DRILLING & EXPLORATION WORLD

DEW

THE COMPLETE ENERGY JOURNAL

IN PUBLICATION SINCE 1989

INTERNATIONAL EDITION

Volume 22 Number 05

ISSN - 0971 - 7242

dewjournal.com

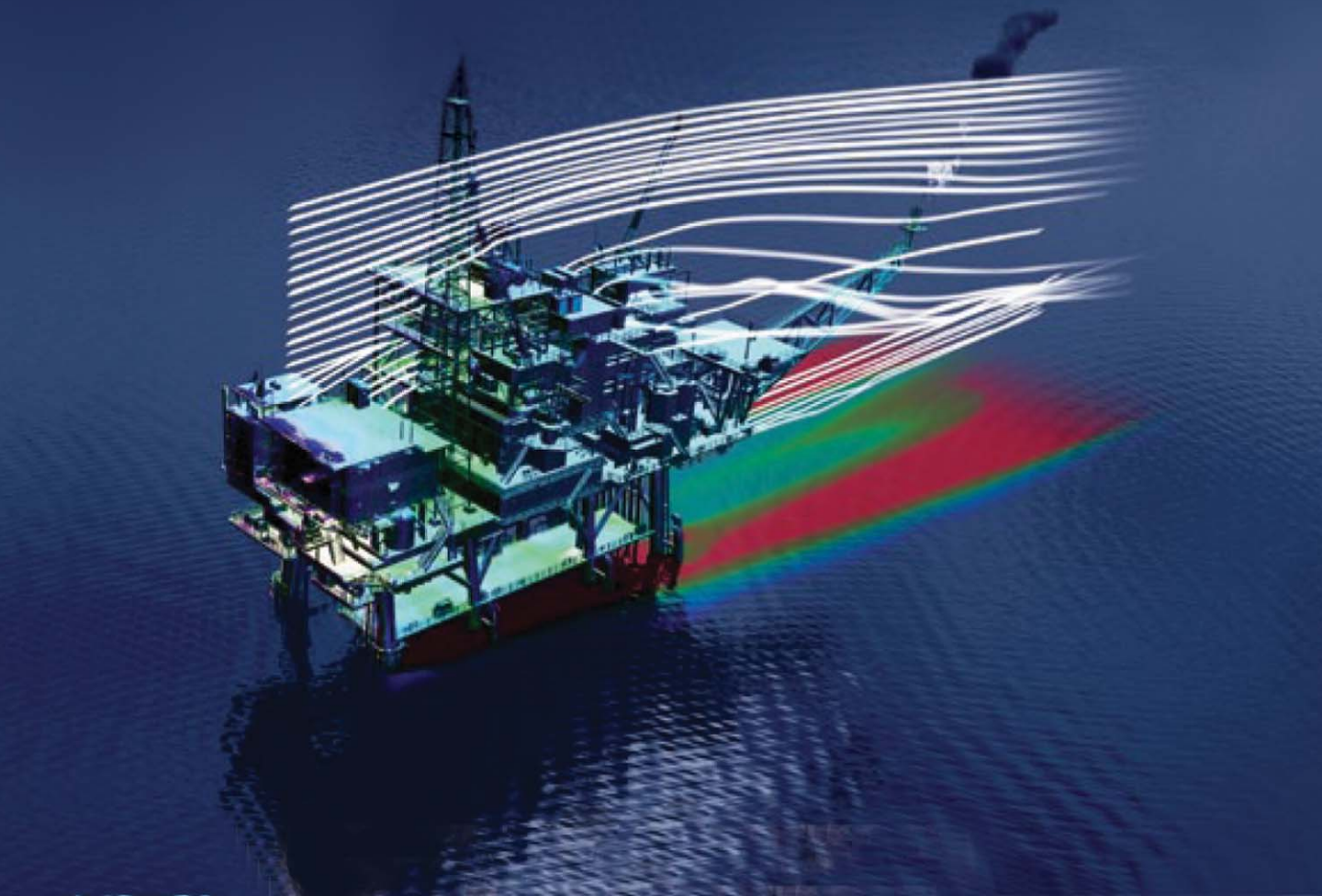
March 2013

Including DEW hr Supplement

1D & 3D Simulation

address deepwater flow assurance challenges

Generating combined 1D/3D simulations promises the best of both worlds: by making it possible to simulate complex systems of piping and equipment at a much higher level of accuracy



