U-Pb zircon geochronology and Nd Isotope Geochemistry of Proterozoic Granitoids in the Western Churchill Province

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Title This presentation comprises both a geochronology and tracer study of the Hudson and Nueltin granites. Information on the source rocks to these granites and by inference the nature of the basement was obtained from both SHRIMP analyses on zircon cores and Sm-Nd isotopes on whole rocks. This study benefited from discussions with Bill Davis.

NATMAP Study Area Our granite selection covered essentially the Western Churchill NATMAP area, namely the Hearne Province from the Manitoba border to the Chesterfield inlet, and west of the Snowbird tectonic zone into the Rae Province.

The Nueltin granites occur mainly in a zone from the southwestern Hearne northward, where Hudson granites are less common.

The ca. 1750 Ma Nueltin granites that are some 80 Ma younger than the Hudson granites have extrusive equivalents in the Pitz formation, a rhyolite.

The Hudson granites are also coeval with the mostly peralkaline Dubawnt minette suite, of restricted extent, that are associated with terrigenous basins.

The Hudson granites, a late tectonic suite, are more ubiquitous than the Nueltin granites, occurring also in a NE trending zone at Wager Bay, and under the Thelon sandstones. Granites of similar age continue through the Penrhyn fold belt into the Nagsitoquidian of Greenland. They are not well exposed in the Kaminak-Rankin Belt.

Western Churchill Province At 1.83 Ga the Hudson granites are roughly coeval with the terminal collision of the Superior and Churchill Provinces and slightly younger than the 1.85 Ga giant Wathaman Batholith in northern Manitoba.

Hudson polished slab shows a typical Hudson type biotite granite. They are typically equigranular, calc-alkaline, quartz monzonitic to granodioritic rocks and have partly concordant contacts. They were likely sill-like bodies, near minimum melts, emplaced not far above their source region. This feature and their aluminous composition explain why so much inherited zircon is contained in these granites.

Nueltin polished slab shows a typical Nueltin rapakivi type granite and a volcanic equivalent Pitz rhyolite. Negative gravity anomalies suggest they represent larger magmatic bodies. The presence of equigranular basaltic clots, and of resorbed quartz and anorthoclase phenocrysts in some very crystal-poor rhyolites suggests that the magmas were generated by intrusion of basalt into crust. They are enriched in LREE, Zr and Th and are more alkaline in composition. All these features are consistent with the absence of inherited zircon in the Nueltin granites.

Zircon Photomicrographs Zircons from four Nueltin Suite granites and twenty Hudson Suite granites were analysed by SHRIMP U-Pb techniques. These backscattered images show why the SHRIMP technique was essential to the analysis of zircons from the Hudson suite. Hudson zircons show numerous cores. Where these are absent, the centre tends to be unzoned and the outer rim well zoned. Nueltin zircons have igneous zoning in their centers and are much more consistent from pluton to pluton.

Hystogram of ages When the results of this and previous ages are combined, giving us 21 reliable Hudson granite ages and 8 reliable Nueltin ages, there is a clear age separation. Intrusion of the Hudson suite lasted ca. 50 Ma, from 1845 Ma to 1795 Ma, with a peak around 1825 Ma; and the Nueltin suite even shorter from 1765-1750 Ma with a ca. 30 million period of magmatic quiescence. Finally, there is no regional age trend in either Proterozoic granite suite.

Model Nd Ages The next topic is inheritance. Whole rock Nd isotopic measurements, with average ε^{143}Nd near -10, indicate a dominant Neoarchean crustal component in both suites of granites, reflected by numerous late Archean inherited zircon ages. Only in the southeast near the Manitoba border do we get Mesoarchean Nd (T_{DM}) model ages

Inherited zircon This same distribution is shown in the zircons, with only the sample in the SE corner showing Meso-to Paleoarchean inherited zircons.

Sample locations This slide shows both zircon and Nd locations and Nd epsilon values, including the low ones in the southeast.

It should be pointed out that in the Forde Lake area in the NW Hearne, no inherited zircon was found in the Hudson granites. This is also the area from where zircons tend to be more euhedral and better zoned.

Archean Inheritance This slide shows the pattern of Neoarchean inherited zircon ages. Inherited zircon ages have been cumulated for the following regions: the southern Hearne, the Central Hearne the NW Hearne and Hanbury granite and the Rae.

A composite Probability Density Distribution curve (PPD) for all Neoarhean inherited ages shows that while there are a few early Neoarchean ages, the bulk indicates uninterrupted inheritance between 2720 Ma and 2500 Ma. A peak is reached shortly after 2700 Ma, but this decreases steadily to 2570 Ma, after which there is a partial hiatus followed by a smaller peak between 2550 and 2500 Ma. This pattern of 77 ages is statistically meaningful.

The regional patterns may be less meaningful, but show certain indications. If we focus on the southern Hearne, there is a greater concentration near 2635 Ma and 2535 Ma. There is an absence around 2600 Ma.

In the Central Hearne, there is a marked concentration near 2670 Ma, or the age of volcanism. Note the absence around 2600 Ma.

In the NW Hearne the distribution is different again. But note the peak around 2600 Ma, where according to the dating of Bill Davis, the 2600 Ma granites come in.

Generally younger ages are obtained in the Rae.

U and Th concentrations A remarkable change was found in Th/U rations as one goes from the central to the NW Hearne from normal values in the NW to low ones in the SE.

Low Th/U ratios characterize metamorphic rocks, but as was shown by Dianelle Rubatto (2002; Chemical Geology), can also be the result of ultrametamorphism.

We interprete the southeastern Hudson granites in terms of small amounts of partial melting associated with burial and heating closer to the Trans-Hudson orogeny.

In contrast, more direct melting of the crust in the NW may have been assisted by mafic magmatism associated with the Nueltin suite.

Crustal Domains A number of inferences can be drawn from this study:

There were two sharp igneous pulses

Inherited zircons show Neoarchean magmatism of over decreasing magmatism

Inherited zircons show regional differences, such as the Mesoarchean crust in the SE
Or the cut-off in 2600 Ma plutonism between the Central and NW Hearne

Th/U ratios on zircons from the Hudson granites show differences from the SE to NW which are interpreted in terms of tectonism: SE ultrametamorphism related to Trans-Hudson orogeny. NW melting aided by mafic magmatism.