

## **Subsurface Risk and Uncertainty Assessment In Petroleum Exploration—The Challenges**

By

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The assessment of risk and uncertainty in oil and gas prospects, plays, basins, or petroleum systems has always presented major challenges. Appropriate model(s) must be described in order to make assignments of the natural variation of geological properties of prospects and contained fluids. Difficulties of description arise through lack of data and uncertainty introduced by the processes or tools of data acquisition.

Historically, a variety of methods have been used to estimate the chance of a hydrocarbon accumulation and a range of discovery volumes. Methods have depended on the data and volume description tools available and corporate culture. Where data were sparse, experts have been used for their opinions. Analog methods have been based on geological characteristics of external areas that are considered comparable to the acreage under exploration. Forecasting uses past history, for example creaming curves, where past discovery volume performance is projected into the future. Specific data inputs for prospect and plays have been used in decision matrices, one off calculations, one-dimensional probability distributions in Monte Carlo estimations, two-dimensional geostatistical descriptions, and three-dimensional estimates of interpreted seismic bodies.

One-dimensional probability based methodologies have enjoyed popularity over the last three decades, particularly in major companies. Expectation curves of volumetric outcomes contain numerous equally probable outcomes in which it is necessary to identify the key risks and uncertainties inherent to the prospect.

All methods have the problem of bias. Knowledge bias arises related to experience in specific basins and the expertise of individuals. Bias can also arise because knowledge is tacit rather than explicit within a group of explorers. Model bias can color evaluation approaches and decisions, and inhibit flexibility to tackle surprising outcomes when drilling. Data bias arises from sampling and modeling of distributions and the human tendency not to perceive distributions beyond the sample data. Data presentations although correctly stated may be misleadingly presented to decision makers. Decision makers may also apply a bias of their own.

No one method is appropriate for all situations as each has particular advantages and disadvantages. Volumetric assessment requires methodologies that are mutually cross challenging. Processes must be explicit, transparent, and systematic while utilizing and capitalizing on the knowledge and data available. Peer challenge is vital. A documented audit trail must be constructed such that feedback loops allow optimum learning and calibration of results.