Reservoir modelling–characterising complex geologies and increasing oil

Tyson Bridger, Product Manager, Emerson Process Management

As oil & gas becomes harder to find and as operators look to new sources of supply while increasing recovery rates, 3D modelling of complex geologies will become essential to future development plans. This article looks at how Emerson, through its reservoir modelling software Roxar RMS, is accommodating complex geologies within the modelling workflow, while still making the workflow as easy to use, intuitive and as accessible as possible.

EMERSON. Process Management

Today's oil and gas operators are faced with two equally demanding challenges. They need to increase oil & gas recovery rates from existing and new fields, and — at the same time — they have to deal with increasingly complex geologies.

Average global recovery rates in the low 20% range are simply not sustainable as new hydrocarbons become harder to find and produce from. Yet, an increase of just 1% would potentially replace three years of global oil consumption.

Operators are working hard to meet this challenge. Norwegian operator Statoil, for example, estimates that it can increase its oil & gas reserves by 1.5 billion barrels of oil equivalent by 2020 through increased recovery rates and technology improvements.

Yet, just as there has been an increased focus on squeezing more from less and in extending the life of oil & gas reservoirs, increasing geological challenges have made the task more difficult.

Geologies such as those associated with salt tectonics, basalts, shale gas or complex carbonate reservoirs are becoming increasingly common as operators move further into frontier regions and look to different sources, such as unconventional resources, to keep up with growing energy demand.

So how are these twin challenges being tackled? One means of extending reservoir life, increasing recovery rates and tackling complex geologies is through reservoir modelling.

The Reservoir Model – A Default Platform

3D reservoir modelling is the default platform for mapping, understanding and predicting reservoir behaviour. A robust, reliable and accurate reservoir model that captures all the field's complexities can provide operators with the crucial information they need when developing assets, maximising production and extending the reservoir's life.

In the past, however, there has been a tendency to simplify such models – to look for compromise when coming up against geological complexities and reservoir heterogeneities in order to make it easier for reservoir engineers to interpret and navigate the modelling workflow.

There is a genuine danger, however, that reservoir models that oversimplify these obvious geological complexities are not going to be able to deliver the vital information operators require in making field development decisions and increasing recovery.

This article will look at how Emerson, through its reservoir modelling software Roxar RMS, is accommodating complex geologies within the modelling workflow, while still making the workflow as easy to use, intuitive and as accessible as possible.

Maximising Seismic

In order to have a complete understanding of the reservoir, it's particularly important that 3D and 4D seismic data is incorporated into the reservoir model. The better you can incorporate reservoir heterogeneities and extend the depth of the static modelling, the more accurate and realistic reservoir models are likely to be. 4D seismic is also highly effective in the mapping and monitoring of fluid

movements.

It was with this in mind that Emerson has incorporated increased seismic functionality into Roxar RMS, enabling 4D seismic data to be incorporated into the reservoir model alongside existing data types, such as geological, geophysical and simulation data.

