ISATIS SOFTWARE

Optimal reservoir volumes estimation with ISATIS, Software Package for the Oil & Gas Industry

Base your decision process on evidence

Reliable reserve estimation requires a top-quality risk assessment. To accurately evaluate the risks, a high-performance probabilistic risk analysis is needed. Modelling the reservoir using a geostatistical approach is part of this risk analysis as geostatistics provide several scenarios that can be ranked in term of risk, hence of cost.

Indeed, reserve classification is subject to uncertainties of various origins (irregular data distribution, erroneous data, multiplicity of data sources, fault mis-management, interpretation uncertainty, …). Therefore, people in the profession are strongly encouraged to use geostatistics to perform in-depth analysis of their data and make sure they get the best assessment of uncertainties to avoid any detrimental consequences when evaluating stocks.

Since 1993, French geostatistical expert GEOVARIANCES' ISATIS package has been meeting resource estimation challenges from industrial & consulting companies around the world. ISATIS provides the Oil & Gas Industry with all the geostatistical techniques in one single professional package so that they can find the appropriate methodology at each stage of the reservoir modelling cycle.

Among these techniques, the geostatistical simulations produce different possible scenarios of the reservoir geometry, but also of the geology and the petrophysical properties. Combining these different plausible scenarios in different ways means that we can obtain a series of plausible volumes for the reservoir and finally their distribution curve.

ISATIS offers the state-of-the-art Volumetrics application. By combining the different possible realizations of the top and bottom surfaces depths and of the petrophysical properties, it allows to derive local and global statistics:

- maps of the maximum, the minimum, the mean or the standard deviation of the thickness of the fluid
- quantile maps and probability maps
- risk curves.

Getting reliable and accurate horizon depths: Time-to-depth conversion and structural modelling

Assessment of volumes uncertainty, whatever the volume considered (GRV, HCPV, IGIP, STOIIP, HIIP), is a key issue in hydrocarbon resource evaluations across the exploration-appraisal-development cycle. Uncertainties are all the more important since seismic data quality is poor and the reservoir structure complex. Mapping top reservoir in time and depth is then inevitably source of great uncertainties.

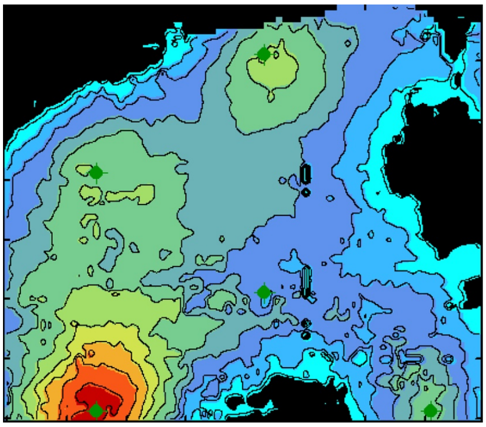

Figure 1. Depth map from regression gridding (red colour is low depth)

In practice, because of many factors, deterministic techniques such as regression or velocity inversion are used. The use of deterministic techniques can have a tremendous influence on the decisions made at the different stages of a project. Conversely the use of geostatistical techniques which are based on well-known methods allow practitioners to use at the best the available data.

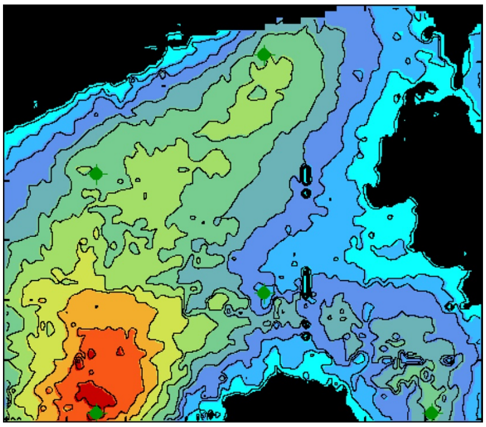

Figure 2. Depth map from Collocated Cokriging Gridding (red colour is low depth)

The main advantage of geostatistics is that it is a model-based approach, which incorporates the spatial structures of the different data (wells and seismic). Optimal results can then be obtained because geostatistics has for objective to minimize errors (through kriging techniques) and to reproduce the spatial trends of the top reservoir depth.

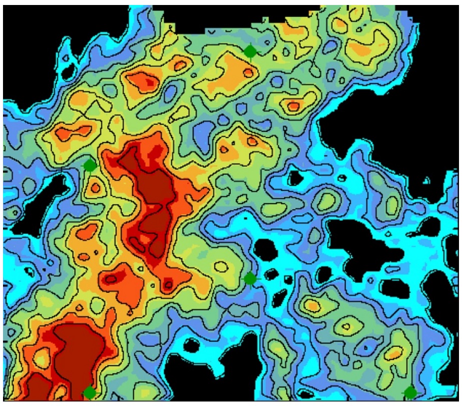

Figure.3 Depth map from one geostatistical simulation (red colour is low depth).

