UNIVERSITÄT BAYREUTH

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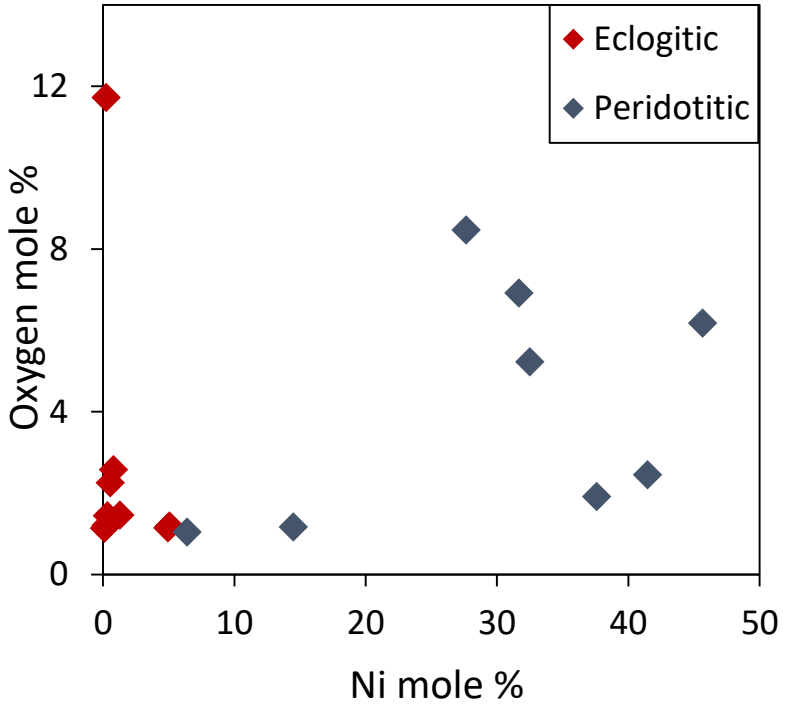
The oxygen content of sulphide inclusions in diamonds and its use as a mantle geothermometer

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- This is a short summary to our experimental study performed to investigate the oxygen content in sulphide melts at mantle conditions relevant to the diamond formation.

- There are reports on considerable amounts of measured oxygen contents in natural sulphide inclusions in diamonds

Measured oxygen in natural inclusions



Inclusions from DO-27 Slave craton, Canada

Davies et al, (1999) and Davies et al, (2004)

