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Long story encrypted in a small grain – zircon from meta-andesite in Lower Köli Nappes reveals complex history of Virisen arc, Scandinavian Caledonides, Sweden

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The Köli Nappe Complex (KNC) of the Scandinavian Caledonide orogen originated as oceanic terranes within the Iapetus Ocean. These terranes have characteristics of magmatic arcs and associated fore-arc or back-arc basins and underwent several periods of rifting and magmatism prior to their accretion to the Baltican margin. U-Pb isotopic dating of magmatic zircon grains from metamorphosed andesitic rock of the Lower Köli Nappe give an age of 491 ± 3 Ma. This date fits with most of the previously published ages of magmatism in an arc system within Iapetus. However, an older age component of c. 520 – 510 Ma has also been found in the studied zircon. The meaning of this age remains enigmatic, but it overlaps with the oldest, and thus somewhat controversial, age obtained for metaigneous rock in the lower KNC – 512 ± 3.5 Ma (Carter et al. 2023).

Combined cathodoluminescence (CL), back-scattered electron (BSE) imaging and chemical mapping revealed three distinct growth zones in zircon. The most internal one (core) can be seen only in few grains and is most noticeable in elemental maps for yttrium. The core is clearly magmatic, however it is partly rounded in shape. The second zone (mantle) displays oscillatory or sector zoning and trace element patterns typical for igneous zircon. Chemical maps show discontinuity of growth between core and mantle. The most external zone (rim) is discontinuous and porous, displaying dark CL and patchy BSE images. Chemical mapping revealed that rims have high Y and U content and often contain multiple small ingrowths of Al-rich phases.

The presence of older, magmatic cores implies that 520 – 510 Ma ages may relate to previous magmatic event and thus support 512 Ma age obtained by Carter et al. (2023). The main igneous phase recorded by the mantle zone confirms that the most widespread magmatism in the KNC occurred c. 490 Ma. The complex structure of the U-rich zircon rims resulted from fluid-induced alteration, the effect of which seems to have been enhanced by radiation damage causing metamictisation .

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