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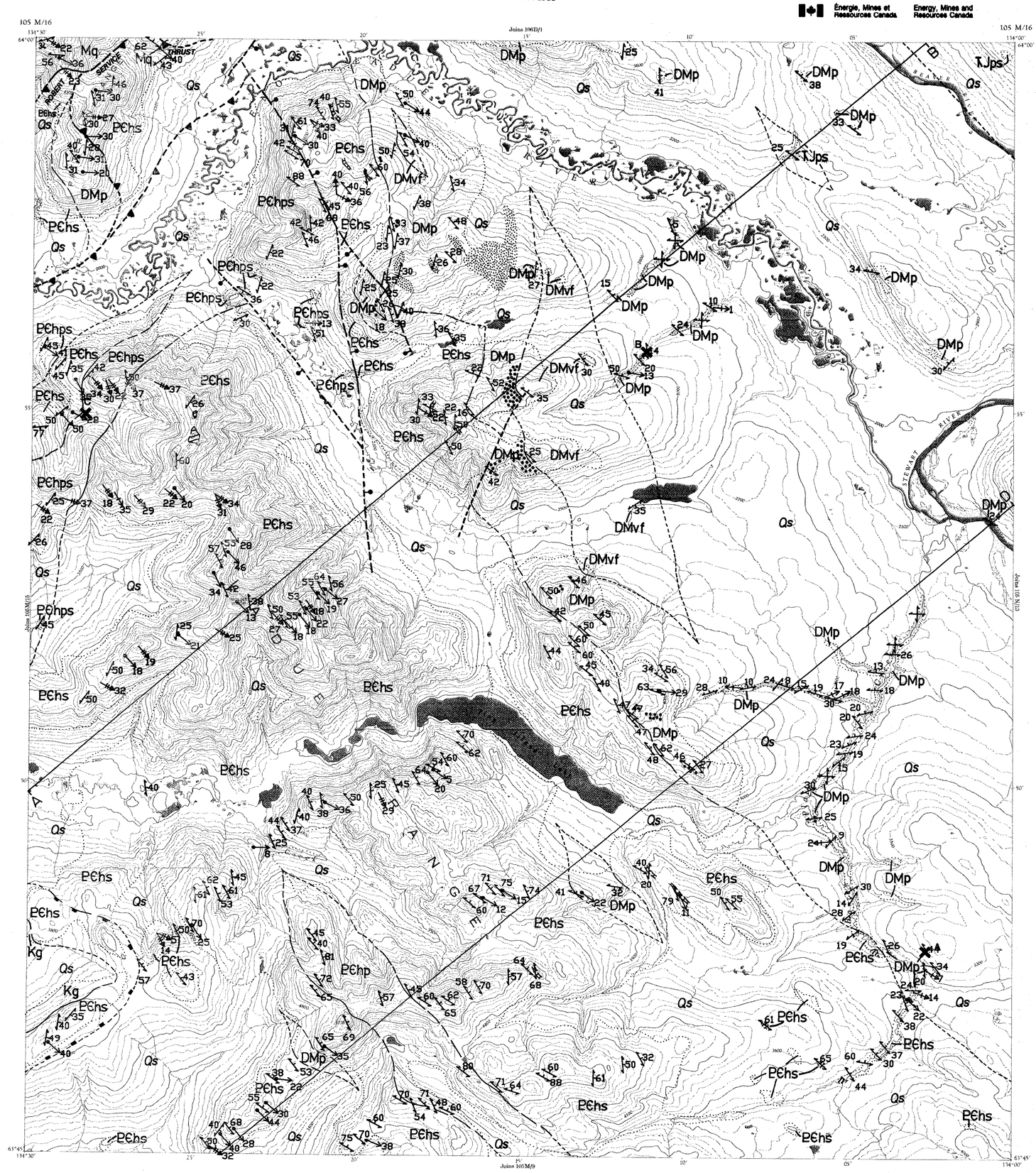

LEGEND
TINY ISLAND LAKE MAP AREA
105M/16

QUATERNARY

Qs — unconsolidated glacial and fluvial deposits; thick vegetation cover

CRETACEOUS

Kg — unfoliated, medium grained, biotite quartz monzonite with scattered alkali feldspar megacrysts up to 2 cm long

