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The competition between fracture nucleation, propagation, and coalescence in dry and water-saturated crystalline rock

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Introduction

This supporting information includes one section of text and two figures.

Text S1. Following the relationships between porosity and permeability calculated for dynamically pulverized monzonite cores (*Aben et al*., 2020), rocks with 0.06-1.6% porosity may have permeability 10^{-16} to 10^{-18} m^{-2}. The flow rate, Q, may be calculated as

$$Q = \frac{kA\Delta P}{\mu L}$$

where k is the permeability, 10^{-16} to 10^{-18} m^{-2}, A is the cross-sectional area of the core, πr^2 with r=0.004 m, ΔP is the fluid pressure difference between the inlet and outlet of sample #4, $0.5 \cdot 10^6$ Pa, μ is the water viscosity, $8.9 \cdot 10^{-4}$ Pa$\cdot$s, and L is the length of the core, 0.01 m. Using these values, Q=7.1*10^{-11} to 7.1*10^{-13} m^3/s. Then, the actual velocity of water in the sample, V, is

$$V = \frac{Q}{A\phi}$$

where ϕ is the porosity of the sample. This flow rate causes water to require about 0.01-1.8 minutes (experiment #4, $\phi = 0.06$ %), 0.05-5.9 minutes (experiment #3, $\phi = 0.2$ %), and 0.46-47 minutes (experiment #5, $\phi = 1.6$ %) to traverse the full 1 cm length. This travel time is less than the full time of the experiment (5 hours) and in some cases less than the time required to acquire a scan and apply a stress loading step.

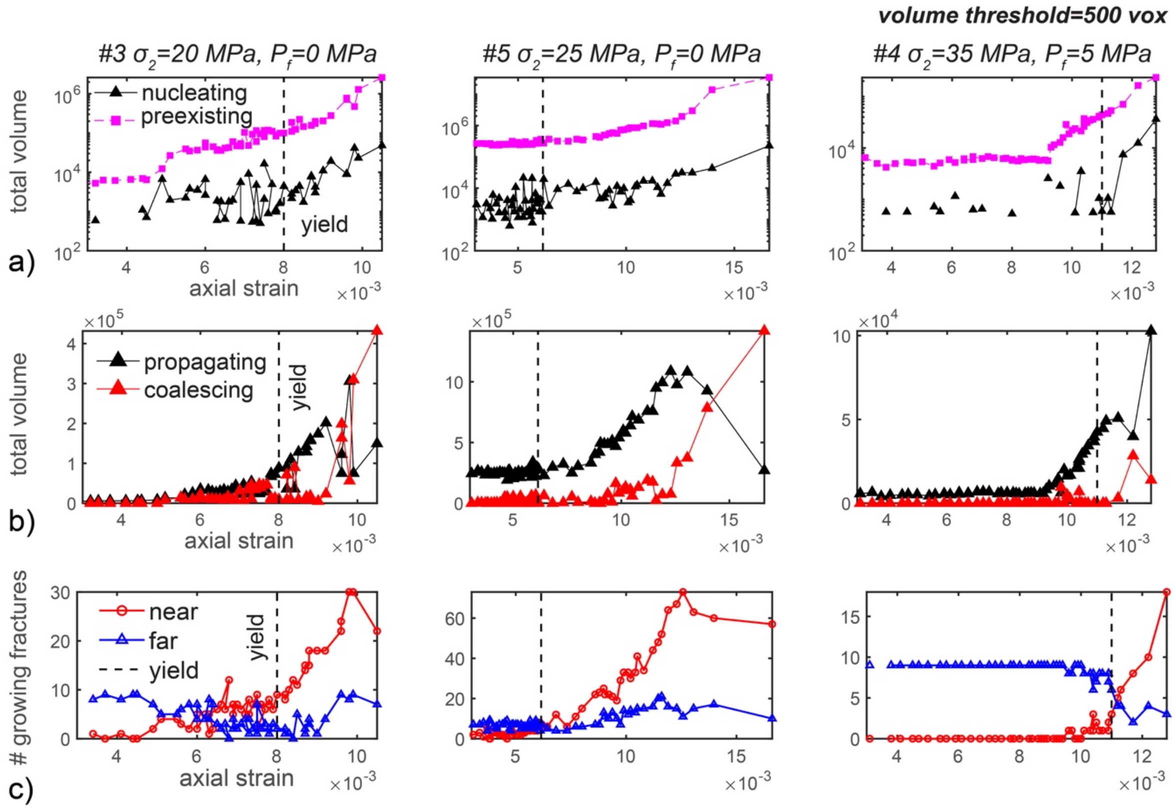

Figure S1. Influence of changing the volume threshold used to extract the fracture networks. a) Total volume of nucleating and pre-existing fractures. b) Total volume of propagating and coalescing fractures. c) Number of growing fractures located near and far from other fractures. The main trends observed when the volume threshold is 100 voxels (shown in the main text in **Figures** 5-6) are the same as those when the threshold is 500 voxels.

