

Beyond Acasta: Newly identified Palaeo-Eoarchaeon Terranes in the Slave Craton

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Rocks preserved from the very early Earth provide the only archives that record the processes governing planetary formation and evolution. Palaeo–Eoarchaeon (3.2–4.0 Ga) terranes offer unique windows into the geological mechanisms that built the first continents, mediated geosphere–hydrosphere interactions, and paved the way for life’s emergence. However, these processes remain enigmatic due to the scarcity of preserved terranes from this period.

The Slave craton (Northern Canada) represents a key repository of Palaeo–Eoarchaeon crust. The foremost example is the Acasta Gneiss Complex, hosting Earth’s oldest rock units at up to 4.02 Ga. This terrane has been the focus of extensive geochemical and geochronological research, often at the expense of neighbouring basement gneiss terranes that remain relatively understudied. The Eokuk Uplift and Kangguyak Gneiss Complex represent two such examples. Investigations into these terranes are further impeded by their remote location, with research restricted to Geological Survey of Canada mapping in the 1990s and associated geochronological work. These provided maximum U–Pb zircon age constraints of 3.25 Ga at Eokuk and 3.37 Ga in the southern Kangguyak Gneiss Complex. Renewed interest in Eokuk followed the recent discovery of a gneiss sample with a zircon crystallization age of ~3.8 Ga—the sixth oldest such age globally—firmly establishing Eokuk as containing evolved ancient crust [1]. However, the relationship between these ancient rocks and the Acasta Gneiss Complex, exposed >300 km south-southwest of Eokuk, remains ambiguous.

This study presents new U–Pb zircon geochronology for both terranes, providing age constraints on 16 components from southern Eokuk and 23 components from northern Kangguyak. The analysed samples represent diverse compositions from granitic, gabbroic and tonalitic orthogneisses to immature quartzites and metaconglomerate paragneisses. Preliminary results confirm the presence of ~3.7–3.8 Ga Eoarchaeon crust in Eokuk and extend the age range of the northern Kangguyak Gneiss Complex to at least 3.4 Ga. These findings reveal that Palaeo–Eoarchaeon crustal components are more widespread in the Slave craton than previously recognised. The Eokuk and Kangguyak terranes thus provide rare and valuable new rock samples for evaluating hypotheses on the processes that built Earth’s first continents.

[1] Stoian, Pearson, Luo, Changling, & Reimink (in prep).