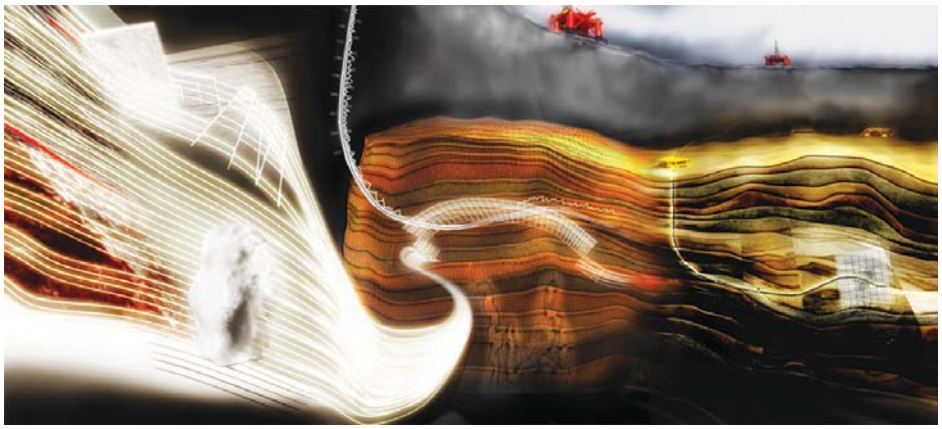


Fig.1

Roxar RMS also comes with enhanced facies modelling tools that help the user rapidly combine the latest 4D seismic surveys into the models to improve the quality of interpretations, structural and property models, simulation models, and well plans. The model can also be the basis for a more quantitative use of 4D seismic data, especially towards history matching.

Emerson's Roxar RMS 2012 (see figure 1), has expanded the software further into the geophysics domain with a new tool, RMS Seismic Inversion, which allows geoscientists to use seismic data to create rock property models quickly and accurately. High frequency information from well logs is combined with band-limited frequency information from the seismic data to provide a fast and highly automated seismic inversion tool.

Aligned to this in RMS 2012 is a powerful new visualisation toolkit, RMS Seismic Attributes, which enables modellers to extract maximum value from seismic by creating attributes that more clearly define reservoir structure and guide the user through the facies modelling process. Key features include new importing tools for SEG-Y data sets and the fast and accurate visualisation of seismic data sets of any size through interactive opacity control and colour manipulation capabilities.

Features such as these, which can help reservoir modellers and engineers better understand their seismic and their reservoir, are playing a key role in increasing oil & gas recovery.

Furthermore, just as 2012 has seen Roxar RMS include new seismic inversion and seismic attribute tools into its modeling workflow, 2013 will also see even more advances in seismic interpretation – creating a scenario where modelers will not only be able to generate accurate models, but also be able to quantify uncertainty as early as possible in the interpretation process and to levels and at speeds not seen previously.

Specifically, 2013 will see Roxar RMS allow multiple geological scenarios to be captured for seismic interpretation, as compared to conventional seismic interpretation workflows where thousands of individual measurements are created and then 'QC'ed to generate just one scenario. Based on the philosophy that more data does not necessarily make a better model, the latest 2013 version of Roxar RMS will also help interpreters get to a series of models faster than they would through traditional workflows

The Challenges of Salt

The ability to model beneath and around salt is also a key challenge to operators and reservoir modellers today – especially with offshore Brazil, the Gulf of Mexico, and offshore Africa all containing significant sub-salt and pre-salt discoveries.

Such salt areas are often characterised by poor visibility (with the oil sometimes under two kilometres of salt) and, although the presence of the salt has little influence on the evolution of the pre-salt play, it profoundly affects the ability to see the target and to map and understand the geometries.

In such circumstances, many reservoir models tend to compromise on common salt-related features, such as complicated overburdens, fault inter-relationships and overturned beds.

This is not the case with Roxar RMS, however, where the software can support complex fault modelling that other applications can't handle and incorporates these models into its advanced 3D gridding engine without simplification.

Additional modelling functionalities ideal for modelling around salt include the building of intrusion objects into structural modelling to better model salt, structural modelling tools that can

