

## Description of Additional Supplementary Information

Title: Supplementary Movie 1

Description: Time-series of 2D x-ray microtomographic ( $\mu$ CT) slices showing the bottom two thirds of the sample and the full shear zone. For scale, grains are 0.25–0.4 mm in diameter.

Title: Supplementary Movie 2

Description: Time-series of 2D x-ray microtomographic ( $\mu$ CT) slices zoomed-in to the shear zone. For scale, grains are 0.25–0.4 mm in diameter.

Title: Supplementary Movie 3

Description: Evolution of shear strain across-strike (x,z-orientation) with lower threshold of 0.0005 (one standard deviation from the mean of the error in the volumetric strain – see Supplementary Fig. 7 – to allow comparison with diffuse, low amplitude compaction).

Title: Supplementary Movie 4

Description: Evolution of dilation across-strike (x,z-orientation) with lower threshold of 0.0005.

Title: Supplementary Movie 5

Description: Evolution of compaction across-strike (x,z-orientation) with lower threshold of 0.0005.

Title: Supplementary Movie 6

Description: Evolution of shear strain along-strike (y,z-orientation) with lower threshold of 0.0005.

Title: Supplementary Movie 7

Description: Evolution of dilation along-strike (y,z-orientation) with lower threshold of 0.0005.

Title: Supplementary Movie 8

Description: Evolution of compaction along-strike (y,z-orientation) with lower threshold of 0.0005.

Title: Supplementary Movie 9

Description: Evolution of acoustic emission (AE) locations (blue circles) and volumetric strain (positive strain is dilation). The axes scales are in digital volume correlation (DVC) window lengths, with 1 window length = 316.4  $\mu\text{m}$  ( $\sim 1$  grain size).