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Garnet U–Pb dating by LA–ICPMS: Opportunities, limitations, and applications

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Geochronology provides the time frame for various fields of research in the earth sciences that investigate the geological history from the mineral scale to tectonic plates. The reconstruction of pressure–temperature-time (*P–T–t*) paths of metamorphic rocks from collisional settings such as orogenic belts, for example, is commonly achieved by linking chronological (U–Pb) and trace element data from U-rich accessory phases such as zircon, monazite, titanite, or rutile, with thermobarometric information derived from rock-forming minerals such as garnet. The ability to extract both types of information from one mineral makes garnet arguably the most versatile and powerful petrochronometer. Garnet has an extensive *P–T* stability field for a wide variety of rock compositions, and changes in *P–T* conditions during garnet growth are recorded in compositional changes. Garnet U–Pb ages can thus be linked to compositionally distinct garnet domains, providing a direct link between *P–T* estimates and chronological data. Although still in its infancy, U–Pb dating of metamorphic garnet by LA–ICPMS is an evolving petrochronological tool with a vast potential and a plethora of possible applications.

This contribution discusses the advantages and limitations of this method, as well as the significance and meaning of garnet ages. The benefits of the method, as compared to conventional isotope dilution techniques, are the ease of sample preparation, rapid data acquisition and processing, high spatial resolution, and relatively low costs. However, the very low (≤1-100 ng/g) and variable U content of regional metamorphic garnet and the frequently ubiquitous presence of inclusions of U-rich accessory minerals are obstacles that affect the precision and accuracy of garnet U–Pb dates, or may render a particular garnet sample undateable altogether. These various aspects of garnet U–Pb dating by LA–ICPMS will be examined by discussing metamorphic garnet from the Alps, which had previously been dated by Sm-Nd chronology (Pollington and Baxter, 2010).

Pollington, A.D., Baxter, E.F., 2010. High resolution Sm–Nd garnet geochronology reveals the uneven pace of tectonometamorphic processes. Earth and Planetary Science Letters 293, 63–71. https://doi.org/10.1016/j.epsl.2010.02.019