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Complexity penalized hydraulic fracture localization and moment tensor estimation under limited model information

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In this paper we present a novel technique for micro-seismic localization using a group sparse penalization that is robust to the focal mechanism of the source and requires only a velocity model of the stratigraphy rather than a full Green's function model of the earth's response. In this technique we construct a set of perfect delta detector responses, one for each detector in the array, to a seismic event at a given location and impose a group sparsity across the array. This scheme is independent of the moment tensor and exploits the time compactness of the incident seismic signal. Furthermore we present a method for improving the inversion of the moment tensor and Green's function when the geometry of seismic array is limited. In particular we demonstrate that both Tikhonov regularization and truncated SVD can improve the recovery of the moment tensor and be robust to noise. We evaluate our algorithm on synthetic data and present error bounds for both estimation of the moment tensor as well as localization. Furthermore we discuss the estimated moment tensor accuracy as a function of both array geometry and fault orientation.

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