DESCRIPTIVE NOTES

PREVIOUS GEOLOGICAL MAPPING

The area was last mapped by Folinsbee (1949; GSC 1:250,000 scale map #977A). There has been no systematic regional mapping in the eastern half of the Lac de Gras sheet since then.

DESCRIPTION OF MAP UNITS

All map units recognized are either Archean metasedimentary and granitoid rocks or younger intrusives (diabase, kimberlite). There is no evidence of basement to the above-mentioned units in the map area. Lithologic units in the map legend are described below in inferred stratigraphic order.

Metasedimentary rocks

Greywacke

Green-brown to rusty brown weathering metagreywacke outcrops throughout the map area. Rocks of this unit are dominantly thin-bedded (1 - 10 cm beds), although thicker beds (to 1 metre) occur. The metagreywackes consist of massive psammitic beds and graded psammite - pelite sequences. Bedding is preserved in porphyroblastic schists, but is less common in migmatitic greywackes. Migmatite occurs only in smaller rafts and panels (N.B. panel is a non-genetic term to describe narrow outcrops of greywacke which extend along-strike) of greywacke within hornblende + biotite tonalites north of Eagle lake.

Granitoid intrusive rocks

Hornblende + biotite quartz diorite

A large, homogeneous pluton of equigranular, medium-grained quartz diorite occurs at the western margin of the map sheet. Preliminary petrographic studies illustrate that mineral assemblages consist principally of plagioclase + biotite + hornblende + quartz ± epidote. The biotite and epidote are thought to be of magmatic origin. Inclusions of microdiorite cognate xenoliths are rare or absent in this body. This pluton is weakly deformed, with poor to non-existent foliation development.

Hornblende + biotite tonalite

East of the quartz diorite pluton, an extensive body of deformed tonalite crops out north of Eagle lake . The hornblende + biotite tonalites are distinguished in the field from the quartz diorites on the basis of lower modal hornblende, higher quartz + biotite contents and the presence of minor K-feldspar. Thin (10 cm - 10 m scale) greywacke septae of variable length (10's - 100's of m) commonly occur in this body; good examples are found along the north shore of Eagle lake and also in association with the NW/SE trending greywacke panels at the northwest margin of the map area. The small, isolated outcrops of hornblende tonalite northeast of Paul Lake are also strongly foliated. This unit typically contains hornblende-rich microdiorite enclaves. The enclaves are boudinaged, with long axes lying parallel to S_1.

Biotite tonalite

These rocks are light brown to white weathering, medium-grained and have weak to strong foliations (and are locally lineated). The biotite tonalite is distinguished in the field from hornblende + biotite tonalite on the basis of hornblende-absent assemblages and a lower colour index. Rocks of this unit are observed to intrude the metagreywackes.

Two mica granite

A distinctive white to light grey weathered surface and abundant primary muscovite characterizes these granites. Rocks typically consist of equal proportions of quartz, plagioclase and K-feldspar, with 5 - 10% of both muscovite and biotite. Aquamarine apatite and tourmaline are common accessories. Garnet, cordierite and sillimanite are also observed, but the latter is invariably found only in association with greywacke inclusions. These granites are fine- to coarse-grained and generally equigranular, but occasionally are weakly porphyritic. A very coarse-grained, K-feldspar-rich, tourmaline-bearing pegmatitic phase forms dykes and small stocks up to 250 m in diameter. These pegmatites are widespread in the map area and occur both internal and external to the two mica granite plutons. The two mica granite is observed to intrude greywacke and both tonalite units.

Porphyritic biotite granite

Light red to pinkish-white weathering, medium- to coarse-grained, K-feldspar porphyritic granite forms a distinctive pluton in the northeast part of the map sheet. K-feldspar phenocrysts range from 1-3 cm in length and display a preferred orientation. Rocks consist of 5-10% biotite, with primary muscovite usually absent, or present only in trace amounts (<1%). One large body (consisting of recognizable multiple intrusives) of this unit is found in the region of the Coppermine River and east of Duchess Lake.

Lack of penetrative deformation is consistent with these rocks being emplaced after the main regional metamorphism and deformational event(s).

Diabase dykes

Diabase dykes, ranging in width from 15 to 100 metres are common in the area, and post-date granite intrusion. The dykes are distinguished on the basis of orientation, and are correlated with known dyke swarms in the Slave Province (Fahrig and West, 1986). Four (and possibly five) dyke swarms are represented; all are interpreted to be of Proterozoic age.

