NORSAR Synthetic 3D Seismic plug-in for Petrel (available on the Ocean Store)

Check your surface interpretation by modeling the seismic response

The plug-in generates synthetic migrated 3D seismic that incorporate 3D illumination and resolution effects from seismic aperture, overburden and reservoir using a patented method called SimPLI (Simulated Prestack Local Imaging).

Having interpreted surfaces from a real 3D seismic (and possibly also having found an estimate of the Reflection coefficients along the surfaces) it is useful for quality control purposes to generate synthetic 3D seismic from the surfaces and compare it with the real 3D seismic.

The synthetic 3D seismic is generated using a 3D convolution process. Unlike 1D convolution, that is common in industry, our method takes into account the effect of lateral resolution and that some dips may not be illuminated.

Using the plug-in the effect of the Migration aperture on the illumination may be studied.

It is also possible to vary reflection angle, thus predicting AVO/AVA effects.

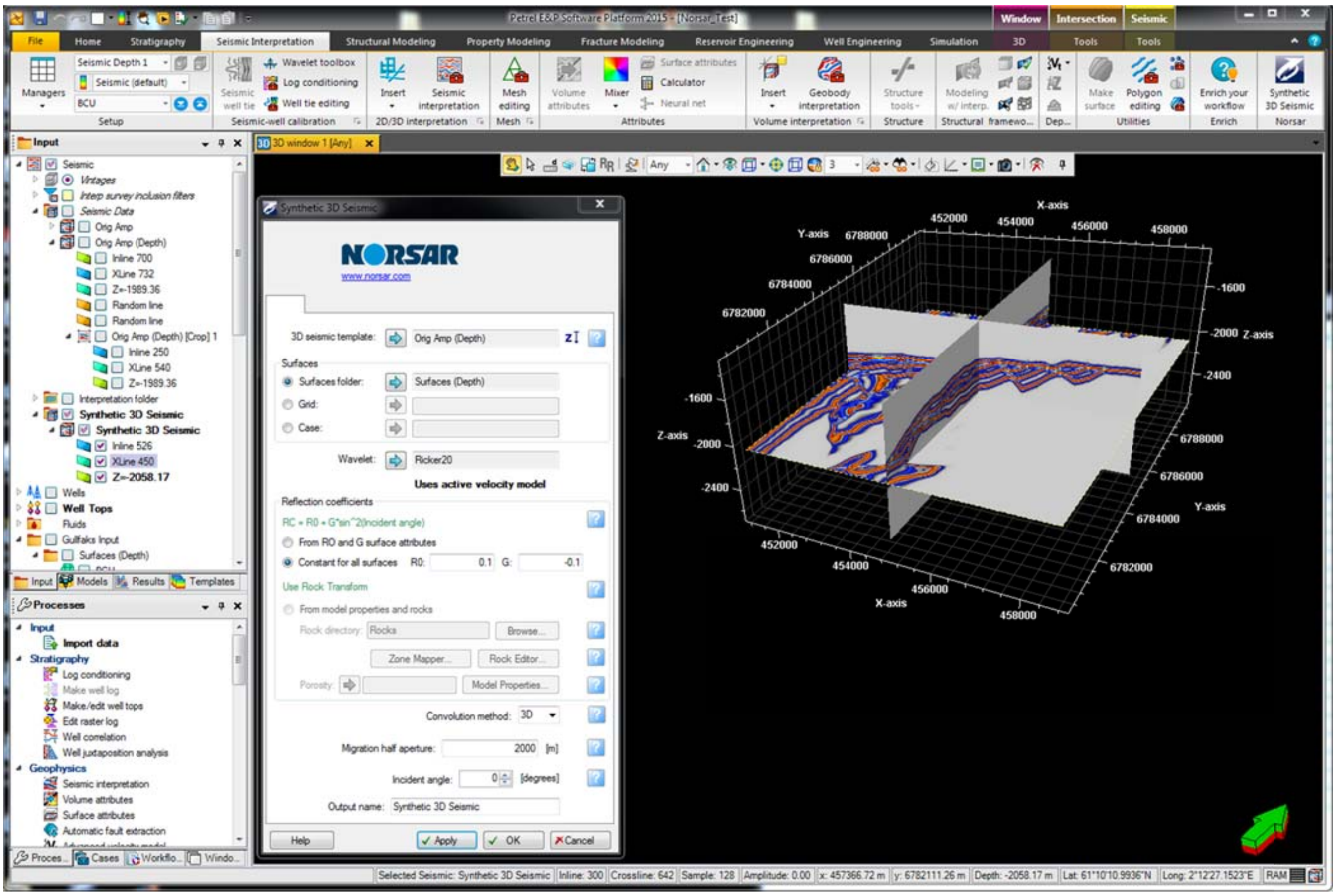

Figure 1: The NORSAR Synthetic 3D Seismic plug-in for Petrel along with a resulting Synthetic 3D Seismic

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The Synthetic 3D Seismic plug-in is easy to use and fast

Look at the figure below showing the GUI of the plug-in.

