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Supplement of

The role of continental lithospheric thermal structure in the evolution of orogenic systems: application to the Himalayan–Tibetan collision zone

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Table S1. Parameter list of the numerical experiments

Material Parameters	Units	Sub-lithospheric Mantle	Continental upper Crust	Continental lower Crust	Lithospheric Mantle	Oceanic Sediment	Oceanic Crust	Weak Zone
Thickness	km	-	25	10	85, 88	4	8	-
Thermal Diffusivities(κ)	$m^2\ s^{-1}$	$9.89\cdot10^{-7}$	$1.21\cdot10^{-6}$	$1.15\cdot10^{-6}$	$9.87\cdot10^{-7}$	$1.21\cdot10^{-6}$	$1.21\cdot10^{-6}$	$1.21\cdot10^{-6}$
Heat Capacity (C_p)	$J\ kg^{-1}K^{-1}$	1250	750	750	1250	750	750	750
Density(ρ)	$kg\ m^{-3}$	3370	2800	2900	3370	3000	3000	3300
Thermal expansivity(α)	K^{-1}	$3\cdot10^{-5}$	$2.7\cdot10^{-5}$	$2.7\cdot10^{-5}$	$3\cdot10^{-5}$	$2.7\cdot10^{-5}$	$2.7\cdot10^{-5}$	$2.7\cdot10^{-5}$
Angle of internal friction(ϕ)	°	30	30	30	30	2	2	2
Cohesion (C)	Pa	$20\cdot10^6$	$20\cdot10^6$	$20\cdot10^6$	$20\cdot10^6$	$10\cdot10^6$	$10\cdot10^6$	$10\cdot10^6$
Flow Law[a]	-	dry olivine(diff/disl)	wet quartzite	wet anorthite	dry olivine(diff/disl)	gabbro	gabbro	gabbro

Visc.prefactor (A*)[b]	Pa^{-n} S^{-1}	$2.37\cdot10^{-15}/6.52\cdot10^{-16}$	$8.57\cdot10^{-28}$	$7.13\cdot10^{-18}$	$2.37\cdot10^{-15}/6.52\cdot10^{-16}$	$1.0\cdot10^{50}/1.12\cdot10^{-10}$	$1.0\cdot10^{50}/1.1$	$1.0\cdot10^{50}/1.1$
Stress exponent (n)	-	1/3.5	1/4.0	1/3	1/3.5	1/3.4	1/3.4	1/3.4
Activation Energy (E)	$J\ mol^{-1}$	$375\cdot10^{3}/530\cdot10^{3}$	$0/223\cdot10^{3}$	$0/345\cdot10^{3}$	$375\cdot10^{3}/530\cdot10^{3}$	$497\cdot10^{3}$	$497\cdot10^{3}$	$497\cdot10^{3}$
Activation Volume (V)	$m^3\ mol^{-1}$	$4\cdot10^{-6}/18\cdot10^{-6}$	0/0	0/0	$4\cdot10^{-6}/18\cdot10^{-6}$	0/0	0/0	0/0
Grain size exponent(m)	-	3/-	1/-	1/-	3/-	1/-	1/-	1/-
Radioactive heating production (H)	$W\ m^{-3}$	0	varies	varies	0	0	0	0
Viscosity cutoffs[c]	Pa s	$10^{18} - 10^{26}$						

[a] Flow law are taken from *Hirth and Kohlstedt* [2003] for dry olivine, *Gleason and Tullis* [1995] for wet quartzite, *Rybacki et al.* [2006] for wet anorthite, *Wilks and Carter* [1990] for gabbro.

[b] The viscosity prefactor, A^*, is scaled from uniaxial experiments for plane strain as in *Ranalli* [1995] and *Tetreault and Buiter* [2012].

[c] User-defined viscosity cutoffs in Eq. (9).

