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Statistics of Petroleum Exploration in the World Outside the United States and Canada Through 2001

Circular 1288

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By Emil D. Attanasi, Philip A. Freeman, and Jennifer A. Glovier

A summary of the geographic location, intensity, productivity, and results of petroleum exploration in the world outside the United States and Canada through 2001, including maps showing explored and delineated prospective areas. This Circular updates and expands the coverage of U.S. Geological Survey Circular 1096.

Circular 1288

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Conversion Factors, Letter Symbols for Units of Measure, and Definitions

Multiply	By	To obtain
Length		
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
Area		
square mile (mi^2)	2.590	square kilometer
Volume		
cubic foot (ft^3)	0.02832	cubic meter
barrel (bbl)	0.1590	cubic meter

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Letter Symbols for Units of Measure

bbl	barrel
bbl/mi^2	barrels per square mile
BBO	billions of barrels of oil (bbl $\times 10^9$)
BBOE	billions of barrels of oil equivalent
BCF	billions of cubic feet (ft$^3 \times 10^9$)
BOE	barrel of oil equivalent
mi^2	square mile
MMBO	millions of barrels of oil (bbl $\times 10^6$)
TCF	trillions of cubic feet (ft$^3 \times 10^{12}$)

Definitions

Thousands	$= 10^3$
Millions	$= 10^6$
Billions	$= 10^9$
Trillions	$= 10^{12}$

1 BOE	= 1 barrel of crude oil (42 gallons)
	= 6,000 cubic feet of natural gas
	= 1.5 barrels of natural gas liquids

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By Emil D. Attanasi,[1] Philip A. Freeman,[1] and Jennifer A. Glovier[2]

Abstract

Future oil and gas supplies depend, in part, on the reserves that are expected to be added through exploration and new discoveries. This Circular presents a summary of the statistics and an analysis of petroleum exploration in the world outside the United States and Canada (the study area) through 2001. It updates U.S. Geological Survey Circular 1096 (by E.D. Attanasi and D.H. Root, 1993) and expands coverage of the statistics to areas where drilling and discovery data have recently become available. These new areas include China, the formerly Communist countries of Eastern Europe, and the countries that once were part of the former Soviet Union in Europe and Asia. Data are presented by country but are organized by petroleum provinces delineated by the U.S. Geological Survey World Energy Assessment Team (USGS Digital Data Series DDS–60, published in 2000).

The data and analysis are presented in maps and graphs, providing a visual summary of the exploration maturity of an area. The maps show the delineated prospective areas and explored areas through 2001; explored areas have a drilling density that would rule out the occurrence of undetected large petroleum accumulations. Graphs summarize the exploration yields in terms of cumulative recoverable discovered oil and gas by delineated prospective area.

From 1992 through 2001 in areas outside the United States and Canada, the delineated prospective area expanded at a rate of about 50,000 square miles per year while the explored area grew at the rate of about 11,000 square miles per year. The delineated prospective area established by 1970 contains about 75 percent of the oil discovered to date in the study area. This area is slightly less than 40 percent of the delineated prospective area established through 2001.

Maps and graphs show the extension of the delineated prospective area to deepwater areas offshore of Brazil and West Africa. From 1991 through 2000, offshore discoveries accounted for 59 percent of the oil and 77 percent of the gas discovered in the study area. The petroleum industry's decision to incur the greater costs of moving offshore and into deeper waters appears to be a response to the absence of onshore prospects of comparable quality. Where natural gas can be commercially developed and marketed, data show an expansion of exploration to target gas-prone areas.

Introduction

Objectives and Methods

Controversy and concern persist about the future supply of world oil (Campbell and Laherrère, 1998; Williams, 2003). Analysts have come to radically different conclusions based on different interpretations of the same data, depending on the variables analyzed. One objective of this Circular is to contribute to the analysis of the world oil supply by expanding the availability of statistics on oil and gas exploration for all areas outside the United States and Canada. The compilation of data in this Circular will eliminate the need for costly and time-consuming replication of effort and will allow researchers and decisionmakers access to exploration statistics for planning purposes.

A second objective is to present a visual summary at a broad scale of world oil and gas exploration. In particular, maps for countries outside the United States and Canada are presented to show the historical exploration areas and the parts of the exploration areas having a high drilling density. Companion graphs summarize the historical exploration yields by area searched. Maps and graphs are used to convey visually the exploration maturity of an area. Making the maps and graphs required development of a method to characterize a common level of exploration maturity across various areas that have significantly different drilling densities.

The statistics of exploration represent one set of indicators that can foreshadow the long-term future of oil-supply problems. During the last three decades, the international oil market has been influenced by efforts of the Organization of Petroleum Exporting Countries (OPEC) to control oil prices by restricting production. The oil price variations during that

period have been substantial, and it is evident that such prices alone are not reliable indicators of the long-term prospects of global oil supply.

Natural gas development for most areas is tied to local demand and the infrastructure to transport gas to international markets. On a calorific or British thermal unit (Btu) basis, gas costs four times as much as oil to transport. For some areas, it is still true that local and international gas demand has been insufficient to sustain prices required to justify the building of infrastructure and the commercial development of gas.

This Circular expands and updates U.S. Geological Survey (USGS) Circulars 981 and 1096 (Root, Attanasi, and Turner, 1987; Attanasi and Root, 1993). It focuses on the world outside the United States and Canada (hereinafter called the study area) because the United States and Canada have historically accounted for most of the world's wildcat wells but have accounted for a relatively small amount of the total new oil and gas discoveries in the last three decades. Circulars 981 and 1096 did not include data on the Former Soviet Union, China, and formerly Communist areas of Eastern Europe. The historical data for these and other areas where petroleum exploration data were restricted for national security reasons will probably remain incomplete, but the early information will diminish in importance with the passage of time. Study area data on wildcat drilling and field sizes are as of January 2002 and are from the IHS Energy Group (2002).

Summary of Findings and Limitations of Study

As shown by the drilling record and the locations of new drilling, the search area for oil and gas has continued to expand, but expansion has slowed considerably. Specifically, for the decade from 1992 through 2001, the prospective area expanded at a rate of about 50,000 square miles per year, and the explored area expanded at a rate of about 11,000 square miles per year. During the prior decade, the prospective area had expanded by 91,000 square miles per year and the explored area by 22,000 square miles per year.

Since 1950, drilling has extended offshore, and through 2001, offshore discoveries accounted for 20 percent of the oil and 28 percent of the gas discovered in the study area. In Europe, for example, offshore discoveries accounted for about 75 percent of the oil discovered through 2001. All major producing regions, with the exception of Russia, have had significant offshore drilling, discoveries, and production. The petroleum industry's decision to incur higher costs by moving offshore appears to be a response to the absence of onshore prospects of comparable quality, although in some countries, exploration has moved offshore for political and environmental reasons. Furthermore, since the early 1990s, the expansion of deepwater offshore exploration has been sufficiently productive to offset the higher costs in that environment.

Consumption, production, and reserves for liquid hydrocarbons (oil, condensate, and natural-gas-plant liquids) and natural gas are shown in table 1. The data were published in the "BP Statistical Review of World Energy 2003" (BP,

2003). Table 1 highlights the balances between production and consumption. For the world, the difference between production and consumption may be explained by a drawdown of inventories or by refinery gain (for crude oil). Refinery gain, or processing gain, is the increase in crude oil product volumes beyond the input crude oil volume that takes place as a result of the refining process itself.

Examination of the balances between liquid hydrocarbon production and consumption shows that the three regions of North America, Europe and Eurasia, and Asia Pacific consume more than they produce. The Western Hemisphere accounts for 37 percent of world liquid hydrocarbon consumption, 28 percent of world liquid hydrocarbon production, and only 14 percent of world liquid hydrocarbon reserves. The hemispheric imbalance for liquid hydrocarbons is expected to increase.

For natural gas, the regional production and consumption balances are closer, but the three regions of North America, Europe and Eurasia, and Asia Pacific consume slightly more than they produce. International trade of gas is limited by the high transportation costs associated with shipping gas overseas.

During the last decade, natural gas has made rapid advances as a commercial resource, but there are still many countries and areas where natural gas is not a commercial commodity. Where gas is not commercial, there is little incentive to report gas discoveries or to determine the magnitude of the discovered gas accurately. This lack of incentive is true whether the gas is associated with oil or whether the gas is in a nonassociated gas field. Because natural gas has been considered noncommercial for most of the petroleum industry's history, care must be taken when interpreting historical gas discovery rates. At this time, there is no obvious way to adjust gas estimates to capture the missing or unreported elements.

The available drilling record outside the United States and Canada is incomplete, especially for data prior to 1950. In the two earlier editions of this Circular (Root, Attanasi, and Turner, 1987; Attanasi and Root, 1993), annual exploratory well counts were gleaned from the annual foreign developments issues of the "American Association of Petroleum Geologists Bulletin" ("AAPG Bulletin"), which reported data by country from 1950 through 1990. In addition, wildcat well counts were reported by Petroconsultants S.A., the predecessor of the IHS Energy Group. The exploratory well counts from the "AAPG Bulletin" and wildcat well counts reported by Petroconsultants S.A. were not very consistent during the 1950s but were very consistent after 1980. Unfortunately, the AAPG discontinued the foreign developments issues in 1990. The well data used in this Circular are from the IHS Energy Group (2002). For recent drilling in most areas, the IHS Energy Group (2002) reports wildcat wells along with other exploratory wells. For a few areas, the IHS Energy Group also reports some development wells.

Information used in this Circular includes well location, depth, initial classification (such as wildcat, exploration, or development), final classification (dry hole or producer), spud date, and completion date. In the past, many countries

Table 1.   Estimated world liquid hydrocarbon and natural gas consumption, production, and reserves for 2002.

[For these estimates, liquid hydrocarbon includes crude oil, condensate, and natural-gas-plant liquids. Data are from BP (2003). Region definitions in this table differ from those in the rest of this Circular and follow BP (2003). Because of rounding, some regional totals may differ slightly from the sum of the component estimates shown. Countries are listed alphabetically within each region]

Country	Annual consumption, 2002		Annual production, 2002		Reserves at end of 2002	
	Liquid (10⁶ bbl/yr)	Gas (10⁹ ft³/yr)	Liquid (10⁶ bbl/yr)	Gas (10⁹ ft³/yr)	Liquid (10⁹ bbl)	Gas (10¹² ft³)
North America						
Canada	726	2,849	1,051	6,478	6.9	60.1
Mexico	654	1,486	1,309	1,228	12.6	8.8
U.S.A. (excludes Puerto Rico)	7,193	23,563	2,810	19,334	30.4	183.5
North America subtotal	8,573	27,898	5,169	27,040	49.9	252.4
South and Central America						
Argentina	129	1,070	292	1,274	2.9	27.0
Bolivia	*	*	*	191	*	24.0
Brazil	675	484	548	321	8.3	8.1
Chile	86	229	*	*	*	*
Colombia	81	215	219	219	1.8	4.5
Ecuador	48	7	150	*	4.6	*
Peru	54	14	36	*	.3	8.7
Trinidad and Tobago	*	*	57	593	.7	23.5
Venezuela	183	964	1,074	964	77.8	148.0
Other countries	419	477	54	74	2.0	6.4
South and Central America subtotal	1,675	3,459	2,429	3,636	98.6	250.2
Europe and Eurasia						
Austria	98	286	*	*	*	*
Azerbaijan	27	279	113	169	7.0	30.0
Belarus	43	586	*	*	*	*
Belgium and Luxembourg	248	522	*	*	*	*
Bulgaria	33	102	*	*	*	*
Czech Republic	64	314	*	*	*	*
Denmark	75	180	135	297	1.3	3.0
Finland	83	145	*	*	*	*
France	718	1,511	*	*	*	*
Germany	989	2,916	*	614	*	11.3
Greece	169	71	*	*	*	*
Hungary	50	420	*	*	*	*
Iceland	7	0	*	*	*	*
Ireland	66	145	*	*	*	*
Italy	709	2,245	38	533	.6	8.0
Kazakhstan	47	342	361	434	9.0	65.0
Lithuania	20	102	*	*	*	*
Netherlands	347	1,387	*	2,114	*	62.0
Norway	76	138	1,215	2,309	10.3	77.3
Poland	154	395	*	141	*	5.8
Portugal	113	106	*	*	*	*
Romania	82	614	47	381	1.0	3.6
Russia	901	13,711	2,810	19,588	60.0	1,680.0
Slovakia	26	268	*	*	*	*
Spain	555	734	*	*	*	*
Sweden	115	28	*	*	*	*
Switzerland	97	99	*	*	*	*
Turkey	236	614	*	*	*	*
Turkmenistan	19	466	66	1,761	.5	71.0
Ukraine	95	2,464	*	607	*	39.6
United Kingdom	611	3,336	899	3,639	4.7	24.6
Uzbekistan	48	1,850	62	1,899	.6	66.2
Other countries	164	469	175	392	2.4	8.4
Europe and Eurasia subtotal	7,083	36,846	5,921	34,880	97.5	2,155.8

Table 1. Estimated world liquid hydrocarbon and natural gas consumption, production, and reserves for 2002.—Continued

Country	Annual consumption, 2002		Annual production, 2002		Reserves at end of 2002	
	Liquid (10⁶ bbl/yr)	Gas (10⁹ ft³/yr)	Liquid (10⁶ bbl/yr)	Gas (10⁹ ft³/yr)	Liquid (10⁹ bbl)	Gas (10¹² ft³)
Middle East						
Bahrain..	*	*	*	325	*	3.3
Iran..	407	2,397	1,229	2,277	89.7	812.3
Iraq..	*	*	741	*	112.5	109.8
Kuwait..	77	307	683	307	96.5	52.7
Oman..	*	*	329	522	5.5	29.3
Qatar..	16	378	276	1,034	15.2	508.5
Saudi Arabia.......................................	498	1,991	3,168	1,991	261.8	224.7
Syria..	*	*	210	145	2.5	8.5
United Arab Emirates	90	1,387	828	1,624	97.8	212.1
Yemen	*	*	173	*	4.0	16.9
Other countries....................................	496	801	18	92	.1	1.6
Middle East subtotal	1,583	7,261	7,655	8,317	685.6	1,979.7
Africa						
Algeria...	82	928	605	2,838	9.2	159.7
Angola..	*	*	330	*	5.4	*
Cameroon..	*	*	26	*	.4	*
Republic of Congo (Brazzaville)	*	*	94	*	1.5	*
Egypt..	201	801	274	801	3.7	58.5
Equatorial Guinea	*	*	87	*	*	*
Gabon...	*	*	108	*	2.5	*
Libya..	*	*	502	201	29.5	46.4
Nigeria..	*	*	735	625	24.0	124.0
South Africa..	183	0	*	*	*	*
Sudan..	*	*	85	*	.6	*
Tunisia..	*	*	28	*	.3	*
Other countries.....................................	457	650	22	237	.3	29.5
Africa subtotal.....................................	922	2,379	2,897	4,702	77.4	418.1
Asia Pacific						
Australia..	309	847	266	1,218	3.5	90.0
Bangladesh...	26	395	*	395	*	10.6
Brunei...	*	*	77	406	1.4	13.8
China..	1,957	1,063	1,236	1,151	18.3	53.3
Hong Kong Special Administrative Region	99	85	*	*	*	*
India	763	995	289	1,003	5.4	26.9
Indonesia...	391	1,225	466	2,492	5.0	92.5
Japan	1,948	2,732	*	*	*	*
Malaysia..	179	953	304	1,776	3.0	75.0
New Zealand	53	194	*	222	*	*
Pakistan	131	738	*	738	*	26.4
Papua New Guinea.................................	*	*	17	*	.2	12.2
Philippines...	121	64	*	*	*	*
Singapore	255	64	*	*	*	*
South Korea..	835	925	*	*	*	*
Taiwan..	298	300	*	*	*	*
Thailand	272	914	72	667	.6	13.3
Vietnam...	*	*	129	*	.6	6.8
Other countries.....................................	173	166	58	582	.8	24.5
Asia Pacific subtotal..............................	7,810	11,660	2,915	10,650	38.7	445.3
World total						
World total...	27,648	89,503	26,986	89,224	1,047.7	5,501.5

*The quantity is not listed separately for an individual country but may be included in the "Other countries" category for the region.

considered this drilling information to be important to national security and thus restricted the publication of information about wells.

