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Abstract

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Subsurface Risk and Uncertainty Assessment in Petroleum Exploration-The Challenges

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 was sparse, experts have been utilised for their opinions. Analogue methods have been based on geological characteristics of external areas that are considered comparable to the acreage under exploration. Forecasting utilises 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 colour evaluation approaches and decisions, and inhibit flexibility to tackle surprising outcomes when drilling. Data bias arises from sampling and modelling 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 utilising and capitalising 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.

Ways of Working and Organization in Exploration

During the last three decades the world has seen significant changes in organisational structures which have had their impact on petroleum exploration units. Command and control structures with strong hierarchies and vertical functional structures have been replaced by flatter organisations. Informal networks critical to the functioning of the organisation were often lost in the process of change. Consequently, organisational structures have developed which formalise critical networks and which emphasize

organisational and individual learning, and sharing and development of knowledge in an explicit manner as a prerequisite of meeting goals.

Effectively, there is no two-dimensional way of describing such an organisation. A single (published) diagram of an organisation can be confining. It encourages behaviours and a culture specific to the relationships exhibited by it and can discourage other desirable behaviours and cultures. An organisation can be viewed as

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a kaleidoscope of networks and frequently some or all people wear more than one hat according to their knowledge and skills. A snapshot at any moment may reveal people working together, adding value and knowledge on prospects and leads, at another fostering and improving their skills, at another developing and facilitating processes, or improving ways of working in self-managed teams.

While there is no specific formula or shape for such an entity the concept can be described as a 'Transformer Organisation' with the capability for its people to realign

themselves into patterns in order to meet any challenge by the external business environment. In an exploration organisation the ability to reorder, renew and disband teams in anticipation of new and changed priorities would reflect such an organisation. This requires an awareness of the total skill complement of all individuals including critical gaps in relation to goals of the exploration unit. A learning culture is vital, including ability to absorb critical lessons for guiding future activity. In small- or medium-sized exploration entities, where the people resource is constrained, such ways of working maximise effectiveness.

Gordon Knox

Education:

1968 University College, University of London, UK, B.Sc (Hons) Geology
1972 University of Liverpool, UK
Ph.D Geology

Experience:

1971 to 1999 Acquired 28 years international experience with Royal Dutch/Shell group, exploring for oil and gas in a broad range of locations. Experience included working and residing in the Netherlands, Nigeria, United Kingdom, New Zealand, Thailand, Sultanate of Oman and Australia. Regional advisory roles were held for African, Middle Eastern, and South Asian basins and in risk and uncertainty assessment of prospects and leads globally. Work environments included land and marine operations,

head office and research and technology centres. Held a variety of positions including Research Geologist, Team Geologist, Chief Geologist, Regional Geological Advisor, Research & Technology Manager, Exploration Manager. Author of several publications. Exploration Consultant with particular interest in risk and uncertainty assessment in petroleum basins and prospects. Visiting Lecturer in Applied Geology at the University of Malta, Malta. Associate consultant with Zawiyah Associates, London, UK

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