

*Supplemental material***Table S1**

Comparison of Bulk modulus of different $\text{Fe}_3(\text{S}_{1-x}\text{P}_x)$ solid solutions. B' was fixed at 4.

Composition	B_0 (GPa)	V_0 (\AA^3)	B'	Ref.
Fe_3P	161(2)	367.1(2)	4	Gu <i>et al.</i> , 2013
$\text{Fe}_3(\text{S}_{0.5}\text{P}_{0.5})$	158(1)	373.02(1)	4	This study
Fe_3S	150(2)	377.01(2)	4	Fei <i>et al.</i> , 2000

Table S2Unit-cell parameters of $\text{Fe}_3(\text{S}_{0.5}\text{P}_{0.5})$ at various pressures*.

P_{diamond} (GPa)	P_{Ne} (GPa)	V (\AA^3)	a (\AA)	c (\AA)	c/a
0.5(3)	-	371.21(5)	9.117(2)	4.466(3)	0.4899
1.0(3)	-	371.19(5)	9.117(2)	4.465(3)	0.4898
4.9(3)	-	363.26(3)	9.049(2)	4.436(1)	0.4902
6.5(3)	7	359.19(6)	9.019(3)	4.416(3)	0.4896
10.0(4)	10	351.78(9)	8.957(4)	4.385(4)	0.4896
11.7(3)	12	350.04(5)	8.941(3)	4.379(2)	0.4898
12.6(3)	13	347.44(5)	8.919(2)	4.368(3)	0.4898
14.3(5)	14	345.23(9)	8.900(4)	4.359(5)	0.4898
15.9(8)	16	342.49(5)	8.877(2)	4.346(3)	0.4896
18.9(7)	18.5	338.28(9)	8.839(4)	4.330(4)	0.4898
20.7(7)	20.5	335.91(5)	8.817(2)	4.321(3)	0.4901
22.6(10)	23	332.47(4)	8.779(3)	4.316(2)	0.4916
24.9(9)	25	329.78(9)	8.749(5)	4.308(3)	0.4925
26.7(11)	26.5	328.49(9)	8.736(6)	4.304(3)	0.4927
28.9(12)	29	325.54(9)	8.758(7)	4.357(3)	0.4975

*Numbers in parentheses represent errors in the last digit.

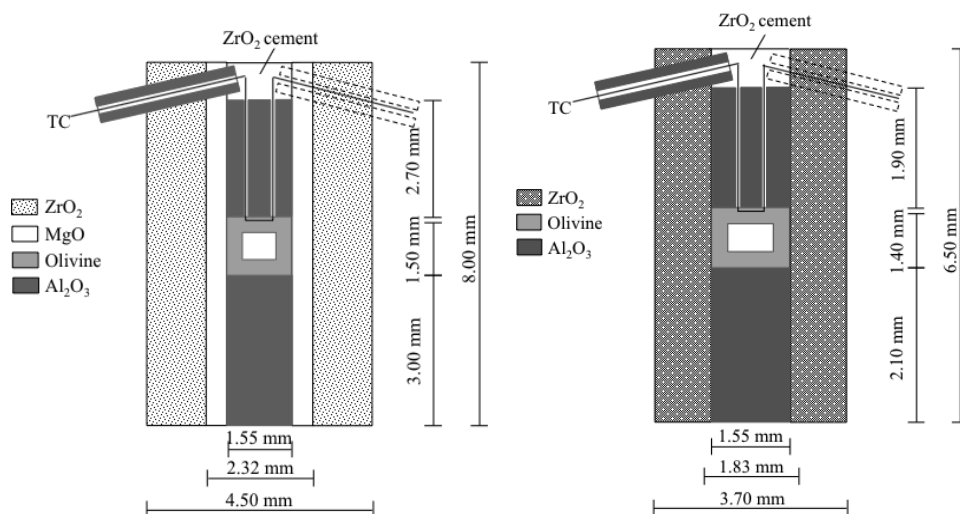


Figure S1 Schematics of the 10/5 (Left) and 8/3 (Right) assemblies.

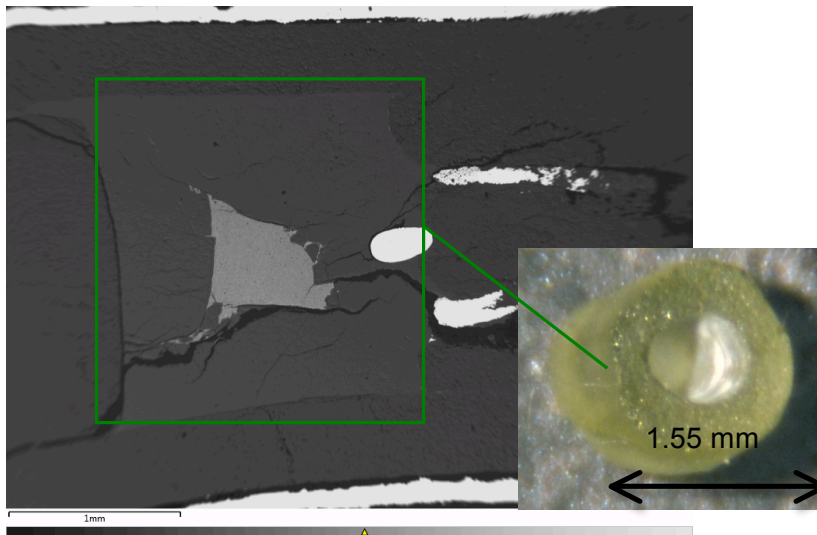


Figure S2 Back scatter electron image of a final product in a home-made olivine capsule. Inset is a photo of this capsule under microscope.

