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Tracking terrane accretion in the crystalline basement beneath the Western Canada Sedimentary Basin using U-Pb and Hf isotopes in detrital zircon

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The Precambrian crystalline basement in northern Alberta is covered by over a kilometre of Phanerozoic sediment. Yet, the buried crustal blocks are key to most tectonic models for the amalgamation of Proto-Laurentia and Nuna [1] [2]. Zircon detrital geochronology and Hf isotope information are critical datasets for establishing when crustal blocks may or may not have been proximal to one another. However, detrital studies have never been done on the basement rocks of northern Alberta, limiting our understanding of when the crustal blocks may have been amalgamated. Additionally, existing age constraints on the meta-plutonic rocks are limited to multi-grain zircon U-Pb geochronology by isotope dilution-thermal ionization mass spectrometry [3], in rocks that record a high-grade metamorphic history.

Here, we present preliminary zircon U-Pb geochronology and Hf isotope results for six detrital samples across northern Alberta to evaluate the possible timing of terrane accretion. These are compared to new U-Pb and Hf isotope data for crystalline basement rocks in both northern Alberta and the Rae Province, which occurs immediately to the northeast. Detrital zircon U-Pb results show prominent peaks at ca. 2.3, 2.0, and 1.9 Ga, while Hf isotope results are dominantly sub-chondritic. These age peaks mimic the age distribution and Hf isotope signature of local metaplutonic rocks. Despite these similarities, the samples also show domainal differences and record minor populations of detritus that do not appear in the age or isotopic record of local crustal units. These zircon thus, may have been exotically sourced from either the Rae or Slave Provinces, or an unidentified local crustal block.

[1] Davis et al. 2021. Can. J. Earth. Sci, v. 58
[2] Cutts, J.A. et al. 2024. G-cubed, v. 25.
[3] Villeneuve, M.E. et al. 1993. GSC Bulletin 447.