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New bedrock mapping and preliminary U/Pb geochronology in the Walmsley Lake area, southeastern Slave Province, Northwest Territories[1]

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Abstract: Bedrock mapping in the Walmsley Lake area, southeastern Slave Province has resulted in the recognition of four regional deformation events. The first predated peak metamorphism and may be correlative with D_1 deformation in the central Slave Province. The second overlapped with peak metamorphism, and its timing and nature suggest that D_2 deformation across the southern Slave Province may also be correlative; however, preliminary U/Pb geochronology indicates that the age of metamorphism and D_2 deformation vary across the map area. Metamorphism is younger in the migmatized rocks, which are characterized by recumbent F_3 folds of the main foliation, and which may typify deeper structural levels. The final phase of deformation involved upright northeast- and northwest-trending cross folding. Overturned stratigraphy and the F_4 fold pattern of the melt-in isograd, suggest the possibility of kilometre-scale, downward-facing nappes, a geometry that has not previously been reported in the Slave Province.

Résumé : La cartographie géologique du substratum rocheux dans la région cartographique de Walmsley Lake, dans le sud-est de la Province des Esclaves, a permis de distinguer quatre épisodes de déformation régionale. Le premier est antérieur à l'atteinte des conditions du métamorphisme maximal et pourrait être corrélé à la déformation D_1 ayant touché la partie centrale de la Province des Esclaves. Le deuxième épisode de déformation s'est déroulé en partie dans les conditions du métamorphisme maximal. Le moment où s'est produite cette déformation ainsi que la nature de celle-ci laissent croire à une corrélation avec la déformation D_2 qui a touché la partie méridionale de la Province des Esclaves. Cependant, l'étude géochronologique U/Pb préliminaire indique que le métamorphisme et la déformation D_2 ne se sont pas déroulés au même moment à la grandeur de la région cartographique. Le métamorphisme est plus récent dans les roches migmatiques montrant une déformation de la foliation par des plis couchés P_3, qui sont peut-être typiques de niveaux tectoniques plus profonds. La phase finale de déformation a produit des plis droits transverses de directions nord-est et nord-ouest. Une stratigraphie renversée et la déformation de l'isograde de passage aux conditions de fusion par des plis P_4 laissent croire à l'existence possible de nappes d'échelle kilométrique à regard tourné vers le bas, une géométrie n'ayant pas été signalée jusqu'ici dans la Province des Esclaves.

[1] Contribution to the Walmsley Lake Targeted Geoscience Initiative

INTRODUCTION

The Walmsley Lake project is jointly funded by the Geological Survey of Canada under the Targeted Geoscience Initiative, and the C.S. Lord Northern Geoscience Centre in Yellowknife. This is the second year of a three-year, multidisciplinary project combining bedrock and surficial mapping, tracer isotopic work and U/Pb geochronology, along with magnetotelluric (MT, by Alan Jones, GSC) and teleseismic (by Dave Snyder, GSC) geophysical transects. The aim of this project is to improve our understanding of the crustal and lithospheric architecture and evolution of the Slave Province and their relationship to the formation, preservation, and distribution of diamonds.

This paper describes the area mapped in 2001, revises the structural nomenclature established last year (MacLachlan et al., 2001b), and presents preliminary U/Pb ages from samples collected in 2000. The bedrock component of the project includes detailed studies of the area's tectonometamorphic evolution (M.Sc. thesis by Scott Cairns, and B.Sc thesis by Mike Schultz, University of Alberta), the petrological evolution and mineral potential of the Aylmer Lake volcanic belt (M.Sc. thesis by Jim Renaud, University of Western Ontario), Proterozoic mafic dyke swarms (M.Sc. thesis by Natalie Piertzak, University of Western Ontario), and petrology and isotope systematics of granitoid rocks (W.J. Davis and K. MacLachlan, GSC). Mapping of the Quaternary geology is being undertaken as part of a Ph.D. thesis by Francois Hardy at Centre Geoscientifique de Quebec, Institute Nationale de Recherches Scientifique-Georesources.

REGIONAL GEOLOGICAL SETTING

The Slave Province has historically been separated into eastern and western domains of contrasting crustal affinity (e.g. Thorpe et al., 1992). The western Slave Province is composed of Mesoarchean basement overlain by an autochthonous cover sequence, termed the Central Slave Basement Complex and the Central Slave Cover Group, respectively (Bleeker et al., 1999). The Central Slave Cover Group is structurally overlain by a ca. 2.72–2.70 Ga (Isachsen et al., 1991), parautocthonous sequence of tholeiitic, predominantly mafic volcanic rocks, which is in turn unconformably overlain by ca. 2.68–2.66 Ga (Isachsen et al., 1991) predominantly felsic calc-alkaline rocks that grade up into a thick sequence of metaturbidite units. Late Archean, predominantly calc-alkaline volcanic rocks in the eastern Slave Province have juvenile isotopic characteristics (Thorpe et al., 1992) suggesting that the basement, if present, is also late Archean (< 2.8 Ga). The volcanic rocks are conformably overlain by a thick metaturbidite sequence. It has been proposed that the boundary between older basement in the west and younger basement in the east is a late Archean suture (e.g. Thorpe et al., 1992; Davis and Hegner, 1992). The calc-alkaline volcanic rocks and overlying turbidite basins are correlative across the entire Slave Province, and Bleeker (2001) has suggested that they represent an overlap sequence. Late Archean regional deformation, metamorphism, and syntectonic plutonism (ca. 2630–2585 Ma; van Breemen et al., 1992; Davis and Bleeker, 1999) occurred approximately synchronously across the entire Slave Province and postdated deposition of the turbidite sequences. Most workers have attributed late Archean metamorphism in the Slave Province to heat from multiple generations of granite plutons (e.g. Bethune et al., 1999).

