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LA-ICP-MS trace element mapping and its application to geochemical transport in garnet

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Existing instrumentation used to interrogate trace element distributions in geological samples includes EPMA, TEM, SEM, SIMS and synchrotron XRF/XRD analysis. Each technique has its inherent strengths and limitations, whether they relate to detection limits, analytical volumes, sample preparation, and/or instrumentation cost and accessibility. Traditionally, LA-ICP-MS has been used to quantify trace element (wt%–ppb) content in a wide variety of materials via spot analysis. However, its utility as an imaging tool has recently emerged to allow 2D mapping with excellent detection limits (ppb) over a wide isotopic range (^{7}Li to ^{238}U), with minimal sample preparation required. This is achieved by rastering of the focused laser beam in linear transects, which are then stitched together by post-acquisition processing to form a quantified or semi-quantified image of the trace element distribution. Large suites of isotopes are able to be collected simultaneously, allowing access to substantially increased geochemical information from analysed samples. We demonstrate the use of the LA-ICP-MS imaging technique to reveal complex trace element zonation patterns in a variety of garnets affected by fluid–rock interaction, including those from metasomatised mid-crustal shear zones and a calcsilicate skarn deposit. Such detailed geochemical records shed light on trace element behaviour during metasomatic processes, including their impact on Sm-Nd and Lu-Hf garnet geochronology. Ultimately, this allows for the construction of coupled *P–T–t–fluid* histories from individual samples.