The basic output from a simulation is also a depth map: one can see that this simulation map is much more variable than any map which could be obtained with gridding techniques (figures.1 & 2). The reason for this is that simulations aim to reproduce the spatial variability and connectivity characteristics of the depth of the layer. Possible continuous oil path and oil traps from the lower left corner to the upper middle part of the reservoir can now be seen.

ISATIS provides several multivariate kriging techniques (co-kriging, collocated co-kriging, kriging with external drift) that can be applied to various types of fields. Their key benefit is that the resulting structural model not only ties to the wells but also reflects the inherent spatial behavior of the seismic information. This is possible because the geostatistical working framework allows the user to take the natural correlation between seismic and well data into account.

Figures.1 and 2 show two depth maps obtained with ISATIS, respectively by regression and geostatistical Collocated Cokriging where 5 wells were available. Both techniques use seismic Two-Way-Time and stacking velocity maps as the seismic information to improve the depth gridding.

Only the geostatistical technique (figure.3) is able to reproduce the trend and the continuity in the structure of the different low depth (pale green to red colour) part of the reservoir. Knowing the connectivity between the different part of the reservoir allowed to optimise production.

Stochastic simulations extend these techniques and constitute a powerful tool to characterize the uncertainty attached to a model of the reality obtained by kriging. By providing a range of iso-probable realizations, they allow to compute probability of occurrence, quantify the uncertainties and assess their impact on depth distributions.

ISATIS offers easy access to appropriate techniques of simulation based on the Turning Bands algorithm (block simulations, simulations with external drift, collocated co-simulations) or on sequential techniques like the Sequential Gaussian Simulations.

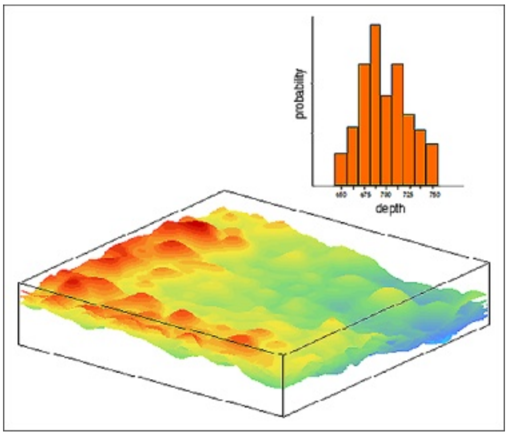

Figure 4. Stochastic simulations allow to compute several realizations of the depth, hence to estimate the minimum and maximum depth of an horizon.

Getting a realistic model when geology gets complex: Facies modelling

High-resolution geological modelling requires the integration of multidisciplinary data (depth converted seismic horizons, fault planes and stratigraphic information) issued from boreholes, cores, seismic, and outcrops used to parameterise the geometries and facies of the depositional environments.

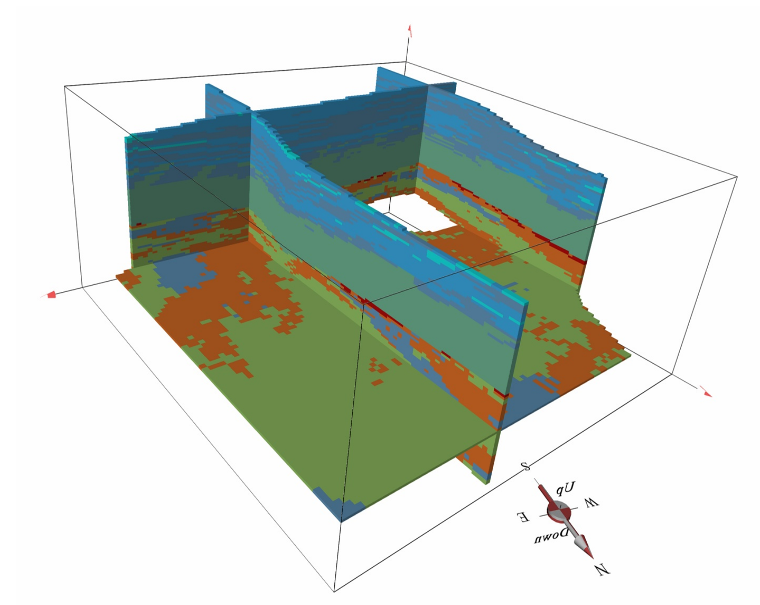

Figure 5. Example of Plurigaussian Simulations with ISATIS (displayed with ISATIS 3D Viewer)

ISATIS is designed to process them all and offers several well-known simulation techniques to model the reservoir geology according to the amount of available information and the reservoir complexity (Boolean Simulations, Sequential Indicator Simulations, Truncated Gaussian Simulations, Plurigaussian Simulations).

