PREVIOUS MAPPING

The area (NTS 76D/16, Ursula Lake) lies in the central part of the Slave structural province, 315 km NNE of Yellowknife. Folinsbee (1949) previously mapped the area on a regional scale in the 1940's (GSC 1" to 4 mile scale map #977A).

DESCRIPTION OF MAP UNITS

All map units recognized are either Archean metasedimentary and granitoid rocks or younger intrusives (diabase, kimberlite). The central part of 76D/16 is dominated by plutons of porphyritic biotite granite and two mica granite, with minor occurences of biotite granodiorite/hornblende-biotite tonalite. The geology of the southwest corner and top portion of the map area is geologically more complex. These regions consist of greywackes of variable grade (biotite spotted slates/phyllites, cordierite + andalusite schists, sillimanite schists and migmatite) plus belts or bodies of biotite granodiorite/ hornblende-biotite tonalite, hornblende-biotite tonalite and diorite/quartz diorite plus porphyritic biotite and two mica granites. Lithologic units in the map legend are described below in inferred stratigraphic order.

Metasedimentary rocks (Agw)

The oldest recognized rocks are metamorphosed sediments ('greywackes' consisting of interbedded psammite/pelite) are present in the map area. Grey-green weathering, graded psammite - pelite assemblages of low metamorphic grade (spotted slates and phyllites) occur to the south of Ursula Lake. Thin, bedding parallel-quartz veins are common, as are quartz net veins; the rocks in general are relatively silicified. Outcrops of banded ironformation (garnet - amphibole - pyrrhotite - arsenopyrite assemblages) were observed in this area. In the extreme southwest corner of the map, the greywackes are at sillimanite grade, possibly a contact metamorphic effect related to the combined effects of the quartz diorite/hornblende-biotite tonalite pluton to the south (in the Paul Lake sheet) and the adjacent hornblende-biotite tonalite body in 76D/16. The greywackes in the southwest part of 76D/16 are dominantly thinly bedded, and combined with the occurrence of BIF and other features observed within the same belt along strike in 76D/10 (e.g. graphite-bearing metasediments) are tentatively correlated with the Contwoyto Formation (as defined by Bostock, 1980).

In contrast, green-brown to rusty brown weathering pelite/psammite assemblages in the greywacke belt in the northern part of the map area consist of cordierite + andalusite grade schist/ psammite, sillimanite grade schist/psammite and migmatite (metatexite). These greywackes are dominantly thickly bedded and characteristically contain mats of fibrolite plus partial melt, similar to metasediments in the Paul Lake map area (76D/9) to the south. No graphite-bearing assemblages, banded iron formation or volcaniclastic sediments are found associated with these greywackes and they are tentatively correlated with the Itchen Formation (as defined by Bostock, 1980).

Granitoid intrusive rocks

Granitoid rocks in 76D/16 have been subdivided into mappable units (diorite/quartz diorite; hornblende-biotite tonalite; biotite granodiorite/hornblende-biotite tonalite; porphyritic biotite granite; two mica granite and pegmatite) on the basis of mineralogy, presence or absence of cognate xenoliths and variation in fabric development. Rocks of the diorite/biotite granodiorite suite are tentatively correlated with the Concession plutonic suite (Bostock, 1980; King et al., 1992; Davis, 1994) in the Contwoyto-Nose Lakes area to the north.

Diorite/quartz diorite (Ad/Aqd)

Four small plutons consisting of variably deformed (massive to foliated), coarse- to medium-grained diorite and quartz diorite occur in the southwestern part of the map sheet. The two larger bodies define weak magnetic anomalies on the regional (800 m) airborne magnetic survey (GSC map #7200G). These rocks are dominated by plagioclase and hornblende, with small, but variable amounts of biotite schlieren, pyroxene, magnetite, quartz and pyrite. Hornblendite and microdiorite cognate cumulate xenoliths are relatively common. No intrusive relationships were observed.