TRIASSIC AND(?) JURASSIC

TJps — recessive, buff to grey weathering, calcareous slate, siltstone, and sandstone; dark grey, finely crystalline limestone

MISSISSIPPIAN
(partly equivalent to the Keno Hill Quartzite)

Mq — fine grained, dark grey to black quartzite and interbedded, black, carbonaceous phyllite

UPPER DEVONIAN, MISSISSIPPIAN, AND(?) YOUNGER
(in large part equivalent to the Earn Group)

DMp — dark blue-grey to black weathering, black, locally baritic, siliceous slate and chert; local, fine grained, dark grey to orange weathering, medium to dark grey quartz arenite (stipple pattern); local, pebble to cobble conglomerate with flattened clasts of chert and rare,large, equant cobbles of quartz arenite (circle pattern); local chert sandstone associated with dark brown weathering, medium grey to black slate; local bedded barite

DMvf — dark grey to orange weathering, foliated, aphanitic, dark grey, felsic volcanic rocks and foliated quartz porphyry

UPPER PRECAMBRIAN AND LOWER CAMBRIAN

HYLAND GROUP

PEchs — grey weathering, very fine to coarse grained, variably calcareous, quartz sandstone; pale green to grey phyllite; minor purple and green banded phyllite (in south part of map area); minor white to grey, fine to coarse crystalline limestone and phyllitic limestone (hachured)

PEchp — dark grey-green and minor purple phyllite

PEchps — dark brown weathering, black graphitic slate and minor interbedded, fine grained dark grey quartzite

- limit of outcrop
- geologic contact (defined, approximate, assumed or extrapolated beneath overburden)
- normal fault, ball on downthrown side (defined, approximate, assumed or extrapolated beneath overburden)
- thrust fault, teeth on hangingwall (defined, approximate, assumed or extrapolated beneath overburden)
- limit of hornfels (defined, approximate, assumed or extrapolated beneath overburden)
- cleavage (S1: vertical, horizontal, inclined)
- fold axis, fold of bedding (FA1)
- fold axis, fold of cleavage (FA2)
- stretch lineation, micro-rodding
- A — mineral occurrence

MINERAL OCCURRENCES
(see descriptive notes)

(A) stratiform barite
(B) stratiform quartz-barite-pyrite
(C) stratifrom quartz-barite-pyrite-carbonate

MAGNETIC DECLINATION - 33 DEGREES EAST
ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL
CONTOUR INTERVAL 100 FEET
BASE MAP IS PROVISIONAL, SOME TOPOGRAPHIC NAMES ARE NOT YET OFFICIAL
PRODUCED 1966 BY THE SURVEYS AND MAPPING BRANCH,
DEPARTMENT OF ENERGY, MINES AND RESOURCES

TINY ISLAND LAKE
YUKON TERRITORY

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Miles
Metres 1000 500 0 1000 2000 3000 4000 Metres
Yards 1000 500 0 1000 2000 3000 4000 Yerges

106D/7	106D/8 INAC O.F. 1990-3	106C/5
106D/2 GREEN 1971	106D/1 INAC O.F. 1990-1	106C/4
105M/15 GREEN 1971	105M/16 INAC O.F. 1990-2	105N/13
105M/10	105M/9	105N/12

Indian and Northern Affairs Canada
Exploration and Geological Services Division
Yukon Region

Open File 1990-2

GEOLOGY OF TINY ISLAND LAKE MAP AREA (105M/16)

by

Steve Gordey
Geological Survey of Canada

Sheet 1 of 2

This open file and open files 1990-1 (J.G. Abbott) and 1990-3 (C. Roots) resulted from a cooperative project between Indian and Northern Affairs Canada and the Geological Survey of Canada

This open file supersedes an earlier written report by Gordey (1990).

