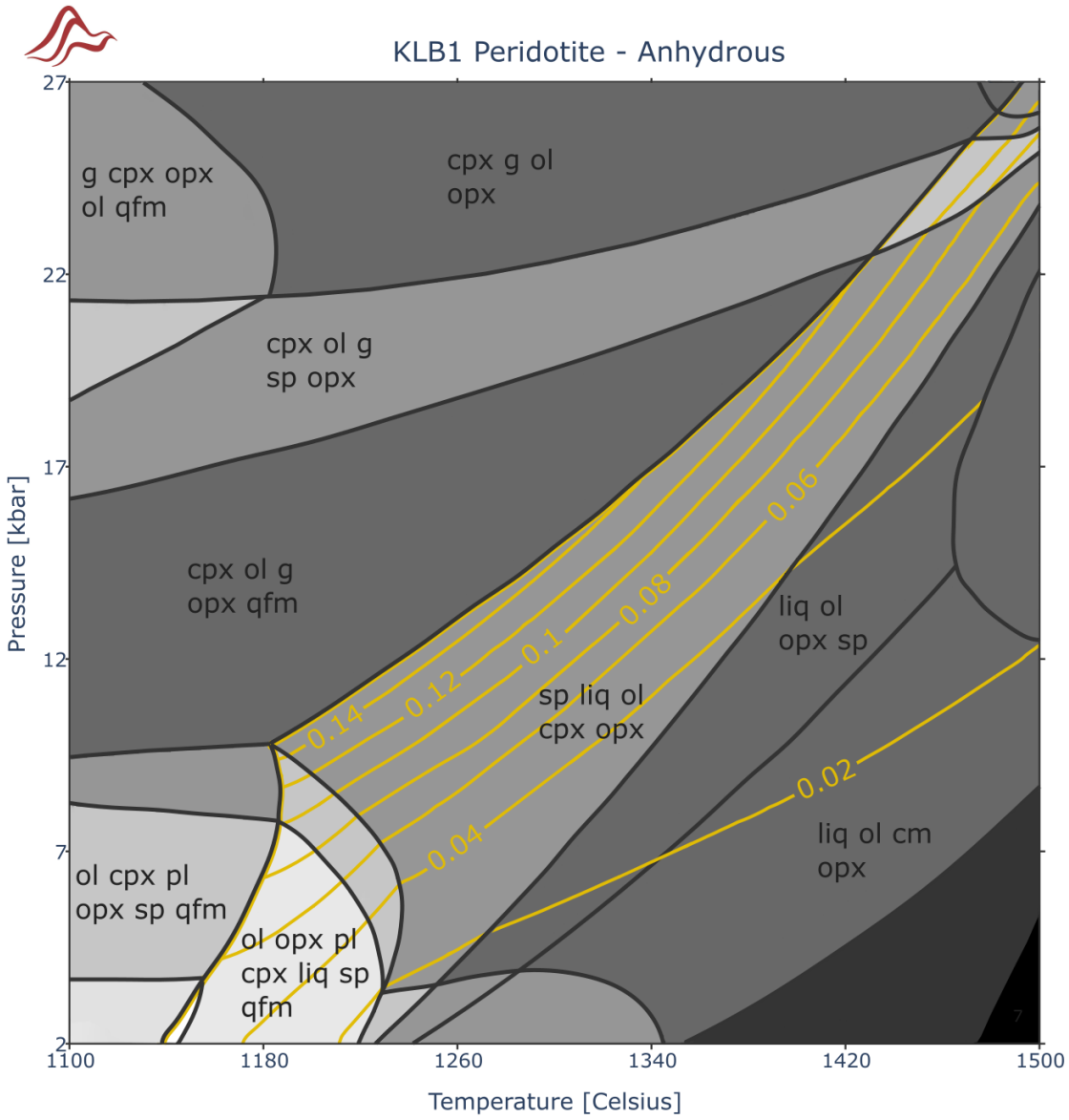
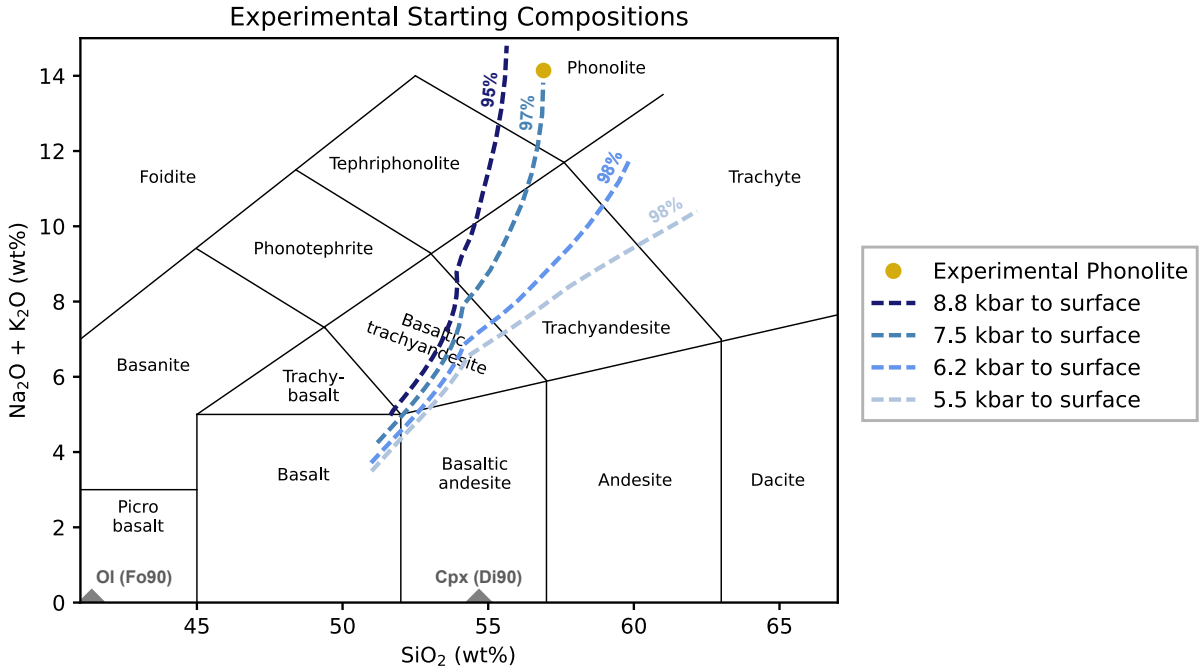
