Exploring the potential of allanite as a geochronometer of high-grade crustal processes

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The REE-rich accessory mineral allanite plays a key role in the storage and mobility of geochemically important trace elements (LREE, Th) in magmatic and high-grade rocks. Allanite occurs in a wide range of rock types, but of particular interest is its common presence in mafic, migmatitic and high-pressure rocks. We report on the response of allanite trace element chemistry and its U-Th-Pb isotopic system to magmatism, partial melting and eclogite-facies metamorphism.

In situ U, Th-Pb geochronology of allanite has been carried out using SHRIMP ion microprobe in conjunction with LA ICP-MS analysis. We analyse allanite with a variety of FeO and trace element compositions from anatectic rocks, granodioritic to tonalitic plutons and high-pressure mafic rocks. Allanite Th-Pb ages are capable of reliably addressing geochronological problems with a precision of 1-2% and 2-5% (2σ) for magmatic and metamorphic rocks, respectively. This study allows preliminary conclusions to be made for the closure temperature of allanite. In the case studies presented, no indication of inheritance has been observed for allanite.

The trace element composition of allanite records changes in paragenesis. Allanite HREE content relative to LREE provides an indicator for the co-crystallization of garnet. Where allanite formed in migmatites display a small negative Eu anomaly, eclogitic allanite lacks a Eu anomaly, which is related to crystallization in the absence of plagioclase. In addition, the Sr content in allanite can be used as an indicator of crystallization above the stability field of plagioclase. This study demonstrates that allanite can be correlated to major metamorphic and rock-forming minerals and therefore the P-T conditions of crystallization.