GEOLOGICAL SURVEY OF CANADA — COMMISSION GÉOLOGIQUE DU CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES

LEGEND

QUATERNARY

Unconsolidated subglacial and proglacial deposits, mainly related to Pleistocene Lake Coppermine; Recent floodplain deposits

MIDDLE PROTEROZOIC

COPPERMINE RIVER GROUP (C)

C — COPPER CREEK FORMATION: basalt flows; minor intercalated sandstone

MACKENZIE DYKES: diabase, gabbro (north-northwest-trending dykes)

MUSKOX INTRUSION (M1–M4)

M4 — Gabbro, granophyric gabbro, granophyre, xenolithic granophyre; minor pyroxenite (websterite)

M3 — Pyroxenite (websterite), orthopyroxenite, clinopyroxenite; minor gabbro, peridotite

M2 — Serpentinized dunite, peridotite, feldspathic peridotite; minor pyroxenite

M1 — Bronzite gabbro, picrite, feldspathic peridotite (feeder dyke and border zone)

DISMAL LAKES GROUP (D1–D2)

D2 — Dolomite, in part stromatolitic; minor red mudstone at base

D1 — Pure quartz sandstone; minor black shale, conglomerate

WESTERN CHANNEL DIABASE: diabase, gabbro (northeast-trending dykes and gently dipping sheets)

HORNBY BAY GROUP (H1–H3)

H3 — LADY NYE FORMATION: quartz sandstone; minor quartz-pebble conglomerate

H2 — FAULT RIVER FORMATION: reddish feldspathic sandstone, siltstone, polymictic conglomerate

H1 — BIGBEAR FORMATION: feldspathic sandstone, quartz sandstone; minor polymictic conglomerate

CLEAVER DYKES: diabase, gabbro (west-northwest-trending dykes)

EARLY PROTEROZOIC

GREAT BEAR INTRUSIVE SUITES (G1–G4)

G4 — Hornblende diorite, quartz diorite; minor pegmatitic granite

G3 — Coarse grained biotite syenogranite, monzogranite

G2 — Hornblende-biotite granodiorite, monzogranite

G1 — Hornblende-biotite quartz monzodiorite, quartz monzonite

McTAVISH SUPERGROUP (M1–M0)

M0 — Altered biotite gabbro (correlation with McTavish Supergroup uncertain)

M9 — Plagioclase-quartz porphyry near Great Bear Lake, plagioclase-hornblende porphyry near McLaren Lake, K-feldspar-plagioclase-quartz porphyry near Augustus Lake (various ages)

M8 — Dacite-rhyodacite ignimbrite, feldspathic-lithic sandstone, polymictic conglomerate, silty mudstone, basalt

M7 — Silty mudstone, megacrystic "golf-ball" rhyolite porphyry, basalt; minor conglomerate, sandstone

M6 — Dacite-rhyolite ignimbrite and lava flows, polymictic conglomerate, feldspathic-lithic sandstone, silty mudstone; minor basalt

M5 — Andesite-dacite-rhyodacite ignimbrite and lava flows

M4 — Rhyodacite-rhyolite ignimbrite; minor rhyolite lava flows (M4c), feldspathic-lithic sandstone, conglomerate

M3 — Dacite-rhyodacite ignimbrite, sills of dacite-rhyodacite porphyry

LABINE GROUP (M1–M2)

M2 — UNDIVIDED CAMERON BAY AND FENIAK FORMATIONS: feldspathic-lithic sandstone, polymictic conglomerate, dacite-rhyodacite-rhyolite ignimbrite, andesite-dacite-rhyolite lava flows, silty mudstone; minor dolomite

M1 — UNDIVIDED PORT RADIUM AND ECHO BAY FORMATIONS: andesite-basaltic andesite lava flows, reworked andesitic sandstone, andesite porphyry; basal mudstone with silicified tuff, minor rhyolite (?) lava flows

Z — Mylonite (protolith uncertain but probably derived chiefly from units A2 and H3), mylonitization predates local Unit G3

HEPBURN INTRUSIVE SUITE (H1–H9)

H9 — Biotite gabbro, biotite bronzite gabbro, pegmatitic granite; minor anorthosite, pyroxenite, peridotite

H8 — Hornblende-biotite diorite, pegmatitic granite; minor hornblendite

H7 — Alaskite (fine grained leucocratic granite-granodiorite)

