

1100°C is controlled by Fe<sup>3+</sup> content. Activation energies ≤ 1.0 eV are associated with Fe<sub>2</sub>O<sub>3</sub> > 0.05 wt%. Most likely, the mechanism is extrinsic semi-conduction due to Fe<sup>3+</sup> doping. Oxidation and reduction of the iron in natural olivine during  $\sigma$  studies to test the validity of this hypothesis have been performed and are discussed elsewhere [19].

#### 4. Geophysical application

When calculating temperature profiles from electrical conductivity-depth distributions, the oxidation state of the iron in the olivine of the mantle has to be considered. This is not a trivial problem since the equilibrium Fe<sup>3+</sup> content of mantle olivine will be controlled by both the oxidation state of the mantle and the distribution of Fe<sup>3+</sup> among the phases in the mantle.

The results of Drickamer et al. [18] may be applicable to this problem. They have shown that Fe<sup>3+</sup> → Fe<sup>2+</sup> with increasing pressure according to the rule

$$\frac{C_{II}}{C_{III}} = K = A (P/P_0)^B, \quad (2)$$

in which  $A$  and  $B$  are constants,  $C_{II}$  and  $C_{III}$  the fraction of sites occupied by Fe<sup>2+</sup> and Fe<sup>3+</sup> and  $P_0 = 1$  kb for the values of  $B$  quoted in ref. [18].

We have plotted the 27 values for  $A$  and  $B$  given in [18] and have discovered a linear relationship between  $\ln A$  and  $B$ :

$$A = \exp(-4B), \quad (3)$$

where  $B$  varies from ~0 to 4 while  $A$  ranges from ~0.3 to 10<sup>-7</sup>. While some of the  $A$ ,  $B$  values are for temperatures other than 295°K, omission of these points does not change eq. (3) significantly. For  $B = 0$ ,  $A = 1$  and for  $A > 1$  (i.e.  $C_{II} > C_{III}$ ),  $B$  is forced to be negative and eq. (2) predicts that pressure will cause the formation of more ferric iron rather than less. Since Drickamer et al. studied substances with  $A < 1$  the validity of eqs. (2) and (3) in the region  $A > 1$  is unproven. Hence, regardless of its attractiveness for geophysical applications in studies of the oxidation state of iron compounds at elevated pres-

ures, in the case of small amounts of ferric iron being present in a basically ferrous compound, the theory is ambivalent or inapplicable.

#### Acknowledgements

This work was performed under the auspices of the Committee on experimental Geology and Geophysics, Harvard University, during the tenure of a National Science Foundation post-doctoral fellowship. The support of the Australian-American Educational Foundation with manuscript preparation costs is gratefully acknowledged. Thanks are due to Professor Francis Birch, Professor Thomas J. Shankland, Dr. Richard Stocker and Uzi Nitsan for helpful discussions. We are indebted to Professor S. Hafner for making the Mössbauer measurements and for many helpful discussions. Part of this study was supported by NSF grant GA16875.

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