

Oxygen isotopes in apatite, titanite, and zircon: tracing a billion years of Archean crustal evolution

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Understanding crustal growth processes, and specially the formation of the first continents on the early Earth, requires a robust identification of primitive magma sources signatures associated to crustal evolution. While this task is particularly challenging in Archean terranes, robust minerals such as zircon are typically targeted to unravel such primary signatures. By relying on zircon only, it remains however difficult to identify whether most granites forming the continental crust result from mixed crustal and mantle sources or if they can be entirely generated by crustal reworking. In this contribution, oxygen isotopes in key, yet underexplored accessory minerals—apatite and titanite; [1]— are used to provide new perspectives and insights into magma petrogenesis, their hidden source evolution and to identify possible secondary cryptic processes.

To test whether and to what extent apatite and titanite may be complementary to zircon, we analysed these phases in two Archean granitoid reference collections from Kaapvaal craton (SWASA collection, [2]) and Pilbara craton (YIPI collection, [3]). Both rock collections span 1 Gyr magmatism, and individual samples are variably affected by deformation and secondary processes. We performed in situ $\delta^{18}\text{O}$ SIMS analyses in single growth domains identified within each phase, allowing a thorough intercomparison of each sample's evolution. Using three different standards for each mineral, we identified notable biases of 0.75‰ per 0.1 Ti apfu in titanite (similar to [4]) and 1.00‰ per F apfu in apatite. Preliminary data indicate that each accessory phase can record and preserve primary $\delta^{18}\text{O}$ magmatic signatures and their (in)consistence also provide a robust means to identify early reworking during crustal formation processes or secondary metamorphic or metasomatic events. This refined, multi-method strategy not only allows to filter data and better constrain interpretations based solely on zircon, but also provides an alternative to investigate zircon-poor lithologies.

[1] Bruand, E., et al. (2019), *Geochimica et Cosmochimica Acta*, 255, 144-162.

[2] Moyen, J. F., et al. (2024), *Earth-Science Reviews*, 250, 104680.

[3] Vandenburg, E. D., et al. (2023), *Earth-Science Reviews*, 241, 104417.

[4] Bonamici, C. E., et al. (2011), *Geology*, 39(10), 959-962.