Geological investigations in Calder River map area, central Wopmay Orogen, District of Mackenzie

Project 860002

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Abstract

Rocks along the eastern Great Bear magmatic zone unconformably overlie 1.90 Ga granite and inferred Archean granite, both of which are locally mylonitized. Preliminary analysis of kinematic indicators within the mylonites suggests northward directed top over bottom movement between 1.90 Ga, the age of the granite that is deformed, and 1.875 Ga, the age of a tuff intercalated with sedimentary rocks that unconformably overlie the mylonites. Rocks of the Great Bear magmatic zone and its basement were folded just prior to, or during transcurrent faulting. When the folds are restored, the mylonitic rocks extend over a width of about 20 km orthogonal to transport direction, suggesting that the zone was never steeply dipping but more likely a nearly horizontal sheet. Stubby westward-thinning wedges of conglomerate within basal Great Bear sections indicate minor west-side down faulting during sedimentation and volcanism. Prefolding plutonic rocks of the Great Bear zone typically progress from intermediate to siliceous with respect to time. A major unresolved problem is whether Archean granitoids of the Wompay fault zone were once part of Slave Craton or formed part of Hottah terrane.

Résumé

Les roches bordant l'est de la zone magmatique du Grand lac de l'Ours, recouvrent en discordance un granite de 1,90 Ga et un granite archéen hypothétique; tous deux sont localement mylonitisés. L'analyse préliminaire des indicateurs cinématiques présents dans les mylonites suggère qu'il y a eu un mouvement vers le nord des couches supérieures entre 1,90 Ga, l'âge du granite déformé, et 1,875 Ga, l'âge d'un tuf intercalé avec des roches sédimentaires recouvrant les mylonites en discordance. Les roches de la zone magmatique du Grand lac de l'Ours et du soubassement de cette zone ont été plissées immédiatement avant, ou durant l'apparition des failles de décrochement. Lorsque les plis sont reconstitués, on voit que les roches mylonitiques occupaient une largeur d'environ 20 km perpendiculairement à la direction de transport, ce qui suggère que cette zone n'a jamais été fortement inclinée, mais formait plus probablement une nappe subhorizontale. Les prismes courts et épais de conglomérat s'amincissant vers l'ouest, à l'intérieur des coupes de terrain basales du Grand lac de l'Ours, indiquent que durant les étapes de sédimentation et de volcanisme, a eu lieu un faillage normal, avec affraissement du compartiment ouest. Les roches plutoniques de la zone du Grand lac de l'Ours antérieures au faillage, passent en général de façon graduelle d'un type intermédiaire à un type siliceux, selon une progression ascendante. Un important problème encore non résolu est de savoir si les granitoïdes archéens de la zone faillée de Wopmay faisaient autrefois partie du Craton du Grand lac des Esclaves, ou du terrain exotique (terrane) de Hottah.

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INTRODUCTION

The Calder River map area (86F) straddles three major tectonic zones of Wopmay Orogen, from east to west: Hepburn metamorphic-plutonic zone, Wopmay fault zone and Great Bear magmatic zone, about three quarters of the area being occupied by rocks of the Great Bear magmatic zone (Fig. 73.1). In recent years, St-Onge et al. (1982, 1983, 1984) mapped the adjoining area to the east (86G); Hildebrand et al. (1983, 1984; Hildebrand and Roots, 1985) mapped the area to the west (86E); and Bowring (unpublished data) mapped much of the area immediately west of the Wopmay fault zone within the Calder River area. Lord and Parsons (1947) and McGlynn (1974, 1976) mapped the Calder River area itself and recognized several distinct packages of rocks; however, their mapping was of insufficient detail to mesh the complex volcanic, sedimentological, plutonic, and tectonic history with that from the recent, more detailed, studies of adjoining areas. Thus, this project concerned mainly with the geology west of the Hepburn metamorphic-plutonic zone, will complete the central transect of Wopmay Orogen.

This progress report summarizes the results of: (1) geological mapping carried out by SAB and assistants during the 1983 field season; (2) geological mapping by RSH, SAB, KPEA, SFG and GCS during the 1986 field season; and (3) geochronology done by SAB during the fall of 1986. Although this work has yielded a considerable body of data, at the same time it has generated new questions, many of which remain unanswered. We highlight the following main points.

1) In the northern half of the map area the boundary between the Great Bear magmatic zone and the Wopmay fault zone is an unconformity. Rocks of the Great Bear magmatic zone unconformably overlie both mylonitized and non-mylonitized granitic rocks of inferred Archean age.

2) Mylonites of the Wopmay fault zone and rocks of the eastern Great Bear magmatic zone were folded about north-south axes prior to, or during, transcurrent faulting.

3) Rocks of 1.90 Ga occur beneath the eastern Great Bear magmatic zone just west of the Wopmay fault zone and are in apparent fault contact with inferred Archean granites of the Wopmay fault zone beneath a major syncline of Dumas Group, the easternmost supracrustal sequence of the Great Bear magmatic zone. This implies that the majority of movement on the brittle faults that characterize the Wopmay fault zone predates the Dumas Group.

4) Mylonites, perhaps related to those of the Wopmay fault zone, occur several kilometres west, within the Great Bear magmatic zone, where they affect the 1.90 Ga basement.

5) The 7-10 km east-west extent of the mylonites, and the fact that they are folded, both suggest that they formed a near horizontal to gently dipping, sheet or braided system when the Dumas Group was deposited on them.

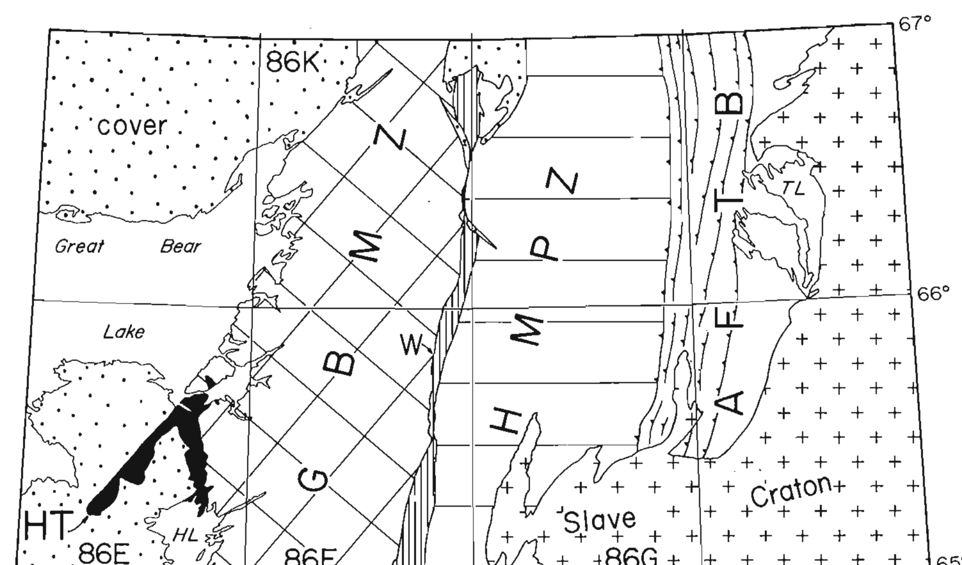

Figure 73.1. Tectonic sketch map of central Wopmay Orogen showing location of Calder River map area (86F).
HT = Hottah terrane;
GBMZ = Great Bear magmatic zone;
W = Wopmay fault zone;
HMPZ = Hepburn metamorphic-plutonic zone;
AFTB = Asiak fold-thrust belt;
HL = Hottah Lake;
TL = Takijuq Lake.

