Passive Seismic

BELVEDERE MAORPET

Monitoring of hydraulic fractures by using passive seismic on the surface

Fracturing (frac) is a well known practice to increase the productivity of a well. Today, as exploration for unconventional gas accumulations became a major issue, the frac treatment is a frequently applied procedure.

The routine process is:

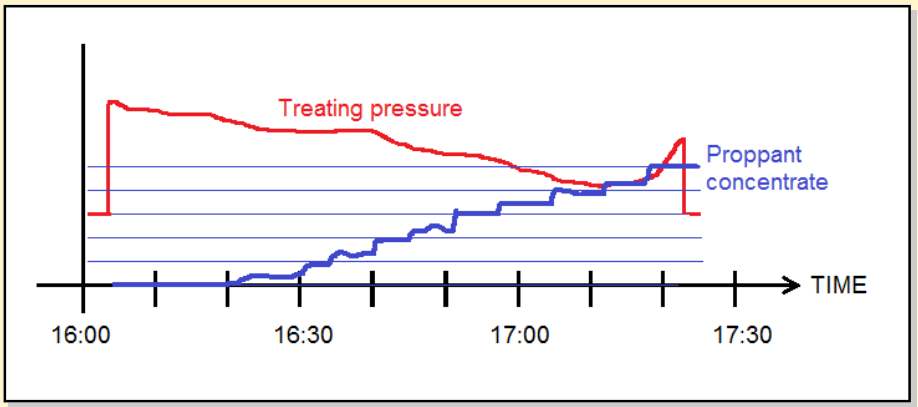
(1) - drilling the well,
(2) - perforating,
(3) - fracturing the opened layer by the application of high pressure,
(4) - pressing a special "proppant" material into the opened fractures,
(5) - finally let the gas to flow in.

The special "proppant" material is responsible to hold the fractured parts open.

Usually the result of the frac is estimated by model simulations. The amount of the applied proppant material, the shape of the perforation and the major rock-stress directions allow to estimate the size and shape of the fractured zone.

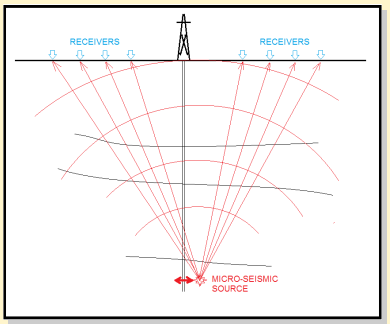
Out of these parameters only the amount of the proppant material is properly known, the rest is only approximated. This opens a wide field for different model constructions.

Passive seismic represents a more reliable way to estimate the size and shape of the fractured zone.

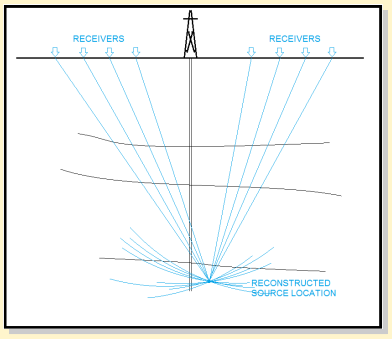


Passive seismic is an expression for the specific seismic methodology, when we don't generate the source signal ourselves, but we listen only the waves, which are generated by various micro-seismic events. There are several variants of the passive seismic method.

Here, in this case the micro-seismic events are triggered by the fracturing and the invasion of the proppant material. It is expected that the fracturing process initiates micro-seismic events in the fractured zone. The waves generated by this micro-seismicity can be recorded. Recording the waves at different locations simultaneously; gives the chance to reconstruct the origin of the source positions. A map of the source positions delineates the extents of the fractured zone.



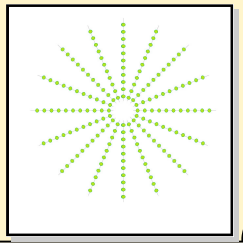
Wave generated by a fracture



Reconstruction of the place of the fracture

Recording can be done on the surface, or in monitoring wells. Belvedere MAORPET Inc's processing method is based on the surface recording, which is far more simple and viable than placing receivers into active wells. Receivers can be placed in any formations, rows, star, or totally random, only the number of receiver points must be high enough, in the range of 600-1200 geophones.

