

Supporting information

Depth-specific thermal conductivities of Triassic sandstones

Anna Albers^{1}, Fabien Glatting¹, Kathrin Menberg¹, Hagen Steger¹, Christina Fliegauf¹, Linda Schindler², Sascha Wilke¹, Roman Zorn², Philipp Blum¹*

¹ Karlsruhe Institute of Technology (KIT), Institute of Applied Geosciences (AGW)
Kaiserstraße 12, 76131 Karlsruhe, Germany

² European Institute for Energy Research (EIFER), Emmy-Noether-Straße 11, 76131
Karlsruhe, Germany

*Corresponding author: anna.albers@kit.edu (+49 721 608 45064)

1 Supplementary results

Table A- 1: Experimentally determined properties of the Triassic sandstones with the minimum (Min), arithmetic mean (Mean), median, maximum (Max), standard deviation (s [W m⁻¹ K⁻¹]) and number of analysed samples.

		Min	Mean	Median	Max	s	Number
Effective thermal conductivity λ_{eff}	[W m ⁻¹ K ⁻¹]	2.3	4.7	5.0	6.1	0.9	101
Saturated thermal conductivity λ_{sat}	[W m ⁻¹ K ⁻¹]	2.7	4.6	4.6	6.4	0.6	141
Dry thermal conductivity λ_{dry}	[W m ⁻¹ K ⁻¹]	1.4	2.5	2.4	3.9	0.5	147
Wet bulk density ρ_b	[g cm ⁻³]	2.15	2.46	2.45	2.68	0.08	156
Dry bulk density ρ_d	[g cm ⁻³]	1.80	2.32	2.31	2.63	0.11	156
Solid density ρ_s	[g cm ⁻³]	2.62	2.68	2.67	2.81	0.03	156
Water content w	[%]	2.0	5.8	5.7	19.4	2	156
Open porosity ϕ_{open}	[%]	5.6	13.2	13.4	23.6	3.3	155
Total porosity ϕ	[%]	2.0	12.9	13.2	18.8	3.2	115
Quartz content	[%]	82	87	86	95	4	10
Feldspar content	[%]	2.5	7.1	7.8	12	2.8	10
Lithic fragment content	[%]	3.5	6.5	6.5	10	2.3	10
Clay content	[%]	1.5	3.2	3.1	5.0	1.4	10
Carbonate content CO_3	[%]	0.1	4.6	0.4	55.5	10.8	147
Permeability K	[mD]	1.2	28.0	3.2	368.1	62.1	154
Average pore diameter d_{pore}	[µm]	0.01	0.14	0.09	1.04	0.18	143
Inner pore surface A_{pore}	[m ² g ⁻¹]	0.06	2.75	2.45	8.5	1.7	142

Table A- 2: Statistics of the estimated thermal conductivities (λ_{est} [W m⁻¹ K⁻¹]) applying the different prediction models with the minimum (Min), arithmetic mean (Mean), maximum (Max), standard deviation (s [W m⁻¹ K⁻¹]) and the root mean square error (RMSE).

	Min	Max	Mean	s	RMSE
Arithmetic mean	5.4	6.5	6.1	0.2	1.6
Harmonic mean	2.0	4.3	2.9	0.4	1.8
Geometric mean	3.9	6.0	5.0	0.4	0.8
Voigt-Reuss-Hill model	3.7	5.4	4.5	0.3	0.7
Statistical spatial distribution mean	3.3	5.3	4.2	0.4	0.8
Hashin-Shtrikman upper bound	5.0	6.4	5.8	0.3	1.4
Hashin-Shtrikman lower bound	3.2	5.6	4.4	0.4	0.7
Hashin-Shtrikman average	4.1	6.0	5.1	0.3	0.8
de Vries, $g_I = 0.75$	3.8	5.9	4.9	0.4	0.8
Weighted arithmetic mean, $f = 0.65$	4.7	6.3	5.6	0.3	1.2
Sugawara and Yoshizawa, $n = 2$	4.0	6.0	5.1	0.4	0.8
Sugawara and Yoshizawa, $n = 2.5$	3.8	5.9	4.9	0.4	0.8
El Sayed	2.7	3.2	3.0	0.1	1.7
Nabawy-Géraud	2.8	4.4	3.8	0.4	1.1