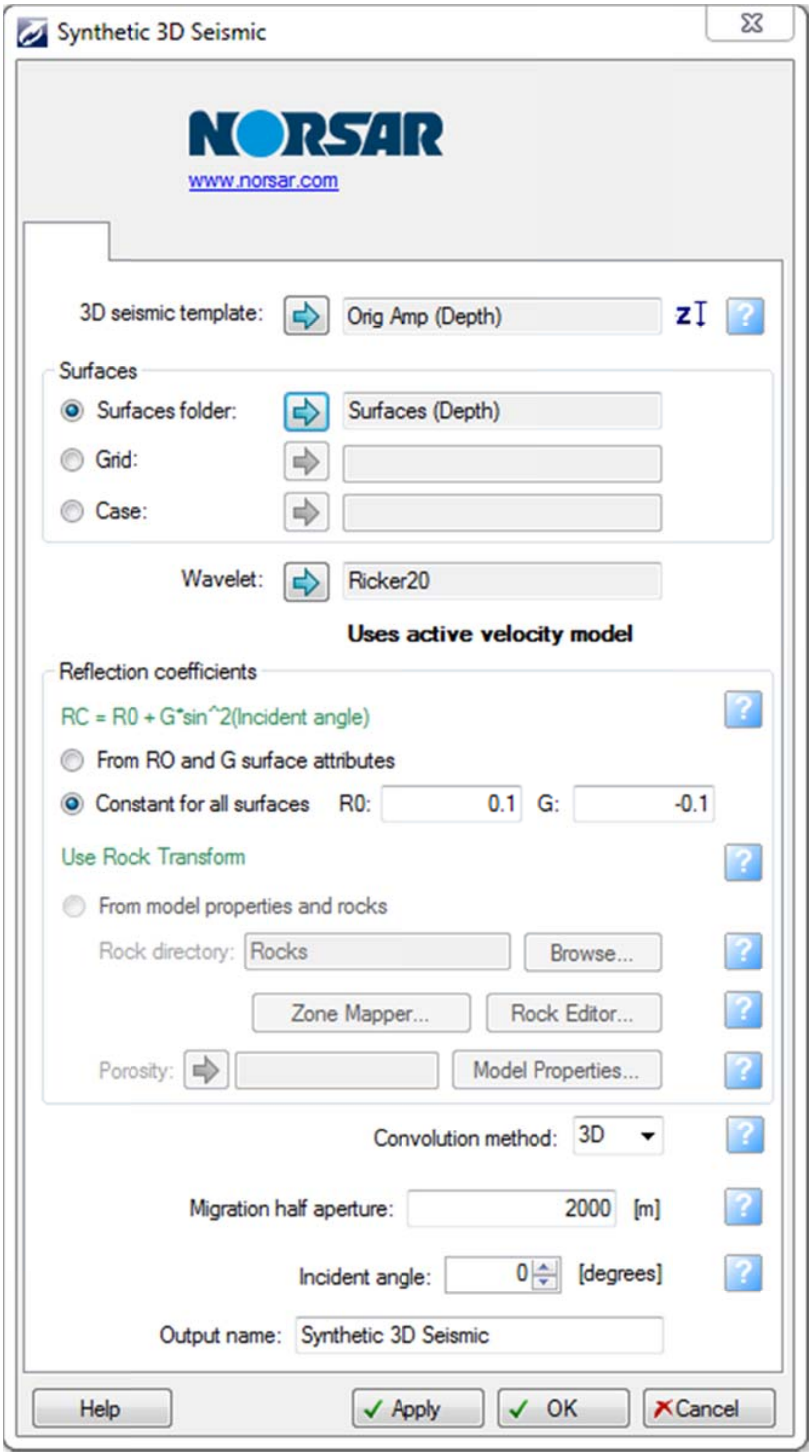


Figure 2: The GUI of the Synthetic 3D Seismic plug-in

A real 3D seismic is used as a *3D seismic template* for the synthetic 3D seismic; the resulting synthetic 3D seismic will have the same sampling and extent as the real 3D seismic. This makes it easy to compare the synthetic seismic with the original seismic from which the surfaces were interpreted. The plug-in can generate synthetic 3D seismic either in Domain Elevation time or Elevation depth. This is also determined by the domain of the template.

The reflection coefficient along the surfaces in a specified *Surfaces folder,* or along horizons in a specified *Grid* or *Case*, is convolved with the specified *Wavelet* using a fast 3D convolution that takes into account illumination and resolution effects. The reflection coefficients are either calculated from Wiggens'/Gelfand's approximation or by using Rock Transform (Drotning et al.) and the Zoeppritz equation (Cerveny, Molotkov, Psencik).

Using the Wiggens'/Gelfand's approximation, reflection coefficients along the surfaces depends on the specified *Incident angle*:

$R = R0 + Gsin^2(Incident\ angle)$

The R0 and G values along the surfaces can be found from surface attributes or set constant for all surfaces.

The reflection coefficients can also be calculated using Rock Transform and the Zoeppritz equation. This method only applies for horizons from a model grid or case. By using model properties and associated rocks above and below each horizon in the model, the velocities V_p, V_s and V_{rho} are calculated using rock transform. The reflection coefficients along the horizons are calculated by the Zoeppritz equation, using the velocities and the *Incident Angle*.

For both cases, by varying the Incident angle; AVO/AVA effects can be predicted.

Instead of specifying the survey from which the seismic was acquired; you only have to specify the *Migration half aperture*, which restricts the illumination.

The illumination is found by ray tracing in the *active velocity model*.

For comparison purposes the industry standard 1D convolution is also implemented.

You can study the effects of the Migration Aperture

Below is an example of Synthetic 3D Seismic generated with two different Migration apertures. Notice how the steeply dipping faults are not illuminated by a narrow Migration aperture.

The standard 1D convolution process on the other hand would result in perfect illumination of the faults.

