Ultra-fast and beyond: LA ICP MS isotope ratio mapping of zircon at 500 Hz

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Laser ablation inductively coupled plasma mass spectrometry (LA ICP MS) elemental mapping techniques have seen an exponential development in the last few years, fueled both by new hardware and software developments. Faster, more efficient aerosol transport systems have continuously pushed the boundaries of accuracy, precision and speed of the analyses. Conversely, advances in data reduction software have streamlined the image generation procedures and have greatly improved the quality of the data[1].

While most of the work has been carried out on deciphering trace elemental distribution in various matrices (*e.g.*, geological and biological samples, archaeological artifacts, etc.), little effort has been invested in looking at isotope ratio distribution, especially in geological samples.

In this contribution we present a novel approach to isotope ratio mapping, using rapid-response sample transport technologies (Aerosol Rapid Introduction System ARIS, Teledyne CETAC Technologies) and ultra-fast laser repetition rates. The ARIS allows for individual single pulses to be resolved at high sampling rates (> 70 Hz; signal decay to baseline levels of <15 ms), as well as boosts the sensitivity of the ICP MS signal. In order to match the sampling speed, the laser needs to be operated at high repetition rates. For this purpose we used repetition rates in excess if 450 Hz, while adjusting the corresponding laser parameters (*e.g.*, scanning speed, spot size, number of spot overlaps) and the ICP MS data acquisition parameters accordingly. This allowed us to monitor all the relevant iotopes used for geochronological calculations (^{90}Zr or ^{91}Zr, ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{232}Th, and ^{238}U).

To test the performances of the setup (sensitivity precision, accuracy, spatial resolution) we investigated several different samples: zircons with clear internal compositional zoning from a Mesozoic miaskitic nepheline syenite, a thalénite-xenotime-zircon-fergusonite-pyrochlore assemblage from a Variscan metasomatic HFSE mineralization, coronitic monazite from a Paleoproterozic polymetamophic gneiss.

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