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Integrated Earth Modeling Technologies: Achievements and Challenges

O. Dubrule* (Total E&P)

SUMMARY

Multi-disciplinary teams have been one of the major developments of the industry in the last twenty years. Technology has supported this evolution of our industry through the game-changing development of 3-D Integrated Earth Modeling, including geostatistical modeling tools, multidisciplinary data integration algorithms, or innovative approaches for quantifying uncertainties associated with Earth Models.

This paper first provides a review of the status of some of the above technologies that have made most progress in the recent years. Some of them have already found a large number of successful industrial applications, others are very promising but have not quite made it into mainstream operations. Multi-point statistics techniques, which incorporate more geological input into geostatistical models, will be discussed first. Then current approaches related to geostatistical inversion of seismic data, and their very successful recent developments, will be covered. For Dynamic Data Integration, Ensemble Kalman Filtering (EnKF) has attracted great interest from academia, resulting in promising developments, but History-Matching applications in companies often remain more basic than those promoted through EnKF. Last but not least, there is still a lot of debate about the best approach for quantifying uncertainty without underestimating it.

From a slightly different perspective, we will also discuss the risks potentially associated with the availability of sophisticated Earth Modeling modules. In a professional context where geoscientists have less and less time to perform modeling studies, Earth Modeling tools incorporate more and more sophisticated algorithms, based on more and more complex assumptions. User interfaces are also made simpler and simpler thanks to the progress of computing languages. As a result, geoscientists are in a very difficult situation to appreciate the weight given to the data they use and the validity of the underlying or implicit assumptions made by the algorithms. In spite of this, the Earth Models they produce are used for flow simulation and resulting economic calculations that will serve as a basis for billion-dollar development decisions.

In conjunction with the developments in the methodology used and the software interfaces, it is crucial that the training of geoscientists goes beyond the pure theory or the simple understanding of a push-button user guide. Geoscientists must be made aware of the fundamental assumptions and concepts they use, especially in relation with the weight given to different kinds of input data or the fundamental quantitative geological concepts used through various geostatistical modeling algorithms.