

What perturbs isotherms? An assessment using fission track thermochronology and thermal modelling along the Gotthard transect, Central Alps

C. Glotzbach¹, C. Spiegel^{1,2}, J. Reinecker¹, M. Rahn³ and W. Frisch¹

¹ Institute of Geoscience, University Tübingen, Sigwartstr. 10, 72076 Tuebingen, Germany
(e-mail: christoph.glotzbach@uni-tuebingen.de)

² Now at FB 5 Geoscience, University Bremen, Postfach 330 44028334 Bremen, Germany

³ Institute of Mineralogy-Geochemistry, University Freiburg, Albertstr. 23b, 79104 Freiburg, Germany

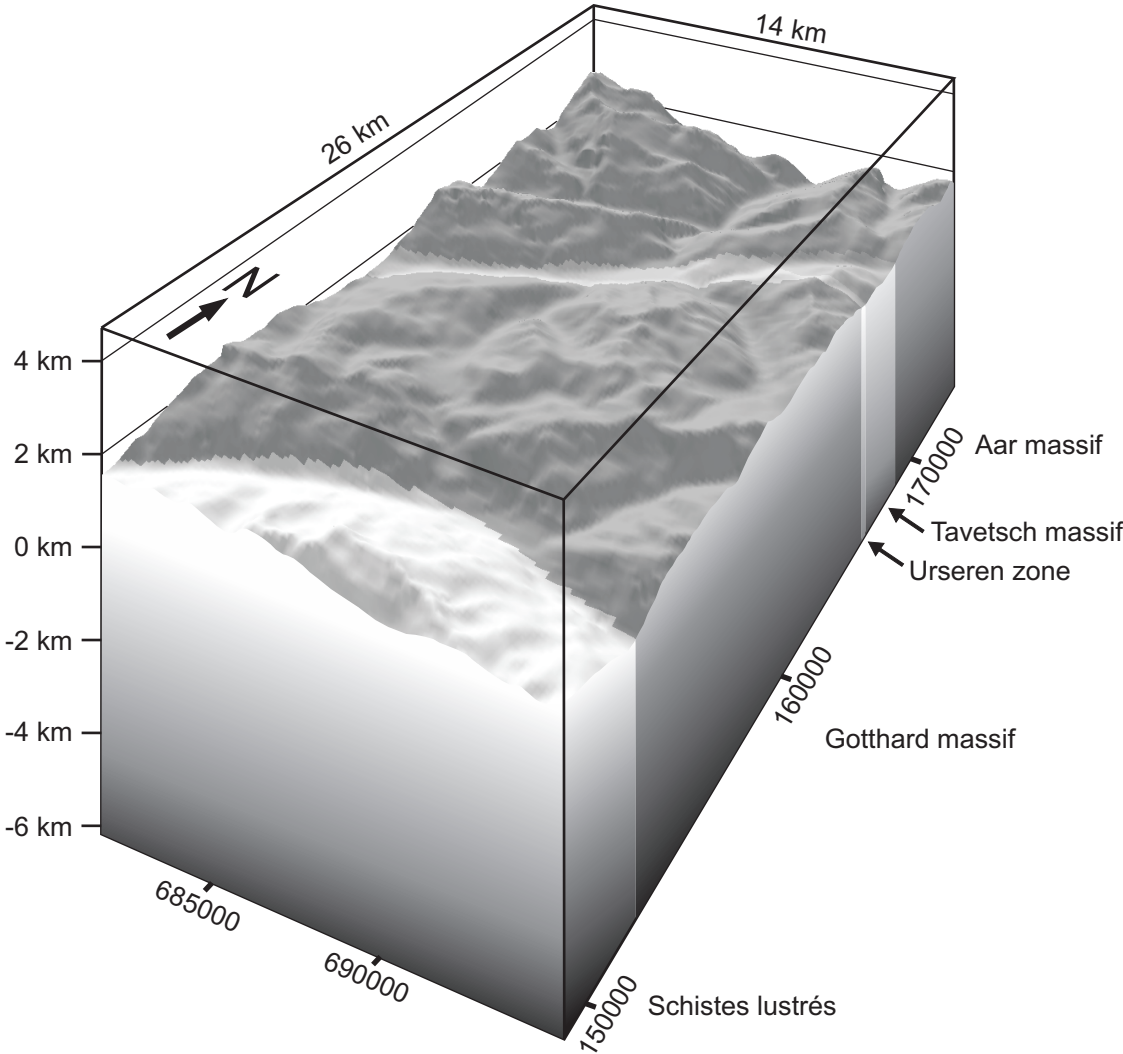
Apatite composition (weight-%) of 15 samples from the Gotthard road tunnel and corresponding surface transect and from Durango, with averages and standard deviations calculated from totally 320 electron microprobe analyses

