Along-fault velocity structure and its temporal changes on a laboratory granite fault undergoing stick-slip cycles.

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We conducted laboratory stick-slip experiments using a rough fault created in a granite sample, while passively monitoring acoustic emission (AE) events and actively monitoring the 2-D velocity structure along the fault plane. It has been observed in nature and lab that the b-value of earthquake frequency-magnitude relations have a negative correlation with stress magnitudes both spatially and temporally (Scholz, 1968; Schorlemmer and Wiemer, 2005), which may be useful for forecasting earthquake hazards from statistics of recorded earthquakes. However, the relation between the two parameters is empirical and is not supported by understanding of the underlying physics. While stress is not an easily observable parameter, velocity which may depend on stress can be observed through geophysical methods. We compare the spatial distribution of AE frequency-magnitude characteristics and the spatial distribution of ultrasonic wave velocity along the fault to seek for explanations to this empirical correlation. AE events and the velocity structure is monitored by 12 AE sensors wrapped around a rough fault created by breaking an intact granite cylinder (4 cm diameter) at 75 MPa confining pressure. The confining pressure is then raised to 150 MPa to promote stick-slip behavior during loading by a constant displacement rate, similar to Goebel et al. (2012). Periodic monitoring of the ultrasonic-wave travel time between the 66 AE sensor pairs indicate that travel times along each ray paths fluctuate systematically as the axial load cycles during multiple stick-slip events. We perform linear and non-linear inversion analyses using the observed travel times to reveal the change in velocity distribution along the fault plane. Preliminary results show that certain regions of the fault may be experiencing more velocity fluctuation than other regions of the fault. We will compare these fluctuations with the spatial distribution of AE events and its frequency magnitude characteristics to reveal any potential correlation that may help to explain the relation between b-values and stress.

Keywords: Acoustic Emission, P-wave tomography, Earthquake Parameters

