Geophysical Research Abstracts, Vol. 9, 02408, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02408

The Late Archean Abitibi-Opatica terrane, Superior Province: a Late Archean oceanic plateau modified by subduction and slab window magmatism

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In the southeastern part of Superior Province, in the Canadian Shield, the Abitibi-Opatica tectonic terrane provides an excellent example to study Late Archean crustal formation and tectonic accretion. It includes the Abitibi granite-greenstone subprovince and the Opatica granite-gneiss belt. The geological, structural, geochronological and geochemical knowledge base for the region is synthesized, a new interpretation of the crustal structure is presented, and new geochemical data for suites of granitoid rocks are incorporated. Based on the data and interpretations, we propose a plate-tectonic model for the origin, and the ca. 60 million years of pre- to syn-collisional tectonomagmatic evolution, of the Abitibi-Opatica terrane. The first-order constraints for a tectonic model are: 1) a 40 km-thick crust, with a 10 km-thick granulitic lower crust, 2) a northern boundary that was originally depositional-intrusive in nature, 3) a southern boundary that is a tectonic suture, 4) a stratigraphic record that includes volcanic rock units of two, broad petrogenetic associations, plume-related and subduction-related, that are intercalated in the stratigraphy, and 5) suites of granitoid rocks, the ages and petrogenetic signatures of which are consistent with the tectonomagmatic history recorded by the volcanic stratigraphy. We propose an essentially actualistic plate-tectonic model, involving subduction along the margin of a thick oceanic plateau crust, causing interaction of a subducting slab with a still-active plume. The thick plateau crust was formed between 2760 Ma and 2735 Ma. Differentiation of the crust involved partial melting of the lower crust to produce a first generation of TTG, that was emplaced as plutons between 2742 Ma and about 2730 Ma, leaving a granulitic residue in the lower crust. Subduction was initiated along

the margins of the plateau crust, and continued from ca. 2730 Ma through ca. 2702 Ma. The period of subduction-related magmatism was punctuated by several Ma of renewed plume-related magmatism, that was followed by 18 Ma of mixed subduction-related and plume-related magmatism, that formed interstratified units. The proposed plate-tectonic model explains the presence of interstratified units of plume-type and subduction-type signatures in the volcanic stratigraphy, and the production of TTG with a subduction-related petrogenetic signature, to the formation of a slab window below the Abitibi-Opatica terrane, during the long-lived (about 35 Ma) subduction below the plateau. The slab window would have formed either by subduction of a divergent plate margin, or by breaking off of the subducting slab due to thermal weakening by the subjacent plume head. In either of those two scenarios, the slab window probably swept across the Abitibi-Opatica terrane, allowing plume-related volcanic rocks to be interstratified with subduction-related volcanic rocks, and for the emplacement of the later suite of TTG, which may have been derived from melting of the slab window margins. Eventually, the Abitibi-Opatica terrane collided with a “southern terrane” at ca. 2700 Ma, which is recorded by large-scale folding, a change in the supracrustal types (dominated by calc-alkaline and detrital basins), and a switch in plutonic geochemistry towards granodioritic magmatism.