H6 — Hornblende-biotite quartz diorite; minor pegmatitic granite

H5 — Coarse grained biotite syenogranite

H4 — Biotite-hornblende tonalite; minor megacrystic (K-feldspar) granodiorite

H3 — Biotite granodiorite (includes some tonalite with scattered pockets of syenogranite)

H2 — Garnet-rich megacrystic (K-feldspar) granite, granodiorite; minor tonalite

H1 — Biotite granite, megacrystic (K-feldspar) granite

CORONATION SUPERGROUP (A1–R)

RECLUSE GROUP (R)

R — FONTANO AND ASIAK FORMATIONS: feldspathic-lithic greywacke, laminated graphitic-sulfidic pelite, semipelite, metagabbro sills in this and older units

EPWORTH GROUP (E1–E5)

ROCKNEST FORMATION (E2–E5)

E5 — Dolomite, probable slope and reef facies (indistinguishable due to karst development beneath Dismal Lakes Group)

E4 — Slope facies dolomitic rhythmite, rhythmite breccias; minor reddish marlstone

E3 — Reef facies stromatolitic dolomite, dolarenite, dolorudite

E2 — Shelf facies cyclic dolomite, shale and stromatolitic cherty dolomite

E1 — ODJICK FORMATION: semipelite, quartzite; minor conglomerate, argillaceous dolomite, graphitic pelite

AKAITCHO GROUP (A1–A0)

Cloos Nappe (A1–A0)

A0 — UNDIVIDED VAILLANT AND STANBRIDGE FORMATIONS: massive pillowed and fragmental metabasalt; metagabbro; minor reef facies stromatolitic and quartz arenaceous dolomite, slope facies dolomite rhythmite and megabreccias, graphitic pelite, feldspathic sandstone and grit

A9 — DRILL FORMATION: feldspathic sandstone and grit, graphitic pelite, quartz-pebble conglomerate with outsize dolomite clasts, mafic tuff, metagabbro

Marceau Thrust Slice (A5–A8)

A8 — UNDIVIDED AGLEROK AND TALLERK FORMATIONS: olive pelite, metabasalt, metagabbro sills, impure mafic tuff, minor carbonate, feldspathic-lithic sandstone, conglomerate

NASITTOK SUBGROUP (A6–A7)

A7 — Porphyrocrastic (K-feldspar) rhyolite (eruptive equivalent of Okrark Sills?)

A6 — Pillowed, massive and fragmental metabasalt, metagabbro; minor rhyolite

A5 — Rhyolite, feldspathic sandstone and grit, metagabbro sills

Okrark Thrust Slice (A2–A4)

A4 — BELLEAU FORMATION: pillowed and massive metabasalt, metagabbro; minor rhyolite, chert, pelite (stratigraphic and structural position uncertain)

A3 — OKRARK SILLS: K-feldspar-porphyritic rhyolite (A3a), plagioclase-porphyritic rhyolite (A3b)

A2 — ZEPHYR FORMATION: arkosic turbidites, semipelite; minor metabasalt, metagabbro, mafic tuff

