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Shedding Light on the Question of Reserves Growth

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USGS World Petroleum Assessment

In 2000, the United States Geological Survey issued its World Petroleum Assessment, covering the thirty year period 1995-2025 (Table 1). The resource estimates from this study are widely quoted to support the argument that oil production can continue to expand. (*Comments now open!*)

Table 1: USGS (2000) Resource Assessment
Conventional oil and NGLs

In assessing the world's total oil endowment to be over 3 trillion barrels, the USGS study defines a huge contribution of 730 billion barrels with the 'potential to be added' to world reserves over the period 1995-2025 as a result of increases in the amount of oil that can be extracted from existing fields. The complete Reserves Growth report (Chapter RG) from the World Petroleum Assessment is available through the USGS website.

It should be noted, that while the USGS total estimate is likely high in each of the three areas assessed, a total endowment of 3.3 trillion barrels is insufficient to enable production to continue growing at historical rates beyond 2020. Forecasts for peak oil occurring much beyond 2020 imply even more unlikely resource estimates.

USGS Methodology

In assessing the potential for reserve growth to increase world resource estimates, the USGS studied apparent field size increases over time in the mature oil producing regions of the United States and applied the observed growth to worldwide remaining reserves and cumulative production, resulting in an average increase of 44%. A flow chart illustrating the process the USGS used is shown in figure 1.

Figure 1: Flow Chart for the USGS Reserves Growth Assessment Methodology.

By using 'proven reserves', this method firstly neglects the significant role that the US reporting environment had on perceived increases. As production and field development proceeds, publicly stated proven reserves are necessarily revised upwards, towards the initial 'proved plus probable' estimate. The real average increase in 2P (or P50) reserves is therefore significantly lower than 44%.

Secondly, the manner in which oil fields are developed now bears no comparison to the early days of the US industry and leaves a lot less to gain. This difference has arisen largely because North American (USA and Canada) mineral rights are vested in the landowner, while almost everywhere else in the world they are vested in the Government.

Since the 1970's, and in contrast to early North American experience, new fields have generally been unitized and fully delineated. This means that the joint field owners are allocated a percentage share in the field based on how much of the field lies within their acreage. Costs and subsequent revenue are apportioned between the owners, enabling agreement on upfront capital costs for appropriate development. The result is that secondary recovery is now generally in place where appropriate from day one.

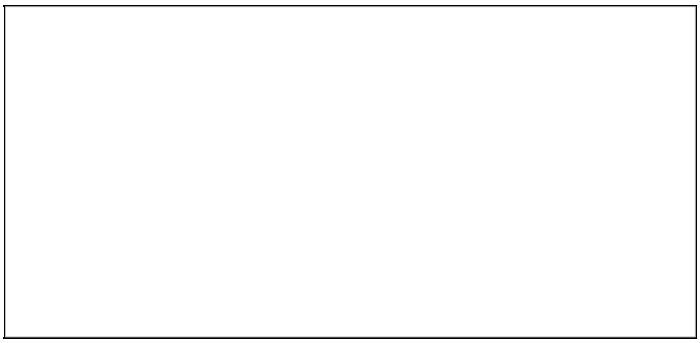

Figure 2: The forest of drilling rigs that occurs when owners of small pockets of land have the mineral rights and compete against each other to extract oil from a field as quickly and cheaply as possible.

As a result of this fundamental difference in ownership and approach it is quite inappropriate to apply the reserve growth experience from North America to non-North American reserves. Development of deep water and smaller fields has only strengthened this trend towards optimized recovery from early in field life. Consequently, there has been relatively little reserves growth observed in offshore producing areas in the last decade.

A New Reserves Growth Methodology

The USGS used a plot function that defined reserves growth as a function of the age of the field. However, largely because of the errors described above, the function is much too optimistic when applied to the rest of the world.

Figure 3: Graphical representation of typical recovery factors (chart from Industry Technology Facilitator, owned by 18 UK North Sea operators).

Rather than applying a growth function simply as a factor of age, we can consider categories of fields according to their current development status. For each category we can estimate the maturity of the current 'proven plus probable' reserves estimate and the scope for further gains:

- For fields that are not yet developed or that are using primary recovery only, the scope for reserves growth is large. However, there are relatively few fields in these two categories.
- For the large fraction of fields where secondary recovery facilities are in operation, or strong natural aquifer pressure support is present, future reserves increments are the additional

contribution that could be achieved by tertiary recovery only.

- For fields where tertiary recovery mechanisms are already operating, the recovery gains expected from those facilities will be included in current reserves estimate. The prospects for further reserve growth in this category are limited.
- For fields at or near the end of their producing lives, especially those decommissioned or de-pressurized in a switch to gas production, there is little scope for reserves growth. While isolated fields may be successfully redeveloped, the average increase in reserves will be low.
- For gas/condensate fields, confidence in ultimate liquid production is somewhat higher and possibilities for enhanced recovery are generally limited to lowering wellhead pressures.

Using these categories, a new estimate of potential reserve growth is presented in Table 2.

Table 2: Assessment of Reserve Growth
Conventional crude oil, condensate and NGLs (billion barrels)
Revision: 29th Nov 2007

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- (a) Primary recovery is often used for initial field production, with pressure maintenance applied once sufficient field experience has been accumulated. Effectively, most fields move from primary recovery to secondary recovery (where required) within a few years of start-up.
- (b) This category includes fields where aquifer support achieves strong pressure maintenance, eg. Burgan, Kuwait.
- (c) Gas/condensate fields are assumed to have potential liquids reserves growth of 10% on average and are therefore included in the same category as fields with secondary recovery.

Clearly the total figure here of 220 billion barrels has limited potential to delay peak oil, compared to the more significant 730 billion barrels suggested by the USGS. The weight that other commentators have given to 'reserves growth' in meeting future production needs implies even higher figures which seem unrealistic.

The estimates presented in Table 2 are necessarily approximate but dramatically improve on the simple and inappropriate extrapolation used by the USGS. Input to refine the figures is welcome; both in terms of the growth possible in each category and the volume of reserves allocated to each category.

As a final note, the USGS estimate of 730 billion barrels of reserve growth over the thirty year study period describes an annual reserves increase of 2.5%. Internal company estimates of annual growth in field reserves are closer to 0.2%. The USGS result is ten times higher than that used within the industry and must be called into question. I hope that this post provides new methodology for which the contribution to be made by reserves growth can be estimated.

Definitions & Abbreviations

- Gb : Giga (billion) barrels.
- NGLs: Natural Gas Liquids.
- Unless otherwise stated, reserves here refer to P50 estimates, ie. proven plus probable. Also referred to as 2P, these are 'best' estimates, which are just as likely to be exceeded as not. P90 (3P) 'proven' reserve estimates are those which have a 90% chance of being exceeded. P10 (1P) 'possible' estimates have only a 10% chance of being exceeded.

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