GEOLOGY OF THE CENTRAL AND NORTHEASTERN WALMSLEY LAKE AREA (NTS 75 N)

The Walmsley Lake area is part of the juvenile late Archean terrane (cf. Thorpe et al., 1992) in the southeastern Slave Province (Fig. 1). In the 2001 map area (Fig. 2) metaturbidite ranges from cordierite grade in the northeast, to migmatite with abundant anatectic melt farther south and west. The metaturbidite succession is locally underlain by mafic to felsic volcanic packages. The supracrustal rocks are intruded by syn- to post-tectonic granitoid plutons that range from biotite tonalite to two-mica monzogranite and syenogranite pegmatite.

Supracrustal rocks

Supracrustal rocks consist mainly of metaturbidite (>90%), with minor (<10%) metavolcanic rocks. Within cordierite-grade metaturbidite, primary sedimentary features were observed (Renaud et al., 2002; Fig. 4a) and younging determined. In the sillimanite-grade and higher grade metaturbidite units bedding is commonly preserved, but finer scale sedimentary structures are less common. Three isograds were mapped in the metaturbidite sequences (Fig. 2), the sillimanite-in, melt-in, and iolite-in isograds, which are described in Renaud et al. (2002).

The volcanic rocks occur predominantly in two distinct belts: the Aylmer Lake volcanic belt in the northeast; and the discontinuous Cook Lake volcanic belt south of Walmsley Lake (Fig. 2). The Aylmer Lake volcanic belt is described in more detail elsewhere (Renaud et al., 2001, 2002) and is outlined only briefly here. It is composed predominantly of pillowed basaltic and andesitic flows at the base, overlain by intermediate to felsic tuffaceous and volcaniclastic material at the top, which grades into the overlying metaturbidite units. A felsic tuff from the upper volcanic package has an U/Pb zircon age of ca. 2676 Ma (K. MacLachlan and W.J. Davis, unpub. data, 2001).

The Cook Lake volcanic belt is exposed in two continuous belts up to 2 km in width, and in metre- to tens-of- metres-scale screens within granitoid rocks. Based on their proximity and lithological similarities they are interpreted to have originally been part of a single volcanic sequence. The largest exposure of this belt comprises mafic to intermediate, pillowed and volcaniclastic rocks at the structural base, overlain by a package of well bedded, intermediate to felsic, volcaniclastic rocks, which are in turn overlain by pillowed mafic to intermediate flows. Above the second pillowed

