Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11802

Olivine, let's talk about the elephant in the mantle room.

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Olivine has been for some time now the derelict mineral of the lithosphere for geochemist. Indeed because of its “tight” crystalline structure, olivine is extremely depleted in trace elements ca 100 times less than usual key peridotitic minerals, garnet and clinopyroxene. Yet, olivine forms more than 60% of the mantle and thus dictated the rheology and geophysical properties of the entire Earth's upper mantle. Therefore, while geophysicists study an olivine mantle, geochemists focus on a pyroxene mantle.

By spicing up our plasma with trace molecular gas, a significant increase in ionization efficiency is achieved for most elements and greatly enhancing the sensitivity of our LA-ICP-MS instruments. Although the production of poly-atomic interferences is slightly increased, the relative simple major-element composition of olivine allows us to monitor and correct for these interferences. Thanks to this remarkable improvement we can finally assess the full ultra-trace-element composition of olivine, including the rare-earth, high-field-strength and large-ion lithophile elements and also the abundance of moderately siderophile and chalcophile elements. For instance, typical detection limits for Lu, Eu, La or Nb are now between 0.02 and 0.05 ppb.

Olivines that equilibrated in the spinel or garnet facies from peridotite xenoliths entrained in alkali basalts and kimberlites and in peridotites from orogenic massifs have been investigated. We have also investigated modally and cryptically metasomatised samples. The results show significant variations in trace-element content depending on coexisting phases, melting degree and metasomatic processes. These demonstrate that olivine ultra-trace element contents and relative abundances provide reliable fingerprints to characterise the composition of the lithospheric mantle.

Olivine xenocrysts are far more abundant and widespread than peridotite xenoliths in primitive lavas. Olivine geochemistry thus provide a new and sensitive tool to increase the resolution of chemical tomography models of the mantle lithosphere and thus provide more robust comparisons to constrain the geochemical interpretation of seismic and magnetotelluric datasets.