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Supplementary Materials for

A thermally conductive Martian core and implications for its dynamo cessation

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Figs. S1 and S2
Table S1

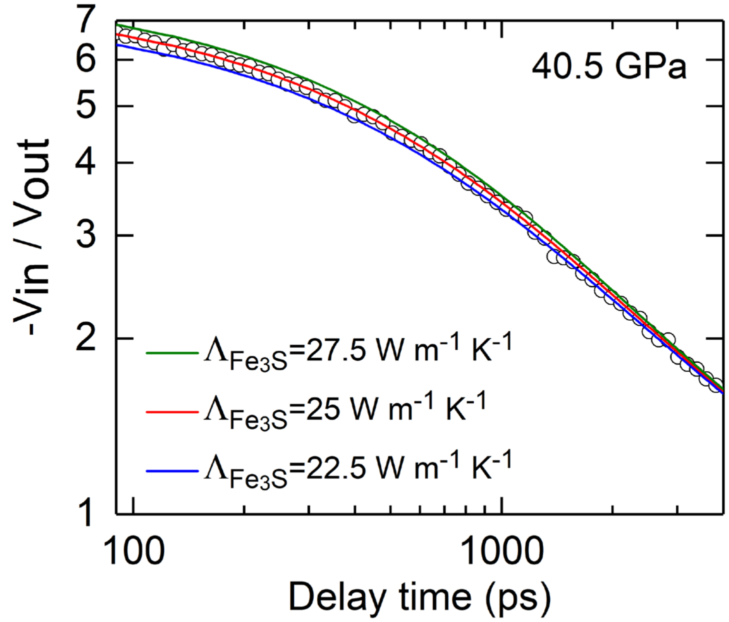

Fig. S1. Example TDTR spectrum (open circles) along with thermal model calculations (color solid curves) for Fe_3S at 40.5 GPa. Using the input parameters listed in Table S1, Λ_{Fe3S}=25 W m^{-1} K^{-1} (red curve) enables a best-fit to the TDTR data. The spectrum ratio $-V_{in}/V_{out}$ is most sensitive to the sample's thermal conductivity at delay times of few hundred picoseconds (ps), see Ref (*57, 58*) for details. A test variation of 10% in Λ_{Fe3S}, i.e., green and blue curves, results in a clear deviation from the data. Such high sensitivity indicates our thermal model fitting and the derived Λ_{Fe3S} are precise and reliable based on the high-quality data.