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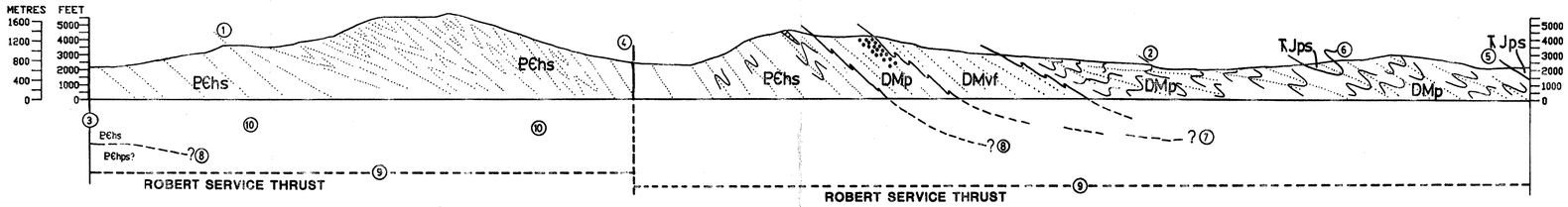
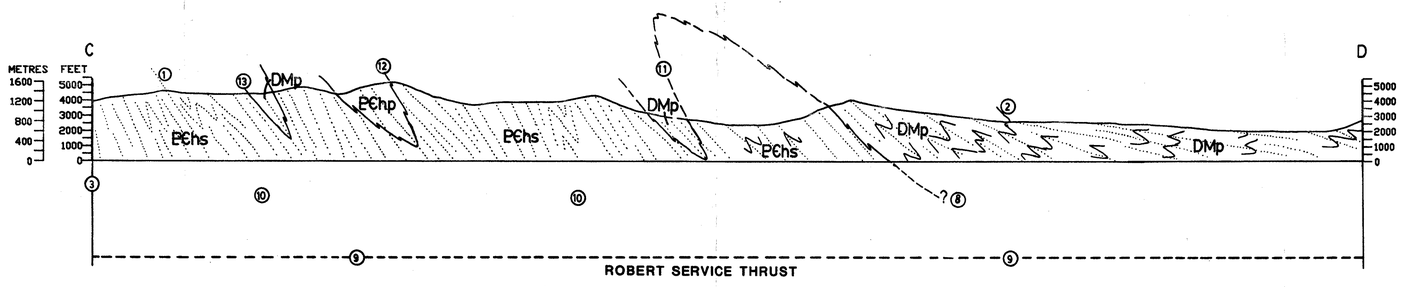
DIAGRAMMATIC CROSS-SECTIONS

(above sea level: scale 1:50,000)
(below sea level: not to scale)



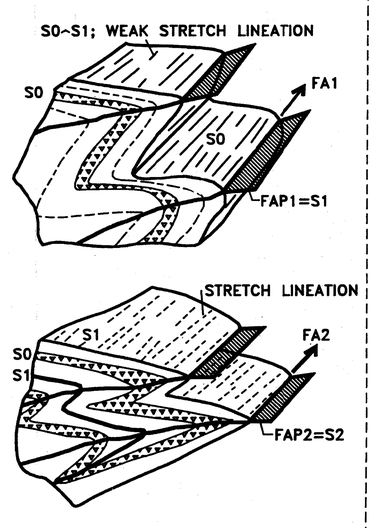


CROSS-SECTION NOTES
(numbers refer to circled numbers on cross-section)

1) Dotted form lines indicate orientation of cleavage (S1). The cleavage is folded by small (and perhaps larger) scale folds.
2) Solid form lines schematically indicate folded bedding. Folds in bedding are rare, but where observed have axial planes parallel with regional cleavage (S1; dotted lines, see note 1).
3) Bottom part of section is not to scale.
4) A steep normal fault with northeast side down may offset the Robert Service Thrust at depth (as indicated). Alternatively this fault could be a splay of the thrust to the hanging wall of the thrust sheet.
5) This is an assumed stratigraphic contact in an area of little exposure. The contact could be a fault.
6) This is an assumed infold of younger strata (as indicated) in an area of little exposure. Alternatively the contacts could be faults.
7) This felsic volcanic unit probably pinches out stratigraphically (and structurally?) in the subsurface.
8) The continuation of these contacts and their disposition relative to the Robert Service Thrust is uncertain (see note 9).
9) The Robert Service Thrust underlies the area at uncertain depth. Its attitude (i.e. flat or dipping), and trace relative to stratigraphy in both the hanging wall and footwall are uncertain. For example, whether the thrust cuts upsection in the hanging wall to the east, and maintains a relatively flat dip (as portrayed) or wheather it remains within the Byland Group and also dips easterly concordant to the foliation and bedding is not known.
10) Structural repetition by thrust faults (splays of the Robert Service Thrust), undocumented because of a lack of marker horizons, could be considerable.
11) Devono-Mississippian strata are presumed to be infolded within the Byland Group, and to join with similar strata to the east via a large anticline as shown. Alternatively, the map pattern could be explained through a combination of thrust faulting and folding.
12) This felsic unit within the Byland Group (PEhp) is assumed to be preserved as an infold within other strata of the group. Alternately, its contacts could be faulted.
13) Devono-Mississippian strata are presumed to be infolded within the Byland Group as indicated. Thrust faulting could also account for the structural repetition.