Among these methodologies, the Plurigaussian Simulations are specifically designed to model complex reservoirs with different structure orientations and heterogeneous deposits (channels, reefs, bars, …) since they provide realistic and detailed images of reservoir geology and internal structure.
This advanced technique may be used in the final stage of field development for which a precise reservoir model is required in order to identify possible bypass oil and optimise the drilling of wells. It is also successfully implemented when dealing with marginal fields which particularly need state-of-the-art technologies to minimize the risks.

Getting an accurate and reliable property model

Benefiting from the correlation between petrophysics and seismic attributes, multivariate kriging techniques allow petrophysical properties to be constrained to a set of facies that realistically depict the geological conceptual model while honoring the well and seismic data.

This is all the most important that this has an impact on the time required for effective history matching during flow simulation.

The same principle is applied to the simulations which are used to produce many similar images of the reality, allowing optimistic and pessimistic scenarios to be derived in an optimal way.

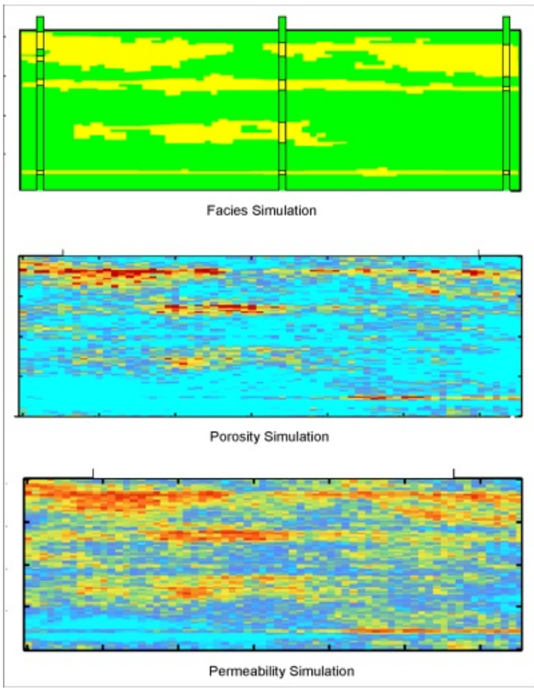

Figure 6. Facies simulations are used to condition the simulations of petrophysics.

Assessing the reservoir volumes with ISATIS state-of-the-art Volumetrics functionality

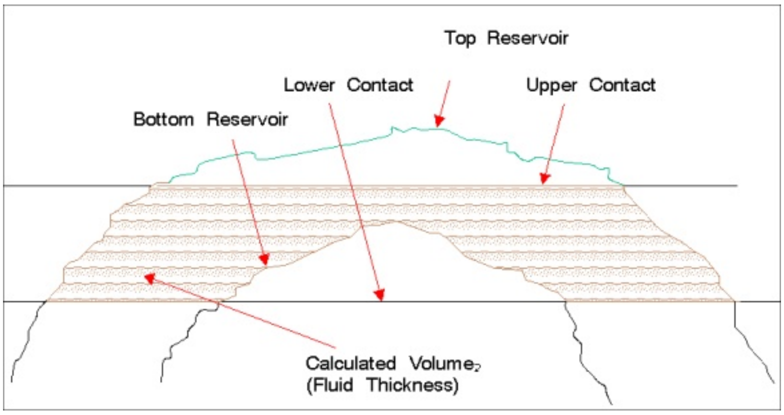

Figure 7. All the variables involved in hydrocarbon volume computations are freely combined in ISATIS Volumetrics application for optimal risk assessment.

Probabilistic analysis involves describing the full range of possible values for each unknown parameter. The results of horizon and petrophysics simulations ultimately end up in ISATIS Volumetrics functionality allowing for valid construction of a probability distribution function of volumes whatever this volume is GRV, HCPV, STOIIP or GIIP. From such distributions, pessimistic, most likely and optimistic scenarios (P10, P50 and P90) can be selected and delivered for flow simulations.

ISATIS Volumetrics strength lies in the way it combines in a totally free manner the involved variables (horizon depths, fluid contacts and petrophysics) and enables the computations of a large number of possible results. Each parameter (surfaces, fluid contacts, petrophysics) can be considered in turn as a constant value, the result of a kriging process or of a simulation process so that a fine analysis of the impact of such and such variable on the risk quantification can be achieved.