Hornblende-biotite tonalite (Ahbt)

Deformed ($S_1 \pm L_1$ fabrics) hornblende-biotite tonalite occurs in two areas within the map sheet. The mineralogy of this unit is hornblende + plagioclase with biotite, quartz, minor K-feldspar and accessory magnetite, pyrite and eidote. In the southwestern part of the map, these rocks are a continuation of the hornblende-biotite tonalite body to the south in the Paul Lake sheet (76D/9). In the northern part of 76D/16, the hornblende-biotite tonalite biodies are part of a belt which continues to the southeast into the Aylmer lake sheet (Lord and Barnes, 1952) and to the northwest into the Contwoyto sheet (King et al., 1991). In these rocks, thin (10 cm - 10 m scale) greywacke septae of variable length (10's - 100's of m) commonly occur; these rocks also typically contain hornblende-rich microdiorite enclaves. The enclaves are boudinaged, with long axes lying parallel to S_1.

Biotite granodiorite/hornblende-biotite tonalite (Abgd/Ahbt)

Granodiorite dominated (with minor hornblende-biotite tonalite) plutons are found in the west central and southwestern part of 76D/16. The granodiorites are massive to foliated ($S_1 \pm S_2$; no mineral lineations oberved), and consist of plagioclase, K-feldspar, quartz, biotite and accessory pyrite and magnetite. Subordinate hornblende-biotite tonalite also occurs within these plutons, consistent with these bodies being multiple intrusives. Small, map scale migmatite grade greywackes occur in the granodiorites in both areas. ,Micro-diorite enclaves are rare to absent.

Two mica granite (A2mg)

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. The central two mica granite batholith extends to the west into 76D/15 and to the east into the Aylmer lake sheet (Lord and Barnes, 1952). Variations in grain size (equigranular fine- to very coarse grained, and sub-porphyritic textures) and mineralogy are consistent with the central batholith and southern map area plutons being composite intrusions. Fabric development consists of one (locally developed) cleavage. This foliation is in general only observed near pluton margins, however, a well developed S_1 fabric is observed throughout the two mica granite body at the south-central edge of the map sheet.

Porphyritic biotite granite (Apbg)

Light red to pinkish-white weathering, medium- to coarse-grained, K-feldspar -rich granite forms a distinctive unit in the map sheet. These rocks are dominantly sub-porphyritic to porphyritic, although equigranular variants are also present. 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%); however secondary muscovite (overgrowing biotite) is very common. The northern porphyritic biotite granite body body is the southern extension of the Pellat Lake monzogranite batholith in the Contwoyto-Nose Lakes sheets (King et al., 1991). The large batholith in the central and southern part of the map area in the Coppermine River area continues southward into 76D/9 (the 'Duchess granite'; Kjarsgaard and Wyllie, 1993). The large areas of granite outcrop consist of a number of recognizable phases (variable grain size and mineralogy), consistent with these bodies being products of multiple intrusions. A lack of penetrative deformation is consistent with these rocks being emplaced after the main regional metamorphism and deformational events (D_1 and D_2).

Pegmatite (Apeg)

Very coarse grained biotite and biotite + muscovite pegmatites occur throughout the map area, associated with two mica and biotite granites. In three areas they form mappable bodies consisting of >60% pegmatite (with granite).

Diabase dykes

Three swarms of Proterozoic diabase dykes (<1 to 50 m in width) are observed. The dykes cut all Archean units. Rocks from separate dyke swarms are distinguished on the basis of orientation, texture, mineralogy and magnetic characteristics. Dykes have been correlated with known swarms in the Slave Province (Fahrig and West, 1986; LeCheminant, 1994).

Contwoyto (045°)

Two Contwoyto dykes, 20 - 40 m wide and trending approximately 045 were noted in the map area. U-Pb baddeleyite studies on a dyke from this swarm further south in the Lac de Gras area yielded an age of 2.23 Ga (A. LeCheminant and O. van Breemen, 1994).

Lac de Gras (010°)

Segments of six different Lac de Gras dykes, 30 - 50 m wide, trending approximately 010 , were observed to outcrop intermittently in the map area. They are distinguished from other dykes by their well-developed ophitic texture. U-Pb baddeleyite studies yielded ages of 2.03 to 2.02 G (LeCheminant and van Breemen, 1994), correlative with the Booth River intrusive suite 300 km to the NNE.

