139-7 - NEW TOOLS FOR HIGH SPATIAL RESOLUTION PETROCHRONOLOGY BY LASER ABLATION AND APPLICATION TO COMPLEX ACCESSORY MINERALS

Monday, September 23, 2024

3:55 PM - 4:10 PM

206B (Anaheim Convention Center)

Abstract

Melting of continental crust in collisional orogenic systems is an important process, controlling crustal rheology and re-distribution of heat and mass, and potentially triggering exhumation of deep crustal rocks. To quantify the tectonic significance of crustal anatexis, it is necessary to establish the timing, duration, and frequency of melting and melt crystallization events. This is commonly achieved by a detailed interrogation of actinide-bearing accessory minerals including zircon, monazite, xenotime, apatite, etc. However, numerous petrochronology studies in a range of orogens have yielded isotopic and elemental data that are complex and often difficult to interpret. Such data show distributions of apparently concordant dates that far exceed the typical timescales for mobilization, transport, and crystallization of melt batches. Interpretations are further complicated by the potential for accessory minerals to preserve inherited domains, actinide gain, lead loss, and/or protracted (re-)crystallization, and the possibility of physical mixing of discrete domains during isotopic/elemental analysis. Using examples from the Canadian Cordillera, the Himalaya, and Zealandia, two new analytical techniques are outlined for the rapid characterization of large numbers of accessory minerals in two- and three-dimensions at micron-scale spatial resolution. The first technique involves coupling a newly developed “TwoVol3” laser ablation chamber on an imageGEO193 laser ablation unit (Elemental Scientific Lasers) to a “Vitesse” time-of-flight inductively coupled plasma mass spectrometer (Nu Instruments). This integrated system enables the generation of isotopic and elemental maps at a rate of at least one megapixel/hour at low ppm detection limits. The second system uses the same ultrafast washout (~1 ms) laser coupled to a Nu Plasma 3D multicollector-inductively coupled plasma-mass spectrometer (MC-ICP-MS) equipped with six Daly detectors for isotopic ratio measurements and an Agilent 8900 Quadrupole ICP-MS for elemental concentration measurements, that similarly enables rapid data collection at high spatial resolution. This presentation will highlight the advantages of each method, and detail new insights into accessory mineral evolution in crustally-derived granites.

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