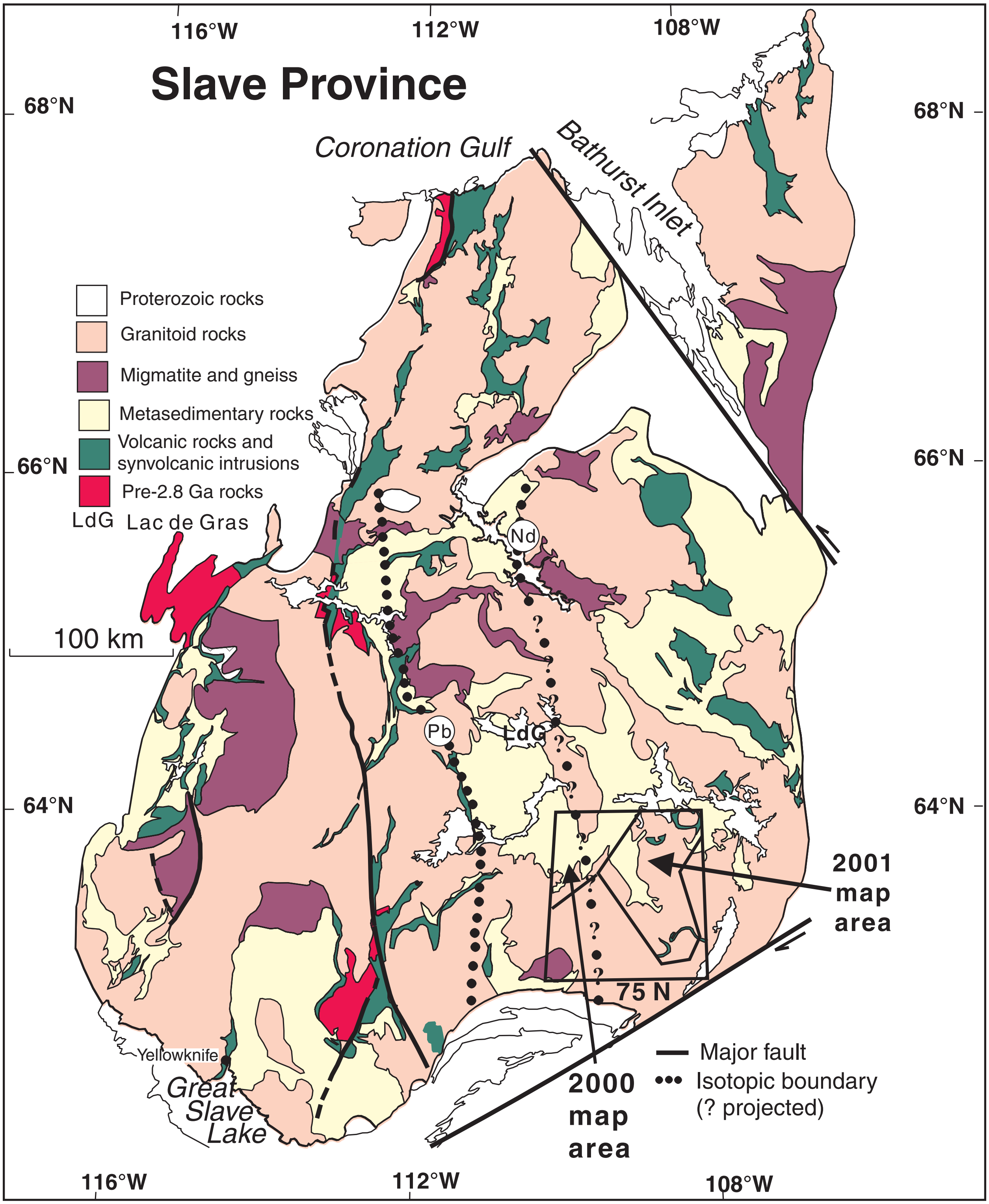

Figure 1. Simplified geological map of the Slave Province.

