large-scale folds suggest that the Burntwood Group northwest of August Lake occupies an upper structural level.

A history of Proterozoic deformation, consistent with that of Zwanzig (1997), is here tentatively interpreted from domes and complex fabrics in the Archean basement gneiss, and from large- and small-scale folds in the Proterozoic supracrustal rocks. An important feature is the protracted development of the basement domes and their internal fabrics during polyphase folding in the Proterozoic rocks. Deformation is interpreted to have spanned four phases of deformation, lasting through high-grade and retrograde metamorphic conditions. The history differs from that of Bleeker (1990) in dividing his phase 3 into a high-temperature phase ($D_3$), related to north-northeast-trending folding and sinistral shear, followed by $D_4$, characterized by northeast-trending folding and southeast-side-up slip during greenschist facies retrogression. Earlier phases are consistent with those proposed by Bleeker (1990) but not necessarily with his absolute ages of deformation.

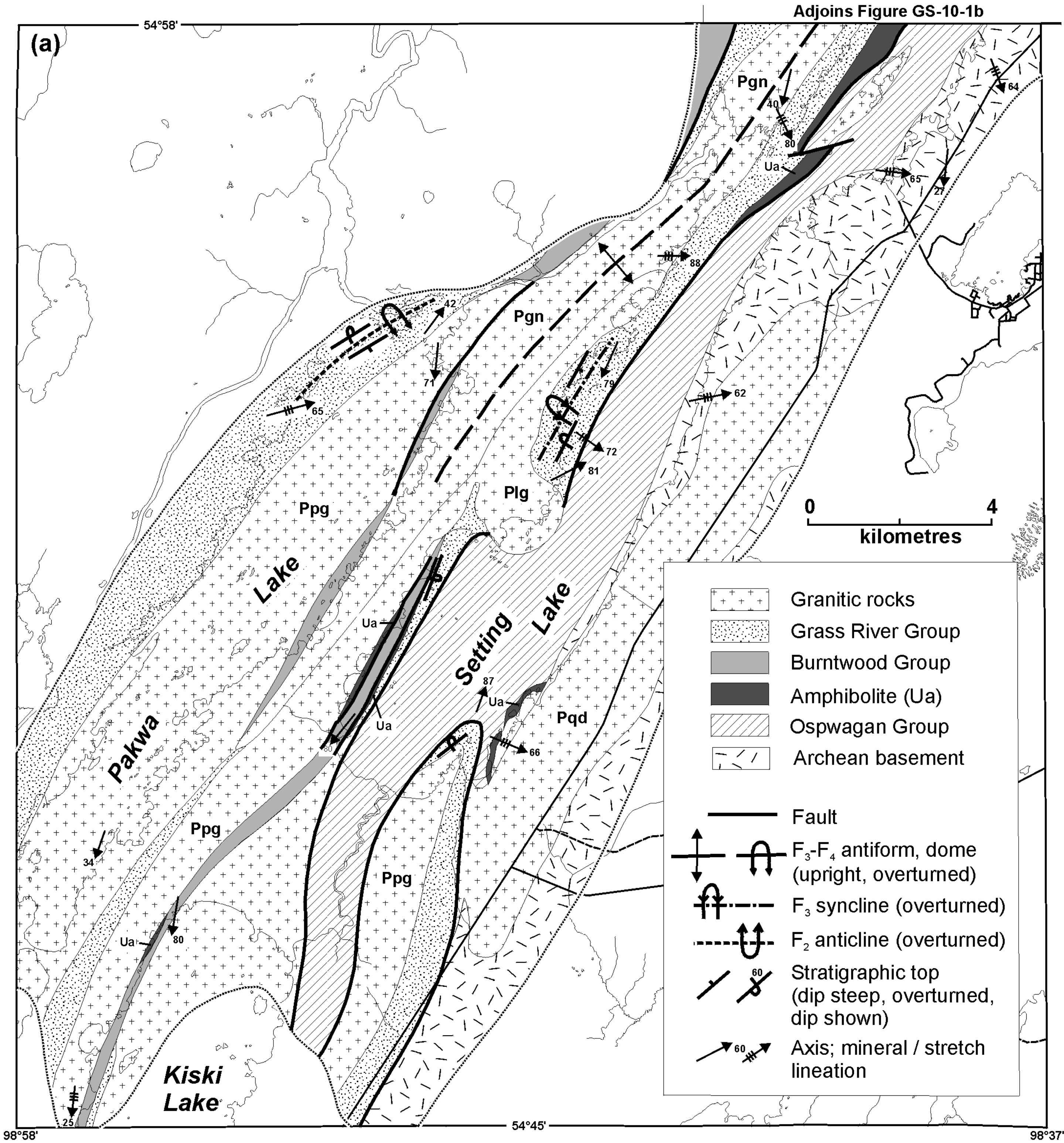
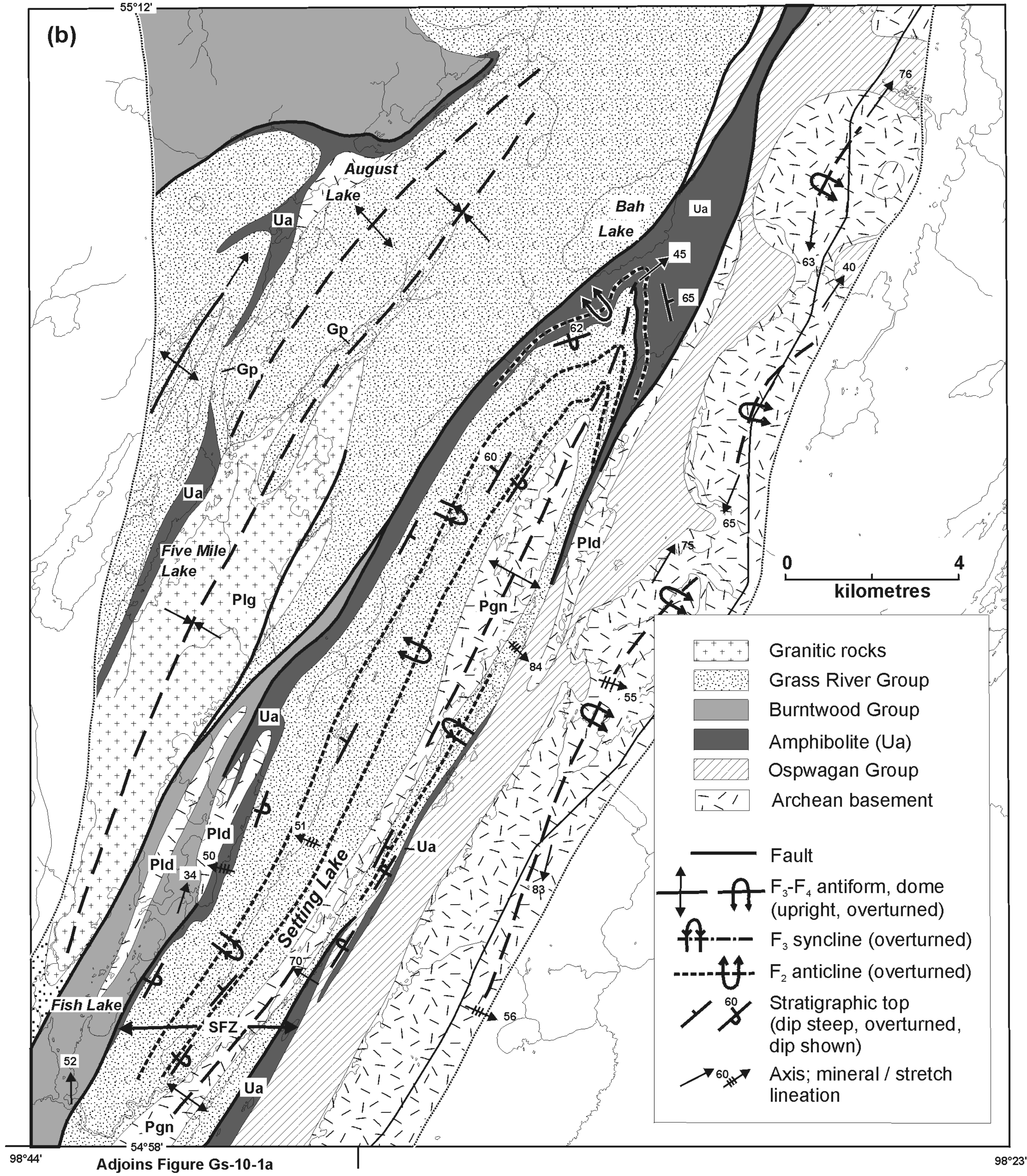