Mackenzie (335°)

A number of dykes of the Mackenzie swarm (at least six, possibly eight), with trends of 330°-340° and up to 50 m wide, were observed in the map area. These dykes are quite common on the eastern and northeastern part of the map area. Previous U-Pb baddeleyite studies on dykes from the Mackenzie swarm yielded an age of 1.27 Ga (LeCheminant and Heaman, 1989).

Kimberlite (k)

A single pipe (on the BHP/DiaMet claim block) is shown on the map. Note that this kimberlite lies under a lake, therefore the pipe outline as indicated on the map is schematic only and does not indicate the actual size (this remains proprietary information). 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 BHP/DiaMet claim block) is unknown. Kimberlite-derived mudstones with Cretaceous to Paleocene dinoflagellate, pollen and spores (Northern Miner, 1993) potentially suggest more than one period of kimberlite emplacement. A U-Pb perovskite age of 86 ± 2 Ma (C.M.H. Jennings, quoted in Pell, 1994) from another kimberlite in the Lac de Gras area (locality unspecified) supports this idea.

ARCHEAN INTRUSIVE RELATIONSHIPS & AGE CORRELATIONS

U-Pb geochronology (in progress) is presently not available for Archean rocks in the Ursula Lake map sheet. Relative ages (based on intrusive relationships and fabric development) are considered to be metagreywacke > diorite ≈ quartz diorite ≈ hornblende-biotite tonalite ≈ biotite granodiorite > 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; Davis, 1994), intruded at *ca.* 2625 - 2580 Ma (van Breemen et al., 1992). Specifically, the diorite - granodiorite suite in the map sheet appears to be equivalent to the Concession suite granitoids found to the north in the Contwoyto-Nose Lakes sheets, dated at 2608 +5/-4 Ma (Davis, 1994). Previous age determinations on two mica granites from the Contwoyto-Nose Lakes sheets are in the range 2599 ± 5 Ma to 2585 ± 4 Ma, and 2582 ±4 Ma for porphyritic biotite granite (summarized in Davis, 1994). Detrital zircon studies on a metagraywacke sample from the Paul Lake sheet to the south of the map area give a preliminary maximum deposition age of 2.67 Ga (M.E. Villeneuve, pers. comm., 1994).

STRUCTURAL GEOLOGY

Fabric elements

S_0 is bedding in metasediments and is defined by textural and mineralogical variation at the outcrop scale. Primary sedimentological features observed include graded turbititic beds and scour and fill, ball and pillow and flame structures.

S_1 is the dominant regional cleavage, axial planar to F_1. In metasediments it is defined mainly by biotite alignment, plus parallel first generation quartz stringers.

S_1 is generally oriented parallel or sub-parallel to S_0 in the metasediments, but is strongly refracted across pelitic and psammitic S_0 beds. S_1 is defined in the diorite/quartz diorite/tonalite/granodiorite suite by mildly anastomosing biotite planes ± aligned microdiorite boudins. A local S_1 fabric in two mica granite is defined by a biotite/muscovite + equidimensional quartz/feldspar foliation.

S_2 is a locally observed cleavage axial planar to F_2. S_2 in the greywackes is defined by biotite, muscovite and a second generation of quartz veins. Cleavage development is best observed in pelitic beds.

F_1 folds are isoclinal, but are rarely seen. However, when observed, S_0 is transposed parallel to S_1, yielding isolated F_1 fold closures with attenuated and sheared off limbs. Mesoscopic and layer-scale F_1 isoclines are determined by frequent changes of S_0 younging directions and bedding/cleavage (S_0/S_1) relationships.

F_2 are asymmetric folds; Z folds predominate, S folds are quite rare.

L_1 mineral lineations (quartz, biotite) observed in metasedimentary rocks are related to flattening across S_1.

L_2 intersection lineations, defined by biotite, muscovite and quartz are observed where both S_1 and S_2 are developed.