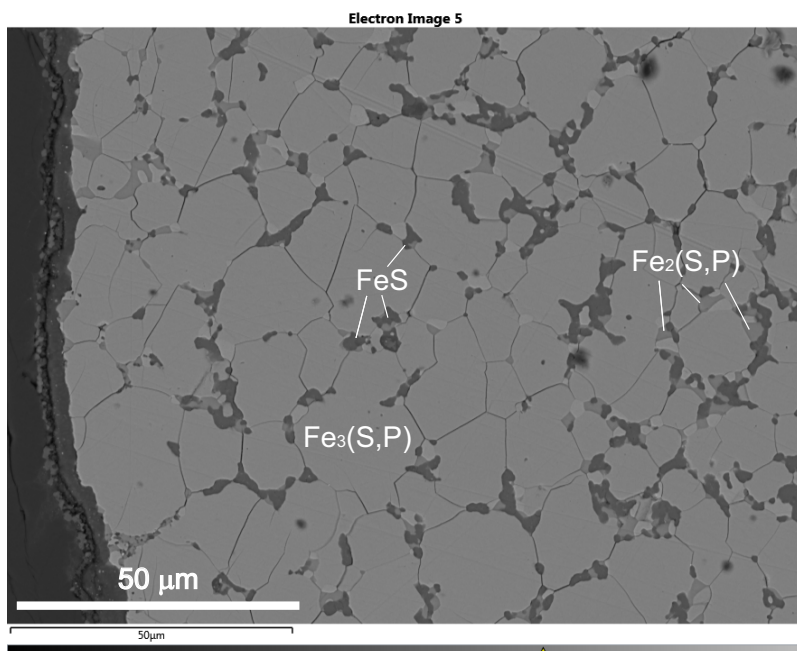


Figure S3 Back scatter electron image of the synthetic sample quenched from 8 GPa. Dark grey areas: FeS particles; Grey area: $\text{Fe}_3(\text{S}_{0.13}\text{P}_{0.87})$ and $\text{Fe}_2(\text{S,P})$ grains.

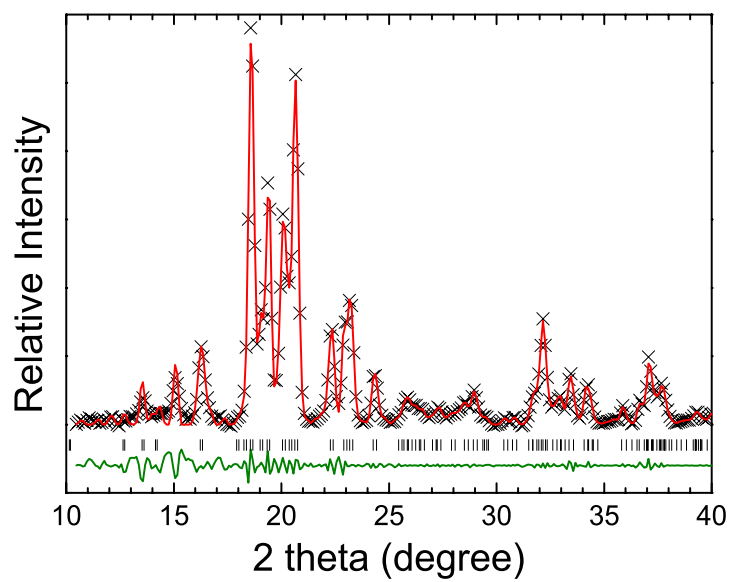


Figure S4 The XRD pattern of synthetic $\text{Fe}_3(\text{S}_{0.22}\text{P}_{0.78})$ solid solution at ambient conditions.

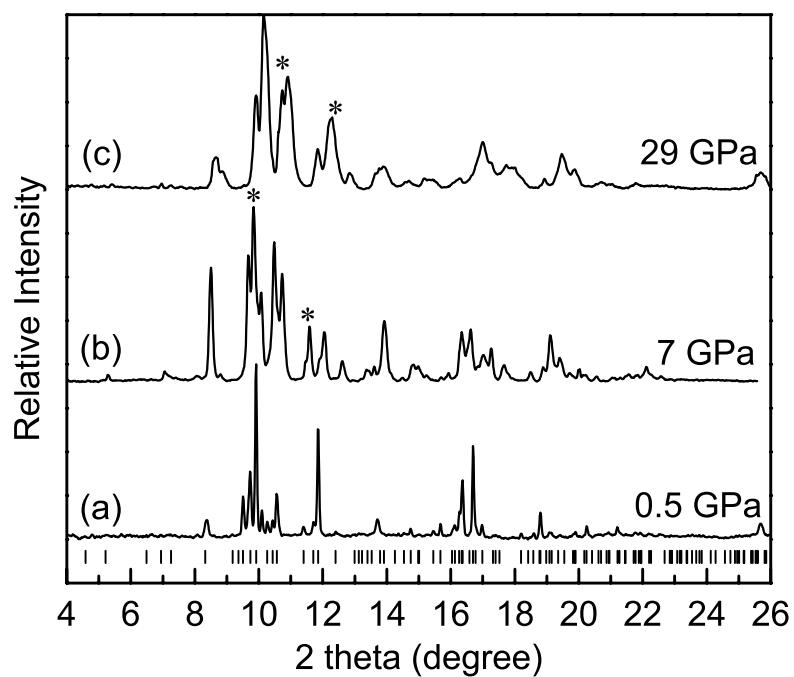


Figure S5 Selected XRD patterns of synthetic $\text{Fe}_3(\text{S}_{0.5}\text{P}_{0.5})$ under pressures. Bars: diffraction lines of $\text{Fe}_3(\text{S}_{0.5}\text{P}_{0.5})$ with *I*-4 structure; Asterisks: diffraction lines of Ne as pressure medium.