6) Preliminary analysis of kinematic indicators within the mylonites suggest northward-directed top over bottom movement.

7) Because granitic rocks of about 1.90 Ga are mylonitized and the mylonites of the Wopmay fault zone are unconformably overlain by supracrustal rocks of the Great Bear magmatic zone, recently dated at 1.875 Ga, the age of mylonitization is constrained to be between about 1.90-1.875 Ga, if the mylonites are coeval. However, the significance and origin of the mylonites are problematic; they may or may not be related to the Calderian orogeny, the deformational event responsible for the dominant north-south folds, east-vergent thrusts, and metamorphism that characterizes most of eastern Wopmay Orogen.

8) The U-Pb zircon age of 1.875 Ga determined from a welded tuff within the lower Dumas Group indicates that it is approximately coeval with andesitic stratovolcanoes and ash-flow calderas of the LaBine Group, interpreted to represent the main arc front then located near the western margin of the Great Bear magmatic zone.

9) Westward-thinning wedges of talus breccia within the Dumas Group, comprising blocks and cobbles of Archean granite and cryptalgal-laminated dolomite blocks derived from stratigraphically lower parts of the group suggest that some west-side-down faulting occurred while the Dumas Group was accumulating.

10) Plutonic rocks of the Great Bear zone generally have systematic compositional variations ranging from intermediate to siliceous with respect to time. One mapped complex contains multiple intrusions, each pulse of which intruded an older more intermediate phase and was progressively more siliceous.

11) The northeast-trending right-lateral transcurrent faults splay and appear to die out as they enter the north-trending strip of Dumas metasedimentary rocks. Since the belt of metasedimentary rocks and the Wompay fault zone, taken together, constitute a boundary between domains of northeast-trending right-lateral faults to the west and northwest-trending left-lateral faults to the east across which few strike-slip faults extend and because there has been considerable north-south extension on both sides of the belt, the north-south extension within the belt is penetrative at the map scale. It may be expressed visually at the outcrop scale by common boudinage of bedding.

12) A large triangular shaped magnetic low, bounded on the northwest by a large transcurrent fault and to the east by the north-south Dumas belt, that occurs in the north-central part of the map area apparently is caused by quartzofeldspathic gneisses and intensely epidotized granitoids not typical of the Great Bear magmatic zone. This suggests that the "triangle-zone" provides a window through the Great Bear magmatic zone into its basement. Similar magnetic lows characterize the southeast sides of several other major faults located farther south suggesting that additional exposures of basement may outcrop in those areas.

ACKNOWLEDGMENTS

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WOPMAY FAULT ZONE

Wopmay fault zone (Hoffman, 1972, 1984; Easton, 1981; King et al., 1983; King, 1985) is a 7-18 km wide, north-trending belt of lenticular brittle-fault bounded blocks. Individual blocks within the area mapped during 1983 and 1986 (Fig. 73.2 and 73.3) include: inferred Archean and other undated granitoids, in places mylonitized; metasedimentary and metavolcanic rocks of the Grant Group (Easton, 1982), locally unconformably overlying undated granitoids; and mylonites derived from metasedimentary rocks of unknown age.

Archean rocks (?)

A long linear belt of inferred Archean granitoid rocks occurs within the Wopmay fault zone (Fig. 73.3). Although the granitic rocks have not been dated directly, granitic rocks to the north, along strike and continuous with those discussed here, yield U-Pb ages close to 2.5 Ga (Bowring and Van Schmus, in press). The granitoid rocks are mainly equigranular to potassium feldspar porphyritic biotite granite and subsidiary hornblende-biotite granodiorite, in places foliated. The belt is widest at the northern edge of the map area and narrows southward until it pinches out at about 65° 40′ north latitude. Wherever we observed the eastern boundary of the granitic belt it passed, with material continuity, into ultramylonite. The transition zone ranges from a few centimetres to about 15 cm wide. The foliation within the mylonites immediately adjacent to the isotropic granitoids dips steeply eastward and contains a subhorizontal stretching lineation. Preliminary field analysis of kinematic indicators, such as rotated feldspar porphyroclasts, shear band foliation, and deflection of planar structure into the shear zone, consistently indicate sinistral sense of shear. The western boundary of the belt is a sharp contact with medasedimentary rocks of the Dumas Group: it is excellently exposed in several places and, as in the Sloan River map area, is an unconformity (Hoffman and McGlynn, 1977; Bowring, 1982). Both the unconformity at the base and the bedding within the metasedimentary rocks dip steeply to the west or are vertical. Therefore, the granitoid rocks are interpreted to occupy the core of an anticline of post-Dumas Group age (Fig. 73.3).