Rarely observed slicken striae have moderate to shallow plunges. Joint surfaces in all rock types are dominantly steeply dipping. Sub-horizontal joints (not measured) in granitoid rocks are interpreted to be cracks developed during pluton cooling.

Structural development

Tectonic fabrics exhibit varying degrees of development and orientation. The deformational history in the map area consists of two phases, D_1 and D_2. Note that in adjacent map areas in the central Slave province (e.g. King et al., 1992, Thompson et al., 1994) which contain the 'older' Slave granitoid suite an earlier deformation event and associated cleavage is observed (S_1) and the main or regional cleavage in these areas is the second cleavage (S_2). The main or regional cleavage in the 76D/10 map area is S_1, an earlier cleavage has not been observed.

S_0 is dominantly steeply dipping. However, moderately dipping beds are locally observed. The main cleavage (S_1) is associated with isoclinal folds (F_1), related to D_1. S_1 forms a discrete, spaced cleavage in the greywackes and is oriented sub-parallel to S_0. The observed S_2 cleavage is locally developed, associated with asymmetric F_2 Z folds (rarely S folds) related to D_2.

Porphyroblast development is complex, suggestive of mineral growth pre-, syn- and post-D_1. At least two generations of cordierite are present. Large, idioblastic porphyroblasts of cordierite and andalusite overgrow S_0 and are wrapped by S_1 (biotite) suggesting that D_1 deformation is preceded by static porphyroblastesis. However, cordierite and andalusite porphyroblasts are also observed to contain dextrally rotated non-planar inclusion trails (syn-D_1). Cordierite is also seen overgrowing S_0, S_1 and a biotite mineral lineation, and rarely being wrapped or cut by S_2 (post-D_1, pre- to syn-D_2). Both cordierite and sillimanite are observed to overgrow andalusite. Isograds in the northern greywacke belt are parallel/sb-parallel to the main regional cleavage (S_1). Cleavage development in the diorite/tonalite suite is consistent with emplacement syn-D_1 and pre-D_2; rare S_2 cleavages in granodiorites suggest slightly later emplacement (syn-D_2) Two mica granites (with local cleavage development) are interpreted to have been emplaced late- to post-D_1. Porphyritic biotite granites are massive (post deformation).

Faulting

Direct evidence for faulting in the map area is limited to one area in the northern part of the map sheet. Although a number of lineaments are apparent on topographic maps and satellite images, no fault gouge was found in surficial exposures, likely a result of subsequent glaciation. However, rare slicken striae were observed throughout the region. Azimuth measurements of slicken striae coupled with strike measurements on steeply dipping, and often haematized joint sets suggest faulting may be associated with the following trends: ≈045°, ≈080° and ≈110°.

METAMORPHISM

In the metasediments, metamorphic grade is quite variable. Biotite grade spotted slates and phyllites are dominant in the southwest part of the map area; a small region of silliminite grade metasediments also occurs in this region between two tonalitic plutons, suggesting a local contact metamorphic effect. In the northern greywacke belt, grade increases northward from cordierite + andalusite porphyroblastic schists through sillimanite grade schists to migmatite (metatexite). The higher grade schists contain sillimanite in the form of fibrolite mats plus rare acicular sillimanite needles plus partial melt, and are similar to the greywackes in the Paul Lake map area to the south (Kjarsgaard and Wyllie, 1994). Small greywacke enclaves associated with diorite/granodiorite suite granitoids are at migmatite grade; in contrast, enclaves in two mica granite have similar metamorphic grade to those observed in the nearby metasediment belts. The metamorphic assemblages observed in the metasediments 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 (> 100) kimberlites have been discovered since the autumn of 1991 in the Lac de Gras area of the central Slave Province. A number of the pipes are diamond-bearing. The diamond grade of the kimberlite pipe at the southern margin of the map sheet is unknown, however, it is suggested to be low as it has not been bulk sampled.

The occurrence of silicate banded iron formation with pyrrhotite and arsenopyrite in the southwestern greywacke belt has potentially important implications for banded iron formation type gold deposits in the region.

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