How much oxygen in the Earth's core?

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Among the possible light elements in the Earth's core (i.e., O, S, Si, C, and H), oxygen is the most plausible candidate, because of its high solar abundance as well as the presence of 10mol % FeO in the Earth's mantle. Many high-pressure experiments have been carried out in the system Fe-FeO and its relevant systems in order to understand the role of oxygen in the Earth's core. Experiments by Ohtani & Ringwood (1984), Kato & Ringwood (1988) and Ringwood and Hibberson (1990) demonstrated very large oxygen solubility in molten iron at pressures above about 15 GPa. On the other hand, more recent experiments by O'Neill et al (1998), Gessman & Rubie (1998, 2000, 2001) showed inverse pressure effect (oxygen solubility decreases with pressure at given temperatures). Based on their experiments, Rubie et al (2004) concluded that oxygen is not the principal light elements in the Earth's core.

In order to estimate the solubility of FeO in molten iron under high pressure, we carried out melting experiments in the Fe-FeO system at 15-23 GPa and 1800-2300 degree C using multi-anvil apparatus at the Magma Factory, Tokyo Institute of Technology. Starting materials used in our experiments were the mixture of Fe and FeO and capsules made of corundum (Al2O3) were employed. Based on Al2O3 content of FeO phase in the run products, we established rigorous criteria to distinguish the exsolved phase (from molten iron upon quenching) and the stable phase during the run. The stable oxide melt always surrounds metallic liquid due to the difference in surface energy, thereby in contact with the corundum capsule. The Al2O3 content of FeO phase (both solid and liquid) in contact with the corundum capsule is much higher than those exsolved from the Al-poor metallic melt.

Based on the new criteria on run products, we estimated the solubility of FeO in molten iron to be 8-10 mol.% FeO at 15 GPa and 2100 degreeC. Revised phase diagram at 15GPa show much smaller FeO solubility than those by Ringwood & Hibberson (1990). On the other hand, experiments at 23GPa shows ca. 3 times higher FeO solubility than at 15GPa at given temperatures. Our new phase diagram strongly support the proposal that oxygen is the principal light element in the core (e.g., Ringwood, 1977).