The role of fluid pressure in induced vs. triggered seismicity: insights from rock deformation experiments on carbonates

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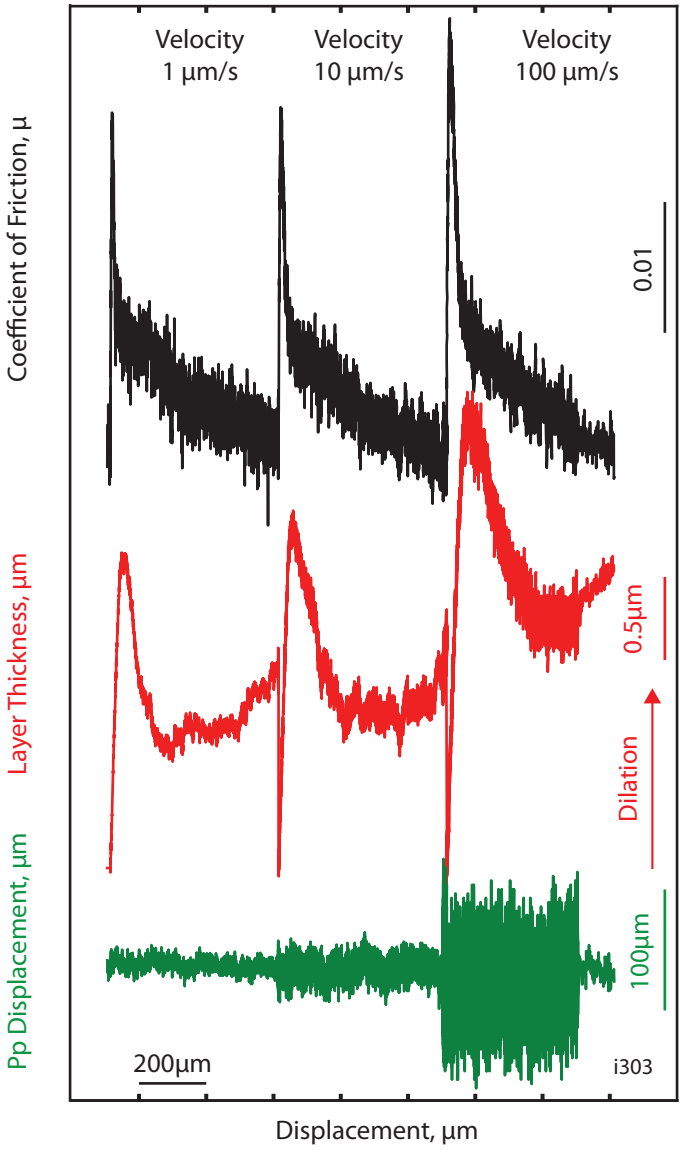
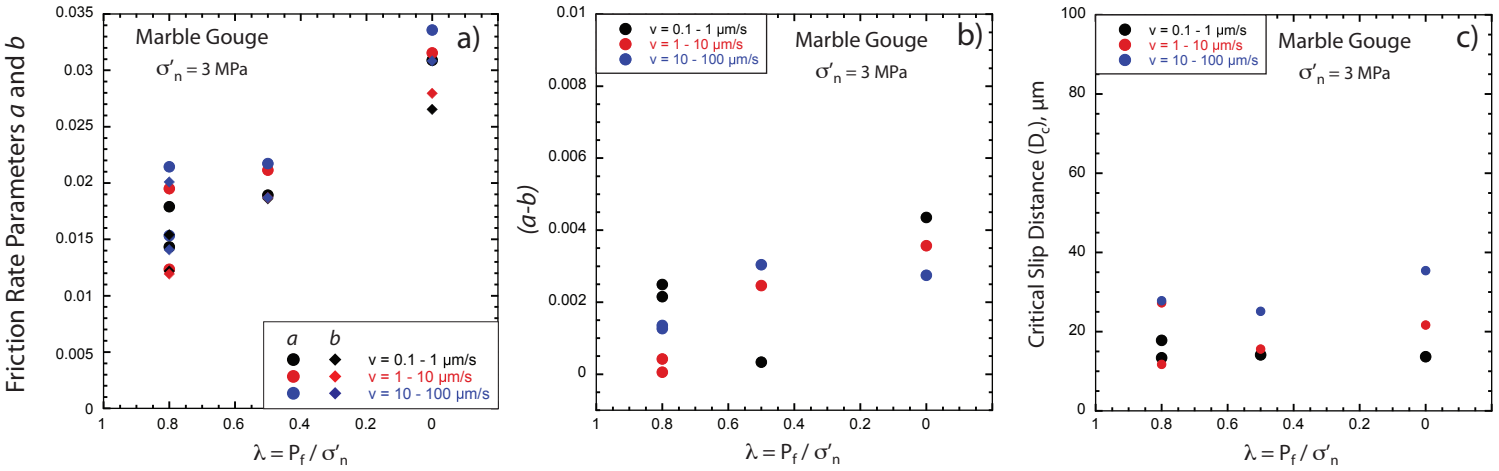
Supplementary Material

