Geology of parts of the Calder River map area, central Wopmay Orogen, District of Mackenzie

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Abstract

Supracrustal rocks of the eastern Great Bear magmatic zone unconformably lie upon rocks of the Hepburn metamorphic-plutonic zone over the entire length of the map area. Rocks of both zones are folded about northerly-trending axes in the region of the Wopmay fault zone. The northerly-trending folds form a central corridor in a regional sigmoidal pattern of folds and reflect local increased shear strain perhaps due to the occurrence of a buried suture. Metasedimentary rocks of the Grant Group lie unconformably on Archean gneisses. At the southern margin of the map area and in the adjoining sheet, the Grant Group and its probable Archean basement are tectonically repeated on a thrust fault. Plutonism within the Great Bear magmatic zone ranges both compositionally and temporally from more intermediate to more siliceous.

Résumé

Les roches supracrustales de la zone magmatique orientale de Great Bear reposent en discordance sur des roches de la zone métamorpho-plutonique de Hepburn couvrant toute la longueur de la carte. Les deux groupes de roches sont plissés suivant des axes à direction nord dans la région de la zone de failles de Wopmay. Les plis orientés au nord forment un corridor central dans une configuration sigmoïdale régionale de plis et reflètent la contrainte accrue localement par suite, probablement, de l'occurence d'une ligne structurale principale. Les roches métasédimentaires du groupe de Grant reposent en discordance sur des gneiss archéens. À la marge sud de la zone représentée par la carte ainsi que sur les feuilles contiguës, le groupe de Grant ainsi que son soubassement probablement archéen se répètent tectoniquement sur une faille chevauchante. Le plutonisme qui règne à l'intérieur de la zone magmatique de Great Bear varie à la fois sur le plan de la composition et sur le plan temporel, allant d'un caractère plus intermédiaire à plus siliceux.

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INTRODUCTION

This paper summarizes field work within the Calder River (86F) map area completed during the summer of 1987. The map area encompasses parts of three tectonic zones of Wopmay orogen, from east to west: Hepburn plutonic-metamorphic zone, Wopmay fault zone, and Great Bear magmatic zone. Work done previous to the current project within the area was of a reconnaissance nature and is listed in Hildebrand et al. (1987a).

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WOPMAY FAULT ZONE

Wopmay fault zone is a 7-18-km-wide north-trending belt of lenticular brittle-fault bounded blocks that lie near the western margin of the Hepburn metamorphic-plutonic zone (Hoffman, 1972; 1984; Easton, 1981: King et al., 1983; King, 1985). Mapping in 1986 (Hildebrand et al., 1987a) showed that rocks of the zone are folded about north-south axes; that supracrustal rocks of the Great Bear magmatic zone unconformably overlie rocks of the Hepburn metamorphic-plutonic zone; and that the folding post-dates the main phase of magmatism within the Great Bear magmatic zone. Part of the southward continuation of the Wopmay fault zone was mapped during 1987.

In the Wopmay Lake area (Fig. 1) supracrustal rocks of the Great Bear magmatic zone unconformably overlie rocks of the Grant Group (Easton, 1981) and probable, but undated, Archean basement. The unconformity is well-exposed east of central Wopmay Lake (Fig. 2) where, low grade sedimentary rocks of the basal Great Bear magmatic zone, the Dumas Group (Hoffman and McGlynn, 1977), sit upon higher grade deformed psammites, carbonates, and mafic intrusions. One kilometre farther south the erosional surface cuts obliquely downward through rocks of the Grant Group and rocks of the Dumas Group lie directly on mylonitic granitoids of probable Archean age.

Directly east of central Wopmay Lake (Fig. 2), 10-15 m of quartzite, semi-pelite, and psammite of the Grant Group unconformably overlie the mylonitic granitoids. The supracrustal rocks are not mylonitized. Thus, the age of mylonitization must be older than the Grant Group: about 1.9 Ga (Bowring, 1984). The lower part of the sedimentary sequence is cut by numerous gabbroic dykes and sills. Overlying the siliciclastic sequence are 5 m of marl, containing conspicuous porphyroblasts of zoisite, which in turn is overlain by a coarsely recrystallized carbonate unit up to 10 m thick. The carbonate unit is overlain by several hundred metres of sillimanite-garnet-biotite schist (Fig. 3). The section is capped by pillowed basalt flows intruded by abundant gabbro bodies.