Data describing historical oil discoveries have improved since the 1980s, but there is still no standard method used internationally to estimate reserves and, therefore, cumulative recoverable oil (reserves plus past production). Field-size estimates are not strictly comparable across countries, as each country may have a different definition of reserves. There is also no evidence that historical estimates of the same field are consistent with recent estimates, and so no attempt was made to calibrate growth functions or to estimate the potential reserve growth in the study area.

This Circular not only summarizes the basic statistics of petroleum exploration and discovery in the world outside the United States and Canada, but also presents a unique set of analytical techniques to interpret these data. Initially the Circular describes background information on the institutional context, the practices of modern petroleum exploration, and the petroleum discovery process (figs. 1–4, tables 1–5). Following this discussion is an explanation of the unique analytical techniques applied in this study to display and analyze the exploration and discovery data at the country and regional levels (figs. 5 and 6). The summary results of the analysis of exploration and discovery data at the regional level and for the entire study area are described (figs. 7–13, tables 6 and 7). These results are aggregates of data for individual countries or small groups of countries, which are shown as maps, graphs, and tables in figures 14 through 57. The concluding section of the text discusses the implications of the analysis for future discovery and production trends.

Exploration Process

The four parts of this section present basic information about the petroleum exploration process so that the reader can understand and interpret the exploration statistics presented in this Circular. In the first part, concepts and nomenclature of exploration statistics are discussed. Exploration statistics are generated by the firms (economic agents) that are exploring for oil and gas, and the data represent their decisions and the outcomes of those decisions. When interpreting exploration statistics, knowledge of the institutional setting in which the firms make decisions is important. Such settings inside and outside the United States are briefly described in the second part.

In the third part, characteristics of oil and gas deposits are identified that result in the predictability of the petroleum discovery process for petroleum plays. The intensity of petroleum exploration in the United States is greater than that in any other country in the world. Although U.S. historical drilling and discovery data are not complete, they represent the most extensive data available in terms of historical, geographical, and geologic breadth for any major producing area in the

world. In the fourth part, U.S. data are used to illustrate how the size distributions of oil and gas accumulations determine the regularity and predictability of the discovery process in plays, basins, and provinces and across petroleum provinces.

Oil and Gas Exploration: Concepts and Nomenclature

Exploration is the search for undiscovered oil and gas resources that have development and production costs no greater than the expected costs associated with producing oil and gas from known deposits and adding to reserves in known deposits (Adelman, 1970). Exploration is one of several ways of adding to oil and gas reserves (defined below). Exploration by the petroleum industry includes surveying of surface geology, processing and interpreting newly collected geophysical data, reprocessing and interpreting previously collected data, acquiring mineral rights and access, taking subsurface samples, and finally drilling exploratory oil and gas wells.

For this discussion, *reserves* are defined as the inventory of commercially producible oil and gas in known deposits. The resources in such deposits should be of such a quality and quantity that the resource can be commercially developed under market conditions similar to those at the time of discovery.

There are no internationally accepted standards for computing reserves. In the United States and Canada, *proved reserves* are defined as estimated quantities of hydrocarbons that geologic and engineering data demonstrate with reasonable certainty to be recoverable from identified fields under existing economic and operating conditions. In many countries, reserves are thought of as the inventory of oil and gas in identified fields. Reserves for these countries represent volumes of technically recoverable in-place resources without regard to cost or producibility in the near future. The government of Mexico, for example, recently changed the standard for reporting reserves by the national oil company (Pemex) from a broad definition to the narrow definition of proved reserves used in the United States and Canada, thus reducing Mexico's reserves by 53 percent (Williams, 2003).

For the United States and Canada, the narrow definition of proved reserves is necessary because the estimated volumes of oil and gas are used in commercial transactions regulated by government securities and financial agencies. Estimates of proved reserves indicate the short-term sustainability of oil and gas production. No more than 10 to 15 percent of proved reserves (and often much less) can be extracted annually in order to avoid reservoir damage; thus, quantities of proved reserves limit annual production to amounts that are much less than the known recoverable resources.

A *reservoir* is a body of porous, permeable rock that contains a natural accumulation of oil or gas, which is confined by impermeable rock or water barriers. A reservoir may be called a *pool*, even though the petroleum exists in the pores

of the rock. A *field* is an area consisting of a single reservoir or multiple reservoirs grouped on, or related to, the same geologic structure and (or) stratigraphic condition (definition from the Energy Information Administration, 2000). Fields are discussed in more detail below.

Wells can be classified into the following categories: (1) new field wildcat wells, (2) shallow pool test wells, (3) deep pool test wells, (4) extension or outpost test wells, and (5) infill development wells. *Exploration wells* include wildcat wells, new pool test wells (shallow or deep pool), and extension wells. The placement of extension wells may be designed to delineate the periphery of an identified pool or to target a new pool at the periphery of a known accumulation. Historically, an exploration well is classified as a *new field wildcat well* when it is drilled at least 2 miles from any known producing area and targets an undiscovered accumulation (American Petroleum Institute, 2002). Risk, or the probability of failure, on average, tends to increase from infill development wells to exploration wells, to new pool test wells, and then to new field wildcat wells. Even infill development wells are not without risk; some development wells are drilled that fail to make contact with the producing formation.

Figure 1 is a diagram showing different types of wells leading to additions to reserves in discovered fields. In the United States during the last two decades, the additions to reserves that were derived strictly from new field wildcat wells represent a relatively small fraction of annual additions to proved reserves. Most of the annual additions to proved reserves were the result of drilling the types of wells repre-

sented in figure 1. The reserves found may be credited to oil and gas fields that were already discovered. For the United States, these additions to reserves were recorded and published annually as *extensions and revisions* by the Energy Information Administration (2000) of the U.S. Department of Energy. The application of fluid injection programs and well stimulation also added reserves to discovered fields. These procedures are designed to increase the flow of hydrocarbons through the production wellbore to attain commercially profitable rates of production.

Estimates of sizes of oil and gas fields are commonly based on *cumulative recoverable petroleum*, which is defined as the sum of past field production and the most recent estimate of reserves. When additions to proved reserves are credited to a field already discovered, the field size based on the estimate of cumulative recoverable petroleum is said to *grow*. Resource analysts describe the hydrocarbon resources that are expected to be added to the proved reserves of discovered fields as *inferred reserves*. The change of known hydrocarbon resources from the inferred reserve category to the proved reserve category typically requires some drilling.

The amount of growth that will ultimately be credited to a new discovery depends on how narrowly the reserve accumulation size estimate is defined. A narrowly defined accumulation size estimate is usually based on the decline function estimate of the reserves for each producing well drilled in the field to date. The initial estimate will likely increase as the accumulation is developed. Alternatively, if the initial accumulation size estimate is based on the technically recover-
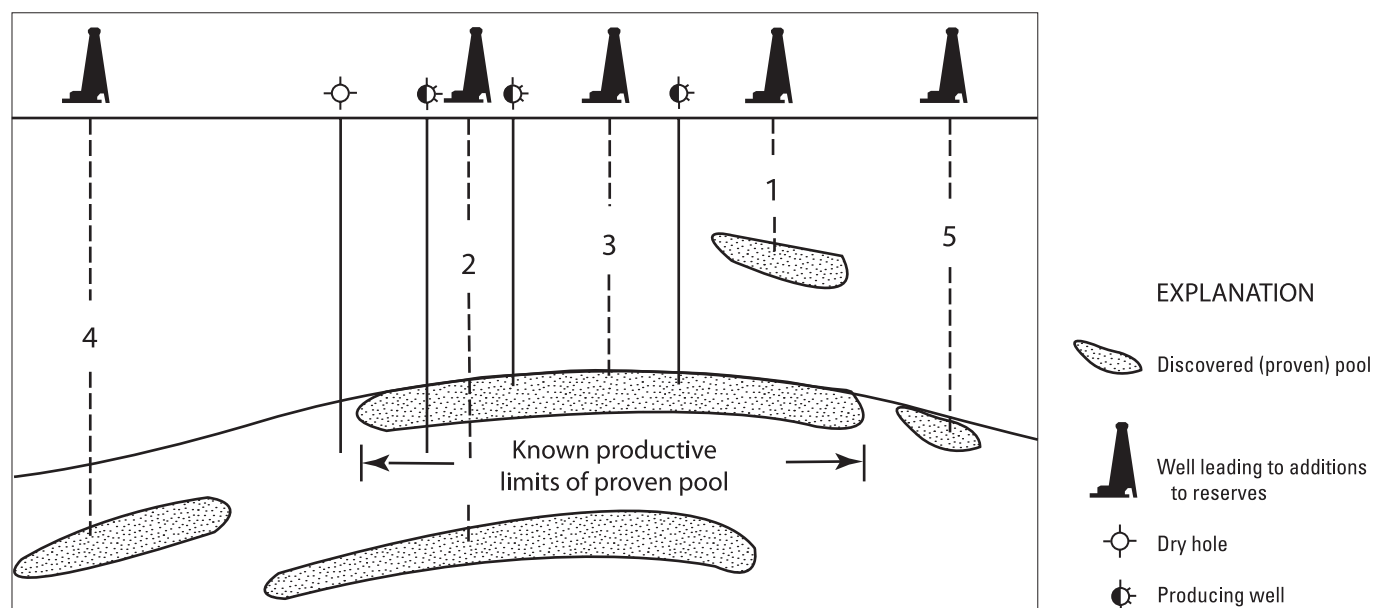
Figure 1.   Diagram of types of wells leading to additions to reserves in discovered fields. The wells (represented by derricks) are as follows: (1) shallow pool test well, (2) deep pool test well, (3) infill development well, (4) new pool test well, and (5) extension or outpost well. Diagram modified from Drew (1997). In practice, the operator or regulatory body may classify the pools penetrated by well types 1–5 as a single field or as more than one field. Recognition of the relations among the accumulations can be complicated by the order in which the wells are drilled.

able value of the in-place volume of oil or gas thought to be contained in the geologic structure or stratigraphic trap, it is not likely to grow as much as the narrowly defined estimates that are tied to production facilities.

There can be some ambiguity as to whether new reserves should be classified as new fields or field growth (see fig. 1). As mentioned above, the Energy Information Administration (2000) defined a field as an area consisting of a single reservoir or multiple reservoirs related to the same individual geologic structural feature and (or) stratigraphic condition. In a single field, two or more reservoirs may be separated vertically or laterally by impermeable strata. From a practical standpoint, the definition of an oil or gas field is not exact. The assignment of pools to fields may be for geologic reasons or for convenience in regulation, or it may be an artifact of the discovery sequence of the pools. Depending on the discovery sequence, the accumulations shown in figure 1 may be assigned to a single field or to more than one field.

Figure 1 shows discrete oil or gas accumulations that are considered to be *conventional* and producible with conventional methods. In contrast, *continuous-type* oil or gas deposits are identified regional accumulations that ordinarily require implementation of unconventional production methods and theoretically have *no hydrocarbon-water contact* that provides a clear-cut accumulation or pool boundary. Outside the United States and Canada, most exploration is focused on discrete oil and gas accumulations that can be produced with conventional methods. Nonetheless, the in-place hydrocarbon resources assessed in continuous accumulations are substantial.

Exploration expenditures are direct investments made by individual firms for the purpose of locating unidentified but potentially commercial quantities of oil and gas. From the perspective of the firm, exploration begins with a hypothesis about the formation of accumulations of hydrocarbons in a specific geologic setting. A literature search may then be conducted to identify potential geographic locations where the hypothesis might be tested. The selection of a target area includes a review of available geologic maps, geochemical data, and geophysical data. Fieldwork or seismic profiling reconnaissance may be required to verify interpretations and to collect additional data to identify specific drilling targets. During drilling, data are continuously collected and interpreted to maximize the probability of locating significant accumulations. After hydrocarbons are encountered by the drill, further geologic, engineering, and economic analyses will determine the potential for a commercial discovery.

Oil and Gas Exploration: Institutional Environment

In the United States

In the United States, mineral rights can be owned either privately or by the Federal or State governments. Government-owned mineral rights are typically transferred to the private

sector for exploration and production. In the past, several systems were used to transfer mineral rights to the private sector. A comprehensive analysis of these institutional systems with respect to economic efficiency and the ability of the government to capture economic rents is beyond the scope of this Circular. At present, however, where significant hydrocarbons are expected, the method used to transfer oil and gas rights to the private sector is the sale of leases through a competitive bidding system.

Private ownership of mineral rights resulted in what economists refer to as "market failures" and then in governmental regulations to remedy these failures. If an oil or gas pool extends beneath several parcels of land, then there could be a number of different property owners with a claim to the oil or gas in a common pool. This situation is the *common property or pool externality*. An *economic externality* is said to occur when the welfare of an individual depends directly not just on his activities, but also on activities of some other economic agent. For example, an economic externality occurs when pollution generated upstream affects the welfare of downstream water users.

In the absence of regulation, oil and gas resources were subject to the *rule of capture*. Historically, the owner who first discovered the pool would start immediately to drill intensively and to produce the resources. In a reservoir, oil and gas flow because of differential reservoir pressures. Thus, by drilling and producing quickly, the first producer could drain resources from his neighbors. In such a situation, neighbors must exploit their parts of the pool as quickly as possible to avoid losing resources to the early producer. This situation results in extremely rapid exploration and production of the resource. The accelerated production reduces the quantity of the resource that can ultimately be recovered from the pool.

Even when oil prices collapse, production does not decline because each producer fears having his part of the pooled drained by a neighbor. To rectify this situation, government regulators in leading oil-producing States instituted a *prorationing system* that limited production for each well to an allowable rate per month and set minimum spacing requirements for wells.

Outside the United States

Outside the United States, national governments typically control the ownership of mineral rights. The rights to explore a concession area are negotiated with the national governments. Although some of the European countries with North Sea production follow an auction system, which in some ways is similar to the U.S. system, these European countries still maintain tight control of resource development. Furthermore, many leading oil- and gas-producing countries outside the United States require separate exploration and production agreements. For some countries, including those in the Middle East, Mexico, and Venezuela, petroleum exploration and production are controlled almost entirely by the national oil
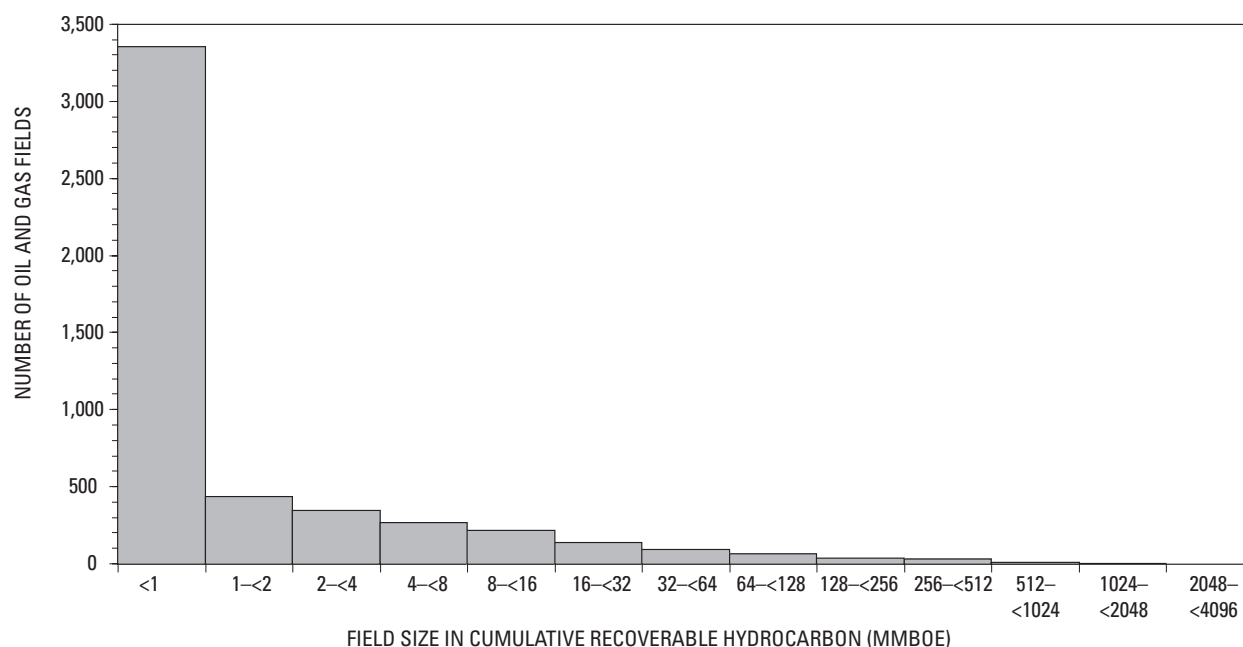
Figure 2.   Histogram showing the size-frequency distribution of oil and gas fields discovered through 1996 in the Permian Basin, West Texas and eastern New Mexico, U.S.A. Data are from the Oil and Gas Integrated Field File made available by William Monroe, Energy Information Administration, 1998. MMBOE, millions of barrels of oil equivalent (10^6 BOE), where 1 BOE = 1 barrel of crude oil or 6,000 cubic feet of natural gas or 1.5 barrels of natural gas liquids. The scale for the field sizes uses unequal intervals defined in powers of 2 to allow all field sizes to fit on the graph.

company, and foreign companies (if allowed at all) are used on a contract basis.

