

# Changing Perceptions of World Oil and Gas Resources as Shown by Recent USGS Petroleum Assessments

## Introduction

The U.S. Geological Survey (USGS) periodically conducts geology-based assessments of the oil and gas resources of the world in recognition of the fact that United States economic security is closely linked to energy resources outside the United States. Four such petroleum assessments have been published in recent years (Masters and others, 1984, 1987, 1991, and 1994). A summary of these assessments (table 1) indicates the magnitude of world conventional oil and gas resources, as perceived in the 1980's and 1990's by the USGS.

These four successive world petroleum assessments evidence changes in perception through time. The assessments were prepared using a consistent methodology by the same core group of geologists. Because of this continuity, differences among the four assessments can be largely attributed to an evolving understanding of world recoverable oil and gas resources rather than to procedural or philosophical changes. In this fact sheet, some of the trends in the estimates of table 1 are examined, with a view toward better understanding world oil and gas resources in the context of the next few decades.

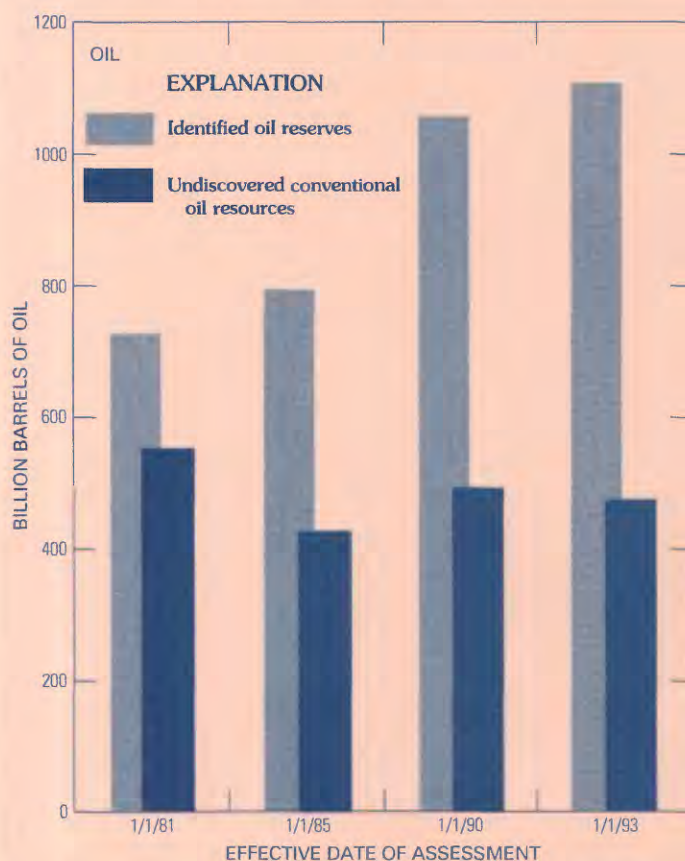
## Most of the World's Foreseeable Supply of Oil Resides in Accumulations Already Discovered

USGS estimates of world undiscovered conventional oil resources changed relatively little from January 1, 1981, to January 1, 1993 (fig. 1). In contrast, estimates of world identified (discovered) oil reserves increased during this 12-year period by a total of 379 billion barrels of oil (BBO). This increase occurred despite declining exploration success (fig. 6 in Masters and others, 1994) (exploration success converts undiscovered resources to identified reserves) and removal from identified reserves through production of 254 BBO (table 1). Thus, the USGS assessments indicate that the bulk of conventional oil yet to be produced in the world resides in fields that have already been discovered (fig. 1). If the trends of figure 1 continue, the proportion of discovered to undiscovered oil resources will increase in the future.

A migration of industry focus from new-field exploration to the more intense development of known productive areas has

already begun. Worldwide, the addition to petroleum reserves through activities other than wildcat drilling has become the most important reserves trend of the 1990's (Oil & Gas Journal, 1996, p. 37).

The trend of increasing estimates of identified oil reserves with each successive assessment (fig. 1) is interpreted here to indicate that future reserve growth of discovered oil fields is being chronically underassessed. If the oil supply likely to result from reserve growth is being significantly underestimated, a near-term imbalance of oil demand over supply due to world resource exhaustion is less likely.



**Figure 1.** Successive USGS estimates of world undiscovered conventional oil resources and identified (discovered) oil reserves. Data are from table 1.

