Quantifying local uncertainty using map-based monte-carlo workflow in Petrel

Dr. Aurelien PIERRE
Suncor Energy Inc.
Jonathan FREPP
Synergraze

Summary

Bond et al. 2002 summarized that the extent of the resource overestimation problem was first brought to light at the 1995 AAPG Hedberg Conference, which was dedicated to petroleum risk management. MacKay (1996) presented the issue, and Otis and Schneidermann (1997) provided an early glimpse of Chevron's poor predictive accuracy of resource estimation before their commitment to an assurance initiative. Harper (2000) described similar resource overestimation problems at BP, particularly in relation to their exploration of deep-water prospects, which were investigated with their most advanced predrill technologies. More recent publications (Ward and Whitaker, 2016; Milkov, 2017) and presentations (Bagley and Bond, 2018; Søiland, 2019) suggest that accurate resource estimation remains a challenge.

These authors worked on techniques for resource estimation widely used in E&P. For exploration, Gross Rock Volume is often calculated by integrating areas from area depth plot. Software like GeoX or REP estimate the uncertainty from area uncertainty (assumptions or surfaces shift). It assigns a global mean value for properties and performs Monte-Carlo simulation, which is good for volume range and provides very fast computation (few seconds per 10,000 cases). However, it does not account for local variation of properties and local variations of uncertainty once reservoir formation is penetrated by at least one well.

Current problem

Spatial uncertainty is rarely quantified although it is almost always the case to have data rich well-known area and poorly understood area for any subsurface evaluation.

Our solution

With a modern geomodeling software and the improved computing time (thanks to cloud-computing), we developed an automated workflow to quickly assess uncertainties. The workflow tools allow to run simple 3D models using hundreds of maps to calculate uncertainties by performing Monte Carlo type simulation. It provides uncertainties maps for all input parameters such as facies, porosity, saturation and Gross rock volumes as well as for output parameters (stooip..).

In more details, uncertainties ranges distribution can integrate structural uncertainty from software like Udomore or Isiatis, reservoir facies and porosity distribution using stochastic algorithms, , saturation using cloud transform... These uncertainty ranges are materialized by generating 100's of maps for each parameters using tailored stochastic workflows.

For facies distribution, main streams orientation and width of channels can vary. For the presented example, we will show how local uncertainty can be better quantified when statistics, and geological concepts are combined using stochastics workflows.

Conclusion

This fast process provides a range of map outputs that help capture uncertainty spatially, identify areas of upside potential, screen development opportunities, and evaluate volumetric ranges on appraisal and development projects. It is particularly useful for fast paced business development activities.

Acknowledgements

The authors want to thank Harouge and Suncor for the authorization the present this work.

References

Bagley, G., and M. Bond, 2018, Prospect risking and volume benchmarking using Wildcat data: London, United Kingdom, Westwood Global Energy Report, 29 p., accessed January 22, 2019

Bond, M. Citron, G. P., and Weaver, D.; Recommended practices in exploration assurance. *AAPG Bulletin* 2022;; 106 (12): 2339–2349

MacKay, J., 1996, Risk management in international petroleum ventures: Ideas from a Hedberg Conference: AAPG Bulletin , v. 80, no. 12, p. 1845–1849,

Milkov, A., 2017, Integrate instead of ignoring: Base rate neglect as a common fallacy of petroleum explorers: AAPG Bulletin , v. 101, no. 12, p. 1905–1916

Otis, R., and N. Schneidermann, 1997, A process for evaluating exploration prospects: AAPG Bulletin , v. 81, no. 7, p. 1087–1109

Rose, P. R., 2012, Risk analysis and management of petroleum exploration ventures: AAPG Methods in Exploration 12, CD-ROM, 164 p.

Søiland, G., 2019, YTF – Statistical analysis of 1700 prospects and leads: Stavanger, Norway, Norwegian Petroleum Directorate, 42 p., accessed January 21, 2021,

Ward, G., and S. Whitaker, 2016, Common misconceptions in subsurface and surface risk analysis: 78th European Association of Geoscientists and Engineers Annual Technical Conference, May 30–June 2, 2016, SPE-180134-MS, 19 p.,