Seismicity During the First Three Months of the Guy-Greenbrier, Arkansas, Earthquake Sequence

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Most microearthquakes (1.5 < M < 2.9) during first 3 months of the Guy-Greenbrier sequence were induced by hydraulic fracturing at some but not all stimulated production wells.

Lower levels of seismicity (M < 1) initiated along the Guy-Greenbrier Fault soon after wastewater injection started in July 2010.

Earthquake monitoring with low-magnitude detection thresholds and precise locations, even with a sparse 3-station seismic network, provides new insights into previously unknown sources of induced seismicity

Introduction

Background

- The earthquake sequence started propagating along the previously quiet ARK1 Guy-Greenbrier Fault in late 2010, and included over 6,500 events.
- Largest earthquake in sequence, Mw 4.7, 2011-02-27.

Research Questions

- Origin of seismicity and induced earthquakes.
- Observation of seismicity and induced earthquakes.
- Modeling of seismicity and induced earthquakes.

Approach

- Detect and assign small earthquakes during first 3 months of the sequence.
- Identify individual stages of injection.
- Estimate optimal and temporal correlates between seismicity, injection, and hydraulic fracturing at all injection sites.

Method: Earthquake Detection

- FAST algorithm: 3D, 1D, and 1D velocity model.
- Assign clusters, analyze seismicity and injection.
- Size and location assign similar spatially.
- Same, spatially, in all time windows.

RESULTS

Cluster 1:

- EC algorithm: 199 events.
- Assigned 6,508 events.
- Cross-correlated each unlocated event waveform with the “stack” representative “stack” waveform.

Cluster 2:

- Identified over 500 events.
- Assigned 6,508 events.

Cluster 3:

- Identified over 1,000 events.
- Assigned 6,508 events.

Cluster 4:

- Identified over 1,000 events.
- Assigned 6,508 events.

Cluster 5:

- Identified over 1,000 events.
- Assigned 6,508 events.

Cluster 6:

- Identified over 1,000 events.
- Assigned 6,508 events.

Cluster 7:

- Identified over 1,000 events.
- Assigned 6,508 events.

Results: Most microearthquakes (1.5 < M < 2.9) during first 3 months of the Guy-Greenbrier sequence were induced by hydraulic fracturing; we also identified initial seismicity on the Guy-Greenbrier Fault induced by wastewater injection starting in July 2010.