**Table 1.** Summary of recent U.S. Geological Survey world petroleum assessments.

[Data are from Masters and others, 1984, 1987, 1991, and 1994. BBO, billions barrels of oil; BBOE, billion barrels of oil equivalent. A gas volume is expressed as its energy equivalent in barrels of oil by assuming that 6,000 cubic feet of gas equals 1 barrel of oil. Identified reserves (category 2) include the projected reserve growth of known fields. Leaders (--) indicate no data]

Category	Oil (BBO)				Gas (BBOE)			
	Effective date of assessment				Effective date of assessment			
	1/1/81	1/1/85	1/1/90	1/1/93	1/1/81	1/1/85	1/1/90	1/1/93
1. Cumulative production . . . . .	445	524	629	699	--	196	266	292
2. Identified (discovered) reserves . . . . .	724	795	1,053	1,103	--	651	750	856
3. Undiscovered conventional resources (mode) . . . . .	550	425	489	471	--	700	736	780
4. Future resources (mode) (categories 2 + 3) . . . . .	1,274	1,220	1,542	1,574	--	1,351	1,486	1,636
5. TOTAL RESOURCES (categories 1 + 2 + 3) . . . . .	1,719	1,744	2,171	2,273	--	1,547	1,752	1,928

## World Gas Resources Are Less Exploited Than World Oil Resources

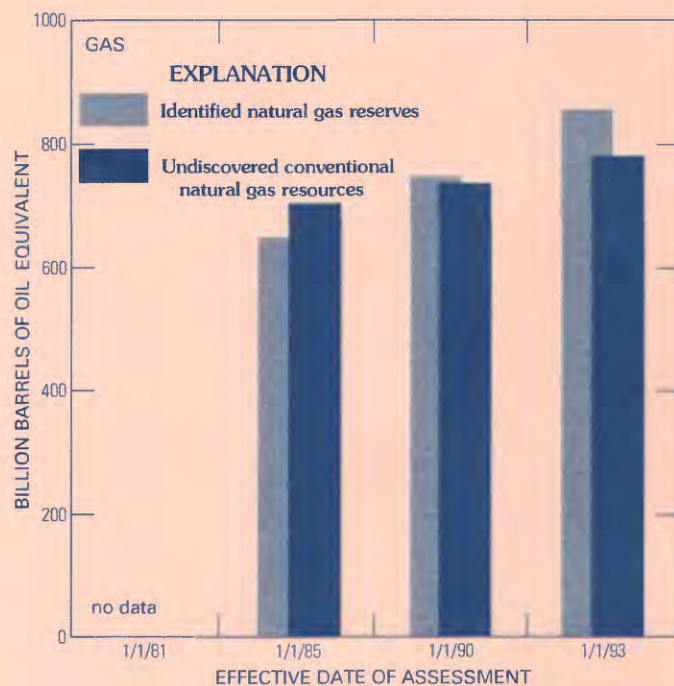
USGS estimates of world undiscovered conventional natural gas resources increased from January 1, 1985, to January 1, 1993, as did estimates of world identified (discovered) natural gas reserves (fig. 2). The ratio of discovered to undiscovered gas resources was slightly greater than 1.0 in the 1993 assessment (fig. 2). In contrast, discovered reserves of oil already exceeded undiscovered oil resources in the estimates of the 1981 assessment (fig. 1).

The proportion of undiscovered to discovered resources is higher for gas than for oil (figs. 1 and 2), implying that the overall exploitation of world natural gas resources lags that of oil, perhaps by several decades. The USGS assessments indicate that a significant fraction of the conventional natural gas still to be produced in the world will come from fields that are not yet discovered (fig. 2).

## Foreseeable World Resources of Conventional Oil and Gas Are Approximately Equal

On an energy-equivalent basis, substantially more oil than gas has been produced in the world (fig. 3). Does this primarily reflect the more vigorous exploitation of oil resources (one aspect of which is the flaring of natural gas), or is the world endowment of recoverable oil in conventional fields much greater than that of gas?

