High-pressure phase transitions in $FeTiO_3$, Fe_2TiO_4 and $FeTi_2O_5$

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Introduction

Iron titanium oxides are of considerable importance in earth science as magnetic minerals and indicators of oxidation state. $FeTiO_3$, Fe_2TiO_4 and $FeTi_2O_5$ are Fe-Ti endmembers of natural ilmenite, spinel and pseudobrookite, respectively. Although several high-pressure investigations on the Fe-Ti oxides have been made with a diamond anvil cell, the results are still controversial, particulary at pressure above 20 GPa.

Experimental methods

We have examined detailed phase relations in $FeTiO_3$, Fe_2TiO_4 and $FeTi_2O_5$ up to 35 GPa and 1600 ºC, using multianvil apparatus with tungsten carbide anvils. The quenched samples were examined by microfocus and powder X-ray diffractometers, and composition analysis was made using SEM-EDS. In-situ X-ray diffraction experiments on $FeTi_2O_5$ were performed with a laser-heated DAC at SPring-8.

Results and discussion

$FeTiO_3$ ilmenite (Ilm) transforms at 14 GPa and 1200 ºC to perovskite (Pv) which changes to $LiNbO_3$-type phase on release of pressure [1]. In contrast to Pv-postPv transition in $MgSiO_3$, $FeTiO_3$ Pv dissociates at 27 GPa into two phases: calcium titanate (CT) type Fe_2TiO_4 + O1-type TiO_2 below 1100 ºC and Fe_2TiO_4 CT + a new $FeTi_2O_5$ phase above 1100 ºC. The in-situ X-ray studies at 35 GPa showed that the new $FeTi_2O_5$ phase has orthorhombic symmetry and is 7 % denser than the low-pressure assemblage of $FeTiO_3$ Pv + TiO_2 O1. Fe_2TiO_4 ulvospinel dissociates into $FeTiO_3$ Ilm + wustite at 4 GPa, which changes into Pv + wustite at 14 GPa, and further they combine into Fe_2TiO_4 CT at 17 GPa. These results indicate that Fe_2TiO_4 CT, TiO_2 O1 and the new orthorhombic $FeTi_2O_5$ phase are stable phases in the FeO-TiO_2 system in the upper part of lower mantle. A $LiNbO_3$-type $FeTiO_3$ phase recently discovered in shocked gneiss in the Ries Crater, Germany, was interpreted to be the retrograde transformation product of $FeTiO_3$ Pv [2]. Based on the phase relations in this study, we estimate that the phase occurred at shock pressure between 14 and 27 GPa.

[1] Leinenweber *et al.* (1991) *Phys. Chem. Min.*, **18**, 244-250. [2] Dubrovinsky *et al.* (2009) *Meteorit. Planet. Sci.*, **44**, A64.