

EGU2020-3316

<https://doi.org/10.5194/egusphere-egu2020-3316>

EGU General Assembly 2020

© Author(s) 2021. This work is distributed under the Creative Commons Attribution 4.0 License.



## Predicting the proximity to system-scale rupture using fracture networks

Jessica McBeck<sup>1</sup>, John Aiken<sup>2,3</sup>, Joachim Mathiesen<sup>4</sup>, Yehuda Ben-Zion<sup>5</sup>, and Francois Renard<sup>1,6</sup>

<sup>1</sup>University of Oslo, Physics of Geological Processes, Dept of Geosciences, Oslo, Norway (j.a.mcbeck@geo.uio.no)

<sup>2</sup>Center for Computing in Science Education, Department of Physics, University of Oslo, Oslo, Norway

<sup>3</sup>Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan, USA

<sup>4</sup>Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark

<sup>5</sup>Department of Earth Sciences, University of Southern California, Los Angeles, CA, USA

<sup>6</sup>University Grenoble Alpes, University Savoie Mont Blanc, CNRS, IRD, IFSTTAR, ISTerre, 38000 Grenoble, France

A fundamental challenge in geophysics is predicting the timing of large earthquakes. A key step in addressing this problem is constraining the factors that indicate the timing of the next large rupture. To isolate the factors that help predict the proximity of the next earthquake, we develop machine learning models to predict the stress distance to macroscopic failure in triaxial compression X-ray tomography experiments on rocks at the stress conditions of the upper crust. In these experiments, we apply increasing axial stress in steps, and acquire a 3D X-ray tomogram at each stress step while the rock is under constant load, revealing the 3D density distribution. Segmenting the density fields provide the locations of rock (voxels dominated by solid), and pores and fractures (voxels dominated by air). We train the machine learning models using the geometry and clustering properties of the fracture networks identified in the tomography scans. We develop extreme gradient boosting (XGBoost) models to predict the stress distance to failure. In experiments on Carrara marble, monzonite, and granite, the models predict the stress distance to failure with  $r^2$  values  $> 0.7$ . We examine the feature importance to identify the factors that provide the best predictive power of the distance to failure. Measurements of the fracture network clustering and the shape anisotropy of fractures tend to have the highest importance of the features, providing greater predictive information than the fracture volume, fracture length, fracture aperture, and fracture orientation relative to the maximum compression direction.