Note on Testing the Adequacy of Discovery Rates of Conventional Oil to Avoid the Formation of a Plateau Peak in World Production

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Abstract

In the application of the parabolic projection technique to geological assessments of the world's conventional oil resources, as with other similar approaches, there is the implied assumption that sufficient oil will be discovered in time from the resource base to avoid a flat *plateau peak*. In the latter situation, the supply of oil from newly discovered reserves is insufficient to allow the increase in production required to form a normal peak. To test this possibility, the parabolic technique was modified to allow an approximate estimate of the oil produced by year from discoveries made after 2003. A first production parabola was calculated using the normal procedure from which a second production parabola was deducted calculated on the basis that no new discoveries were made after that year. The difference in the cumulative totals between the two parabolas was taken to represent the future production that results from discoveries occurring later than 2003. This quantity of oil must be available from new discoveries to allow the peak to form in an unconstrained way.

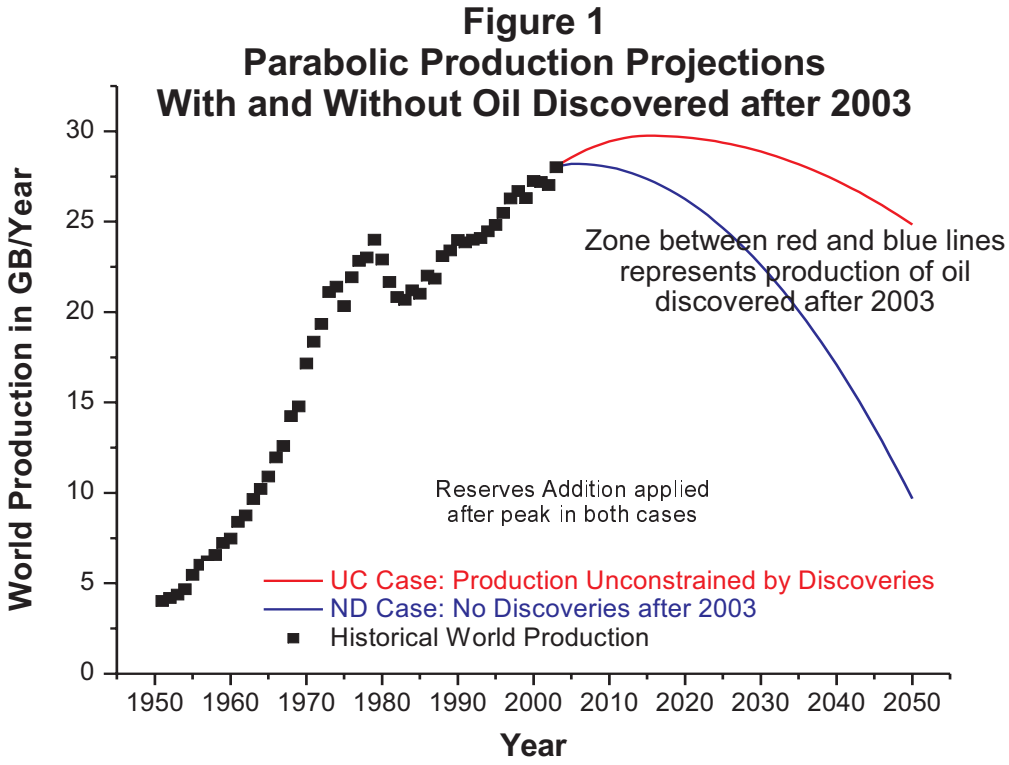
The cumulative quantity of oil required from new discoveries made after 2003 to avoid a plateau peak was compared with the cumulative quantity of oil resulting from two low-discovery scenarios. In the first, it was assumed that oil would be discovered at the rate of 10 gigabarrels (GB) per year in 2003 and this rate would decline at 3% thereafter; in the second, the rate was assumed to be 5 GB per year in 2003 with the same rate of decline of 3% per year. In both cases, sufficient oil was discovered to allow an unconstrained peak that was reached in 2015. The crossover point where insufficient oil would be limiting and so result in a plateau peak for these two scenarios was 2048 and 2033 respectively. Given that these discovery scenarios were at the low end of the expected range, there is little possibility that the rate of discovery itself will ever constrain the shape of the peak in world production. This calculation, however, does not deal with the related question as to whether the newly discovered oil could actually be produced in time due to other factors such as delays resulting from its location in ultra deep water or in hostile environments. This latter issue is beyond the scope of this note.

