

Melting of residual eclogites with variable proportions of quartz/coesite

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Eclogite and pyroxenite layers and veins within the peridotitic mantle may be important in genesis of many magmas. Understanding high pressure melting of residual eclogites with varying amounts of quartz/coesite (qz/co) will improve understanding of the melting behaviour of heterogeneous mantle assemblages.

We are investigating the phase and melting behaviour of a residual eclogite composition, which crystallizes garnet (grt) + clinopyroxene (cpx) at 3.0 & 4.0 GPa with no qz/co (REC). The melting behaviour of REC reveals the anhydrous solidus of a coesite-free eclogite.

The subsolidus phases of REC are grt and cpx at 3.0 & 4.0 GPa. The solidus is at 1325±25°C at 3.0 GPa, and at 1475°C±25°C at 4.0 GPa. Melt compositions and proportions with cpx > grt are controlled by grt-cpx cotectics. At 3.0 GPa, cpx/grt ratios decrease with increasing % melting. At 4.0 GPa, cpx/grt ratios are lower at a given % melting than at 3.0 GPa.

We are also studying eutectic-like melting in coesite-bearing eclogites with varying proportions of qz/co. REC10 and REC20 are identical to REC, but have 10% and 20% higher SiO₂ contents, respectively.

Both REC10 & 20 crystallise sub-solidus as grt + cpx + qz/co at 3.0 GPa. The solidi of both are similar at 3.0 GPa, at 1275±25°C. Low-% melting (<20%) is eutectic-like until qz/co melts out. Like REC, grt-cpx cotectics control high degree melting for all compositions, with cpx abundance always exceeding grt. However, for REC, the proportion of cpx always exceeds those in REC10 & 20, but the % melt is always lower than for REC10 & 20 at given temperature.

Melts vary with increasing % melting from andesitic to basaltic for REC & REC10, but from dacitic to basaltic-andesitic for REC20. At <25% melting, melt in REC has lower Mg# at given % melting than melt in REC10 & 20. The contrary is given at higher % melting.

Garnet and cpx in REC have higher Mg# at a given % melting than grt and cpx in REC10 & 20. Towards higher % melting (>25% melting), variations in cpx Mg# diminish.

These variations of residual grt and cpx Mg# and melt Mg# are principally because melts from REC (qz/co-free) are more mafic at a given % melting. These outcomes reveal the strong dependence of Mg# of residual mineral phases & melt on the presence or absence of qz/co in melting of eclogites.

Bond strength and the compression of framework minerals

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It is commonly assumed that the relationship between bond strength and bond length for a particular pair of atoms is a simple and single-valued for a given coordination environment; longer bonds are weaker. This is the basis of the concept of bond valence. In strongly-bonded oxide minerals, the range of bond lengths found for a given polyhedron is so small that it was long thought that the polyhedral bulk moduli were essentially independent of structure type. This view is incompatible with the discovery that the response of the perovskite structure to high pressures is controlled by the equipartition of bond-valence strain between the A and B cation sites within the structure [1]. The same appears to be true, within experimental uncertainties, for all framework structures with rigid-unit modes. In perovskites, this explicitly implies that the octahedral compressibility depends not only upon the octahedral cation, but also upon the compressibility of the extra-framework site. Thus the octahedral compressibility of a B cation site must change as the A-site cation is changed, whether or not the B-O bond lengths change as a result of the substitution on the A site. The strength of bonds is thus dependent upon the crystal environment and not solely upon the bond length. The observation of a plateau effect in the variation of octahedral compressibilities in perovskite solid solutions suggests that the bond-valence matching principle is followed not just globally, but on a local scale as well. Such observations should allow the change with pressure of the excess thermodynamic properties of solid solutions to be directly related to the microscopic (atomic scale) evolution of the structure.

[1] Zhao J., Ross N.L., & Angel R.J. (2004) *Acta Cryst.* **B60**, 263-271.