# A new geothermometer based on the oxygen content of sulphide inclusions in diamonds

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Sulphides are the most common type of inclusions found in diamonds and are widely used to determine the timing and lithology of diamond formation. Typical inclusions are monosulfide solid solutions (MSS) in the Fe-Ni-S system with minor amounts of Cu, Co and Mo. Previous experimental studies show that oxygen partitions into sulphide melts but most importantly measurements of natural sulphide inclusions indeed show measureable oxygen concentrations. If the parameters that control sulphide oxygen concentration can be determined then they could be potentially used to understand formation conditions of diamonds.

We performed a series of high pressure (3-11 GPa) and high temperature (1573-1973 K) experiments in order to parameterize the oxygen content in sulphides in equilibrium with a mantle peridotite assemblage relevant to diamond formation. Multi-anvil experiments were carried out in graphite capsules and a peridotite silicate composition was equilibrated with molten FeS for at least 5 hrs. Run products that contained mantle silicate minerals and quenched sulphide melts were analysed using the electron microprobe. In some cases Ir was added in sufficient quantities to saturate the sulphides and form an Fe-Ir alloy from which the oxygen fugacity could be accurately determined.

We measured up to 16 weight % of FeO in our experimental sulphide melts at mantle conditions. Moreover, the content of oxygen in the sulphide is found to be not controlled by $fO_2$ or $fS_2$, which is in disagreement with previous experimental studies conducted at ambient pressure conditions. The experiments indicate that the oxygen concentration is mainly controlled by the FeO activity in coexisting silicate phases and the temperature. In order to fit the data and to account for the observed FeO dependence, we developed a thermodynamic model using an end-member equilibrium between olivine, pyroxene and FeO in the sulphide melt. Using this relationship with measurements of oxygen in natural sulphide inclusions in diamonds reveals temperatures for lithospheric diamond formation in the range of 1140 – 1410 ºC.