Introduction

There are two generally accepted axioms in the field of petroleum resource assessment. First, both oil and natural gas must be discovered before they can be produced. Second, the rate of discovery, whether higher or lower than expected, has a diminishing influence on the timing of the peak in production the closer the peak is approached.

This note follows a previous paper that summarizes recent work by this author in the field of the parabolic projection of geological resource assessments.[1] In this and other studies of this kind, it is usually assumed that the rate of discovery will not limit the projected production: it is the size of the resource base itself which is limiting. Stated another way, in most cases, conventional oil will be produced in a reasonably predictable way after its discovery. For this reason, the parabolic projections in the cited paper may be considered the unconstrained case.

Were the rate of discovery to be the limiting factor, the projection would likely follow the form of a *plateau peak* in that the production would be constrained at some point to a relatively level period rather than increase to follow the parabolic projection. Unfortunately, the interpretation of plateau peaks is complicated by other causes: conventional natural gas production in North America shows signs of following such a flat extended track over time but this is due mainly to the more rapid depletion of new wells than anticipated. In effect, for the current natural gas case on this continent, even the



present high rate of drilling cannot keep up with the production the resource base could support.

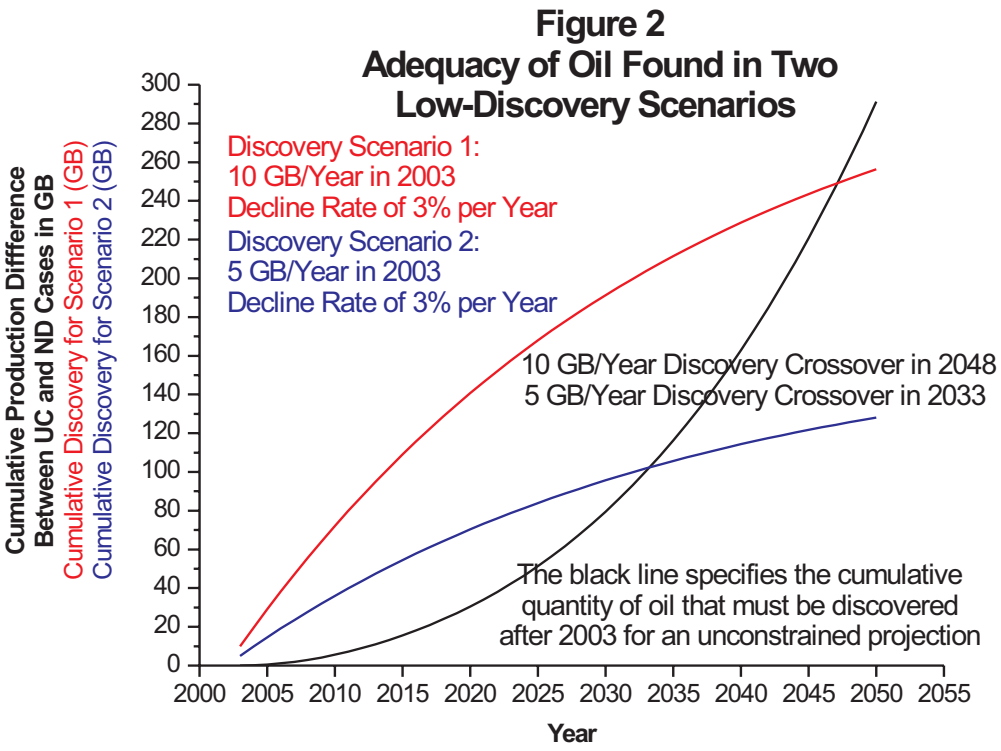
The parabolic technique was modified in this paper to examine whether the rate of discovery might limit the production projections based upon the assessment of world oil resources by the U.S. Geological Survey[2]. This application of the parabolic projection technique is also an example of its power to distinguish over time between the future production anticipated from as yet undiscovered conventional resources and that due to the growth in reserves after discovery due to advances in both exploration and production methods termed here the Reserves Addition.

Methodology

The following procedure was employed to assess whether an inadequate discovery rate might limit the parabolic projection to a plateau peak.

1. The parabolic technique was applied to the resource assessment data provided by the U.S. Geological Survey in the same manner as in Reference 1 but recalculated to include the most recent information available to the year 2003 taken from the *BP Statistical Review of World Energy*.[3] This projection appears as the red line in Figure 1 which peaks in 2015 and is designated as the Unconstrained Case (UC) in this note. The Reserves Addition was applied after the peak as before.

