Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.20560

U-Pb zircon petrochronology in magmatic systems: a tribute to URStime

BLAIR SCHOENE

Princeton University

Presenting Author: bschoene@princeton.edu

The last 15 years have seen great strides in using zircon U-Pb geochronology as a petrochronologic tool in magmatic systems, from large igneous provinces, to batholiths, to ore deposits. Urs Schaltegger helped inspire early versions of this work and has been at the center of it ever since. This talk highlights some of the accomplishments and future opportunities to further improve our understanding of magmatic processes through petrochronology, with a focus on zircon ID-TIMS U-Pb geochronology – Urs' tool of choice.

The goals of petrochronology in magmatic systems revolve around knowing where and when melt was present. Specifically, what processes influence how the location, amount, and compositions of the melt and solid (and gas!) phases change through time? These goals cannot be reached without precise and accurate time constraints, and zircon is a primary but imperfect tool for providing them. We have seen improvements in both the theoretical and modeling framework for the growth of zircon in magmas and also an expanding toolbox used to combine the geochemistry and textures of zircon with their high-precision dates. But theory and observation do not always match, which can be due to either analytical insufficiencies or theoretical oversimplifications. Analytical challenges include that volumes of material analyzed for high-precision age average out processes recorded over finite, and difficult to quantify, durations. Techniques that measure age with the highest spatial resolution generally lack the precision to capture processes occurring on magmatic timescales. Numerical modeling techniques have improved such that they can predict zircon and major phase growth histories in magmatic systems with prescribed boundary conditions. However, our samples contain the mind-boggling complexity of magmatic processes, but the models do not.

Harmonizing these approaches will require further reconciling the strengths and weaknesses of high-precision and high-spatial resolution geochronology in addition to models of increasing sophistication. Creative combinations of these approaches with complementary analytical tools that measure geochemical and isotopic compositions on a spectrum of scales will carry on Urs Schaltegger's legacy in the geochronologic community and beyond.