# Induced Seismicity:
## Can it be good for your field?

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An earthquake caused by changes in the stress field due to human activity.

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| Cause: injecting fluid into a reservoir under high pressure to open new or pre-existing fractures to increase permeability and flow volume | |
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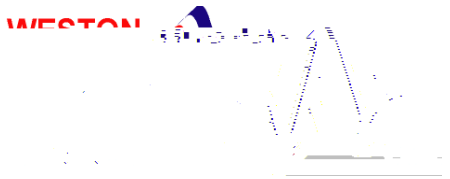
In 2008, residents near the Dallas-Ft. Worth airport began experiencing minor earthquakes, including a magnitude 3.3. Event locations were found to be in

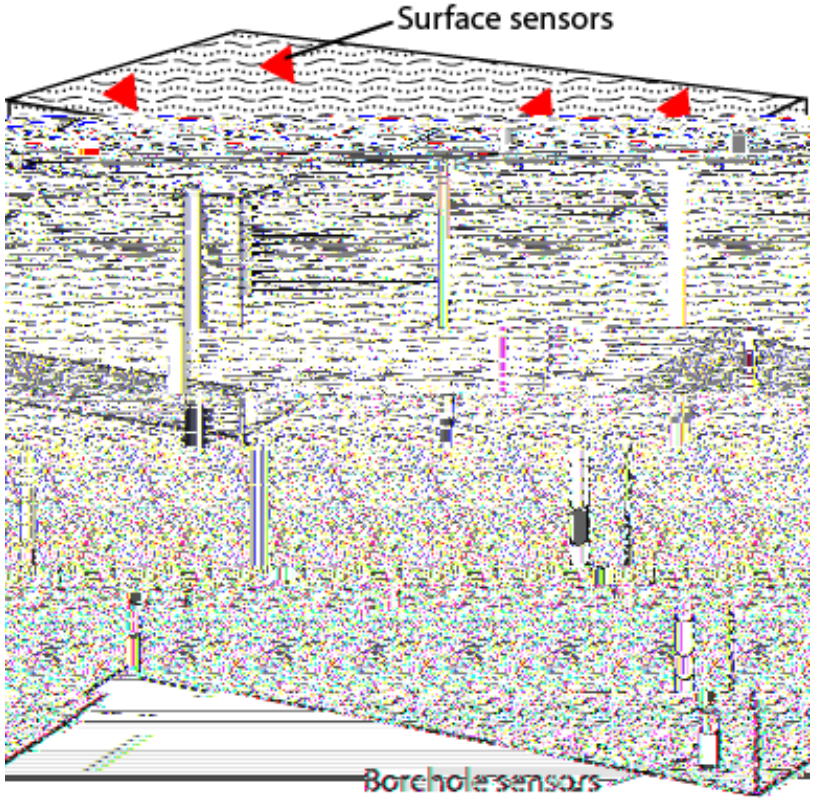


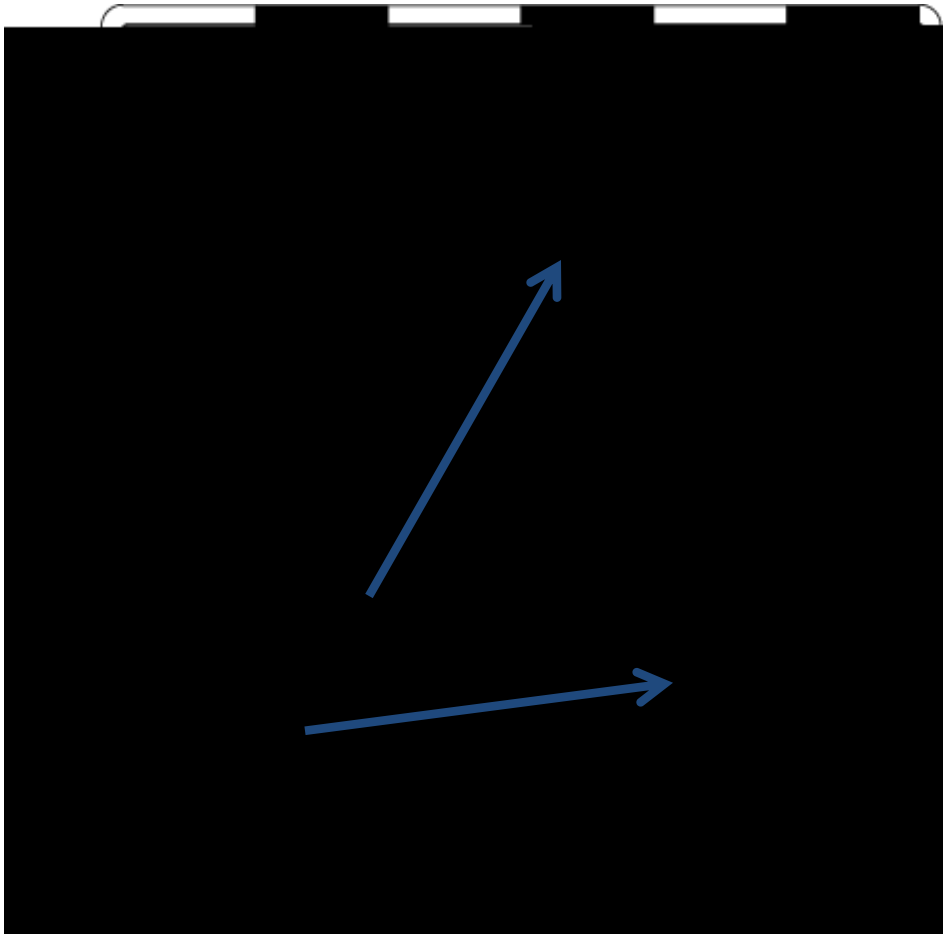
Installation of a seismic monitoring network is the only way to know if induced microseismicity is occurring.

The network can consist of an array of (near-)surface sensors, an array of borehole sensors near the reservoir depth, or a combination.

Ideally, the network should be installed prior to any field development to provide a seismic baseline.

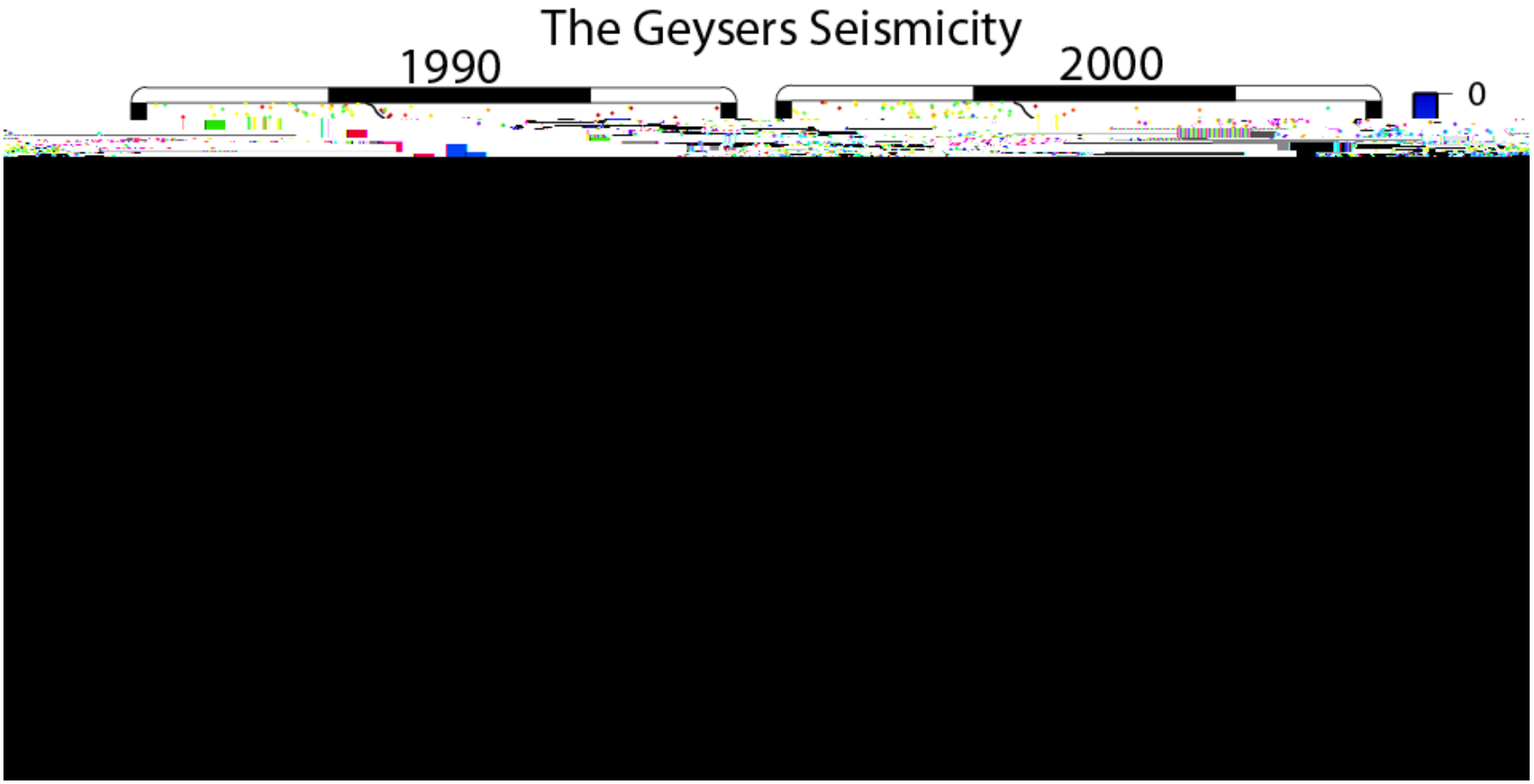
Not only will a seismic network make the operator aware induced seismicity is being generated, but this information may allow improved reservoir characterization and performance.


