SUPPLEMENTARY METHODS

Because of the symmetry of the problem, only one half of the CFB is modeled. Grid cells are 1560 × 1560 m and each cell includes 36 particles, so that the effective resolution is 260 × 260 m. All boundaries in the models are rigid, undeformable and free-slip, and neither forces nor velocities are applied at any of the boundaries.

Rheological model

Frictional flow is described using the Coulomb criteria (Moresi and Solomatov, 1998) combined with a strain softening function (Wijns et al., 2005)

$$\tau_{yield} = (C_0 + \tan(\phi)\ \sigma_n)\, f(\varepsilon), \qquad \text{(S1)}$$

where τ_{yield} is the shear stress, C_0 is the cohesion of the material at atmospheric pressure, ϕ is the angle of internal friction, σ_n is the stress normal to the failure plane approximated by the lithostatic pressure (Moresi and Solomatov, 1998) and

$$f(\varepsilon) = \begin{cases} 1-\beta(\varepsilon/\varepsilon_0) & \varepsilon < \varepsilon_0 \\ 1-\beta & \varepsilon \geq \varepsilon_0 \end{cases}, \qquad \text{(S2)}$$

where ε is the accumulated strain, taken as the second invariant of the deviatoric plastic strain tensor, and ε_0 is the "saturation" strain from which the yield stress is reduced by a proportion β (Wijns et al., 2005). Values for these parameters are given in Table DR1.

Thermal model

The crustal heat production is calculated back in time using

$$H = \Sigma_i \varsigma^i C_0^i H^i \exp(a \ln(2)/\tau^i_{1/2}), \qquad \text{(S3)}$$

where i is a radioactive element amongst U^{238}, U^{235}, Th^{232} and K^{40}, ς^i is the natural proportion of the radioactive element, C_0^i is the concentration of the element (Table DR1), H^i is rate of heat release of the element, a is the age for which the radiogenic heat production is calculated and $\tau^i_{1/2}$ is the half-life of the element.

SUPPLEMENTARY REFERENCES

Moresi, L., and Solomatov, V., 1998, Mantle convection with a brittle lithosphere: thoughts on the global tectonic styles of the Earth and Venus: Geophysical Journal International v. 133, p. 669-682.

Wijns, C., Weinberg, R., Gessner, K., and Moresi, L., 2005, Mode of crustal extension determined by rheological layering. Earth and Planetary Science Letters v. 236, p. 120-134.

