Recent in situ geochronology studies with the CAMECA ion microprobe

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RESUMO: SIMS (Secondary Ion Mass Spectrometry) is a powerful micro-analytical technique that provides direct in situ measurement of elemental and isotopic composition in selected µm-size areas of the sample. The CAMECA IMS 1280-HR is a ultra-high sensitivity ion microprobe that delivers unequalled analytical performance for a wide range of SIMS applications (isotope ratio measurements, analyses of trace elements ...).

In particular, this tool has been extensively used for geochronology applications (U-Pb dating in Zircon) as it provides isotope measurements at high sensitivity. The instrumental design has been optimized for this application: high transmission at high mass resolution mass spectrometer, high density O^-/O_2^- primary beam spots, combined with oxygen flooding technique for improved sensitivity and highly reproducible analytical conditions.

Several papers have been published recently presenting pioneering Geochronology results. A selection of data will be presented, among which:

- A method of precise U-Pb dating for zircons at a scale <5µm, using Gaussian primary ion beam illumination (instead of projected mode). Combined with oxygen flooding technique and optimized transmission settings, this method has been successfully demonstrated on well-characterized zircon standards (160-1100 Ma).
- Zircon age determination using depth profiling on detrital zircons found in metamorphic rocks. Metamorphism affected only a very thin zircon rim (<1 µm), too small for spot analysis, therefore a different approach was applied based on depth profiling. A Concordia age of 475 ± 10 Ma, corresponding to the timing of the peak metamorphism, could be determined from the outer ~1.15 µm of the zircon.
- Ion imaging analysis of problematic zircon crystals. A pioneering method combining scanning ion imaging and depth-profiling was used to analyze zircon crystals from Southern India, region affected by UHT metamorphism at ca. 570 Ma. Results showed the presence of nm-scale domains of isolated radiogenic Pb whose formation is assigned to annealing processes during the UHT event.
- Baddeleyite (ZrO_2) dating is a challenging application, because grains are small (<20µm) and crystal orientation effects are known to affect U–Pb ages. Recent study shows that accurate U–Pb baddeleyite dates (<1-4%) can be obtained using the CAMECA tool thanks to: the oxygen flooding which enhances the Pb yield (×7!) & reduces crystal orientation effects, and the “ion microscope” design for an improved spatial resolution.
- New protocol for in situ rutile (TiO_2) dating, using an O_2^+ beam (combined with oxygen flooding). This method offers many advantages: ease of operation, higher overall secondary ion signal (due to the high primary beam intensity) and reduced common Pb contribution (due to higher sputter rates) resulting in precise and accurate rutile dating.

PALAVRAS-CHAVE: SIMS, ION MICROPROBE, GEOCHRONOLOGY