Surface sensors
Borehole sensors



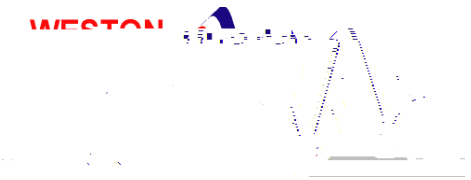
Mapping induced seismicity can show fluid flow pathways.

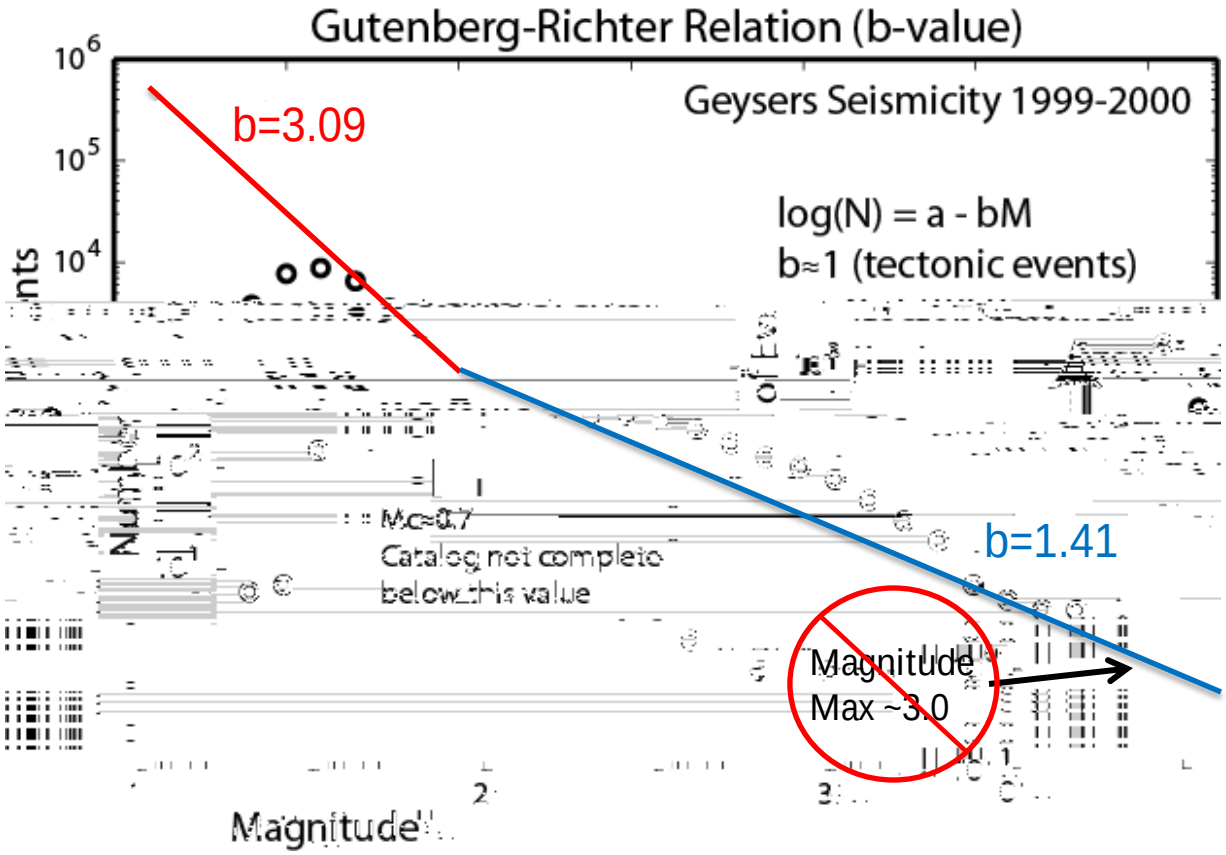
It can also identify a fluid flow pathway problem.




