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Neoarchean magmatism in the NW Superior Craton: Granitoids of the North Caribou Terrane

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The North Caribou Terrane (NCT), located in northwestern Ontario and eastern Manitoba, is the core of the Archean Superior Province. Like many Archean terranes, the NCT is characterized by central greenstone belts of strongly deformed metavolcanics and metasediments surrounded by variably deformed granitoids. We are investigating these external granitoids that comprise the larger batholiths surrounding the North Caribou Greenstone belt in the NCT in an attempt to understand the magmatic history and processes involved in batholith formation. Mapping and petrologic work identified two distinct groups of granitoids in the region: voluminous, massive to gneissic tonalite, trondhjemite, granodiorite (TTG) batholiths and massive pegmatitic to aplitic K-feldspar-rich granites, which intrude the margins of the greenstone belt and are also ubiquitous throughout the TTG suites. These rocks cross-cut all rock types and occur mostly as convoluted, brittle-ductile dykes (Figure 1). There are two types of pegmatitic rocks: an undated suite consisting primarily of K-feldspar and quartz with minor oxides, including magnetite, and S-type intrusions, containing muscovite, biotite, garnet, and less K-feldspar. Notably, zircon and titanite are absent from pegmatites.

The TTG batholiths have a wider variety of compositions, ranging from tonalite to granite (*sensu stricto*). Important accessory minerals include titanite, zircon, epidote, and hornblende. Epidote tends to occur in cross-cutting quartz veins, which suggests a late- to post-magmatic metasomatic event. This thermal episode was accompanied by moderate-temperature strain as evidenced by undulose extinction and bulging recrystallization in quartz and planar alignment of biotite and amphibole. Migmatitic textures in discrete parts of the batholiths indicate that partial melting of, or melt segregation within, the TTG batholiths could be the source for the K-feldspar-rich pegmatites. We performed Al-in-hornblende geobarometry on several batholith samples spanning granitic, granodioritic and tonalitic compositions; emplacement depths are variable across the batholith, ranging from pressures of 3.0±0.5 kbar (~13 km) to the southeast (tonalite) and 6.5±0.5 kbar (~20 km, granodiorite) to the north of the belt. To complement our geobarometric data, we also carried out U-Pb geochronology on igneous titanites and zircons using LA-ICP-MS methods to determine crystallization ages. The oldest zircons have a ca. 3.0 Ga inherited core, but the majority of grains have well-defined concordant ages of ca. 2850 Ma or ca. 2730 Ma. The former age signature is more prominent in the north of the belt, in contrast to the ca. 2730 Ma age that is more localized in the south-centre margin of the belt. In one sample, zircons have 2850 Ma cores and 2730 Ma rims. Titanite ages are similar to those from zircon. These new U-Pb ages are in accord with the few previously reported ages from the NCT (e.g. Breaks et al. 2001, Klipfel 2002, Wyman et al. 2010).

The original core of the Superior Province, recorded in the inherited zircons in this study and detrital and volcanic zircons from elsewhere in the NCT (Percival 2007, Lin et al. 2006) had formed by 3.0 Ga. This crust was subsequently deformed and intruded by, or incorporated into, 2850 Ma granitoids, which form the large batholiths that comprise much of the NCT. At this stage, the granitoids of tonalitic composition were emplaced at midcrustal levels. Later magmatism, at 2730 Ma, was more evolved with granodioritic to granitic composition. This stage of magmatic activity took place at shallower, mid- to uppercrustal depths. The most recent magmatic activity (granitic pegmatites) was post-deformation, occurred near the brittle-ductile transition, and has a highly evolved composition. The discrete magmatic events recognized in the NCT shows a long history of magmatism, over 300 Ma, and re-working of existing crust in the interior of the craton.

Figure 1: Pegmatite intruding strongly lineated amphibolite. Notice brittle and ductile structures (cracks parallel to lineation and pinched-out amphibolite rafts), suggesting pegmatites were intruded near the brittle-ductile transition.

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