Sample	n	F	Cl	SiO ₂	MnO	Ce ₂ O ₃	SrO	P ₂ O ₅	CaO	Dpar
MRP 229	10	3.23±0.19	0.100±0.020	0.030±0.010	na	0.04±0.02	bd	44.00±0.61	54.68±0.37	1.42±0.09
MRP 231	49	3.70±0.10	bd	0.012±0.020	0.054±0.014	na	0.036±0.043	43.90±0.50	54.90±0.70	1.26±0.11
MRP 232	49	3.45±0.19	0.013±0.006	0.023±0.044	0.103±0.039	na	0.040±0.028	43.80±0.40	54.80±0.30	1.34±0.13
MRP 233	9	2.72±0.19	0.028±0.004	0.010±0.010	na	0.04±0.01	0.040±0.020	40.81±0.56	54.65±0.32	1.57±0.15
MRP 234	10	3.88±0.22	bd	0.120±0.090	na	0.11±0.05	bd	43.69±0.77	54.15±0.57	1.41±0.10
MRP 236	10	4.02±0.18	bd	0.150±0.100	na	0.13±0.05	bd	41.11±1.00	54.12±0.60	1.29±0.14
MRP 239	10	4.03±0.23	bd	0.040±0.050	na	0.06±0.02	bd	44.46±0.50	54.58±0.28	1.25±0.10
MRP 241	7	3.48±0.08	bd	0.030±0.020	na	0.02±0.02	0.020±0.020	43.62±0.40	54.71±0.10	1.47±0.09
MRP 242	10	3.62±0.19	bd	0.040±0.010	na	0.05±0.03	0.020±0.020	42.40±0.24	54.87±0.25	1.41±0.09
MRP 244	49	3.47±0.19	bd	0.057±0.071	0.071±0.046	na	0.100±0.065	43.60±0.40	54.90±0.40	1.32±0.14
MRP 245	5	3.27±0.10	bd	0.250±0.120	na	0.19±0.09	0.080±0.030	42.85±0.78	54.43±0.42	1.63±0.10
MRP 247	12	4.09±0.11	bd	0.210±0.080	na	0.16±0.08	0.020±0.010	44.58±0.48	54.01±0.35	1.13±0.14
MRP 248	10	4.15±0.23	bd	0.160±0.140	na	0.14±0.04	bd	43.99±0.36	54.04±0.25	1.12±0.12
MRP 249	10	3.75±0.22	0.006±0.005	0.150±0.040	na	0.21±0.05	0.020±0.020	43.65±0.77	54.48±0.26	1.34±0.12
MRP 291	50	4.03±0.22	bd	0.025±0.098	0.520±0.290	na	0.012±0.016	43.40±0.40	54.10±0.60	1.26±0.12
Durango	20	3.61±0.09	0.410±0.020	0.480±0.050	0.010±0.010	0.71±0.04	0.050±0.020	42.78±0.75	53.46±0.33	1.63±0.11

n is the number of measurements; na means not measured; bd means below detection, with detection limits in ppm:

F 140, Cl 40, SiO₂ 100, Ce₂O₃ 180, SrO 170, P₂O₅ 470, CaO 105

Shaded relief overview of the 3D finite difference model of the Gotthard transect with coordinates of the Swiss reference system. Different colours refer to the involved geological units: Aar massif, Gotthard massif, Tavetsch massif, Urseren zone and Schistes lustrés.



Geometrical, physical and thermal parameters used for numerical modelling

Parameter	Description	Value	Unit
T	temperature	variable	°C
t	time	variable	s
x,y,z	Cartesian coordinates	variable	m
$\Delta x, \Delta y, \Delta z$	nodes spacing	132.9	m
S	heat production	see Table 2	W kg ⁻¹
u	exhumation rate	0.45	km Ma ⁻¹
ρ	density	2 700	kg m ⁻³
c_p	specific heat	1 000	J kg ⁻¹ K ⁻¹
k	thermal conductivity	see Table 2	W K ⁻¹ m ⁻¹
T ₀	air T at sea level	11.88	°C
α	atmospheric lapse rate	4.6	°C km ⁻¹
G _B	vertical bottom geothermal gradient	20	°C km ⁻¹