JewelSuite™ – Changing the Way You Think about Reservoir Modeling

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by: O&G Next Generation

Making maps and models of the subsurface is the mainstay for establishing funding and operations of oil and gas producers worldwide. Over the past hundred years these maps and models (including the processes, data types and machines used in generating them) have evolved to attempt better understanding of the subsurface. Although each of the major subsurface geoscience disciplines (geophysics, geology and engineering) has made a great deal of progress within their own areas of expertise it seems that no-one has been overlooking the problem at the 30,000 foot level. Most critical field development and drilling decisions are still made without integrating the data and the human interaction and interpretation of the data. Moreover, most 3-d models or 2-d maps will not include the latest information from the field as it takes too long to incorporate it or the associated specialists needed to assimilate data into the 3-d model or map have been seconded to a "more important" project. Finally, it is expected that due to the demographics of the Oil and Gas Industry that these same seasoned specialists will be on the endangered species list soon. As costs for field operations escalate, the industry will need to consider different ways and means to make 3-d models more quickly, while at the same time incorporating all of the field data from all disciplines (both old and new) in order to maximize the effectivity of their field operations.

Historically, each discipline in the 3-d modeling and mapping business had people almost entirely focused on solving the problems associated with their specialty. For example, while the geophysical groups were busy modeling seismic anomalies in the time domain the flow engineers were making new grids that more effectively solved the problems associated with flow behavior. This software development environment led to what "best in class" type software which may have further separated the disciplines. With each discipline speaking it's increasingly specialized and sophisticated language and with little regard as to how other disciplines could use these new types of models and data to effectively solve production and exploration problems it is no wonder why most all decisions are made for the most part by "gut feeling". Indeed, the problem is analogous to business planning and business intelligence (BI) where disparate information with different quality levels (errors or emissions) within organizations needs to be combined to make more effective decisions.

A common component that all 3-d modeling, mapping and simulation software packages have in common is a gridding system. Most all of the gridding systems associated with each of the major disciplines was specifically designed to solve their unique problems. For example Pillar Gridding was developed as a means of letting geologists build 3 dimensional models quickly and efficiently. These same grids were sometimes totally incompatible or at least created significant inaccuracies with models "coming from" the geophysicist or "going to" the engineering groups or team members. With each discipline having their own software maps and or 3-d models (and made on purpose built grids for that specific problem) collaborative meetings that are held for the purpose of minimizing risk and maximizing productivity per well or for the field in total can be a total disaster. Typically, geophysicists bring their structural map(s) and 3-d models, geologists bring their stratigraphic map(s) and columns while the engineers bring fluid contact map(s) and flow models to each meeting. If the drilling is being done in geomechanically difficult areas a fourth discipline (drilling and completion engineers) brought their maps and concerns to the meeting as well. Collaboration and facilitation amongst the different maps, models and disciplines is at best difficult which in turn forces field development decisions to be made from a "gut feel" as opposed to a more enlightened risk analysis process.

Thanks to new tools built into and around JewelSuites flexible and familiar Windows interface all of the geoscience disciplines can now define, create and easily maintain up-to-date static and dynamic reservoir simulation models. The approach is facilitated through JewelSuites™ patented gridding technique which enables fast, accurate links to models and maps generated in purpose built applications while providing a framework to integrate the data into one consistent 3-d gridding technique. The grid and associated properties can then easily be passed and utilized amongst the disciplines.

This 4th generation Windows based reservoir modeling tool solves many of the important bottlenecks in today's multi-disciplinary reservoir modeling requirements, with emphasis on:

- Reducing model building model and update times by orders of magnitude
- Seamless data integration across disciplines
- An easy and intuitive interface that all disciplines can utilize for analysis of data and modeling (both static and dynamic) assumptions
- Handling of complex geological reservoir structures
- The Microsoft .NET framework based Software Development Kit (SDK) provides for the integration of custom software and purpose built specialist software in the form of plug-ins.