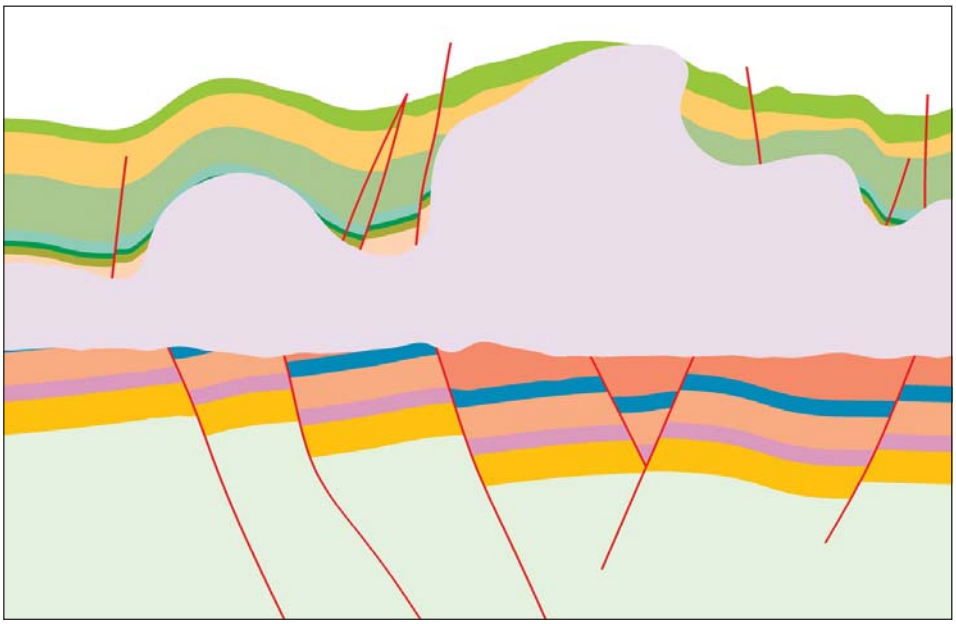


Fig.2

handle overturned un-faulted surfaces as well as diapiric structures resulting from the penetration of overlaying materials, and a new grid data structure. The resulting models are then incorporated into an advanced 3D gridding engine without simplification.

Figure 2 shows how Roxar RMS's structural and fault modelling capabilities can allow modellers to incorporate the entire geological section from target to surface and to handle it as a single entity. The illustration shows a cross-section of the full model, including the deformed post or supra-salt section (in green) and the deformed salt body (grey) sitting on the rifted and eroded pre-salt section (pink and blue).

Details of where the salt-based reservoirs are and how they communicate with each other require accurate model building to capture fault linkages and complex fault populations. And unlike many other software packages, Emerson's Roxar RMS doesn't look towards simplification.

The Challenges of Unconventional Resources

The growth in unconventional resources development is also asking more questions and creating new challenges reservoir modelling.

Take shale gas fields, for example – so prevalent in North America and also on the rise in Africa and Europe.

Many shale fields come with faults that can negatively affect fracturing programmes and reservoir formation, and also have complex fracture network distributions that make it difficult to distinguish between natural and induced fractures.

Aligned to this is the importance of horizontal drilling and stimulation. In order for a well to perform to its full potential, it is crucial for operators to remain in contact with the shale for as long as possible and, due to shale's low permeability, expose as much of the shale as possible to the pressure drop that allows the gas to flow in fracture treatment programmes.

In such circumstances, through reservoir modelling's ability to identify areas of structural complexity and map faults and fractures, it can provide crucial input to drilling strategies, fracturing programmes, well spacing, and the understanding of stimulated reservoir volumes.

Roxar RMS, for example, can help facilitate the quick importing of microseismic fracture data into the reservoir modelling, the characterisation and modelling of natural fractures, and the compiling of other data sources from petrographic, wireline and production data. The 3D grids, which are generated through RMS, can map variables quickly and accurately and populate the grid with formation properties, such as porosity, permeability and water saturation.

Furthermore, with the need to populate the model in mind, property modelling tools are able to represent heterogeneities in as many as three dimensions. Conceptual models, trends or seismic attributes can all be used to guide the distribution of rock types, permeabilities or any other parameters the operator wishes to model in 3D.

The latest fracture modelling developments within Roxar RMS have also led to fast-track fracture modelling functionality and to the generation of effective permeability maps based on the distribution of fractures and constrained by well tests — maps that can then be taken directly to reservoir simulators.

Today, fracture density maps can be generated through a number of different methods, including proximity to fault, curvature and stress models, allowing the easy integration of different principles of fracture formation.

Figure 3 illustrates some of the main steps of the modelling process within shale. From top left to bottom right, these include well log data analysis: static characterisation of fractures along the wellbore; an occurrence map of the natural fracture network (in the case of fault-linked fractures, the map is based on distance to nearest fault); and the target digitising process where RMS provides advanced tools to edit and monitor targets.

