

# Does machine learning help to predict frictional stick-slip dynamics of granular faults?

O. Dorostkar\*, D. Strebel†, B. Meade‡ and J. Carmeliet§

\* Department of Mechanical and Process Engineering,  
ETH Zürich, Tannenstrasse 3, 8006 Zürich, Switzerland  
e-mail: domid@ethz.ch, web page: <http://odorostkar.com/>

† Swiss Federal Laboratories for Materials Science and Technology (Empa),  
Überlandstrasse 129, CH-8600 Dübendorf, Switzerland  
e-mail: dominik.strebel@empa.ch, web page: <https://www.strebel.io/>

‡ Department of Earth and Planetary Sciences,  
Harvard University, 24 Oxford Street, Cambridge MA 02138, USA  
e-mail: meade@fas.harvard.edu, web page: <https://summit.fas.harvard.edu/>

§ Department of Mechanical and Process Engineering,  
ETH Zürich, Tannenstrasse 3, 8006 Zürich, Switzerland  
e-mail: cajan@ethz.ch, web page: <http://www.carmeliet.ethz.ch/>

## ABSTRACT

The role of granular frictional interaction has been highlighted in various geophysical phenomena such as fault slip, glacier flow, volcanic deformation and landslide. Characterization and prediction of frictional behaviour of sheared granular media can help understanding the physical processes that take place in geophysical systems leading to catastrophic natural hazards. Modern data analysis techniques like machine learning algorithms can help to identify signals of importance and augment our ability to characterize the complex behaviour of such systems. Here we use machine learning and show that in a mature fault system, which contains a granular gouge at its core due to comminution and wear of host rock, the instantaneous state of friction can be estimated. Using the advantage of Discrete Element Method (DEM) simulations in extracting grain scale info, we will discuss how machine learning enables us to better understand the physical processes that dictate fault frictional slip, and to predict time, location and size of slip events in a simulated granular fault gouge.