Table S2. List of the numerical experiments

Mode name	T_{pro_moho} (˚C)	T_{retro_moho} (˚C)	$H_{pro\text{-}uc}$ (W m^{-3})	$H_{retro\text{-}uc}$ (W m^{-3})	$H_{pro\text{-}lc}$ (W m^{-3})	$H_{pro\text{-}lc}$ (W m^{-3})	Collision Patterns
m1	450	450	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m2	450	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m3	450	550	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m4	450	600	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m5	500	450	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m6	500	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m7	500	550	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I

m8	500	600	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m9	550	450	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m10	550	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m11	550	550	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m12	550	600	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m13	600	450	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m14	600	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m15	600	550	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m16	600	600	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I

m17	450	500	$1.5\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m18	450	500	$2.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m19	450	500	$3.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m20	450	500	$4.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m21	450	500	$1.0\cdot10^{-6}$	$1.5\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m22	450	500	$1.5\cdot10^{-6}$	$1.5\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m23	450	500	$2.0\cdot10^{-6}$	$1.5\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m24	450	500	$3.0\cdot10^{-6}$	$1.5\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m25	450	500	$4.0\cdot10^{-6}$	$1.5\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II

m26	450	500	$1.0\cdot10^{-6}$	$2.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m27	450	500	$1.5\cdot10^{-6}$	$2.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m28	450	500	$2.0\cdot10^{-6}$	$2.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m29	450	500	$3.0\cdot10^{-6}$	$2.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m30	450	500	$4.0\cdot10^{-6}$	$2.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m31	450	500	$1.0\cdot10^{-6}$	$3.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	I
m32	450	500	$1.5\cdot10^{-6}$	$3.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m33	450	500	$2.0\cdot10^{-6}$	$3.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m34	450	500	$3.0\cdot10^{-6}$	$3.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II

m35	450	500	$4.0\cdot10^{-6}$	$3.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m36	450	500	$1.0\cdot10^{-6}$	$4.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m37	450	500	$1.5\cdot10^{-6}$	$4.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m38	450	500	$2.0\cdot10^{-6}$	$4.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m39	450	500	$3.0\cdot10^{-6}$	$4.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m40	450	500	$4.0\cdot10^{-6}$	$4.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m41	450	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$2.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m42	450	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$6.0\cdot10^{-7}$	$4.0\cdot10^{-7}$	II
m43	450	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$2.0\cdot10^{-7}$	$2.0\cdot10^{-7}$	II

m44	450	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$2.0\cdot10^{-7}$	II
m45	450	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$6.0\cdot10^{-7}$	$2.0\cdot10^{-7}$	II
m46	450	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$2.0\cdot10^{-7}$	$6.0\cdot10^{-7}$	II
m47	450	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$4.0\cdot10^{-7}$	$6.0\cdot10^{-7}$	II
m48	450	500	$1.0\cdot10^{-6}$	$1.0\cdot10^{-6}$	$6.0\cdot10^{-7}$	$6.0\cdot10^{-7}$	II

