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Going back in time: mineral pitfalls and associated SIMS tricks

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Secondary Ion Mass Spectrometry (SIMS) is a technique extensively applied to minerals to go back in geologic time. Either by dating old grains of zircon or apatite and unravelling their geochemical environment through their stable isotope signature, or by utilizing such minerals as time capsules, storing information about the past in their cargo of inclusions.

However, minerals can be subject to secondary processes such as dissolution-reprecipitation, diffusion, amorphization, in response to large-scale geodynamic events or local radiations. These processes alter the primary chemical and isotope composition of minerals. The likelihood and magnitude of such alteration increases with the age of the minerals.

The thorough characterisation of mineral internal textures (BSE, CL imaging using SEM), and inter-mineral relationships where possible, is key to assessing the reliability of mineral grains, or their inclusions, in preserving their primary geochemical information. Complex zoning, porosity, cracks, composite inclusions, are obvious signs of potential secondary processes. They can largely be avoided using the in-situ capability of the SIMS: using spot analyses down to a few microns, or analyzing grains by scanning ion imaging to assess the impact of potential secondary processes on the primary dataset. Regardless, the effect of secondary processes can be difficult to gauge based on mineral texture alone, or they can leave only cryptic signs of modifications. In these cases, combining isotope systems or isotope to elemental analyses during single analyses can allow filtering of SIMS datasets to identify and exclude altered compositions.