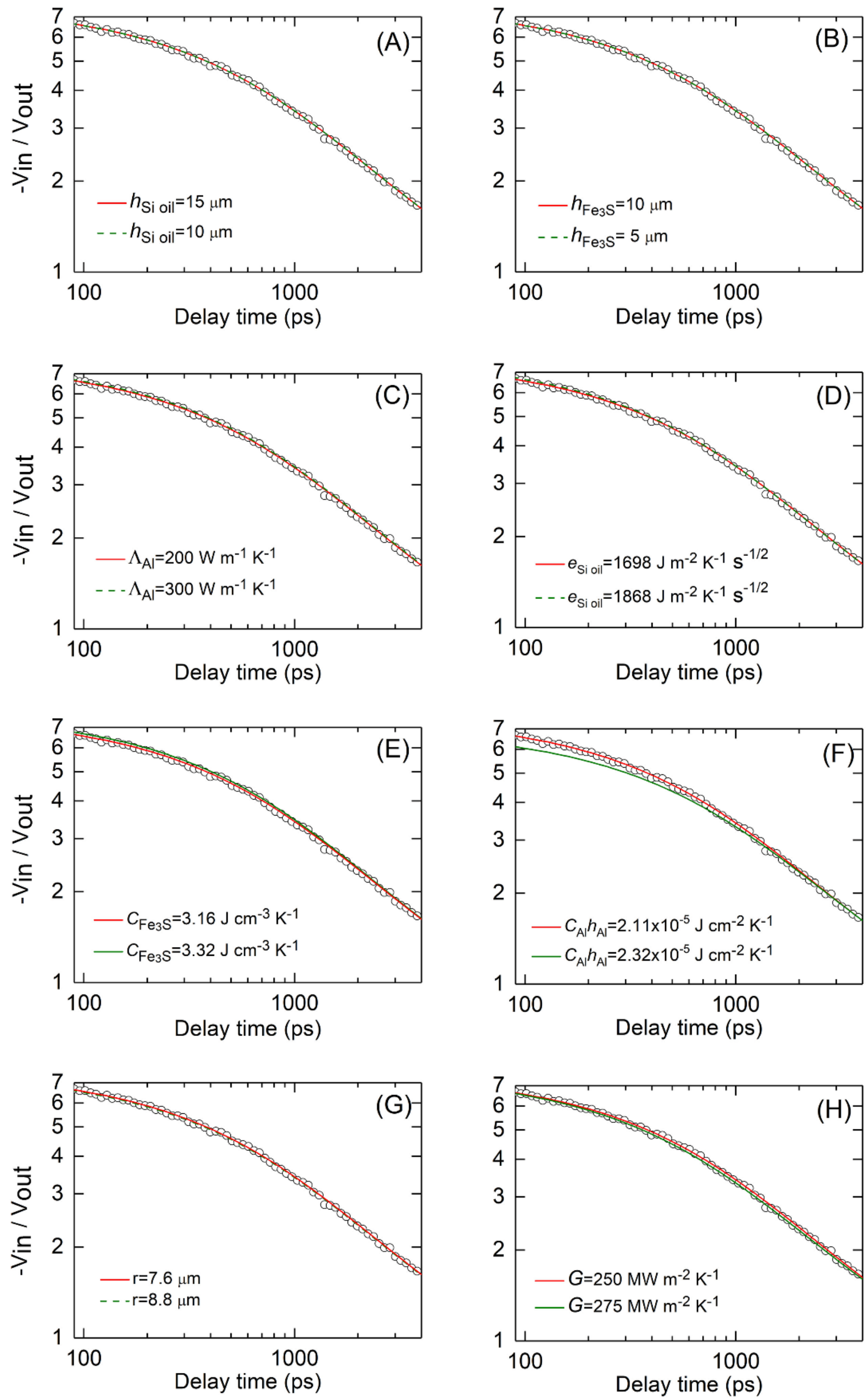

Fig. S2. Sensitivity tests of the thermal model to input parameters for Fe_3S at 40.5 GPa. Thermal conductivity of Fe_3S, Λ_{Fe3S}, is fixed at 25 W m^{-1} K^{-1}, as shown in Fig. S1. (A) and (B) Changes in the thicknesses of silicone oil ($h_{\text{Si oil}}$) and Fe_3S (h_{Fe3S}) by 33% and 50%, respectively, have essentially no influence on the model calculations, i.e., the derived Λ_{Fe3S} is not affected by the uncertainties in the $h_{Si\ oil}$ and h_{Fe3S}. (C) Large uncertainty in the high thermal conductivity of Al film has very minor effect on the Λ_{Fe3S}. (D) If the thermal effusivity of the pressure medium silicone oil, $e=(\Lambda_{Si}C_{Si})^{1/2}$, has 10% uncertainty, it requires the Λ_{Fe3S} to decrease to 24.5 W m^{-1} K^{-1} to re-fit the data, i.e., producing 2% uncertainty. (E) If the volumetric heat capacity of Fe_3S, C_{Fe3S}, is 5%, a Λ_{Fe3S}=24.3 W m^{-1} K^{-1} can re-fit the data, i.e., propagating 3% uncertainty. (F) In our analysis, the major uncertainty is from the uncertainty in the heat capacity of Al film per unit area, i.e., product of volumetric heat capacity and thickness, $C_{Al}\,h_{Al}$. This is because the ratio $-V_{in}/V_{out}$ at few hundred picosecond delay time scales inversely with the $C_{Al}\,h_{Al}$ (*58*). If there is a 10% uncertainty, it requires ~16% change in the Λ_{Fe3S} to fit the data. (G) Changing the laser spot size by 15% does not influence the model calculation, i.e., its uncertainty has essentially no effect on the Λ_{Fe3S}. (H) 10% variation in the thermal conductance of Al/Fe_3S and Al/silicone oil interfaces, *G*, lead to a very minor change in the model calculation, propagating only ~4% uncertainty in the Λ_{Fe3S}.

Table S1. Input parameters in the thermal model for Fe_3S at 40.5 GPa and 300 K in TDTR measurements

P (GPa)	C_{Fe3S} (J cm^{-3} K^{-1})	C_{Al} (J cm^{-3} K^{-1})	h_{Al} (nm)*	$e=(\Lambda_{Si}C_{Si})^{1/2}$ (J m^{-2} K^{-1} s$^{-1/2}$)	r (μm)	$h_{Fe3S/Si\ oil}$ (μm)	Λ_{Al} (W m^{-1} K^{-1})	G (MW m^{-2} K^{-1})
40.5	3.16	2.68	79.0	2260	7.6	10/15	200	250

*In this experimental run, the Al thickness at ambient pressure is 90 nm.
C_{Fe3S}: Fe_3S heat capacity, C_{Al}: Al heat capacity, h_{Al}: Al thickness, e: silicone oil thermal effusivity, r: laser spot size, h_{Fe3S}: Fe_3S thickness, $h_{Si\ oil}$: silicone oil thickness, Λ_{Al}: Al thermal conductivity, G: thermal conductance of Al/Fe_3S and Al/silicone oil interfaces.