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Spectral Characteristics of Continuous Acoustic Emission (AE) Data from Laboratory Rock Deformation Experiments

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Continuous acoustic emission (AE) data recorded during rock deformation tests facilitates the monitoring of fracture initiation and propagation due to applied stress changes. Changes in the frequency and energy content of AE waveforms have been previously observed and were associated with microcrack coalescence and the induction or mobilisation of large fractures which are naturally associated with larger amplitude AE events and lower-frequency components. The shift from high to low dominant frequency components during the late stages of the deformation experiment, as the rate of AE events increases and the sample approaches failure, indicates a transition from the micro-cracking to macro-cracking regime, where large cracks generated result in material failure.

The objective of this study is to extract information on the fracturing process from the acoustic records around sample failure, where the fast occurrence of AE events does not allow for identification of individual AE events and phase arrivals. Standard AE event processing techniques are not suitable for extracting this information at these stages. Instead the observed changes in the frequency content of the continuous record can be used to characterise and investigate the fracture process at the stage of microcrack coalescence and sample failure.

To analyse and characterise these changes, a detailed non-linear and non-stationary time-frequency analysis of the continuous waveform data is required. Empirical Mode Decomposition (EMD) and Hilbert Spectral Analysis (HSA) are two of the techniques used in this paper to analyse the acoustic records which provide a high-resolution temporal frequency distribution of the data.

In this paper we present the results from our analysis of continuous AE data recorded during a laboratory triaxial deformation experiment using the combined EMD and HSA method.