The primitive nature of large low shear-wave velocity provinces

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Online supplementary information

Depth (km)	T_{min} (K)	T_{max} (K)
700	1425	2325
800	1450	2350
900	1475	2375
1000	1500	2400
1100	1525	2425
1200	1550	2450
1300	1325	2475
1400	1600	2500
1500	1625	2525
1600	1650	2550
1700	1675	2575
1800	1700	2600
1900	1725	2625
2000	1750	2650
2100	1750	2700
2200	1800	2800
2300	1850	2900
2400	1900	2950
2500	1950	3000
2600	2000	3100
2700	2000	3600
2800	2100	4100
2900	2300	4800

Supplementary Table S1. Temperature range for all reference models.

Parameter	min	max
Fraction of main component, $(Mg,Fe)SiO_3$ + $(Mg,Fe)O$	0.85	1.0
Fraction of (Mg,Fe)-perovskite ($(Mg,Fe)SiO_3$) in main component	0.7	1.0
Fraction of $FeSiO_3$ in (Mg,Fe)-perovskite	0.0	0.2
Fe-Mg partition coefficient (defining the fraction of FeO in (Mg,Fe)O)	0.1	0.6
Fraction of $CaSiO_3$ in ($CaSiO_3$ + Al_2O_3 + SiO_2) component	0.0	1.0
Fraction of SiO_2 in ($CaSiO_3$ + Al_2O_3 + SiO_2) component	0.0	1.0
Fraction of perovskite converted to post-perovskite (where applicable)	0.0	1.0

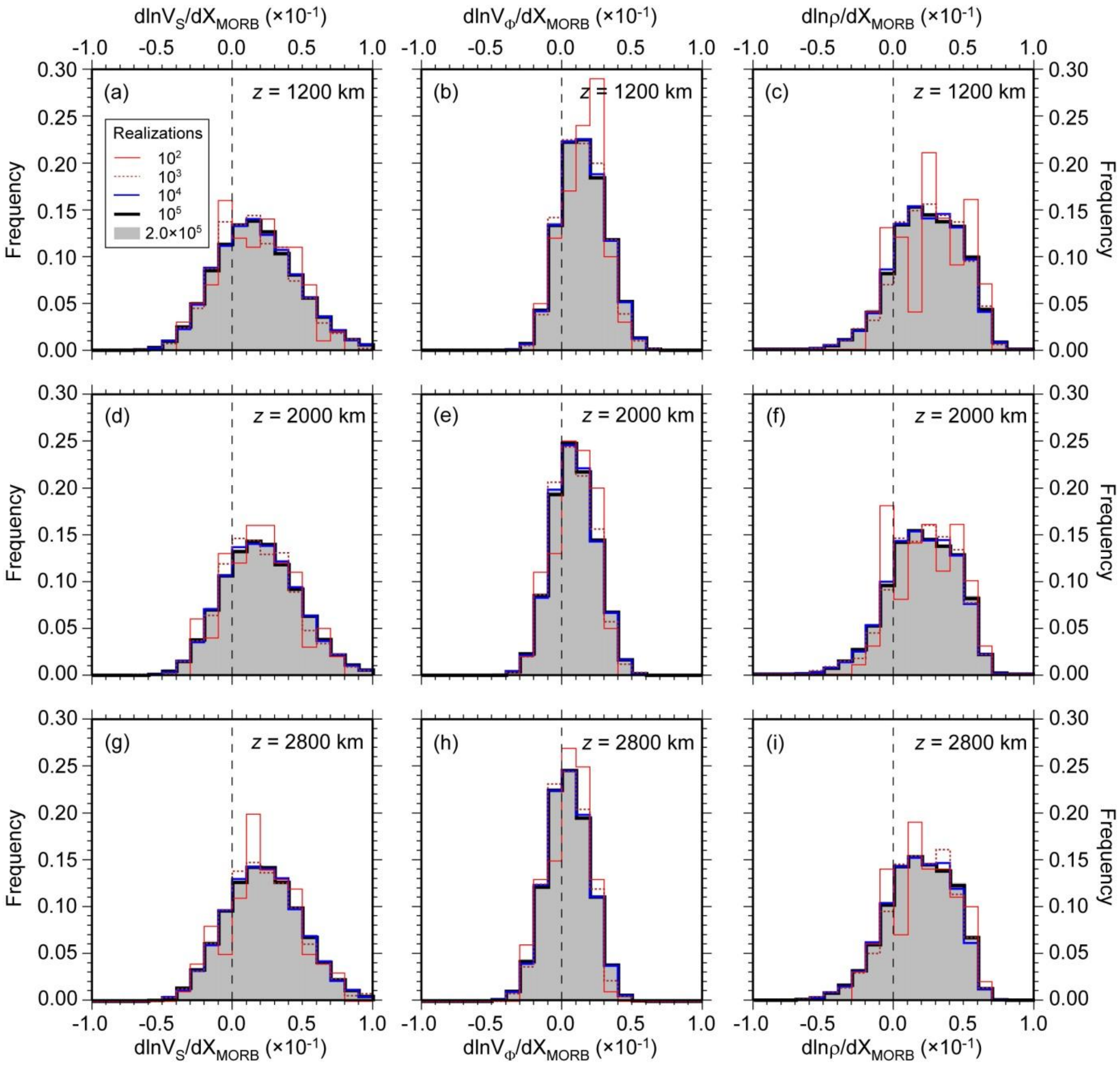
Supplementary Table S2. Compositional ranges for reference models when calculating the seismic sensitivities to temperature, perovskite, SiO_2, iron, and post-perovskite. Unit is volume fraction, except for the Fe-Mg partition coefficient.