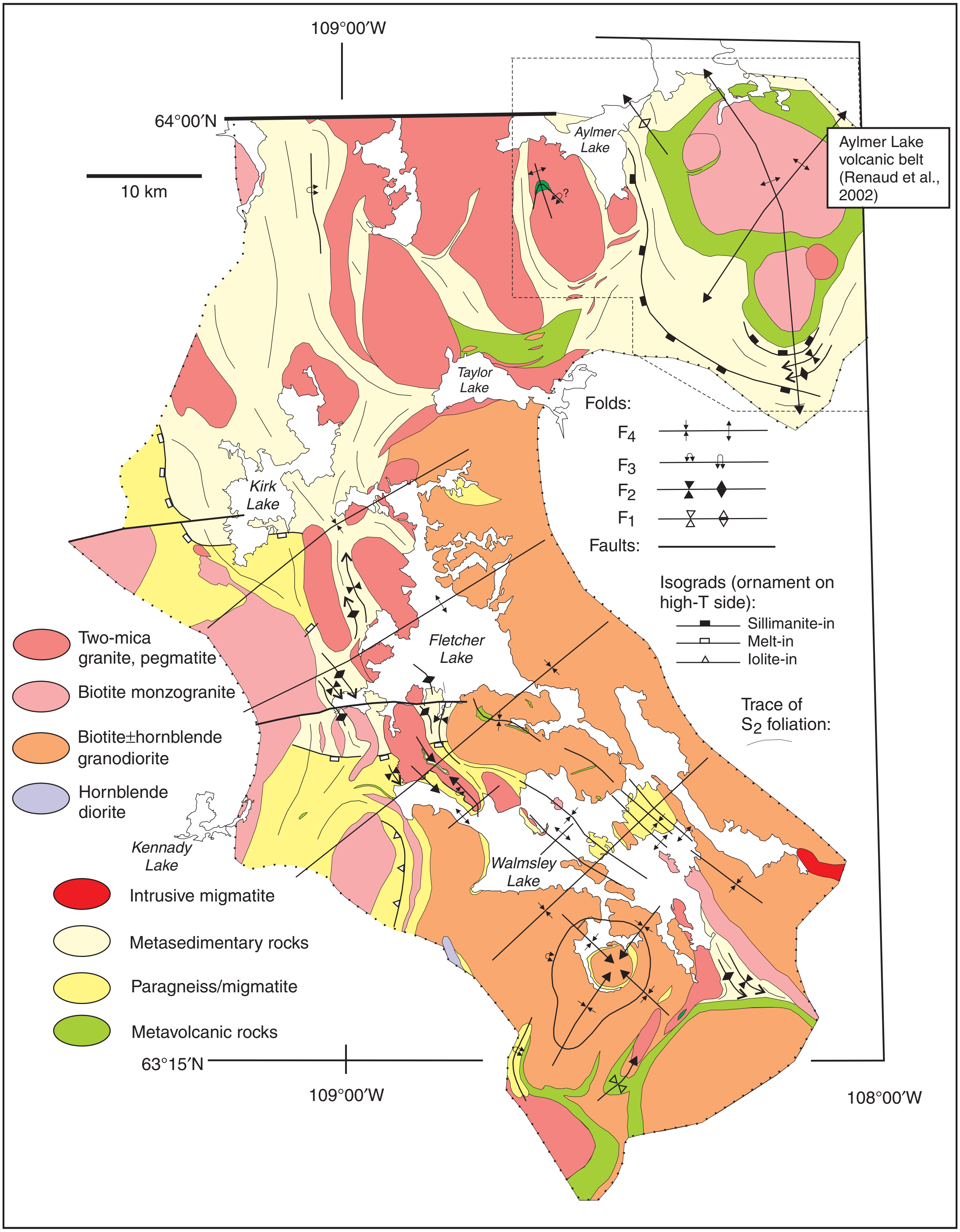

Figure 2. *Geological map of the 2001 map area, central and northern Walmsley Lake sheet,* (after *K. MacLachlan, C. Relf, S. Cairns, J. Renaud, and A. Mills, unpub. map manuscript, (2001))*

horizon, intermediate volcaniclastic rocks are locally preserved and overlain by metaturbidite. No younging indicators were observed as a result of the high degree of deformation, but elsewhere in the Slave Province, including the Aylmer Lake volcanic belt, turbidite overlies the volcanic rocks, and therefore we infer that this sequence is stratigraphically right way up. Intermediate and felsic volcaniclastic rocks are interlayered on a scale of centimetres to metres, and typically contain the assemblage plagioclase, hornblende, and garnet± biotite±quartz. The felsic layers locally contain a pale, greyish-brown amphibole. In the hinge zone of a tight to isoclinal fold, pillows with epidotized cores and rims (*see* Fig. 4b) have aspect ratios of 3:1 on surfaces perpendicular to the fold axis; however, they are lineated parallel to the fold axis, with aspect ratios greater than 10:1. Much of the mafic material in this belt has an irregular banded appearance with lighter bands composed predominantly of plagioclase+epidote±garnet±quartz, and darker bands of hornblende and plagioclase. In the least strained parts of the volcanic package, pillows exhibit progressive flattening to form irregularly banded rocks where discreet pillows can rarely be recognized. Therefore, we interpret the irregularly banded, compositionally bimodal, mafic rocks to be strongly flattened pillows. The pillowed volcanic rocks are locally bleached, and contain sparse disseminated pyrite and pyrrhotite, and sulphide stringers. Layer parallel, coarse-grained, hornblende gabbro and hornblende leucogabbro bodies also occur.

Only parts of the stratigraphic sequence described above occur in the adjacent, smaller, and more discontinuous parts of the Cook Lake volcanic belt.

Granitoid rocks

The granitoid rocks show compositional variations and changes in degree of deformation from north to south across the map area. In the north they are predominantly massive to weakly foliated two-mica granite and pegmatite. In contrast, granitic rocks in the southern part of the map area are well foliated granodiorite to monzogranite that form shallowly dipping sheets.

The two-mica monzogranite ranges from muscovite<<biotite to muscovite≈biotite and from massive to weakly foliated to schlieric. Typical accessory phases include garnet and blue-green apatite. These plutons commonly contain abundant syenogranite pegmatite that has both gradational and sharp contacts with the monzogranite. In the north the plutons form massive to weakly foliated, elliptical bodies that generally have steep contacts with surrounding metaturbidite. Many of these bodies are partially mantled by sheets of syenogranite pegmatite parallel to layering and foliation in the surrounding metaturbidite (Fig. 4c). The two-mica granite is mineralogically and morphologically similar to late syn- to post-tectonic, two-mica granite from the northwestern part of the map sheet (Fig. 3) mapped in 2000 (MacLachlan et al., 2001b). An undeformed, K-feldspar porphyritic, two-mica monzogranite that cuts, and therefore postdates, the sillimanite isograd north of Reid Lake (Fig. 3), has a preliminary U/Pb age of ca. 2612 Ma (K. MacLachlan and W.J. Davis, unpub. data, 2001). The garnet-bearing, two-mica pluton east of Reid Lake (Fig. 3) also postdates the sillimanite isograd and has a preliminary U/Pb age of ca. 2589 Ma (K. MacLachlan and W.J. Davis, unpub. data, 2001), indicating that there is a wide age range for two-mica monzogranite in the area.

Two-mica granite bodies in the central and southern part of the 2001 map area are more strongly foliated and occur as sheets both concordant with, and oblique to, compositional layering in the metaturbidite, although their foliation parallels the main foliation in the adjacent metaturbidite. The significantly higher strain state and sheet-like nature of the two-mica granite bodies in the south may be a function of deeper structural level, as they are associated with higher grade metaturbidite, but raises the possibility that they could be older than those in the north.

Syenogranite pegmatite occurs both in association with a variety of granite plutons, and also as bedding- and foliation-parallel and crosscutting dykes as well as discontinuous lenticular pods (possibly boudins) parallel to layering and S_2, within the metaturbidite units. The pegmatite bodies typically contain muscovite±biotite and accessory apatite±garnet± tourmaline±sillimanite.