(Please notice: some of the receiver patterns might be patented by some contractor companies)



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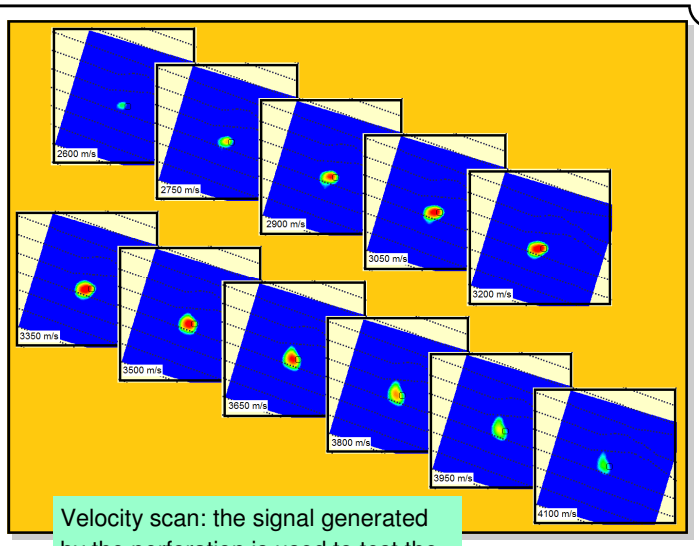
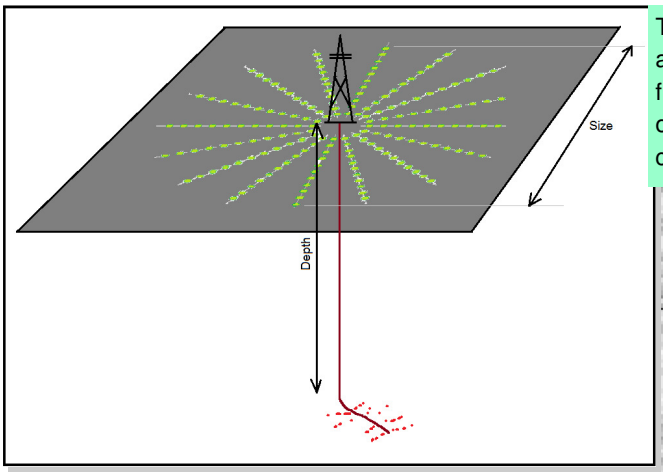
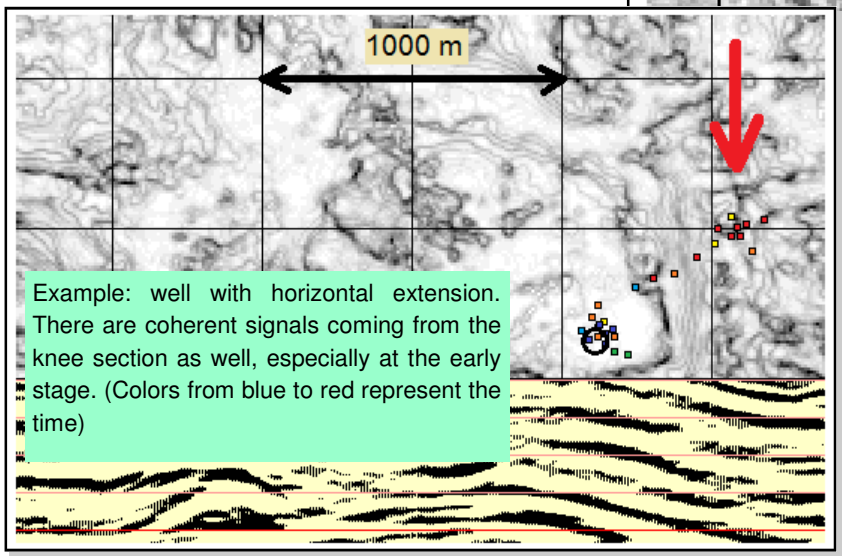


