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Integrated Petrochronolgy combining automatic EDS-BSE-SEM and LA-ICP-QMS analyses in petrographic thin sections

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Laser ablation-inductively coupled plasma mass spectrometry (LA-ICP-MS) is a very convenient analytical tool for fast U-Pb dating of accessory minerals in petrographic thin sections and mounts. However, the interpretation of geochronological data in complex rocks requires the integration of mineral textures, thermodynamic data in compositional domains, as well as the morphology and textural position of accessory minerals (i.e. inclusions, host phases, matrix vs porphyroblast, etc...). These data are fundamental to unravel complex events usually recorded in polymetamorphic terranes. In this contribution, we describe the analytical protocols used in the AndalChron lab (IACT, CSIC-UGR, Granada) for the fast automatic detection and textural characterization of accessory minerals by automatic EDS-BSE-SEM, and their subsequent analyses by LA-ICP-QMS in petrographic thin sections and mounts. AndalChron uses a Zeiss EVO-15 equipped with Oxford Instruments Max80 EDS and BSE detectors to scan full thin sections detecting accessory minerals using a custom scheme that discriminates accessory minerals by combining information from chemical composition, morphology and different thresholds of BSE brightness. The result of the automatic detection procedure is a complete thin section map with the location of the different accessory phases –mapped by color—in a high-resolution BSE map of the thin section. The detection procedure also provides a table with accessory coordinates, different morphometric parameters and their semi-quantitative composition. Every accessory has a unique ID number that is used to identify grains in the subsequent analysis by LA-ICP-MS and the geochronological data reduction process. A thin section of a granulite facies rock is typically scanned in less than 2 hours, resulting in the detection of hundreds of zircon, monazite and rutile grains in a BSE map of the thin section. For zircon mounts, an additional and medium-resolution Cathodoluminescence map is simultaneously acquired.

U-Pb analyses are then performed using a CETAC–Photon Machines 193 nm laser system coupled to an Agilent 8800 ICP-MS/MS. The thin section maps coordinates are calibrated in the ablation cell coordinate referenced system in a two-step process. The double volume ablation cell permits automatic selection of hundreds of spot locations with automated control of the positions and unattended analysis for hours. The precise position of accessories to analyze, their BSE maps for thin sections – or Cathodoluminescence maps in case of zircon mounts are available for analyses point selection, and automatic pictures of analyses are then taken for every spot after the LA-ICP-MS analysis. If EDS-SEM automatic quantitative data of accessories are acquired during detection, the chemical data are used for internal standardization for quantitative REE, and other trace elements, simultaneous acquisition by LA-ICP-MS.

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