Parameter	min	max
Fraction of main component, $(Mg,Fe)SiO_3$ + $(Mg,Fe)O$	0.9	1.0
Fraction of (Mg,Fe)-perovskite ($(Mg,Fe)SiO_3$) in main component	0.7	1.0
Fraction of $FeSiO_3$ in (Mg,Fe)-perovskite	0.0	0.2
Fe-Mg partition coefficient (defining the fraction of FeO in (Mg,Fe)O)	0.0	1.0
Fraction of $CaSiO_3$ in ($CaSiO_3$ + Al_2O_3) (set to 1.0 minus the fraction of main component	0.0	1.0

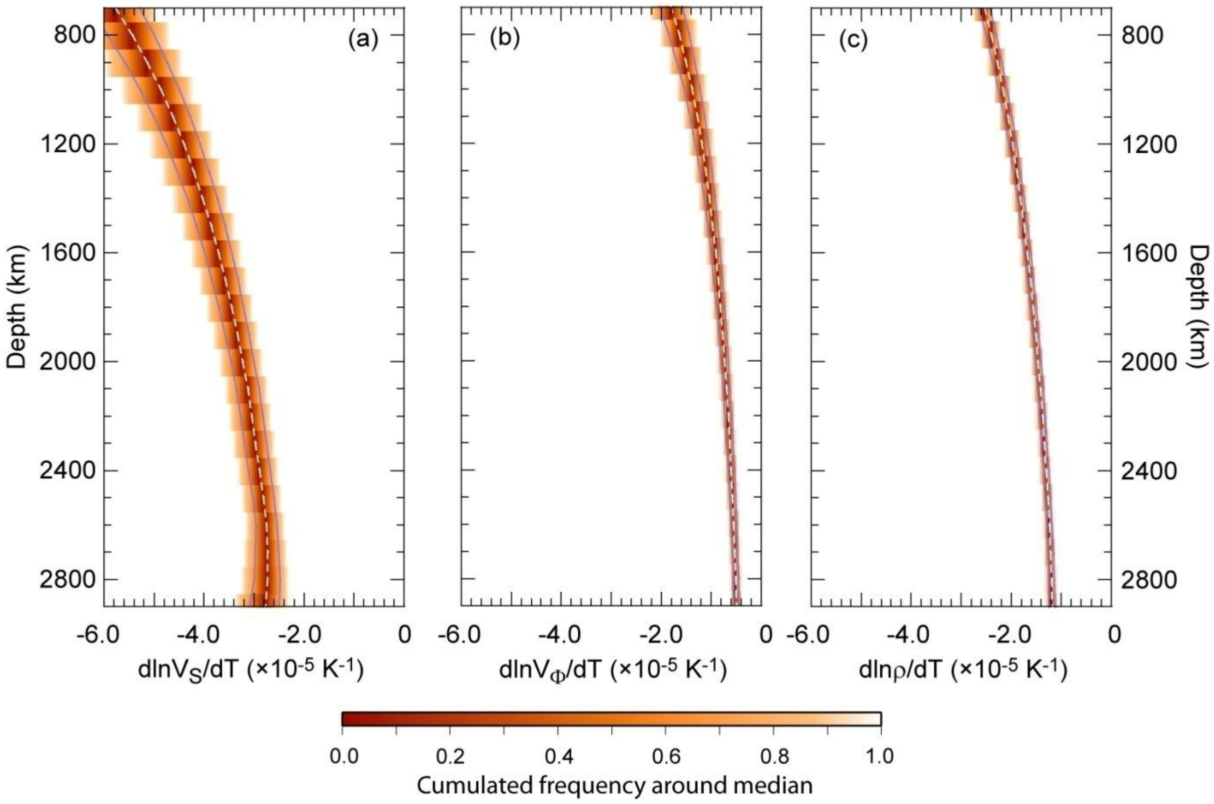
Supplementary Table S3. Mineralogy ranges for non-MORB components when calculating the seismic sensitivities to MORB. Unit is volume fraction, except for the Fe-Mg partition coefficient.

