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Imaging trace-element zoning in pyroxenes using synchrotron XRF mapping with the Maia detector array: Benefit of low-incident energy

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Abstract

Trace-element zoning in igneous phenocrysts and cumulus phases is an informative record of magmatic evolution. The advent of microbeam X-ray fluorescence (XRF) mapping has allowed rapid chemical imaging of samples at thin section to decimeter scale, revealing such zoning patterns. Mapping with synchrotron radiation using multidetector arrays has proved especially effective, allowing entire thin sections to be imaged at micrometer-scale resolution in a matter of hours. The resolution of subtle minor element zoning, particularly in first-row transition metals, is greatly enhanced in synchrotron X-ray fluorescence microscopy (XFM) images by scanning with input beam energy below the Fe$K\alpha$ line. In the examples shown here, from a phenocryst rich trachybasalt from Mt Etna (Italy) and from a Ni-Cu-PGE ore-bearing intrusion at Norilsk (Siberia), the zoning patterns revealed in this way record aspects of the crystallization history that are not readily evident from XFM images collected using higher incident energies and that cannot be obtained at comparable spatial resolutions by any other methods within reasonable scan times. This approach has considerable potential as a geochemical tool for investigating magmatic processes and is also likely to be applicable in a wide variety of other fields.

Keywords: Synchrotron, X-ray fluorescence mapping, pyroxene, zoning, Mt Etna, Norilsk