The structure of the Wopmay fault zone is complex but in the Calder River map area is dominated by the north-south folds. The folds, as stated earlier, are clearly younger than the main phase of magmatism within the Great Bear zone. The folds appear to form the central corridor in a regional set of folds that occur within the Great Bear zone to the west (see Hildebrand et al., 1987b) and the Hepburn metamorphic-plutonic zone to the east (see King, 1986). In both areas the folds trend northwest; however, as they approach the central corridor the orientation of their axial traces curves progressively into a northerly trend and they become much tighter. Thus, the overall pattern of the axial traces of the folds is sigmoidal and reflects, at least in the central area, dextral strike-slip movement (Fig. 4). The reason for the localization of increased shear strain within the central corridor is unknown but may relate to the contact between Hottah terrane and Hepburn metamorphic-plutonic zone buried beneath the Dumas Group within the corridor (Hildebrand et al., 1987a).

Most of Wopmay Orogen is cut by a conjugate set of transcurrent faults (Hoffman et al., 1984; Tirrul, 1984) which are younger than the folds. The north-south corridor along the Wopmay fault zone forms a domain boundary between northwest-trending, left-lateral faults to the east and northeast-trending, right-lateral faults to the west. Although the transcurrent faults are younger, only a few northwest-trending, left-lateral examples cut the corridor with most of the faults bending, splaying and dying as they approach it. Since rocks on both sides of the corridor are megascopically deformed by the faults and those within it are not, rocks of the zone must be penetratively strained. Because this deformation is superimposed over older north-south oriented fabrics related to the folding we have not been able to separate the effects of the two deformations at the grain scale. However, in many places within the corridor rocks of the Dumas Group have a well-developed moderately-plunging northerly oriented mineral lineation.

HEPBURN METAMORPHIC-PLUTONIC ZONE

In the southeast corner of the map area is a small part of an interesting structure which we found during a brief reconnaissance to continue to the southeast onto the adjoining map sheet as shown by Wilson and Lord (1942). Metamorphosed supracrustal rocks of the Grant Group unconformably overlie granitic gneisses of inferred Archean age and are in turn overlain by granitic gneisses of similar lithology to those beneath the unconformity (Fig. 5). The structurally higher slab of gneisses has been dated as 2.5 Ga (U-Pb zircon) and is, like the lower gneisses, unconformably overlain by metasedimentary rocks of the Grant Group. The Grant Group, sandwiched between the gneisses, comprises pyritic schist, orthoquartzite, volcanic cobbly conglomerate, and sillimanite-potassium feldspar gneisses and migmatite. They are cut by a variety of leucocratic granitic intrusions ranging from strongly deformed to non-deformed. Rocks of the Grant