Two small bodies of massive to moderately foliated hornblende diorite were observed in the 2001 map area (only larger one shown in Fig. 2). The contacts between this unit and adjacent rock types is not exposed, but based on lithological similarity this unit is likely correlative with two pre-S_2 bodies of hornblende diorite that make up part of the Anarin suite of MacLachlan et al. (2001b; Fig. 3). One of the Anarin suite hornblende diorite samples has a preliminary U/Pb zircon age of ca. 2614 Ma (K. MacLachlan and W.J. Davis, unpub. data, 2001).

A large pluton of well foliated biotite±hornblende granodiorite underlies much of the south-central and eastern parts of the present map area. This unit is heterogeneous and ranges from tonalitic to monzogranitic, although biotite granodiorite is the predominant composition. It is likely composed of numerous smaller plutons, but the detail of mapping and/or quality of exposure was not sufficient in most areas to delineate individual bodies. Hornblende has a patchy distribution, and is commonly associated with partially digested amphibolite xenoliths, suggesting that it may be largely xenocrystic; however, homogeneous hornblende diorite bodies (above) have been recognized within this map unit, and thus in some parts the hornblende may be part of the igneous assemblage. Accessory phases such as epidote, magnetite, and titanite, are also unevenly distributed. Locally within the granodiorite, abundant, supracrustal screens up to several tens of metres are common, and it is possible to trace map units, and 'ghost' isograds (from mineral assemblages in these screens), through the pluton.

Contacts between the granodiorite and supracrustal rocks are typically layer parallel and foliation parallel, and define open, shallowly plunging, upright folds. These outcrop-scale

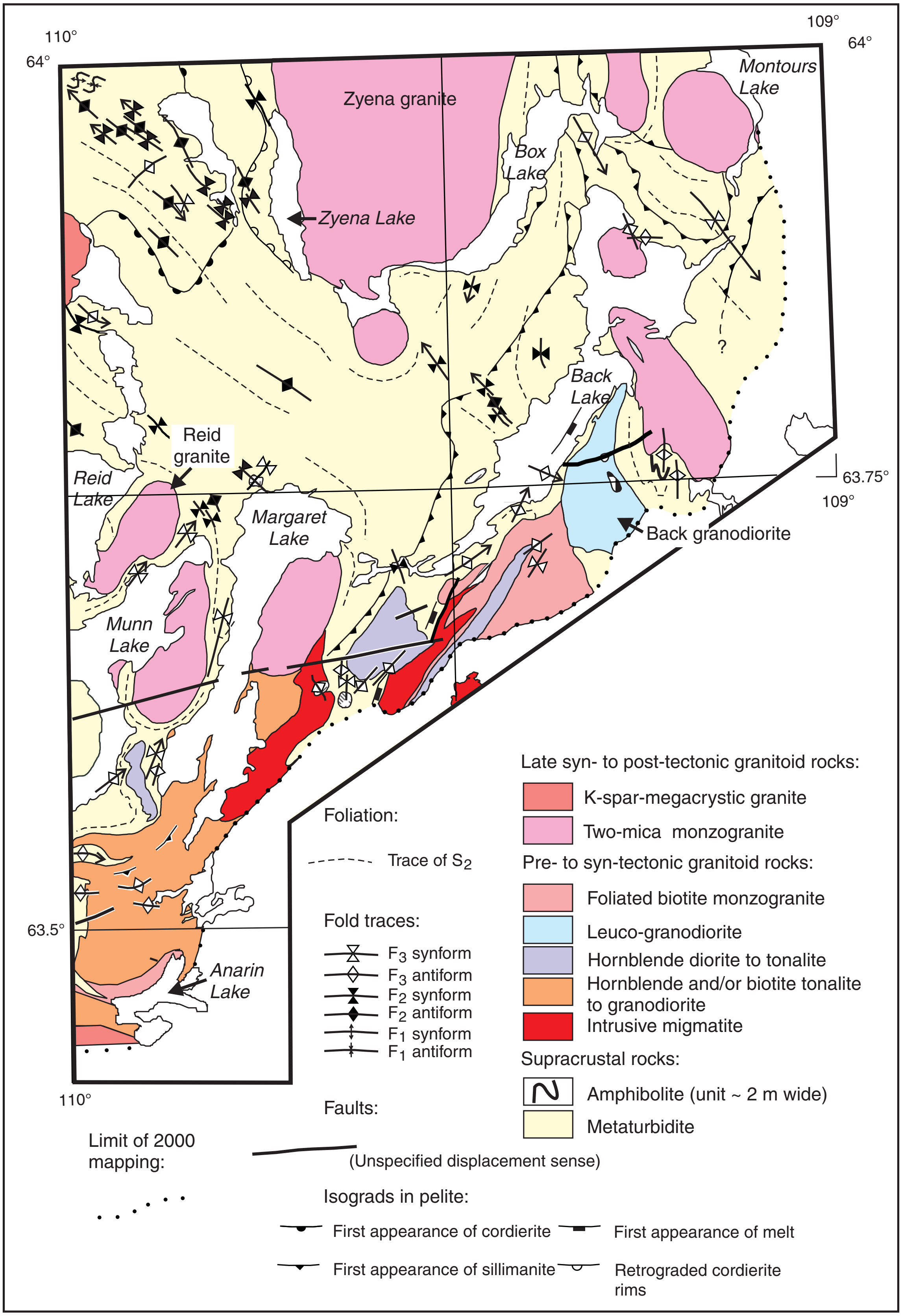

*Figure 3. Simplified geological map of the 2000 study area, northwestern Walmsley Lake area, (*after *MacLachlan et al., 2001a).*

