SOLID-LIQUID EQUILIBRIA INVOLVING SPINELS, ILMENITE AND PSEUDOBROOKITE IN THE SYSTEM FeO·Al₂O₃·TiO₂ IN CONTACT WITH METALLIC IRON, W. A. Schreifels and A. Muan, Geosciences Dept., The Pennsylvania State University, University Park, Pa. 16802.

Phases in which titanium is a major constituent are important indicators of crystallization histories of lunar rocks from the mare regions. A number of previous reports from our laboratories as well as from other research groups have dealt with solid-solid equilibria involving such phases (e.g. references 1-3), and a few studies have dealt with solid-liquid equilibria (e.g. reference 4). Further interpretations of the data obtained and their applications to lunar petrology require a better understanding of the crystal chemistry and thermodynamic properties of the phases involved. As a step in this direction, we have studied solid-liquid equilibria in the system FeO·Al₂O₃·TiO₂ under strongly reducing conditions approximating those prevailing on the lunar surface. Within this simple model system occur two spinels (one titanium-rich, one aluminum-rich), ilmenite and pseudobrookite in equilibrium with a liquid phase. The interrelations among these phases is the major topic of the present study.

Oxide mixtures of selected compositions were prereacted and prereduced in CO₂/CO atmospheres and subsequently placed in iron crucibles for equilibration runs in an inert atmosphere (purified N₂) at selected temperatures. Following equilibrations, the samples were quenched to room temperature and the phases present identified by microscopic, x-ray and electron microprobe analysis.

The liquidus surface thus determined is shown in Fig. 1. Four piercing points have been located, with phase assemblages and temperatures as follows: Wustite, ulvöspinel, hercynite and liquid, 1306°C; ulvöspinel, ilmenite, ferropseudobrookite and liquid, 1340°C; ulvöspinel, hercynite, ferropseudobrookite and liquid, 1367°C; hercynite, ferropseudobrookite, corundum and liquid, 1465°C. The data obtained in the present study confirm the limited mutual miscibility between titane and aluminate spinels, and provide quantitative data for the effect of Al₂O₃ on mutual stability relations among spinel, ilmenite and pseudobrookite phases at high temperatures (~1300-1400°C) and strongly reducing conditions. Clearly, Al₂O₃ has a strong stabilizing effect on the phase assemblage spinel + pseudobrookite relative to ilmenite at these high temperatures. The phase relations thus determined is a clear demonstration of the role of "entropy-stabilized" phases (here spinels and pseudobrookite) at high temperatures in oxide systems. At lower temperatures, the pseudobrookite phase in the system "FeO"·Al₂O₃·TiO₂ under strongly reducing conditions decomposes to the phase assemblage ilmenite + rutile + corundum (5).
LIQUID-SOLID EQUILIBRIA INVOLVING SPINELS

Schreifels, W. A. et al

REFERENCES


5. Hauck, J. and Muan, A., unpublished data.

Liquidus surface of a part of the system "FeO"-Al$_2$O$_3$-TiO$_2$ in equilibrium with metallic iron.