MESOSCOPIC FOLD STYLES

Diagrammatic sketches of minor fold styles and nomenclature of fabric elements (see " Mesoscopic Fabric Data" and "Descriptive Notes"). Folds are typically less than 2 m in amplitude, but locally amplitudes may be up to 10 m. The dominant fabric within the map area is penetrative cleavage (S1). Stratigraphically and structurally high within the Robert Service thrust sheet this cleavage is unfolded and axial planar to small scale (and? large scale) folds (FA1 = fold axis; FAP1 = fold axial plane) of bedding (S0; figure (a)). At lower structural and stratigraphic levels, the cleavage (S1) is folded by small scale, overturned, tight folds (FA2 = fold axis; FAP2 = fold axial plane) with which is locally developed an axial plane cleavage (S2; figure (b)). A strong stretching lineation coaxial to FA2 is evidenced in hand specimen as a fine rodding; thin section study shows the rodding to be formed by elongate grains and ribbons of quartz. However, this stretching lineation cannot be attributed entirely to strain related to the folding at low structural levels. A weak, coaxial stretching lineation is locally found at higher structural levels where such folds (FA2) are absent. The aforementioned fabric elements are buckled and warped by younger folds (FA3, FAP3 not shown on this diagram; see "Mesoscopic Fabric Data").



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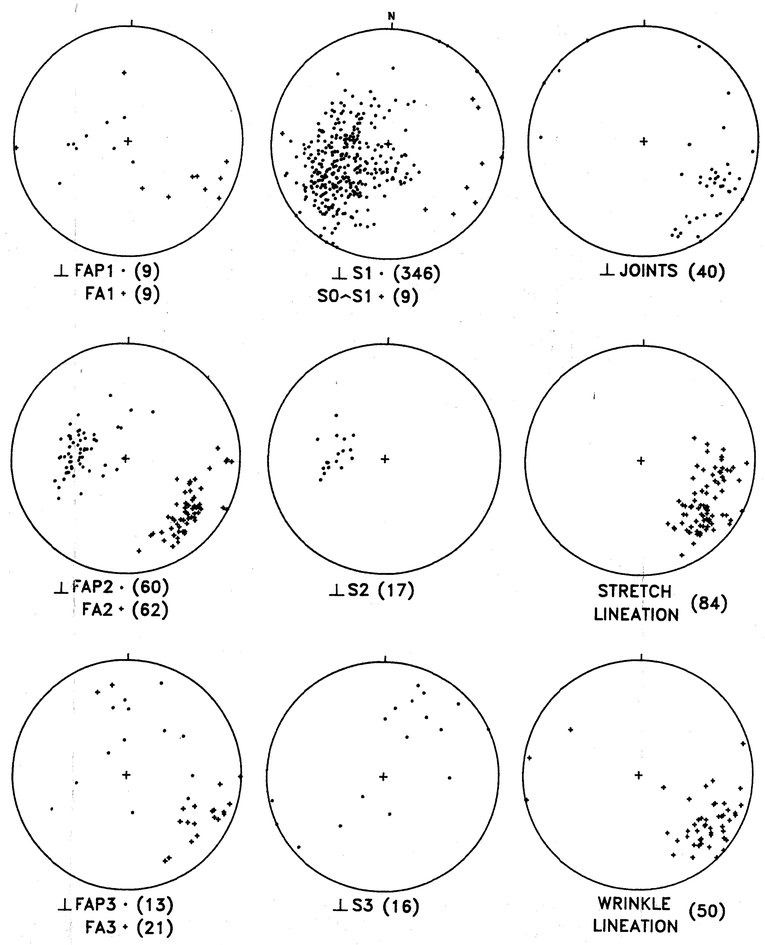
MESOSCOPIC FABRIC DATA

Equal-area stereonet plots of fabric elements. Dots refer to poles to planar elements. Crosses refer to linear elements. The nuabers in brackets refer to the nuaber of measurements. For fabric element notation and discussion see sections on "Mesoscopic Fold Styles" and "Descriptive Notes".



