

Supplementary Information for

Pressure-driven processes explain the decreasing magnetization
of the subducting oceanic crust in the Japan Trench

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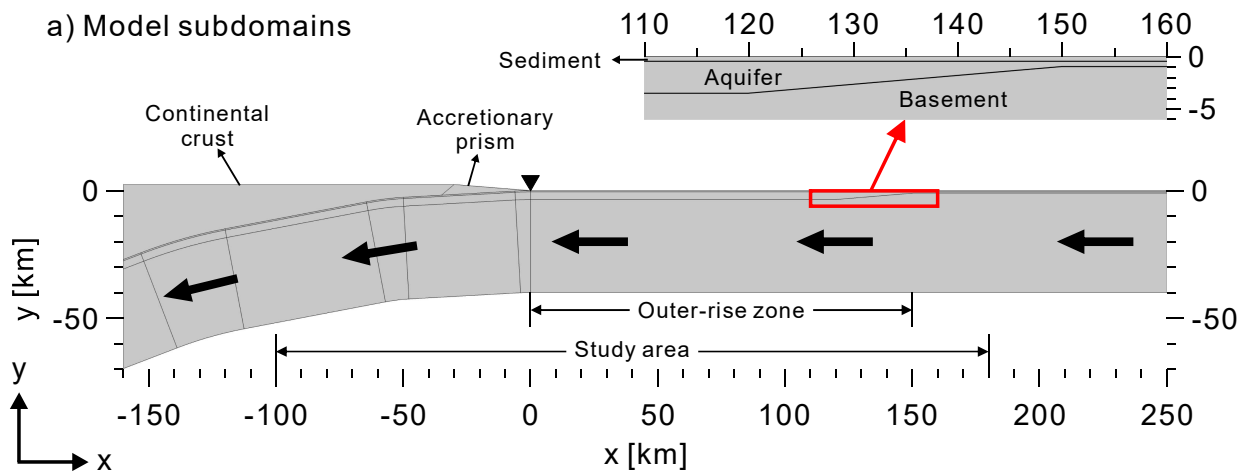
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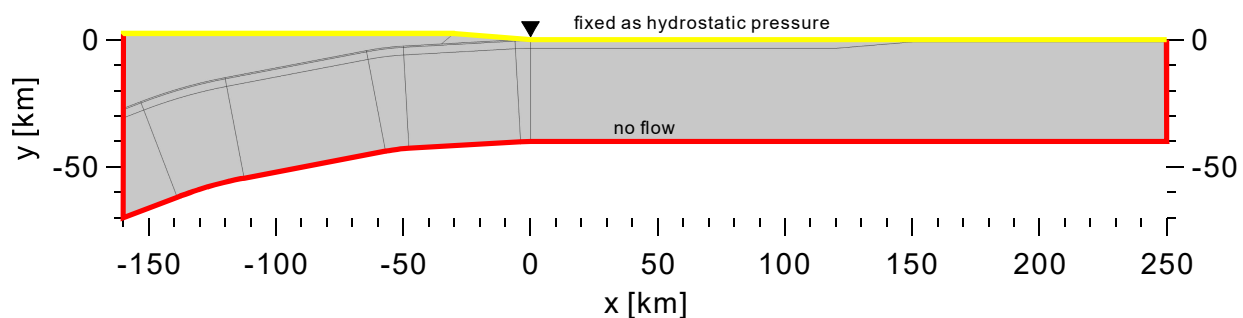
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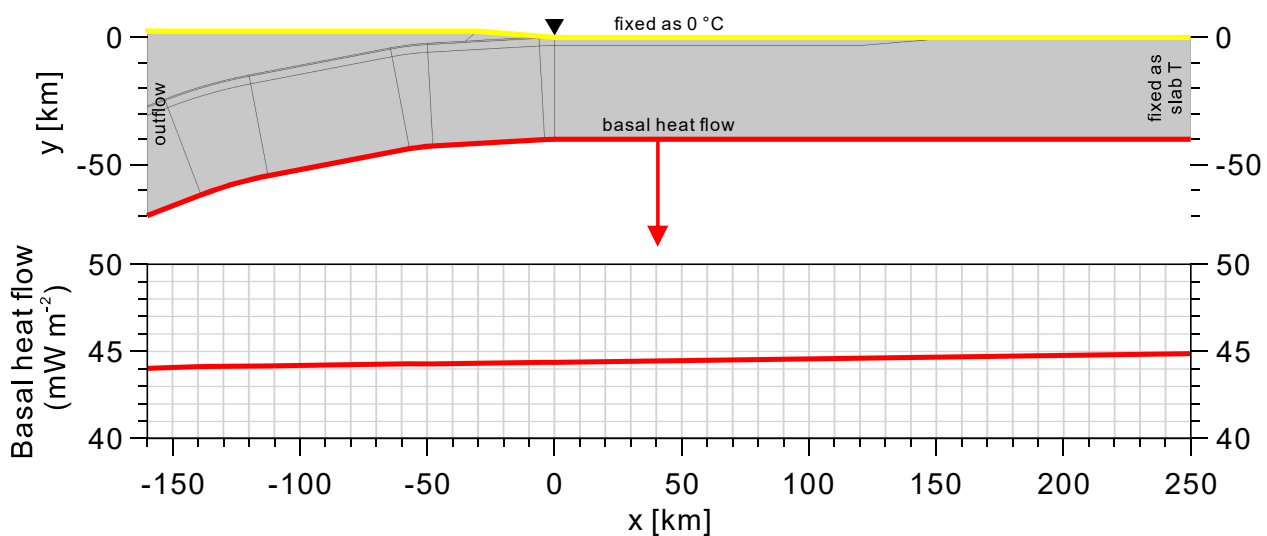
a) Model subdomains



