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Garnet U-Pb dating by LA-ICP-MS: Regional metamorphic garnet vs. skarn garnet

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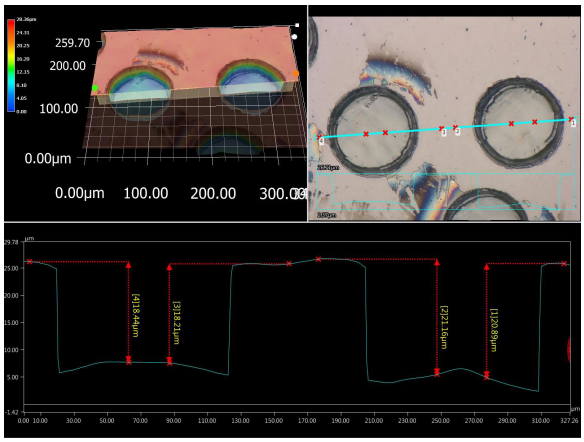

Fig. 1. 104 µm laser ablation pits from a skarn garnet sample (Bor Pit, Dalnegorsk, Russia)

Garnet has an extensive pressure-temperature (P-T) stability field for a wide variety of rock compositions, and changes in P-T conditions are reflected in compositional changes during garnet growth. Due to these characteristics, garnet is key for metamorphic petrologists that investigate, e.g., the evolution of crustal metamorphic rocks, or of upper mantle lithologies. While major and trace element compositions and patterns have been intensively studied to decipher the growth history of garnet, time-intensive conventional dating techniques do not allow for a distinction between chemically different domains, unless the grains are exceptionally large.

Recent improvements in analytical capabilities, in terms of sensitivity and spatial resolution, have enabled geochronologists to pursue garnet U-Pb dating by LA-ICP-MS. The major advantages of this method are the ease of sample preparation, rapid data acquisition and processing, and the high spatial resolution (Fig. 1). This relatively new field of research has therefore great potential for extracting chronological information from compositionally divers garnet specimens. Moreover, garnet grows during the prograde evolution of metamorphic rocks, thus providing prograde to peak metamorphic ages that complement peak to retrograde metamorphic ages commonly obtained from accessory phases such as zircon and monazite.

In this study we investigated two regional metamorphic almandine-pyrope garnet and two grossular-andradite skarn garnet samples to exemplify the vast variability observed in natural garnet with respect to composition, inclusion density and U-content. Our results demonstrate that the dating of skarn garnet is mostly straightforward, due to its high U-content (~1-10 µg/g) and the lack of inclusions. The dating of regional metamorphic garnet, however, is commonly complicated due to low U-contents (<<1 µg/g) and abundant inclusions. In fact, one of the two regional metamorphic garnet samples did not yield a reliable U-Pb age. We further observed differences in ablation behaviour between the different garnet types. This has a bearing on the accuracy of U-Pb ages and potential matrix effects will be discussed.