Sensitivity to	T_{ref}	C_{ref}	T_{per}	C_{per}
Temperature	Table S1	Table S2	T_{ref} +/- 1 K	C_{ref}
MORB	Table S1	Tables 1 and S3 0.0 < M < 1.0 = MORB nM = 1.0 – M = non-MORB	T_{ref}	M +/- 0.1% plus nM -/+ 0.1%
(Mg,Fe)-perovskite	Table S1	Table S2 X = (Mg,Fe)-perovskite Y = all other minerals	T_{ref}	X_{ref} +/- 0.1% X plus Y_{ref} +/- 0.1% Y
Iron	Table S1	Table S2 X = iron ($FeSiO_3$ +FeO) Y = all other minerals	T_{ref}	X_{ref} +/- 0.1% X plus Y_{ref} +/- 0.1% Y
SiO_2 phase	Table S1	Table S2 X = SiO_2 Y = all other minerals	T_{ref}	X_{ref} +/- 0.1% X plus Y_{ref} +/- 0.1% Y
post-perovskite	Table S1	Table S2 X = post-perovskite ($MgSiO_3$ + $FeSiO_3$ + Al_2O_3) Y = all other minerals	T_{ref}	X_{ref} +/- 0.1% X plus Y_{ref} +/- 0.1% Y

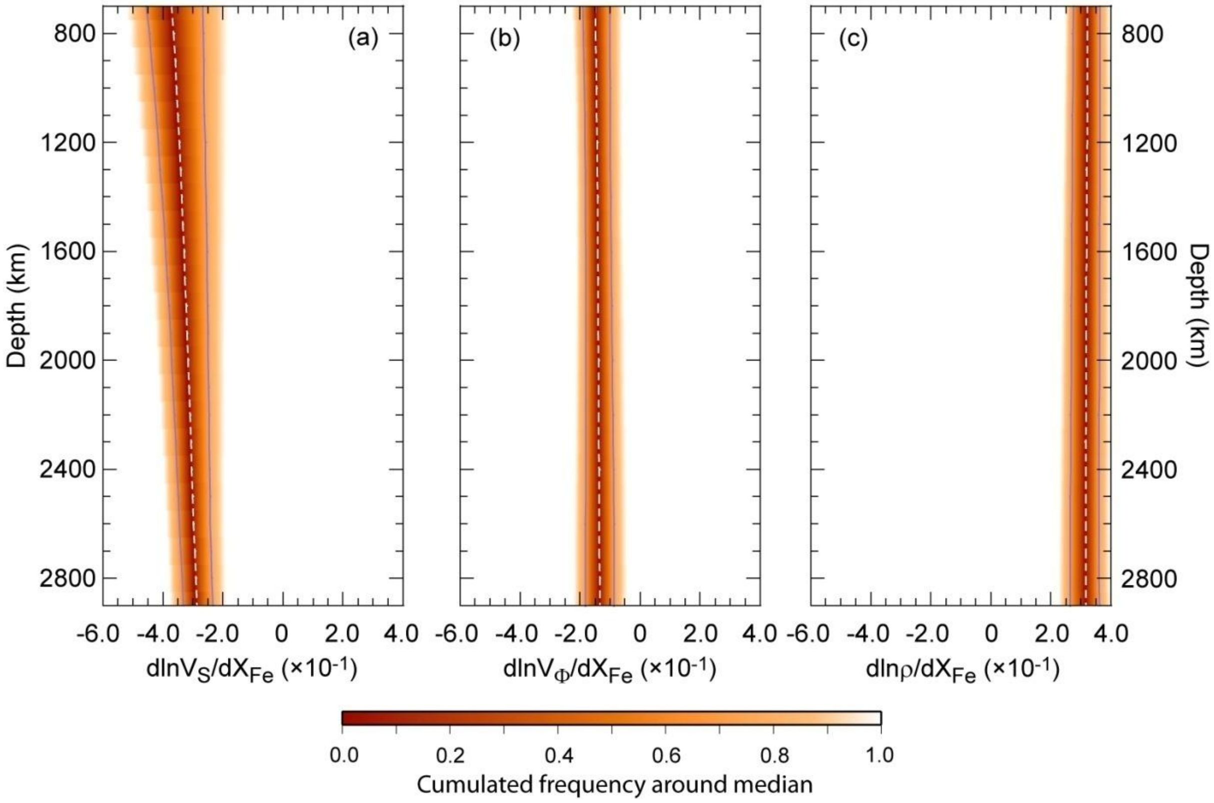
Supplementary Table S4. Summary of difference in temperature T and chemical composition C between reference (denoted with subscript *ref*) and perturbed (denoted with subscript *per*) models for each thermo-chemical parameter tested. Perturbed T and C listed are for the maximum difference between reference and perturbed model. In practise, for each of the 100000 models, a random number between 0 and these maximum values is chosen.



