Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.34346

Deciphering trace elements signatures of zircon through Earth's deep time

CHRIS YAKYMCHUK

University of Waterloo

Understanding the long-term evolution of the continental crust relies on a fragmentary rock record. Alleviating the preservation bias of the rock record is the use of detrital accessory minerals (most commonly zircon) that are tied—via geochronology—to a date and trace element signature that are used to infer tectonic environments or physical attributes of the continental crust. Zircon is noted for its propensity to host redox-sensitive elements (Europium and Cerium), temperature sensitive elements (Titanium), and trace elements tied to pressure–sensitive minerals (garnet and feldspar). However, there are various petrological processes that occur across diverse tectonic environments that result in a preserved trace element signature in zircon. Consequently, there are diverging opinions as to the utility of using the zircon trace element archive to infer properties of Earth's continental crust and how these attributes have changed through time[1,2,3].

Here, I investigate various intensive variables in evolving petrological systems that are expected to influence trace element concentrations in zircon using quantitative phase equilibrium modelling. Interdependencies between temperature, pressure, titania activity, oxygen fugacity, residual mineral assemblage, melt fraction, and open/closed system behaviour complicate the use of simple geochemical proxies. Modelling of partial melting or magmatic fractionation of mafic source rocks in variably thick crust followed by equilibrium or fractional crystallization of resultant granitoids (the dominant primary source of zircon in the geological record) demonstrates that some signals of secular change can potentially be deconvolved from large zircon data sets. However, this requires considering the confluence of factors that influence intensive variables in natural petrological systems throughout Earth's history.

[1]Roberts, N.M., et al. 2024. *Geoscience Frontiers*, *15*, p.101852, [2]Tang, M., et al., 2024. *Earth and Planetary Science Letters*, *643*, p.118897, [3]Bartoli, O. and Carvalho, B.B., 2025. *Earth-Science Reviews*, *268*, p.105175