*Figure GS-10-1a and b: Sketch map of the Setting Lake area: (a) southwest part, (b) northeast part, showing a preliminary structural interpretation. SFZ = Setting Lake Fault Zone. Various Proterozoic granitoid rocks are labeled on the figure. They are, from oldest to youngest: Pqd = quartz diorite, Pgn = granodiorite gneiss, Ppg = porphyritic granite to monzodiorite, Plg = gneissic to leucogranite, Pld = leucogranodiorite. Gp = pelitic and felsic members of the Grass River Group. Stratigraphic tops are generalized from the regional succession of formations, pillow tops and crossbedding. Unlabelled dips are steep. Axes are mostly from $F_3$ and $F_4$ minor folds. Lineations are mainly from hornblende alignment, interpreted to have formed during $D_3$ commonly parallel to the $L_4$ stretching lineation.*



(b)
55°12'
August
Lake
Bah
Lake
Ua
Gp
Five Mile
Lake
Plg
Pld
Pgn
Setting Lake
SFZ
Fish Lake
54°58'
98°44'
98°23'
Adjoins Figure Gs-10-1a
0
4
kilometres
Granitic rocks
Grass River Group
Burntwood Group
Amphibolite (Ua)
Ospwagan Group
Archean basement
Fault
F3-F4 antiform, dome (upright, overturned)
F3 syncline (overturned)
F2 anticline (overturned)
Stratigraphic top (dip steep, overturned, dip shown)
Axis; mineral / stretch lineation

### Basement and cover

The Archean basement gneiss forms a chain of northeast-trending domes and saddles overturned with the Ospwagan Group cover toward the northwest (Fig. GS-10-1a, b). A protracted process of doming ($F_2$-$F_4$) has deformed Archean migmatitic layering and gneissosity as well as composite Hudsonian schistosity ($S_1$-$S_3$ in Table GS-10-1). Early Proterozoic schistosity is best preserved in gently dipping areas of the basement saddles, suggesting that it first formed as a recumbent $S_1$ foliation, which is presently subparallel to the Archean gneissosity. Coarsening $S_1$ into $S_2$ and local, shallow east-west plunging crenulation ($L_2$?) of $S_1$ may have occurred during $F_2$ recumbent folding in the supracrustal rocks (below).

**Table GS-10-1**
**Deformation Phases**

| | | |
|---|---|---|
| $D_1$ | Development of shallow dipping $S_1$ foliation at low angles to Archean gneissosity in the basement migmatites, probably beneath a sheared unconformity at the base of structurally thickened Ospwagan Group. Possible faulting of units in the Kisseynew Domain against the TNB. | Hudsonian metamorphism (low grade?) |
| $D_2$ | Folding ($F_2$) at a high angle to the present trend of the domes. Possible east–west crenulation and $S_1$ recrystallization to $S_2$ schistosity. Southwest-verging recumbent folding and probable southwest thrusting of basaltic rocks (Ua) and Ospwagan Group sedimentary rock over rocks of the Kisseynew Domain. | upper amphibolite grade |
| $D_3$ | Upright folding ($F_3$), close to the present northeast-trend of the domes, well developed in the migmatites of the Kisseynew Domain. Steeply plunging mineral lineation formed during vertical thickening and doming by $F_2$-$F_3$ interference. Development of local $S_3$ schistosity cutting $S_2$. Sinistral slip in the SFZ. | upper amphibolite grade |
| $D_4$ | NNE-trending upright folding ($F_4$) during continued doming, development of $S_4$ cataclastic foliation, mylonite and striation. Pegmatite intrusion. Horizontal compression and mainly southeast-side-up slip in the SFZ. | low-middle greenschist |

A mineral and stretching lineation ($L_3$) generally plunges steeply east or southeast and occurs in steeply dipping schistosity transposed into $S_3$. $L_3$ is generally a strong, penetrative hornblende lineation interpreted to lie close to the direction of elongation during early doming. The high-temperature L-S fabric is equally developed in the basement gneiss and in mafic Proterozoic dykes to indicate that the fabric formed near the peak of the Hudsonian metamorphism (Table GS-10-1).

The composite $S_2$-$S_3$ schistosity, Archean gneissosity and veins are deformed in northeast-trending upright minor folds ($F_4$) parallel to the trend of the domes. These structures lack axial planar foliation, but the youngest set of pegmatitic mobilizate is generally parallel to the late axial planes. Minor $F_4$ fold axes and crenulations curve northeast-southwest over the domes (Fig. GS-10-1b) and formed during the final stage of doming.

