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Approximate Seismic Diffusive Models of Near-Receiver Geology: Applications from Lab Scale to Field

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This paper presents a novel and simple method of seismic envelope analysis that can be applied at multiple scales, e.g. field, m to km scale and laboratory, mm to cm scale, and utilises the diffusive approximation of the seismic wavefield (Wegler, 2003). Coefficient values for diffusion and attenuation are obtained from seismic coda energies and are used to describe the rate at which seismic energy is scattered and attenuated into the local medium around a receiver. Values are acquired by performing a linear least squares inversion of coda energies calculated in successive time windows along a seismic trace. Acoustic emission data were taken from piezoelectric transducers (PZT) with typical resonance frequency of 1-5MHz glued around rock samples during deformation laboratory experiments carried out using a servo-controlled triaxial testing machine, where a shear/damage zone is generated under compression after the nucleation, growth and coalescence of microcracks. Passive field data were collected from conventional geophones during the 2004-2008 eruption of Mount St. Helens volcano (MSH), USA where a sudden reawakening of the volcanic activity and a new dome growth has occurred. The laboratory study shows a strong correlation between variations of the coefficients over time and the increase of differential stress as the experiment progresses. The field study links structural variations present in the near-surface geology, including those seen in previous geophysical studies of the area, to these same coefficients. Both studies show a correlation between frequency and structural feature size, i.e. landslide slip-planes and microcracks, with higher frequencies being much more sensitive to smaller scale features and vice-versa.