It also offers the possibility to combine one realization of a variable with a realization of a second variable according to specific rules taking into account the rank of the simulation realization. At last, calculation of volumes may be refined by zones, facies or stratigraphic units.

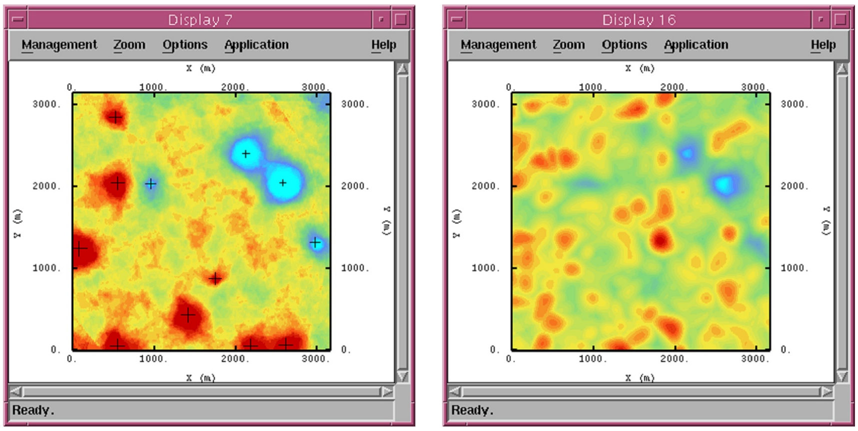

Figure 8. Example of statistical results derived from ISATIS simulation post-processing : probability depth to be above Oil Water Contact (a), means of the 30% lowest depth values (b).

Conclusion

With ISATIS, you get a risk indicator through the E&P cycle.

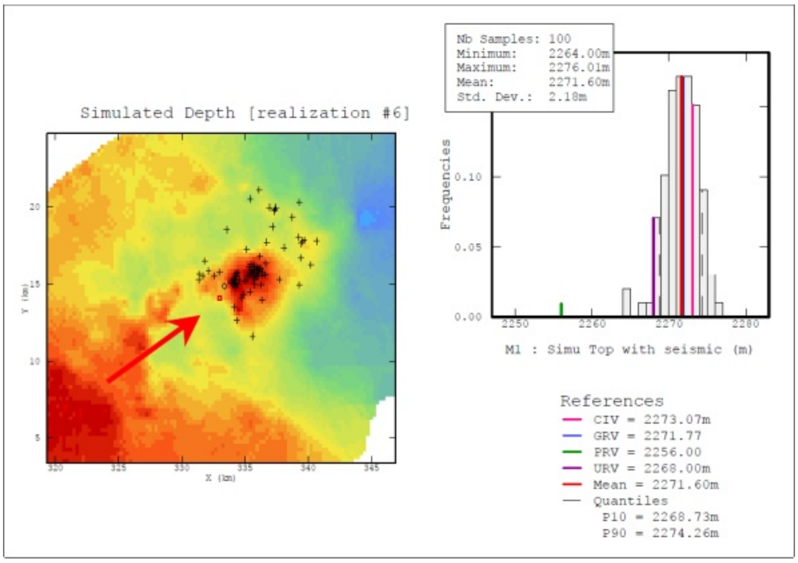

Figure 9. The histogram of 100 simulated depth values at the red square location is displayed, together with basic statistics, P10 and P90 quantiles. Moreover, values of particular interest may be displayed on the histogram.

Valuable information on the variability of key parameters can be obtained from geostatistical simulations. With ISATIS Volumetrics application, uncertainties on volumes may easily be derived from these simulations.
However, Volumetrics is not the only application dedicated to risk analysis in ISATIS. Statistical calculations on the various simulations allow to obtain iso-probability closure maps, quantile maps and risk distribution curves allowing the quantification of the uncertainties in drilling a new well, in locating the spill point and in volumetrics.

A specific tool for detailed analysis of the local distribution of the simulated values is also available. Such local statistics improve:
- the quality control of simulations
- the possibility to validate the simulations on new well locations
- the aid in accurate geosteering.

Using ISATIS, decision is made according to a fully quantified risk calculation.

ISATIS is a trusted solution which ensures that people make the best use of all available data to get optimal and reliable images of the reality. This is all the most possible as ISATIS full connectivity with usual market file formats and its interfaces with standard reservoir modelling packages (GOCAD™ from Paradigm, PETREL™ from Schlumberger and the RML™ from Beicip-Franlab) makes the software an incomparable tool for data integration.

More info on www.geovariances.com.