MELTING AND OTHER PHASE TRANSFORMATIONS AT HIGH PRESSURE

by

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INTRODUCTION

The fusion curves of the four Group VIII metals nickel, iron, platinum and rhodium and the phase diagrams of bismuth and rubidium have been determined to 100, 000 atm.* The volume changes which occur at the melting points for the Group VIII metals were calculated from the initial slopes of their fusion curves. This volume increment has been directly measured for iron only and the present data agree with the directly measured value. The phase diagram for bismuth was of interest because of its complexity and because it proved to have a conveniently located transformation at room temperature which now serves as a pressure reference point at about 120, 000 atm. Rubidium was expected to have an electrical resistance cusp at about 130, 000 kg/cm^2 similar to the one for cesium at 55, 000. Such a cusp was not found but its fusion curve was unusual in that it showed a maximum.

THE FUSION CURVES OF NICKEL, IRON, PLATINUM AND RHODIUM

The different types of samples used in melting point determinations are illustrated in Figs. 1, 2, 5 and 6. In the designs of Figs. 1 and 2, the detection of melting was by a sharp increase in electrical resistance, the occurrence of a maximum millivolt reading on a Ni-Ni 20 per cent Co junction (in the case of nickel) or a latent heat step in a rising temperature-time curve. The resistance change associated with melting for iron is quite small so in order to detect it unmistakably probe wires drawn from the same pure iron that was used for the specimen were inserted near the center where the sample was hottest and melting first occurred. The voltage drop across these wires due to the heating current in the rod showed a sharp increase at the melting point. Examples for these means of detection are illustrated in Figs. 3 and 4.

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*Unless otherwise stated, pressures quoted in this article are based on the electrical resistance transitions observed by Bridgman on Bi, Tl, Cs and Ba.

53 mole per cent Mg_2SiO_4. Extrapolation to the closure of the 2 phase field, that is, at 100 mole per cent Mg_2SiO_4, results in a transition pressure of 100 kb$\pm$ 15 kb. This would be roughly equivalent to a depth 300 km below the surface of the earth.

Now the experimental p-t univariant slope of the olivine-spinel transition of the Mg_2GeO_4 end member(5-6) is equal to 25°C/kb but a value of about 13°C/kb may be inferred (from the total p-t-x of the system) for the Mg_2SiO_4 end member. It will be seen that, if slopes of this range of values are plotted passing through a point at 550°C and 100 kb ($\pm$15 kb) and then compared to the various postulated temperature gradients with dept in the mantle, phase transitions of the olivine-spinel type certainly should be part of any consideration of the "400 km" discontinuity. These results strongly support Clark's remark on the need for equipment for the direct study of the inversion. Such studies on the pure forsterite and on a simplified assemblage of minerals to approximate the best deduced compositions of the mantle will be important contributions. What form this equipment will take is not too clear. In view of our experience, some of it represented in the discussion of G.C. Kennedy's "calibration" paper, the accuracy of the uncomplicated uniaxial type apparatus is certainly better with respect to temperature and appears to be as good as the best of the piston-cylinder pressurized gas types below 700°C.

References

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