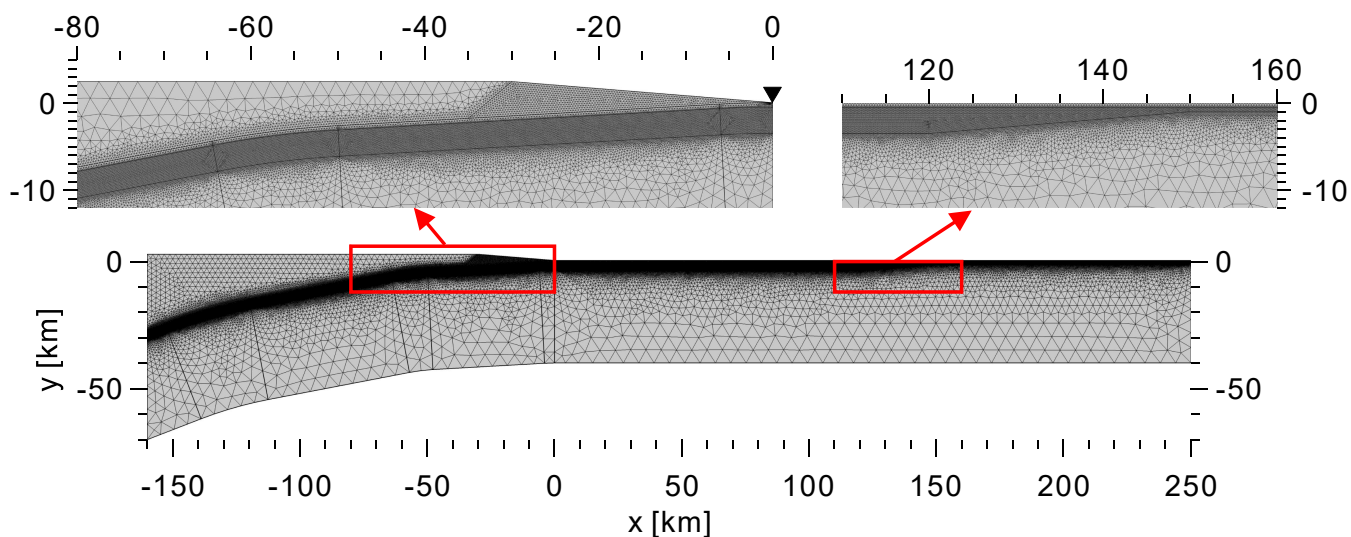
b) B.C for continuity and Darcy's equations