Seismicity patterns and depths show variations from 1990 to 2000.

Significant number of events occurring within close proximity to major faults.






Can help infer event type and largest possible event magnitude (Risk Management).

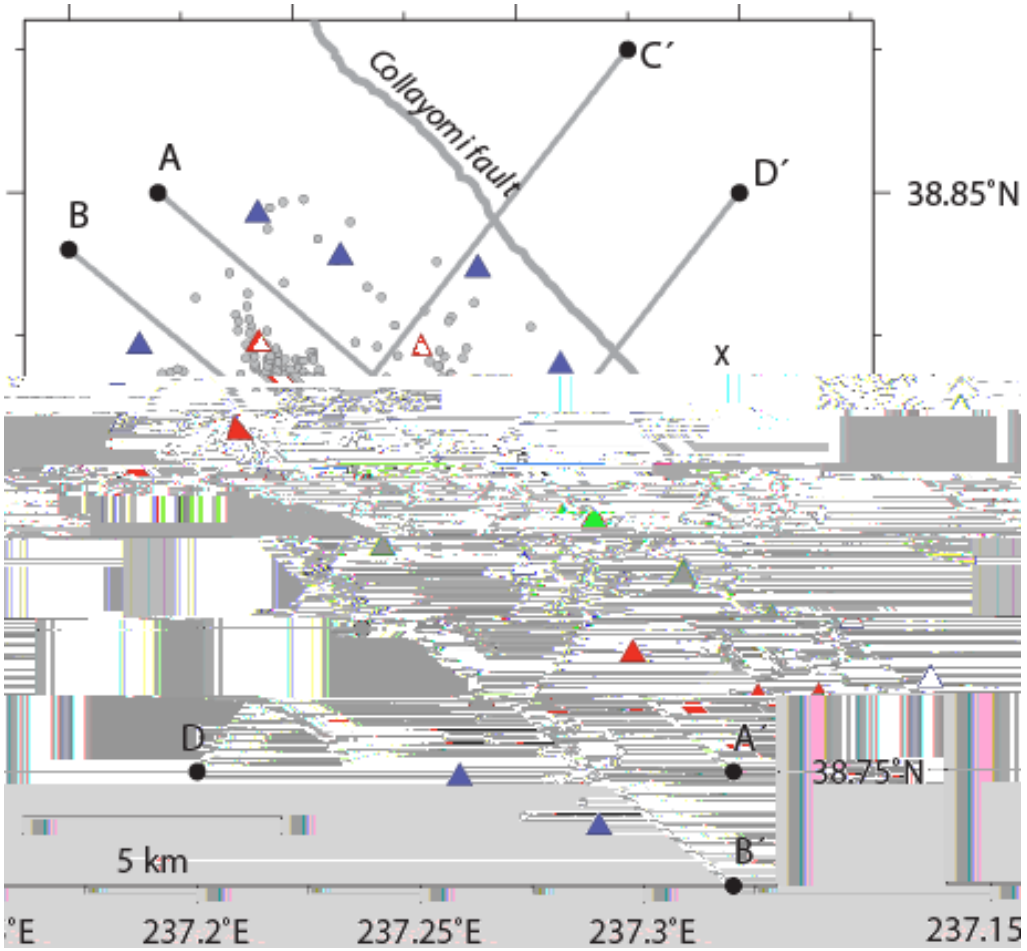
Recent work indicates b-value can highlight fluid flow pathways as b-values decrease with distance from the injection point.