McKay (080°)

A single MacKay dyke, 50 metres wide and trending approximately 080°, is exposed intermittently across the central part of the map sheet. An estimated age of 2.4 Ga (K/Ar whole-rock; Fahrig and West, 1986) for this swarm suggests it is the oldest dyke in the map area.

Contwoyto (045°)

Three Contwoyto dykes, 20 - 40 m wide and trending approximately 045° were noted in the map area. Preliminary U-Pb baddeleyite studies yield an age of 2.23 Ga (A. LeCheminant and O. van Breemen, pers. comm.)

Lac de Gras (190°)

Three Lac de Gras dykes, 35 - 60 m wide, trending approximately 190°, outcrop intermittently in the map area. These dykes are easily distinguished by their well-developed ophitic texture. The Lac de Gras dykes are observed in the field to cut Contwoyto dykes. Preliminary U-Pb baddeleyite studies yield an age of 2.03 Ga (A. LeCheminant and O. van Breemen, pers. comm.).

Mackenzie (335°)

Six dykes of the Mackenzie swarm, with trends of 330° - 340° and up to 100 m wide, occur in the map area. Cross-cutting relationships observed in the field suggest the Mackenzie dykes are younger than the Lac de Gras, Contwoyto and MacKay dykes, consistent with their U-Pb baddeleyite age of 1.27 Ga (LeCheminant and Heaman, 1989).

`305'

Thin dykes, 15 - 20 metres wide, trending 300° to 310° can be traced intermittently over a distance of 25 km in the northeast part of the map sheet. The age of this dyke is unknown and its relationship to the other swarms (specifically the Mackenzie) is equivocal.

Kimberlite

Several kimberlite pipes occur in the area. The `Point Lake' pipe is shown on the map; exact locations of other pipes remain proprietary information at this time. A Rb/Sr three point isochron yielded an Eocene age of 52 ± 1.2 Ma (Northern Miner, 1993), however the exact location of the specific kimberlite dated (other than being in the Dia Met/BHP claim block) is unknown. Kimberlite-derived mudstones with Cretaceous to Paleocene dinoflagellate, pollen and spores (Northern Miner, 1993) potentially suggest two periods of kimberlite emplacement. The observation that kimberlites in the Lac de Gras area have either a positive or a negative remnant magnetic polarity (Buckle, 1992) is consistent with two periods of kimberlite emplacement.

ARCHEAN INTRUSIVE RELATIONSHIPS & AGE CORRELATIVES

U-Pb geochronology is presently not available for Archean rocks in the Paul Lake map sheet. Relative ages (based on intrusive relationships) are suggested to be metagreywacke > quartz diorite > ≈ hornblende + biotite tonalite > biotite tonalite > two mica granite ≈ porphyritic biotite granite. On the basis of mineralogy, preliminary geochemistry and relative degree of deformation, all granitoid rocks in the map area are considered correlatives of the `younger Slave granitoid suite' (King et al., 1992), intruded at ca. 2625 - 2580 Ma (van Breemen et al., 1992). Further details and tentative correlations can be found in Kjarsgaard and Wyllie (in press). The metagreywackes in the map area are typical of the metasedimentary rocks of the Yellowknife Supergroup (Henderson, 1970).

STRUCTURAL GEOLOGY

Fabric elements

Fabric elements measured in the field are summarized as follows and described more completely below:

S_0 is primary compositional layering in metagreywacke. It is defined by textural and mineralogical variation at the outcrop scale.

S_1 is the dominant regional cleavage, generally oriented parallel or sub-parallel to S_0 in the metagreywackes.

S_2 is a locally observed, symmetric crenulation cleavage.

F_1 folds are isoclinal. Frequent changes in younging direction of S_0 are observed at the mesoscale and S_1 verges both clockwise and counter-clockwise. Fold closures are not observed due to pervasive lichen cover and shoreline exposures that parallel the regional strike of S_0.

F_2 is a steeply plunging open fold with limbs that extend beyond the limits of the map area, and a wavelength of >20 km. The crenulation cleavage (S_2) is believed to be genetically related to F_2 folding, as it lies parallel to the axial trace.

Structural development

The deformation history of the Paul Lake sheet is polyphase. Tectonic fabrics exhibit varying degrees of development and heterogeneity. S_0 is dominantly steeply dipping, becoming moderate in the F_2 hinge zone. The main cleavage (S_1) is associated with cryptic isoclinal folds (F_1) in metagreywacke. S_1 forms a discrete, spaced cleavage in metagreywackes and is oriented sub-parallel to S_0.