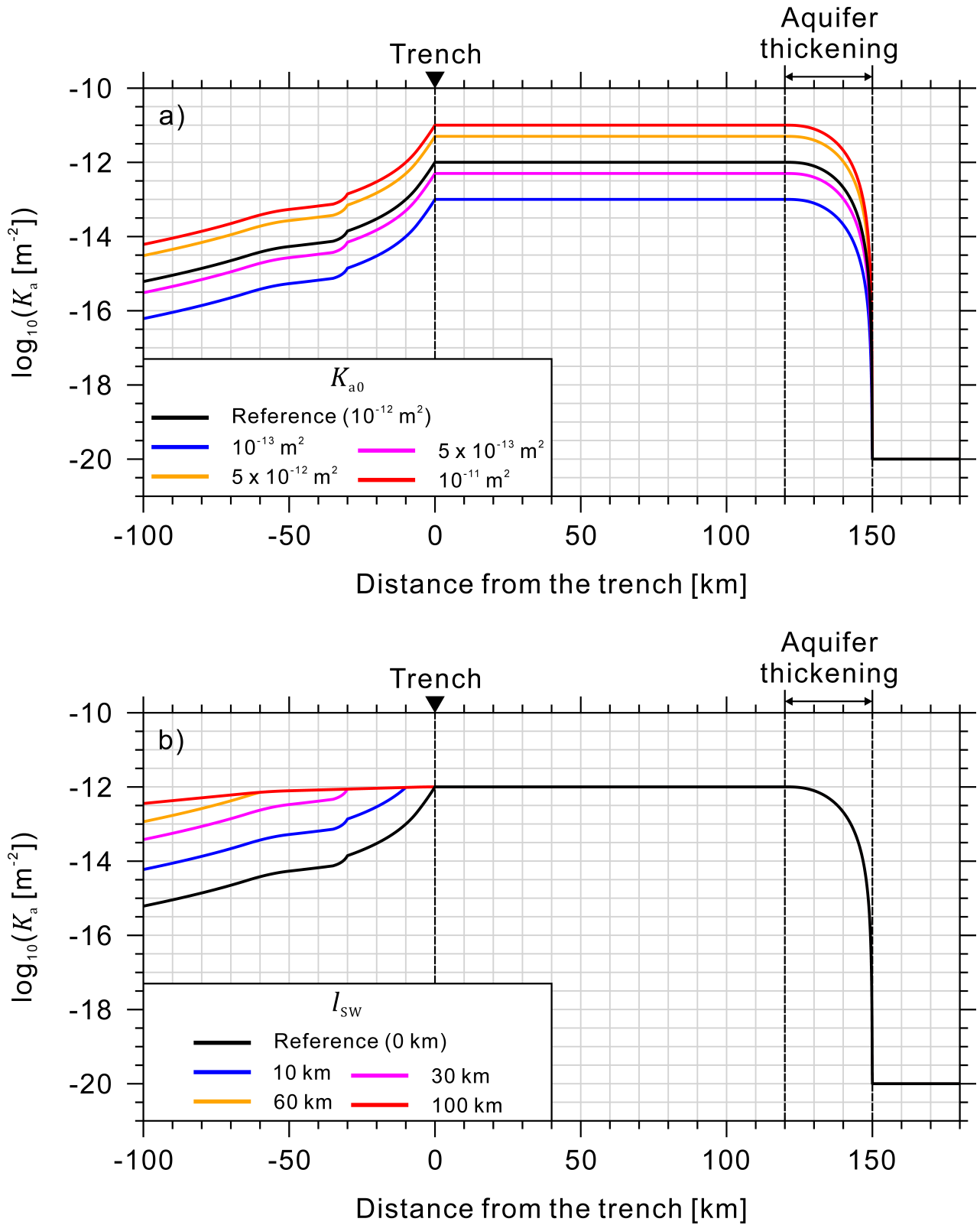
c) B.C for energy equation



d) Mesh



Supplementary Fig. 1. Model geometry with its subdomains, boundary conditions, and mesh. The trench ($x = 0$ km) is marked with a black reverse triangle. **a** The model geometry and its subdomains consisting of sediment, oceanic plate (aquifer and basement), accretionary prism, and overlying continental crust. Both the oceanic plate and overlying sediment converge from right to left and are marked with black arrows. The aquifer thickens from 0.5 to 3 km over the distance, $120 \leq x < 150$ km, to consider increases in permeability owing to fracturing and faulting. **b** Boundary conditions for continuity and Darcy's equations. **c** Boundary conditions for the energy equation. The basal heat flow and slab temperature (slab T) were assigned to yield a surface heat flow of $\sim 50 \text{ mW m}^{-2}$ for the initial condition. **d** Model meshes. Fine meshes were assigned for the sediment, aquifer, and accretionary prism, while coarse meshes were assigned for the basement and overlying continental crust.



