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Phase relations of iron-oxygen liquids and the effect of oxygen on the elastic properties of planetary cores

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Oxygen is a potential light element in terrestrial planetary cores. It is important, therefore, to understand the conditions under which oxygen could have partitioned into liquid iron metal during core formation and to measure the effects it has on core properties such as density and longitudinal wave velocity. Experiments with oxygen-bearing iron liquids are intrinsically difficult, because liquid properties are hard to measure under the very high temperature conditions at which oxygen starts to dissolve in liquid iron. To provide constraints on the effect of oxygen on the properties of liquid iron we have drawn data from a wide range of experimental phase relations measurements involving liquid and solid phases in the Fe-Mg-O system. We also employ data on liquid densities. A self-consistent thermodynamic model is developed that is fit to these different types of experimental data. We use measurements on the miscibility gap between Fe and FeO-MgO liquids to constrain the non-ideality of mixing between these melt components, which is further constrained using data on the eutectic composition and temperature in this system. We further refine the pressure dependence of the non-ideality, which provides constraints on the excess volume of mixing between the two components. Endmember constraints are derived from the melting curves of Fe, FeO and MgO. The resulting model can be not only used to calculate the amount of oxygen that may have partitioned into iron liquid during core formation but can also be used to calculate the liquid elastic properties. We use this model to explore the oxygen content of the Earth's core and exsolution of oxides from the core on cooling.