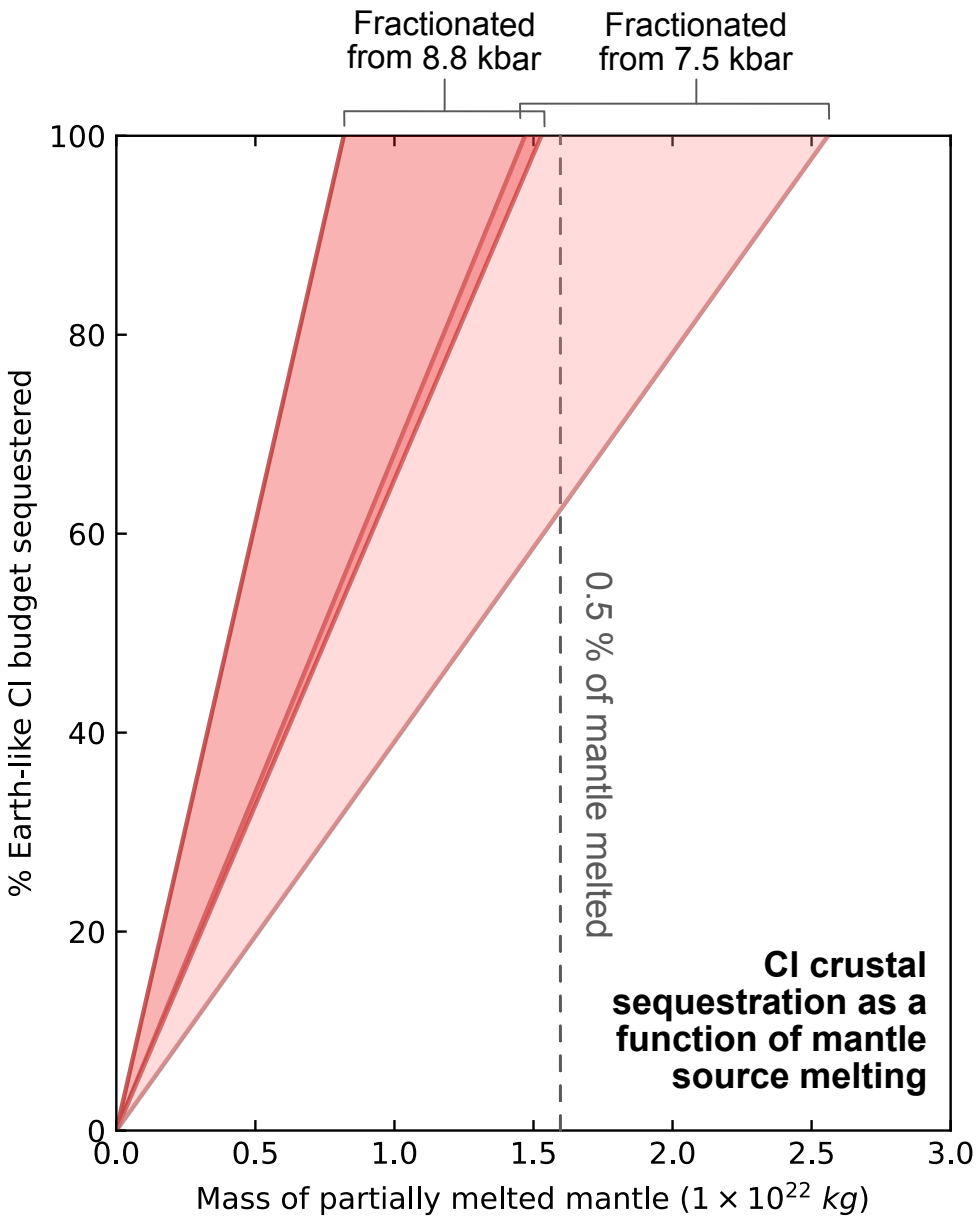
Supplementary Information