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Experiments

Methods

Starting materials

- Silicate – KLB 1 Peridotite
- Sulphide –FeS - with Ni, Cu, Ir

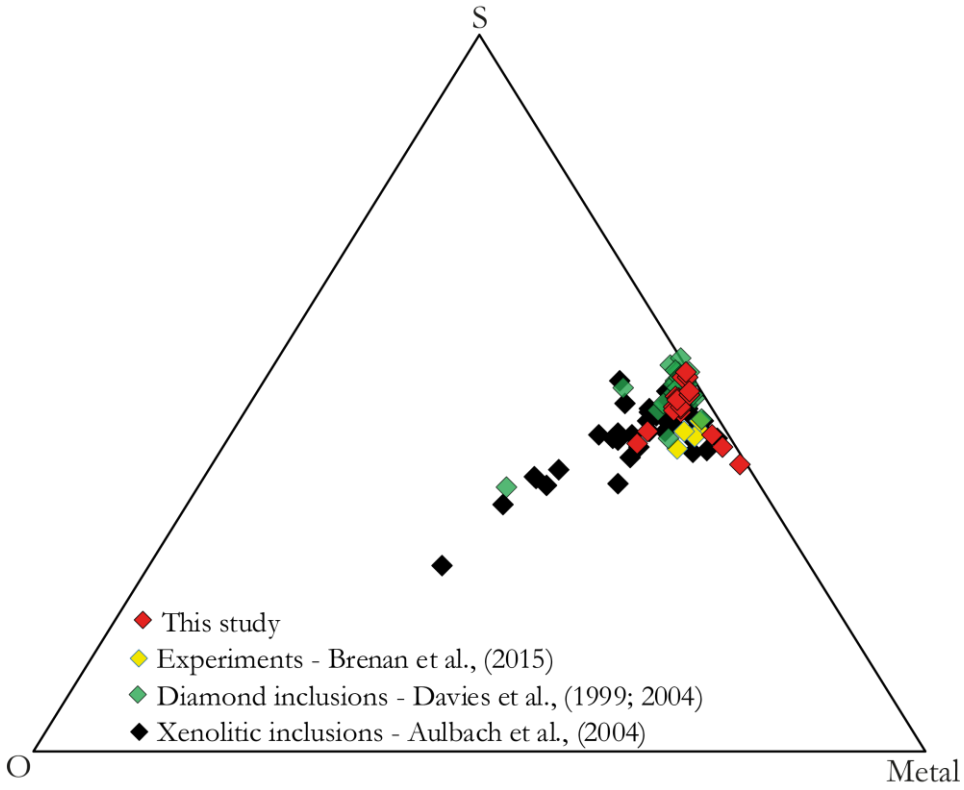
Multi-anvil experiments

- Pressure 3 – 15 GPa
- Temperature 1300 – 1800 °C
- Oxygen fugacity QFM-1 – QFM-3

Sample analysis

- Electron microprobe (EPMA)
- Scanning electron microscope (SEM)

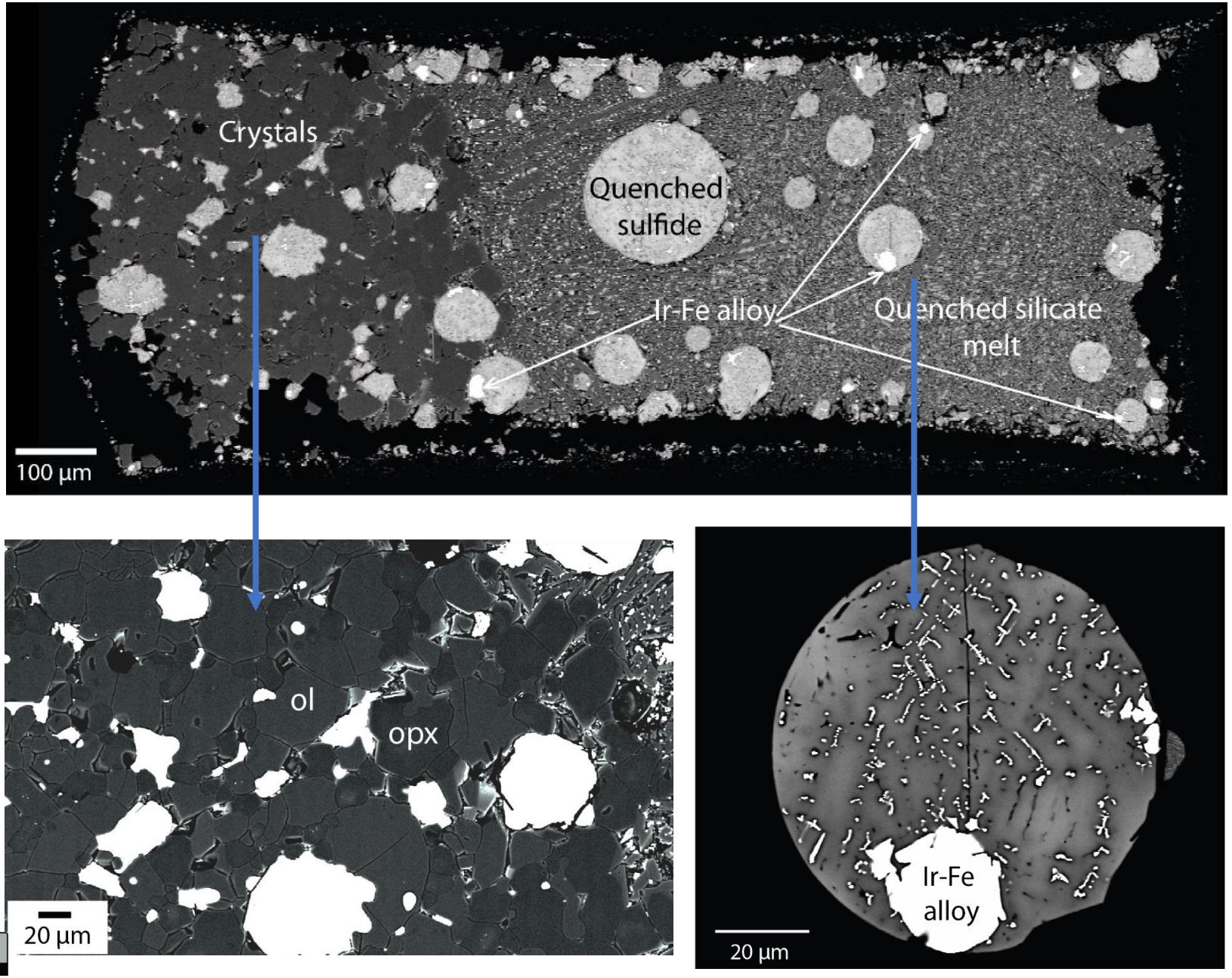
Composition - experimental samples and natural samples