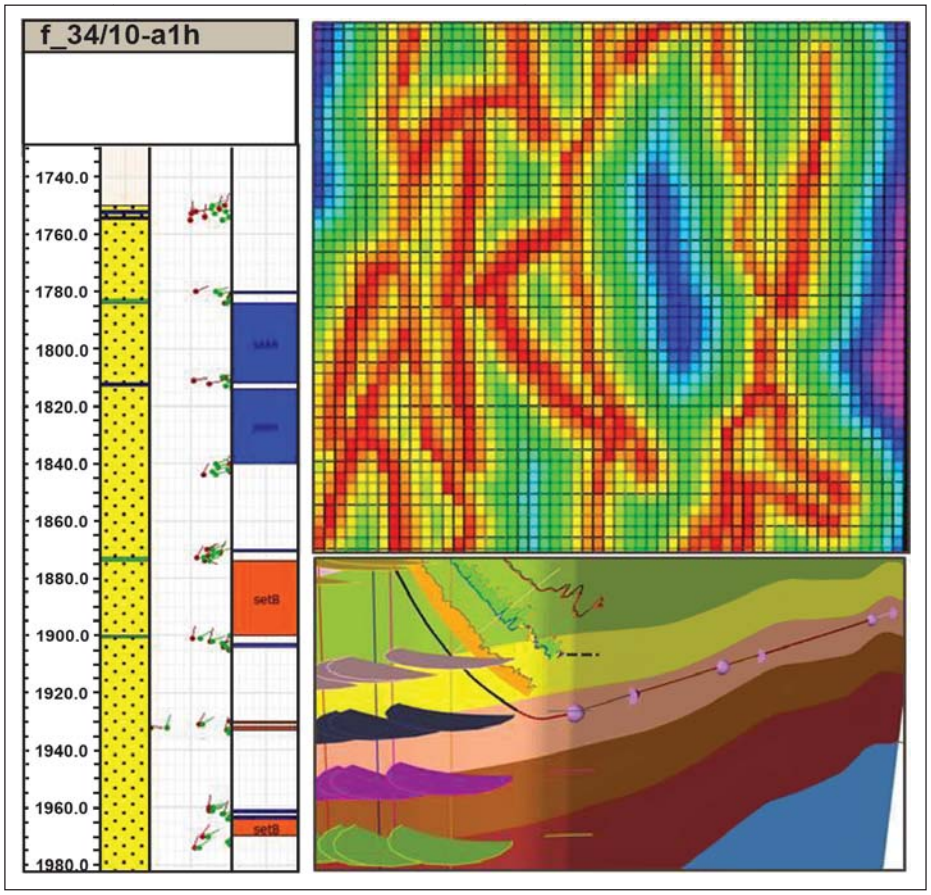


Fig.3

Roxar RMS also comes with a field planning module that is particularly applicable to unconventional assets such as SAGD (Steam Assisted Gravity Drainage) and shale gas fields.

RMS Field Planning enables modellers to quickly and accurately create multiple, optimal well plans for their fields. The tool can design multiple targets, optimise pad and target locations, and automatically generate well paths with user defined constraints – so important with unconventional assets.

Key features of the tool include increased flexibility in importing and exporting multiple targets in Comma Separated Values (CSV) format files; a Target Generator that enables modellers to create multiple copies of a target input with horizontal or vertical distance; the automatic generation of planned trajectories through a new Well Assignment Table; and three new data objects that can be visualised or interactively edited in 2D or 3D.

The result with all these tools is a robust reservoir model for unconventional resources that is considered to be a proper representation of the geology.

Modelling Complex Geologies

As oil & gas becomes harder to find and as operators look to new sources of supply while increasing recovery rates, 3D modelling of complex geologies will become essential to future development plans. Setting the standard will be reservoir modelling packages such as Roxar RMS that can leverage the seismic and accommodate complex geologies while ensuring the work flow remains accessible. dewjournal.com

about the author

Tyson is currently Product Manager within Emerson's Roxar Software Services division. Prior to joining Emerson, Tyson spent 20 years at Schlumberger, with the last seven years as part of the Petrel portfolio team where he was responsible for the business side of product development, outlining product strategy, business cases and high level functionality requirements. Tyson was born in the UK but grew up in South Africa. He began his career working as part of a land seismic field crew in South Africa.