The main driver for the development of this new software is the shifting E&P market - where production of complex fields and heavy hydrocarbons has become increasingly important - thus requiring up-to-date reservoir models with a fast turnaround time in weeks instead of months. The JewelSuite™ vision, to build better and higher quality reservoir models, is realized by no longer focusing on 'best in class' for individual parts of the static and dynamic workflow, but to generate better insight on the total integrated reservoir model, referred to as *3 models in 1*: the geophysical model, the geological model, and the reservoir simulation model.

The solution to these problems is a new kind of pillar gridding, which combines the advantages of pillar gridding namely lower computer memory requirements and a regular ordering of stratigraphic layers, but overcomes the disadvantages mentioned above. There are two types of pillars in this grid: the vertical pillars and the pillars along the discontinuities like faults, intrusions or unconformities. The pillars along the discontinuities connect the vertical pillars. As a result horizontal surfaces can be modeled as a discontinuity and the gridding does not require that the fault block reaches the top or the base of the reservoir. Faults can also end in the middle of a reservoir without problem. No cell distortion occurs except along the discontinuities. The gridding process requires that discontinuity surfaces are truncated properly against each other and no holes are present. This is accomplished by computing the truncations lines from the edge of the surfaces in two directions. First from the inside direction to resolve any intersecting surfaces and then in the outside direction to close any holes.

The start of this static 3-d modelling process is typically the creation of what is called the structural model. Such a model will consist of a number of surfaces that represent the significant faults and horizons of a subsurface interpretation. The structural model establishes the water-tight framework in which a reservoir modeller will embed reservoir-scaled strata and reservoir properties. While this sounds like a simple problem, in practice it is quite difficult. The geometric and topological relationships of reservoir geology are quite complex in themselves, and the raw data provided by the typical interpretation system is generally either ambiguous or is inconsistent for the purpose of structural modelling. Approaches that rely on simplifying assumptions that prevent the modeller from accurately representing the complexity they see in the seismic are no longer acceptable due to the realities of trying to "squeeze" more oil or gas out of existing reservoirs. Obviously, much more detail would be required to accurately describe all the steps in an efficient and totally integrated geological modeling and reservoir simulation workflow. However, these details go beyond the space limits of this article. We simply intend to describe the main workflow to achieve a true Integrated Reservoir Modeling approach.

Typically, the next step in the reservoir modeling and evaluation process is building the simulation model. To ensure a consistent and integrated reservoir model throughout the modeling workflow, the same Gridding technology is applied to create the up-scaled reservoir simulation model, with identical geometrical representation. Once again the realistic and accurate representation of the geology, topology and geometry of the reservoir is present in the simulation model promoting total integrated, 3 models in 1, reservoir modeling. Due to the high degree of orthogonally of the up-scaled grid, and absolute lack of undefined or so-called squeezed cells, the ideal combination of geological modeling and reservoir simulation is created.

Through the integration of (3rd party) reservoir simulators such as Eclipse, CMG and Sensor, JewelSuite can connect the complex geology as present in the JewelSuite™ Grid geometry, the grid properties and well perforations to the reservoir simulation deck generator. This process allows for properly handling the polyhedral cells at the fault locations by computing the cell pore volumes and generating the non-neighbor connections across the fault surfaces. An important advantage of this method is consistent X and Y permeability values, resulting in more precise transmissibility calculations and reservoir simulation results.

To enable all disciplines to contribute to the reservoir modeling workflow loop, generic downscaling methods are provided. This allows mapping in 2-d or 3-d of any reservoir simulation property back to the higher resolution geological model or seismic volume. Quality control and collaboration of the reservoir flow simulation results with the upstream static models is easily and quickly accomplished. Having all disciplines involved in the modeling process allows for a collaborative environment and better insight into the reservoir and optimum use of the specialized talents and knowledge base within the organization.

A fundamental problem of geosciences is the creation of accurate 3-d models of the subsurface. We can send a man to the moon but we cannot send him to the subsurface ... yet!. That being said, we did not make a successful moon landing without significant collaboration and teamwork which the JewelSuite™ Grid enables.

More information

For more information about the presented integrated reservoir modeling methodology and automated structural modeling and geological modeling tools, please refer to the JewelSuite™ web site www.jewelsuite.com, or e-mail the authors at info@jewelsuite.com.