The Reality of Reserve Growth

Between 1995 and 2003, reserve growth from existing fields worldwide added three times more oil to conventional reserves than new field discoveries[1]. Estimation of future reserve growth will be a critical factor for energy resource analysis.

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Reserve growth is the increase in successive estimates of recoverable crude oil, natural gas, and natural liquids in discovered accumulations.

Such increases have been observed in almost all existing fields, with large fields in mature petroleum provinces generally having the largest relative gains. In these mature petroleum provinces, the contribution from reserve growth in existing fields increases over time while that from newly discovered fields decrease. For example, reserve growth is the most important source for additional reserves in the United States.

In 1960, Arrington[2] was probably the first to publish a method to model or estimate reserve growth. In 1994, Attanasi and Root[3] were the first to attempt to forecast the growth of oil and gas fields for the conterminous United States. Since then, interest in reserve growth has been gaining momentum, more so in recent years as petroleum experts around the world speculate on the remaining oil and gas reserves. Accordingly, understanding and evaluating this growth is a critical component of energy resource analysis.

As part of the U. S. Geological Survey's (USGS) domestic and international assessment projects, an extensive study has been initiated to evaluate and develop reserve growth models for all major petroleum provinces and countries around the world. The goal is to make better estimates of future reserve growth potential.

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Influencing Factors

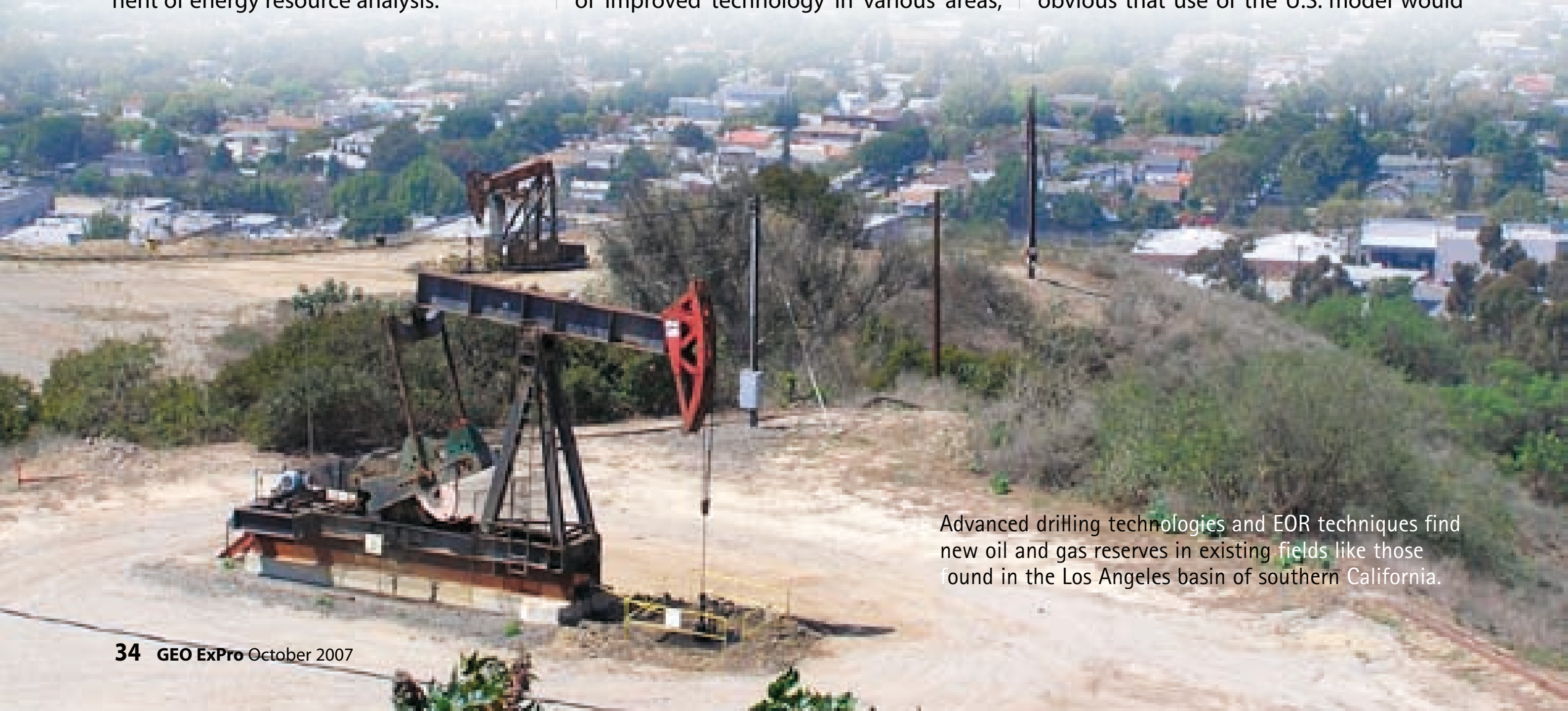
Reserve growth results from five main factors: 1) additional reservoir and geologic information leading to an increase in in-place-hydrocarbon volumes in existing reservoirs or pools; 2) discovery of new reservoirs or pools in the existing fields; 3) improvements in recovery factor owing to better understanding of reservoir characteristics and behavior through use of improved technology in various areas, including better logging techniques, horizontal drilling, and reservoir simulation; 4) application of enhanced oil recovery (EOR) methods; and 5) economics.

Of these factors, the application of the EOR process has probably contributed the most to reserve growth. Of all the EOR processes, thermal recovery and carbon dioxide injection are technically and economically the most successful processes (Figure 1)[4].