For countries that permit foreign participation, exploration concession agreements generally require a commitment to collect data and to drill a specified number of wells in exchange for the right to explore. The concession areas are sufficiently large so that if a field is found, then the field will likely be contained in a single concession. The concession contract typically specifies that all data collected by the foreign exploration firm should revert to the government. The agreement also specifies what rights, if any, the foreign exploration firm might have in the event of a discovery. If a discovery is made, then a production concession is negotiated, often requiring the foreign exploration firm to share production with the national oil company or to assume the role of contract producer with payments taken in kind as a percentage of production.

Each government has a different set of contract provisions and production taxes designed to attain a specific set of policy goals. These goals may include the training and employment of local workers, the construction of infrastructure, and the provision of social services to the local communities. Moreover, each government typically reserves the right to tailor provisions on an individual basis.

Exploration of Plays and Sedimentary Basins

For petroleum exploration within a well-defined sedimentary basin, regularity in the discovery process allows one to

use the past discovery history to predict the nature and distribution of future discoveries in the basin. The petroleum industry uses the concept of the *petroleum play*, commonly identified in terms of a geologic formation, as a basis for classifying exploration targets (White, 1980; Baker and others, 1984). Although in recent years the concept of a *petroleum system* has been used to provide a conceptual framework for tracing oil and gas migration from its origin to its place of final accumulation (Magoon and Dow, 1994), most exploration geologists still focus on petroleum plays. A play is defined as a set of known or postulated oil and (or) gas accumulations sharing similar geologic, geographic, and temporal properties, such as source rock, migration patterns, timing, trapping mechanism, and hydrocarbon type. Typically, a play may contain pools related to a specific rock unit that might represent single fields or represent parts of fields (Gautier and others, 1996).

In this Circular, field size is measured in terms of fluid volumes expressed in barrels of oil or natural gas liquids and in cubic feet of gas. On the basis of calorific heating values, it is assumed that 1 barrel of oil is equivalent (BOE) to 6,000 cubic feet of natural gas; that is, 1 BOE = 1 barrel (bbl) of crude oil or 6,000 cubic feet (ft^3) of natural gas or 1.5 barrels of natural gas liquids. In addition, a field having at least 20,000 cubic feet of gas per barrel of crude oil is classified as a *gas field*; otherwise, the field is classified as an *oil field*.

Most of the conventional hydrocarbon resource discovered in a basin is contained in a small proportion of the accumulations, and therefore the observed size-frequency distributions of discoveries in most petroleum plays (and

Table 2.   Number of fields and percentage of fields and discovered oil and gas in each field-size class for the U.S. Permian Basin through 1996.

[MMBOE, millions of barrels of oil equivalent. On the basis of calorific heating values, it is assumed that 1 barrel of oil is equivalent to 6,000 cubic feet of natural gas; that is, 1 BOE = 1 barrel of crude oil or 6,000 cubic feet of natural gas or 1.5 barrels of natural gas liquids. Volumes of discovered oil and gas used to figure the percentage of hydrocarbons in each field-size class are reserves plus past production. Data are from the Oil and Gas Integrated Field File made available by William Monroe, Energy Information Administration, 1998. Rounding affects some cumulative percentages]

Field-size class (MMBOE)	Fields			Oil and gas	
	Number of fields	Percentage	Cumulative percentage	Percent in size class	Cumulative percentage
2,048–4,096	1	0.02	0.02	4.86	4.86
1,024–2,048	4	.08	.10	12.14	17.01
512–1,024	14	.28	.38	19.05	36.05
256–512	27	.54	.92	17.43	53.48
128–256	35	.70	1.63	11.23	64.71
64–128	61	1.23	2.85	9.92	74.63
32–64	91	1.83	4.68	8.01	82.64
16–32	133	2.67	7.35	5.61	88.25
8–16	216	4.34	11.69	4.66	92.91
4–8	267	5.36	17.05	2.85	95.76
2–4	344	6.91	23.96	1.85	97.61
1–2	432	8.68	32.64	1.15	98.75
0.5–1	481	9.66	42.30	.64	99.40
0.25–0.5	495	9.94	52.24	.33	99.73
0.125–0.25	483	9.70	61.94	.16	99.89
0.0625–0.125	451	9.06	71.00	.08	99.97
<0.0625	1,444	29.00	100.00	.03	100.00
Total	4,979	100.00	---	100.00	---

petroleum provinces) are highly skewed. Figure 2 shows the size-frequency distribution of oil and gas fields discovered in the Permian Basin (West Texas and eastern New Mexico, of the United States) through 1996. Table 2 shows the percentages of discovered hydrocarbons associated with each field-size class in the Permian Basin through 1996. The Permian Basin is the most prolific oil-producing basin in the onshore conterminous United States. The largest 46 fields (or 0.92 percent of the fields) contain more than 53 percent of the hydrocarbons discovered by 1996, whereas the 1,444 fields in the smallest size class (each containing less than 62,500 BOE) represent 29 percent of the fields but account for only 0.03 percent of the hydrocarbons.

The shape of the Permian Basin size-frequency distribution is typical of many plays and basins in that most of the hydrocarbons are found in a few very large accumulations or fields. Exploration drilling success ratios (numbers of successful exploration wells divided by numbers of total exploration wells drilled) provide no information about the sizes of future discoveries because the (typically) large number of small accumulations determines the final success ratios. The largest Permian Basin field, containing nearly 2.6 billion barrels of oil equivalent (2,600,000,000 BOE or 2.6 BBOE), is at least six orders of magnitude larger than the fields in the smallest size class. If the interval endpoints on the *x* axis in figure 2 were not in powers of 2 (16–<32, 32–<64), then the size classes for the smallest category and the largest category could not have been graphed without a scale break in the axis.

For most fields, the surface expression is related to the volume of petroleum in the field. For example, the East Texas field in East Texas contains 6 billion barrels of oil (6 BBO) and has a surface area of 200 square miles, whereas a field containing 1 million barrels of oil (1 MMBO) could have a surface expression of 1 square mile (Attanasi and others, 1981).

An important consequence of the size distribution is that for an area open to drilling, when deposit surface is roughly proportional to volume, then with random drilling, the average discovery size will decline with equal increments of exploratory drilling. This decline occurs because the larger deposits, with the largest surface areas, have a higher probability of being found. As they are found early in the discovery process, it will take more wells to identify the remaining smaller deposits. Any improvement in exploration efficiency above purely random drilling just accelerates discovery of the large fields and the decline in the discovery rate.

Figure 3 shows the progression in the average sizes (in barrels of oil equivalent) in fields discovered from 1920 through 1995 in 5-year intervals in the Permian Basin. The regularity of the discovery process allows the expected yields of future exploration to be computed with simple analytical models. The discovery rate (yield per exploratory well) is controlled by the field sizes and the order of discovery.

Exploration access, distance from market, and technology are factors determining the order in which basins are explored. In the early years of the U.S. petroleum industry,
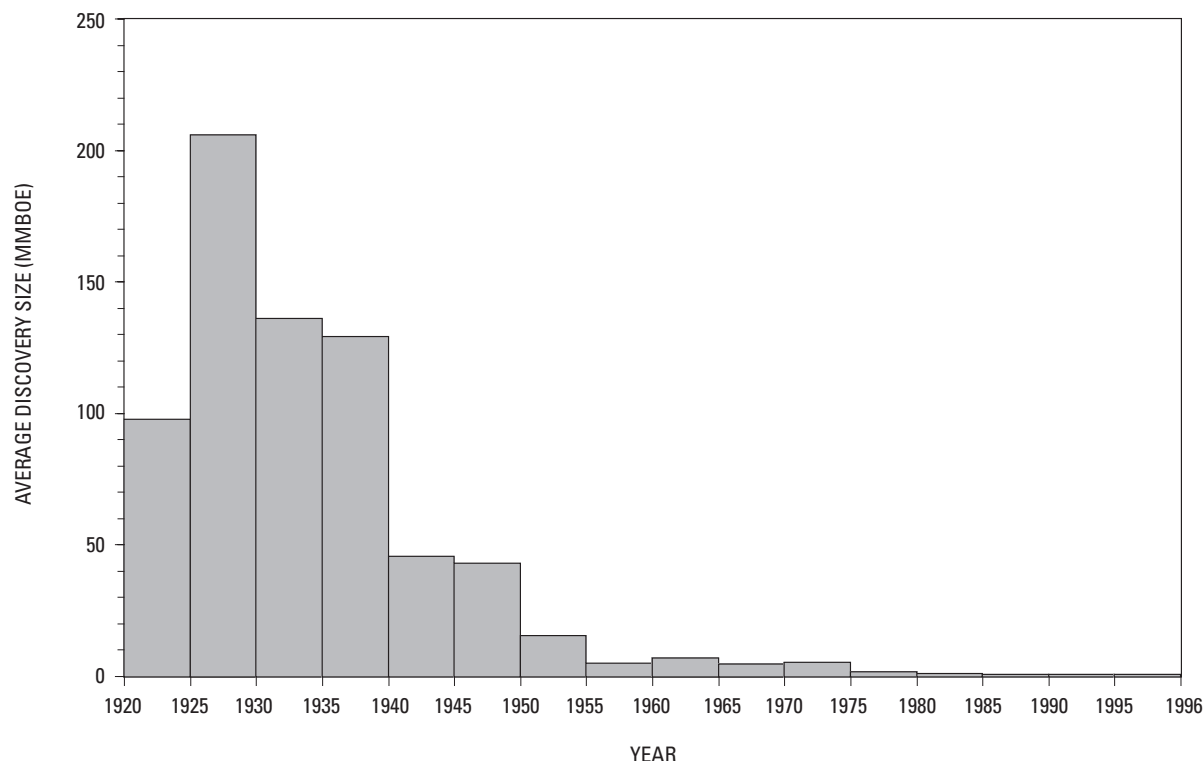
Figure 3.   Graph showing average sizes of fields discovered in 5-year intervals in the Permian Basin between 1920 and 1996. Data are from the Oil and Gas Integrated Field File made available by William Monroe, Energy Information Administration, 1998. MMBOE, millions of barrels of oil equivalent (10^6 BOE), where 1 BOE = 1 barrel of crude oil or 6,000 cubic feet of natural gas or 1.5 barrels of natural gas liquids.

search intensity was influenced by the state of production technology, the costs of transporting oil to market, and the maturity of markets. Some remote prolific basins were not explored as early as the less prolific areas closer to market areas.

The exploration histories of many sedimentary basins follow predictable patterns. New-field wildcat wells are drilled in unproven plays at low but irregular rates, expressed as number of wells per year. After a significant discovery is made, there is typically an influx of new prospectors similar to the 19th century gold rushes; the prospectors create much higher rates of drilling. Drilling rates eventually decline as returns deteriorate and exploration in other plays or basins becomes more attractive. As other plays in the basin are tested, the process is repeated.

Oil and gas production typically exhibits substantial economies of scale so that larger fields are typically less costly to find and produce than smaller fields. If the industry is reasonably efficient in finding the largest and lowest cost accumulations early in the discovery process, then the past discovery sequence provides information useful in estimating the magnitude and characteristics of the undiscovered resources. For countries where field size is narrowly defined (such as the sum of only proved reserves plus past production), the true discovery sizes will generally increase with field development, and such behavior should be taken into account when estimating sizes of recent discoveries.

Discoveries across Provinces: United States and Study Area

In the United States, relatively few petroleum provinces contain most of the hydrocarbons discovered to date. Figure 4A shows the distribution of cumulative recoverable hydrocarbon discoveries (past production and proved reserves of oil, gas, and natural gas liquids) in fields discovered through 1998, expressed in barrels of oil equivalent for the onshore provinces in the conterminous United States. The distribution represents 57 provinces from the conterminous 48 States that were delineated and assessed by the U.S. Geological Survey for the 1995 National Assessment of United States Oil and Gas Resources (Gautier and others, 1996). Of the 57 provinces in the conterminous 48 States with the largest discoveries, only 4 provinces contain 63 percent of the hydrocarbon discovered to date, and the top 9 provinces contain more than 80 percent of the discovered hydrocarbon (NRG Associates, Inc., 2001). The top 9 provinces based on cumulative recoverable hydrocarbon discoveries expressed in barrels of oil equivalent are as follows (in order of decreasing size): Western Gulf, Permian Basin, Anadarko Basin, Louisiana-Mississippi Salt Basins, San Joaquin Basin, Appalachian Basin, Los Angeles Basin, San Juan Basin, and Bend Arch-Fort Worth Basin (NRG Associates, Inc., 2001).