Our experimental samples represent the composition of natural sulphide inclusions found in diamonds

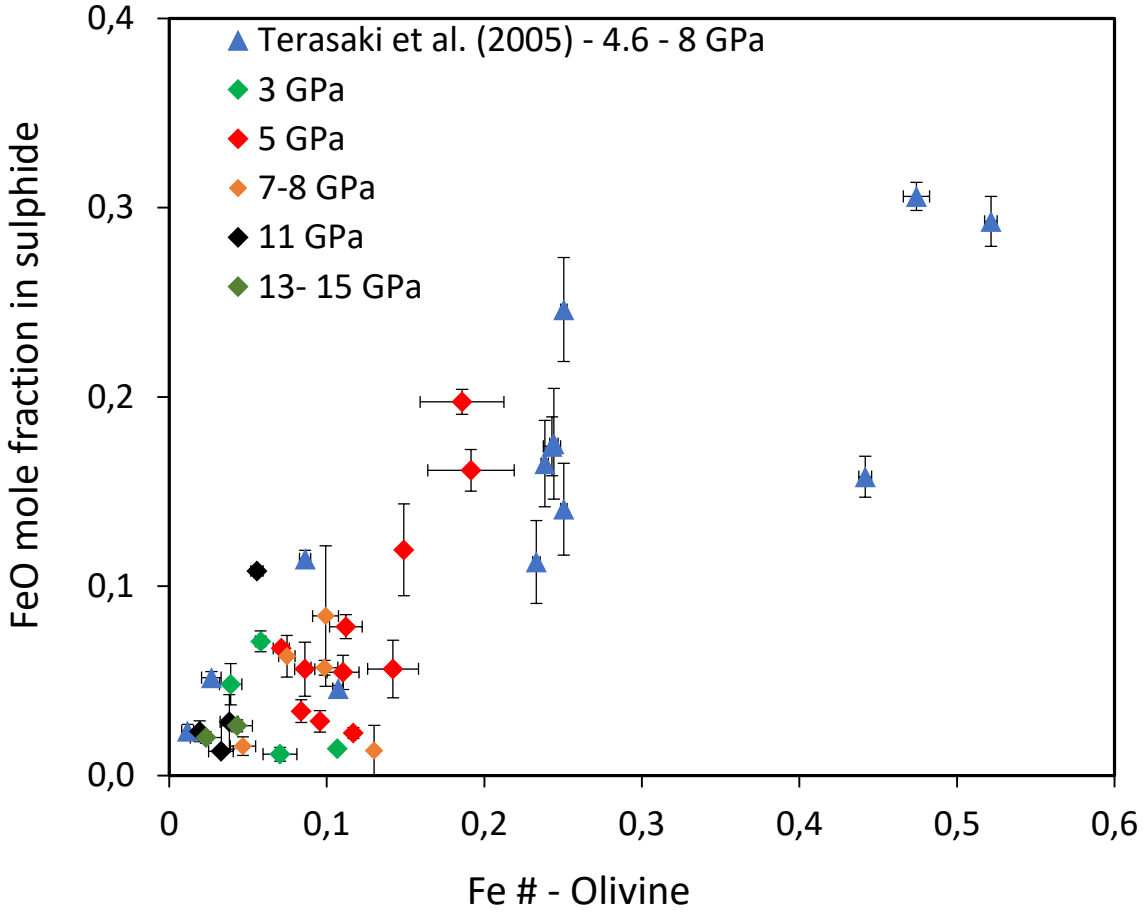
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Experimental run products