Figure 4. ***A)*** *Cordierite-grade metaturbidite showing well preserved graded bedding (beds up to 1 m thick).* ***B)*** *Sheeted contact between metaturbidite (Mt) and pegmatite dykes (Peg); hammer (40 cm) for scale.* ***C)*** *Pillowed mafic volcanic rocks with epidotized cores and rims; hammer (40 cm) for scale.* ***D)*** *Recumbent, isoclinal, F_3 fold of layered volcanic rocks, pen (15 cm) for scale.*

structures reflect the larger scale geometry of the pluton, which is interpreted as a gently dipping, undulating sheet. This unit is interpreted to be correlative with the Anarin suite described from the 2000 map area (MacLachlan et al., 2001a, b).

Biotite (<5% to 20%) monzogranite forms several plutons in the central and southern part of the map area. These bodies define concordant sheets that parallel compositional layering and foliation in the supracrustal rocks. They range from fine grained and well foliated to coarse grained and weakly foliated, are locally K-feldspar porphyritic, and commonly contain a minor pegmatitic component.

Deformation history

Four phases of folding and fabric development were documented during the 2001 field season, in contrast to the three phases recognized during 2000 (MacLachlan et al., 2001b). The first two events D_1 and D_2, correspond to D_1 and D_2 in the 2000 map area, whereas, D_4 from 2001, corresponds to D_3 in the 2000 map area. The third deformation event, distinguished this year, was not observed as a regionally significant event in the 2000 map study area.

D_1 deformation

Within metaturbidite units S_1 is a sparsely preserved fabric, predating peak metamorphism. S_2 is the predominant fabric and is generally defined by peak metamorphic minerals (Renaud et al., 2002). F_1 folds in the metaturbidite units were recognized by reversals in younging direction, where S_2 transects both limbs, and therefore postdates folding.

In contrast to the deformation record in the metaturbidite sequences, field evidence suggests that in the volcanic belts the main foliation, defined by flattening fabrics and aligned metamorphic minerals, is S_1. For example, the tight fold on the northwestern edge of the Aylmer Lake volcanic belt is a fold of bedding, with an axial-planar fabric (S_1, Renaud et al., 2002). The overlying turbidite units, which are also affected by this fold, contain S_2, which transects both limbs, indicating it is an early (F_1) fold. A map-scale isoclinal fold in the Cook Lake volcanic belt is also tentatively interpreted as an F_1 fold (Fig. 2). It does not preserve an axial-planar foliation in the hinge area, but is characterized by a strong, axis-parallel extension lineation. The fold is overturned to the west, and the lower limb is intensely thinned. Metaturbidite units in the core of the fold contain a strong S_2 foliation, which is anticlockwise (in map view) from bedding across most of the core, and at a high angle to bedding near the thinned lower limb. Given that no reversal in bedding and/or cleavage relationships was observed adjacent to the lower limb, the foliation is interpreted to postdate folding.

D_2 deformation

Throughout the metaturbidite units, the predominant fabric is defined by aligned metamorphic minerals. This fabric has been designated S_2 and is axial planar to tight to isoclinal folds of bedding, which are designated as F_2 folds (Renaud et al., 2002). In the volcanic rocks, small-scale F_2 crenulations of the S_1 fabric were observed locally. Up grade of the melt-in isograd, F_2 folds can locally be recognized, but the S_2 fabric is typically strongly reworked by D_3 (*see below*).

In the northern part of the present map area (Fig 2), two-mica granite units are massive to weakly foliated, with margins roughly parallel to S_2 in the metaturbidite. They locally have observable metamorphic aureoles delineated by randomly oriented fibrous sillimanite. Based on their lack of fabric, and locally observed, post-S_2 aureoles (*see* Renaud et al., 2002), these plutons are interpreted to have intruded during the waning stages of D_2, before temperatures had dropped below ambient sillimanite conditions.

The southern part of the map area is predominantly underlain by well foliated, biotite granodiorite. In areas where D_3 transposition is not too intense, the granodiorite cuts the S_1 foliation in the Cook Lake volcanic belt and contains a foliation oblique to the contact. Since the granodiorite postdates S_1 the foliation within it must be S_2 or younger. Biotite monzogranite and two-mica leucogranite plutons in the southern part of the map area are also well foliated, in contrast to lithologically similar rocks in the north, and this foliation is assumed to be S_2. This suggests either that the plutons are older in the south (synchronous with D_2 rather than late synchronous to postdating D_2) or that D_2 started later or continued longer in the south. A third possibility is that the foliation in these rocks is actually S_3 (*see below*), and that strong transposition of fabrics has transposed S_2 parallel to, and thus, indistinguishable from S_3. Uranium-lead geochronology is underway in an attempt to clarify the relationships.