Large-scale commercial petroleum production began in the United States in the middle of the 19th century. By the end
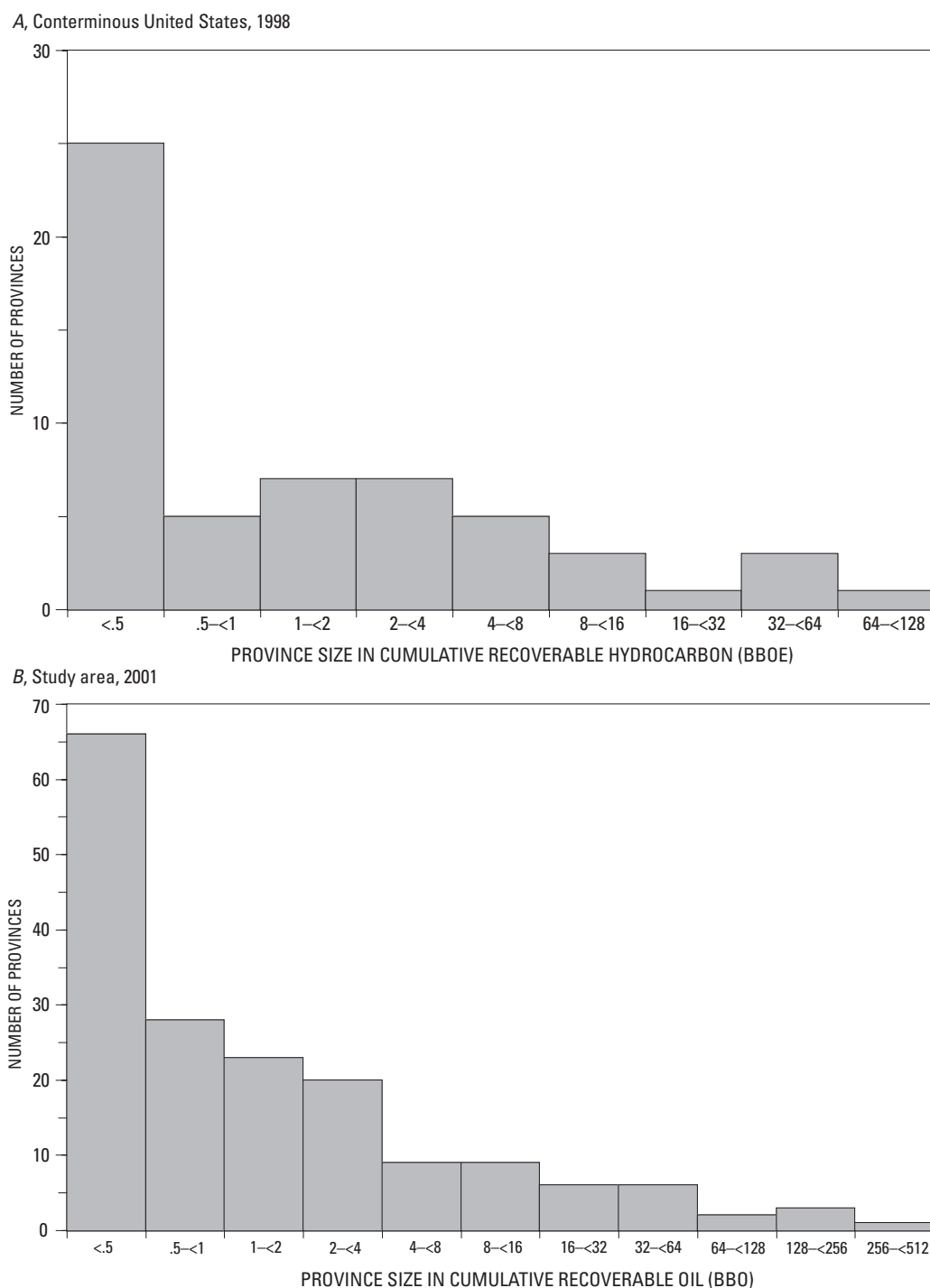
Figure 4. Histograms showing the frequency distribution of cumulative recoverable hydrocarbon volumes (oil, gas, and natural gas liquids in billions of barrels of oil equivalent, BBOE) for 57 onshore provinces of the conterminous United States and cumulative recoverable oil volumes for 173 provinces of the study area, which is the world outside the United States and Canada. In both histograms, the unequal intervals for size classes are defined in powers of 2 to allow all province sizes to fit on the graph. A, Histogram showing the frequency distribution of cumulative recoverable hydrocarbon volumes through 1998 for the 57 onshore provinces of the conterminous United States having the largest discoveries. Data from NRG Associates (2001). B, Histogram showing the frequency distribution of cumulative recoverable oil volumes (in billions of barrels of oil, BBO) through 2001 for the 173 provinces in the study area that have had at least one discovery of at least 100 million barrels of oil or 600 billion cubic feet of gas. Field data from IHS Energy Group (2002); province boundaries from U.S. Geological Survey World Energy Assessment Team (2000). In the study area, seven provinces have no reported oil discoveries but have gas discoveries of at least 600 billion cubic feet of gas (which have minor volumes of oil associated with the gas).

of 1901, petroleum provinces containing more than half the recoverable petroleum (oil and gas) resources in the onshore provinces of the conterminous 48 States had reported at least one discovery of at least 10 million barrels of oil equivalent (10 MMBOE) recoverable. By the end of 1920, the provinces that contained 94 percent of recoverable oil and gas discovered through 1998 had already been explored to such an extent that at least one field of 10 MMBOE had been discovered in each province. The exploratory drilling through 1920, however, represented only a small percentage (less than 5 percent) of the total exploratory drilling through 1998. Since 1920, most onshore exploratory drilling in the conterminous 48 States has been followup drilling in these and other, less prolific provinces (IHS Energy Group, 2001; NRG Associates, Inc., 2001).

Even for the study area, relatively few provinces account for most of the oil discovered to date. The distribution of the quantities of known recoverable oil and gas across petroleum provinces was studied by assigning fields to petroleum provinces. Estimates of recoverable oil and gas by field are from IHS Energy Group (2002). The petroleum province boundaries were established by the geologists of the USGS (U.S. Geological Survey World Energy Assessment Team, 2000). The provinces were then classified as significant if they had at least one discovery that contained either 100 million barrels of oil (100 MMBO) or 600 billion cubic feet (600 BCF) of gas. There were 173 significant provinces, of which 33 were significant for gas only. Figure 4*B* shows a histogram of the cumulative recoverable oil discoveries in these 173 provinces. Table 3 lists the 40 most prolific of these provinces arrayed by the volume of recoverable oil.

For areas outside the United States and Canada, the five provinces with the largest volumes of cumulative recoverable oil discoveries account for 52 percent of the total study area oil discovered through 2001 (tables 3 and 4). Similarly, the top 16 provinces with the largest volumes of cumulative oil discoveries (all having cumulative discoveries of at least 20 billion barrels of oil (20 BBO)) account for 81 percent of the total oil discovered. Nine provinces have discoveries between 10 and 20 BBO and could eventually achieve 20 BBO.

Table 3 identifies the year of the earliest discovery for each of the most prolific 40 oil provinces. The provinces that were discovered first were not necessarily the most prolific provinces. About 23 percent of the oil discovered in the study area through 2001 was located in provinces that had at least one discovery by 1925. Similarly, 59 percent and 93 percent of the oil discovered in the study area through 2001 were located in provinces having at least one discovery by 1950 and 1975, respectively.

Empirical studies that describe the exploration and discovery process suggest that within a defined area open to exploration, the larger fields tend to be discovered early in the exploration process, leading to a declining average discovery size (Kaufman, 1993). Size distributions of accumulations within basins are skewed. Moreover, when the petroleum basins and provinces are arrayed by magnitude of discovered hydrocarbons, the distribution is also skewed. In other words,

a small proportion of the provinces accounts for most of the discovered petroleum. However, the most prolific basins and provinces were not always the earliest explored. Provinces that were explored early were accessible, both legally and technologically, to exploration and commercial production.

Measures of Exploration Maturity

There is strong interest in measures or indices that describe the petroleum exploration maturity of areas. The geographical region of interest may consist of an individual country, groups of countries, or entire continents. Here, *exploration maturity* is defined relative to a density of drilling that, in turn, implies an approximate threshold size of an undiscovered accumulation. An area is *mature* relative to a threshold size if the drilling is sufficiently dense that there is little chance that accumulations at least as large as the threshold size remain undetected in the exploration area.

Petroleum exploration maturity is evaluated by using data generated by the exploration process. These data include all successful and dry well locations (density of drilling) and the locations and magnitudes of discoveries. The well locations reflect the industry's evaluation of the area, and the discovery data reflect the exploration outcomes. Although the complete set of geologic data used to locate exploration and development wells cannot be replicated by a single entity, the locations of past successful and dry wells are available.

Gross wildcat or exploration well counts are inadequate and misleading measures of exploration maturity in large regions. A well drilled near existing wells or production is less likely to find new oil than a well drilled further away from production. Well location data allow the calculation of distances between wells. A minimum distance between wells is necessary for an accumulation of a specific size to remain undetected. Drilling density and distances between wells convey information about the likelihood of occurrence of undetected target accumulations in the search area.

For an individual country, oil and gas exploration is generally confined to only a small fraction of the total land area. Consider the case of wildcat drilling where wells are sited according to a regular grid. If drilling is confined to a fixed area, then the probability of having an undetected accumulation declines as drilling density increases; this decline is called the *crowding-out effect*. Alternatively, for a given density of drilling, using the definitions given above, the exploration for larger accumulations is more advanced (mature) than the exploration for small accumulations. The degree of exploration maturity for a confined area is conditional on the distance between wells, the target size, and the spatial arrangement of wells.

When the exploration area is fixed, the crowding-out effect of wildcat wells together with a rough ordering of discoveries by size produces a declining discovery rate. However, when exploration expands into frontier areas, the

Table 3. Forty most prolific provinces in the study area and their year of first discovery and cumulative recoverable volumes of oil and gas in their petroleum discoveries through 2001.

[Provinces are ranked by the cumulative recoverable volumes of oil in the petroleum discoveries, which are the sum of past production and proved reserves of oil, gas, and natural gas liquids. Years and oil and gas volumes are from IHS Energy Group (2002); province names and code numbers are from U.S. Geological Survey (USGS) World Energy Assessment Team (2000). BBO = billions of barrels (bbl × 10⁹) of oil; TCF = trillions of cubic feet (ft³ × 10¹²)]

Rank	USGS petroleum province name and code number	Year of first discovery	Oil (BBO)	Gas (TCF)
1	Mesopotamian Foredeep Basin, 2024	1938	326	295
2	Greater Ghawar Uplift, 2021	1932	147	260
3	West Siberian Basin, 1174	1953	139	1,531
4	Zagros Fold Belt, 2030	1905	137	486
5	Rub Al Khali Basin, 2019	1954	101	212
6	Volga-Ural Region, 1015	1932	68	100
7	East Venezuela Basin, 6098	1867	63	173
8	Maracaibo Basin, 6099	1914	55	53
9	Niger Delta, 7192	1954	51	194
10	North Sea Graben, 4025	1966	49	167
11	Sirte Basin, 2043	1958	45	48
12	Villahermosa Uplift, 5305	1954	42	51
13	West-Central Coastal, 7203	1951	26	22
14	North Caspian Basin, 1016	1898	22	187
15	South Caspian Basin, 1112	1869	21	71
16	Trias/Ghadames Basin, 2054	1956	21	41
17	Bohaiwan Basin, 3127	1961	19	18
18	Widyan Basin-Interior Platform, 2023	1938	18	15
19	Songliao Basin, 3144	1959	16	5
20	Campos Basin, 6035	1974	14	10
21	Timan-Pechora Basin, 1008	1930	14	42
22	Central Sumatra Basin, 3808	1939	13	2
23	Middle Caspian Basin, 1109	1893	12	32
24	Tampico-Misantla Basin, 5301	1901	12	22
25	Red Sea Basin, 2071	1907	10	9
26	Putumayo-Oriente-Maranon Basin, 6041	1963	9	2
27	Junggar Basin, 3115	1897	8	5
28	Bombay, 8043	1958	7	28
29	Baram Delta/Brunei-Sabah Basin, 3701	1910	7	40
30	Carpathian-Balkanian Basin, 4061	1835	6	8
31	Interior Homocline-Central Arch, 2020	1989	6	17
32	Llanos Basin, 6096	1948	5	8
33	Fahud Salt Basin, 2016	1962	5	11
34	Illizi Basin, 2056	1956	5	41
35	Gippsland Basin, 3930	1924	4	11
36	San Jorge Basin, 6058	1907	4	5
37	Malay Basin, 3703	1969	4	62
38	Vestford-Helgeland, 4017	1981	4	37
39	Kutei Basin, 3817	1897	3	59
40	Saline-Comalcalco Basin, 5304	1904	3	4

Table 4.   Regional distribution in the study area of total and offshore wildcat wells drilled through 2001 and total and offshore estimated cumulative recoverable oil and gas discovered through 2001.

[Data are from IHS Energy Group (2002). BBO, billions of barrels (bbl $\times 10^9$) of oil; TCF, trillions of cubic feet (ft$^3 \times 10^{12}$)]

Region	Total			Offshore		
	Wildcat wells	Oil (BBO)	Gas (TCF)	Wildcat wells	Oil (BBO)	Gas (TCF)
Mexico	1,083	57.5	98.3	120	32.6	21
Caribbean	515	.4	<.1	27	<.1	<.1
Central America	234	.1	<.1	64	0	0
South America	16,203	169	423	2,017	18.8	86.2
Europe*	19,069	75.6	690	4,727	56.3	338
Middle East	3,819	755	2,196	413	103	689
Africa	9,794	169	607	2,735	59	208
Asia	13,036	160	1,043	3,979	47.6	406
Southwestern Pacific..............	4,740	7.93	209	1,099	6.34	181
Russia....................................	11,354	235	2,009	57	2.51	139
Total study area	79,847	1,630	7,275	15,238	326	2,068

*Data for Europe excluding Greenland and Iceland, which have 7 and 0 wildcat wells, respectively.

overall discovery rates can be irregular. The exploration area may expand because of changes in legal restriction or as a result of economic factors or technological breakthroughs. For example, offshore deepwater discoveries are now commercial because of recent advances in technology and improved economic conditions.

To summarize, the petroleum industry does not site exploration wells on a regular grid, and so wells are not evenly distributed. Well locations, distances between wells, and the arrangement of wells are used to initially delineate the search areas, that is, areas where the drilling record shows that firms have explored for petroleum. Well locations and the distances between wells are also used to determine the degree of maturity of exploration of an exploration area already delineated. This determination is accomplished by comparing distances between wells to a threshold deposit size so that a pool of a larger size will not remain undetected. Wells that are closer than the minimum specified distance to preclude the given deposit size provide only redundant information.

In the next section, a scheme to standardize the information conveyed by different well densities is explained. The scheme also provides the basis for the development of graphical tools and numerical measures that are used to describe the location and extent of the area of interest and the maturity of exploration of that area.

Delineated Prospective Area and Explored Area: Definitions

A country or political entity commonly encompasses more than one petroleum province. Locations within an individual country or a group of countries are described mathematically as a set of grid points in a plane. For ease in comparing data in this Circular with data in USGS Circulars 981 and 1096 (Root, Attanasi, and Turner, 1987; Attanasi and Root, 1993), the grid-point spacing used herein has been kept the same. The grid points are 2.83 miles apart, and the area of each cell having the grid points as corners is 8 square miles. Each grid point is identified by a longitude and a latitude location.

The *delineated prospective area* is described as the set of all (grid) points that are reasonably close to wells (producing or dry) and that are also inside the area drilled. The scheme for choosing the grid points that constitute the delineated prospective area (and for computing the magnitude of the delineated prospective area) is based on examination of all non-overlapping triangles (see fig. 5) formed by wells at their vertices. A grid point is said to be in the delineated prospective area if it is located within a triangle that is small enough to fit inside a circle that has a radius of 20 miles. The delineated prospective area, in square miles, is computed as the combined (non-overlapping) area of those triangles having a well at each vertex and fitting inside a circle with a radius of 20 miles (see fig. 5). The delineated prospective areas are then displayed on maps as closed polygons.

The 20-mile radius was chosen in USGS Circulars 981 and 1096 (Root, Attanasi, and Turner, 1987; Attanasi and Root, 1993) because it corresponded to a scale that was convenient for visual presentation of the area of interest for petroleum exploration. The 20-mile radius was also consistent with the precision of the data on the locations of the wells and discoveries. When a radius smaller than 20 miles is used, numerous gaps (data-poor areas) in the prospective area appear, whereas when a larger radius is used, there is a loss of resolution in defining the prospective area.