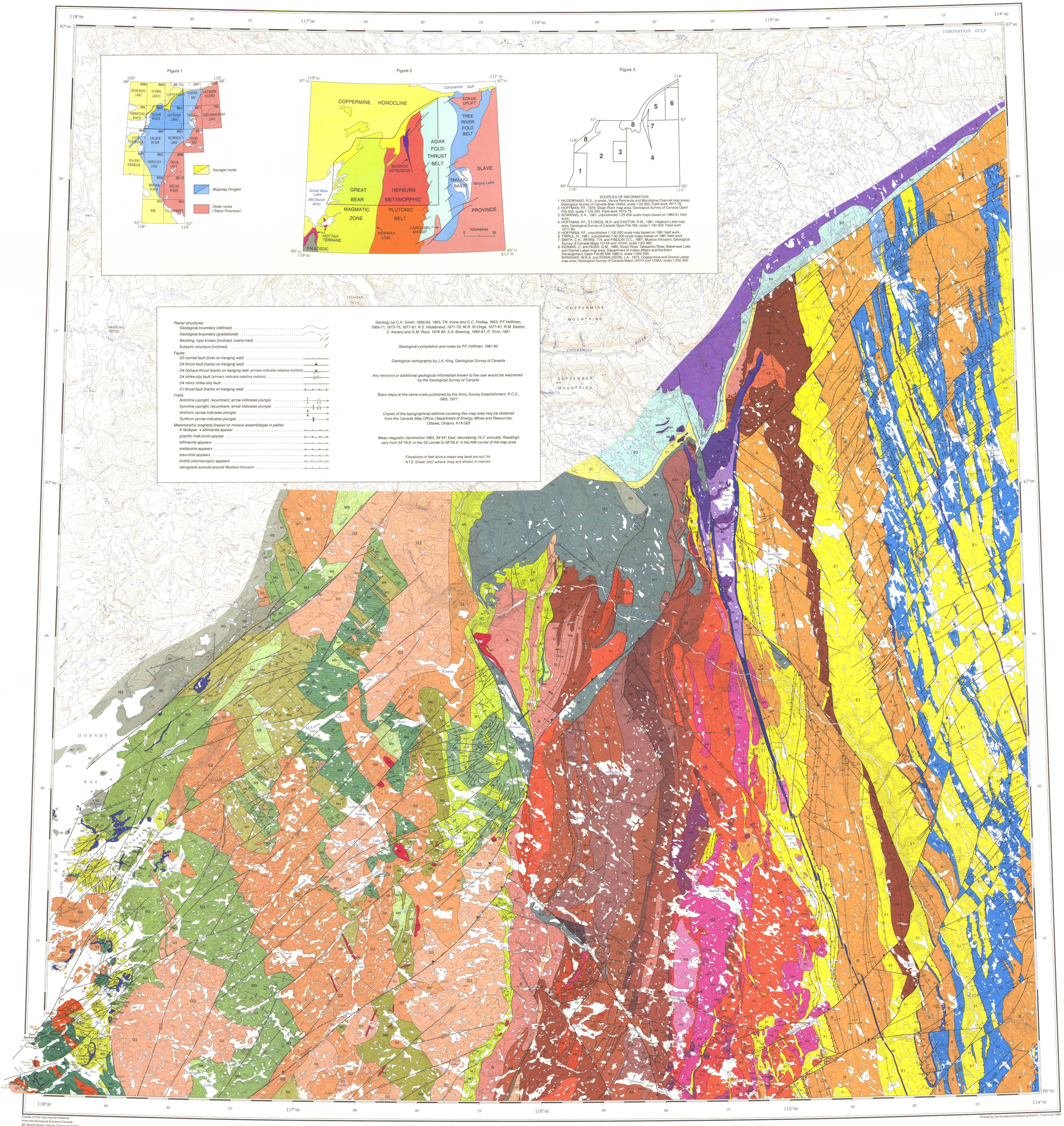
High Grade D4 Crustal Blocks (A1)

A1 — IPIUTAK AND ZEPHYR(?) FORMATIONS: migmatite derived from arkose, semipelite, mafic tuff, metabasalt, metagabbro; minor marble, porphyritic rhyolite

ARCHEAN

Allochthonous Basement (B)

B — Altered hornblende-biotite granodiorite, monzogranite, syenogranite pegmatite