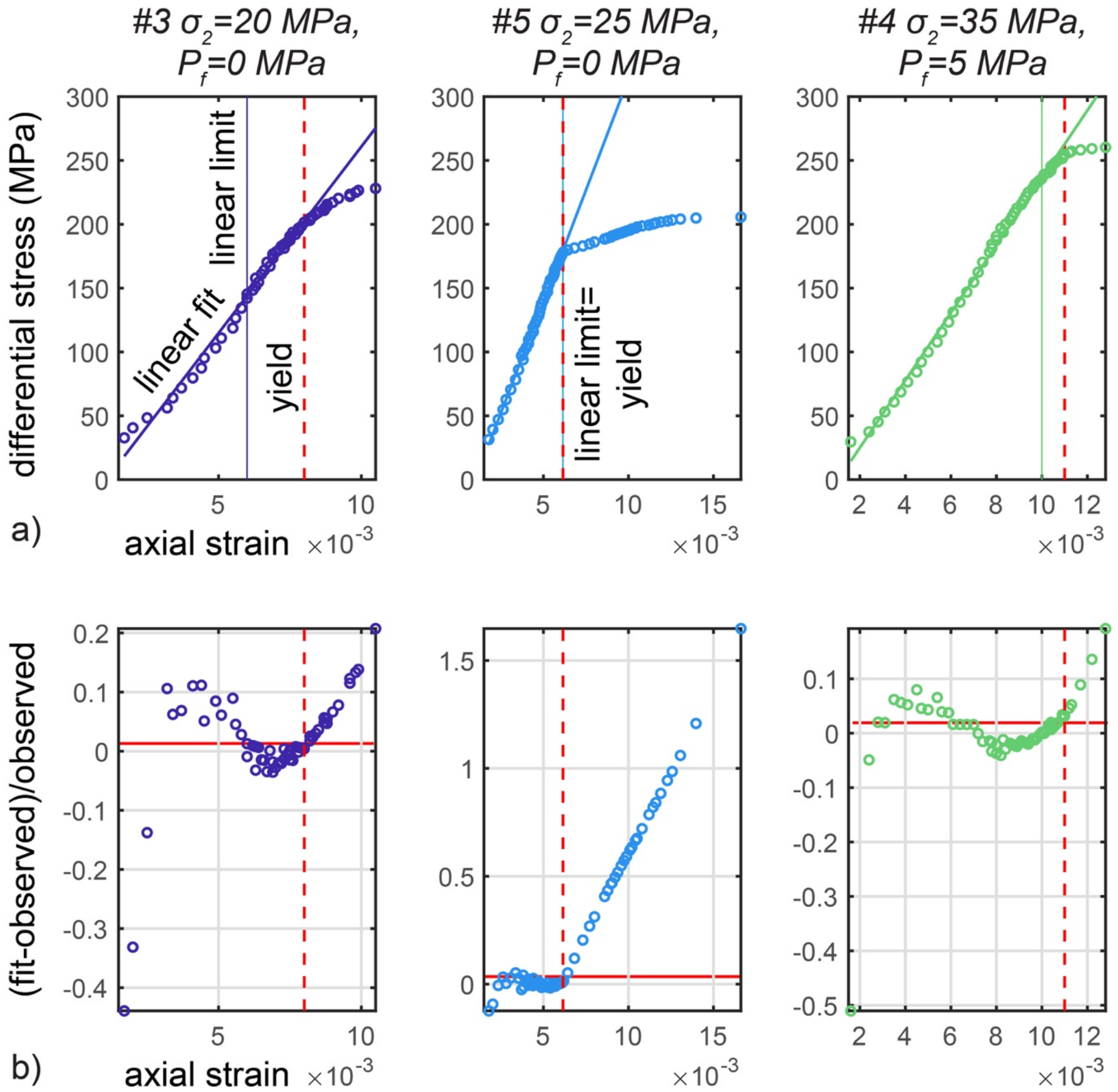

Figure S2. Identification of axial strain at macroscopic yield point. a) Differential stress and axial strain relationships with axial strain at limit of linear phase (vertical solid line), corresponding linear fit (solid line) and resulting yield point (red dashed line). b) Normalized difference between the differential stress of the linear fit and observed differential stress, $\Delta\sigma$=$(\sigma_{fit} - \sigma_{obs})/\sigma_{obs}$, where σ_{fit} and σ_{obs} are the differential stress of the linear fit and observed. The yield point occurs at the largest axial strain when $\Delta\sigma$ < 0.01 (red line).