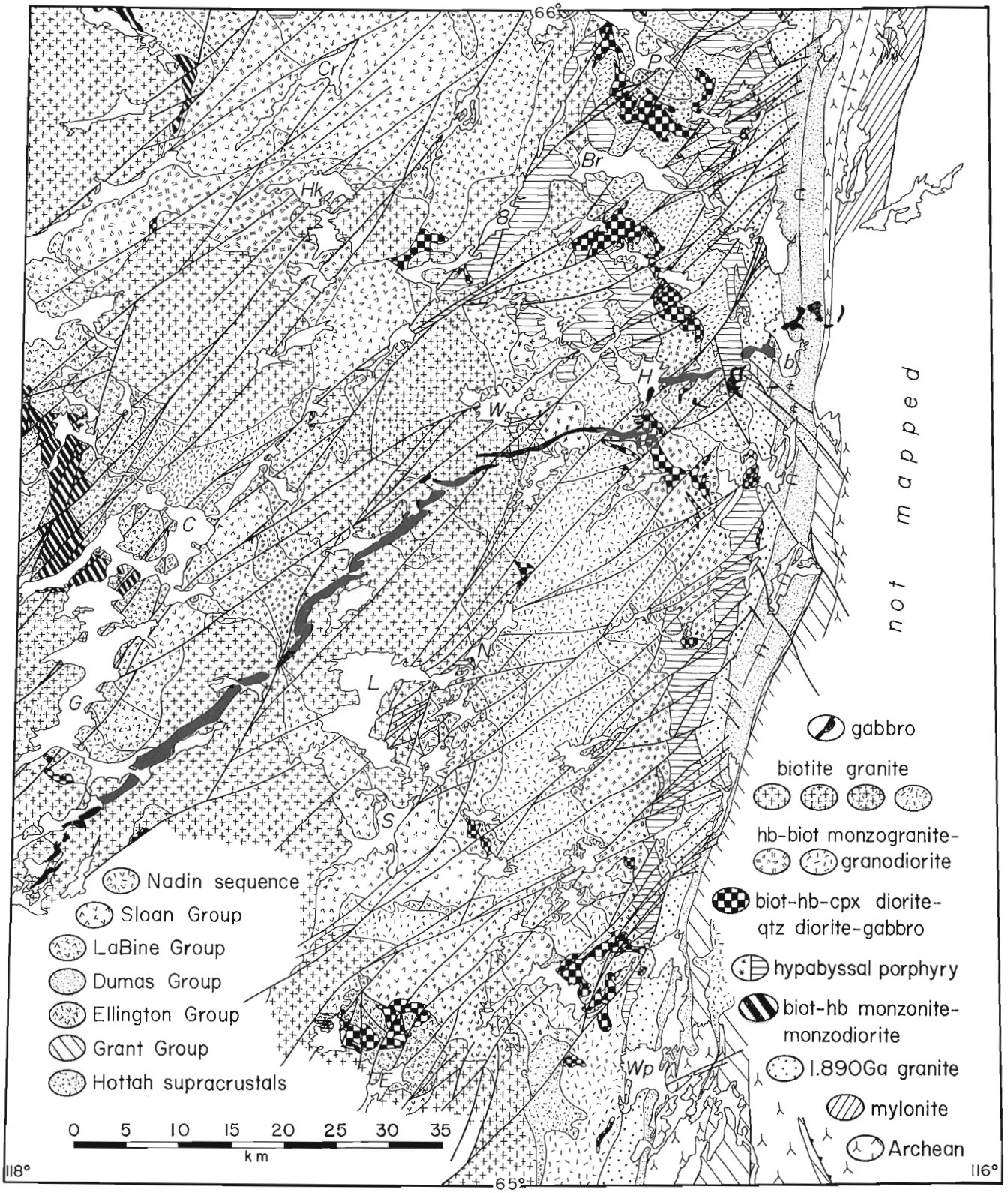

Figure 1. Generalized geological map of the Calder River map area showing distribution of major rock units mapped to date. Geology in the Ellington Lake area was simplified from Pelletier (1986). *C* = Clut Lake; *G* = Grouard Lake; *W* = Wiley Lake; *H* = Hansen Lake; *Br* = Breadner Lake; *b* = Brain Damage Lake; *Cr* = Cruickshanks Lake; *Hk* = Hooker Lake; *L* = Lever Lake; *S* = Self Lake; *N* = Nadin Lake; *E* = Ellington Lake; *Wp* = Wopmay Lake.

Group are recumbantly folded about axial planes that parallel both the unconformity and the overlying contact. Deformation, in the form of mylonitic foliation within the overlying gneisses increases downward toward the contact. On the basis of tectonic repetition and the occurrence of highly strained rocks at the contact, we interpret the contact to be a thrust fault along which granitic gneisses were transported and emplaced above rocks of the Grant Group. Thus, the Grant Group and its basement consitute a window beneath Archean granitic gneisses. This implies that major areas of the orogenic hinterland may be Archean basement rather than high-grade Grant Group: a possibility recognized by King (1986). The oval shape of the structure is probably due to the refolding of older northerly-oriented Calderian structures by the northwesterly-trending Great Bear folds.

GREAT BEAR MAGMATIC ZONE

Sloan Group

Rocks mapped as Sloan Group (Hoffman and McGlynn, 1977) are dominantly intermediate ash-flow tuffs. The largest area of rocks belonging to the Sloan group is located in the Cruickshanks Lake area (Fig. 1). There, greater than 2 km of densely-welded, lithic-rich, dacitic ash-flow tuff, containing 35-45 % broken phenocrysts and abundant round to oval-shaped cognate inclusions, is overlain by conglomerate, thinly-bedded tuff and siliclastic sedimentary rocks, rhyolitic lava flows, and rhyodacitic ash-flow tuff. The conglomerate is clast-supported and monomictic comprising dacitic cobbles and boulders in a matrix of dacitic debris. Minor sandstone beds within the conglomerate are crossbedded and also composed of dacitic material. The conglomerate unit is wedge-shaped in cross-section and thickens rapidly toward the northwest until it intersects a major strike-slip fault. It is not present northeast of the fault and presumably is displaced northeastward out of the map area. The base of the thick dacitic tuff unit is not exposed within the map area because it is intruded by a hypabyssal porphyry consisting of euhedral-subhedral phenocrysts of quartz and feldspar in a red to pink aphanitic groundmass.

