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Laboratory simulation of VT, hybrid and LF seismic signals.

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We report results from experiments in which we have reproduced seismic signals in the laboratory by monitoring the acoustic emission (AE) output during deformation of cylindrical samples of Etna basalt at an effective pressure representative of conditions under the volcanic edifice (40 MPa). Using novel instrumentation that allows us to record the continuous AE waveform during the experiment (at a sampling rate of 10Mhz), we have been able to record a variety of characteristic seismic signals during the different phases of deformation, shear fracture and fluid flow in the shear/damage zone. The low rate of AE observed during the initial compactive phase of deformation increased exponentially during the dilatant phase and accelerated hyperbolically when approaching dynamic failure. All the AE events recorded during deformation are related to brittle mechanisms and show typical high frequency volcano-tectonic (VT) features. Following shear faulting, rapid decompression of the internal pore-water pressure was induced in order to stimulate rapid fluid outflow from the shear/damage zone. AE events recorded during this phase of the experiment show that fluid decompression within the sample creates resonance and fluid decompression related signals, along with fluid induced shearing and frictional sliding along the fault plane that are qualitatively very similar to low frequency (LF) and hybrid events seen at the field scale, and which commonly precede volcanic unrest.

In order to better demonstrate the relationship between LF signals and the

shear/damage zone, experiments were repeated using samples with a central 3 mm diameter conduit that allows pore fluid to escape rapidly from the shear/damage zone. AE from these experiments show the same hybrid and LF events, with the events generated during decompression and fluid outflow preferentially located within the damage zone created during the faulting process. We further demonstrate that the events related to fluid outflow show a higher proportion of CLVD (compensated linear vector dipole) source mechanisms and lower frequencies than events related to brittle shear failure which show primarily double couple source mechanisms. Using a simple size-frequency scaling relation (Burlini et al., 2006), our laboratory-measured frequencies can be shown to scale appropriately to data from source dimensions of hundreds of metres to a few kilometers, typical of natural volcanic events.