Discussion of Reserves and Probabilities—Synergism or Anachronism?

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Cronquist's concise discussion of the deterministic and probabilistic methods of reserves estimation in "Reserves and Probabilities—Synergism or Anachronism?" (Oct. 1991 *JPT*, Pages 1258–64) explains some of the problems facing the modern evaluator. As Cronquist explains, these problems result partly from the changing face of the petroleum industry, away from the mature geologic settings and operating areas (such as the U.S.).

Having been associated in the international sphere (with no inherent biases toward either method), I have noticed a trend toward the probabilistic method over the past few years. I suggest that a probabilistic approach is more suitable in today's environment for the following reasons: to evaluate the "undiscovered" portion of the resource base on the same basis as reserves, to try to reduce the effects of biases between different technical functional groups, and to acknowledge the fact that the skills base of the modern manager has become more financial and managerial than technical. Let me discuss each of these points in turn.

1. It is common practice for explorationists to use the probabilistic method to estimate undiscovered portions of oil and gas resource bases (**Fig. D-1**). Obviously, this is useful because of the relatively uncertain nature of such variables as trap and seal.

In the current divisions proposed by the Soc. of Petroleum Engineers, World Petroleum Congress, and others, a boundary is established between the volumes that are considered to be currently economically recoverable (reserves) and those that are not. Thus, a classification scheme, following McKelvey's[1] work, that could include prospects, leads, fields, and productive fields using similar evaluation methods would be useful.

2. Biases also are apparent between reserves estimations undertaken by different groups, who often use different criteria. This can cause perceptions to change over time, making development planning, design, and financing difficult. **Fig. D-2** shows a typical example of how reserves can change through time.

As Cronquist points out, the deterministic "proved" reserves often are not suitable for planning. This causes problems because different groups have different views of reserves. For example, the financer, the explorationist, and the engineer all see the reserves differently. This can result in a situation like that shown in Fig. D-2 where the facilities engineer is given reserves (option based on financing reserves) that do not allow him to build facilities efficiently.

3. One of the changes that I have observed is the backgrounds and experience levels of modern decision makers or managers. In the past, managers (the end users of reserves estimates) had an intimate knowledge of at least some of the parameters in an evaluation. Modern managers often cannot draw upon appropriate skills to risk these parameters themselves. Because of a lack of knowledge about the uncertainties of the input variables, the manager often cannot realistically compare estimations from different technical groups, especially when it comes to raising or supplying funds for exploration or field development.

The probabilistic approach is often preferred because it yields a probability distribution from which *both* "proved" and "expected" values can be derived with a consistent and well-defined procedure. The calculated distribution is subjective, but it is for all reserves estimations. However, the probabilistic approach is the only way to quantify systematically the range of uncertainties involved and is considered by many to be superior to the sometimes vague and noninterelatable proved, probable, and pos-

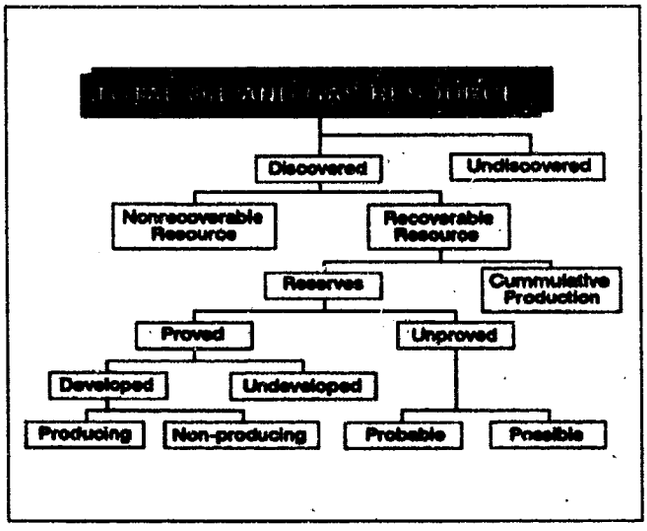

Fig. D-1—Oil and gas resource base.

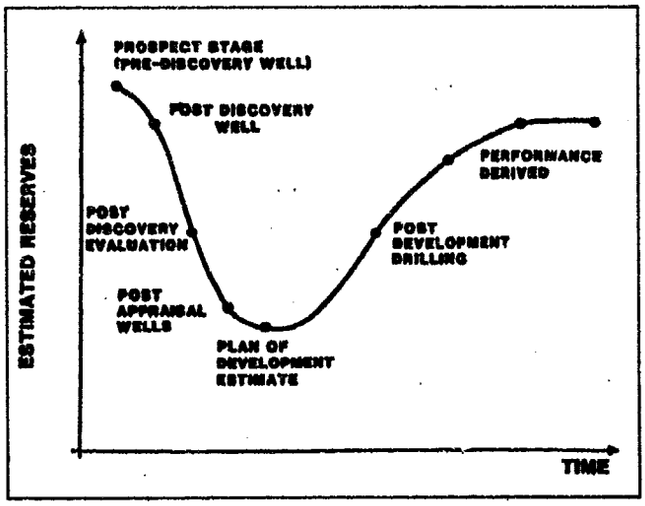

Fig. D-2—Example of changes in reserves estimates during the life of the field.

sible categories, as well as the "undiscovered" portion.

The probabilistic method is often prone to abuse because of the selection process of input parameters. Types of distribution are critical but are frequently "lost" in the reporting process. It is also difficult to duplicate results when probabilistic methods are used.

Throughout the life of a petroleum resource, there will always be uncertainty in the basic data and resultant volume estimates. Volume calculations with the deterministic method rely on single point (best guess, most likely, or average) values for the basic input data and variables, especially in the assessment of proved volumes. Thus, much is left to the assessor in estimating the single point value. Also, multiplying the most likely input values almost never generates the most likely value of the resource volume. Thus, the deterministic method can lead to resource volumes that are substantially in error. Also, deterministic volumes do not indicate any probability of occurrence, which makes it difficult to make management decisions based on these estimates.

An assessment of the sensitivity of a resource volume to changes in input variables, over their likely ranges, is essential if optimal management decisions are to be made. This is especially important in exploring new ventures and field development planning, where the risk of exposure to financial loss must be weighed against the magnitude and probability associated with the potential reward. The most convenient way to express this sensitivity is to make use of the expectation curve technique and stochastic methods in general, especially with the increasing availability of computer power.

However, no matter which method of calculation is used, the quality of the input data depends on the appraiser's skills. There is no panacea.

References

1. McKelvey, V.E.: "Concepts of Reserves and Resources," *Methods of Estimating the Volume of Undiscovered Oil and Gas Resources*, John D. Haun (ed.), AAPG, Tulsa (1975).

(SPE 24316)