The computation of the delineated prospective area mapped in figures 14–57 used locations of all wildcat, exploration, and development wells, both successful and dry, along with the locations of fields. All data except data for wells with
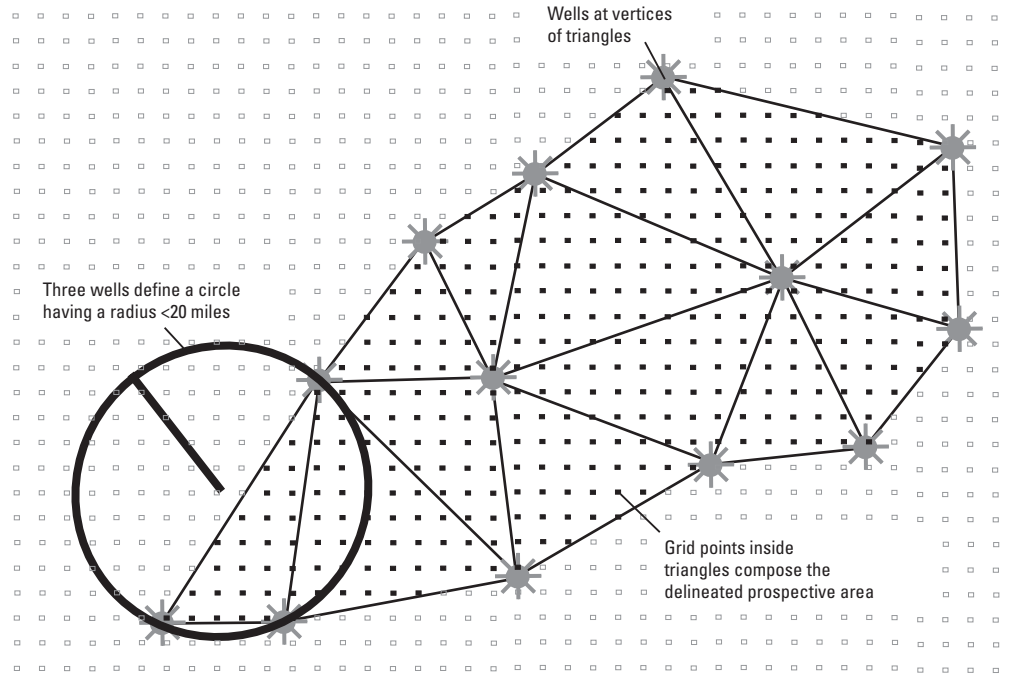
Figure 5. Diagram for identifying and computing delineated prospective area. To facilitate comparisons with Circular 1096 (Attanasi and Root, 1993), the delineated prospective area was calculated the same way for this Circular from grid points that were evenly spaced 2.83 miles apart. If three non-colinear wells define a circle having a radius less than 20 miles, then the triangle connecting the wells defines the delineated prospective area. Grid points that lie within such triangles appear as the delineated prospective area on the maps in figures 14–57. Because the grid point symbols in figures 14–57 are too large to be distinguished separately, the area covered by the grid points appears as a continuous area.

a missing or obviously incorrect location were used because, for some areas, most of the wildcat well history, particularly prior to 1950, is missing. The dry and producing well locations and field locations may represent the only evidence of prior exploration. Use of all the data added some redundancy to the computations but assured that no area that had been searched was excluded because of missing wildcat or exploration wells.

When exploration begins in a country, the prospective area delineated by drilling expands rapidly and then stabilizes later as technological barriers stop further drilling or if yields to drilling in the new area decline. After the stabilization of the delineated prospective area, one might characterize most exploratory drilling as followup drilling, which is more intense drilling in an already delineated prospective area. The *explored area* is defined as the area consisting of the points in the delineated prospective area that are within 2 miles of a well.

Suppose that a well is a distance of exactly 2 miles from another well and that the area covered by a circle between the wells is classified as "explored." In this situation, the largest field that could occur between the wells and in the explored area would have a surface area of 3.14 square miles. (The circle would have a diameter of 2 miles, and so the radius would be 1 mile. The area would then be 3.14 square miles.) Expected recovery from pools having that surface area would vary with pay thickness and with reservoir properties. For the Permian Basin, for example, fields with surface areas of 3.14

square miles averaged recoverable oil of less than 12 MMBO (Attanasi and others, 1981). For the offshore Gulf of Mexico, where reservoir properties are better than in the Permian Basin, fields with 3.14 square miles of surface expression generally averaged less than 24 MMBO (Attanasi and Haynes, 1984). According to these data, for areas designated as explored, the largest possible undetected accumulations are in the range of 12 to 24 MMBO. Although such pool sizes are important locally, if overlooked, they will not significantly change the outlook for undiscovered resources on a global scale.

For some provinces, much of the delineated prospective area may never become explored area because the delineated prospective area was found to be unproductive and not worth further evaluation. A single well can potentially condemn a large area if the well indicates that the occurrence of commercial discoveries is unlikely (because of problems with the timing of hydrocarbon generation, because of a defective trap or seal, or because of the lack of reservoir-quality rock).

The maps for individual countries or groups of countries in the study area show the location of the delineated prospective and explored areas (figs. 14–57). On these maps, exploration maturity is conveyed qualitatively as one compares visually the extent of prospective and explored areas. Accompanying each map is a graph showing cumulative delineated prospective and explored areas, in square miles, plotted against the cumulative number of wildcat wells drilled. The interpreta-

tion of these graphs is explained below in the section, "Tools for Analysis: Graphs."

Measuring Productivity of Delineated Prospective Areas

Discovery rates are often calculated as the aggregate volume of oil or gas in new discoveries divided by the number of exploration wells drilled during a specific time interval. Such discovery rates describe yields per unit of exploration. For a single play having a fixed boundary, the discovery rate declines as progressively smaller accumulations are found. For basins containing several plays, if there is a sustained decline in discovery rates, then analysts will extrapolate the discovery rates to predict future finds, finding costs, and volumes of undiscovered recoverable resources. However, if the area of interest includes multiple sedimentary basins, then discoveries from new areas may offset declining discoveries in old areas, and the discovery rate for the entire region may not decline during the historical data period. With this situation, extrapolation of discovery rates is not useful.

The procedure devised for separating the confounding effects of a declining discovery rate in an old area and a different, and perhaps increasing, discovery rate in new areas required the assignment of discoveries to the grid points in the delineated prospective area. Each point in the delineated prospective area was labeled with a *prospective area date*, which is the year that the point became part of the prospective area. The volume of oil and gas of each discovery was assigned to the grid point in the delineated prospective area that was closest to the field. The prospective area date of a point assigned to the volume of a discovery typically precedes the discovery date of the field. By attaching volumes of oil and gas to delineated prospective area points and prospective area dates, the quality (in terms of petroleum volumes) of the new prospective area can be compared with the quality of the older areas. Yields to drilling in old areas can be compared with the yields to drilling in new areas, in order to decide whether future drilling should target sites already in the delineated prospective area or sites that would open new delineated prospective areas.

Tools for Analysis: Graphs

Two types of graphs showing time profiles of selected variables were developed to supplement the maps of the delineated prospective area and explored area (figs. 14–57). A generalized version of the first type of graph is figure 6*A*, which shows the growth of cumulative delineated prospective area and explored area, arranged by the year when the areas became prospective or explored, versus the cumulative number of wildcat wells, which are also ordered by time. Each point in the delineated prospective and explored areas carries dates that indicate the year in which that location entered the prospective area category and the year in which that location entered the explored area category. The slope of the graph of cumulative

delineated prospective area is, in part, determined by the mix of wildcat wells targeting sites inside and outside the current delineated prospective area. A straight line for cumulative prospective area could indicate a constant fraction of new wildcat wells sited inside and outside the current delineated prospective area. An increase in the slope of the graph could indicate that more wells were devoted to expanding the prospective area. A rollover in the graph (decline in slope) could indicate that more wildcat wells were sited in areas that were already prospective, thus reducing the amount of prospective area added per wildcat well drilled. At the top axis of the graph, the closer the 10-year markers are to each other, the smaller the number of wildcat wells that were drilled in that decade. A decline in the number of wildcat wells drilled could be related to market conditions or to changes in political institutions.

The second type of graph (fig. 6*B*) shows cumulative recoverable oil and gas discoveries as functions of cumulative delineated prospective area, where the increments of prospective area are ordered by time. If all areas are equally productive (and if followup drilling is assumed to be instantaneous), then the graph of cumulative oil or gas discovered versus cumulative delineated prospective area ordered by time is a straight line (fig. 6*B*, curve A). If the earlier delineated prospective area is better endowed than the later delineated prospective area, then the shape of the graph is concave down (fig. 6*B*, curve B). Alternatively, if the later delineated prospective area is better endowed than earlier delineated prospective area, then the graph is concave up (fig. 6*B*, curve C).

Care should be taken when interpreting graphs that show later delineated prospective areas as less productive than early areas. An apparent decline in the volume of discoveries per unit area for recently added areas could be exaggerated because of insufficient time for followup drilling required to develop resources. However, if sufficient time has elapsed without significant discoveries or followup drilling in the later delineated prospective area, then the reduced hydrocarbon yields in this part of the delineated prospective area probably reflect the petroleum endowment accurately.

When an economic or technological advance occurs, such as the movement of Western European petroleum exploration to the North Sea or the movement of exploration to highly productive deepwater areas off Brazil and West Africa, the newly delineated prospective areas immediately show high yields relative to the earlier areas. In graphs for such situations, the curve of cumulative oil and gas discoveries plotted as a function of delineated prospective area is concave up.

Statistics of Exploration and Analysis

Exploration Effort

Table 5 presents the annual totals of wildcat wells drilled in the study area by country and by region from 1961 through 2001 (tables 5–7 follow the "References Cited"). The share

A

YEAR

(Graph A: AREA, IN THOUSANDS OF SQUARE MILES (vertical axis, 0–8) vs CUMULATIVE NUMBER OF WILDCAT WELLS (horizontal axis, 0–100); top axis YEAR with markers 1960, 1970, 1980, 1990, 2000. Curves labeled "Delineated prospective area" and "Explored area.")

B

YEAR

(Graph B: OIL, IN BILLIONS OF BARRELS (vertical axis, 0–5) vs DELINEATED PROSPECTIVE AREA, IN THOUSANDS OF SQUARE MILES (horizontal axis, 0–6); top axis YEAR with markers 1960, 1970, 1980, 1990, 2000. Curves labeled A, B, and C.)

Figure 6.   Generalized graphs of the possible profiles of the growth in the cumulative prospective area and the explored area. *A,* Profiles showing the growth in cumulative delineated prospective and explored areas plotted against the cumulative number of wildcat wells drilled, where both the areas and the wildcat wells are ordered by time. The top axis shows 10-year markers; the closer the markers are to each other, the fewer the wildcat wells that were drilled in that decade. *B,* Profiles A, B, and C of the cumulative oil discovered through 2001 and graphed by the year that the field location was classified as part of the delineated prospective area. Profile A is straight line and indicates that the delineated prospective areas identified by early exploration and late exploration are equally productive. Profile B indicates that the delineated prospective area identified by early exploration is more productive than the delineated prospective area identified by late exploration. Profile C indicates that the delineated prospective area identified by early exploration is less productive than the delineated prospective area identified by late exploration.

of worldwide wildcat drilling accounted for by wildcat wells drilled in the United States and Canada declined from 93 percent in 1950 to 66 percent in 2000. The most dramatic reductions in wildcat wells drilled in the United States came in the 1990s as annual wildcat drilling declined from a high of 9,151 wells in 1981 to an average of 1,645 wildcat wells per year during the period from 1991 through 2000 (American Petroleum Institute, 2003). For the period from 1961 through 2001, the data in table 5 show that the share of study area's wildcat wells drilled in Europe declined as the share of the wildcat wells drilled in Africa and Asia increased.

The use of wildcat-well drilling as a measure of exploration effort can be misleading. Many of the wildcat wells drilled outside the United States, Canada, and Europe were directed at testing new plays, whereas most of the U.S., Canadian, and European wildcat wells were drilled in lower risk proven plays. Even within the same country, use of wildcat-well counts as a measure of exploration effort can be misdirected. For well counts to be a meaningful measure of exploration effort, the wells should be of roughly equivalent costs. Shallow-water offshore wells are typically much less costly to drill than deepwater wells, and onshore wells are less costly than offshore wells given the same basic subsurface and geologic conditions.

Figure 7 shows that changes in international oil price levels led changes in annual wildcat drilling in the study area from 1968 through 2001. Changes in the market price of oil affect the petroleum industry's revenues for all fields, its cash flow position, and its ability to fund exploration. Price changes also create expectations regarding future prices. In an environment of increasing prices, the expectation that such price levels can be sustained in the future tends to encourage the industry to explore and produce oil in high-cost areas.

Regional Exploration Statistics and Analysis

The regional discovery data for the study area are summarized in tables 4 and 6 (tables 5–7 follow the "References Cited") and in figures 8 through 11. Table 4 lists total and offshore wildcat wells along with the oil and gas discovered by region. Table 6 lists for each region the significant geologic provinces and the year of first discovery and cumulative recoverable oil and gas discovered through 2001 for each. Some of the 173 significant provinces in the study area have resources in two regions, which are apportioned to the appropriate region in figures and tables of this Circular (table 6).

Figure 8 shows for each of the major regions the discovery sequence and the magnitude of the cumulative recoverable oil in each significant province. The most prolific provinces (defined on the basis of cumulative recoverable oil) are commonly identified early, but they are not generally the first found in the discovery history of a region.

The regional annual discovery rates for oil and gas by 5-year intervals are shown in figures 9 and 11, respectively, for the period from 1951 through 2000. These figures also show which portions of total discoveries are onshore and offshore.

Figure 7.   Graph showing that the average price of imported crude oil to U.S. refineries led the annual wildcat drilling rate in the study area from 1968 through 2001. Price data are from American Petroleum Institute (2003); wildcat well data are from IHS Energy Group (2002).

The regional oil discovery rates calculated on the basis of oil per wildcat well for 5-year intervals from 1951 through 2000 are presented in figure 10.

For most areas, gas was not commercial during the period from 1951 to 2000, and so the reporting of gas that is discovered with oil and as nonassociated gas is likely to be incomplete and understated. Because wildcat wells typically have no predrilling-intent information reported by the data services, in countries where gas is a commercial resource, there is no way to distinguish the proportion of wells targeting oil prospects and those targeting gas prospects.

The results of the regional computations of the delineated prospective areas and explored areas are presented in figures 12*A–G* and 13*A–G*. Table 7 provides a summary of data for the 10 regions computed by adding together data from the individual countries and country groups (tables 5–7 follow the "References Cited"). Although table 5 presents data for the Caribbean, Central America, and Mexico, these data are included in figures 12 and 13 only in the study area graphs in figures 12*H* and 13*H*. This analysis of exploration and yield data focuses on trends showing exploration maturity; a full interpretation of the data should also consider government resource development policies, regulations, and the market conditions. For example, for some of the countries, when natural gas became a commercially marketable commodity, the gas yield curves show the later prospective areas to be better endowed than early areas as exploration may have shifted to areas prone to discovery of nonassociated gas accumulations.

The regional delineated prospective area and explored area shown in figures 12 and 13 and discussed in the following sections on each region are aggregated from the data shown in figures 16 through 54. Maps are provided for the Caribbean (fig. 14) and Central America (fig. 15), but these areas are not discussed as a separate region because the discovered petroleum is very small. No map was made for Mexico because although the discovery data for Mexico may be reasonably complete, substantial amounts of exploration drilling data are missing. Data for each region are derived from figures as follows: South America, figures 16–24; Europe, figures 25–27; Middle East, figures 28–32; Africa, figures 33–44; Asia, figures 45–53; southwestern Pacific, figures 54–56; and Russia, figure 57.

In the discussions about the relative richness of prospective area within regions, the prospective area is described in terms of an early half and a late half. Suppose there is a region where half of the total prospective area that was delineated through 2001 became prospective by 1970. Then the *early half of the prospective area* is that part of the prospective area that became prospective before January 1970, and the *late half of the prospective area* is that area that became prospective after January 1970.

Mexico

According to available data, Mexico has five significant provinces (table 6). The Villahermosa Uplift accounts for 73 percent of the oil and 52 percent of the discovered gas in Mexico through 2001. The Tampico-Misantla Basin has discovered oil of 11.5 BBO and discovered gas of 21.553 TCF. The two provinces together account for 93 percent of the oil and 74

percent of the gas discovered through 2001. The historical well data for Mexico are incomplete.

South America

South America accounts for about 10 percent of the oil and 6 percent of the gas discovered in the study area (table 4). South America has a long history of petroleum exploration and discovery. The East Venezuela Basin (fig. 22) and the Maracaibo Basin (figs. 20 and 22) each have cumulative recoverable oil discoveries in excess of 20 BBO (table 6). Along with the Campos Basin (fig. 24), these provinces account for 78 percent of the oil discovered through 2001 in South America (table 4). Discoveries in the East Venezuela and Maracaibo Basins occurred early in the exploration history of South America (fig. 8*A*). For gas, the three most prolific provinces—the East Venezuela Basin (fig. 22), Maracaibo Basin (figs. 20 and 22), and Santa Cruz-Tarija Basin (figs. 18 and 23)—accounted for 65 percent of the discovered gas. With the exception of gas in the Santa Cruz-Tarija Basin, most of this gas was associated with oil discoveries.

Oil and gas discoveries prior to 1951 account for 50 percent of the oil and 32 percent of the gas discovered through 2001. Since 1950, the period from 1956 through 1960 represents the peak 5-year period of annual oil discoveries and oil discovered per wildcat well (figs. 9*A* and 10*A*). By the last period, 1996–2000, more than half of the oil discovered was offshore (fig. 9*A*). For gas, the peak period of annual discoveries was from 1996 through 2000 (fig. 11*A*), and about one-third of the gas discovered during that period was in offshore fields.

