

## Precipitate Distribution in Reduced Olivine

A. Duba,<sup>1</sup> J. N. Boland,<sup>2</sup> and J. Akella<sup>1</sup>

<sup>1</sup>Lawrence Livermore National Laboratory, Livermore, Ca. 94550

<sup>2</sup>Institute of Earth Sciences, State University of Utrecht,  
P.O. Box 80.021 3508 TA Utrecht, Netherlands

We have heated natural olivine single crystals from San Carlos, Arizona and dunite from Anita Bay, New Zealand, in reducing atmospheres of CO<sub>2</sub> and CO at temperatures from 1150 to 1400°C in order to compare the distribution of metallic phases produced experimentally due to reduction with those observed in meteorites (Rambaldi & Wasson, 1981). In single crystals, the initial stages of the reduction reaction is controlled by the gas-solid interface. The high concentration of metallic precipitates observed within the first  $\mu\text{m}$  of the surface decreases rapidly with depth in the crystals (Fig. 1). During the initial stages of the reduction reaction in polycrystalline dunite, both the gas-solid interface and grain boundaries serve as nucleating sites for the metallic phases (Fig. 2). At times greater than about 10 hours at 1300° and 1400°C, reduction produces Fe-Ni precipitates of 1 to 2  $\mu\text{m}$  diameter throughout the olivine crystals. The Ni/Fe ratio in the precipitates, produced by heating olivine in CO/CO<sub>2</sub> mixtures outside its stability field, is directly proportional to the initial Ni/Fe ratio of the olivine and the oxygen fugacity ( $f_{\text{O}_2}$ ), and is inversely proportional to the duration of the reduction episode. Thus, the highest Ni/Fe ratios in the precipitates are observed during the initial phase of the reduction at  $f_{\text{O}_2}$  just outside the olivine stability field.

There is an association of voids with these precipitates as shown in Fig. 3. These voids are likely the result of the reduction reaction, although it is possible that the reduction exploits regions of the single crystal which contained gas bubbles prior to our experiment.

The reduction of Ni/Fe in olivine produces excess silica which at the temperatures of our experiments should react with the more magnesian olivine residue to produce some pyroxene, however, in none of the olivines studied could we find sufficient pyroxene to account for the amount of Ni/Fe produced. We interpret this negative result as an indication that olivine can tolerate a slight excess of silica. STEM results confirm that excess silica is present in the interior regions of these reduced olivines.

An interesting feature is observed if platinum metal is in contact with the olivine single crystals during reduction episodes at temperatures of 1300°C and greater. Some of the iron is lost to the platinum during the reduction process, and the surface of the olivine in contact with the platinum serves as a site for the nucleation and growth of a magnesian pyroxene. Deeper than about 2  $\mu\text{m}$  in these crystals there is no evidence of a pyroxene although there are Ni/Fe particles throughout the crystal.

Our experimental observations suggest that the Ni/Fe precipitates observed in meteoritic olivines, could be due to some reduction process during the chondrule formation.

### Reference

E. R. Rambaldi and J. T. Wasson, "Fine, nickel-poor Fe-Ni grains in the olivine of unequilibrated ordinary chondrites", preprint, 1981."

## PRECIPITATE DISTRIBUTION IN REDUCED OLIVINE

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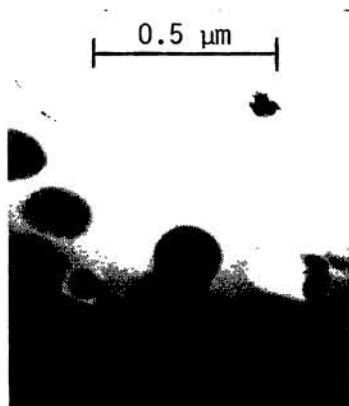


Fig. 1. Single crystal of reduced San Carlos olivine: Bottom of photo is surface of the crystal.

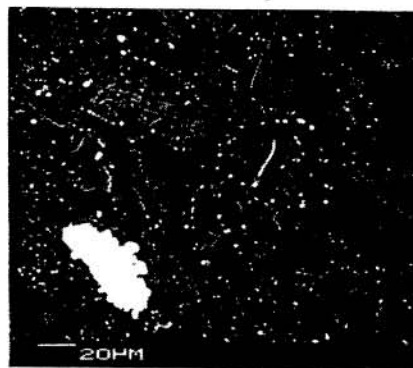


Fig. 2. Reduced Anita Bay dunite.

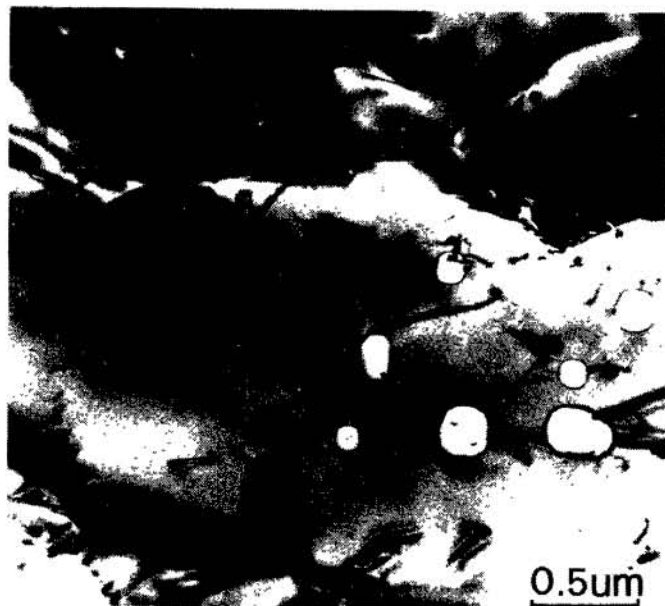


Fig. 3. Reduced San Carlos single crystal. Voids are labeled "B", "P" is Fe/Ni precipitate.

"Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore Laboratory under contract number W-7405-ENG-48."