Melting of peridotite at lower mantle conditions: LH-DAC experiments with metal encapsulated samples

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Seismological studies indicate that the lowermost mantle has distinct heterogeneities which might result from fractional crystallization of an early magma ocean and/or the continued accretion at the CMB of subducted oceanic crust. To gain insights into the origin, composition and properties of these lower mantle heterogeneities, we aimed to carefully determine melting phase relations of the main component of the Earth's mantle: peridotite. In order to overcome the significant temperature gradients experienced in conventional LH-DAC experiments, we have developed a microfabrication technique for total metal encapsulation of the samples.

Oxide mixes of KLB-1 composition were melted at 1 atm by resistance heating in 10-15 μm diameter sample chambers cut into a 10 μm thick Mo filament. After quenching, a pre-cut was made to form a capsule wall surrounding the quenched samples, and the sample-bearing filaments were coated on both sides with a 3-5 μm layer of Mo metal by magnetron sputtering deposition.

The encapsulated samples were loaded between KCl discs as the pressure medium in diamond anvil cells and heated at or above the solidus using double sided heating with two 100 W fibre lasers and a beam spot of ~30 μm diameter. The recovered samples were later exposed and analysed by FIB (Fig. 1). Elemental maps collected from samples heated at 24, 55 and 72 GPa show that the partially molten samples have Si, Al, Ca and Fe enrichment in the pressumably melted areas which form evenly distributed veins and channels in between a Mg-rich solid matrix. Further analysis by TEM will be performed to clarify the near-solidus phase relations and phase compositions.

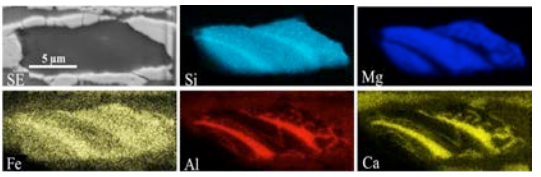

Fig. 1. FIB of recovered sample, 72 GPa and 3600K.