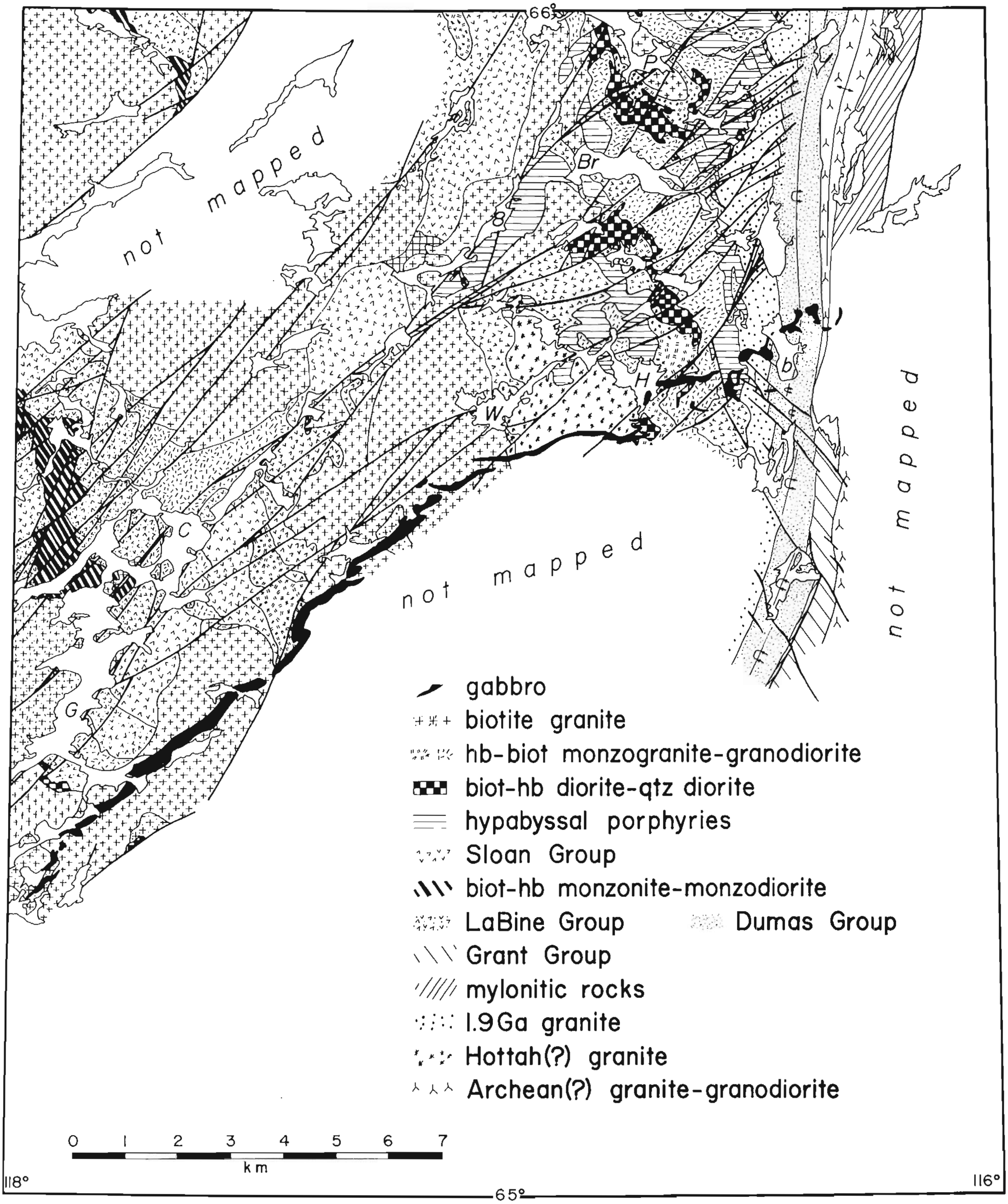

Figure 73.2. Geological sketch map of Calder River map area showing distribution of major rock units mapped to date.

C = Clut Lake;
G = Grouard Lake;
W = Wiley Lake;
H = Hansen Lake;
8 = Lake 837;
Br = Breadner Lake;
P = Handley Page Lake;
S = Smokey Lake;
b = Brain Damage Lake.

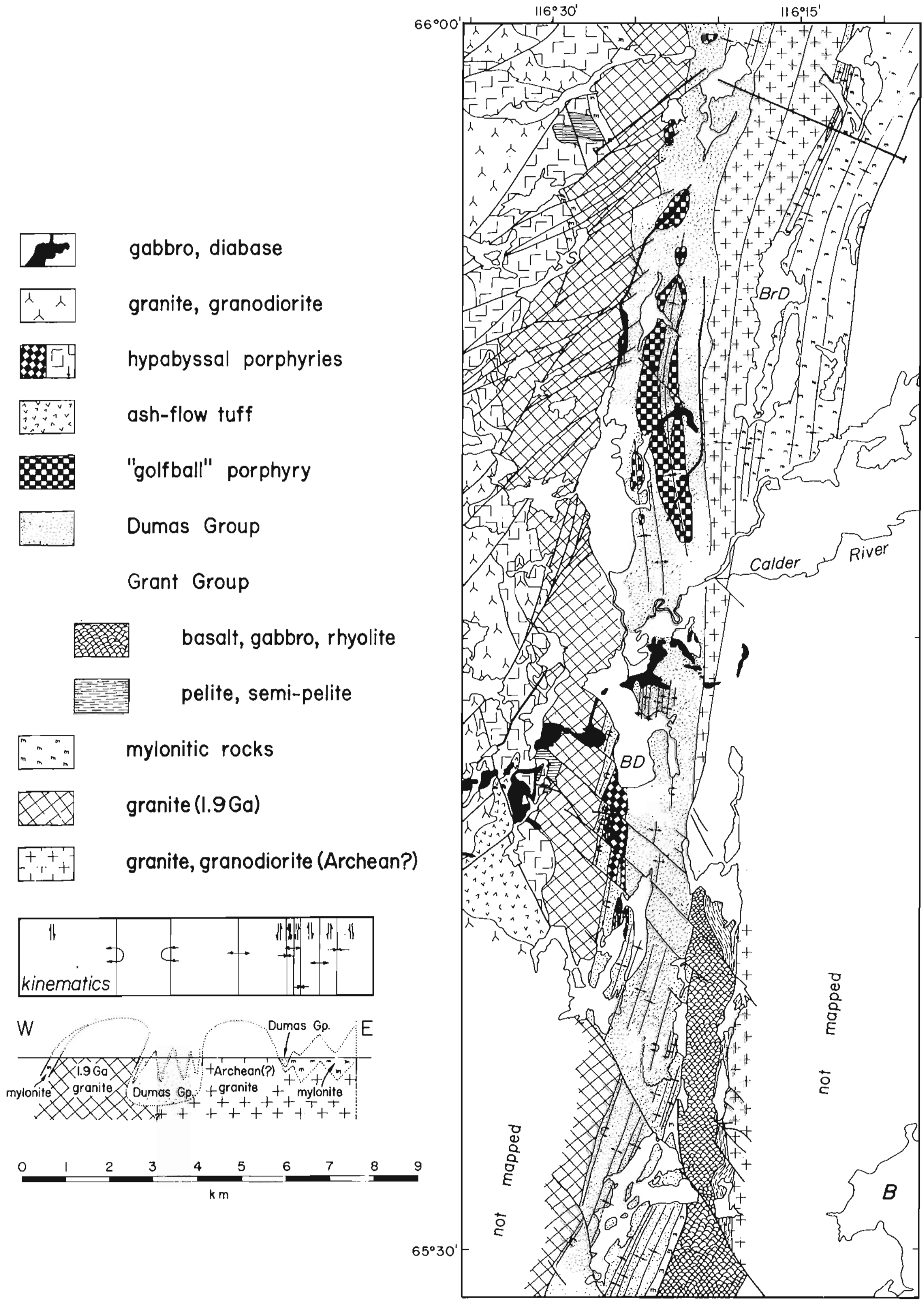

Figure 73.3. Geological sketch map of the northeastern part of Calder River map area showing the distribution of units in and adjacent to the Wopmay fault zone. The cross-section, constructed along the heavy lines in the northernpart of the map, is to scale but schematic. The plan view diagram of fold axes and sense of shear as deduced from kinematic indicators shows the consistent northward-directed top over bottom movement. B = Bishop Lake; Brd = Broken Dish Lake; BD = Brain Damage Lake; S = Smokey Lake.

Mylonitic rocks

One of the major rock types of the Wopmay fault zone is mylonite. The mylonites are derived from a variety of granitoids, some possibly Archean, as above, and others of unknown age, ranging in composition from syenogranite to quartz diorite as well as from metasedimentary rocks of unknown affinity. The zone containing the mylonitic rocks lies between the above mentioned anticline of inferred Archean granite on the west and a northward-trending brittle fault to the east: a width of about 3-4 km (Fig. 73.3). Within this belt the strain is extremely heterogeneous comprising ultramylonitic zones ranging from 1 km to 1 cm in width derived from less strained, but everywhere foliated and lineated, rocks.

