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Protracted tectono-metamorphic history of the SE Superior Province : contribution of 40Ar/39Ar thermochronology in the Abitibi-Opatica contact zone, Québec, Canada

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Archean orogens mainly consist of greenstone belts juxtaposing deeper crustal domains of TTG-type plutonic rocks. The greenstone belts show regional folds, penetrative steeply-dipping fabrics, and localised shear zones, whereas the plutonic belts predominantly display dome structures. Concurrently, rocks in Archean orogens undergone MT/HT-LP/MP metamorphic conditions that vary, from upper to lower crustal domains, between greenschist- and granulite-facies, respectively. These structural and metamorphic variations are well-documented, but modes of deformation related to such orogens is still debated. Some studies suggest that the Archean tectonic processes were comparable to present-day plate tectonics and the Archean greenstone belts were interpreted as tectonic collages commonly documented in Phanerozoic subduction/collision zones. Alternative models propose that the Archean tectonics were different from those predicted by the plate tectonics paradigm, mainly due to the existence of a hotter mantle and a mechanically weak crust. In such models, the burying and exhumation of crustal rocks are attributed to the vertical transfer of material, resulting in the development of pop-down and domes structures. As a contribution of the study of mechanisms that might have operated during the Archean, we present a structural and metamorphic study of the contact zone between the Abitibi subprovince (ASP), which contains greenstone belts, and the Opatica subprovince (OSP), which is dominated by plutonic rocks, of the Superior Province. The 40Ar/39Ar dating of amphiboles and micas is used to constrain the age and duration of regional metamorphism and associated deformations.

On the basis of seismic profiling, showing a north-dipping lithospheric-scale reflector, the ASP-OSP contact has been interpreted as the surficial trace of an Archean subduction zone. However, our structural analysis suggest that the ASP overlies the OSP and that the ASP-OSP contact does not show evidences of an important sub-vertical shearing deformation as expected if it was a major upper plate-lower plate boundary. Furthermore, the contact does not present significant metamorphic break between the two domains, but a progressive increasing of metamorphism toward the OSP, from greenschist- to amphibolite-facies conditions. Based on these structural and metamorphic characteristics, we suggest that the OSP exposes the deepest rocks at outcrop of an ASP-OSP crust in the study area. Regionally, the 40Ar/39Ar ages acquired during this study indicate that the ASP-OSP contact records a protracted metamorphic history that started around 2685 Ma. The structural and isotopic age data suggest that, from 2685 Ma to 2632 Ma, the deepest level of the ASP and the underlying OSP reached amphibolite-facies metamorphic conditions and that regional deformation was accommodated by an overall horizontal shortening and sub-vertical transfers of crustal material. Subsequently, the cooling of these crustal rocks was accompanied by strain localisation, which led to the development of oblique strike-slip shear zones from 2600 Ma, when the lateral flowing of crustal material became predominant.

Our 40Ar/39Ar data compared with metamorphic ages documented in adjacent areas of the Superior Province suggests that the peak and duration of regional metamorphism might have been coeval over a large region. This rather favours a mode of pervasive deformation as expected in vertical tectonics.