DESCRIPTIVE NOTES

The map area is located 90 km northeast of Mayo, Yukon, about 50 km from the point of nearest road access at Keno City. The only previous geologic work was by Bostock (1948) who mapped this region at 1:250,000 scale as part of his reconnaissance mapping of the larger Mayo map area (NTS 105M). Green (1971) conducted 1:50,000 scale mapping in the Mayo Lake region that adjoins the study area on the west. Adjacent regions to the north and east have been mapped at 1:250,000 scale by Blusson (1974; 105N,106C) and Green (1972; 106D). Concurrent with the present work Abbott (1990a,b; 104D/1) and Roots and Abbott (1990a,b; 106D/7, D/8E1/2) undertook 1:50,000 scale geologic mapping of contiguous map areas to the north (see index map, sheet 1).

Most of the map area lies within the hanging wall of the Robert Service thrust. Strata range in age from late Proterozoic to Triassic and consist dominantly of sandstone, slate, conglomerate, chert, felsic volcanics and minor limestone. Jura-Cretaceous deformation was intense, as exemplified by small-scale, overturned to recumbent folds, and the development of penetrative planar and linear fabric. These obscure bedding and other primary features and render the determination of original stratigraphic thicknesses impossible. The nature of many contacts, i.e. whether faulted or folded is also ambiguous. Metamorphism is of low greenschist facies grade. A small mid-Cretaceous granitic intrusion occurs in the southwest part of the area. No fossil occurrences are known within the map area.

STRATIGRAPHY

The oldest exposed strata are those of the Byland Group (Gordey, in press; "Grit Unit" of Green, 1972) which underlie much of the western part of the area. Two mappable units are recognized. In the northeast, dark brown weathering, black graphitic slate and minor, thin bedded, fine grained, dark grey quartz sandstone (PEhps) form a thick member structurally (and stratigraphically(?)) low within the Byland Group. The upper and more extensive part of the group (PEhs) consists of sandstone, phyllite and minor limestone. Sandstone and phyllite are of equal abundance, the former occurring as beds from less than a centre to up to 20 m thick. The sandstone rangesin grain size from very fine grained to granule mixed and is typically bimodal. Large grains of quartz, commonly blue in colour are surrounded by a fine grained, recrystallized quartzose matrix. Fresh plagioclase and orthoclase constitute less than a few percent. The amount of matrix carbonate is variable; in some beds, sand grains float in a calcareous matrix. The coarsest sandstone occurs at Mt. Roop, where quartz grains range up to 13 mm in diameter. Phyllite is pale green to grey on fresh and weathered surfaces, although dark grey to black varieties occur locally. Distinctive purple and green banded phyllite in intervals from a few to up to 30 metres in structural thickness, are restricted to the south part of the area. In only one area can a thick band of phyllite be separately mapped (PEhp). Relatively pure limestone is rare within the Byland Group. Members range from less than a metre to as much as 50 m thick and consist of white to grey, fine to coarse crystalline limestone. The lack of continuity and erratic distribution of the limestone may result from structural disruption.

Gritty quartrose sandstone and slate of the Byland Group are widespread in central Yukon. Based on regional correlation, a Late Proterozoic - earliest Cambrian age for these strata in the Tiny Island Lake area is likely (Fritz et al, 1983). The member of black graphitic slate corresponds to the "Upper Schist Division" mapped by Green (1971) in the Mayo Lake area to the west.

Overlying the Byland Group is a succession dominated by dark bluish-grey to light grey weathering, jet-black siliceous slate and chert, within which are members of quartite, chert conglomerate and chert sandstone (DMp). The quartzite is fine grained, dark grey to orange weathering, and medius to dark gray on fresh surface. It forms massive unfoliated members, typically less than 30 m thick but locally thicker, whose contacts with the enclosing slate are sharp. Members of chert pebble conglomerate are found near the base of the succession and are up to 40(?) metres in thickness. The conglomerate consists of flattened clasts of dark grey to black chert(?) and argillite to 10 centimeters in width and less than a centimetre thick. Large, undeformed, equant, well rounded scattered clasts of fine grained quartz sandstone, up to 15 cm across, make up to 10 percent of the rock. Not typically associated with the conglomerate, members of chert sandstone occur locally in association with dark brown weathering, medium grey to black slate. The black slate and chert, the chert-bearing clastic rocks and occurrences of barite (described below), are typical of the Earn Group, a regionally extensive unit of Late Devonian and earliest Mississippian age (Gordey et al, 1982; Gordey, 1988). The quartzite members may correlate with mid- to late Mississippian quartzite (e.g. Keno Hill Quartzite) that is also widespread in central Yukon (Green, 1971; Tempelman-Kluit, 1970).