Both the mylonitic rocks and the granitic rocks described above are tightly folded about north-trending axes. Fold wavelengths are on the order of 1-2 km. Dips of foliation on the fold limbs are typically steep, ranging from 65-85° with tight axial zones: they are large chevron-like folds. The mylonites have near horizontal mineral lineations. Kinematic indicators within the mylonites are consistently dextral on westward-dipping fold limbs and sinistral on fold limbs that dip eastward (Fig. 73.3). This indicates a sense of northward top-over-bottom movement when the effects of folding are removed.

Infolded remnants comprising volcanic and sedimentary rocks of the Dumas Group (Fig. 73.3) clearly indicate that the mylonites were folded after deposition of the supracrustal rocks, because bedding in the sedimentary rocks parallels the foliation in the mylonites. The unconformity between the supracrustal rocks and the mylonitic rocks is well exposed in several places northwest of Broken Dish Lake (Fig. 73.3).

Another zone of mylonitic rocks, mapped by SAB in 1983, occurs west of Bishop Lake (Fig. 73.3) and is in fault contact with the Grant Group on the east and unconformably overlain by sedimentary rocks of the Dumas Group to the west. This zone is less than a kilometre or so wide and is exclusively derived from granitoid rocks. The major protolith is a coarsely potassium feldspar porphyritic biotite syenogranite. Here, as in the mylonite belt to the north, the strain is heterogeneous and varies from ultramylonite to moderately foliated and lineated granite. Foliation within the zone dips steeply westward as does bedding in the overlying supracrustal rocks. Mineral lineations are nearly horizontal with kinematic indicators suggesting a dextral sense of shear. Because the spatial and temporal relationships, as well as the sense of shear, of the mylonites within this zone are similar to those of the more northerly belt, the two are considered to have originally been part of the same shear zone or shear system.

Grant Group

This group of rocks, mainly basalts, pelites and psammites, in places lying unconformably upon undated granitic basement, is another principal fault-bounded package of rocks within the Wopmay fault zone (Easton, 1982; King, 1985). It is amply described by those workers and is therefore not described in further detail here.

1.90 GA GRANITE AND HOTTAH TERRANE

Other than a few siliceous porphyries intruding the Akaitcho Group and Archean granitoids forming basement to both the Akaitcho and Grant groups, no plutons older than those of the Hepburn batholith were previously known near the eastern side of the Great Bear magmatic zone except for a small area of deformed granite, dated at 1.938 Ga, in the northeastern Sloan River map area (Bowring and Van Schmus, in press). During the 1986 field season we recognized a large pluton that is unconformably overlain by the Dumas Group in the Calder River map area.

The pluton, mapped during the field season and dated this fall, is a north-trending body coarsely potassium feldspar porphyritic biotite syenogranite. It is unconformably overlain by sedimentary rocks of the Dumas Group along the western side of the main overturned syncline shown in Figure 73.3, and zircons from a sample collected during the 1986 field season have yielded a preliminary U-Pb age of about 1.90 Ga. The granite is characterized by 2-6 cm size potassium feldspar phenocrysts, common in eastern exposures and decreasing in abundance westward, and anhedral quartz phenocrysts to 1 cm, and subhedral-euhedral plagioclase to 5 mm. The rock contains a conspicuous foliation, defined by biotite, that is best developed near the unconformity. In the northern part of the map area, north of the Calder River, the westernmost parts of the body are mylonitized (Fig. 73.3). The foliation within the mylonites dips westward at about 60°, has a subhorizontal stretching lineation, and preliminary examination of kinematic indicators suggests a dextral sense of shear. The mylonites and the granite are intruded by porphyries and granitoid plutons of unknown age. The westward dip of the mylonites suggests that the granite occupies the core of an anticline with its eastern limb overturned (Fig. 73.3). Because the sense of shear is compatible with the mylonites of the Wopmay fault zone they are considered to represent different parts of the same shear zone/system. If so, then the mylonites are exposed over an east-west distance of about 8 km, when separation on younger transurrent faults is restored, and since the mylonites are tightly folded their original east-west extent must have been considerably greater – perhaps 20 km or more. The fact that they are folded, coupled with the concordance between bedding in the Dumas Group and foliation in the mylonites, plus the consistent sense of north-directed top-over-bottom movement when the effect of the late folds is removed, suggest that prior to deposition of the Dumas Group the mylonites formed one nearly horizontal sheet. Since the zone was probably in excess of 20 km wide it is unlikely to have been a steeply dipping planar surface when the Dumas Group was deposited upon it.

The occurrence of the 1.90 Ga granite and the inferred Archean granitoids along the western and eastern sides, respectively, of the Dumas syncline for a distance of about

30 km suggests that the contact is not intrusive for it is far too linear. The contact is more likely to be a brittle fault similar to those of the Wopmay fault zone east of the Dumas syncline (King et al., 1983). If this interpretation is correct, the movement on the fault predates deposition of the Dumas Group.

Rock units suspected to be part of Hottah terrane occur farther to the west, mainly in the area around Wiley Lake (Fig. 73.2). In that area bodies of biotite-quartzofeldspathic gneiss, too small to represent on the map, occur along the northwestern margin of a large monzogranite pluton. A somewhat larger body of strongly epidotized granite occurs just to the northwest and, although not yet dated, is possibly of Hottah age. Whatever its age, it is one of the most altered granitoid rocks known anywhere within the Great Bear zone or Hottah terrane. Several other plutonic bodies, ranging from porphyritic hypabyssal intrusions to larger holocrystalline plutons in the same area are of unknown age.

GREAT BEAR MAGMATIC ZONE

The Great Bear magmatic zone comprises thick sequences of sedimentary and calc-alkaline volcanic rocks (MacTavish Supergroup), generally divided into 3 groups (Hoffman, 1978), from east to west: Dumas, Sloan, and LaBine. The supracrustal rocks are intruded by granitoid plutons whose compositions overlap those of the volcanic rocks. The LaBine Group clearly underlies the Sloan Group in the western part of the zone but age relations between the Sloan and Dumas groups have been equivocal: is the Dumas Group younger than the Sloan Group (Hoffman and McGlynn, 1977) or coeval with the LaBine Group (Hildebrand et al., in press)?

Dumas Group

In the Calder River map area, strata correlative with the lower part of the Dumas Group as defined by Hoffman (1978) in the Sloan River map area to the north, occur predominantly in a long, narrow overturned syncline along the western side of the Wopmay fault zone where they unconformably overlie rocks of inferred Archean age (Fig. 73.2 and 73.3) to the east and the 1.90 Ga granite to the west. On the east side of the syncline, as mentioned earlier, the unconformity dips steeply westward or is vertical; this contrasts with exposures on the Sloan River map area to the north where it dips at about 30-40° to the west. The western contact of the main Dumas belt is also an unconformity and there a coarsely porphyritic biotite granite of Hottah terrane is beveled to a near planar surface. Bedding in the overlying sedimentary rocks is concordant with the contact for at least 30 km along strike. The group was also found within the Wopmay fault zone where it occurs as synclinal remnants unconformably overlying granitic and mylonitic rocks (Fig. 73.3). In those areas bedding in the group parallels the foliation within the granites and mylonites. In the Calder River area the Dumas Group is metamorphosed to greenschist grade, which contrasts with the regional subgreenschist grade of the group in the east-central part of the Sloan River map area.