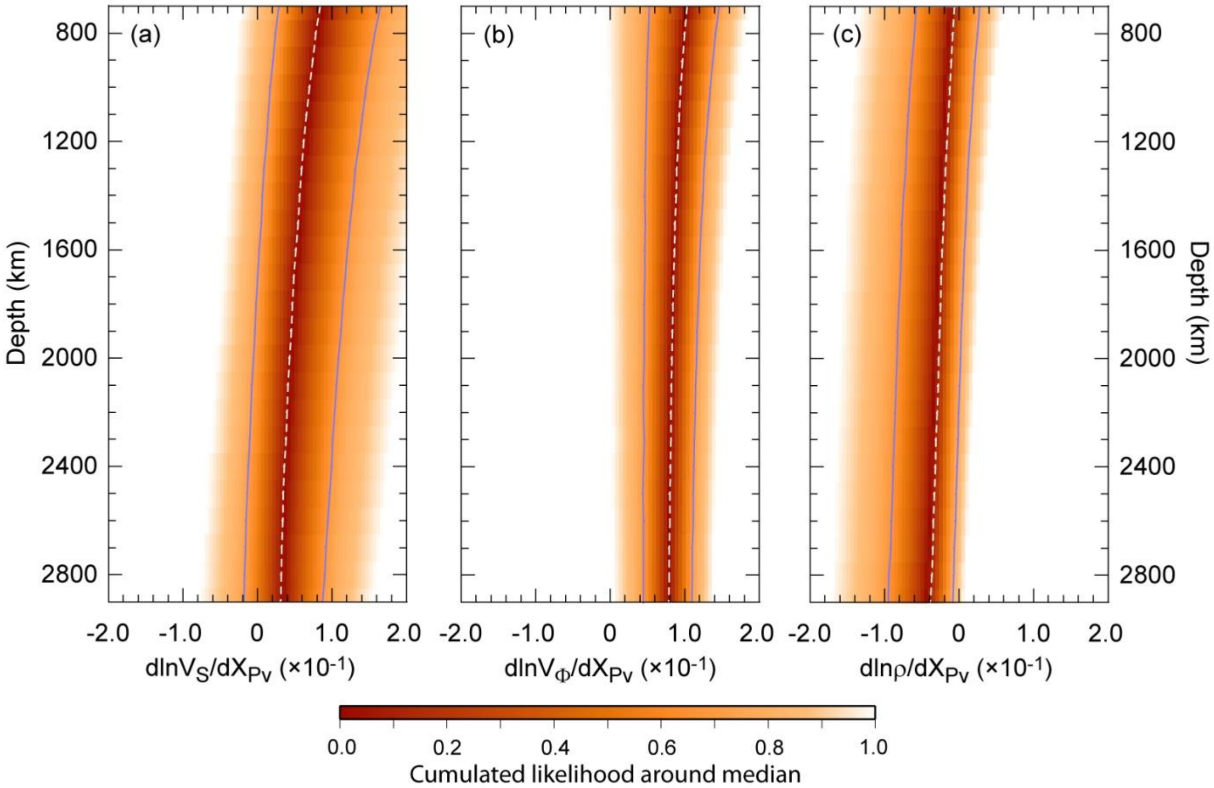
Supplementary Figure S1. Frequency histograms of the sensitivities of shear-wave velocity (left), bulk-sound velocity (middle), and density (right) to the volume fraction of MORB for several samplings of the model space of the oxide composition. The number of realizations, *N*, is indicated by the legend in plot a. Three depths are considered, from top to bottom 1200, 2000, and 2800 km.