MAP 1576A

GEOLOGY

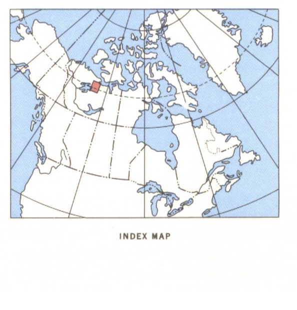
NORTHERN INTERNIDES OF WOPMAY OROGEN

DISTRICT OF MACKENZIE

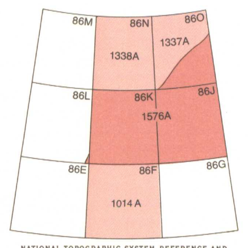
NORTHWEST TERRITORIES

Scale 1:250 000

Universal Transverse Mercator Projection



INDEX MAP



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

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DESCRIPTIVE NOTES

This map was compiled from results of more detailed mapping projects (1:25 000 to 1:125 000 scales) done between 1973 and 1981 in the Early Proterozoic Wopmay Orogen (Fig. 1), on the west side of the Archean Slave Province in the northwest of the Canadian Shield. The area is located about 400 km north of Yellowknife, capital of the Northwest Territories and principal logistical centre for this part of the western Arctic. The Coppermine River is mostly flat water within the map area and affords an excellent cross section of the orogen. The Coppermine River valley, most prominent topographic break in the glacially-scoured bedrock peneplain, was the site of a Quaternary proglacial lake and associated deltas, the deposits of which are being incised by the Recent river system (D.A. St-Onge, 1980). In the valley and a few other places where Quaternary deposits are present, the bedrock geology was interpreted with the assistance of 1:50 000 scale aeromagnetic maps published by the Geological Survey of Canada in 1981. Most of the geology was mapped by ground-level traverses at a spacing of 5 km or less, and interpolated between traverses by airphoto interpretation. The original sources of geological data (Fig. 3) should be consulted for structural data and lithological details not shown on the 1:250 000 scale compilation.

Wopmay Orogen consists of five tectonic zones (Fig. 2), of which the three central ones occur in this map area. Essentially, Zones 2 and 3 comprise the allochthonous shelf and slope-rise facies respectively of a collided continental-margin prism flanking the Slave Province. Zone 4 is a younger Andean-type magmatic arc, and all three zones have been affected by terminal collision to the west (Hoffman, 1980). The syntectonic Hepburn Intrusive Suite provides a minimum age of 1.89 Ga for the first collision, perhaps involving Hottah Terrane, and the succeeding (Great Bear) magmatic arc was active around 1.87 Ga, according to U-Pb zircon studies (Van Schmus and Bowring, 1980).

The continental-margin prism (Coronation Supergroup) accumulated in three tectono-depositional stages, corresponding to the Akaitcho, Epworth and Recluse groups. The Akaitcho Group, limited to Zone 3, is a complex assemblage many kilometres in thickness of submarine arkosic metasediments, tholeiitic metabasalt and subordinate metarhyolite (Easton, 1981), capped in Cloos Nappe by stromatolitic dolomite reefs and forereef talus breccias. The Akaitcho Group accumulated in an active rift zone caused by east-west extension of the Archean granitic basement, now exposed in this map area only at the north end of Muskox Intrusion. The Epworth Group is a sedimentary prism of "passive-margin" type, the 2-km-thick shelf facies of which onlaps the Archean basement in Zone 2 (St-Onge et al., 1982) and correlative continental slope and rise facies overlie the top of the Akaitcho Group in Zone 3. The shelf break, defining the Zone 2-3 boundary, is marked by an abrupt facies change and westward pinchout of the Rocknest Formation, a profusely stromatolitic peritidal dolomite, and a more gradational westward-deepening facies change in the underlying Odjick Formation, which consists of craton-derived clastics. The Recluse Group sharply overlies the Epworth Group and consists of many kilometres of hemipelagic pelite and turbidites of nonvolcanic feldspathic-lithic greywacke, deposited in an eastward migrating foredeep fed axially from the north so that more distal facies occur in Zone 3 and more proximal facies in Zone 2. The foredeep resulted from attempted westward subduction of the margin and consequent collisional foreshortening (D1 deformation) of the marginal prism. A swarm of gabbro sills (not shown at this scale), most numerous near the shelf break, intruded the Epworth and Recluse groups just prior to D1.

The D1 deformation involves east-west shortening, vertical thickening and eastward translation of the Coronation Supergroup relative to the Slave Province (Fig. 2). The very limited extent of basement involvement at the present level of erosion is noteworthy. In most areas, D1 deformation evolved from eastward-directed thrusting to tight upright folding with wavelengths mostly too small to be shown at this scale. In the Akaitcho Group, the thrusts are largely replaced by early eastward-facing recumbent folds which, like the thrusts, have been refolded. The compositionally diverse, in part peraluminous, granitoids of the Hepburn Intrusive Suite were emplaced in Zone 3 as D1 deformation waned, analogous in tectonic setting to the Neogene granitoids of the Himalayas. Isograds, related to prograde thermal metamorphism concentric with the early mesozonal intrusions of the suite (map units H1-H3), crosscut and must postdate the D1 thrusts in Zone 3, but are affected by the upright D1 folds, with which the dominant tectonic lineation in the metamorphic rocks is coaxial. The early intrusions and peripheral highgrade rocks possess a gently inward dipping synplutonic foliation that is superimposed upon and also affected by upright D1 folds. Early D1 folds and associated steeply-dipping cleavage are recumbently refolded in the highgrade rocks about axial surfaces coplanar with the synplutonic foliation. Younger intrusions of the suite (map units H4-H9) are more epizonal in character, more discordant with the regional metamorphic isograds and less strongly foliated. The isograds dip inward beneath Hepburn Batholith, the cluster of plutons medial to Zone 3, indicating a funnel-shaped profile but dip outward east of the truncated batholith on the west margin of the zone (St-Onge, 1981). The D1 foreshortening of the marginal prism and consequent generation, mainly by crustal melting, of the Hepburn Intrusive Suite may have been caused by collision of the Hottah Terrane (Fig. 2) with the Slave Province margin.

