An Update on the Geology and Geochronology of the Wecho River Area

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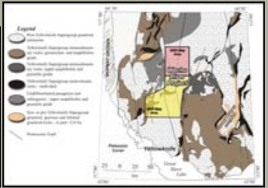
LOCATION



Introduction

The Wecho River area, located ~100 kilometres north of Yellowknife, NT, was the focus of a two-year bedrock mapping project. Mapping of the southern portion of the area was completed during the summer of 2004; the northern portion was completed during the summer of 2003 (*maps above*). Presented here are preliminary results of 2004 mapping, along with preliminary geochronological results of samples collected from the northern part of the study area during 2003.

Regional Geology (southern Wecho River area)

Previous bedrock maps show the southern part of the Wecho River area to be underlain by undifferentiated Archean metasedimentary (including minor mafic metavolcanic) and granitoid rocks. This study was able to further delineate the supracrustal rocks, as well as sub-divide the granitoids based on their physical attributes.

The supracrustal sequence is disrupted by young granitoid intrusions, and is offset more than 10 kilometres by a Proterozoic fault (West Bay-Indin), dividing the turbidites into two distinct belts: the Mosher-Inglis belt and the Wheeler-Germaine belt (*map at right*).

The plutonic rocks in the the study area include a diversity of granitoids (*Map at Right*) ranging from hornblende-tonalite/granodiorite to two-mica granites. The most expansive of the granitoid units is a syn-deformational and metamorphic granite to granodiorite with innumerable supracrustal enclaves. Generally, the granitoid units in the study area can be correlated with granitoid units throughout the southern Slave Province.

Future work includes precise U/Pb zircon and monazite ages, coupled with tracer isotopes and whole-rock geochemistry of these plutonic rocks to complement relative age constraints defined during field mapping. This, in turn, will help unravel the evolution of the this part of the craton during the Neoarchean.

Deformation

Archean deformation is best preserved in the lower-grade turbidites. D_1 is characterized by large-scale isoclinal folds, with no associated penetrative foliation. D_2 and D_3 are characterized by S_2 and S_3 cleavages and crenulation cleavages that are only distinguishable when they occur together. Some evidence does indicate that S_2 formed prior to cordierite growth, whereas S_3 formed synchronous with it.

In the higher-grade rocks, bedding is generally preserved and foliations are defined by relict cordierite, sillimanite, and melt (D_2/D_3?) and tends to overprint older structures. Locally, melt is observed to have been sheared (both dextral and sinistral); these melt-bearing shears are crenulation cleavage-like and may indicate late metamorphic extension.

North- and northeast-trending, map-scale Proterozoic faults truncate and dismember all rock types in the area. These are usually defined by breccia zones.

Volcanic Gneiss – D_1.

F_1 fold cut by later foliation. Wheeler Lake. Pen magnet north.

S_3 crenulation cleavage at Mosher Lake. Pen magnet north.

Sinistral shear in metatexite. North of Germaine Lake. Pen magnet north.

Folded segregation cleavage. East of Germaine Lake. Pen magnet north.

Folded foliation (defined by sillimanite). East of Inglis Lake. Pen magnet north.

UPDATE ON THE GEOLOGY

Supracrustal Rocks

Two supracrustal belts occur in the southern part of the Wecho River area. In the southwest is the Mosher-Inglis belt which is the southeastern arm of a large supracrustal package that continues northward to the Indin Lake area. The Mosher-Inglis belt is dominated by greywacke-mudstone turbidites. Intercalated mafic volcanic rocks are interpreted as a relict stratigraphic marker unit; to the west, overlying turbidites contain iron formation and felsic volcanic rocks (*ca.* 2658 Ma); to the east, underlying turbidites lack iron formation and felsic volcanic rocks.