2. A second parabolic projection was then plotted by deducting the oil expected to be found after 2003 from the standard parabola above and designated the No Discovery (ND) Case. This second parabola was drawn staged at 2003 to provide a lower boundary case on the assumption that no further discovery of oil occurs after this date (Blue line in Figure 1). To do this, the undiscovered oil total of 724 gigabarrels (GB) expected in the Mean Case of the USGS Assessment was deducted from the Staged Parabola calculated for the Unconstrained Case but with an arbitrary correction to account for that oil already discovered in the period from the date of the assessment in 1999 to 2003. Forty GB were deducted from the 724 GB published to compensate for an assumed discovery rate of 10 GB/year over the four-year prior period. The new No



Discovery Case (ND) parabola was then drawn following the usual procedure except that the ten-year period for selection of the desired parabola was back-calculated based on production in 1993.

3. One other adjustment was also necessary for the ND Case. The Reserve Addition given for the UC Case in the USGS assessment of 672 GB was used to draw its Extended Parabola after the peak in 2015. For the ND Case, it appeared more realistic to reduce the Reserves Addition by making it proportional to one-half the area of the two Staged Parabolas calculated for these cases, that is, to the quantity of oil expected to be found after the peak but before the reserves addition. The rationale for this correction is the smaller the reserves resulting from the discovery process, the smaller the likely Reserves Addition. In the absence of data, a simple linear relationship was employed. The value of the Reserves Addition estimated in this way fell to 410 GB for the ND Case as compared to the 672 GB published for the UC Case by the USGS. In both cases, the Reserves Addition was assumed applicable only after the peak had passed. After these two adjustments, the two parabolas appear as the red line for the UC Case and the blue line for the ND Case in Figure l. Actual world historical oil production from 1950 is also plotted based upon data published in the BP Statistical Review of World Energy. The peaks for the two cases occur in 2015 (UC) and 2005 (ND) respectively.

4. In Figure 1, the difference between the UC and ND Cases provides an approximation of the quantity of oil expected to be discovered year-by-year after 2003. The black line in Figure 2 represents the difference between these two parabolas calculated as a cumulative total and was plotted by year to 2050. The cumulative quantity of oil actually discovered must at least equal or exceed this level at all times to avoid a plateau peak.

5. The adequacy of the cumulative production of oil discovered after 2003 was tested by two scenarios at the low end of the expected discovery range. In the first `low' discovery scenario, the discovery rate was assumed to be 10 GB/Year starting in 2003 with the decline set at 3% per year thereafter. In the second `ultra low' discovery scenario, the discovery rate in 2003 was assumed to be 5 GB/year in 2003 with the decline rate again set at 3% per year. The cumulative values of the two discovery scenarios were plotted by year in Figure 2 (red line starting at 10 GB for 2003 and blue line starting at 5 GB for the same year). The actual rate of discovery at present is a matter of dispute, but is almost certainly higher than 5 GB/Year.

In Figure 2, it may be seen that there is adequate oil available from discoveries starting at 10 GB/year until 2048. For the ultra low 5 GB/year starting rate,

the crossover occurs earlier in 2033 but even in this case well after the peak in 2015. This result is interpreted here to mean that even at these relatively low discovery rates, enough oil would be found each year to avoid a constrained plateau peak.

Nevertheless, this calculation does not deal with the related issue as to whether this discovered oil could actually be produced in a timely way. This is a different question and one not addressed in this note. For example, some of the oil discovered after 2003 might be found in Arctic regions, in very deep water, or in a conflict zone such that it could not be produced for a number of years (if at all) due to the constraints of a difficult location. If so, a plateau peak could still result.

Conclusion

The parabolic technique devised to project assessments of conventional world oil resources was modified to provide an estimate of cumulative production from discoveries made after a given specified date, in this note 2003. This technique was applied to the assessment of world resources of conventional oil published by the U.S. Geological Survey to determine whether a constraint due to a slow discovery process would cause the formation of a plateau peak. This was tested with two discovery scenarios selected at the low end of the expected finding range.

No such limit is likely due to a low rate of discovery. This conclusion, however, refers to the rate of discovery alone in that there is still a chance that the oil found could not be produced in time to avoid some constraint on output. This latter possibility is beyond the scope of this note.

References

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