Within the major overturned syncline, rocks of the Dumas Group are tightly to isoclinally folded. The folds are generally upright although overturned folds have steeply inclined axial planes. Typical of the sedimentary rocks within the entire belt is an intense cleavage that parallels bedding on the fold limbs. Bedding within axial zones is incipiently transported (Fig. 73.4).

Wherever the unconformity was mapped, a basal conglomerate and/or regolith is absent to poorly developed. Along the eastern side of the main overturned syncline, rocks above the unconformity comprise medium- to coarse-grained mostly subangular to subrounded sandstone containing about 10-15% feldspar. The sandstone occurs as thin lenses up to 3 m thick where it is best developed in paleotopographic lows eroded into the Archean basement. Along strike variations appear to relate to the basement rock type – specifically to grain size; that is, where it is coarse grained granite the sandstone contains angular chips and subrounded granules of potassium feldspar, yet where the basement rock type is ultramylonite the rock immediately overlying the unconformity is finer grained than elsewhere and contains few, if any, grains larger than medium sand-size. Bedding within the unit is poorly developed but appears to consist of low angle cross stratification and some ripple cross stratification. This unit, interpreted as transgressive strandline sands, is gradational upward into a locally occurring dolomite unit.

Along the western side of the belt there are local lenses and lag deposits of pebbly sandstone clearly derived from the underlying granite. The sandstone is arkosic and stratification is predominantly low angle crossbedding. The arkose is only a few metres thick and is overlain by a succession of intercalated carbonate and siltstone beds. Individual beds are 1 to 5 cm in thickness and there are sparse horizons of slump

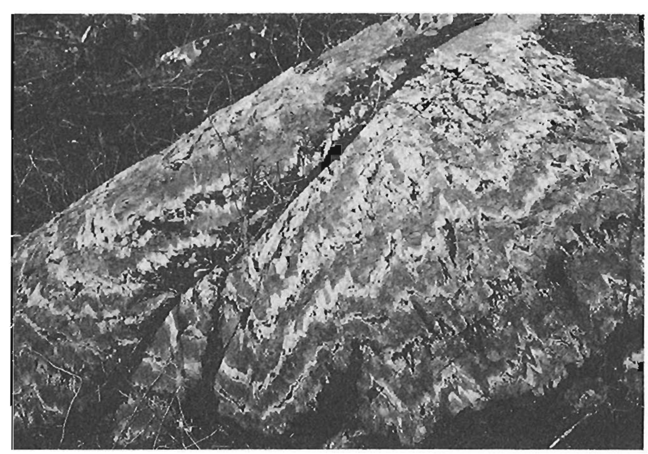

Figure 73.4. Axial zone of overturned fold showing incipient transposition along steeply dipping cleavage planes. The photograph was taken looking south, down the plunge of the fold, the overturned limb is to the right (west). Pen in extreme upper right of outcrop for scale. GSC 204400-R.

folds. Overlying the interbedded units are sandstones composed of almost only plagioclase grains and mafic debris, now metamorphosed to assemblages of albite, chlorite, and actinolite. Relict through crossbedding is well preserved in sets up to 20 cm thick.

The dolomite unit, found only along the eastern side of the belt, comprises about 1.5 m of laminated, brown, medium grained, ferroan(?) dolomite with wavy to irregular stratiform stromatolites, minor units containing microdigitate or digitate stromatolites with up to a few millimetres of synoptic relief, and rare tufted stromatolites. Platy oncolites, draped by layers of cryptalgal tufa are present but rare, as are sand-filled mudcracks and prism cracks. The dolomite unit, interpreted to represent carbonate tidal flats, contains several laminae of medium grained sandstone near the top and is overlain by a major mudstone-siltstone unit.

Abruptly overlying the carbonate unit is at least 40 m of finely to thickly interlaminated mudstone and siltstone containing lenses of conglomerate and minor thin beds (1-4 cm) of sandstone. Within the mudstone-siltstone some beds are size-graded. Although this unit is strongly cleaved, there is no evidence for desiccation in the form of mudcracks or mudchips; therefore, this unit is interpreted to have accumulated during rapid subsidence and to represent a distal shelf or basinal mudstone facies.

In the northern part of the map area there are several local conglomeratic lenses intercalated with the mudstone-siltstone sequence (Fig. 73.5). They are 3-15 m thick and contain clasts up to 1 m in diameter. The rock is clast-supported, has a sandy matrix, and contains subrounded to subangular clasts of granitoid rocks similar to those beneath the unconformity, angular blocks of stromatolitic dolomite, and minor sandstone clasts probably derived from stratigraphically lower units. The conglomerate units are not present in sections 2 km to the west. This, coupled with the occurrence of older lithologies in the conglomerate and the abrupt drowning of the tidal-flat carbonates by thick section of muds, suggests west-side-down normal faulting just to the west of the present outcrop belt during deposition of the mudstone. The conglomerates probably represent debris shed from the west-facing fault scarps along which granitoid basement was exposed.

Numerous beds of tuffaceous rocks occur interbedded with the mudstone-siltstone sequence in the central part of the syncline of Dumas Group. The tuffs, thin units that are mostly less than 20 m thick, vary from simple cooling units of ash-flow tuff containing 10-25% phenocrysts to reworked tuffs containing in excess of 50% broken crystals. They typically pinch out along strike and appear to fill shallow paleotopographic depressions. A recently completed U-Pb zircon age from one of the welded tuffs in this sequence indicates emplacement at 1.875 Ga, the same age as rocks of the LaBine Group. Thus, it appears that the Dumas Group represents material deposited cratonward of the main Great Bear arc front as represented by the LaBine Group.

The mudstone-siltstone sequence is cut by a distinctive quartz-plagioclase-potassium feldspar porphyritic intrusion, informally referred to as the "golfball" porphyry because the potassium feldspar phenocrysts are round and about the size of golfballs. The porphyry is similar to those mapped in the Sloan River map area by Hoffman (1978, 1984) and Bowring (1982). In that area the porphyries are sheet-like bodies (1.864 Ga, Bowring and Van Schmus, in press) that occur in the cores of anticlines, but in the Calder River map area they occur in the cores of synclines (Fig. 73.3). This suggests a slightly deeper level of erosion in the latter area and is in keeping with the higher metamorphic grade there.

The "golfball" porphyry and the mudstone-siltstone sequence are unconformably overlain by several metres of conglomerate and sandstone. The unconformity was first recognized during the 1983 field season by SAB and an unconformity also occurs above the "golfball" porphyry in the Sloan River map area (Bowring, 1982). In the Calder River area where the unconformity occurs on the porphyry there is typically a conglomerate containing almost exclusively porphyry debris of various grain size from sand to cobbles. Where the porphyry is absent it is difficult to recognize the unconformity because units above and below it are similar in composition and are roughly concordant with one another.

