American Mineralogist, Volume 91, pages 560–567, 2006

The high-pressure phase transformation and breakdown of $MgFe_2O_4$

SOFIA WINELL,[1,*] HANS ANNERSTEN,[1] AND VITALI PRAKAPENKA[2]

[1]Department of Earth Sciences, Uppsala University, SE 752 36 Uppsala, Sweden
[2]Consortium for Advanced Radiation Source (CARS), University of Chicago, Chicago, Illinois 60637, U.S.A.

ABSTRACT

The high-pressure transformation of $MgFe_2O_4$ was studied by Mössbauer and Raman spectroscopy and synchrotron X-ray diffraction using the DAC technique and laser annealing at temperatures of 1500–2000 K. The high-pressure phase of $MgFe_2O_4$ was observed from in situ Mössbauer spectra at 17 ± 1 GPa after laser annealing by the appearance of two quadrupole doublets. This indicates a disordered distribution of Mg and Fe in an early stage. The displacive nature of the transformation of the spinel into its high-pressure polymorph was shown at increasing pressure by the redistribution of iron into only one site. After decompression Mössbauer spectroscopy revealed the presence of Fe_2O_3 in the sample. This was further confirmed by Raman spectroscopy at ambient conditions and by in situ high-pressure XRD, indicating a partial breakdown of the spinel into its constituent oxides MgO and Fe_2O_3. The XRD pattern of the high-pressure phase of $MgFe_2O_4$ can be indexed in agreement with the $CaMn_2O_4$-type structure, with cell parameters $a = 2.775(2)$, $b = 9.283(16)$, and $c = 9.446(5)$ Å at 23 ± 2 GPa. The multiphase spectra from all three analytical methods suggests that inhomogeneous conditions prevailed in the DAC experiments, resulting in two different reactions at high pressure and temperature, i.e., $T < 1800$ K: $MgFe_2O_4 \rightarrow Fe_2O_3 + MgO$ and $T > 1800$ K: $MgFe_2O_4 \rightarrow$ hp-$MgFe_2O_4$.

Keywords: High-pressure studies, magnesioferrite, phase transition, Mössbauer spectroscopy, XRD data