Bridging the Gap between Reservoir and Seismic

New modelling package SeisRoX uses rapid simulation of PSDM to aid seismic reservoir characterisation and monitoring.

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A principle goal within seismic modelling today is to incorporate more quantitative interpretation. NORSAR, a Norwegian research institute, aims to achieve this with the launch of its new modelling software, SeisRoX™. The key components within the software are comprehensive rock physics modelling, 3D illumination effects caused by overburden and survey geometry, and the rapid simulation of 3D prestack depth migrated (PSDM) seismic cubes.

Simulated Prestack Local Imaging

The inspiration behind SeisRoX was to create a software tool to bridge the gap between reservoir properties and seismic response. SeisRoX succeeds because it enables the user to begin with the observed rock physics properties and progress through to the 3D PSDM image, all within one software package, on a laptop, in a timescale of minutes rather than weeks.

The core of the software is a model which describes the geometrical structure and properties of the PSDM target of interest. This model is classified into three different domains: the geological, the elastic and the reflectivity domain. It is built up within the software, and existing reservoir or geo-models can be imported or updated as required.

The PSDM simulator, SimPLI (Simulated Prestack Local Imaging), which combines reflectivity data with information from the background model and incorporates the effects of illumination as well as lateral and vertical resolution, is so rapid that users are able to change rock properties or survey specifications and immediately see the effect on the PSDM image. The SimPLI method is a generalized 3D convolution technique which enables the user to predict 2D and 3D illumination and resolution effects in prestack acquisition. Innovative functionality coupled with pre-defined workflows and a user driven environment make it suitable for many applications, including survey planning, interpretation, time-lapse reservoir studies, seismic imaging and AVO/AVA analyses.

An important characteristic of the system is that the PSDM modeling process is designed for target-orientated analyses, so that the model-based analysis is concentrated within a user-defined sub-area.

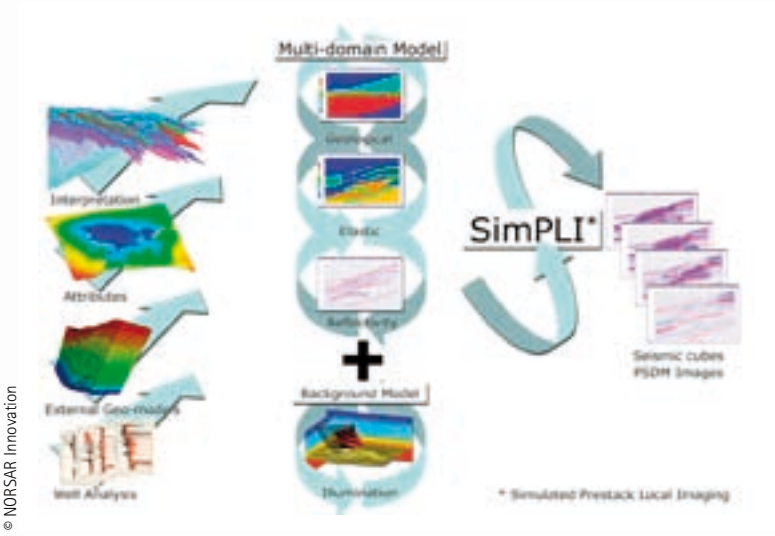
Integration and Innovation

The background model (overburden) is completely decoupled from the SeisRoX model (reservoir). This means that once the physical geo-model has been established, any reservoir parameter can be interactively altered and the effect on the PSDM response seen imediately by the user. This makes the understanding of parameter uncertainties and their effects a real possibility, enabling efficient testing of different model hypotheses.

The innovative technology within the SimPLI software is combined with comprehensive rock physics modeling capability and a ray tracing engine so that the geoscientist can use any or all of these tools. The ease with which data can be imported and then moved iteratively between the geological, elastic and reflectivity domains before simulating an accurate 3D PSDM image means quantitative interpretation is a real possibility.

Photo: Isabelle Lecomte

SeisRoX demonstrated some typical workflows during a SVALEX field trip to Storvola, on Spitsbergen in the Svalbard archipelago.



The seismic modelling technology within SimPLI combines the reflectivity data with the information obtained from the background model, via ray tracing to simulate a PSDM image.

Interactive parameter adjustment

By taking the reservoir model and adjusting various important parameters, such as offset, pulse, rock properties and time, it is possible to see how PSDM will affect the final depth image in SeisRoX.

