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Application of the virtual field optimization method for locating acoustic emissions with large arrival time picking errors in anisotropic media

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An existing virtual field optimisation method (VFOM) has been extended for source location of the acoustic emission data in anisotropic media. Many advanced arrival-time-picking-free algorithms have been proposed, however, these algorithms consider whole or part of the waveforms and as a result, they are usually very time-consuming and are limited to the resolution of the grid search. On the other hand, those methods that use the seismic arrival times are highly affected by the large arrival time picking errors. In contrast, the VFOM reduces the effect of large picking arrival time errors by minimizing a virtual objective function instead of minimising the residual error between the calculated model and the measured arrival. This paper reformulates this method for anisotropic rock and investigates its performance in such media. Several true-triaxial experiments have been performed on 80mm cubic anisotropic foliated gneiss samples at the Rock Fracture Dynamics Facility, University of Toronto. Acoustic emission data was recorded and sensor to sensor velocity surveys was carried out throughout these experiments. Moreover, high-resolution 3D fracture networks of the failed samples have been reconstructed using micro CT images. The acoustic emission source locations are calculated using the extension of VFOM for anisotropic media as proposed in this paper and compared to the commonly used collapse grid and the simplex methods. Reconstructed 3D fracture networks along with other parameters are used to compare the accuracy and performance of these methods.