Overall, the lithic and crystal-rich nature of the tuff coupled with its extreme thickness and dense welding suggest that it is intracauldron facies tuff. The composition of the overlying conglomerate indicates that portions of the tuff were uplifted and eroded shortly after cooling. Such a process occurs during resurgent doming of the central portions of calderas. Resurgence would provide the necessary monolithological source as only thick intracauldron facies tuff is typically exposed on resurgent domes. The porphyritic pluton intruding the lower part of the tuff could represent a resurgent intrusion. The diameter of the caldera is unknown because we were unable to find either the structural or topographic walls within the map area; however, as the unit was traced for about 15 km along strike, the caldera must be at least that wide.

Additional ash-flow tuff units assigned to the Sloan Group occur as a northeasterly dipping strip extending from Clut Lake southeastward to Self Lake (Fig. 1). In the Clut Lake area the tuffs clearly overlie rocks of the LaBine Group (Hildebrand et al., 1987a) and in the Self Lake area they overlie rocks termed the Ellington Group by Pelletier (1986); thus the diverse sequence of interbedded lavas, tuffs, and sedimentary rocks of the lower Ellington Group may be correlative with the LaBine Group (Hoffman and McGlynn, 1977) to the west and the Dumas Group to the east.

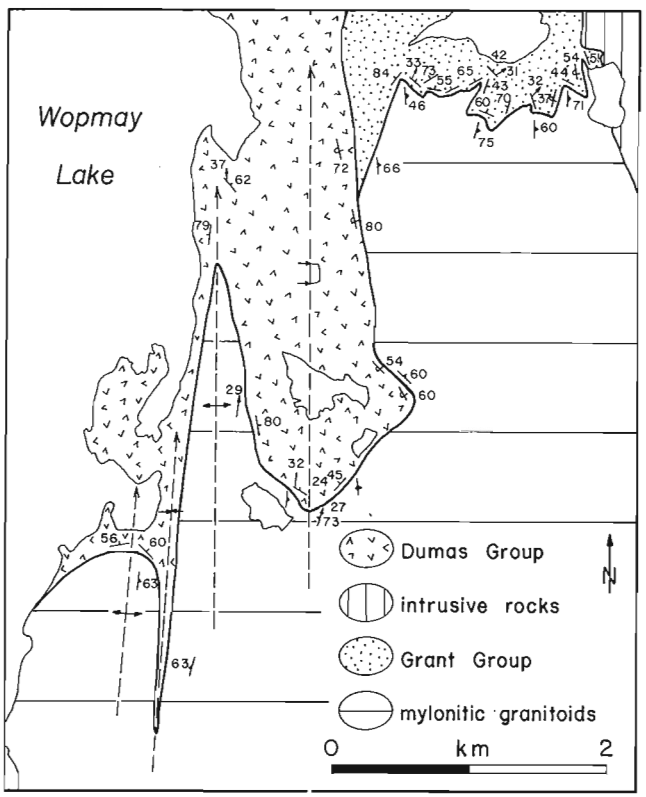

Figure 2. Geological sketch map showing northerly-plunging folds of the Wopmay fault zone and the unconformities between the various units.

Figure 3. Sillimanite-garnet-biotite schist of the Grant Group, east of Wopmay Lake. Note pen in top centre for scale. GSC photo 204401-A.

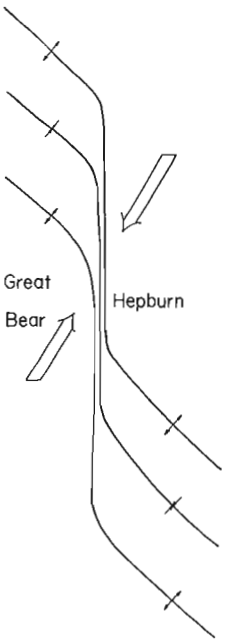

Figure 4. Model for the origin of the northerly-oriented folds in the Wopmay fault zone and the regional sigmoidal form outlined by their axial traces.