Supplementary Fig. 2. Aquifer permeability (K_a) with the distance from the trench used in the model experiments. a Aquifer permeability by varying the initial aquifer permeability (K_{a0}). **b** Aquifer permeability by varying the landward extent of the zone of gradual permeability decrease (l_{sw}).

Supplementary Table 1. Model Parameters

Thermodynamic values	
Density of the pore water at 0 °C ρ_{f0} [kg m ⁻³]	1036.5
Heat capacity of the pore water $(\rho c_p)_f$ [J m ⁻³ K ⁻¹]	4.2×10 ⁶
Heat conductivity of the pore water k_f [W m ⁻¹ K ⁻¹]	0.6
Density of the sediment grain ρ_s [kg m ⁻³]	2600
Heat capacity of the sediment grain $(\rho c_p)_s$ [J m ⁻³ K ⁻¹]	1.6×10 ⁶
Heat conductivity of the sediment grain k_s [W m ⁻¹ K ⁻¹]	2
Density of the oceanic plate grain ρ_{op} [kg m ⁻³]	3000
Heat capacity of the oceanic plate grain $(\rho c_p)_{op}$ [J m ⁻³ K ⁻¹]	3.19×10 ⁶
Heat conductivity of the oceanic plate grain k_{op} [W m ⁻¹ K ⁻¹]	2.6
Density of the accretionary prism grain ρ_{ap} [kg m ⁻³]	2600
Heat capacity of the accretionary prism grain $(\rho c_p)_{ap}$ [J m ⁻³ K ⁻¹]	^a 1.6×10 ⁶
Heat conductivity of the accretionary prism grain k_{ap} [W m ⁻¹ K ⁻¹]	^a 2
Density of the continental crust grain ρ_c [kg m ⁻³]	2700
Effective heat capacity of the continental crust $(\rho c_p)_c$ [J m ⁻³ K ⁻¹]	^b 2.5×10 ⁶
Effective heat conductivity of the continental crust k_c [W m ⁻¹ K ⁻¹]	^b 2.5
Permeability and porosity values	
Initial aquifer permeability K_{a0} [m ²]	^c 10 ⁻¹²
Aquifer porosity ϕ_a [·]	^d 0.1
Basement permeability K_b [m ²]	^e 10 ⁻²⁰
Basement porosity ϕ_b [·]	^d 0.1
Continental crust permeability K_c [m ²]	10 ⁻²⁰
Continental crust porosity ϕ_c [·]	0.01
Other values	
Effective coefficient of friction μ' [·]	^f 0.08
Final aquifer thickness d_a [km]	^g 3
Landward extent of the zone of gradual permeability decrease l_{sw} [km]	^h 0
Radiogenic heat production in the sediment γ_s [μW m ⁻³]	ⁱ 1.5
Radiogenic heat production in the accretionary prism γ_{ap} [μW m ⁻³]	ⁱ 1.8
Radiogenic heat production in the upper continental crust γ_{c1} [μW m ⁻³]	^j 1.3
Radiogenic heat production in the lower continental crust γ_{c2} [μW m ⁻³]	^j 0.27

^aAverage value from Lin et al.¹

^bSpinelli and Harris²

^cThe low value of aquifer permeability suggested in Hutnak et al.³ for the 130-Ma old oceanic crust in the vicinity of the Japan Trench.

^dRay et al.⁴

^eKatayama et al.⁵

^fExperimental value of saturated montmorillonite-granite assemblage⁶

^gFujie et al.⁷

^hFrom the experiments⁸

ⁱHyndman et al.⁹ and Yamaguchi et al.¹⁰

^jPeacock and Wang¹¹

Supplementary References

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