A marked contrast exists in our designations of the main foliation in metaturbidite (S_2) and volcanic rocks (S_1). The preservation of S_1 in the volcanic rocks is at odds with its nearly complete overprinting by S_2 in the metaturbidite units. The difference is attributed to varying rates of recrystallization. In typical greenstone terranes, volcanic belts form structurally rigid, homoclinal panels, and mineral assemblages above greenschist facies are characterized by idioblastic grains with low surface energies. Coupled with the fact that the mineral assemblage (hornblende+plagioclase±garnet) is stable over a wide temperature range, recrystallization is relatively minor. The adjacent, well layered turbidite units, on the other hand, deform readily, and undergo progressive dehydration during metamorphism. Aided by strain and grain-boundary diffusion, recrystallization occurs readily, and overprinting of early fabrics is common.

Deformation postdating peak metamorphism

At least two distinct phases of deformation postdate the main foliation in the metaturbidite units (S_2) and are regional in nature. There are also post-S_2 fabrics and structures that are not easily interpreted in terms of the regional events.

D_3 deformation

D_3 is characterized by metre- to kilometre-scale, tight to isoclinal, overturned to recumbent folds of S_2 and S_2-parallel granitoid sheets, and is designated D_3. Because of later F_4 folding the vergence of F_3 folds is undetermined. An axial-planar crenulation cleavage (S_3) is locally developed in schistose metaturbidite units. Monazite from two samples of migmatized metaturbidite east of Back Lake (Fig. 3, MacLachlan et al., 2001b) were dated. Single grain, abraded fractions from both samples have slightly discordant $^{207}Pb/^{206}Pb$ ages ranging from 2589 Ma to 2584 Ma. It is unclear whether these represent the age of peak metamorphism or of reworking during D_3.

Based on the assumption that metaturbidite sequences stratigraphically overlie volcanic rocks, the western exposure of the Cook Lake volcanic belt is downward facing. The adjacent upward-facing limb is exposed in the core of a structural basin on the south side of Walmsley Lake (Fig. 2). A refolded (by F_4), recumbent F_3 isocline on the scale of several kilometres has been invoked to account for this overturning.

D_4 deformation

A second regional event, postdating peak metamorphism is characterized by upright, open, cross folds with northeast- and northwest-trending axial traces. No overprinting relationships were documented between these two fold sets, but they both overprint F_3 folds. Thus, they are designated as northeast-trending F_4 and northwest-trending F_4 and are correlative with northeast-trending F_3 and northwest-trending F_3 of MacLachlan et al. (2001b).

The melt-in isograd between Kirk and Fletcher lakes is intersected by an F_4 synform-antiform pair (defined by opposing F_2 plunge directions), and the maximum curvature of the isograd coincides with the F_4 fold traces (Fig. 2). If this curvature is a synform-antiform pair, then the geometry requires that the isograds are regionally hot-side-up. Evidence for postmetamorphic (D_3), kilometre-scale overturning of stratigraphy, supports the interpretation that the isograd is overturned.

A number of postmetamorphic structural elements cannot be systematically linked to either D_3 or D_4. For example, migmatitic metaturbidite units commonly exhibit small-scale, seemingly randomly oriented folds and crenulations. This is particularly apparent in paragneiss with large degrees of leucosome (>15%), where the folds may be attributed to movement of the melt phase and disruption of compositional layering.

Proterozoic dykes

Three sets of diabase dykes occur in the Walmsley Lake area and all crosscut fabrics in the host rocks. Based on orientation, they are correlated with the approximately 080° trending, ca. 2.23 Ga (LeCheminant et al. 1996) MacKay swarm, the approximately 050° trending, ca. 2.21 Ga (LeCheminant et al., 1996) Malley swarm, and the northwest-trending, ca. 1.27 Ga (LeCheminant and Heaman, 1989) Mackenzie swarm. Both the Malley and Mackay swarms commonly contain disseminated pyrrhotite and pyrite, and feldspars are slightly greenish, suggesting they have been weakly altered and/or metamorphosed. Both of these dyke sets typically occur along pronounced topographic lineaments, some of which displace Archean units and are interpreted as Proterozoic normal faults (e.g. MacLachlan et al., 2001a). Several dykes with a northerly strike (about 010–030°) were also mapped, and based on their orientation could be part of the ca. 2.0 Ga Lac de Gras swarm (LeCheminant, 1994).

Samples for whole-rock geochemical analysis were collected to compare the geochemical characteristics of the dykes with those of known dyke swarms. It has been suggested that Proteozoic faults and dykes may have played a role in the emplacement of kimberlite units in the Lac de Gras area (Wilkinson et al., 2001), and we intend to assess this hypothesis for the Walmsley Lake area.