The delineated prospective area for South America doubled between 1974 and the end of 2001, but the oil discovered in the prospective area added between 1974 and the end of 2001 (the late half of the area) amounts to only 16 percent of the oil discovered in the area that became prospective before 1974 (the early half of the prospective area) (figs. 12*A* and 13*A*). Similarly, the gas discovered in the late prospective area amounts to only 27 percent of the gas discovered in the early prospective area (fig. 13*A*). By the end of 2001, the explored area represented 25 percent of the prospective area (table 7). Wildcat drilling declined in the 1990s (table 5), and there was a parallel slowdown in the expansion of prospective area.

Figure 13*A* shows a slight increase in productivity for both oil and gas for the areas added since the mid-1980s. The large discoveries in the newly added areas are in the deepwater Campos Basin (fig. 24) offshore of Brazil. Commercial exploration and development of these deepwater areas required innovations in exploration and production technologies. Petrobras, the national oil company of Brazil, led development of deeper offshore waters as part of the government's overall energy policy. The maps in figures 14–25 show the 200- and 1,000-meter (656- and 3,280-foot) bathymetry contours. In water deeper than 200 meters, exploration and development are substantially more costly than in the adjacent shallow areas.

Europe

In this Circular, Europe is considered to be continental Europe (figs. 25–27), excluding Russia, Greenland, and Iceland. Russia is discussed as a separate region. Greenland has seven wildcat wells, and Iceland has none, but their data were excluded from the European totals, and maps of these areas are not included.

Some significant provinces have resources in two regions, which are apportioned to the appropriate region in figures and tables of this Circular (table 6). For example, discoveries shown in figure 27 for the European parts of the Dnieper-Donets Basin and the Azov-Kuban Basin do not include discoveries in the Russian parts of the basins (fig. 57). Similarly, discoveries shown in figure 27 for the European part of the Aegean do not include discoveries in the Middle East part of the Aegean (fig. 28).

Europe accounts for just less than 5 percent of the oil and for 9 percent of the gas discovered in the study area (table 4). Oil discoveries date from the mid-1800s (fig. 8*B*). The North Sea Graben (fig. 25) accounts for 65 percent of the cumulative recoverable oil and 24 percent of the cumulative recoverable gas discovered in Europe through 2001. The four most prolific oil provinces—North Sea Graben (fig. 25), Carpathian-Balkanian Basin (fig. 27), Vestford-Helgeland (fig. 25), and Northwest German Basin (fig. 25)—account for 81 percent of the oil. The four most prolific gas provinces—North Sea Graben (fig. 25), Northwest German Basin (fig. 25), Anglo-Dutch Basin (fig. 25), and Dnieper-Donets Basin (fig. 27)—account for 69 percent of the natural gas.

Oil and gas discoveries prior to 1951 account for only 8 percent of the oil and 10 percent of the gas discovered through 2001. The 5-year period from 1971 through 1975 had the highest annual rate of oil discovered and oil per wildcat well discovered (figs. 9*B* and 10*B*). The 5-year period from 1956 through 1960 had the highest annual gas discovery rate (fig. 11*B*). During that period, Gronnigen, the largest gas field in the region, was discovered in the Northwest German Basin. Advances in offshore technology and the high oil prices during the 1970s ensured that the North Sea discoveries could be commercially developed.

The delineated prospective area of Europe doubled between 1968 and the end of 2001 (fig. 12*B*). The shapes of the oil and gas yield curves shown in figure 13*B* reflect the expansion of the prospective area into the North Sea and the offshore area's richer oil endowment compared to the endowment of onshore areas. The late half of the prospective area, principally the North Sea Graben, has more than 3.5 times the oil found in the early half of the prospective area. Although gas discoveries in the delineated prospective area added between 1968 and the end of 2001 amounted to two-thirds of the gas discovered in the early half of the prospective area, government regulation and market conditions may have delayed gas-field development in the late half of the area.

A, Year of first discovery for significant provinces in South America
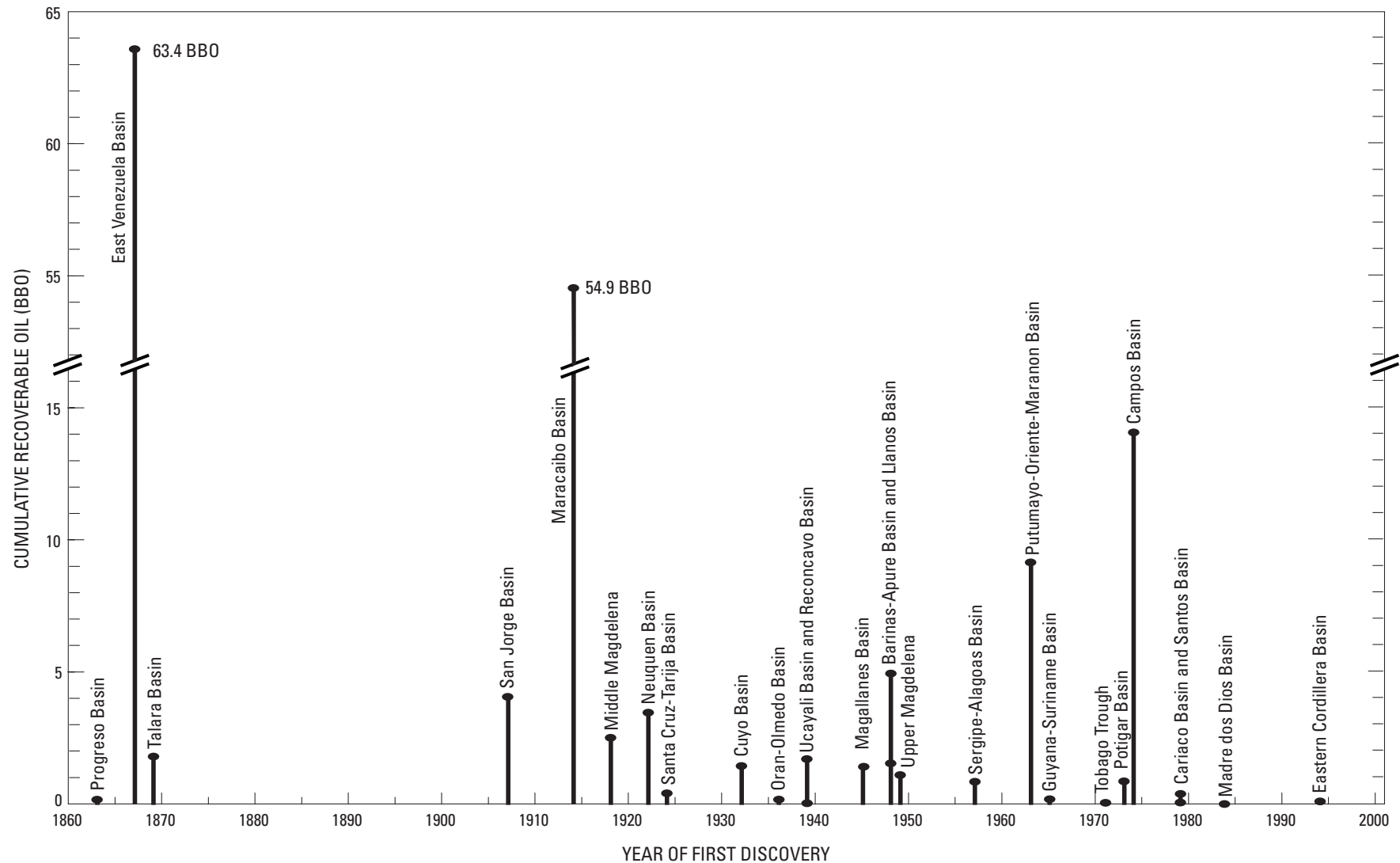
Figure 8. Graphs showing historical sequence by year of first discovery in each significant petroleum province and magnitude of cumulative recoverable oil discoveries through 2001 in each province for six regions: *A,* South America; *B,* Europe; *C,* Middle East; *D,* Africa; *E,* Asia; and *F,* Russia. Large discoveries require breaks in the vertical axis in parts *A, B, C,* and *F.* Some of the significant provinces have oil in two regions, which is apportioned to the appropriate region in this figure. Significant provinces plotted have had at least one discovery of at least 100 million barrels of oil; significant provinces defined solely on the basis of at least one gas discovery containing at least 600 billion cubic feet of gas are not plotted in this figure but are listed in table 6. BBO, billions of barrels (bbl × 10⁹) of oil. Years of first discovery and estimated volumes of cumulative recoverable oil are from IHS Energy Group (2002).

B, Year of first discovery for significant provinces in Europe
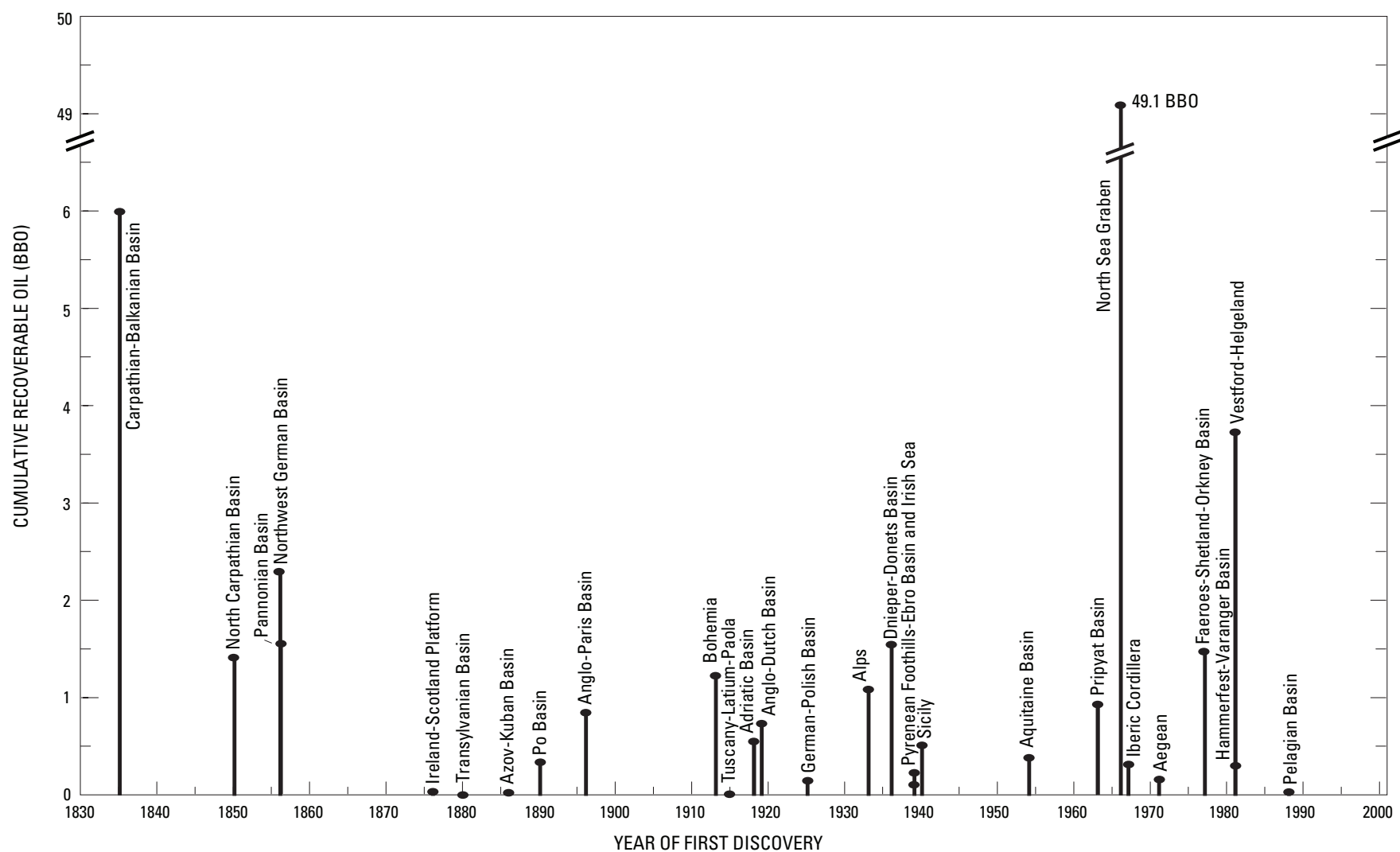
Figure 8. Continued.

C, Year of first discovery for significant provinces in the Middle East
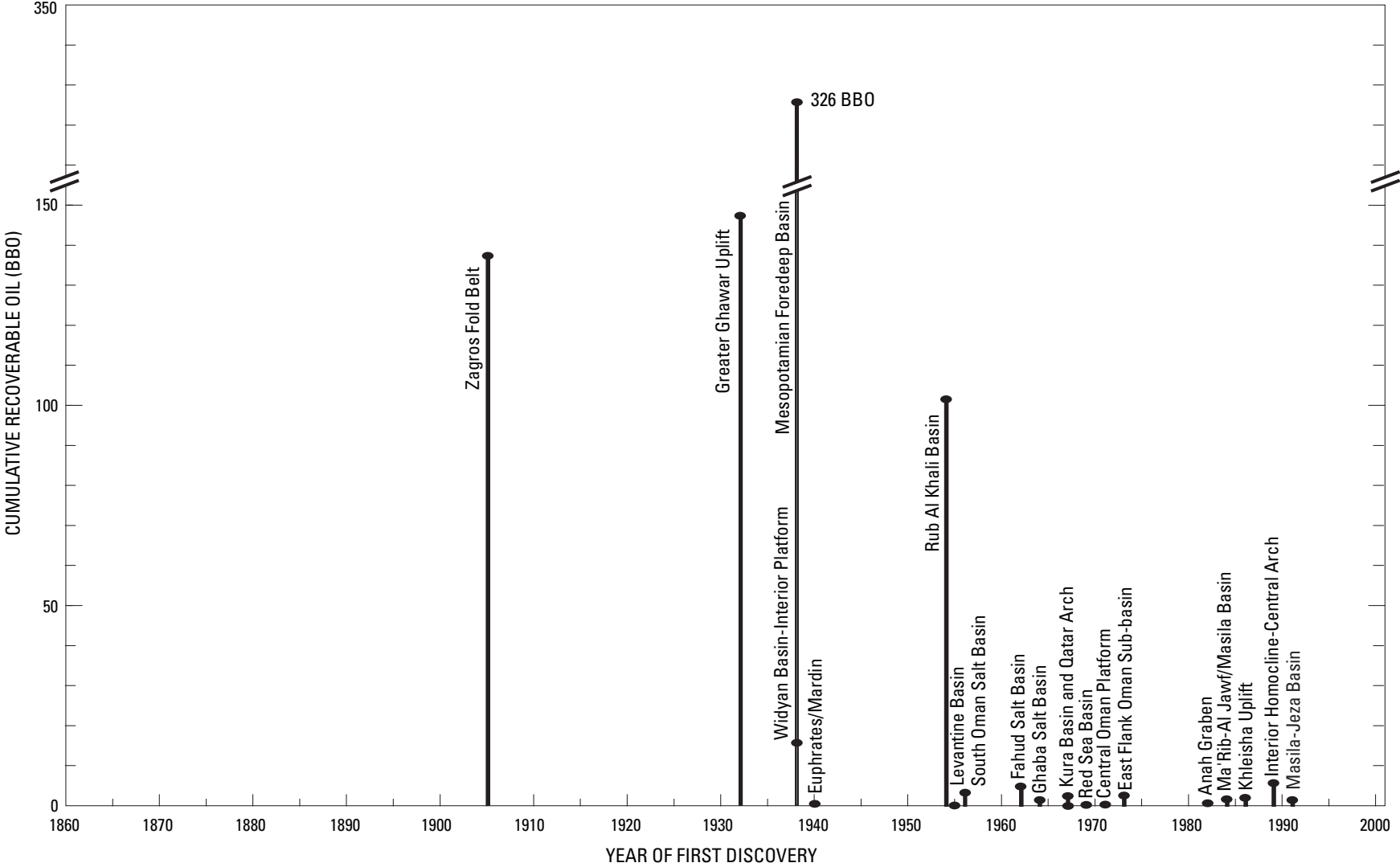
Figure 8.   Continued.