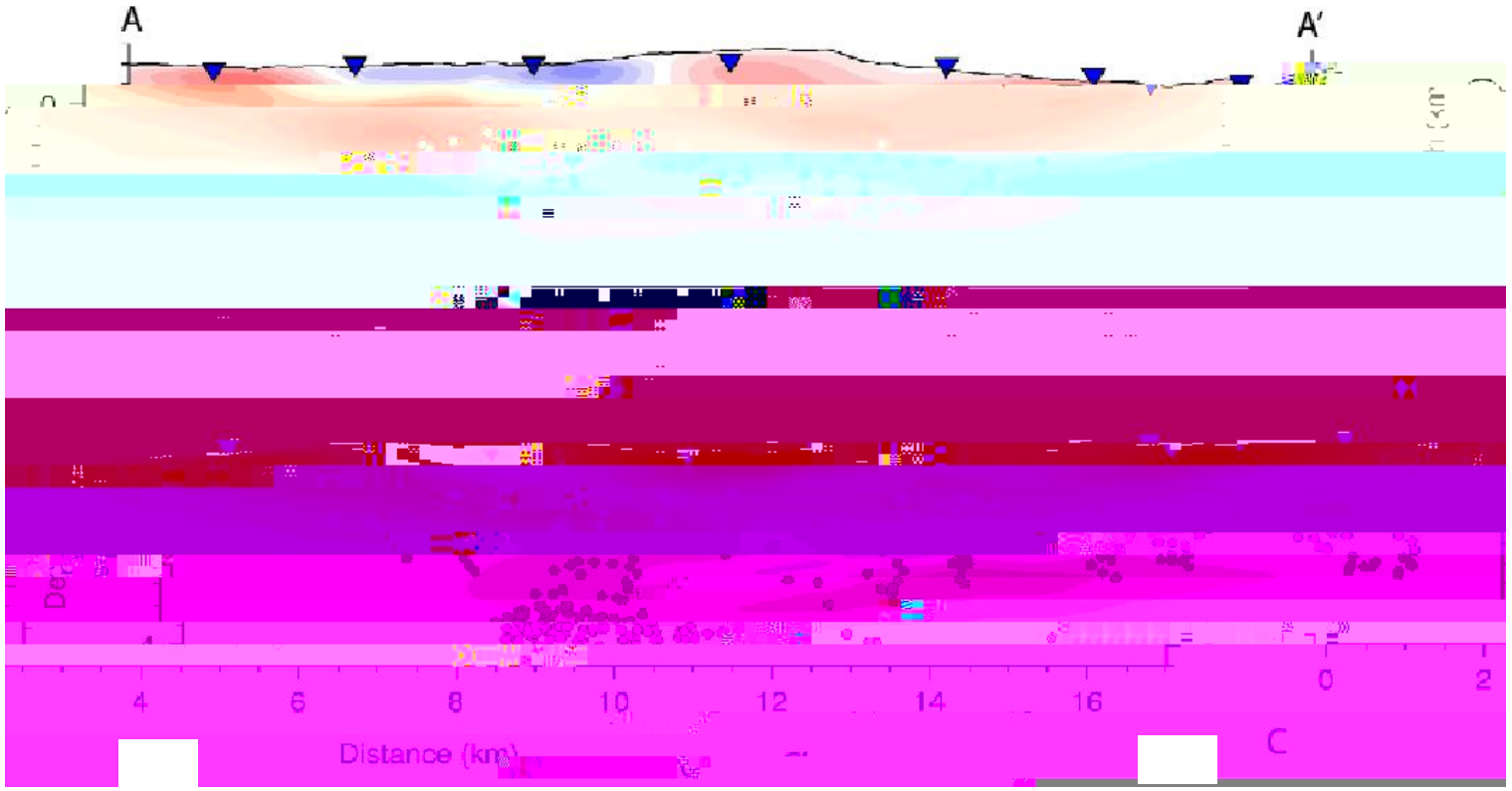
Inverse relationship to differential stress, with largest magnitude events occurring in regions of low b-value.