A large unconformity is suspected below the black siliceous slate unit (DMp) and above the Byland Group. Chert and argillite of Cambrian to mid-Devonian age that are diagnostic of this interval elsewhere in the region are absent along the contact. The large quarzite clasts within the conglomerate of the upper unit (DMp) resemble quartzite of the Byland Group, from which they were likely eroded. Chert and argillite clasts in the conglomerate may derive from the now-missing lower Paleozoic stratigraphy. Unfortunately, the angular relationship of bedding below and above the unconformity are obscured by deformation. The contact may be an angular unconformity or disconformity, but critical data are lacking.

Orange weathering felsic volcanic rocks form a thick, homogeneous unit (DMvf) within black siliceous slate (DMp) southwest of Keno Hudse River. Whether they form a single depositional lens, or are internally structurally repeated is unclear. A strong foliation obscures their volcanic nature and imparts the false appearance of shistose quartz sandstone. This section examination however reveals volcanic textures for the quartz such as large monocrystalline grains, wi-pixserved euhedral grain boundaries and embayment textures. The rocks are composed of up to 20% quartz and minor feldspar phenocrysts up to 2 mm across in a recrystallised fine-grained matrix. The strong foliation is defined by seams of white mica. In some specimens phenocrysts are rare. Whether the rocks include felsic flows, tuffs or both is uncertain. A Late Devonian or Mississippian age for the volcanics is assused based on the most likely age of enclosing strata (DMp).

The youngest(?) strata within the map area comprise dark brown to light grey weathering slate, siltstone, and dark grey finely crystalline limestone (KJps). These occur as rare, small infolds(?) within the Devono-Mississippian slate and also underlie the northeast corner of the map area. A Triassic and (?)Jurassic age is likely because shale, siltstone, and limestone like that of this unit typify Upper Triassic strata elsewhere in central Yukon (Gordey and Irvin, 1987).

The succession in the footwall of the Robert Service thrust, in the northwest corner of the map area, is dominated by fine grained, dark grey to black quartzite, and interbedded black, carbonaceous phyllite (Mq). The quartzite occurs in beds from a few centimetres thick to units more than 20 metres thick and ranges from clean to impure. The thicker units are typically massive, fine grained, clean quartzite that may have a parting ranging from 10 to several metres in thickness. These quartzites differ from those in the hanging wall of the Robert Service thrust (DMp) in having more intimately admixed pelite. This unit (Mq) has been mapped regionally as the Keno Hill Quartzite (Green, 1971), and traced westard from the Mayo area nearly to Dawson, Yukon. Conodonts recently recovered from the Keno Hill Quartzite near Dawson indicate a Mississippian (late Visean) age (Orchard, pers. comm. 1989; see also Abbott 1990a,b).

INTRUSIVE ROCKS

In the southwest corner of the map area a small body of unfoliated, medium grained, quartz monzonite intrudes the Byland Group. Fresh biotite is the chief mafic mineral and makes up about 10 percent of the rock. Hornblende occurs rarely as coarse chloritized grains. Scattered alkali feldspar megacrysts to 2 centimetres in diameter consitute less than five percent. Surrounding the intrusion is andalusite-bearing hornfels up to five hundred metres in width. This pluton is part of the mid-Cretaceous Selwyn Plutonic Suite which is composed of numerous plutons of similar type, many of which have yielded mid-Cretaceous ages (Anderson, 1983).

The only other intrusive rocks in the area include rare sills, the thickest 60 m across, of altered fine to coarse grained pyroxene gabbro. Their age is uncertain although the strongly foliated margins of these bodies indicate emplacement before Jura-Cretaceous regional deformation. In Tiny Island Lake map area, they were only observed within strata of the Byland Group. However, to the north abundant and correlative(?) greenstone bodies of Triassic age include the Mississippian Keno Hill quartzite (Green, 1971; Abbott, 1990a).

