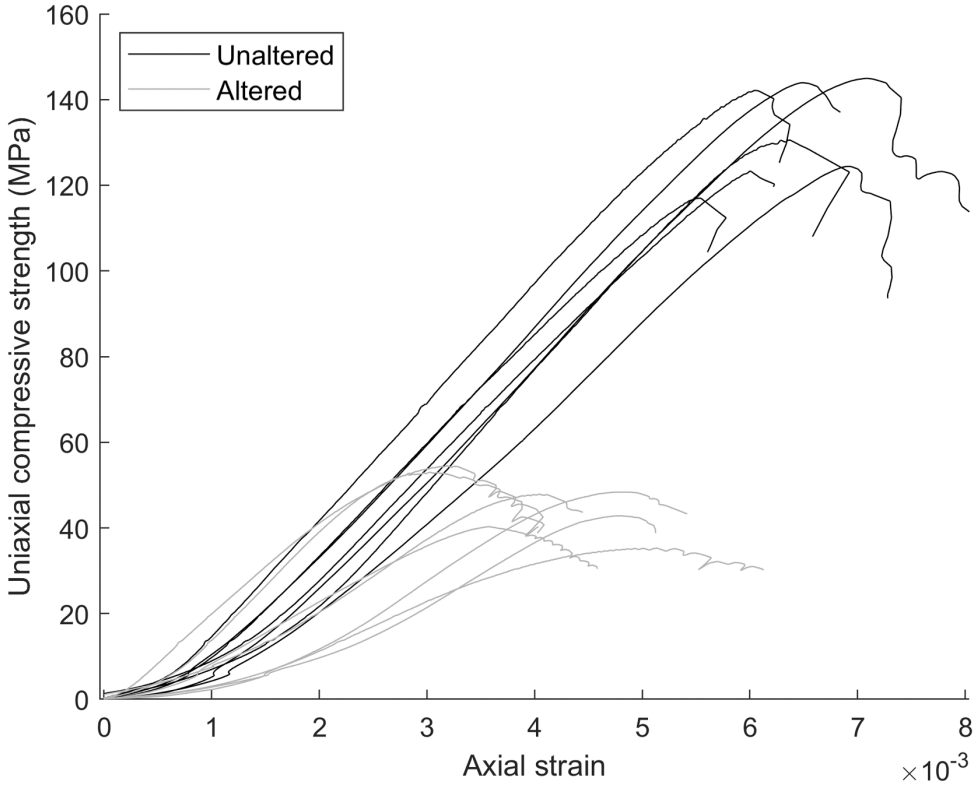
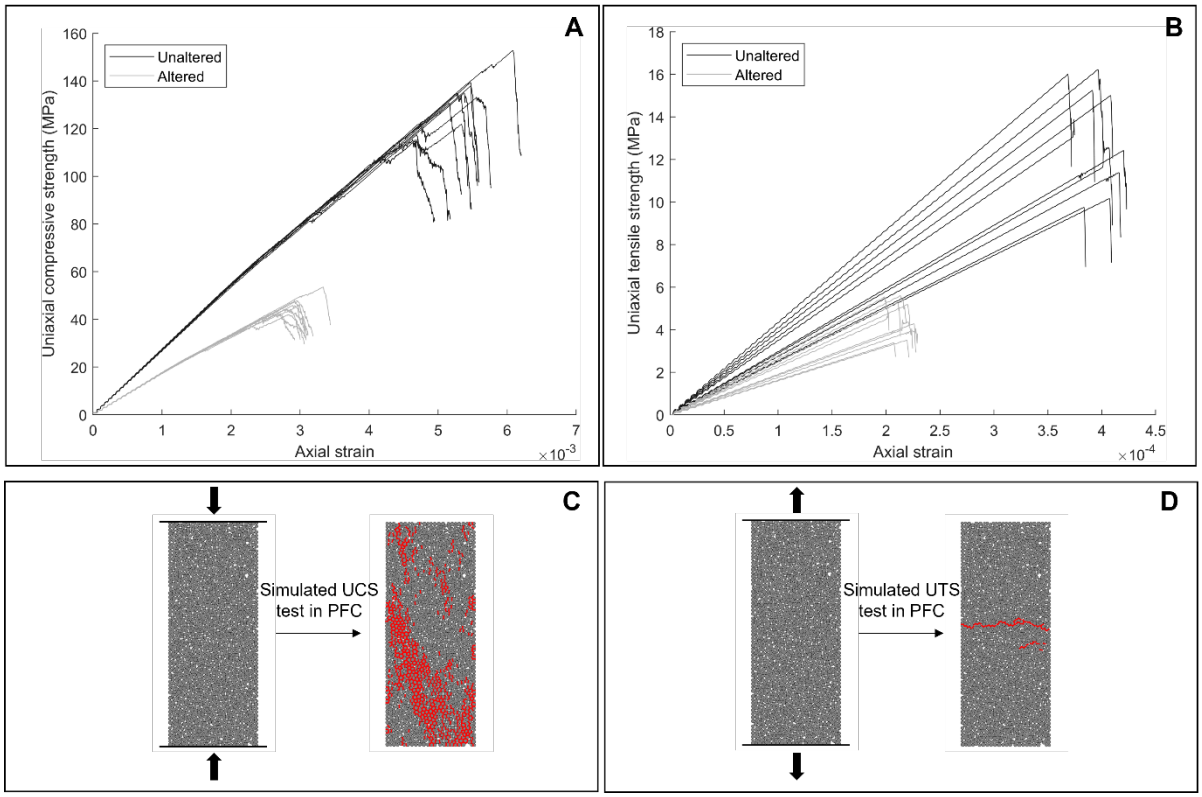
Harnett, C.E., et al., 2022, Large-scale lava dome fracturing as a result of concealed weakened zones: Geology, v. 50, https://doi.org/10.1130/G50396.1

Supplemental Material



Supplementary Figure 1. Stress-strain curves for the laboratory uniaxial compressive strength (UCS) tests used for calibration in this study. Black shows tests on unaltered rock (Merapi sample M-U) and grey shows tests on altered rock (Merapi sample M-HA1.



Supplementary Figure 2. Stress-strain curves from repeated laboratory tests in Particle Flow Code (PFC), calibrating the (a) uniaxial compressive strength (UCS) and (b) direct uniaxial tensile strength of 40 × 100 mm samples with average values guided by the laboratory data in Figure 1. UCS tests are stopped when the stress reaches 70% of peak stress. For each of the altered and unaltered strength scenarios, 10 tests are run using a different initial seed number to give a different initial particle packing. Dark gray shows unaltered material properties (E = 26.9 ± 0.3 GPa, UCS = 131.6 ± 11.5 MPa, and UTS = 13.3 ± 2.4 MPa) while light gray shows altered material properties (E = 17.3 ± 0.2 GPa, UCS = 45.7 ± 3.4 MPa, and UTS = 17.3 ± 0.2). Panels (c) and (d) show model setup for laboratory tests, where particles are shown in grey. Red shows fractures (i.e., broken contacts) in each case, clearly showing failure in shear (c) and failure in tension (d).

Supplementary Table 1: model input parameters

Micro-parameter	Unaltered material	Altered material
Flatjoint shear stiffness	8.0e9	8.0e9
Flatjoint normal stiffness	8.0e9	8.0e9
Young’s modulus	2.65e10 Pa	1.7e10 Pa
Cohesion	8.42e7 Pa	2.9e7 Pa
Tensile strength	1.6e7 Pa	0.55e7 Pa
Average particle radius	1.0±0.2 m	1.0±0.2 m