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Discovery of a giant juvenile 3.3–3.1 Ga terrane in the Rae craton, Canada

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The volume, nature and origin of continental crust that existed on Earth before 3 Ga is poorly understood. One of the greatest obstacles in addressing these topics is the apparent paucity of preserved ancient (>3 Ga) crust. Despite being one of the largest Archean nuclei on Earth, the record of ancient crust in the Rae craton is virtually unexplored. Previous work has hinted at the presence of pre-3 Ga crust at the southern [1] and western [2] margins of the craton, but the true aerial extent, age, nature and origin of that ancient crust is unknown.

In this study, we present whole-rock Sm-Nd isotope and elemental data, and zircon U-Pb, Hf and O isotope data, for granitoids from the western margin of the Rae craton. Samples with crystallization ages >3.0 Ga and/ or Sm-Nd depleted mantle model ages ≥3.2 Ga define an ~1000 x 100 km belt that stretches from central Canada to the Arctic coast, which we call the Kugyoak terrane. Pre-3.0 Ga granitoids from this terrane are broadly similar in composition to typical Archean tonalite-trondhjemite-granodiorite [3]. These granitoids yield crystallization ages between 3.25 and 3.07 Ga, initial zircon εHf values between +3 and -2, mantle-like zircon O isotope compositions and rare ca. 3.3 Ga inherited zircon.

Collectively, these data show that one of the largest Paleo to Mesoarchean terranes on Earth was previously unrecognized, and that this terrane represents a volumetrically significant addition of juvenile ca. 3.3–3.1 Ga continental crust. Granitoids from this giant terrane yield little-to-no evidence for interaction with the large volumes of pre-3.5 Ga continental crust (up to 45% of present-day continental volume) that are inferred from proxy records, such as detrital zircon U-Pb-Hf isotope data, to have been present at the time of its formation [4].

[1] Hartlaub et al. (2005) *Precambrian Research* 141, 137–153. [2] Henderson and Theriault (1994) *Geological Survey of Canada Current Research* 1994-F, 43–47. [3] Moyen and Martin (2012), *Lithos* 148, 312–336. [4] Hawkesworth et al. (2019) *Geoscience Frontiers* 10, 165–173.