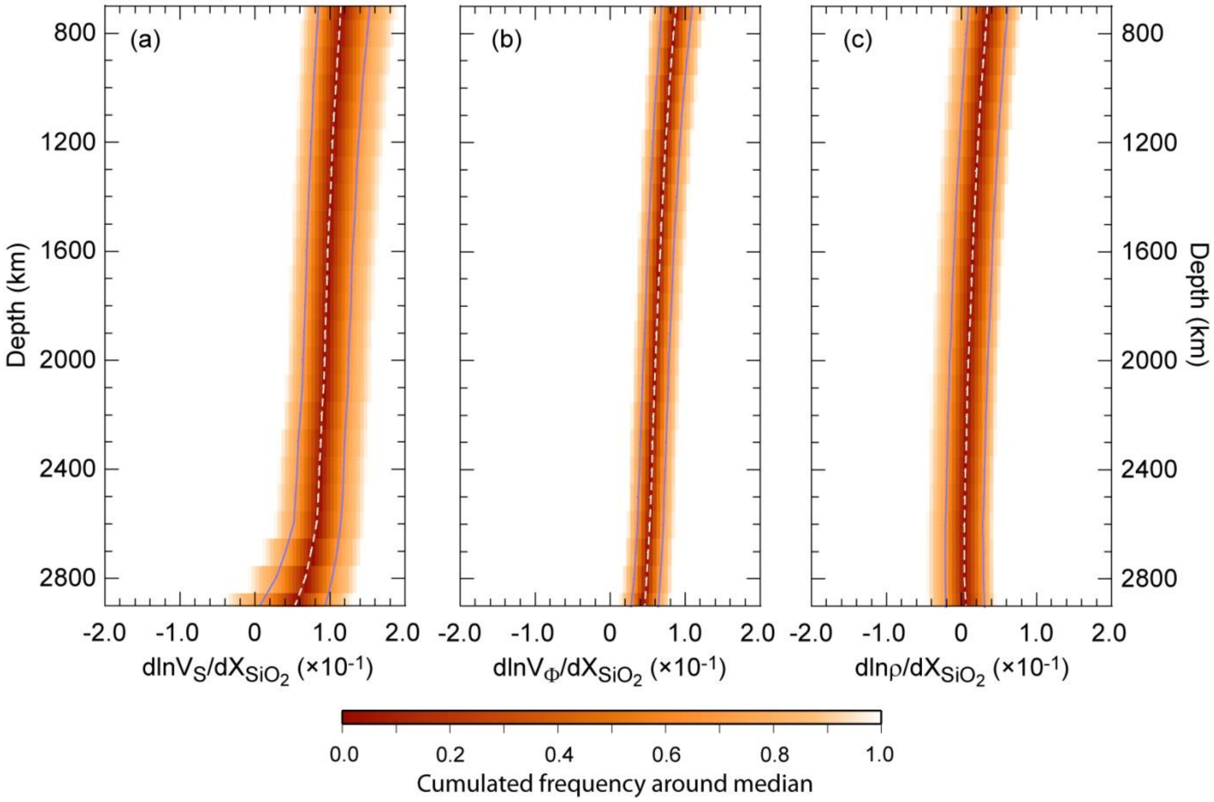
Supplementary Figure S2. Sensitivities of shear-wave velocity (left), bulk-sound velocity (middle), and density (right) to temperature as a function of depth. The color code indicates the cumulated likelihood around the median value. On each plot, the white dashed line indicates the median value (*i.e.*, 50% of the explored sensitivities lie on each side of this line), and the blue curves represent the 0.15 and 0.85 quartiles (*i.e.*, 70% of the explored sensitivities lie within the area bounded by these curves).