The second supracrustal package, the Wheeler-Germaine belt, occurs in the northeast. This belt is the southern extension of the Armi Lake belt and consists of higher-grade psammites and semi-pelites with horizons of silicate iron formation. It is not clear if the Mosher-Inglis and Wheeler-Germaine belts were once contiguous, as late Archean granitoids and Proterozoic faults have dismembered them.

Sillimanite-facies turbidite beds near Inglis Lake. Hammerhead north.

Bleached pillows with garnet in selvages. Northwest corner of map.

Diatexite with iolite. North of Germaine Lake.

Intrusive Rocks

There is a diversity of granitoid rocks in the southern Wecho River area. They range from two-mica granites to hornblende-granodiorites that intruded syn- to late-deformation and metamorphism (~2.605 to 2.58 Ga). Tonalites and granitic gneisses are rare, but occur locally as enclaves in the younger granites.

Examples of mixed granitoids in the study area.

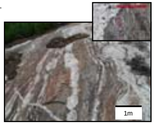
Metamorphism

Metamorphic grade increases from greenschist (biotite zone) in the southwest to upper-amphibolite (sillimanite + K-feldspar zone) in the northeast of the study area. The biotite-cordierite isograd mimics the intrusive contact of the 'dirty granite' (*map below*), consistent with other areas in the southwestern Slave Province and indicating the granitoid is syn-metamorphic. Metamorphism of the higher-grade rocks, however, has not been linked to a particular granitic phase. These higher-grade rocks range from cordierite + sillimanite ± andalusite schists to metatexite and diatexite containg assemblages of sillimanite, melt, iolite, garnet, K-feldspar, but lacking of granulite-grade assemblages. Injection migmatites are prevalent, particularly north of Wheeler and Germaine lakes.

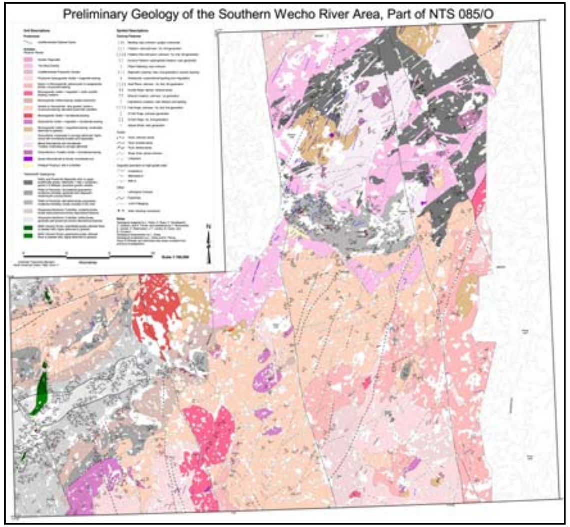
Biotite-facies mudstone/greywacke beds at Mosher Lake. Beds young towards the right of the photograph (flames, scours, grading). Pen north.

Zoned cordierite porphyroblasts in greywacke, Mosher Lake. Pen magnet north.

Sillimanite overgrowths on cordierite. Wheeler Lake. Pencil lead is 0.5mm wide.



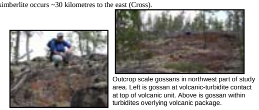
Injection migmatite – metatexite and granodiorite. Inset is large garnet with plagioclase rim. Granodiorite sills are garnet-rich. North of Wheeler Lake.



Mineral Deposit Potential

A number of gold showings are known from the Mosher and Wheeler lake areas. These include volcanic-hosted and turbidite-hosted, which are generally associated with iron formation. North of Mosher Lake, recent exploration has identified VHMS-style mineralized horizons in the mafic volcanic rocks.

To date, kimberlite has not been discovered within the study area. The nearest kimberlite occurs ~30 kilometres to the east (Cross).



Outcrop scale gossans in northwest part of study area. Left is gossan at volcanic-turbidite contact at top of volcanic unit. Above is gossan within turbidites overlying volcanic package.

Outcrop scale gossan associated with silicate and sulfide iron formation. Northwestern most corner of study area.