A subsequent deformation (D2), mainly developed in the Tree River Foldbelt (Fig. 2) of Zone 1, may be responsible for a broad east-trending structural arch west of Coppermine River at the latitude of Marceau Lake (66° 25′ N). East of the river, it trends northeast toward the basement promontory north of Takijuq Lake (Fig. 2). This transverse arch is documented by the variation along strike in exposed stratigraphic level in Zone 2, the plunge of D1 folds and lineations, the westward deflection of D1 thrust traces in Zone 3, the narrowing of Hepburn Batholith exposing the stem of the plutonic funnel, and the changes in sequence of the "K-feldspar + sillimanite" and "granitic melt-pods" isograds that imply an increase in metamorphic pressure of at least 1 kb across the arch (M.R. St-Onge, in press). The origin of D2 deformation is uncertain but its age must be very close to that of the north-northwest-directed thrust nappes affecting the Great Slave Supergroup in Athapuscow Aulacogen (Hoffman et al., 1977; Hoffman, 1981), which are probably related to a collision in the Churchill Province.

The Great Bear Magmatic Zone developed after the first collision (D1), probably after D2, and consists of folded calc-alkaline volcanic rocks and subordinate continental sediments, little metamorphosed, intruded by epizonal granitoids of which some are comagmatic with, and some younger than, the volcanics (Hoffman and McGlynn, 1977; Hildebrand, 1981). The McTavish Supergroup consists of many overlapping sequences, each several kilometres in thickness, of which only the LaBine, Jaciar, Dumas and Perrault groups have been mapped in detail. The volcanics are dominantly dacite-rhyodacite-rhyolite ignimbrites and related intrusive porphyries, remnants of andesitic stratovolcanoes, and subordinate rhyolite flow-domes and high-Al_2O_3, low-TiO_2 flood basalts. Toward the margins of the magmatic zone, the volcanics are intercalated with sediments derived mainly from volcanic and plutonic rocks within the zone. Although the Dumas Group (map unit M7) is near the top of the overall stratigraphic sequence, which appears to get younger from west to east, it unconformably onlaps allochthonous Archean basement along much of the Zone 3-4 boundary. This important unconformity is well exposed at latitude 66°19′N, just south of the Sloan River crossing. The supergroup is strongly folded about northwest trending axes which, even with the effect of younger (D4) rotations removed, are oblique to the regional north trend of the zone, suggesting a dextral transpressive deformation (D3) of the zone.

The extensive epizonal plutonic rocks of the Great Bear Magmatic Zone are divided into four suites on the basis of lithology and local age relationships. The G1 suite comprises laccoliths that characteristically have lower quartz contents than succeeding intrusions and have strong alteration haloes. The G1 and G2 suites are at least partly synvolcanic, and they are affected by the D3 folds. The G2 granitoids are distinct lithologically from rocks of similar composition in the Hepburn Intrusive Suite by the dominance of hornblende over biotite. The G3 and G4 suites postdate the D3 folding, and have no preserved volcanic equivalents. A swarm of north-northeast-trending rhyolite porphyry dykes converges on the south tip of the G3 granite at Spence Lake, cutting the G2 but not the G3 plutons. Anomalous ductile strain occurring in the southeast corner Zone 4 postdates the G2 plutons but predates the G3 granites and G4 diorites. The McTavish Supergroup and the two oldest plutonic suites are interpreted as products of an Andean-type magmatic arc related to eastward subduction of oceanic lithosphere west of the Hottah Terrane following its collision with the Slave Province. The cessation of calc-alkaline magmatism, onset of D3 transpression, and perhaps consequently the generation of anatectic G3 granites might have been caused by ridge subduction and resulting change in relative plate motion prior to terminal collision.