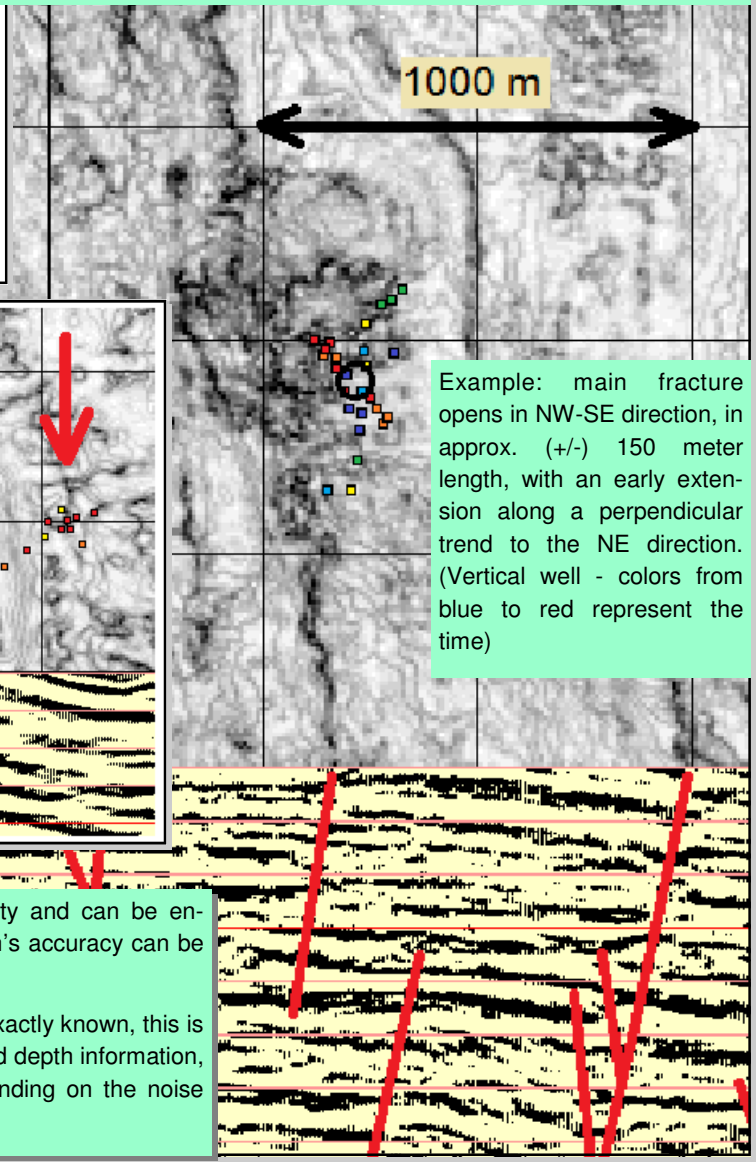
Velocity scan: the signal generated by the perforation is used to test the parameters



The horizontal extents of the surface recording area should have approximately the same diameter, as the expected depth of the fractured zone. The received signal is very weak compared to the other surface noises. Only the sufficient amount of the receivers can compensate for the energy differences.



Example: well with horizontal extension. There are coherent signals coming from the knee section as well, especially at the early stage. (Colors from blue to red represent the time)



Example: main fracture opens in NW-SE direction, in approx. (+/-) 150 meter length, with an early extension along a perpendicular trend to the NE direction. (Vertical well - colors from blue to red represent the time)

Accuracy: horizontal resolution depends on the grid density and can be enhanced by proper interpolation. The horizontal point location's accuracy can be in the range of a half meter.

Vertical resolution is more problematic. The basic depth is exactly known, this is the depth of the perforation. When we try to use the extracted depth information, the inaccuracy can grow to the range of 100 meter, depending on the noise conditions and receiver geometry.