D, Year of first discovery for significant provinces in Africa

Figure 8. Continued.

E, Year of first discovery for significant provinces in Asia
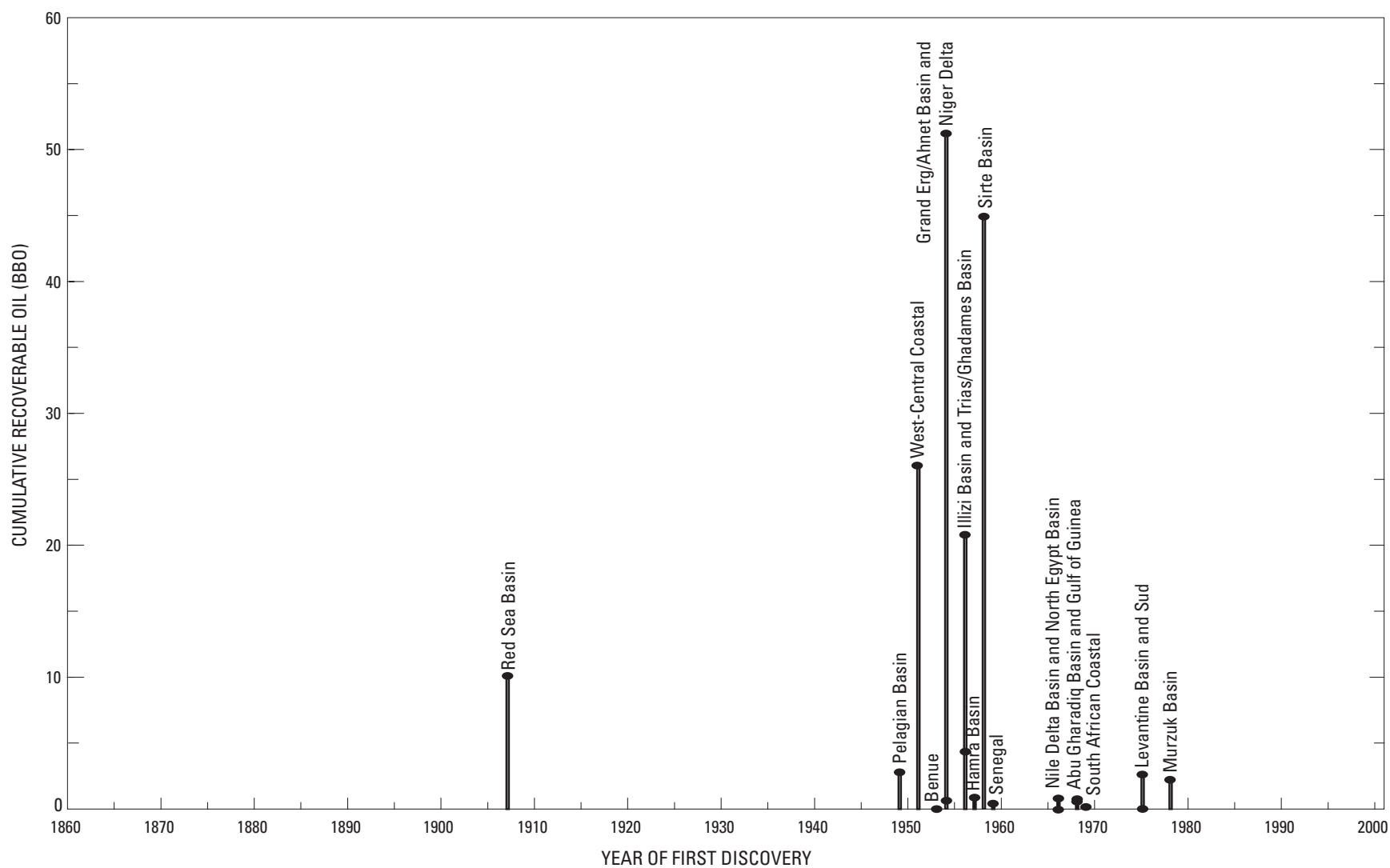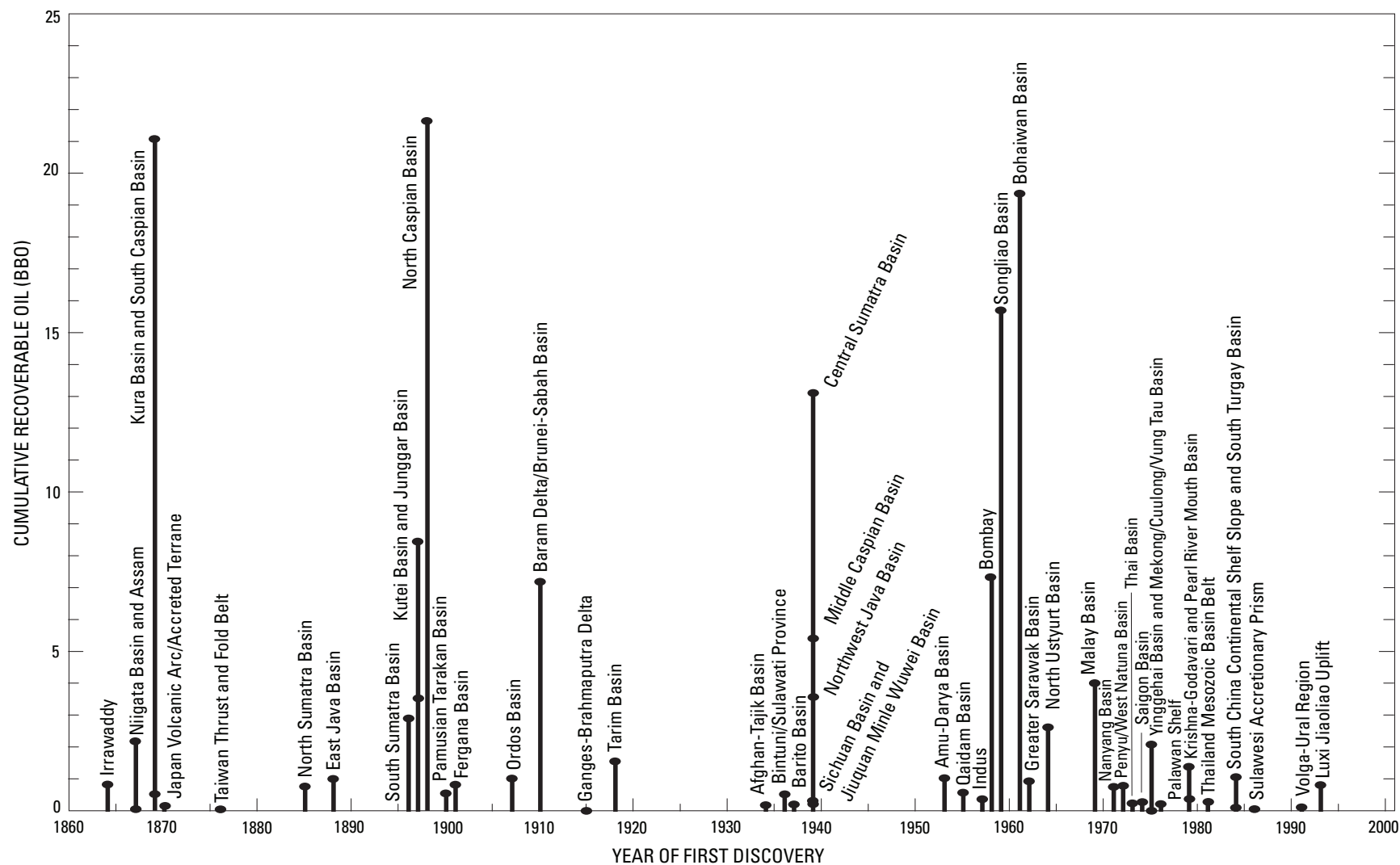
Figure 8.   Continued.

F, Year of first discovery for significant provinces in Russia
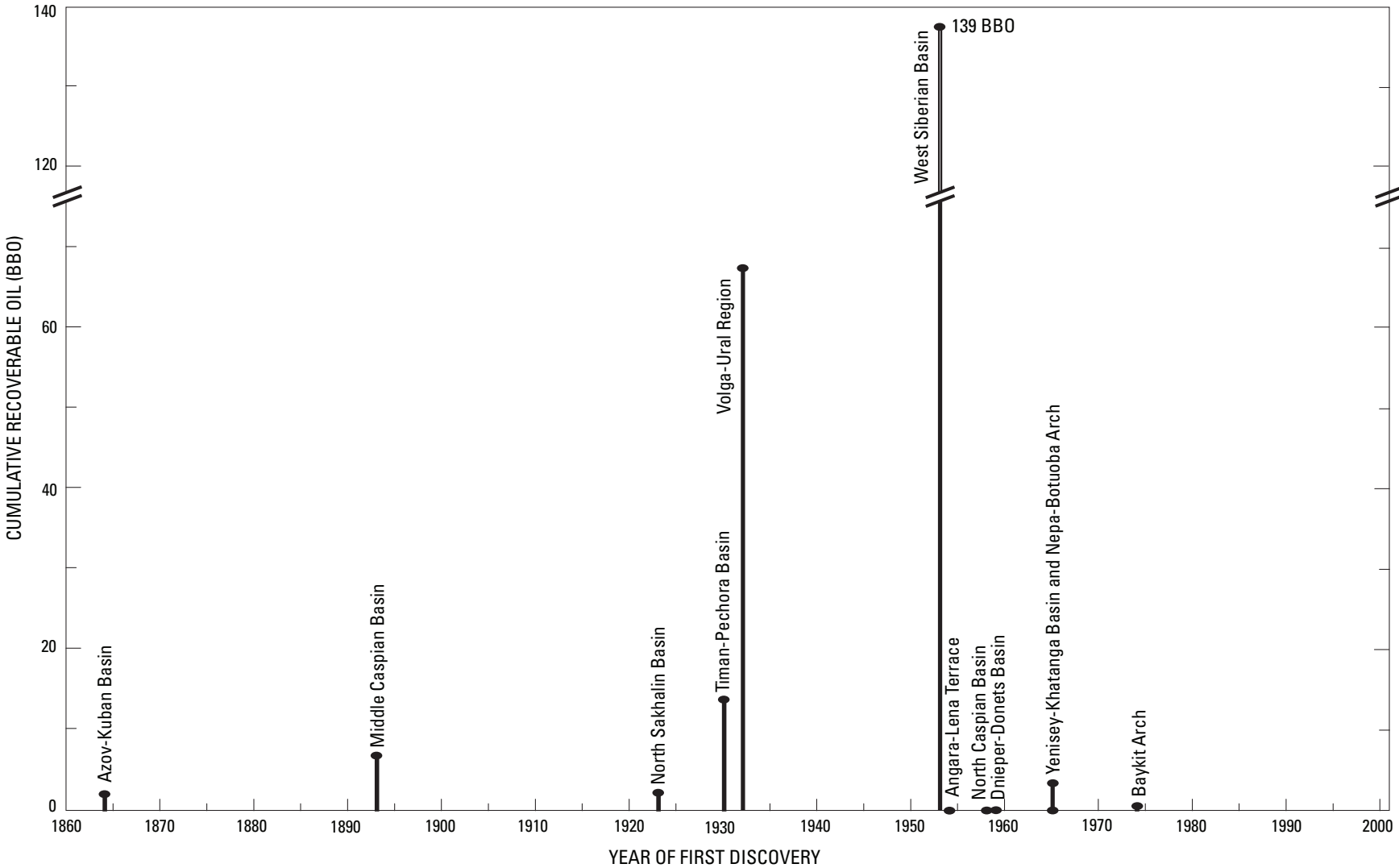
Figure 8. Continued.
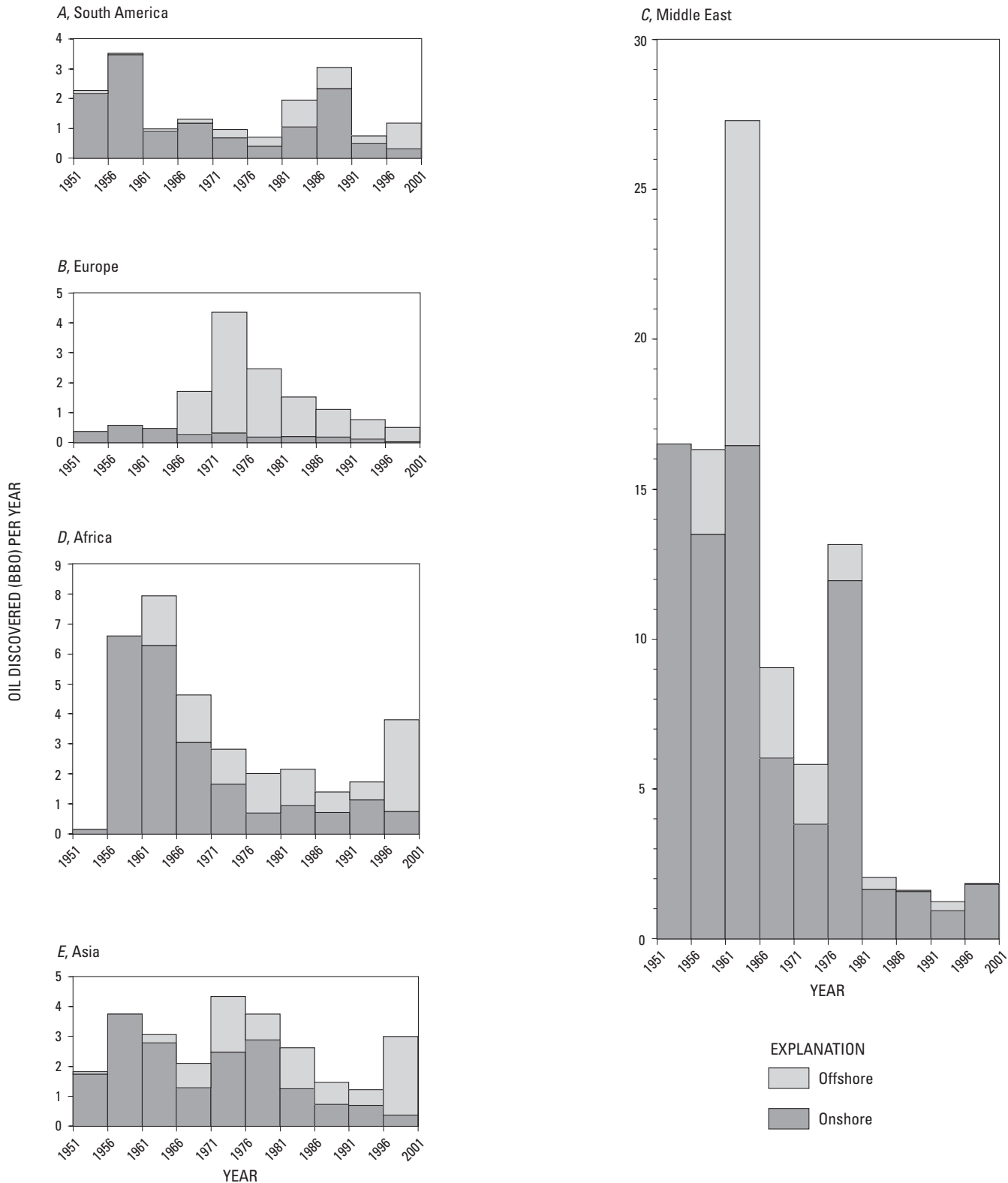
Figure 9.   Graphs showing average annual volume of oil discovered offshore and onshore for 5-year intervals from 1951 though 2000 for seven regions and the whole study area: *A*, South America; *B*, Europe; *C*, Middle East; *D*, Africa; *E*, Asia; *F*, Southwestern Pacific; *G*, Russia; and *H*, Study area. The study area graph (fig. *9H*) includes data for Mexico, Central America, and the Caribbean, as well as for the seven regions for which data are graphed in figures *9A–G*. BBO, billions of barrels of oil (bbl × 10^9). Discovery size estimates are from IHS Energy Group (2002).