A cataclastic foliation ($S_4$) is defined by a spaced cleavage with chlorite, fine white mica and an epidote coating. It occurs in all components of the reworked Archean gneiss, including the young pegmatites. A fine striation ($L_4$ stretching lineation) on the cleavage surface is oblique or perpendicular to the axes of the $F_4$ upright folds. The style of folding is consistent with flexural slip along $L_4$ during $F_4$. Near the contact with the Ospwagan Group, i.e., along all promontories on the southeast shore of Setting Lake, the north-northeast-trending cataclastic foliation ($S_4$) is the dominant structure and grades into bands of mylonite. Dips range from vertical to 55° southeast and indicate that the unconformity between the basement and Ospwagan Group was sheared and overturned toward the northwest. Kinematic indicators in the shear zones show a consistent southeast-side-up sense of slip. A horizontal sinistral slip component appears to be more common than a dextral component.

Systematic reversals in topping direction at 10-200 m intervals in the Ospwagan Group coarse grained greywacke (Zwanzig, 1997) are here tentatively interpreted as $F_1$ folds. Quartz diorite intrusion (Pqd) into the basement occurred before peak metamorphism and $F_3$.

### Setting Lake Fault Zone (SFZ)

The stratigraphic package that occupies the SFZ and the main part of the Kisseynew Domain does not extend into the TNB. An Archean basement provenance of the Ospwagan Group indicates a separate depositional basin from the Kisseynew basin, which had a provenance that is partly Paleoproterozoic volcanic arc (Bailes, 1980, Zwanzig, 1990). Potentially, a domain of ocean floor rocks (partly preserved in unit Ua) may have separated the TNB from the Kisseynew basin. Much of the displacement responsible for juxtaposing the different domains is interpreted to have taken place in the SFZ, which is therefore a key to regional structural analysis.

The stratigraphic tops in the Grass River Group and pillow tops in the amphibolite (Ua) define large-scale synmetamorphic $F_2$ folds south of Bah Lake (Table GS-10-1; Fig. GS-10-1a). The $F_2$ folds are isoclinal (sheet like) and have a strong $S_2$ axial planar foliation. They are interpreted to define a synclinorium in the Grass River Group and a complimentary anticline in the amphibolite. These folds were probably recumbent during $F_2$ and had a southerly vergence (Fig. GS-10-2). The $F_2$ folds were subsequently refolded with $S_2$ in an upright $F_3$-$F_4$ antiform that has granodiorite gneiss (Pgn) in the core (Fig. GS-10-3). Consequently, the Grass River Group structurally underlies the amphibolite in the limbs of this antiform. Dips are away from the granodiorite, but the unconformity tops down, toward the $F_2$ synclinorium (Fig. GS-10-1b). Sandstone along the main synclinal trace contains quartz-sillimanite knots on the northwest shore of Setting Lake but only metamorphic muscovite east of the sillimanite-biotite isograd, which lies near the $F_3$-$F_4$ anticlinal trace. This indicates that the $F_2$ folds formed before the metamorphic peak, but the axial planar $S_2$ schistosity shows that high-grade metamorphism was well underway during $F_2$. A reversal in the bedding/schistosity ($S_0$/$S_2$) intersection across the $F_2$ trace indicates an upward facing syncline, consistent with southerly $F_2$ vergence. The various units in the limbs of the $F_2$ anticline were probably juxtaposed with the amphibolite (Ua) during $D_1$-$D_2$ thrusting and $D_3$-$D_5$ displacement along steeply dipping faults (Figs. GS-10-1b and GS-10-3).

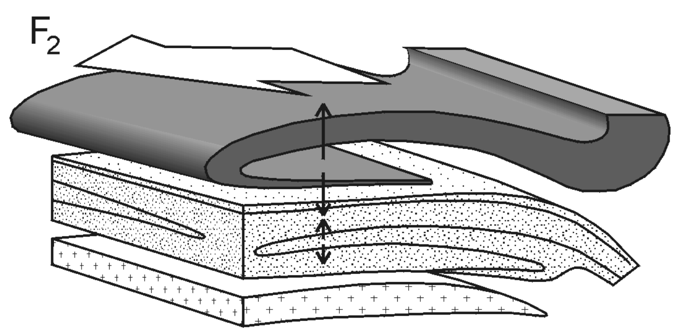



*Figure GS-10-2: Structural interpretation of $F_2$ folds in the Bah Lake-northwest Setting Lake area before $F_3$ refolding. This schematic block diagram shows an $F_2$ recumbent anticline in amphibolite (Ua) with southerly vergence (arrow) and an underlying $F_2$ synclinorium in the Grass River Group resting on granodiorite gneiss. The anticline is shown with an empty core for clarity. Patterns are as in Fig. GS-10-1a, b.*