Large, idioblastic porphyroblasts, wrapped by S_1 suggests that D_1 deformation is preceded by static porphyroblastesis of cordierite, andalusite, staurolite and biotite. These porphyroblasts contain straight inclusion trails, suggesting a relict cleavage related to either a previous, but unrecognized folding event, or the early stages of S_1 fabric development. A more locally developed crenulation cleavage (S_2) appears to be genetically related to the large, open fold (F_2) in the map area.

Moderately-dipping stretching lineations trending approximately 020°, C and S fabric in granitoids, local transposition of S_1 and the presence of sheath folds suggest the development of localized high strain zones in the limbs of the F_2 fold. Further evidence can be found in folded pegmatite veinlets, bedding-parallel shearing and localized ramping of greywackes. Strain partitioning is only observed within the greywackes, close to rheological interfaces with syn-kinematic granitoids.

F_2 Geometry

The main greywacke outcrops lie in a folded belt (F_2). This greywacke belt parallels the northwest arm of Lac de Sauvage, passes through the closure and follows the long axis of Paul Lake. In the Lac du Sauvage limb, the dominant bedding orientation is about 135°/70°. In the Paul Lake limb, it is 255°/75°. Bedding orientations between Lac du Savage and Paul Lake are consistent with ductile folding. The statistical mean fold axis for S_0 trends 008° and plunges 70°. Discontinuous biotite tonalite outcrops of variable size are also found following the trend of the F_2 fold (in the lineament along the northwest arm of Lac du Sauvage and between Paul Lake and Eagle lake). The biotite tonalite outcrops are inferred to have formed a continuous unit before intusion of two mica granite.

Zones of high strain

Three areas of high strain (Paul Lake; north shore Eagle lake; northwest arm Lac du Sauvage) are evident from field and structural studies. All occur within or adjacent to areas of metagreywacke outcrop and regional lineaments, but are also observed in the adjacent tonalites.

One, and possibly two generations of high strain structures are observed in the limbs of the regional F_2 fold. The two high strain zones (HSZ) in the northwest part of the map sheet at Eagle lake and Paul Lake, appear to have an overprinting relationship to one another. The Paul Lake HSZ is associated with transposition of S_1 and development of sheath folds, oriented sub-parallel to the long axis of Paul Lake. The Eagle Lake HSZ is is oriented parallel to an asymmetric crenulation cleavage that cuts the sheath folds in the Paul Lake area. The zone itself has a consistent stretching lineation (defined by hb + plag + qtz) oriented at about 020°/60°. The regional significance of the overprinting fabric is currently equivocal in the absence of solid kinematic evidence to link the crenulation cleavage with the Eagle lake HSZ.

A third high strain zone lies in the northwest arm of Lac du Sauvage. It is indicated by progressive strain of porphyroblasts, development of C and S fabrics and shear bands in rocks adjacent to the lineament. Ramping of S_0 and folding of pegmatite veinlets in greywackes are consistent with dextral kinematics.

METAMORPHISM

In pelitic rocks, there is a subtle variation in mineral assemblages suggesting that metamorphic grade increases slightly northward. Porphyroblasts of biotite, cordierite and andalusite (var. chiastolite) are ubiquitous in pelitic layers. Garnet occurrence is variable, but its restriction to narrow, bedding-parallel zones, suggests its occurrence is a function of bulk composition, rather than metamorphic grade. Sillimanite (var. fibrolite) is common throughout the region (typically overgrowing the porphyroblasts), as are occasional blades of accicular sillimanite. Metagreywackes are generally sillimanite-bearing in the main contact zones with granitic rocks, whereas those found in narrow panels within tonalite tend to be sillimanite-absent and migmatitic in character. The metamorphic assemblages observed in the greywackes are similar to those observed in other areas of the Slave Province (Thompson, 1978) and are consistent with low-P, high-T metamorphism.

ECONOMIC GEOLOGY

Numerous (> 50) kimberlites have recently been discovered in the Lac de Gras area of the central Slave Province, many diamondiferous. In 76D/9, the `Point Lake' pipe has been bulk sampled, with 101 carats recovered from a 160 tonne sample (grade = 63 c/100t); approximately 25% of the stones are of gem quality, with a few of the stones in the 1 - 3 carat range (BHP/DiaMet press release, June 1992).

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ACKNOWLEDGEMENTS

The following are thanked for their assistance. Bedrock mapping, S. Alvarado (1993) K. Buchan, T. LeCheminant, T. Peterson, P. Orr, T. Sagriff (1992). Fieldlog and AutoCad consultation, digitizing assistance, K. Baker, P.Arscott and B. Brodaric, CGD. Digital output using ARC/INFO software, Vic Dohar, Cartography Unit, GICD.