U-Pb Zircon, Monazite, and Titanite Geochronology in the Wollaston Lake Area, Saskatchewan: Timing of Deformation, Metamorphism, and Magmatism

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ABSTRACT

The Wollaston Domain forms the eastern part of the western cratonic margin of the Paleoproterozoic Trans-Hudson Orogen. It comprises Archean crystalline basement of the Hearne craton and Paleoproterozoic metasediments with subordinate mafic and felsic intrusions of Hudsonian age. The present tectonic configuration of the Wollaston Domain resulted from the oblique collision of the Superior Province into the accreted Reindeer Zone and Hearne Province during the Hudsonian Orogeny. A summary review of U-Pb zircon, monazite, and titanite ages from Archean and Paleoproterozoic protoliths in the Wollaston Lake area is presented, which provides constraints on the thermotectonic history of the Hearne Province.

New and recent U-Pb zircon data from orthogneisses of granitic to trondhjemitic composition provide evidence that two main pulses of Kenoran magmatism occurred at 2730 to 2700 Ma and 2630 to 2590 Ma. The timing of Archean granulite-facies metamorphism is less constrained by an interpreted metamorphic age of 2566 Ma from a migmatitic tonalitic gneiss. Evidence for strong reworking, interfolding, and tectonic interleaving of the Archean orthogneisses at 1810 to 1775 Ma is revealed by integrated U-Pb geochronology and field work. The depositional age of the Paleoproterozoic Wollaston Group in poorly constrained at 2550 to 1950 Ma. The oldest formed leucosomes in the Wollaston Group metasediments are deformed by F_1 folds. This folding event took place during D_{H1} crustal thickening. The leucosomes are interpreted as the product of an early high-T, moderate-P metamorphic event (M_{H1}). These leucosomes are possibly contemporaneous with the intrusion of ca.1840 Ma grey granites of similar peraluminous composition. Tholeiitic to calc-alkaline mafic plutonism at ca. 1830 Ma produced the Sandy Islands Gabbro Complex and other mafic/intermediate intrusions. This magmatic event is probably a manifestation of the initial collision between the Reindeer Zone and Superior Province. Slab breakoff of a northwest-dipping subduction zone beneath the Hearne Province may have occurred at this time. Monazite ages of 1816 and 1812 Ma from meta-quartzite and pelitic gneiss, respectively, tightly constrain the timing of peak high-T, low-P metamorphic conditions in the Wollaston Lake area. Calc-alkaline plutonism at 1820 to 1810 Ma is associated with peak metamorphism (M_{H2}). The Sm-Nd data and trace-element geochemistry of these calc-alkaline granitoids indicate their derivation by deep crustal melting of Archean crust. The co-existence of magmatic epidote and high-Al hornblende in some of the granodiorites of the gabbro complex suggests that crustal levels of ca. 20 km are exposed in this part of the orogenic belt. Single-grain monazites from pegmatites of peraluminous composition yield U-Pb ages ranging from 1820 to 1790 Ma. Integrated field work and petrographic studies reveal that decompression, uplift, and cooling occurred during D_{H3} transpression under amphibolite-facies conditions. The timing of this deformation is constrained by monazite ages of 1806 to 1790 Ma and titanite ages of 1800 to 1775 Ma.

In summary, our data suggest that the geology of the Wollaston Lake area represents a complex tectonic configuration of Archean and Paleoproterozoic crustal elements. We interpret the linear nature of the Wollaston Domain as a syn- to late-tectonic crustal-scale transpressional feature related to the Trans-Hudson Orogen.