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Analysis of a microseismic signal using a wavelet transform

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Research on wavelet analysis has produced important contributions to different scientific areas, and has motivated the diverse use of wavelet analysis in recent years. Wavelets have properties such as localization. This is essential for the analysis of non-stationary and transient signals. Other properties are orthogonality, multirate filtering or space-scale analysis, which make this tool attractive for many application fields. In this paper we explore the potential of wavelet transforms for analysis and information extraction from a microseismic trace. The main scientific objective is to examine the wavelet representation as a matching filter for processing important features across time-scales to extract characteristics of interest such as energy and predominant time scales. This information can subsequently be exploited for microseismic event detection and elimination of spurious signals. The potential of the discrete Haar wavelet transform is explored as a detection tool of microseismic events. It yields differences of non-overlapping weighted averages of observations when used with a given one-dimensional time-series, and tends to emphasise discontinuities in the raw data set. The orthonormal decomposition of the signal energy estimated by the wavelet variance into time-scales provides a useful means of describing the change of variability associated with the triggering events. The computation of the variance at each scale is obtained using the sum of squared wavelet coefficients. The magnitude quantifies the contribution of changes at each time-scale to the sample signal energy. A high value of energy at a specific time location relative to the scale average energy would mean that the signal recorded at this time contributes more than the average over time at that scale. Energy changes associated with microseismic events arrival can be enhanced by aggregation of the change measure across the scales. The arrival detection procedure is implemented to identify microseismic events in a seismic trace.