Supplementary Figure 1. Pseudosection of KLB-1 mantle peridotite. Yellow lines are isopleths of $NaSi_{1/2}$, which together define the range in P-T conditions of alkaline partial melting. Mineral phase fields include clinopyroxene (cpx), feldspar (fsp), garnet (g), liquid melt (liq), olivine (ol), orthopyroxene (opx), spinel (spn). Diagram constructed using MAGEMinApp and the alkaline melting relations of Weller et al. (2024)[71].



Supplementary Figure 2. Total alkali silica (TAS) diagram showing the fractionation paths (95 to 98%) of partial melts derived from varying degrees of adiabatic decompression melting of a KLB-1-like Venusian mantle source. The phonolitic experimental starting composition used in this study is indicated by the yellow spot. Fractionation paths demonstrate the generation of alkaline and evolved siliceous melts under low-degree partial melting and progressive differentiation. Cpx (Di90) is clinopyroxene with 0.9 Mg/(Mg + Fe), and Ol (Fo90) is olivine with 0.9 Mg/(Mg + Fe).



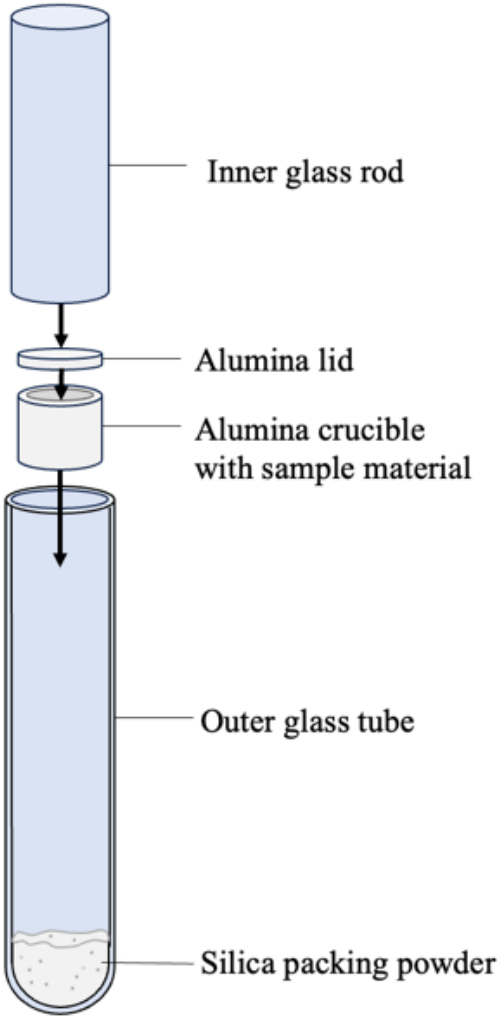
Supplementary Figure 3. Degree of NaCl sequestration in the Venusian crust by mass of mantle source melt.

Supplementary Table 1. Starting compositions and CIPW norms.

Bulk Composition (wt%)	
Oxide	Phonolite[a]
SiO_2	57.63
TiO_2	0.6
Al_2O_3	20.43
FeO	4.16
MnO	0.19
MgO	0.59
CaO	1.91
Na_2O	8.83
K_2O	5.49
SO_3	0
P_2O_5	0.17

CIPW Norm (wt%)	
Mineral	Phonolite[a]
Acmite	0.22
Diopside	7.18
Albite	32.60
Orthoclase	32.44
Olivine	2.78
Nepheline	22.68
Apatite	0.39
Ilmenite	1.14
Magnetite	0.56

[a]Modified from Carmichael et al. (1974)[78].



Supplementary Figure 4. Vacuum-sealed experimental assembly.

References

71. Weller, O. M. *et al.* New Thermodynamic Models for Anhydrous Alkaline-Silicate Magmatic Systems. *J. Petrol.* **65**, egae098 (2024).

78. Carmichael, I. S. E., Turner, F. J. & Verhoogen, J. *Igneous Petrology*. (McGraw-Hill, New York, 1974).