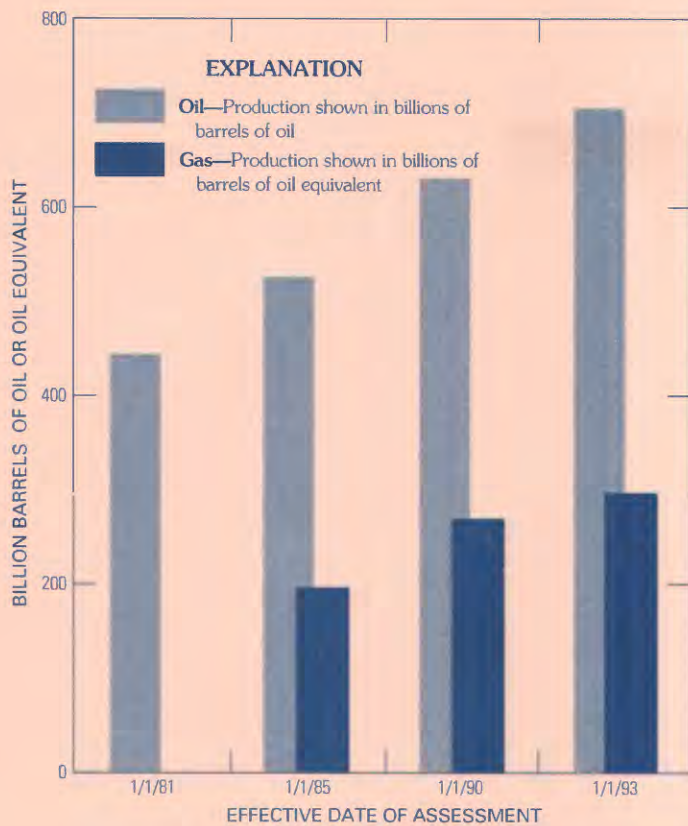
Three successive USGS world petroleum assessments concluded that world future resources (discovered reserves plus undiscovered resources) of conventional oil and gas are



**Figure 2.** Successive USGS estimates of world undiscovered conventional natural gas resources and identified (discovered) natural gas reserves. Data are from table 1.

approximately equal on an energy-equivalent basis (fig. 4). These predictions resulted from the summation of detailed basin-scale geologic evaluations by regional experts and could not have been anticipated a priori.

In the United States, which is heavily explored and where gas generally finds a ready market, cumulative oil production is only 1.2 times greater than cumulative gas production on an



**Figure 3.** Cumulative world production of oil and natural gas. Data are from table 1.

energy-equivalent basis (Masters and others, 1994). The USGS domestic petroleum assessment (U.S. Geological Survey National Oil and Gas Resource Assessment Team, 1995), done in 1995 independently of USGS world assessments, predicted approximately equal future resources of conventional oil and natural gas in the United States.

The world future resources of conventional oil and natural gas foreseen in recent USGS assessments do not differ from one another nearly so much as cumulative production data (fig. 3) might suggest and, in fact, are estimated to be nearly equal on an energy-equivalent basis.

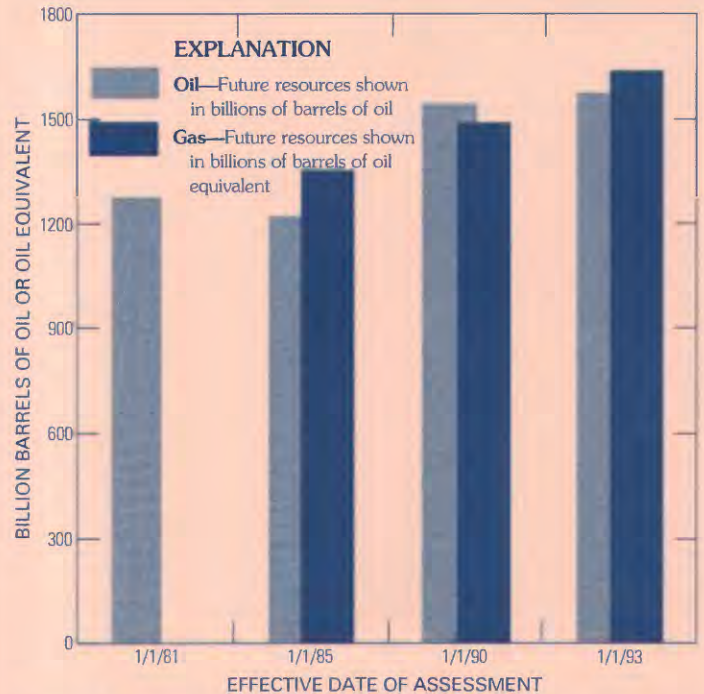
### Perceptions of the World Petroleum Resource Base Increase Through Time

USGS estimates of world total recoverable resources (cumulative production, identified (discovered) reserves, and undiscovered resources) for conventional oil plus natural gas increased by 910 billion barrels of oil and oil equivalent in the 8-year span from January 1, 1985, to January 1, 1993 (fig. 5). The amount of world "ultimate" oil and gas resources is not seen by USGS assessments as a fixed, absolute quantity, but rather as a time-dependent volume that increases as perception limits recede.