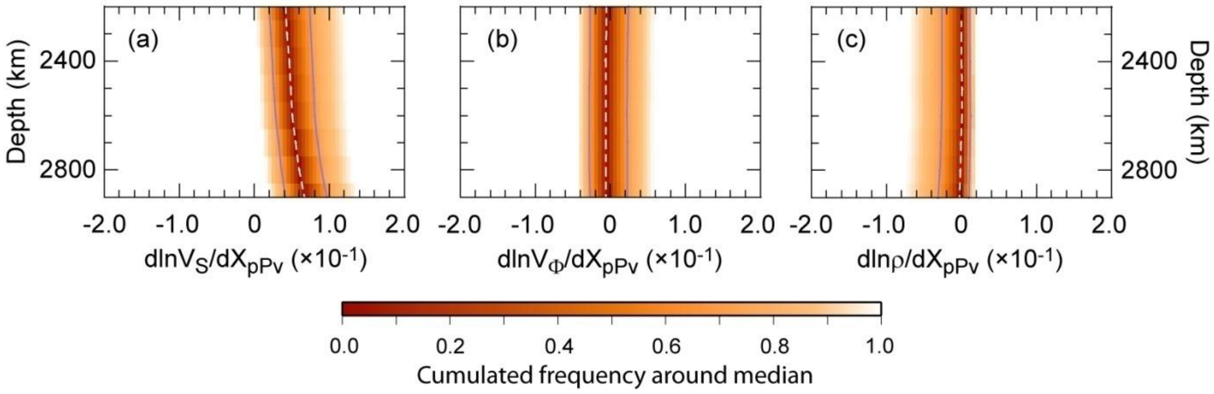
Supplementary Figure S3. Sensitivities of shear-wave velocity (left), bulk-sound velocity (middle), and density (right) to the global volume fraction of iron (FeO plus $FeSiO_3$) as a function of depth. The color code and curves description are similar to those in Figure S2.



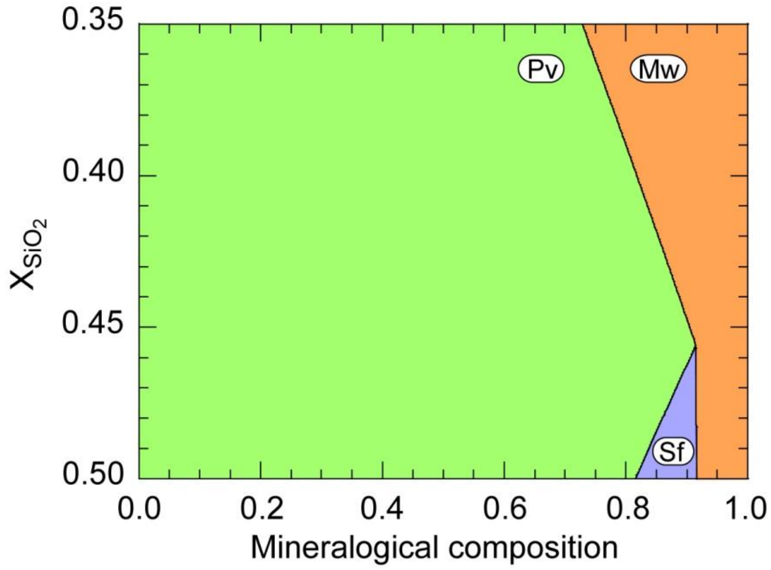
Supplementary Figure S4. Sensitivities of shear-wave velocity (left), bulk-sound velocity (middle), and density (right) to the volume fraction of (Mg,Fe)-perovskite as a function of depth. The color code and curves description are similar to those in Figure S2.



Supplementary Figure S5. Sensitivities of shear-wave velocity (left), bulk-sound velocity (middle), and density (right) to the volume fraction of free SiO_2 as a function of depth. The color code and curves description are similar to those in Figure S2.



Supplementary Figure S6. Sensitivities of shear-wave velocity (left), bulk-sound velocity (middle), and density (right) to the volume fraction of post-perovskite as a function of depth. These sensitivities are defined only in the depth range 2200-2900 km, where post-perovskite might be present. The color code and curves description are similar to those in Figure S2.



Supplementary Figure S7. Phase diagram of the mineralogical composition as a function of the volume fraction of the SiO_2 obtained by minimization of Gibbs free energy (Connolly, 2005). The volume fraction of FeO is fixed to 9.0%. Depth and temperature are 2800 km and 2500 K, respectively. For simplicity, post-perovskite phase is neglected. Observed phases are (Mg-Fe)-perovskite (Pv), seifertite (Sf), and periclase/ wüstite (Mw). For comparison, the volume fraction of (Mg-Fe)-perovskite obtained for a pyrolitic composition (with volume fraction of SiO_2 and FeO of 40% and 6%), is around 70%.