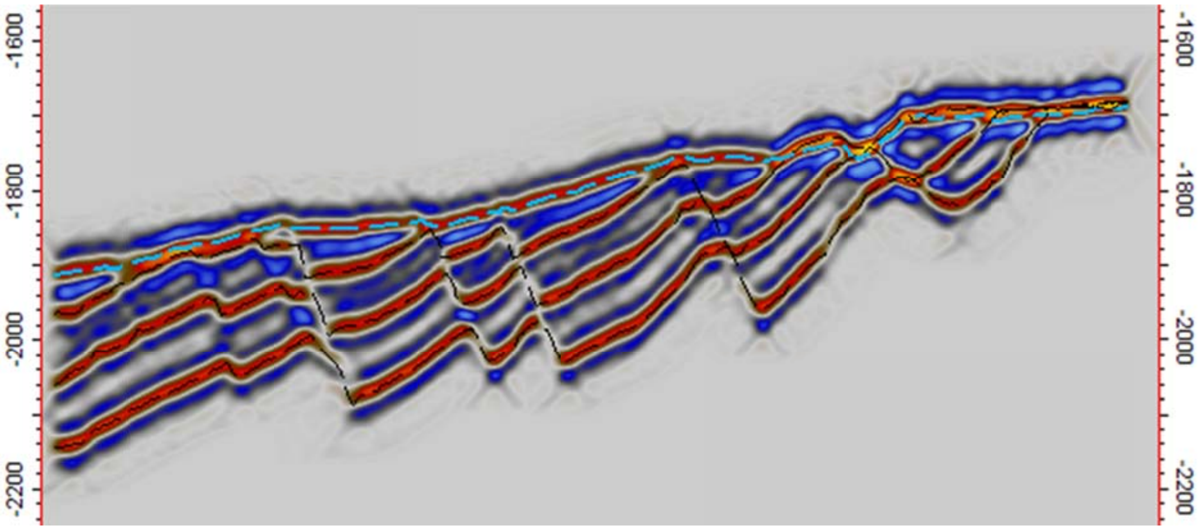


Figure 3: Inline through a Synthetic 3D Seismic. Migration half aperture = 500 m.

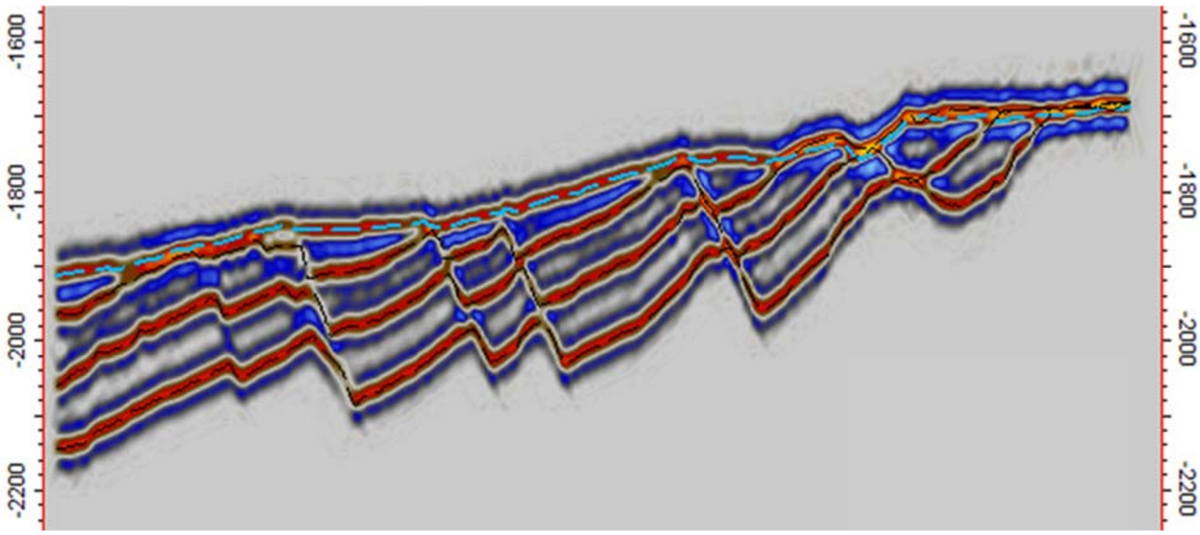
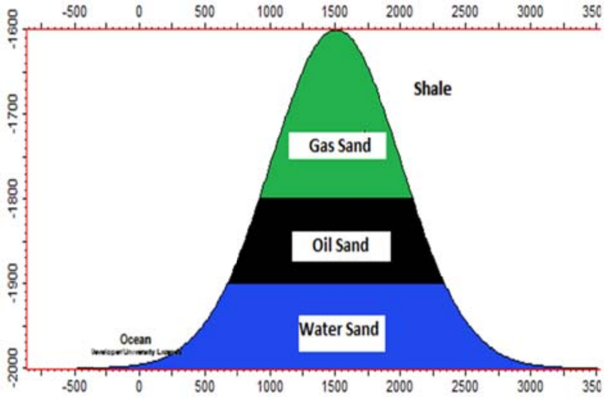


Figure 4: Inline through a Synthetic 3D Seismic. Migration half aperture = 1000 m.

You can study AVO/AVA effects

Below is an example of an analytical anticline structure.