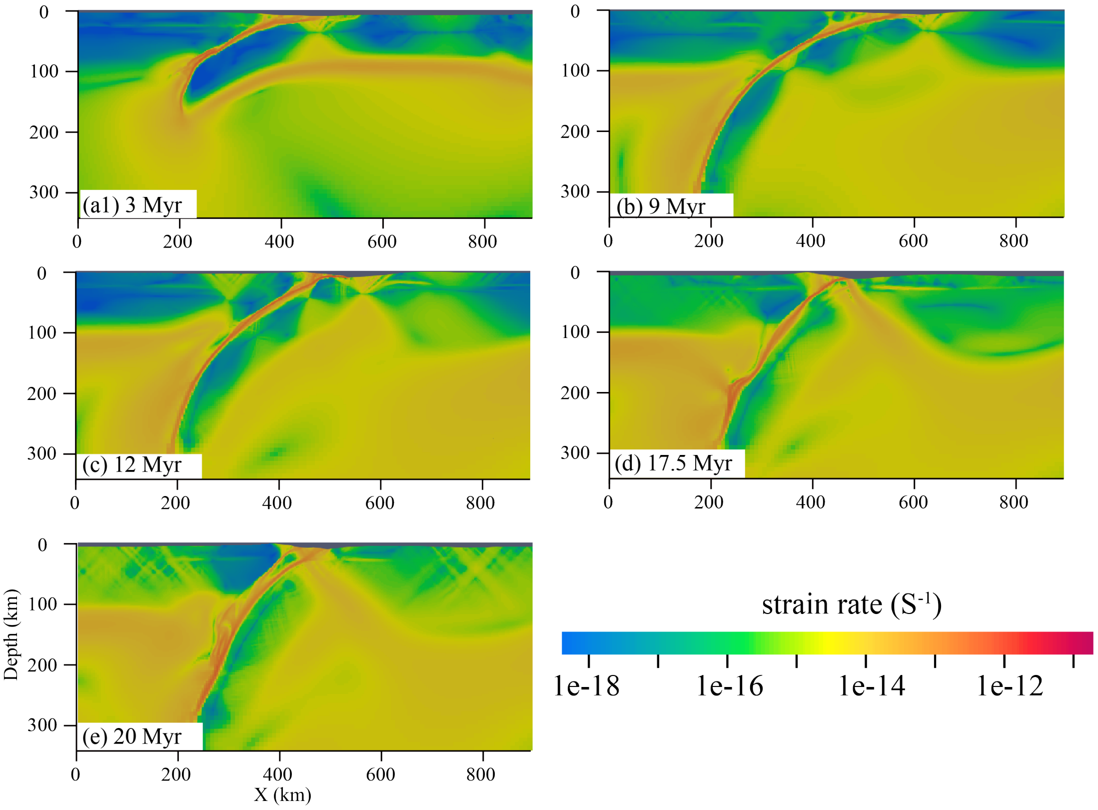

Figure S1. Strain rate for Model m2 at selected model times.

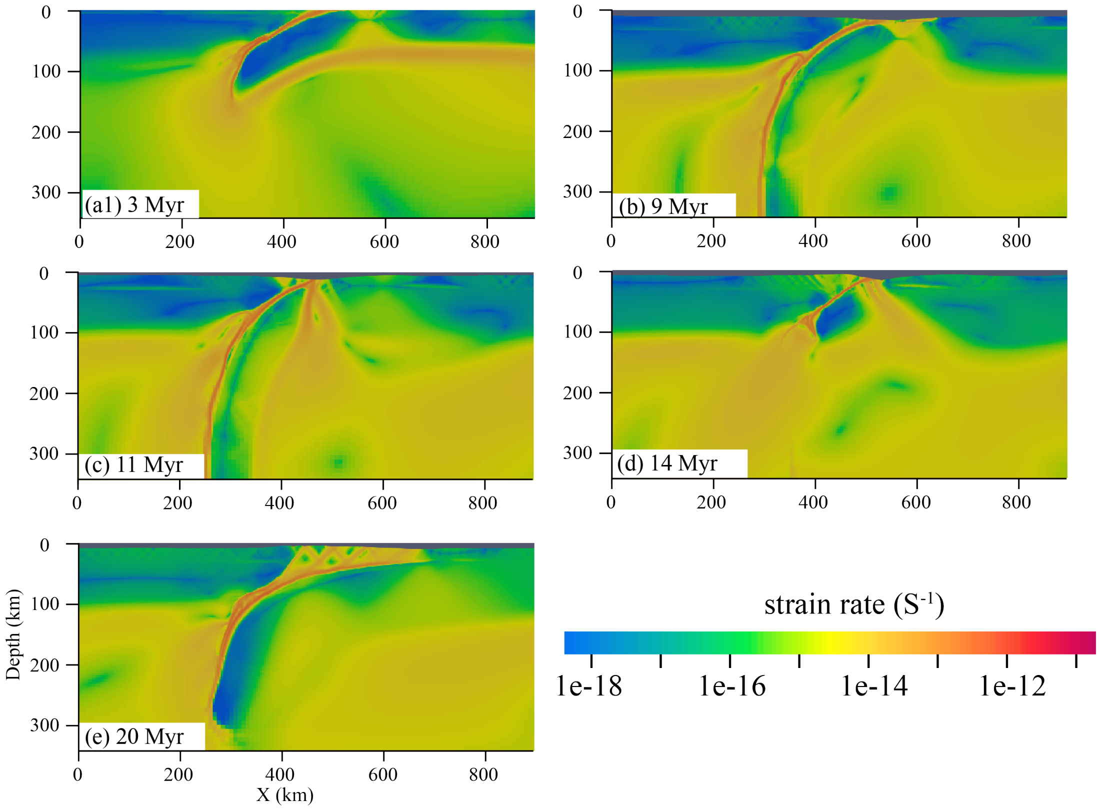

Figure S2. Strain rate for Model m7 at selected model times.