

Oxidation state and decarbonation of eclogites : experimental constraints between 4 and 6 GPa

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During subduction, carbonated lithologies carried by oceanic plates can be introduced in the earth's mantle. In order to simulate eclogite decarbonation during subduction the model reaction coesite + carbonate = clinopyroxene + CO₂ has been experimentally investigated at pressure-temperature conditions ranging from 4 to 6 GPa and from 950 to 1450°C using the multianvil apparatus. Additionally, the oxidation state of samples were carefully controlled by two redox buffer reactions. One corresponds approximately to the slab oxygen fugacity (i.e., rather oxidising, close to C/CO₂). The other buffer relates to mantle oxygen fugacity (i.e., more reducing). All experiments were performed on a mixture of natural quartz and ankerite (an iron-bearing carbonate).

The iron-free reaction (system containing SiO₂, CaO, MgO, CO₂) had been bracketed by Luth (1995) at 1500°C at 6 GPa and 1200°C at 4 GPa. In the iron-bearing system, the decarbonation temperature is lowered and melting occurs between 1100°C and 1200°C depending on pressure. Melts are carbonated and have a small fraction of dissolved silicate. The redox conditions have a strong effect on the location of the decarbonation reaction. It takes place at more than 100°C higher temperature in oxidising conditions. This effect could be explained by either lowering of CO₂ activity at low fO₂ or direct carbonate reduction by the buffer.

On the other hand, oxygen fugacity does not greatly affect melting temperature. However, although they are all carbonatitic, melt compositions and evolutions are function of oxygen fugacity. For oxidising conditions, melts become less calcic as temperature increases. For reducing conditions, Ca content of melts increases with temperature.

This study shows that in order to predict the fate of carbonates introduced in the mantle via subduction, one must identify where carbonates react. The reaction paths and the nature of the melts will depend on whether carbonates stay in the slab or are incorporated into the mantle wedge (e.g., by delamination).