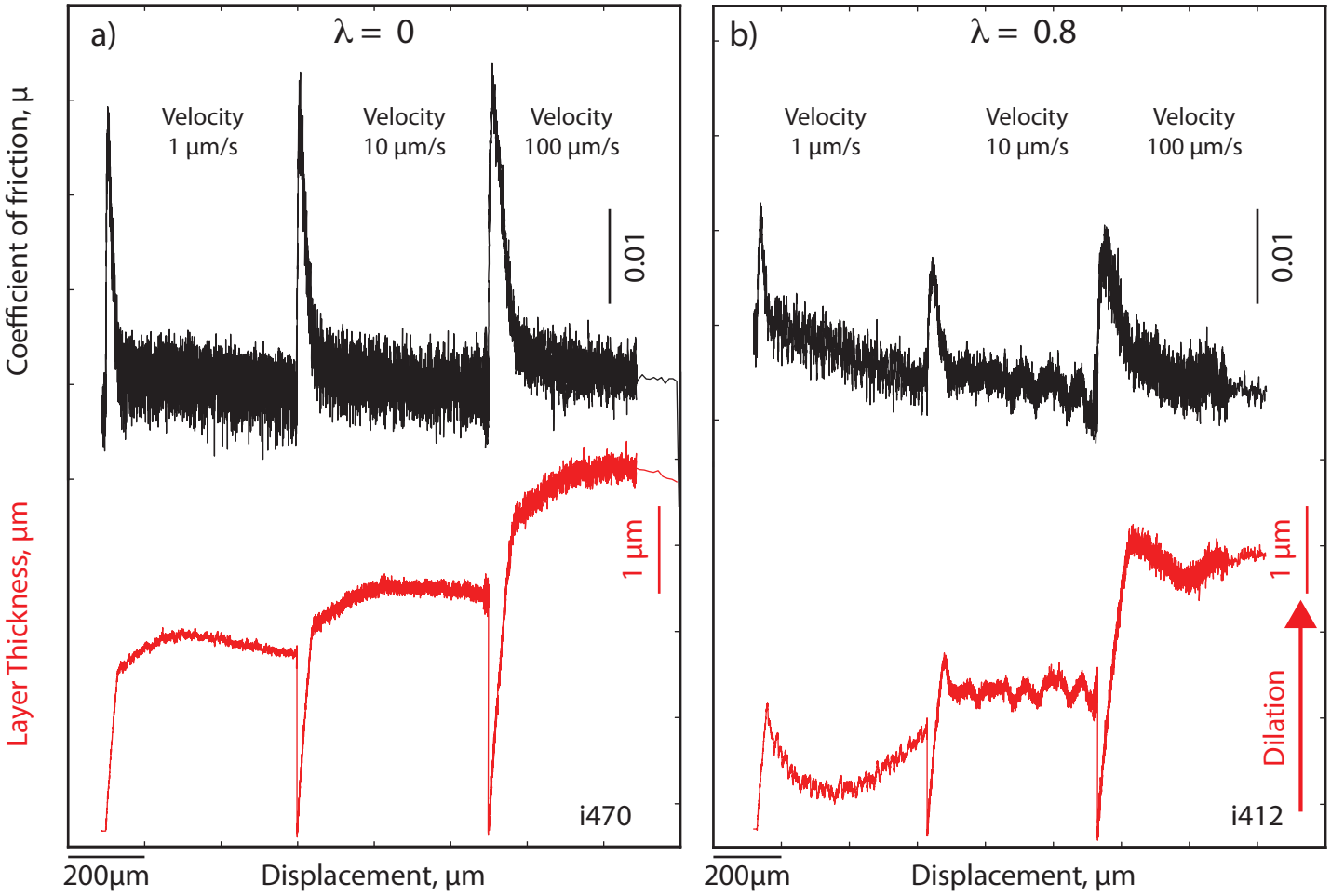
Contains Extended Data Figure 1, 2, 3



Extended Data Figure 1. Experimental curves showing the evolution of friction (black) layer thickness (red) and up-stream pore fluid pressure displacement (green) during a series of velocity steps from 0.1 to 100 µm/s.



Extended Data Figure 2. (a) Friction rate parameters *a* and *b*; (b) *(a-b)* and (c) D_c obtained for the same effective normal stress (3 MPa) but at different fluid pressure levels as expressed by the pore fluid factor, λ.



Extended Data Figure 3. Evolution of friction (black) and layer thickness (red) during velocity steps for experiments conducted at (a) $\lambda = 0$ and (b) $\lambda = 0.8$ and the same effective normal stress of 3 MPa.

Exp. Num.	Gouge Material	σ_n (MPa)	P_c (MPa)	P_f (MPa)	σ'_n (MPa)	λ (P_f / σ_n)	Velocity Steps (μm/s)	*(a-b)*	*Dc*
i274	Carrara Marble	2	19	18	3	0.85	10 – 1 1 – 10 10 – 100	0.002489 5.3e-5 0.001355	17.788 11.738 27.846
i412	Carrara Marble	2	19	18	3	0.85	0.1 – 1 1 – 10 10 – 100	0.002155 0.000422 0.001268	13.399 27.318 30.174
i413	Carrara Marble	2	4	2.5	3	0.5	0.1 – 1 1 – 10 10 – 100	0.000334 0.002464 0.003044	14.178 15.655 25.168
