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Including Geological Uncertainty and Economic Analysis in a Rapid Simulation of Hydrocarbon Exploration

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Manly's approximation method has been applied to hydrocarbon discovery process modeling in order to approximate the expected value and the standard deviation of the total discovery volume for a given exploratory effort. A major benefit of this method is that it allows the model to run much faster than the regular simulation method, yet it gives accurate results. This paper extends the benefit of Manly's approach by allowing the approximation method to incorporate the uncertainties in geological parameters that drive Manly's approximation, in order to provide an approximation of the complete distribution of total discovery volume that can result from exploration activity. In addition, it allows the model to include economic parameters into an evaluation of the economic worth of the results of exploration activity, producing distributions of net present value within a short period of time. The offshore Nova Scotia Shelf Basin is selected for demonstrating the methodology.

KEY WORDS: Probabilistic model; Manly's approximation; field-size distribution; number of fields; Nova Scotia Shelf.

INTRODUCTION

There are tremendous financial risks attached to exploration for hydrocarbons in frontier regions because of the high uncertainties in geological and economic factors. Therefore, it is essential for a company to try to assess the potential results of future exploration before making a decision to explore any region. An inadequate appreciation of the uncertainties in geological and economic parameters can lead to misjudged policies, costly exploration failures, and other severe consequences for oil and gas companies.

To cope with these uncertainties, various techniques based on different approaches have been developed and are being used to forecast future hydrocarbon discoveries in an effort to reduce the risk. These approaches range from the basin and play level of analysis to continental aggregations and from detailed structural and process models to simple extrapolations and curve-fitting. They also range from geologic-based attempts to estimate the *in situ* resource base to the economic based estimates of supply (Power and Fuller, 1992). These techniques provide systems for evaluating the future discoveries of hydrocarbons and economic outcomes. However, some of them do not yield objective quantitative appraisals, because they involve an intuitive blending of geological qualities and subjective weighting qualities. Some do not allow for quantitative assessment of risk and uncertainty in hydrocarbon exploration and cannot account for other possible reserve levels and economic uncertainties.

A probabilistic model of the hydrocarbon discovery process has been accepted widely from the 1970s for evaluating the future discoveries of hydrocarbons because of its capability of incorporating specific geological, technological, and economic attributes of the process of exploration. A precursor of this probabilistic model was the work of Arps and Roberts (1958), who

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