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Predicting source rock silica from igneous zircon characteristics

TARYN SCHARF[1], VLADIMIR PUZYREV[2], CHRISTOPHER L. KIRKLAND[3] AND MILO BARHAM[4]

[1]Timescales of Mineral Systems Group, Curtin University
[2]Schlumberger-Doll Research
[3]Curtin University
[4]Timescales of Mineral Systems Group, School of Earth and Planetary Sciences, Curtin University

Presenting Author: t.scharf@curtin.edu.au

Zircon is often used for studies of crustal petrogenesis and geotectonic evolution, given its suitability for dating and geochemically fingerprinting deep-time geological processes. The physical characteristics of zircon grains also carry information, as these features are influenced by the physico-chemical conditions of the crystal's growth environment. For example, zircon 2D shape has been used to support the discrimination of detrital zircon sources, particularly when crystalline sources have non-unique ages and isotopic signatures[1]. Similarly, igneous zircon 2D shape - as measured from crystal cross-sections in geochronology mounts - has been attributed to the changing crystallisation environment that accompanies the change in silica content of a parent melt[2]. However, despite the apparent links between zircon shape and growth environment, predictive relationships between zircon shape characteristics and source rock chemistry are challenging to define. Here we present the results of a neural network that predicts source rock silica content using data that is readily accessible during routine geochronology analyses; namely, zircon 2D shape, cathodoluminescence texture, and grain U and Th content. The model was trained and tested using a Western Australian dataset with a broad spatial (>2.5 x10^6 km^2), temporal (>3 Gyr) and compositional (47-69% whole-rock silica) range. It was applied to a case study of crystalline rock from West Greenland, where it predicts the source rock silica of a zircon population to within ~5% of the measured whole-rock value. Our approach demonstrates potential as an inexpensive, non-destructive tool for extracting geochemical information from datasets when this information is lacking, or when an alternative means of assessing parent melt characteristics, independent of trace element partition coefficients, is sought.

References

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