Maximum magnitude error due to:

Subset of largest and best located induced seismic events (circles) in year 2000 and the monitoring array (triangles).

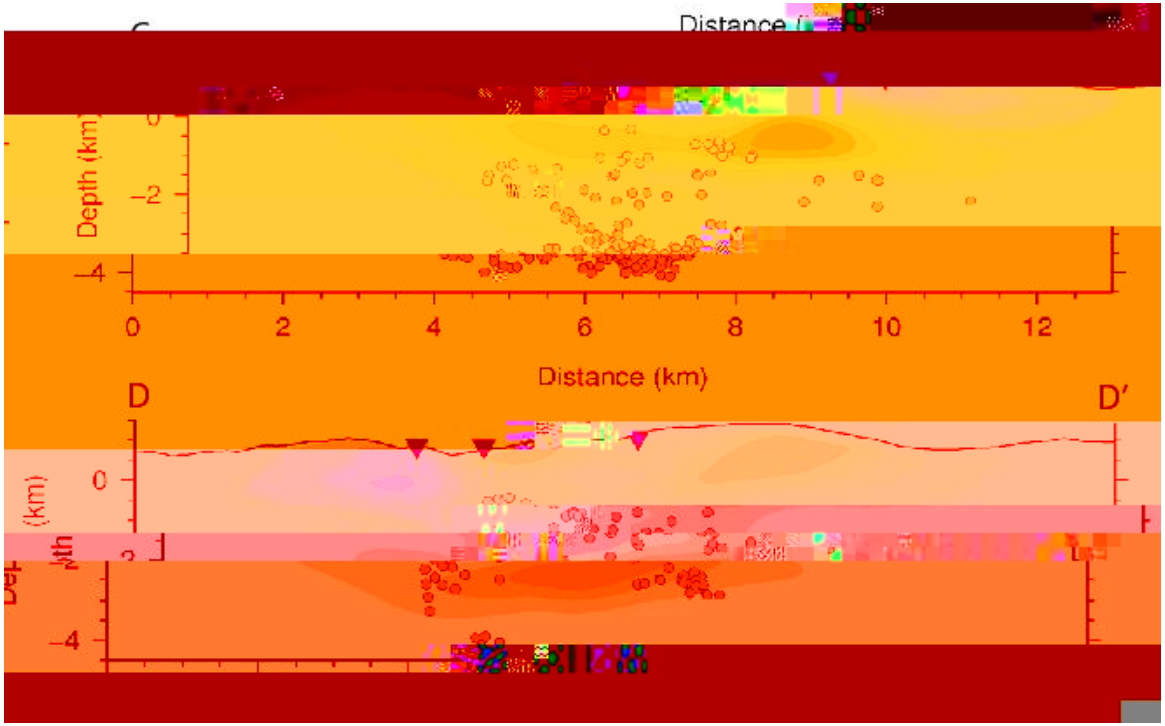
A tomographic inversion produced a 3-D seismic velocity model that is shown along 4 cross sections in following slides.






Velocity model cross-sections showing relative difference between current velocities and starting model.

Variations in seismic velocities could indicate differences in temperature, fracture density, fluid saturation, etc.




Difference maps can be produced at specified time intervals to look for changes in the field.

Can be combined with active source measurements to generate higher resolution maps.

Induced seismicity often has a negative connotation, but the vast majority goes unnoticed. With a seismic monitoring network, the seismicity could provide a low-cost wealth of information not otherwise available.

Although monitoring induced seismicity may not answer all questions directly, it can provide relevant information to help infer the answers to questions and raise new questions.

There are numerous analysis methods, in addition to those introduced here, that can be performed to gain more field information.