SUPPLEMENTARY FIGURES

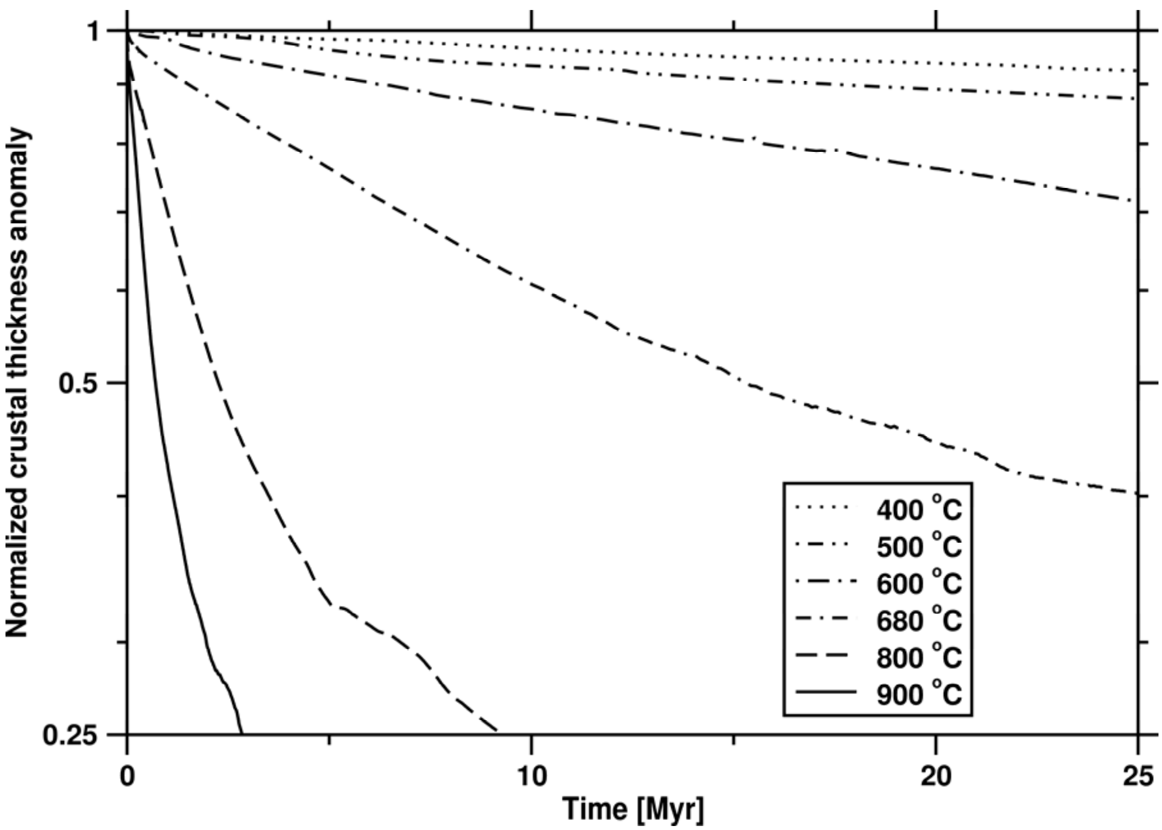

Figure DR1. Relaxation of the crustal thickness anomaly. Evolution of the elevation difference between the two Lagrangian position trackers shown in Fig. 1. A logarithmic scale is used for the vertical axis. Results are presented for a CFB 9 km thick and for a continental crust 40 km thick.