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FeO in sulfide melt



Fe# = Fe/Fe+Mg

- Increase of X_{FeO} in sulfide with increasing Fe# of coexisting silicate minerals

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Thermodynamic model

- Equilibrium between Silicate crystals and FeO in sulfide melt

$$Fe_2SiO_4 = FeSiO_3 + FeO \text{ (sulfide)}$$

- ΔG^0 of the reaction

$$\Delta G^0 = -RT \ln K_D - W^{en}_{Fe-Mg}(1 - X^{en}_{Fe})^2 + 2\,W^{ol}_{Fe-Mg}\left(1 - X^{ol}_{Fe}\right)^2 + RT\,\Upsilon^{sulphide}_{FeO}$$

W_i - Margules interaction parameter; X_i - Mole fractions, γ - Activity coefficient

- FeO-FeS-NiS mixture

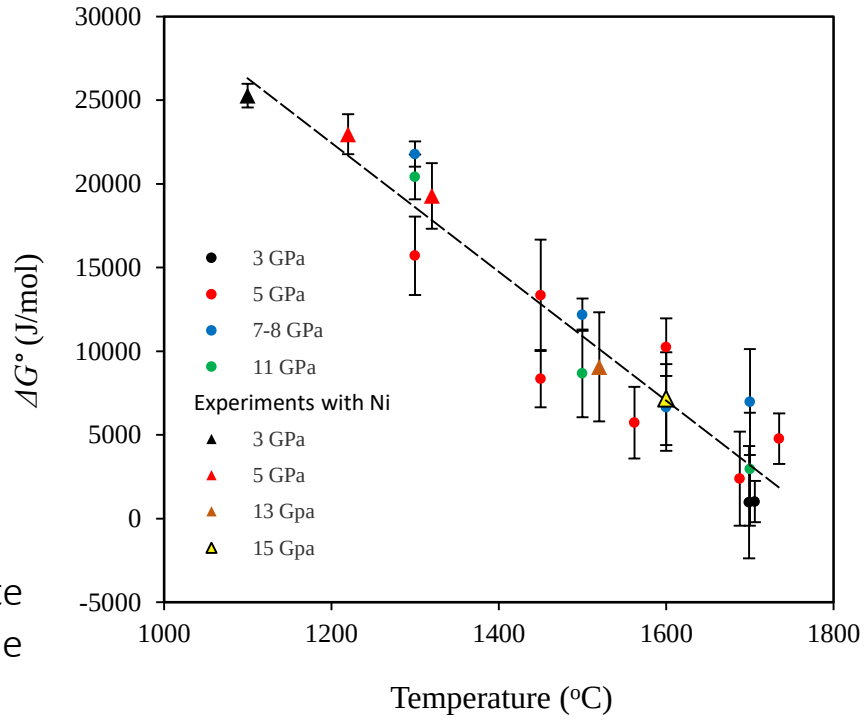
Mixing parameters were calculated using ternary asymmetric mixing model

Mukhopadhyay et al., (1993)