Dumas Group

The Dumas Group mapped during the past field season occurs as a continuation of the northward trending, overturned syncline previously mapped to the north (Hildebrand et al., 1987a). The syncline narrows southward but it is continuous over the entire length of the map area. The lithologies vary little from those described in Hildebrand et al. (1987a) except that in the extreme southern part of the sheet at Wopmay Lake there are considerable more intermediate and mafic intrusions within the group. Also, the degree of deformation is greater in the south with most of the rocks displaying a conspicuous shallow- to moderately-plunging mineral lineation.

In the northern part of the map area rocks of the Dumas Group within the syncline lie unconformably on 1.890±5 Ga (U-Pb zircon age) granite on the west and rocks of the internal zone to the east. During 1987 we mapped the southward continuation of the contacts and found the unconformities on both sides of the syncline to be well-exposed in many places. In the Wopmay Lake area the eastern limb of the syncline is overturned and low-grade interbedded sitstones and mudstones of the Dumas Group (Fig. 6) unconformably overlie sillimanite-garnet-biotite psammites of the Grant Group (Fig. 3).

Farther to the north where the major syncline of Dumas Group narrows markedly, basaltic and gabbroic pebbly conglomerate of the basal Dumas Group lie unconformably on metabasites of the Grant Group. The contact is exposed on the side of the prominant west-facing scarp. In fact, we have now examined and mapped the escarpment over the entire length of the map area and it is interpreted to be an unconformity wherever it has been observed.

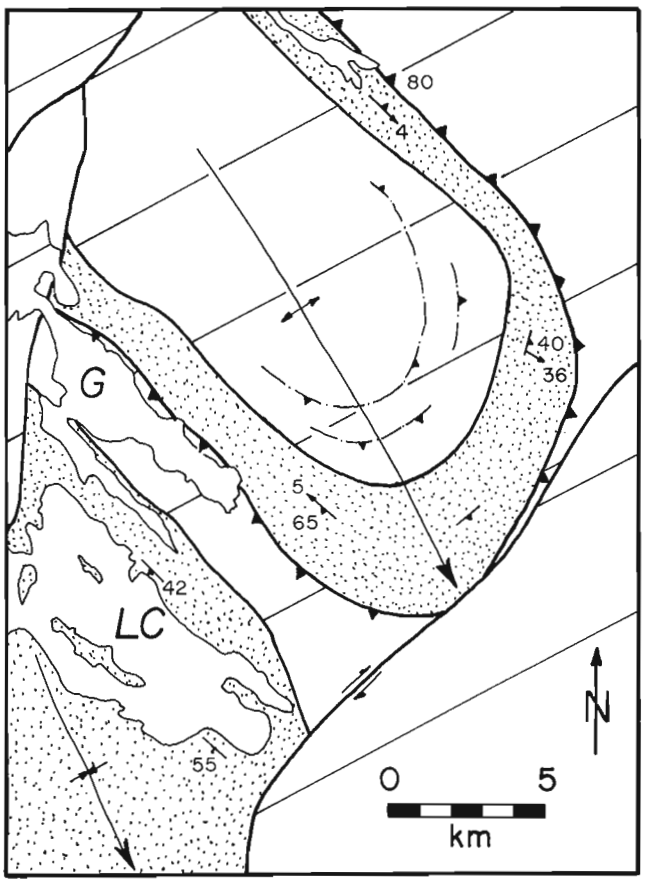

Figure 5. Geological sketch map showing window through possible basement-involved thrust. Cover sequences are stipled and basement gneisses are ruled. The dashed and dotted lines are trend lines of foliation. Geology taken in part from Easton (1981) and Wilson and Lord (1942). *G* = Grant Lake; *LC* = Little Crapeau Lake.

The western limb of the fold is vertical to overturned nearly everywhere along strike and in several places we observed a well-developed regolith up to 5m thick developed from the underlying 1.890 Ga granite (Hildebrand et al., 1987a). The granite is visibly altered for an additional 20 m beneath the regolith.

