Fabrication of synthetic olivine capsules for use in experiments

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We present a method for manufacturing polycrystalline olivine capsules suitable for use as containers in near-liquidus experiments on olivine-saturated melt compositions. The capsule manufacture involves a 2-stage process: the subsolidus reaction of a pressed pellet of oxides (including Fe_2O_3) under reducing conditions to form olivine; followed by pressing of the ground product into the desired capsule form, and then subjection of this capsule to cycles of heating (to near-solidus conditions) and cooling in order to stimulate grain growth.

We developed this method in order to avoid common problems of iron loss from the melt to its wire-loop, and reactions between wire loops and reactive sulphide liquids. In addition, using olivine as a capsule material allows the Fe/Mg ratio of silicate melts to be buffered. Olivine-melt partitioning of trace elements can also readily be measured.

The method of heat treatment is critical because of residual porosity in the capsule. Due to the high wetting-angle of olivine by basaltic melts, porous capsules readily absorb the silicate melt, which can then escape the outer walls altogether. We have tried various methods of avoiding this problem, including using pressed capsules of olivine-melt mixtures, but the cycles of heating and cooling is the only approach which has so far been reliably successful (i.e. the melt is contained for long periods, even at 1 atmosphere pressure).

The range of capsule compositions that can be manufactured spans the entire range of known solar system olivines. The capsules can host relatively large volumes of melt, which are easily analyzed by techniques that suffer from poor spatial resolution. We hope that this method will make possible a range of hitherto unfeasible experiments.