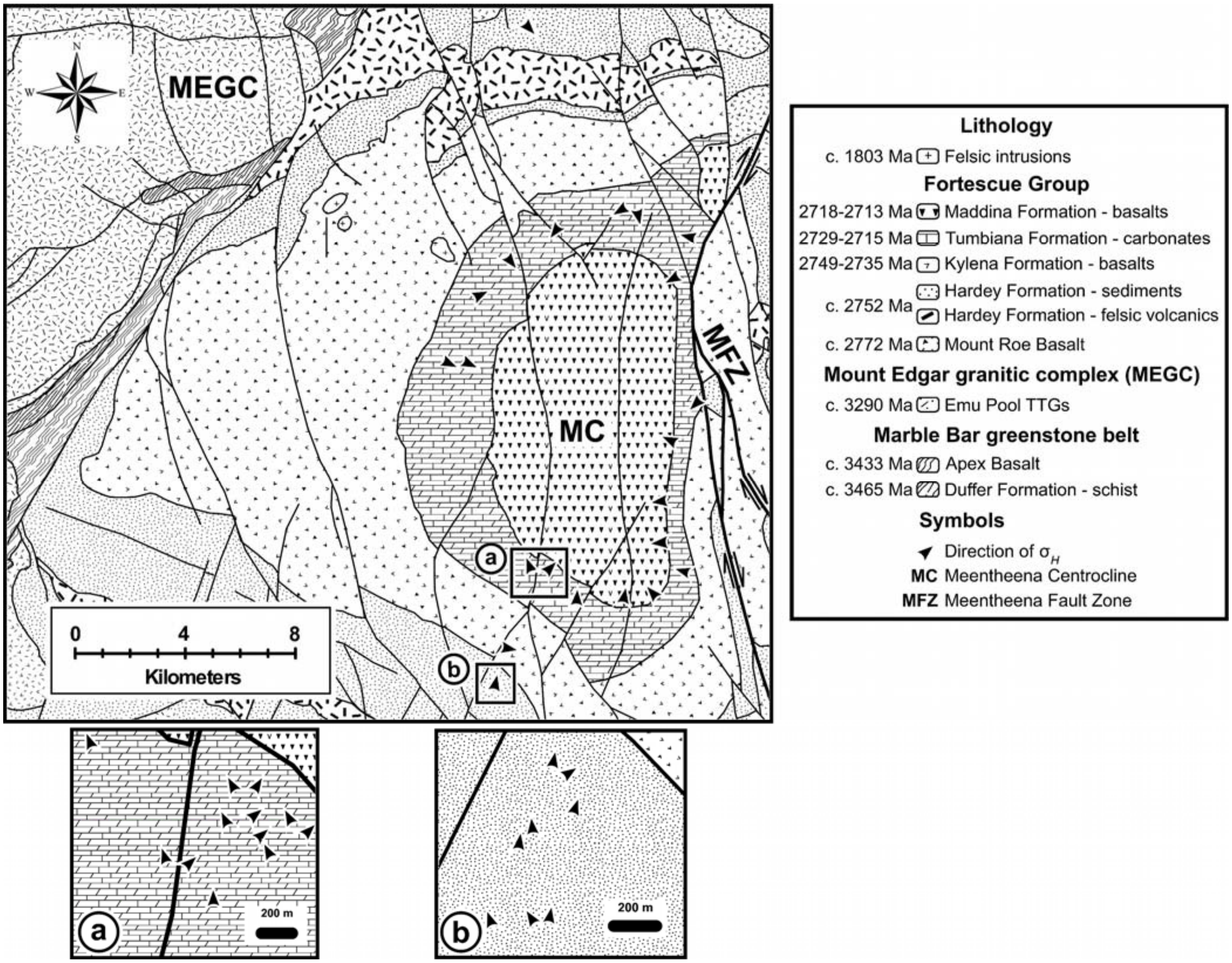

Figure DR2. Directions of the maximum horizontal compressive paleostress σ_H in the Meentheena Centrocline. These directions are derived from the multiple measurements of conjugate fractures and bedding plane at 33 sites, assuming that σ_H is aligned with the acute bisector of each pair of fractures. Insets *a* and *b* illustrate local variability. The simplified geology is from Williams and Bagas (2007).

SUPPLEMENTARY TABLES

TABLE DR1. LIST OF PARAMETERS USED IN THE MODELS

Parameter*	Meaning	Value(s)	Unit
a) Mechanical parameters			
β	Strain weakening factor	0.8	
ε_0	Strain from which weakening is maximum	0.5	
ρ_{atm}	Atmospheric density	2.5	kg m^{-3}
ρ_{cc}	Crustal density	2720	kg m^{-3}
ρ_{CFB}	CFB density	2840	kg m^{-3}
ρ_m	Mantle density	3370	kg m^{-3}
σ_{cc}	Crustal maximum yield stress	250	MPa
σ_m	Mantle maximum yield stress	500	MPa
ϕ_{cc}	Crustal internal angle of friction	15	°
ϕ_m	Mantle internal angle of friction	25	°
b_{atm}	Atmospheric pre-exponential constant	$7.5\ 10^{18}$	Pa s
η_{0cc}	Crustal reference viscosity	$1.48\ 10^{29}$	Pa s
η_{0m}	Mantle reference viscosity	$1.19\ 10^{28}$	Pa s
C_{cc}	Crustal cohesion	10	MPa
C_m	Mantle cohesion	200	MPa
g	Acceleration of gravity field	9.81	m s^{-2}
Q_{atm}	Atmospheric activation enthalpy	0	kJ mol^{-1}
Q_{cc}	Crustal activation enthalpy	540	kJ mol^{-1}
Q_m	Mantle activation enthalpy	280	kJ mol^{-1}
R	Gas constant	8.31	J mol^{-1} K^{-1}
T_p	Upper mantle potential temperature	1330	°C
b) Thermal parameters			
κ	Thermal diffusivity	$0.9\ 10^{-6}$	m^2 s^{-1}
C_p	Heat capacity	1000	J kg^{-1} K^{-1}
[U]	Uranium concentration †	0.75	ppm
[Th]	Thorium concentration †	2.9	ppm
[K]	Potassium concentration †	0.75	wt.%
H_{cc}	Crustal heat production	Table DR2	μW m^{-3}
q_m	Basal mantle heat flux	Table DR2	mW m^{-2}

*Non-listed parameters for the CFB are taken equal to crustal ones.
†From Taylor and McLennan (1995)

TABLE DR2. THERMAL VALUES

a* Ga	H_{cc} μW m^{-3}	q_m mW m^{-2}	d_{cc} km	T_{Moho} °C
1.65	0.69	12.0	40	404
2.75	0.98	12.0	40	496
			30	322
2.30	0.84	23.0	40	598
			30	406
2.75	0.98	26.0	40	682
			30	460
3.25	1.19	29.5	40	797
			30	535
3.60	1.39	32.0	40	896
			30	598

*To compute radiogenic heat production