

Isotope Geochemistry Applications of Atom Probe Microscopy

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Atom Probe Microscopy (APM) is a three-dimensional nanometer-scale chemical and isotopic analysis technique with enormous potential for development within isotope geochemistry. Traditionally applied in materials science, its recent introduction to the geosciences has already generated new insights into nanoscale geochemical processes, revealing significant chemical and isotopic nanostructures within minerals of geological interest [1, 2].

While the spatial resolution of conventional isotope geochemical studies is typically limited to the micron scale, APM can peer well below this limit, to provide quantification of isotope variability at nanometre scales. However, substantial work remains to fully develop and standardise the methods and analytical tools required to utilise atom probe microscopy for isotope studies, and to establish the technique as a standard tool for isotope geochemistry.

To date, APM isotope studies in geological material have focused on radiogenic isotopes. But there is also potential for nanoscale isotopic fingerprinting in stable isotope systems, and in identifying isotopic patterns arising from nucleosynthetic or biosynthetic processes.

This presentation reviews the state-of-the-art in applying APM to isotope geochemistry, discussing questions of accuracy and applicability. The areas where there is currently need for further development, and the possibilities for future directions in nanoscale isotopic analysis are considered. Recent examples from the Geoscience Atom Probe facility are also presented, showing a variety of cases in which APM has revealed new information from well-studied systems.

[1] Valley, Reinhard, Cavosie, Ushikubo, Lawrence, Larson, Kelly, Snoeyenbos & Strickland (2015), *American Mineralogist* 100, 1355-1377.

[2] Peterman, Reddy, Saxey, Snoeyenbos, Rickard, Fougerouse & Kylander-Clark (2016), *Science Advances* 2, e1601318.