- ΔG^0 increase with decreasing temperature

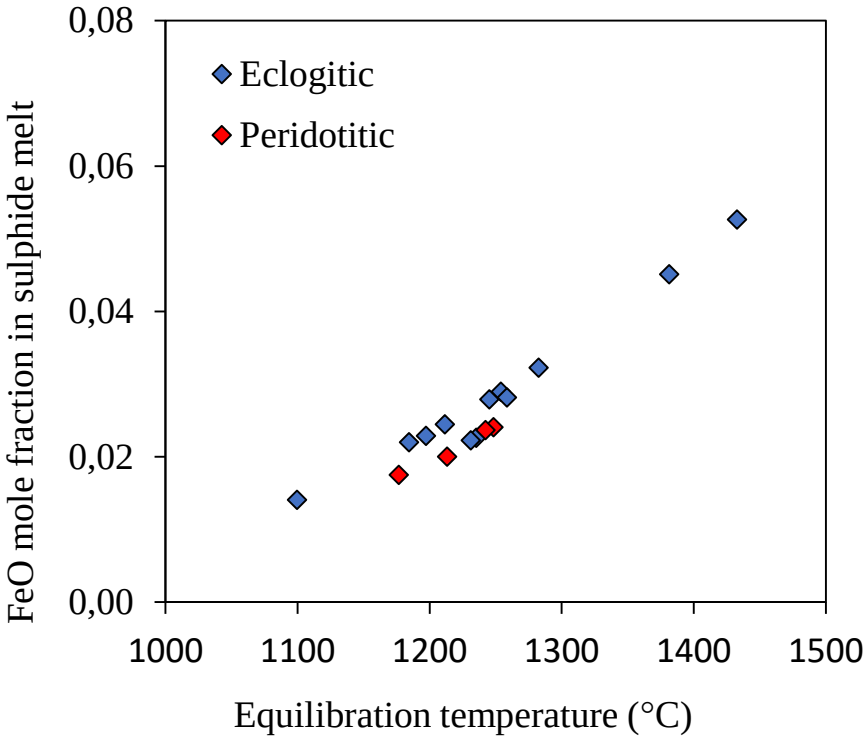
$$\Delta G^0 = 87341.9 - 44.0 * T$$

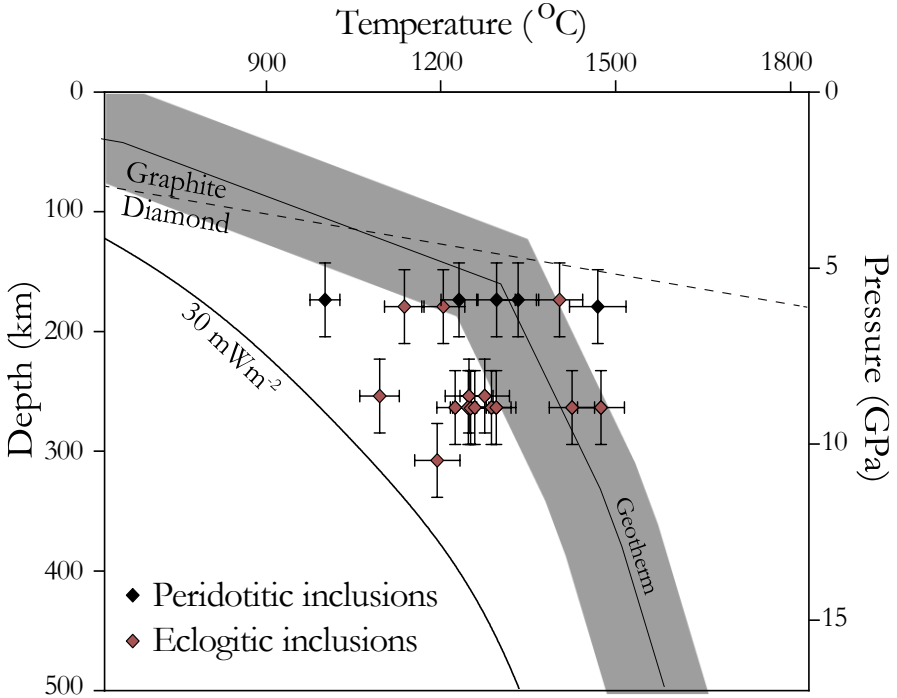
- This temperature dependence was used to calculate equilibration temperatures of natural sulphide inclusions in diamonds



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Mantle geothermometer





Calculated equilibration temperatures as a function of measured FeO concentrations in natural sulphide inclusions in diamonds

Depths were calculated using associated garnet inclusions

Substitution of Al for Mg and Si in majoritic garnet *(Beyer and Frost, 2017)*

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