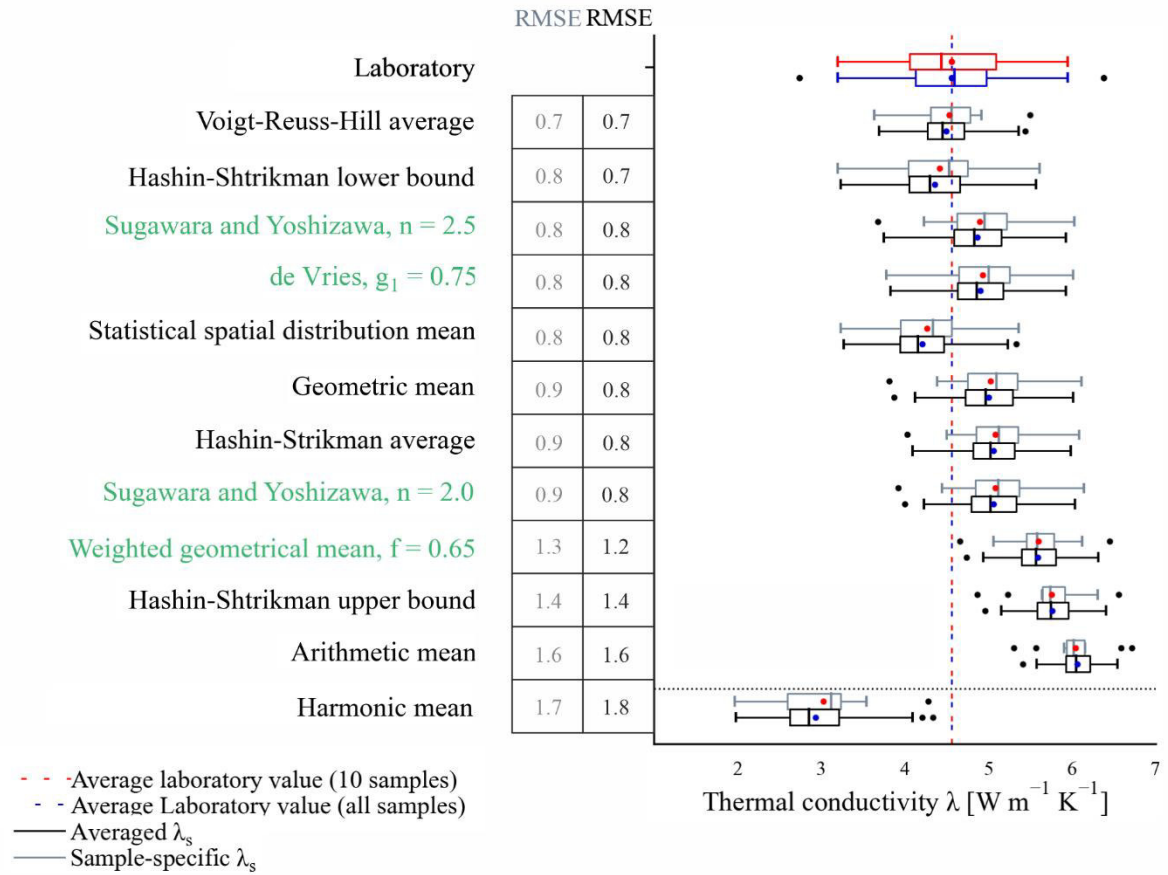


Fig. A- 1: Estimated thermal conductivities from theoretical models, comparing the approach using an average matrix thermal conductivity (λ_s) with using the sample-specific matrix thermal conductivities

Table A- 3: Error in estimated thermal conductivities, comparing the approach using an average matrix thermal conductivity with using the sample-specific matrix thermal conductivities for the ten samples with known mineralogy

	Mean error [%]	Maximum error [%]
Voigt-Reuss-Hill average	2.5	4.8
Hashin-Shtrikman lower bound	2.1	4.1
Sugawara and Yoshizawa, $n=2.5$	3.1	5.8
de Vries, $g_1=0.75$	2.5	4.8
Statistical spatial distribution mean	2.2	4.2
Geometric mean	2.8	5.3
Hashin-Shtrikman average	2.7	5.1
Sugawara and Yoshizawa, $n=2$	3.1	5.8
Weighted geometric mean	2.9	5.6
Hashin Shtrikman upper bound	3.1	5.9
Arithmetic mean	3.1	5.9
Harmonic mean	1.3	2.4