i470	Carrara Marble	3	0	0 Saturated	3	0	0.1 – 1 1 – 10 10 – 100	0.004352 0.003571 0.002752	13.682 21.669 36.079
i303	Carrara Marble	2	19	11	10	0.5	0.1 – 1 1 – 10 10 – 100	0.003505 0.004021 0.003561	20.469 32.189 37.886
i475	Carrara Marble	2	19	3	18	0.14	0.1 – 1 1 – 10 10 – 100	0.002727 0.003553 0.003542	49.180 43.817 104.94
i273	Carrara Marble	2	19	3	18	0.14	10 – 1 1 – 10 10 – 100	0.003200 0.003442 0.009416	50.345 59.750 50.823
i355	Carrara Marble	5	30	28	7	0.8	0.1 – 1 1 – 10 10 – 100	-0.00061 0.001056 0.002788	39.841 53.309 63.014
i359	Carrara Marble	5	30	18	17	0.5	0.1 – 1 1 – 10 10 – 100	0.001075 0.004223 0.004320	50.885 51.968 58.870
i358	Carrara Marble	5	30	5	30	0.14	0.1 – 1 1 – 10 10 – 100	0.003707 0.003186 0.005867	72.658 95.465 73.544
i305	Limestone Gouge	2	19	18	3	0.85	0.1 – 1 1 – 10 10 – 100	0.000914 3.80e-05 0.000253	6.2066 6.7239 26.281
i324	Limestone Gouge	2	19	11	10	0.5	0.1 – 1 1 – 10 10 – 100	0.000591 0.001266 0.003726	37.667 44.377 60.479
i304	Limestone Gouge	2	19	3	18	0.14	0.1 – 1 1 – 10 10 – 100	0.001912 0.002072 0.005374	87.908 93.415 86.515

Extended Data Table 1. Summary of experiments and boundary conditions