Other mafic dykes

A small swarm of metamorphosed and deformed mafic dykes with amphibole phenocrysts occurs south of Walmsley Lake. This swarm comprises four east-striking dykes up to 1 m wide that follow a prominent lineament. The dykes locally contain networked veins of carbonate in their centres, and subangular to rounded xenoliths of foliated granitic material that differ compositionally and texturally from the granite that hosts them. Based on strain state, metamorphic grade, phenocryst assemblage, and the presence of exotic xenoliths, the dykes are tentatively correlated with late Archean lamprophyres near Yellowknife (e.g. Armstrong et al., 2000).

Economic potential

In the Walmsley Lake area few significant metallic mineral occurrences have been documented (e.g. The Northern Minerals Database; 2000/09/15). The mineral potential of the Aylmer Lake volcanic belt is discussed by Renaud et al. (2002). The mineral potential of the Cook Lake volcanic belt is largely unknown, although a number of stratabound gossans have been mapped in the belt (K. MacLachlan, C. Relf, S. Cairns, J. Renaud, and A. Mills, unpub. map manuscript, 2001). Some gossans have considerable strike continuity (up to several kilometres), and one is associated with a carbonate-cemented breccia with large (up to 1 cm) sphalerite crystals. Grab samples collected from the belt yielded no anomalous metal contents.

The potential for gold and base metals in the metaturbidite succession appears to be low: banded iron-formation has not been observed and quartz veins are uncommon. Within the granitoid rocks that underlie much of the map area, no significant areas of alteration or quartz veining were observed.

In contrast to the area's low metal potential, its diamond potential is considered to be high. Several diamondiferous kimberlite bodies occur in the area (e.g. De Beers and Mountain Province's Gacho Kue property), and a number of companies are actively exploring for diamonds. Ice-flow patterns being documented as part of this study (F. Hardy, unpub. map manuscript, 2001) will provide a regional framework for evaluating kimberlite indicator mineral results.

DISCUSSION

The east-west subdivision of the Slave Province (Davis and Hegner, 1992, Thorpe et al., 1992), is assumed to have had a fundamental control on its structural grain; however, a number of recent studies (e.g. Grutter et al., 1999; Bleeker et al., 1999) suggest there are important northeast-trending, crustal and mantle domains in the Slave Province. In order to assess the relative importance of northeast-trending tectonic domains to the composite structural grain in upper crust, it is critical to understand regional variations in the tectonic history. The best known area of the Slave Province is the Yellowknife domain, which is widely thought to typify the central Slave Province (e.g. Bleeker et al., 1999), and which provides a useful area for comparison with the evolving mapping in the Walmsley Lake area.

The relative timing and nature of D_1 in the Walmsley Lake area allow correlation with D_1 in the Yellowknife domain, which is constrained to be after 2660 Ma and before 2630 Ma (Davis and Bleeker, 1999). Uranium-lead geochronology is underway to determine if the absolute timing of D_1 is similar in both areas.

In areas away from the influence of abundant plutons, D_2 structures in the Walmsley area are oriented northwest-southeast, which is typical of D_2 structures in the Yellowknife domain. Furthermore, D_2 in both areas is broadly synchronous with peak metamorphism, and we tentatively suggest that D_2 could be correlative across the southern Slave Province, however, preliminary U/Pb geochronology from the Back Lake area (MacLachlan et al., 2001a), and correlation of granitoid units (this study), suggest that the timing of peak metamorphism (and D_2) across the Walmsley Lake area varied. In the northwesternmost part, granite plutons as old as ca. 2612 Ma cut S_2 and the sillimanite-in isograd (Fig. 3). A hornblende diorite formed previous to or early in D_2 deformation provides a maximum age of ca. 2614 Ma for S_2 and peak metamorphism in the northwest; however, monazite samples in migmatitic metaturbidite east of Back Lake (Fig. 3) yield metamorphic ages of 2590–2585 Ma, indicating either that metamorphism occurred 20 Ma later there, or that high temperatures endured longer within the higher grade rocks.

The correlation between recumbent F_3 folds, overall shallowly dipping structures, and migmatized metaturbidite, suggests that these domains may represent deeper structural levels. The younger, high-temperature conditions in the migmatitic rocks are interpreted to have facilitated D_3 deformation. This style of D_3 deformation has not been documented in the Yellowknife domain, although isoclinal folds with shallowly dipping axial surfaces have been reported in granulite-grade rocks in the Snare domain, west-central Slave Province (Pehrsson et al., 2000).

The orientation of isograd surfaces in the Walmsley Lake area may be significantly different than elsewhere in the Slave Province. The pattern of F_4 folds of the melt-in isograd suggest it is hot-side-up, and evidence for kilometre-scale, F_3 overturning of stratigraphy supports the interpretation that the isograd is, in fact, overturned. This is insufficient proof of regional-scale overturning; however, it suggests the possibility of downward-facing nappes, a geometry that has not been previously reported in the Slave Province. This hypothesis will be tested through further mapping, P-T studies, and U/Pb geochronology.

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