What we've learned through petrochronology by U-Pb TIMS-TEA

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Over the last decade increased effort has been made to integrate high-precision ID-TIMS U–Pb geochronology with complementary petrologic information, e.g., field observations, petrographic context and geochemistry of dated phases. An approach we have developed and exploited, U–Pb TIMS-TEA, involves retaining the wash solution from routine ion separation chemistry and analyzing it by either single-collector ICP-MS (trace elements) or multicollector ICP-MS (e.g., Hf isotopes).

Most of our work has focused on characterizing zircon in magmatic systems, in order to: 1) calibrate the rates of magma differentiation by resolving mineral geochemical trends in absolute time, 2) relate accessory mineral chemistry to major phase crystallization, 3) deconvolve primary vs. inherited zircon domains in oft-complex age spectra so as to more accurately reconstruct magmatic histories, and 4) help better identify and interpret pre-eruptive zircon growth in volcanic samples. Although uncertainties in partition coefficients still limit quantification of geochemical modeling, we've made considerable progress on some of these goals.

In some magmatic systems, zircon geochemistry exhibits trends over several hundred kyr, permitting quantification of closed system crystallization, pinpointing timing of magma rejuvination, calibrating supersolidus cooling rates, and identifying different pulses of emplaced magma. Other systems show no zircon age–compositional correlations, although zircon geochemistry often still exhibits trends in cross-plot space (e.g., Zr/Hf vs. Gd/Yb). Such examples may reflect zircon populations derived from geochemically similar magmas that are sampled at different thermal maturities. In both cases, U–Pb TIMS-TEA data better permit constraining where liquid was in a system as a function of time – the most important factor in building quantitative models of magmatic systems at all levels of the crust.