Other supracrustal sequences

Along the southeastern side of Nadin Lake (Fig. 1) is an interesting sequence of supracrustal rocks whose stratigraphic position is unclear due mainly to its isolated location and tight folding. The sequence consists of thinly bedded to laminated mudstones and siltstones, granite bouldery conglomerate, and densely-welded rhyolitic to dacitic ash-flow tuff. The conglomerate occurs between the tuffs and sedimentary rocks. Although facing directions within the sedimentary rocks were found we were unable to determine the overall facing direction of the pile because the sedimentary rocks are tightly folded. However, the lack of any clasts of ash-flow tuff within the conglomerate suggests that the tuffs lie stratigraphically above the conglomerate.

Prefolding supersuite

Members of this suite mapped during the field season are diverse in composition and texture, ranging from equigranular granite to orbicular quartz diorite, diorite and gabbro. In most cases the mafic-intermediate rocks are older than the more siliceous rocks.

The largest pluton of the suite mapped is a variably foliated and lineated porphyritic granite that trends southeast from Wiley lake (Fig. 1). Potasssium feldspar, quartz, and plagioclase phenocrysts are surrounded by a fine-grained groundmass of feldspars, quartz, and biotite. Because it intrudes volcanic and sedimentary lithologies typical of the Great Bear magmatic zone; has contacts that trend southeast parallel to the regional folds; and is intruded by intermediate composition plutons it is considered to be a formation of the prefolding suite.

Many other plutons were mapped during the field season and they are, for the most part, typical of those described by Hildebrand et al. (1987a, b). A notable exception is the occurrence of orbicular diorite, quartz diorite, and gabbro in the east central parts of the map area (Fig. 7). The bodies are very heterogeneous and occur as remnants, or roof pendants, within younger granodiorites and monzogranites. Associated with the orbicular rocks are coarsely pyroxene porphyritic gabbros and minor pyroxenite.

Postfolding suite

Several plutons which most likely postdate folding were mapped during the field season. Two oval shaped bodies are located south and west of Hooker Lake and another occurs in the Lever Lake area (Fig. 1). The three plutons are

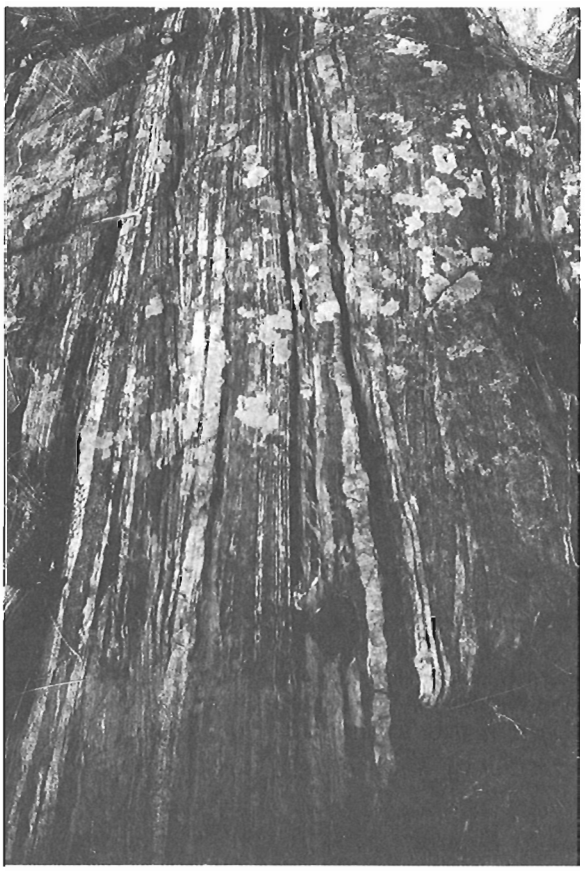

Figure 6. Interbedded volcanogenic siltstones and mudstones of the Dumas Group, east of Wopmay Lake. The rocks shown in this photo unconformably overlie those of Figure 3. Note pen for scale. GSC photo 204401.

Figure 7. Orbicular quartz diorite. GSC photo 204400-Y.

dominantly potassium feldspar porphyritic rocks with no visible fabric. Typically, quartz, potassium feldspar and plagioclase sit in a much finer groundmass of feldspars, quartz and biotite. Contacts with wall rocks are sharp and local pegmatites are common. The pluton at Lever Lake locally contains abundant miarolytic cavities and on the large peninsula that protrudes from the eastern side of the lake there is a considerable area of miarolytic granophyre attesting to its epizonal character.

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