The last significant compressional deformation (D4), presumably related to terminal collision west of the Hottah Terrane, is manifested by a remarkable system of transcurrent faults and oblique east-vergent thrusts that postdate the G4 intrusions and predate the Cleaver Dykes and probably all of the Hornby Bay Group, basal sequence of the Coppermine Homocline (Fig. 2). The transcurrent faults form a conjugate system of northeast-trending right-slip and northwest-trending left-slip faults. The bulk strain is mainly east-west shortening and north-south extension, with a small clockwise rotation resulting from the predominance of right-slip over left-slip faults, perhaps an "edge effect" of the more rigid Slave Province. The deformation is achieved by counterclockwise rotation of dextral shear fractures and clockwise rotation of sinistral ones, in other words, rotation toward the direction of maximum extension. The effect of these rotations on older structures is well illustrated on the map. The arcuate D4 thrusts may have evolved from major transcurrent faults that became linked by north-south zones of eastward-directed thrusting, localized at boundaries between right-slip and left-slip fault domains. The D4 thrusts west of the Muskox Intrusion and on the Zone 3-4 boundary between Benoit and Perrault lakes may be localized at sinistral "steps" in a dextral fault system extending from the Tilchuse River to the northeast corner of the map area. The thrust zone north of Vaillant Lake in the southeast part of the map area bounds a "quiet" area to the west, lacking transcurrent faults, and an area of extreme fault rotations to the east. The bilobate thrust at Wentzel Lake in the southwest corner of Zone 3 juxtaposes mineral assemblages that differ by at least 3 kb in metamorphic pressure in the Redrock Lake map area (St-Onge et al., 1982). Postorogenic extensional reactivation of the D4 thrusts accounts for the graben-like outliers of Hornby Bay Group sandstone that occur preferentially along the thrust traces. Regionally, the D4 deformation is probably coeval with major transcurrent motion on the sinistral Bathurst and dextral McDonald fault systems, which extend over 500 km into the craton east of the orogen.

The onlapping postorogenic sediments of the Hornby Bay and Dismal Lakes groups are well described by Kerans et al. (1981). The three siliciclastic formations of the Hornby Bay Group were deposited by fluvial systems that flowed to the southeast (Bigbear Formation), southwest (Fault River Formation) and west (Lady Nye Formation) successively. There are regoliths in the basement (Wopmay Orogen) rocks beneath all three systems but by far the deepest is associated with the Fault River Formation. Fossil karst breccias are developed in the Rocknest Formation dolomite beneath the basal surface of the Dismal Lakes Group. The Cleaver Dykes and Western Channel gabbro sheets both postdate D4 faulting, but only the sheets are observed cutting the Hornby Bay Group. One or both might be related to the Narakay Volcanic Complex (Ross, 1982) in the northwest part of Takaatcho River map area (Fig. 1), which occurs stratigraphically in the upper Hornby Bay Group. The Muskox Intrusion is a funnelform layered ultramafic-mafic intrusion exposed obliquely from roof to feeder dyke due to the regional tilt of the Coppermine Homocline (Irvine and Baragar, 1972). Its emplacement is dated stratigraphically by a karst horizon near the top of the Dismal Lakes Group (Kerans, 1982). Scientific drilling and subsequent petrological studies of this intrusion have led to significant new concepts concerning magmatic processes in igneous intrusions (Irvine, 1980).

Extrusion of the thick Coppermine River Group flood basalts was accompanied by extension normal to the Muskox Intrusion and Mackenzie Dykes. This deformation (D5) is manifested in rocks below the lavas by north-northwest-trending normal faults and extensional reactivation of D4 thrusts. The age of faulting is bracketed as post-Muskox Intrusion and pre-Rae Group (Baragar and Donaldson, 1973). The northward 3-7° tilting of Coppermine Homocline (D6) occurred sometime after deposition of the Rae Group, which overlies the Coppermine River Group (Baragar and Donaldson, 1973).

The compiler wishes to acknowledge the exceptional dedication of all those whose mapping is represented here, and the free flow of data and ideas among us. These notes were prepared with the knowledge of a large number of unpublished high-precision U-Pb zircon ages covering most of the igneous suites in the orogen, obtained by Samuel A. Bowring and W.R. Van Schmus at University of Kansas, Lawrence.

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MAP 1576A

NORTHERN INTERNIDES OF WOPMAY OROGEN

DISTRICT OF MACKENZIE

NORTHWEST TERRITORIES

Canada