The synclinal remnants of Dumas Group that occur within the Wopmay fault zone have a different stratigraphy than sections of the group farther west. They comprise a basal arkosic sand and/or pebbly conglomerate overlain by amygdaloidal basalt flows, cut by brick-red siliceous porphyries. This stratigraphy is similar to that found in the Sloan River map area above the erosional surface cut into the "golfball" porphyry. The lack of the thick section of mudstones and siltstones characteristic of the Dumas Group beneath the unconformity suggests that the sections preserved in the Wompay fault zone represent the "upper" Dumas Group, and that the basin in which the thick mudstone-siltstone sequence accumulated was, at least in part, fault bounded on its eastern

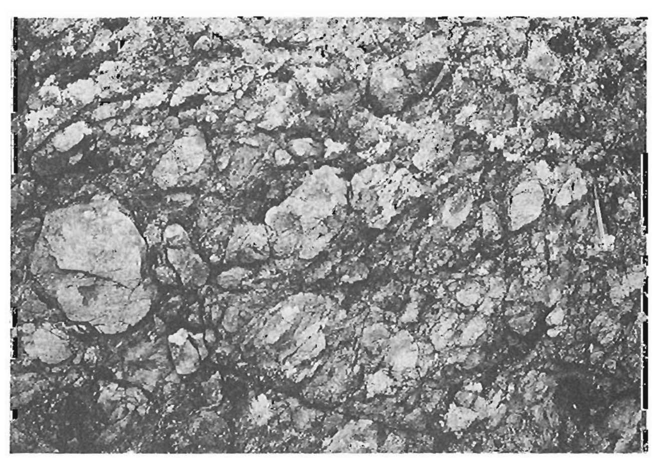

Figure 73.5. Clast-supported granitic conglomerate of the Dumas Group. Pen in left centre for scale. GSC 204400-P.

side and that the margin lay between the two preserved synclines. This is consistent with sedimentological evidence for west-side-down faulting during the deposition of the lower Dumas Group as discussed earlier.

LaBine Group

Rocks of the LaBine Group are the oldest rocks of the western Great Bear magmatic zone. They unconformably overlie rocks of the Bell Island Group (Reichenbach, 1986) and lie unconformably beneath tuffs of the Sloan Group. Most of the LaBine Group in the Calder River map area was described in detail by Hildebrand (1984a,b); however, new exposures of the group were found along the east side of Grouard Lake (Fig. 73.2). The rocks placed within the LaBine Group are: intensely altered mafic-intermediate lavas, tuffs, and associated sedimentary rocks, have correlated with Camsell River Andesite; and densely welded, lithic and crystal-rich, intermediate ash-flow tuff assigned to White Eagle Tuff. Complete descriptions of the units are found in Hildebrand (1984a).

In the Grouard Lake area the upper part of the LaBine Group is a several kilometre thick section of simple cooling units of ash-flow tuff informally termed the "younger ash-flow tuffs" (Hildebrand, 1984a). During the 1986 field season we recognized that they are correlative with tuffs of the Sloan Group and, therefore, are shown on the current map as Sloan Group (Fig. 73.2).

Sloan Group

In the Calder River map area rocks mapped as Sloan Group consist almost entirely of densely welded ash-flow tuffs. Most of the tuffs are probably of intermediate composition as they contain 25-40% phenocrysts of plagioclase, quartz, ferromagnesian minerals, and potassium feldspar phenocrysts. There is a remarkable paucity of sedimentary rocks intercalated with the ash-flow tuffs; consequently, it is extremely difficult to define individual stratigraphic units. Where it is possible to map individual units, the Sloan Group comprises sequences, many kilometres thick, of simple cooling units that probably represent outflow facies sheets erupted from unknown sources. The great thicknesses of the sequences suggests that they may represent material deposited in older calderas. Other units of densely welded, crystal-rich intermediate ash-flow tuff are in excess of 1 km thick. They probably represent intercauldron facies tuff ponded within calderas during subsidence.

Granitic rocks

Granitic rocks make up a sizable proportion of the Great Bear magmatic zone mapped during 1986. There are two main assemblages of granitic rocks within the zone separated from one another in time by a period of oblique folding: a prefolding supersuite comprising intermediate to siliceous rocks and a postfolding suite comprising dominantly siliceous bodies and dyke swarms (see Hildebrand et al., in press). The folds within the Great Bear zone generally have gently plunging axes that trend northwest, except along the eastern and western margins of the zone where they trend north. The prefolding granites are identified by their general concordance with stratigraphy and their dominant northwest trend while plutons of the post-folding suite are discordant with respect to both stratigraphy and folds. In general, the folded plutons are more intermediate in composition and contain more hornblende than their post-folding counterparts, which are dominantly biotite syenogranites (Hoffman and McGlynn, 1977; Hildebrand et al., in press).

Prefolding supersuite

The oldest rocks of the Great Bear zone mapped during the current project are intermediate in composition. They occur most commonly as remnants along the contacts between younger granites. A few other bodies occur as enclaves up to several kilometres across in younger granodiorites and monzogranites. In the northern part of the area are much larger bodies, some 10 km or more across. At least one of the large bodies forms part of a typical zoned plutonic complex.

The intermediate bodies vary considerably in composition, individual bodies comprising clinopyroxene-biotite-hornblende bearing diorite, quartz diorite, monzodiorite, and quartz monzodiorite. Although some renmants are fairly uniform in composition, others are quite heterogeneous and internal variations that span this entire range are common; in fact, one body grades from biotite-hornblende monzodiorite to biotite syenogranite over a 100 m interval.

A 100-200 m wide body of pyroxenite occurs with a small swarm of mafic dykes east of Handley Page Lake. The pyroxenite occupies the central portion of an irregular-shaped gabbro body. This body and the dykes crosscut apparently folded plutonic rocks of the area but the age of those rocks is unknown.

The largest and most common granitoid plutons of the prefolding suite are hornblende-biotite monzogranites and granodiorites. They are mostly seriate textured rocks containing 15-30% ferromagnesian minerals. Potassium feldspar phenocrysts are common in many bodies but are absent in others. At least one of the bodies is sheet-like. It occurs west of Handley Page Lake (Fig. 73.2) and has eastward dipping upper and lower contacts parallel to eutaxitic foliation in the ash-flow tuffs that it intrudes. As the body is exposed over a horizontal distance of 2 km and the dip of contacts and bedding is 30°, the pluton is about 1 km thick. It appears to be the southernmost part of the Torrie pluton (Hoffman and McGlynn, 1977), one of the two largest folded plutons mapped to date in the Great Bear magmatic zone.

Perhaps the most interesting plutonic complex mapped during the 1986 field season is a zoned intrusive complex at Handley Page Lake (Fig. 73.6). It comprises three distinct phases, from oldest to youngest and from margin to core: (1) clinopyroxene-biotite-hornblende diorite and quartz diorite with local zones of clinopyroxenite, (2) hornblende-biotite monzogranite and granodiorite, and (3) potassium feldspar porphyritic biotite syenogranite. Contacts between each successive phase are sharp and the complex appears similar in composition and intrusive history to the Tuolomne intrusive series (Bateman and Chappell, 1979) of the Sierra Nevada batholith. A detailed petrological and chemical study of the complex will form part of a Bsc. thesis by SFG at Carleton University.

Numerous porphyritic intrusive bodies occur throughout the mapped area. The largest occurs along the western side of the 1.90 Ga granite just west of the main Dumas syncline, where it intrudes mylonites derived from the granite (Fig. 73.3). The body is coarsely porphyritic containing potassium feldspar phenocrysts to 4 cm, anhedral quartz blobs up to 2 cm, and plagioclase to 5 mm. It weathers brick red and ranges from weakly foliated to nondeformed. Several similar bodies that strike northwest occur north of Handley Page Lake and another large unit of porphyry occurs along the eastern side of Lake 837 (Fig. 73.2).