Although other factors (reserve reporting policies, proximity to infrastructure and oil/gas prices) impact reserve growth, the quantification of their impact is difficult. Therefore, most studies have focused on evaluating the reserve growth sensitivity to geologic and reservoir engineering parameters.

Models

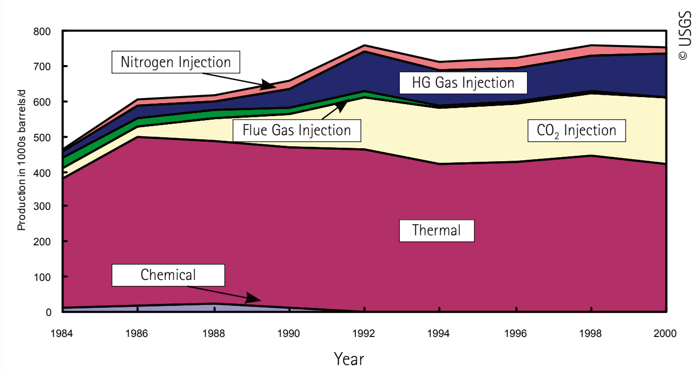
The first attempts to estimate reserve growth potential for countries outside the United States used reserve growth functions developed for U.S. fields. However, as more data were collected from other oil provinces around the world, it became obvious that use of the U.S. model would



Advanced drilling technologies and EOR techniques find new oil and gas reserves in existing fields like those ound in the Los Angeles basin of southern California.

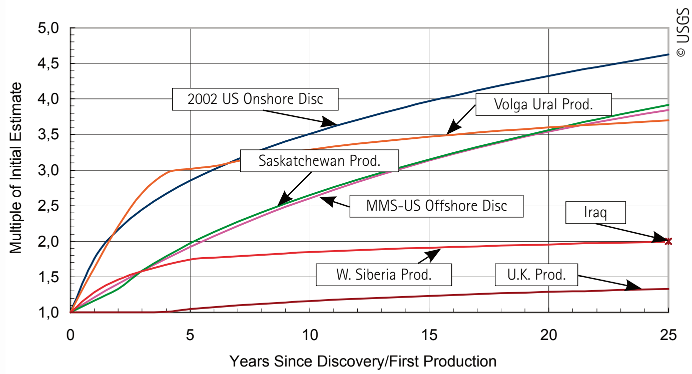
not necessarily give correct reserve growth potential for all other areas.

Since then, the U.S. Geological Survey (USGS) has developed several reserve growth methods — namely Monotone Least Square, Modified Arrington, and Group Growth. These methods are time based and all are still in use. Each method has its merits and drawbacks and therefore it is better to use two or more methods to show the range of reserve growth rather than depending on only one number.



Graph of U.S. oil production showing performance of different EOR methods, 1984 to 2000.

"Reserves are most commonly revised upward



Graph displaying reserve growth for different petroleum provinces over a 25-year period. The data illustrates 1.3- to 4.6 fold increases, depending upon the maturity and circumstances of production for each area plotted.

Reserves are generally revised upward or downward over the life of a field, but most commonly upward. The application of enhanced oil recovery many years after the field is shut-in or abandoned results in a second, and sometimes a third, round of reserve growth following a time lapse that may span several years. Because of these considerations, a reserve growth method that is divorced from the time element is needed; therefore, the USGS is actively pursuing such an approach to develop a reserve growth method based on percent depletion rather than time.

Actual Comparisons

Comparing reserve growth from one petroleum province to another is complicated by the following factors: 1) Reference year. This could be either the discovery year or the first production year; 2) Reserve reporting. In most countries, reserves are reported by reservoir by field, however, in Canada they are by pool; 3) Field development schedule. In Russia, it generally takes several years before a newly discovered field is developed due to the time taken by the State Committee of Reserves to review and approve the field for development. This contrasts to most U.S. fields that are developed shortly after their discovery.

When observed over a 25-year period, either from time of discovery or from year of first production, reserve growth varies across the world's mature petroleum basins. For example, total growth varied from 2.0-fold for the West Siberian Basin of Russia to 4.6-fold for U.S. onshore fields.

Although about two-thirds of the world's oil and gas reserves are located in the Middle East and North Africa, no known reserve growth studies have been published for countries in these regions, except for Iraq. Based on limited data, the USGS estimated a reserve increase of about 1.6-fold for Iraq over a period of 20 years, which would roughly translate to a 2-fold increase over a 25-year period. The lower increase in reserve growth there could be attributed to various factors, such as the Iraq-Iran wars and UN sanctions. In West Siberia, the low 2.0-fold increase is partly due to different reserve booking requirements and insufficient investments (Figure 2)[5]. The U.K. North Sea, having the lowest reserve growth, is an exception because the high cost of development dictated more precise reserve estimation upfront and hence lowered reserve growth. The oil reserve growth for the U.K. and Saskatchewan (Canada) are also shown in the attached graph.

Importance in Estimating Reserve Growth

Reserve growth has now become an important part of estimating total potential reserves of an individual province or country. The scientists at the USGS are continuing their research for a deeper understanding of the reserve growth phenomenon by evaluating the impact of its various aspects. Some of these aspects include lithology, infrastructure, crude oil price, operating environments, government policies, and technology.

As the world's known petroleum reserves continue to decline, there will be more pressure on geologists and engineers in the oil industry to make the reserve estimates more precise through application of the reserve-growth concept. In fact, the concept could be applied even to the undiscovered resources with some qualifications as to the inherent risk.

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