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The tectonometamorphic context of the north-west Opinaca, Superior Province, Eeyou Istchee Baie James

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The Opinaca subprovince, part of the Superior craton, is a major Neoarchean metasedimentary basin, composed mainly of migmatised paragneiss and granitoid intrusions. The maximal depositional age of the thick flysch-like sequence is constrained from detrital zircons at 2690 Ma. Deposition was immediately followed by the intrusion of granodioritic magmas. Ensuing deformation and metamorphism of the Opinaca subprovince lasted at least until 2613 Ma, with major metamorphic peaks constrained at 2666 Ma and 2636 Ma. Models proposed in the literature to explain the formation and later deformation and metamorphism of the Opinaca subprovince are diverse, ranging from an accretionary prism to a back-arc basin, and each imply contrasting styles and intensity of metamorphism. Confusion arises from the fact that the vast majority of the Opinaca subprovince has been affected by a late, strong migmatisation episode, obliterating most of the pre-anatectic information that would have been recorded on its tectonic journey, with the exception of the northwestern zone of the complex which appears to have avoided anatexis. The presence of staurolite grade schists suggests that this section might have kept evidence of the earliest tectonometamorphic phases, which are key in reconstructing the geodynamic context of the subprovince.

In the NW Opinaca subprovince, isograds traced from index minerals highlight a garnet => staurolite => sillimanite => anataxis progression, indicating greenschist facies in the north-west to upper amphibolites facies in the south-east. Phase equilibrium modeling predicts conditions between 580-640 °C and 3.9-6.6 kbar for samples from the staurolite zone, with garnet core composition isopleths intersecting at 607° C and 5.2 kbar. Garnet REE show profiles concordant with growth zoning. U-Pb monazite geochronology indicates two pulses of metamorphism, at 2670 and 2645 Ma. Lu-Hf dating of garnet supported by textural analysis and trace element mineral chemistry indicate that garnet and staurolite growth corresponds to the younger population of monazite, circa 2645 Ma. The first generation of monazite around 2670 Ma must thus reflect a low-pressure metamorphic event that did not involve garnet growth, as supported by their trace element content.

The favored geodynamic environment in the lights of these results involves deposition of the wacke sequences in a magmatically active extensional basin by 2690 Ma. Widespread felsic magmatism close to the time of deposition is not consistent with the accretionary wedge hypothesis. The rift-like basin more likely underwent continued extension and eventually regional low-P metamorphism until at least 2670 Ma. Crustal thickening was active by 2645 Ma, illustrating basin closure through oblique convergence. Opening and closure of a back-arc basin or of an aborted rift basin therefore better explains the evolution of the Opinaca subprovince.