Carbon in the Deep Mantle: Sub- and super-solidus phase relations in the system CaO-MgO-FeO-SiO_2-CO_2 in Earth's Lower Mantle

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The lower mantle is potentially the largest carbon-bearing resevoir in Earth. Primordial volatiles may, for example, have become isolated in the lower mantle during accretion, assuming that Earth was not entirely molten. Alternatively, crystallisation of a moderately volatile-rich global magma ocean from the mid-lower mantle outward may have resulted in a relatively volatile-enriched deep basal magma body. Furthermore, billions of years of plate tectonics has facilitated the recycling of carbon-bearing lithospheric material into the deep mantle. Carbon and other volatiles in the deep mantle may promote chemical mass transfer through melting and may potentially have a large influence on the rheological properties of the mantle. However, despite its fundamental importance for understanding the evolution of the Earth, our understanding of phase relations and melting in carbon bearing lithologies at the high pressure (*P*) and temperature (*T*) conditions of the lower mantle is extremely limited.

In this presentation we report the results of sub-solidus and melting phase equilibria investigations in the system CaO-MgO-FeO-SiO_2-CO_2. Several starting compositions were synthesised from mixtures of SiO_2 and $MgSiO_3$ glass with $MgCO_3$, $CaCO_3$, and $FeCO_3$ as the source of carbon. Samples were pressurised in a diamond anvil cell (DAC) and heated from both sides using two 100 W fibre lasers operating at a wavelength of 1070 nm. Using beam shapers and beam expanders, a uniform temperature profile was produced over a spot of ~ 30 μm diameter, as measured on both sides using spectroradiometry. To futher minimise temperature gradients, we have fabricated novel fully encapsulated samples for the DAC using a combination of laser machining and DC magnetron sputter coating. Angle dispersive synchrotron x-ray diffraction measurements were made on the *P*-*T* quenched samples at beamline I15 at the diamond light source, UK in order to identify and characterise the phases present in the run products.