

# The Effect of Sintering on the Kinetics of the Phase Transformation of Olivine to Wadsleyite or Ringwoodite

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## Introduction

It has been pointed out that sintering after the compression stage is an important process for studying reaction kinetics.<sup>1,2</sup> The hot-pressing stage is necessary to produce an equilibrium microstructure in the starting material and to reduce the density of dislocations and other defects resulting from pressurization of powdered samples. In this study we examine the effect of annealing on the kinetics of the olivine phase transformations.

## Materials and Methods

Experiments were carried out at beamline 13-BM. The starting material is San Carlos olivine. The powdered samples were dried in a vacuum oven at 160°C for several hours prior to sample loading. Pure olivine powder and powder NaCl (mixed with BN), which was used as the pressure standard, were loaded into the same cell. The sample was compressed to about 12 GPa at room temperature using the 250-ton LVP coupled with a T-Cup device and then annealed in the stability field of olivine at 1100°C for 40 minutes. Following sintering, the temperature was decreased to 550°C and kept constant, while pressure was increased to the target value. The temperature was then increased again stepwise to induce the phase transformation. The phase transformations were monitored by x-ray diffraction, while the sample assembly remained under the desired P, T conditions. The pressure was calculated based on the Decker's EOS of NaCl, and the temperature was measured by a W-3%Re/W-25%Re thermocouple. We were able to keep track of P and T throughout the entire experiment.

## Results and Discussions

The sintering indeed has a large effect on the kinetics of the phase transformation of olivine to ringwoodite. The high-pressure phases did not appear to be forming in any appreciable amount at any temperatures lower than 800°C within a few hours (Fig. 1). After 4.5 hours at 15 GPa and 850°C, significant amount of ringwoodite had formed. It is interesting to note that, according to the phase diagram, the above P and T conditions are within two-phase loops of wadsleyite and ringwoodite.<sup>3</sup> However, wadsleyite did

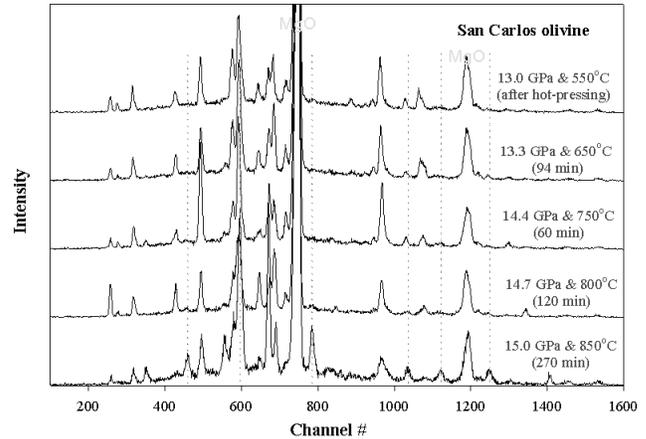


FIG. 1. Diffraction patterns for annealed olivine. Dotted vertical lines are guidelines for ringwoodite diffraction peaks.

not appear to be present. It is possible that at the experimental conditions, metastable ringwoodite tends to form first and then acts as nucleation sites for wadsleyite.

## Acknowledgments

This work was supported by the Center for High Pressure Research (EAR8917563) and NSF grant EAR-0001217. Use of the Advanced Photon Source was supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38. We wish to thank the GSECARS team for assisting us during the course of this study.

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