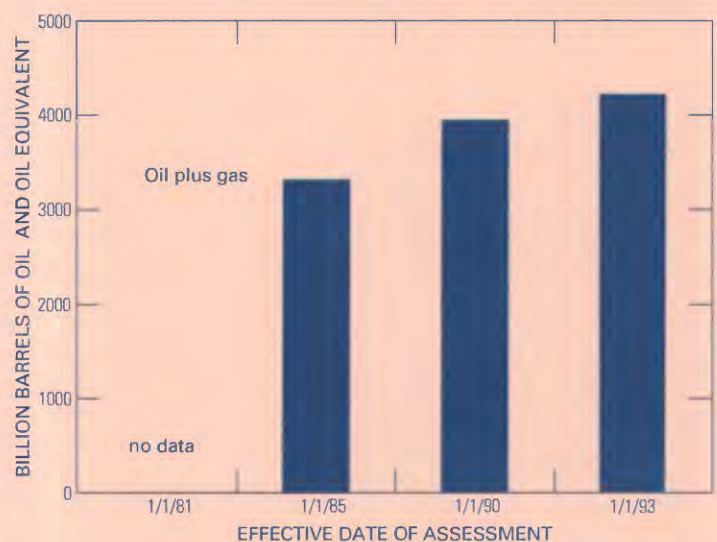
Upward revisions in petroleum resource forecasts are not unique to the USGS. Estimates of total resource limits regularly increase (Adelman and Lynch, 1997). If world recoverable petroleum resources are envisioned as forming a continuum extending from high- to low-quality accumulations, an

argument can be made that the end of this continuum is not yet in sight.

Nonetheless, oil and gas resource assessments that are firmly grounded by data serve a valuable purpose. As summarized by Masters (1993), such assessments present a numerical hypothesis—the "where and when"—for petroleum resource conditions of the Earth as perceived at a particular point in time. Quantitative assessments facilitate recognition of the big picture, which is necessary for purposes of planning and investment, and also form the foundation for periodic adjustments to the big picture made necessary by changes in technology and scientific understanding.



**Figure 4.** Successive USGS estimates of world future resources (identified (discovered) reserves plus undiscovered resources) for conventional oil and natural gas. Data are from table 1.



**Figure 5.** Successive USGS estimates of world total resources (cumulative production plus identified (discovered) reserves plus undiscovered resources) for conventional oil plus natural gas. Data are from table 1.

## References Cited

- Adelman, M.A., and Lynch, M.C., 1997, Fixed view of resource limits creates undue pessimism: *Oil & Gas Journal*, v. 95, no. 14 (April 7), p. 56–60.
- Masters, C.D., 1993, World petroleum resources—Where, why, and how much?: *Geological Society of Malaysia, Bulletin* 33, p. 5–19.
- Masters, C.D., Attanasi, E.D., Dietzman, W.D., Meyer, R.F., Mitchell, R.W., and Root, D.H., 1987, World resources of crude oil, natural gas, natural bitumen, and shale oil: *Proceedings of the 12th World Petroleum Congress*, Chichester, England, John Wiley and Sons, v. 5, p. 3–27.
- Masters, C.D., Attanasi, E.D., and Root, D.H., 1994, World petroleum assessment and analysis: *Proceedings of the 14th World Petroleum Congress*, Chichester, England, John Wiley and Sons, v. 5, p. 529–541.
- Masters, C.D., Root, D.H., and Attanasi, E.D., 1991, World resources of crude oil and natural gas: *Proceedings of the 13th World Petroleum Congress*, Chichester, England, John Wiley and Sons, p. 51–64.
- Masters, C.D., Root, D.H., and Dietzman, W.D., 1984, Distribution and quantitative assessment of world crude oil reserves and resources: *Proceedings of the 11th World Petroleum Congress*, Chichester, England, John Wiley and Sons, v. 2, p. 229–237.
- Oil & Gas Journal, 1996, Oil and gas reserves, oil output rise in 1996: *Oil & Gas Journal*, v. 94, no. 53 (December 30), p. 37–38.
- U.S. Geological Survey National Oil and Gas Resource Assessment Team, 1995, 1995 National Assessment of United States oil and gas resources: *U.S. Geological Survey Circular* 1118, 20 p.

---

### For more information please contact:

---

James W. Schmoker  
Denver Federal Center, Mail Stop 939  
Denver, CO 80225  
(303) 236–5794; e-mail: [schmoker@usgs.gov](mailto:schmoker@usgs.gov)

Thaddeus S. Dyman  
Denver Federal Center, Mail Stop 939  
Denver, CO 80225  
(303) 236–5730; e-mail: [dyman@usgs.gov](mailto:dyman@usgs.gov)