Layer	VP [km/s]	VS [km/s]	RHO [g/cm^3]
Shale	2.2	0.8	2.2
Gas Sand	2.0	1.1	2.1
Oil Sand	2.2	1.2	2.2
Water Sand	2.4	1.3	2.3

Surface	R0	G
TopReservoirGas	-0.071	-0.34
TopReservoirOil	0	-0.4
TopReservoirWater	0.066	-0.45
GasOilContact	0.071	-0.063
OilWaterContact	0.066	-0.059

Figure 5: Anticline "bright spot" structure

The figures below show the resulting Synthetic 3D Seismic resulting from these surfaces for two different Incident angles: 0 and 30 degrees.

Notice how the TopReservoir Oil is not visible on the normal incidence Synthetic 3D Seismic, but has a negative reflection at the 30 degrees Synthetic 3D Seismic. Also the amplitude of the TopReservoirGas reflection increases with Incident angle. The amplitude of all other surfaces (and in particular the TopReservoirWater) decreases with Incident angle. Notice also how an increase in the Incident angle leads to pulse stretching

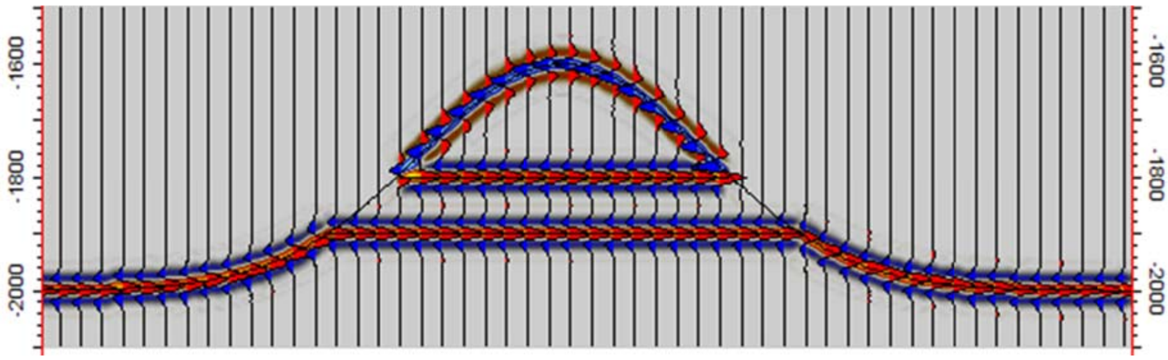


Figure 6: Synthetic 3D Seismic of a "bright spot". Incident angle = 0 degrees.

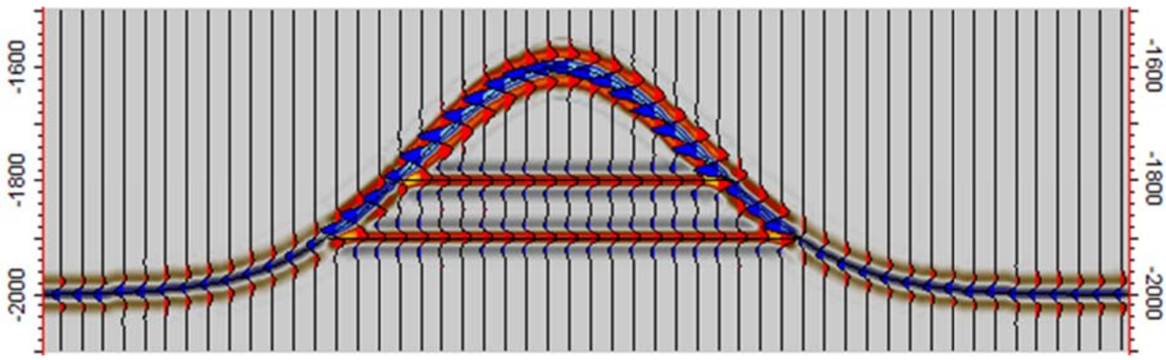


Figure 7: Synthetic 3D Seismic of a "bright spot". Incident angle = 30 degrees.