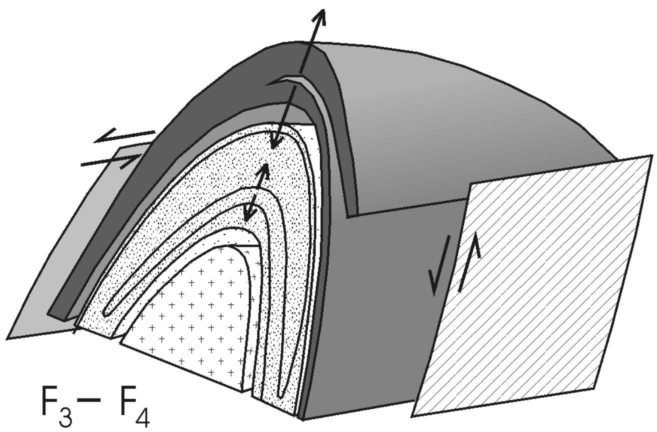



*Figure GS-10-3: Structural interpretation of the $F_3$-$F_4$ antiform refolding the $F_2$ structures (symmetric arrows) shown in Fig. GS-10-2. Repeated faulting (asymmetric arrows) has juxtaposed various units with the amphibolite (Ua). Patterns are as in Fig. GS-10-1a, b.*

The Setting Formation is in fault contact with the Grass River Group on the west and southeast sides of the southern end of the lake (Fig. GS-10-1a). These belts of the Grass River Group top toward each other and the adjacent faults, i.e., toward the centre of the lake. Amphibolite (Ua) and the Burntwood Group underlie the western belt. This relation suggests that part of the Setting Formation was thrust southwest over the rocks of the Kisseynew Domain during $D_2$ and possibly folded into an $F_3$-$F_4$ synform.

Major and minor $F_3$ folds are developed on the northwest shore of the southern bay of Setting Lake (Fig. GS-10-1a). These are characterized by folded foliation ($S_2$), bedding and veins but with a biotite schistosity ($S_3$) in the axial zone of tight folds. Quartz-sillimanite knots flattened in $S_3$ indicate that conditions of peak metamorphism had been attained. The porphyritic granite to monzodiorite (Ppg) has strong northeast-trending subvertical foliation and augen texture that are interpreted as $S_3$. Feldspar pressure shadows on the K-feldspar augen suggest near magmatic conditions. Asymmetric trails on the K-feldspars have a shallow southerly plunge that indicates sinistral-reverse slip. Consequently, the large intrusions are interpreted to have been emplaced during the beginning $D_3$ deformation or earlier.

The bounding faults and shear zones in the SFZ were probably active from $D_2$ to $D_4$. They appear to have involved thrusting, sinistral slip, northwest-southeast compression and southeast-side-up slip (Fig. GS-10-3).

**Northwestern zone**

The stratigraphic units in the SFZ extend northwest into the main part of the Kisseynew Domain, but vary in composition and grain size. The general lack of pebbly sandstone and conglomerate suggest a more distal environment for the Grass River Group in the northwest.

The Burntwood Group has sharp contacts with the Grass River Group and the amphibolite (Ua). There are no mafic dikes in the Burntwood Group to indicate an association between volcanism and sedimentation. Consequently, the major fault between the amphibolite (Ua) and the Burntwood Group in the SFZ is interpreted to extend into the northwestern zone.

Large northeast-trending folds in the northwestern zone are interpreted as $F_3$-$F_4$ structures. Tight minor folds ($F_3$) commonly have the folded $S_2$ foliation cut by $S_3$. Earlier folds are indicated by the complex fold pattern at August Lake. Restricted shear zones with retrograde mineral assemblages mark $D_4$ structures.

## TECTONIC AND ECONOMIC IMPLICATIONS

Because nickel-bearing ultramafic intrusions are restricted to the sedimentary rocks in the Ospwagan Group, the truncation of these units on the southeast side of the Setting Lake Fault Zone provides an important limit for exploration. However, the shape and orientation of this boundary at depth must be considered. If some of the mafic volcanic and subvolcanic rocks (unit Ua) were thrust over the Ospwagan Group from the Kisseynew Domain, then deeper thrusts with the same vergence may have carried rocks of the TNB under the Kisseynew Domain, where they may surface in structural culminations. Work on the geochemistry, volcanic characteristics and contacts of the mafic rocks should provide clues to their origin. The mafic sills in the Setting Formation may be related to *in situ* volcanism.

Accurate mapping of the boundary zone provides important local information. For example, this year's work indicates that the Setting Formation, in the southern part of the lake, is in fault contact with the Grass River Group. Thus, a structural slice of the Ospwagan Group was carried into an area that is generally underlain by Kisseynew gneisses.


## ACKNOWLEDGEMENTS

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