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The Late Archean Abitibi-Opatica terrane, Superior Province: a modified oceanic plateau

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The Late Archean Abitibi greenstone belt, in SE Superior Province, Canada, is one of the largest greenstone belts on Earth. The classical model for the Abitibi belt is one of tectonic accretion and thrust stacking of allochthonous magmatic arcs and plateau fragments, resulting in a thickened crust with a granulitic base. A new model proposes that the Abitibi greenstone belt is the upper crustal part of a larger tectonic terrane, the Abitibi-Opatica terrane, that includes the Opatica gneiss belt. The Abitibi-Opatica terrane would represent a modified oceanic plateau, tectonically accreted to older crustal blocks ca. 2700 Ma. That model requires the existence of a thick crust prior to tectonic accretion, rather than thickening of crust as the result of collision. The plateau model is discussed in light of new and compiled geochronological, geochemical, and structura data and interpretations for volcanic, plutonic and metamorphic rocks, including exposed rocks of upper, middle and lower crustal origins.

Volcanism in the Abitibi belt spanned 2760 Ma through 2698 Ma. Compiled geochemical and geochronological data show the volcanic stratigraphy records periods of interstratified plume-related and subduction-related volcanism that are explained by initiation of subduction along the margins an oceanic plateau. Geochemical data from distinct suites of tonalites, granodiorites and granites are also consistent with that interpretation and indicate the presence of two TTG magmatic suites, one drived by melting of the base of the plateau and the other including slab-melt components.

The geodynamic origin of the plateau and the presence of a thick plateau crust prior

to tectonic accretion are tested by new geochronological studies of granulite- and amphibolite-grade rocks of the Kapuskasing structural zone (KSZ) that represents exposed lower to middle crust of the Abitibi greenstone belt. We have used laser ablation (LA) -ICP-MS, to carry out "in-situ" dating of zircons from a mafic Cpx-Grt granulite and from two Hbl-Bt-Grt metatonalites. Zircon crystals are mostly 40 microns or less in size. BSE and CL images reveal the zircons are unzoned, patchwork zoned, and sector zoned. The crystals are devoid of oscillatory zoning and their morphologies are mainly anhedral to subhedral; they are interpreted to be of metamorphic in origin. That interpretation is supported by REE elements patterns that show characteristic HREE depletion, suggesting equilibrium of zircons with garnet.

Metamorphic zircons dated 3190 Ma, 2850 Ma, and 2800 Ma, all record pre-Abitibi (pre-2760 Ma) metamorphic events. Thus the amphibolite- to granulite-grade rocks of the Kapuskasing zone contain components of an older high-grade terrane. Younger zircon dates record thermal events in the lower to middle crust that accompanied four known Abitibi magmatic events, including tonalite (2748 Ma), granodiorite (2700 – 2690 Ma), syenite and sanukitoid (2685 – 2675 Ma), and granite (2660 Ma) magmatism. It is interpreted that the metamorphic zircons formed as the result of thermal events that accompanied magmatic events. The results indicate the existence of high-grade metamorphic rocks in a crust 20 km thick (or more), that recorded thermal events before, as well as during, collisional tectonics, supporting the oceanic plateau model for the Abitibi-Opatica terrane. Finally, the results also indicate that the Abitibi-Opatica oceanic plateau was initiated during rifting of an older continental margin, from which the pre-2760 Ma zircon components were derived.