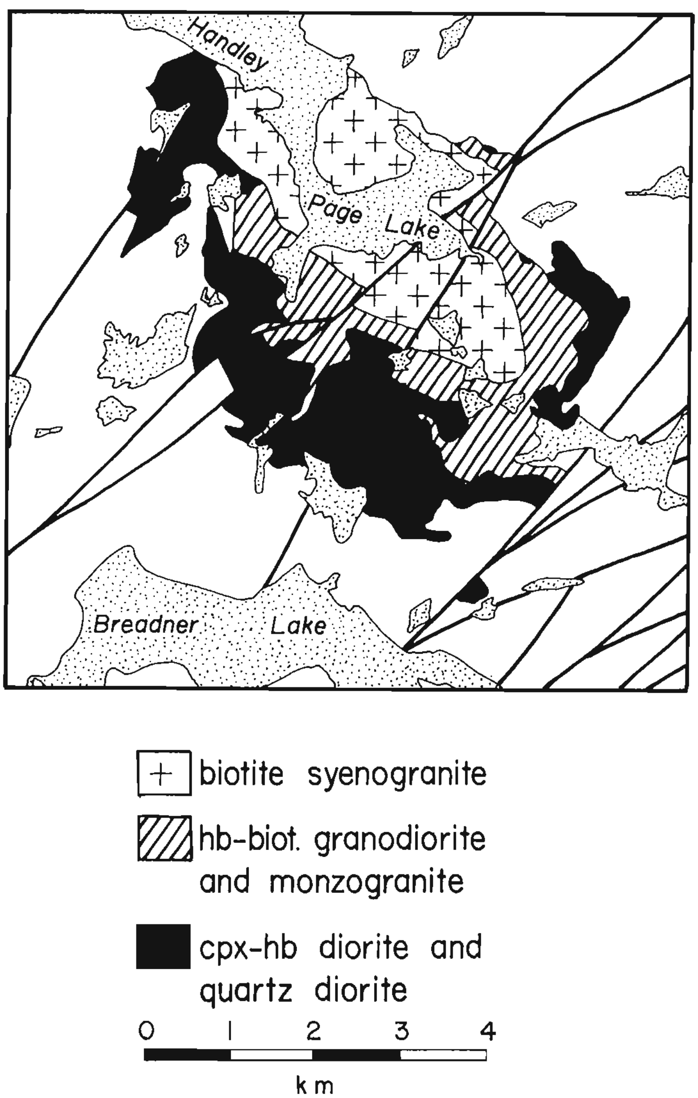

Figure 73.6. Geological sketch map showing the distribution of major rock types in the Handley Page intrusive complex.

Postfolding suite

This suite comprises mainly biotite syenogranite plutons which postdate the main period of folding within the Great Bear zone. The bodies crosscut fold axes and are ovoid to irregular-shaped plutons greater than 15-20 km in diameter (Fig. 73.2). They are typically potassium feldspar porphyritic. Sharp external contacts and little compositional variation with individual bodies are the rule. Miarolitic cavities and pegmatites are relatively common near the margins of some bodies.

Dyke swarms

Two major dyke swarms were mapped during the 1986 field season. Both appear to postdate folding as they cut plutons of the biotite syenogranite suite. They are cut by the transcurrent faults. Therefore, they are about the same age as the Grouard porphyry dykes of Hildebrand (1984a). One of the swarms occurs to the east of Lake 837 and the other occurs east of Hansen Lake (Fig. 73.2).

Dykes of the former swarm are generally brick-red weathering and contain variable quantities of biotite, hornblende, plagioclase, quartz, and potassium feldspar phenocrysts in an aphanitic to finely phaneritic groundmass. They trend north-northeast (Fig. 73.7). The other dyke swarm extends from Smokey Lake (Fig. 73.3) to southeast of Hansen Lake with the greatest concentration just east of Hansen Lake. This swarm is a bimodal suite consisting of brick-red siliceous dykes with phenocryst assemblages similar to dykes east of Lake 837 and dark-brown to black weathering hornblende-plagioclase porphyritic dykes that are probably intermediate to mafic in composition. The swarm trends northeast except in the southern region of extent where orientations swing sharply to the east (Fig. 73.8). The siliceous dykes are concentrated east of Hansen Lake and do not occur north of the Calder River. The siliceous dykes are older of the two: the intermediate-mafic dykes typically intrude the contact between the siliceous dykes and their wall rocks. Adjacent to their margins the intermediate-mafic dykes are commonly black, flinty, nearly aphyric but become progressively more coarsely crystalline and more porphyritic towards their interiors. They commonly contain potassium feldspar xenocrysts rimmed by a white weathering feldspar, probably albite, and quartz xenocrysts armoured by a ferromanesian mineral, probably clinopyroxene. Although the quartz shows a reaction relationship with the melt the groundmass typically contains 5-10% modal quartz.

Transcurrent faults

Abundant northeast-trending transcurrent faults, typical of the Great Bear magmatic zone (see Hildebrand et al., in press and references therein), were mapped during the field season. Most exhibit right lateral separation but a lack of piercing

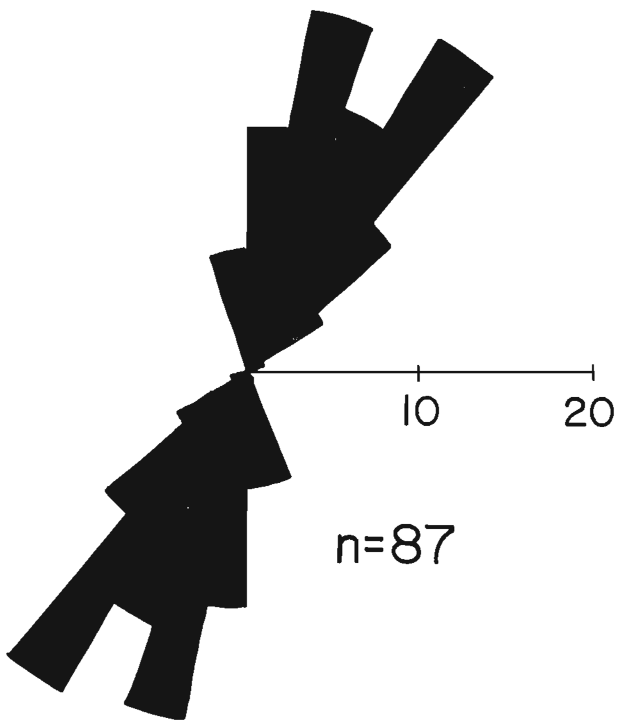

Figure 73.7. Rose diagram of siliceous dykes east of Lake 837.