Rose diagram of glacial striae and predominant ice advancement direction; to whet the appetite of those in search of kimberlite.

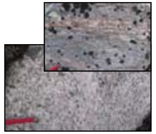
UPDATE ON THE GEOCHRONOLOGY

U-Pb Geochronology

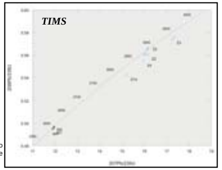
Presented here are preliminary results of the geochronological investigation of four granitoid suites identified in northern part of the Wecho River area, which is part of an M.Sc. thesis study by S. Buse. Samples were collected during field mapping in 2003 (*map below right*). Zircons and monazite grains were analyzed by thermal ionization mass spectrometry (TIMS), which has been complemented by an ion microprobe study (SHRIMP). These investigations were undertaken to help answer two questions: 1) what is the crystallization age of each sample? 2) With what rocks did the granitoids interact and where does the Mesoarchean basement occur? The answers to these questions will help explain observed field relationships (e.g. timing of deformation and metamorphism) and help define the sub-surface extent of Mesoarchean basement in the southwestern Slave Province.

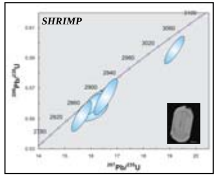
1. Magnetite-Granite to Granodiorite

The granite occurs in the northern part of the study area (*map below*). It has flattened quartz grains, is locally gneissic, and contains enclaves of mafic granulite. The highly deformed and recrystallized nature of the granodiorite point to intrusion prior to granulite-grade metamorphism. Where it is gneissic, the granodiorite appears similar to Mesoarchean basement exposures elsewhere in the southern part of the craton.



Outcrop photographs of granite. Bottom photo shows deformed quartz grains in granite. Top photo shows locally occurring gneiss. Could the gneiss be Mesoarchean basement?



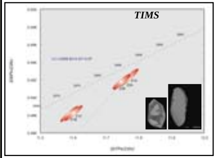


The zircons in the granodiorite yield TIMS ages between 2855 and 2970 Ma and ion probe ages between 2872 and 2902 Ma with one end-member at 2970 Ma; monazite yields a TIMS age of 2601 Ma. Although the ion probe zircon ages are similar and could represent a crystallization age of the pluton, the zircons have variable Th/U ratios, indicating the zircons are from different populations of similar age.

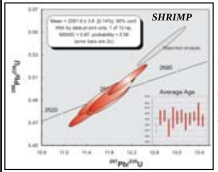
Due to the variability of the zircons (both TIMS and ion probe), we suggest they were inherited by the granodiorite. In this case the monazite age of 2600.6±1.3 Ma may be the crystallization age of the pluton and the zircons are interpreted to be inherited from the Central Slave Basement Complex.

2. Charno-Enderbite to Enderbite

The suite is orthopyroxene-bearing granodiorite, tonalite, and quartz diorite that occurs as large enclaves in the northern part of the study area (*Map Below*). The unit intruded during granulite-grade metamorphism and is extensively intruded by young, sheet-like porphyritic granites. The crystallization age will help define the timing of granulite-grade metamorphism.

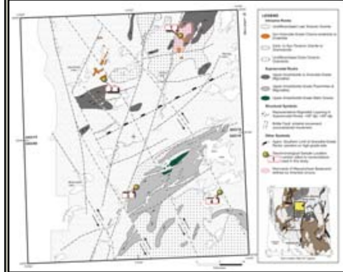


Photomicrograph of granulite-grade enderbite.



The enderbite zircons have highly variable grain morphology; all of which are quite altered. Initial TIMS analysis was on two groups of zircons yielding ages of 2590 Ma and 2580 Ma. The older age of 2590 Ma is interpreted as the minimum crystallization age for the rock, while the age of 2580 Ma is interpreted as later metamorphic growth. Twelve analyses were completed on the ion probe, which give a weighted mean age of 2591.9±3.6 Ma. This supports the TIMS data and is interpreted as the crystallization age of the enderbite.

