Geophysical Research Abstracts
Vol. 19, EGU2017-17171-1, 2017
EGU General Assembly 2017

QEMSCAN+LA-ICP-MS: a 'big data' generator for sedimentary provenance analysis

Pieter Vermeesch (1), Martin Rittner (1), and Eduardo Garzanti (2)

(1) Department of Earth Sciences, University College London, London, UK (p.vermeesch@ucl.ac.uk), (2) Department of Earth and Environmental Sciences, Universita di Milano-Bicocca, Milan, Italy

Sedimentary provenance may be traced by 'fingerprinting' sediments with chemical, mineralogical or isotopic means. Normally, each of these provenance proxies is characterised on a separate aliquot of the same sample. For example, the chemical composition of the bulk sample may be analysed by X-ray fluorescence (XRF) on one aliquot, framework petrography on another, heavy mineral analysis on a density separate of a third split, and zircon U-Pb dating on a further density separate of the heavy mineral fraction. The labour intensity of this procedure holds back the widespread application of multi-method provenance studies. We here present a new method to solve this problem and avoid mineral separation by coupling a QEMSCAN electron microscope to an LA-ICP-MS instrument and thereby generate all four aforementioned provenance datasets as part of the same workflow. Given a polished hand specimen, a petrographic thin section, or a grain mount, the QEMSCAN+LA-ICP-MS method produces chemical and mineralogical maps from which the X-Y coordinates of the datable mineral are extracted. These coordinates are subsequently passed on to the laser ablation system for isotopic and, hence, geochronological analysis. In the process of finding all the zircons in a sediment grain mount, the QEMSCAN yields the compositional and mineralogical compositions as byproducts.

We have applied the new QEMSCAN+LA-ICP-MS instrument suite to over 100 samples from three large sediment routing systems: (1) the Tigris-Euphrates river catchments and Rub' Al Khali desert in Arabia; (2) the Nile catchment in northeast Africa and (3) desert and beach sands between the Orange and Congo rivers in southwest Africa. These studies reveal (1) that Rub' Al Khali sand is predominantly derived from the Arabian Shield and not from Mesopotamia; (2) that the Blue Nile is the principal source of Nile sand; and (3) that Orange River sand is carried northward by longshore drift nearly 1,800km from South Africa to southern Angola. In addition to these geological findings, the first applications of QEMSCAN+LA-ICP-MS highlight some key advantages of the new workflow over traditional provenance analysis: (a) the new method not only increases sample throughput but also improves data quality by reducing significant biases associated with mineral separation and grain selection; (b) the three case studies highlight the importance of zircon 'fertility' for interpreting detrital zircon U-Pb datasets, and the ability of QEMSCAN to quantify this crucial parameter semi-automatically; (c) QEMSCAN+LA-ICP-MS provides an opportunity to add textural information to detrital geochronology and, for example, quantify possible grain-size dependence of U-Pb age distributions. But besides these advantages, the three case studies also reveal a number of limitations: (a) mineral identification by QEMSCAN is not as reliable as commonly achieved by human observers; (b) heavy mineral compositions obtained by QEMSCAN cannot easily be compared with conventional point counting data; and (c) apparent grain sizes can be greatly affected by polishing artefacts. In conclusion, QEMSCAN+LA-ICP-MS is a transformational new technique for provenance analysis but should be used with caution, in combination with conventional petrographic and heavy mineral techniques.