STRUCTURE

Most of the Tiny Island Lake area lies in the immediate hanging wall of one of the largest thrust sheets in the Cordilléra, the Robert Service thrust, that transects the northwestern part of the map area. This fault can be traced westward 200 km towards Dawson, Yukon. Its easterly and southerly continuation are uncertain. Along its length it places Late Proterozoic - Cambrian strata of the Byland Group against the Mississippian Keno Hill quartzite. In the Tiny Island Lake area, the intensity of deformation increases structurally and stratigraphically downward towards the trace of the Robert Service thrust. Mesoscopic folds typically have amplitudes less than 2 m but in places they range up to 10 m in amplitude. Larger folds may be present, but their recognition is hindered by poor exposure and lack of marker horizons.

At high structural levels in the east and south part of the area the dominant fabric is a moderate dipping penetrative cleavage (S1; see stereonet and fold diagrams). Rarely, portions of limbs of large overturned folds in bedding are observed whose axial planes are concordant to this fabric. Rare measured fold axes (FA1) and cleavage-bedding intersection lineations (30°S1) plunge shallowly to the east and east-southeast.

At lower structural levels and best displayed in Byland Group strata northwest of Mount Roop, deformation is more complex and additional fabric elements are developed. Gently southeast-plunging overturned folds (FA2, FAP2) that fold the aforementioned cleavage (and beddings) are ubiquitous. Interlimb angles generally range between 60 and 90 degrees. Axial planes (FAP2) generally trend northerly and dip shallovly or moderately to the east. A locally developed axial planar cleavage (S2) crosscuts the pre-existing cleavage (S1) and bedding. Lower structural levels are also characterised by an east to southeast plunging rodding or stretching lineation (see stereonets). It is best displayed in competent strata such as coarse gritty sandstone of the Byland Group, and in spectacular stretched conglomerate (unit DMp) in the northwest corner of the map area. However, this lineation also persists into higher structural levels where refolding (i.e. FA2) is not obvious, so it cannot be assigned with certainty to only that fold style. The fabric of Devono-Mississippian conglomerate in the east part of the map area, although chiefly a result of flattening, does locally display a coaxial stretching lineation.

Superimposed on all of the above fabric elements are broad upright buckles and local, tight, upright, or northeast verging folds (FA3, FAP3). An axial planar crenulation cleavage is locally developed (S3). Although broadly coaxial with the fold axes and stretching lineation described above, the folds deform, and therefore postdate, these older structures. Phyllitic and shaly strata throughout the area display southeast plunging wrinkle lineations (see stereonets). These in part, reflect this latest deformation, but some could be related to the earlier folding. In many cases the coaxial nature of the deformation does not permit a distinction to be confidently made. Locally, steeply dipping, northeast-trending AC-type joints are well-developed (see stereonets).

North to northwest trending normal faults of large stratigraphic throw offset map-unit contacts in the northwest part of the area. Their traces relative to topography indicate near vertical dips. The southeast extent of these faults may be greater than portrayed but there are no markers within Byland Group strata with which to gauge offset. Whether these faults represent tear faults confined to the Robert Service sheet, or whether they cut through the sheet (see cross-sections) and extend northward into the adjacent area is uncertain.

The southeast-plunging stretching lineations and coaxial overturned folds in the hanging wall of the Robert Service thrust reflect ductile deformation during low-grade metamorphism. The trend of the lineation may indicate northwest transport of the thrust sheet during the formation of these fabrics. Alternatively, it may represent fold-parallel extension that is orthogonal to generally northeast directed contraction. The intensity of strain diminished upward within the thrust sheet, leading to concurrent(?) development of the simple: fold geometry, with the same extension direction, at higher levels. The late folds reflect minor amounts of north(?) directed shortening related to final emplacement of the sheet or to post-emplacement shortening. The northwest transport direction that might be inferred from the stretching lineation differs from the north to northeast transport assumed from the general shortening direction of the Cordilleran thrust and fold belt.

The annotated cross-sections identify large scale structural problems in the map area. The most significant is the unknown trajectory and depth of the Robert Service thrust. In addition, the cause of juxtaposition of different lithologies of the Byland Group (PEhs, PEhps) in the northwest part of the area is uncertain. A thrust fault along Keno-Ladue valley is assumed to separate unit PEhps from strata to the north. The "lens" of unit PEhs within unit PEhps is shown with unfaulted contacts, although thrust repetition could account for this geometry.