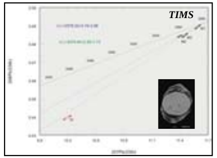
Geology of the Northern Wecho River Area

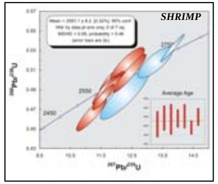


4. K-feldspar Porphyritic Granite

The K-feldspar porphyritic granite is found throughout the study area as weakly foliated sheet-like intrusions. It is one of the youngest granitoids identified. The crystallization age of this granite will help define the timing of the latest intrusions in the southwestern Slave Province.

Outcrop photographs of porphyritic granite. Left photo shows large K-feldspar phenocrysts in granite. Right photo shows granite intruding older granodiorite (see 3).

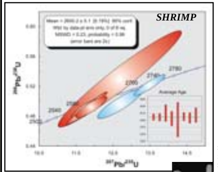




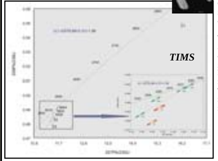
Monazites from the K-feldspar porphyritic granite yield TIMS ages between 2575 and 2580 Ma but zircons exhibit complicated core-rim structures making them difficult to analyze by this method. Ion probe work on zircon rims and cores yield consistent ages; the weighted mean average of 9 analyses is 2591±8 Ma is interpreted as the crystallization age for the rock. Three other analyses yield ages of 2726 Ma and are interpreted as inherited.

3. Biotite-Granodiorite to Tonalite

The biotite-granodiorite extensively intrudes supracrustal rocks of the Armi Lake belt is abundant in the southern part of the map area as well (*map at left*). The granodiorite is moderately foliated (biotite), and the generation of the deformation is equivalent to a foliation defined by sillimanite and melt in the semi-pelitic rocks. The age of the granodiorite will constrain the maximum age of the upper-amphibolite-grade metamorphism in the Armi Lake belt.



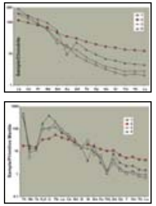
Outcrop photograph of granodiorite dyke forming boudins sub-parallel to foliation defined by sillimanite + melt. Pencil north.



The granodiorite yields small, altered zircons and core-rim structures indicate inheritance. Ion probe analysis of ten zircons yield a weighted mean age of 2600±5 Ma, interpreted as the crystallization age of the rock. Two grains have ages of 2701 and 2720 Ma and are interpreted as inherited.

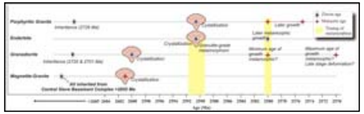
Several monazites were analyzed by TIMS and yield ages between 2568 to 2580 Ma. Two types of monazite growth are recorded: ~2570 Ma and 2580 Ma grains. The 2570 Ma grains, which have higher Th/U ratios, represent the maximum age of the younger generation. The 2580 Ma grains represent the minimum age of an older growth of monazite.

Preliminary Geochemistry



All geochronology samples are also the focus of an intensive trace-element and isotope geochemistry study. At left are normalized diagrams showing preliminary results.

Summary of U-Pb Geochronology



This study has narrowed the crystallization ages of the four plutonic suites investigated. As well, it has highlighted various events in each rock's history, including inheritance, post-crystallization perturbances, and growth. The geochronological dataset will also act as a 'baseline' for a Sm/Nd study of these samples and other similar samples from throughout the study area.

Future geochronological work will focus on samples collected from the southern part of the Wecho River area during the 2004 field mapping. These include a magnetite-hornblende-granodiorite, magnetite-granite and a detrital zircon study of two biotite-facies greywacke samples.

Acknowledgements

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