

**Table S1.** Parameters used in this study

Runs	Top boundary	Weak crustal layer	Thickness of the crust ( $d_{crust}$ ) [m]	Box geometry	Resolution	Friction coefficient ( $\mu$ )	Activation volume ( $V_{act}$ ) [m <sup>3</sup> /mol]
<b>case1</b>	free slip	no	0	2-D Cartesian	512 × 256	0.10	6.34 · 10 <sup>-7</sup>
<b>case2</b>	sticky air	no	0	2-D Cartesian	512 × 256	0.10	6.34 · 10 <sup>-7</sup>
<b>case3</b>	sticky air	yes	6 · 10 <sup>3</sup>	2-D Cartesian	512 × 256	0.10	6.34 · 10 <sup>-7</sup>
<b>case4</b> <sup>a</sup>	sticky air	yes	6 · 10 <sup>3</sup>	2-D Cartesian	256 × 128	variable	variable
<b>case5</b>	sticky air	yes	18 · 10 <sup>3</sup>	3-D Spherical	64 × 192 × 64	0.07	8.89 · 10 <sup>-7</sup>

<sup>a</sup> Standard setup used for the regime diagram.