METAMORPHISM

The rocks in the area have undergone chlorite grade greenschist facies metamorphism, as indicated by minerals defining cleavage. Cleavage in Byland Group sandstone, the felsic volcanics and locally chert conglomerate, is defined by fine to medium grained muscovite and chlorite that wraps around primary mineral grains and lends the rock a slightly phyllitic appearance. In originally fine grained strata, the micas are very fine grained and cleavage surfaces are smooth and phyllitic. Deformation and metamorphism were probably synchronous because the metamorphic micas are deformed, and because formation of a stretching lineation and local stretched conglomerate indicate ductile deformation mechanisms that require elevated temperature.

Quartz veins, the products of metamorphic fluids and accompanying strain, are ubiquitous at lower structural levels in the Robert Service thrust sheet and diminish in abundance upwards. They are typically a few centimetres or less in width, although pods of bull quartz up to 10-15 cm across are not uncommon. They vary in deformation style from planar and crosscutting to tightly folded, indicating they were likely emplaced during deformation.

GUIDE TO MINERAL EXPLORATION

The eastern part of the map area has high mineral potential. However, it has seen surprisingly little exploration and no occurrences were known previous to this work. Strata which underlie this area (DMp) largely correlate with the Earn Group which elsewhere in the northern Cordillera hosts significant stratiform lead-zinc-silver-barite occurrences (Tom, Jason at Macmillan Pass (see Bailes et al, 1986; McClay and Bidwell, 1986)). The felsic volcanics (DMvf) provide a target for volcanogenic massive sulphide mineralization. Mineralization at the Marg property, although in the footwall of the Robert Service thrust (in area 106D1, just north of the Tiny Island Lake area), is hosted in Mississippian felsic volcanics (Turner and Abbott, 1990). The volcanogenic massive sulphide MM deposit in the Pelly Mountains, Yukon is also hosted in felsic volcanics of Mississippian age (Mortensen and Godwin, 1982). Regional geochemical reconnaissance (Hornbrooke and Friske, 1988) has outlined coincident stream sediment anomalies for antimony, mercury, zinc, barium, cadmium, copper and silver in this area. Two occurrences of stratiform barite, discovered during the present work, indicate Devono-Mississippian(?) hydrothermal activity (see below). Exploration should not be confined to the present map area; although not known in detail, this belt of economically significant strata extends southeasterly into Lansing (105M) map area (Blusson, 1974, unit Pz).

Byland Group strata do not hold as much exploration promise as the Devono-Mississippian succession. They are relatively barren of significant mineral occurrences elsewhere in central Yukon, and stream sediment geochemical anomalies for most elements are singularly lacking (see Hornbrook and Friske, 1988). Three mineral occurrences were found during the present work. Occurrence (A) (within unit DMp) consists of relatively pure laminated barite at least 4 m thick that extends along strike at least 100 m. Lack of exposure prevents delimiting its top, base or lateral extent. No associated sulphides were observed. At occurrence (B), country rock of black siliceous slate (DMp) grades sharply upward to pyritic chloritic phyllite, about 2 m thick, which in turn grades sharply upward to at least 2-3 metres of rock composed of barite-quartz-pyrite. The lateral and vertical extent of this baritic horizon are not exposed in outcrop. At occurrence (C), a folded, fine grained rock consisting of quartz, barite, pyrite, and carbonate occurs as a lens about 3 metres thick and at least 25 metres long within black, graphitic slate of the Byland Group (PEhps). Pyrite occurs as disseminated grains and in laminae up to one centimetre thick in the upper 10 cm of the horizon. Other sulphide minerals were not noted.

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Indian and Northern Affairs Canada
Exploration and Geological Services Division
Yukon Region

Open File 1990-2

GEOLOGY OF TINY ISLAND LAKE MAP AREA (105M/16)

by

Steve Gordey
Geological Survey of Canada

Sheet 2 of 2

SCALE 1:50,000 ÉCHELLE

Miles 1 | 0 | 1 | 2 | 3 Miles
Metres 1000 | 500 | 0 | 1000 | 2000 | 3000 | 4000 Mètres
Yards 1000 | 500 | 0 | 1000 | 2000 | 3000 | 4000 Yards

(SCALE FOR CROSS-SECTION)

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