Through the software it is easy to establish the effect that streamer length, survey azimuth and survey offset have on the PSDM image. This enables the geoscientist to quickly quantify and understand how altering the survey parameters will lead to the optimum survey design.

Varying the dominant frequency of the source pulse will have an effect on the PSDM data. For a given target model and illumination coverage, SimPLI quickly generates a set of images for a range of pulses, demonstrating that a higher dominant pulse frequency quantifiably gives better resolution.

Once the background model and the survey have been established, the user is able to alter rock properties within the SeisRoX multi-domain model and instantly see the resulting effect on the simulated PSDM image. The comprehensive rock physics modeling contained within SeisRoX provides all the functionality the user expects from a standalone rock physics software package, with the advantage of being fully integrated with a 3D seismic PSDM simulator. This enables realistic sensitivity tests to be performed on the data to establish a degree of confidence in the model. The process can be repeated for multiple parameters within the models, such as pressure, porosity and density, enabling the user to make quick comparisons of their effects on the 3D PSDM image.

A particularly important application of SeisRoX is within seismic time-lapse (4D) studies. A reservoir baseline model would be defined showing, for example, the level of water saturation in the reservoir at that time. From this, SeisRoX calculates the P- and S-velocity and density and the corresponding PSDM image. Over time, the water saturation will change due to production and the model can simulate a PSDM dataset at different time steps, accurately incorporating the effect of illumination as well as lateral and vertical resolution.

NORSAR

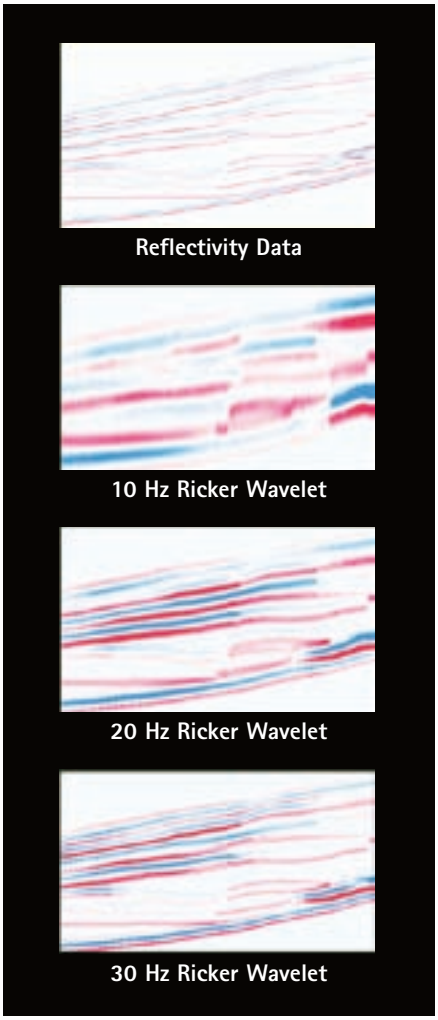
NORSAR Innovation markets commercial software packages for 2D/3D seismic modelling and reservoir analysis on behalf of the research institute NORSAR. NORSAR's R&D history includes research projects, consulting services and software development for the petroleum industry over a period of 25 years.

The core applications for NORSAR software are 2D and 3D seismic ray modelling, survey planning, illumination analysis, reservoir analysis, Green's functions for PSDM and time-to-depth conversion based on ray tracing. However, the modular design of NORSAR's software allows packages to be tailored to individual project requirements.

NORSAR software products are used by leading E&P companies throughout the world. The products are based on cutting edge research and supported by experienced sales and support teams.

Quick, intuitive and quantifiable

The integrated solution provided by SeisRoX enables the entire modelling procedure, from rock physics property analysis through to the simulation of the 3D PSDM image, to be performed within one software package. The inherent benefits of this approach are numerous and include less time importing and exporting data, easier and more fruitful cooperation within the asset team, and the use of workflow management tools, leading to improved QC and communication. In addition, rapid and accurate simulation of 3D PSDM data through SimPLI software facilitates better reproduction of illumination and resolution effects, so that the link between individual rock physics properties and the PSDM image is quick, intuitive and quantifiable.



For a given target model and illumination coverage, SimPLI generates a set of images for a range of pulses. High pulse frequency results in better resolution, but the software makes it possible to quantifiably determine the effect of the pulse frequency on the 3D PSDM image (data courtesy of the SVALEX project, sponsored by Statoil).