Supplementary information: Details of alphaMELTS calculations

In all cases, calculations are performed using the pMELTS model in alphaMELTS (1.3.1). The new garnet model is used and fO_2 is not imposed. Input files are documented below:

1) KLB1-solidus

Calculations for fig. 1, fig. 5a, fig. 6 and fig. 8, and to determine the garnet-in pressure on the solidus.

These calculations are performed on a 'nominal' solidus (F=0.005). The KLB-1 bulk composition of Davis et al. (2009) is used, with Fe2O3 set to 0.3 wt.%. Components considered are those in the system NCFMASOCrTi, i.e. the components used in our model plus TiO_2. Input files are documented below:

MELTS file

```
Title: KLB-1, majors Davis et al., 2009
Initial Composition: SiO2 44.84
Initial Composition: Al2O3 3.51
Initial Composition: FeO 7.93
Initial Composition: Fe2O3 0.3
Initial Composition: MgO 39.52
Initial Composition: CaO 3.07
Initial Composition: Na2O 0.3
Initial Composition: TiO2 0.11
Initial Composition: Cr2O3 0.32
Initial Temperature: 1500.0
Initial Pressure: 40000.00
Final Pressure: 1
Increment Pressure: -500
```

Settings file

n.b. ! = line not read i.e. variable set to FALSE

```
ALPHAMELTS_VERSION        pMELTS
!ALPHAMELTS_OLD_GARNET    true
!ALPHAMELTS_ALTERNATIVE_FO2        true
!ALPHAMELTS_IMPOSE_FO2    true
ALPHAMELTS_MODE           isentropic
ALPHAMELTS_DELTAP         -500
ALPHAMELTS_DELTAT         0
ALPHAMELTS_MAXP           40000
ALPHAMELTS_MINP           1
ALPHAMELTS_MAXT           2400
ALPHAMELTS_MINT           500
```

Batch file

```
1               # select MELTS file
KLB1.melts
10              # phase diagram mode
1               # on
4               # execute
1               # superliquidus initial guess
liquid          # boundary to track
1               # track melt fraction by mass
0.005           # F = 0.005
0               # quick search
```

0

Calculations for table 1 are performed with this KLB-1 bulk composition at a given pressure and melt fraction by mass. The settings file used is as above.

2) MM-3 Isobaric calculation

Calculations for fig. 10b

These isobaric calculations are performed on the bulk composition MM-3, Falloon et al. (2008) with Fe2O3 set to 0.3 wt.%. Components considered are those in the system NCFMASOCrTi, i.e. the components used in our model plus TiO_2. Input files are documented below:

MELTS file
Title: MM-3, Falloon 2008
Initial Composition: SiO2 45.50
Initial Composition: Al2O3 3.98
Initial Composition: Fe2O3 0.30
Initial Composition: FeO 6.85
Initial Composition: MgO 38.30
Initial Composition: CaO 3.57
Initial Composition: Na2O 0.31
Initial Composition: Cr2O3 0.68
Initial Composition: TiO2 0.11
Initial Temperature: 2000.0
Final Temperature: 1300
Initial Pressure: 15000
Final Pressure: 15000
Increment Temperature: -10
Increment Pressure: 0

Settings file
ALPHAMELTS_VERSION pMELTS
!ALPHAMELTS_OLD_GARNET true
ALPHAMELTS_MODE isobaric
!ALPHAMELTS_ALTERNATIVE_FO2 true
!ALPHAMELTS_IMPOSE_FO2 true
!ALPHAMELTS_FRACTIONATE_SOLIDS true
ALPHAMELTS_DELTAP 0
ALPHAMELTS_DELTAT -10
ALPHAMELTS_MAXP 40000
ALPHAMELTS_MINP 1
ALPHAMELTS_MAXT 2400
ALPHAMELTS_MINT500

Isobaric melt productivity (fig. 5b) was calculated at 15 kbar using the bulk composition of KLB-1 from section 1) and the settings file from section 2).