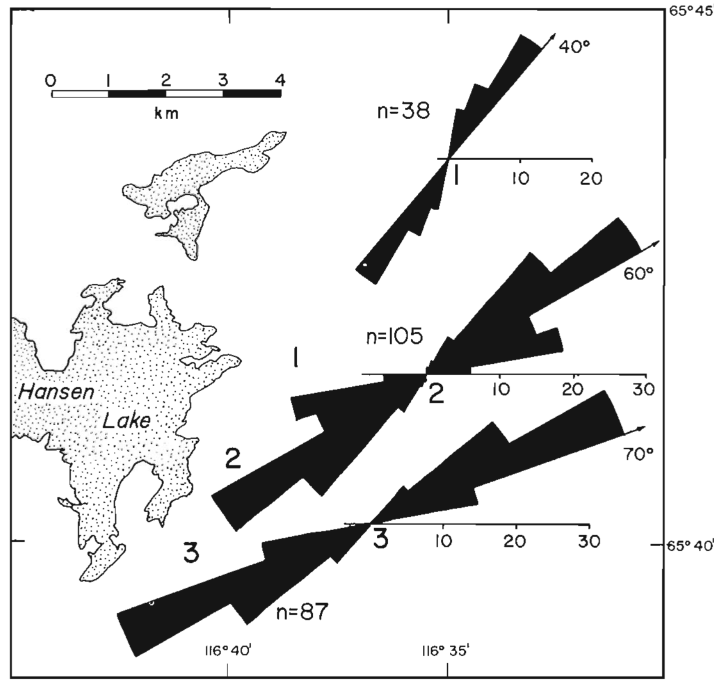

Figure 73.8. Rose diagrams of bimodal dyke swarm east of Hansen Lake. The numbers 1, 2 and 3 refer to the approximate locations for each of the rose diagrams. Note the progressive change in orientation from north to south.

points precludes any estimation of true displacement. The majority of the faults splay as they approach the synclinal Dumas belt and die out: they do not offset the eastern unconformity between the Dumas Group and the Archean granites. Although some northwest-trending, left-lateral faults, characteristic of the area east of the Dumas Group (Hoffman, 1984), cross the Dumas belt, for the most part it, and/or its basement (the zone of north-south oriented folds affecting the rocks in the vicinity of the Wopmay fault zone is here informally termed the "folded zone") forms a domain boundary between northeast-trending right-lateral faults to the west and northwest-trending left-lateral faults to the east. Because the faults are present on either side of the folded zone but do not in general cut it, there is a compatibility problem; that is, rocks within the folded zone must have extended in a north-south direction but deformation must be penetrative at the map scale. On the outcrop scale the only observed feature compatible with such deformation is pervasive boudinage of bedding (Fig. 73.9) indicating significant north-south extension but the age of the boudinage is unknown.

Triangle zones

Along the southeast side of the major transcurrent fault passing just east of Lake 837 is a triangular-shaped zone $36 \times 60 \times 53$ km that appears on aeromagnetic maps as a magnetic low relative to the "normal" magnetic signature of the Great Bear magmatic zone. Rocks of the region known to have relatively low magnetic susceptibility include Archean basement, Coronation Supergroup, Hepburn intrusive suite, Hottah terrane, and post-folding granites of the Great Bear zone. To date we have mapped only the northern half of the triangle zone but much of the area includes rocks that do not resemble the suite of post-folding granites of the Great Bear zone; therefore, they maybe predate the Great Bear magmatic zone. If so, then the triangle zone provides a "window" through the eastern Great Bear zone into its basement. Similar magnetic lows occur farther south on the southeastern sides of several of the largest transcurrent faults that cut the zone at regular intervals of about 20 km suggesting that additional exposures of basement to the Great Bear zone may be found in those areas.

YOUNGER GABBRO

There are three major diabase-gabbro assemblages known to occur in the Calder River map area: north-trending diabase dykes found mostly in the central to eastern parts of the sheet; northwest-trending diabase dykes of Cleaver diabase (Hildebrand, 1984b); and a large northeast-trending gabbro sheet, that dips northwestward and extends from Hottah Lake in the southwest to the Wopmay fault zone in the northeast (Fig. 73.2). Age relations between the two diabase dyke swarms were not observed but the gabbro still clearly cuts dykes of Cleaver diabase.

Figure 73.9. Arkosic sandstone of the Dumas Group. Note the boudinage formed in the more competent layers. GSC 204400-U.

Figure 73.10. Oblique aerial photograph, looking west over the floodplain of the Calder River where it crosses the Dumas syncline. GSC 204400-T.

ECONOMIC GEOLOGY

Mineralized zones proved to be scarce in the area mapped during 1986. Mineralized quartz veins were, however, found southwest of Wiley Lake in a transcurrent fault zone. One of the veins, 15 cm thick, contains a 2.5 cm central zone of pyrite, chalcopyrite, sphalerite, and bornite. The other, 20 cm thick, has margins of amethyst and a 10 cm core of honey-coloured sphalerite mantled by dark brown sphalerite.

Although no evidence for mineralization was seen, the pyroxenite bodies northeast of Handley Page Lake might be potential sources of platinum-group metals, but unless the bodies expand considerably at depth the tonnage would almost certainly make any deposit subeconomic.

QUATERNARY AND RECENT GEOLOGY

Although the area is generally free of extensive Quaternary cover there are numerous eskers that trend approximately east. A large field of boulders several kilometres across occurs at the east end of Handley Page Lake along the Calder River. Sets of raised beaches occur in the western part of the map area and may be related to ancient Lake McConnell (Craig, 1965). The Calder River has a well developed floodplain where it crosses the Dumas syncline (Fig. 73.3). There, the river is a typical meandering river with spectacular point bars and oxbow lakes (Fig. 73.10).

DISCUSSION

The occurrence of 1.90 Ga granitic rocks along the eastern side of the Great Bear magmatic zone, coupled with their close proximity to Archean granitoids of unknown affinity has some potentially interesting implications for the development of Wopmay Orogen. Based on similarities in age, lithology and geochemistry, Reichenbach (1985, 1986) suggested that volcanic rocks of the Akaitcho, Grant, and Bell Island groups are coeval and were erupted within the same basin – the Grant and Akaitcho Groups deposited unconformably upon Archean basement and the Bell Island Group deposited unconformably upon pre-1.900 Ga Proterozoic basement (Hottah terrane). This, coupled with data suggesting that Hottah terrane represents a magmatic arc (Hildebrand and Roots, 1985), led to a model in which the Coronation Supergroup originated within a marginal basin, with the Bell Island Group deposited on the western side of the basin and the Grant-Akaitcho assemblage deposited on the eastern side (Reichenbach, 1986; Hildebrand et al., in press). This model implies that Hottah terrane was contiguous to Slave Craton just prior to 1.90 Ga; however, a major unknown is whether the Hottah arc developed upon Archean crust of the western Slave Province or whether it developed on different basement that had earlier been accreted to Slave Craton. Thus, the close proximity of undated, but probably Archean, rocks known to unconformably lie beneath Akaitcho and Grant groups, and possible Hottah terrane, occurring in the triangle zone, brings up the question of whether or not Akaitcho, Grant, and Bell Island groups and their respective basements ever formed a coherent block, and if so did it extend to form a marginal basin on stretched Slave Craton, or is the entire assemblage exotic with respect to the craton and central and upper parts of the Coronation Supergroup? At present this question remains unanswered but additional mapping and geochronology, both to the north and south, may discover the answer.

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