F, Southwestern Pacific

G, Russia

OIL DISCOVERED (BBO) PER YEAR

H, Study area (Note change in vertical scale)
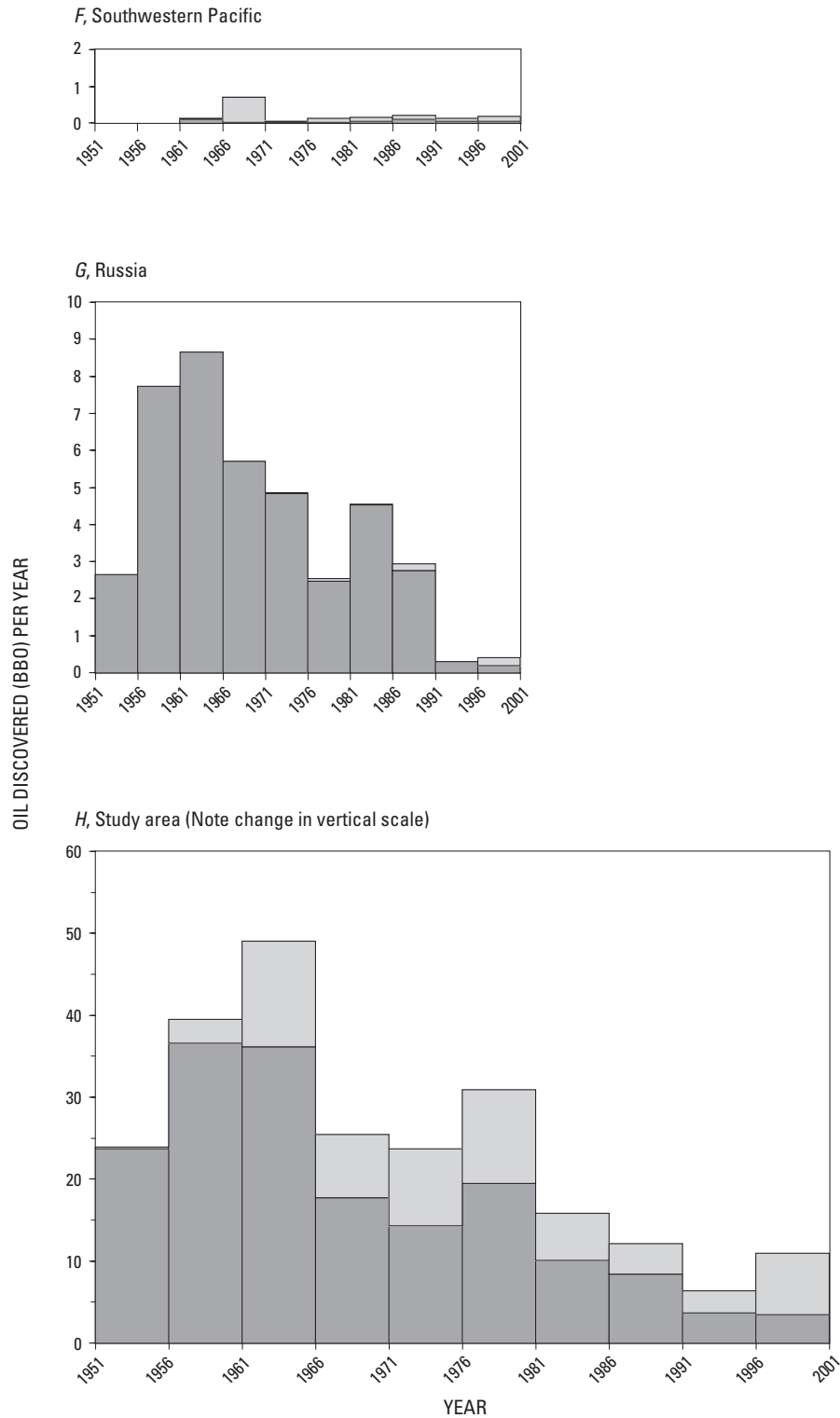
YEAR

Figure 9.   Continued.
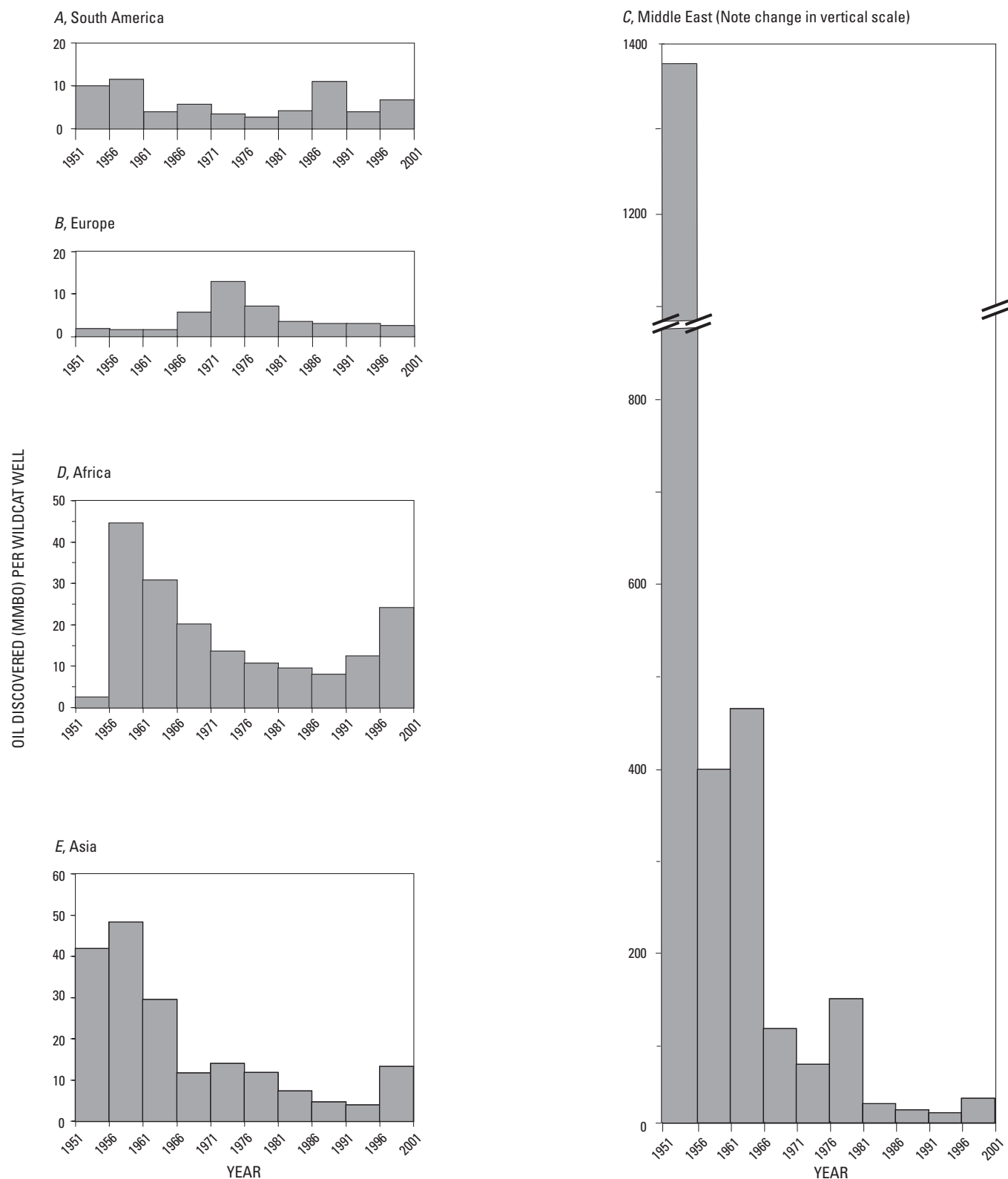
Figure 10.   Graphs showing oil discovery rate per wildcat well for 5-year intervals from 1951 through 2000 for seven regions and the whole study area: *A,* South America; *B,* Europe; *C,* Middle East; *D,* Africa; *E,* Asia; *F,* Southwestern Pacific; *G,* Russia; and *H,* Study area. The study area graph (fig. 10*H*) includes data for Mexico, Central America, and the Caribbean, as well as for the seven regions for which data are graphed in figures 10*A–G*. MMBO, millions of barrels of oil (bbl × 10^6). Wildcat well data and discovery size estimates are from IHS Energy Group (2002). Discovery rates reflect data for all wildcat wells and discoveries both onshore and offshore.

F, Southwestern Pacific

G, Russia

H, Study area (Note change in vertical scale)

YEAR

OIL DISCOVERED (MMBO) PER WILDCAT WELL
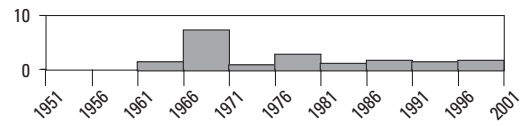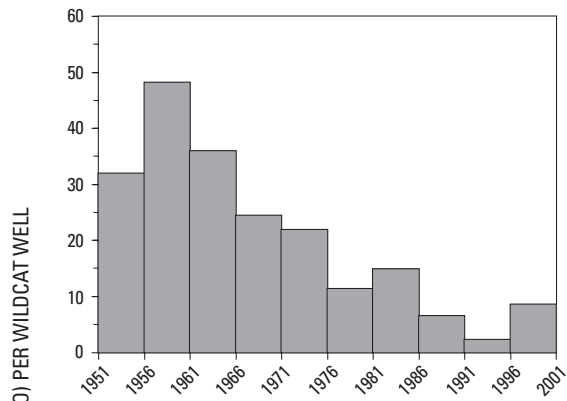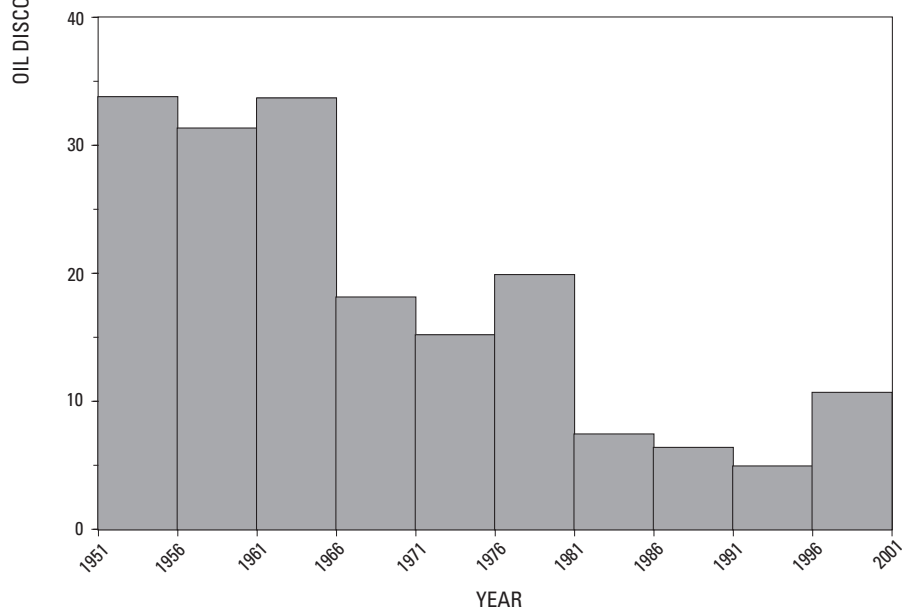
Figure 10. Continued.
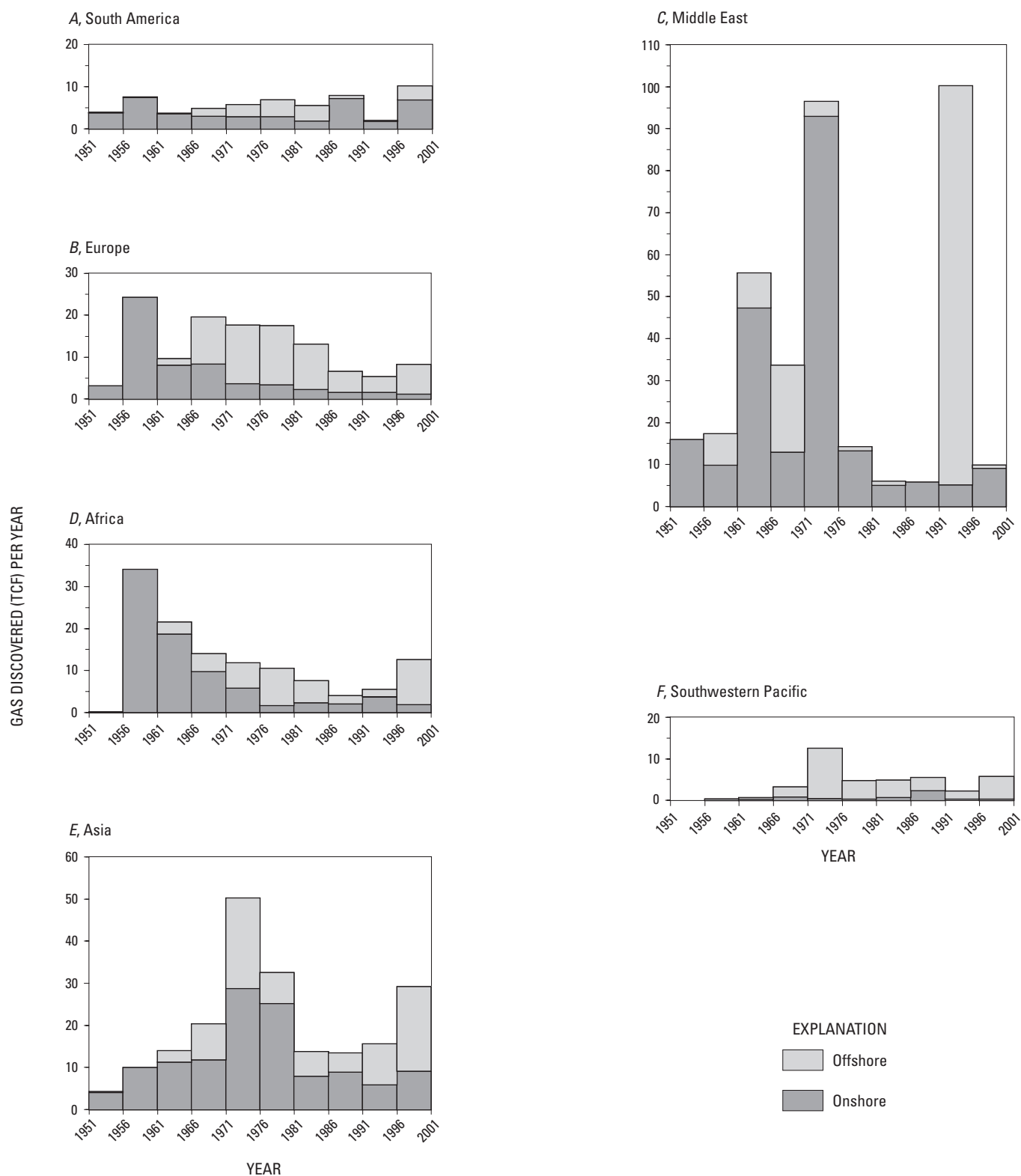
Figure 11.   Graphs showing average annual volume of gas discovered offshore and onshore for 5-year intervals from 1951 through 2000 for seven regions and the whole study area: *A,* South America; *B,* Europe; *C,* Middle East; *D,* Africa; *E,* Asia; *F,* Southwestern Pacific; *G,* Russia; and *H,* Study area. The study area graph (fig. 11*H*) includes data for Mexico, Central America, and the Caribbean, as well as for the seven regions for which data are graphed in figures 11*A*–*G*. TCF, trillions of cubic feet (ft^3 × 10^{12}). Discovery size estimates are from IHS Energy Group (2002).

G, Russia

H, Study area (Note change in vertical scale)

YEAR
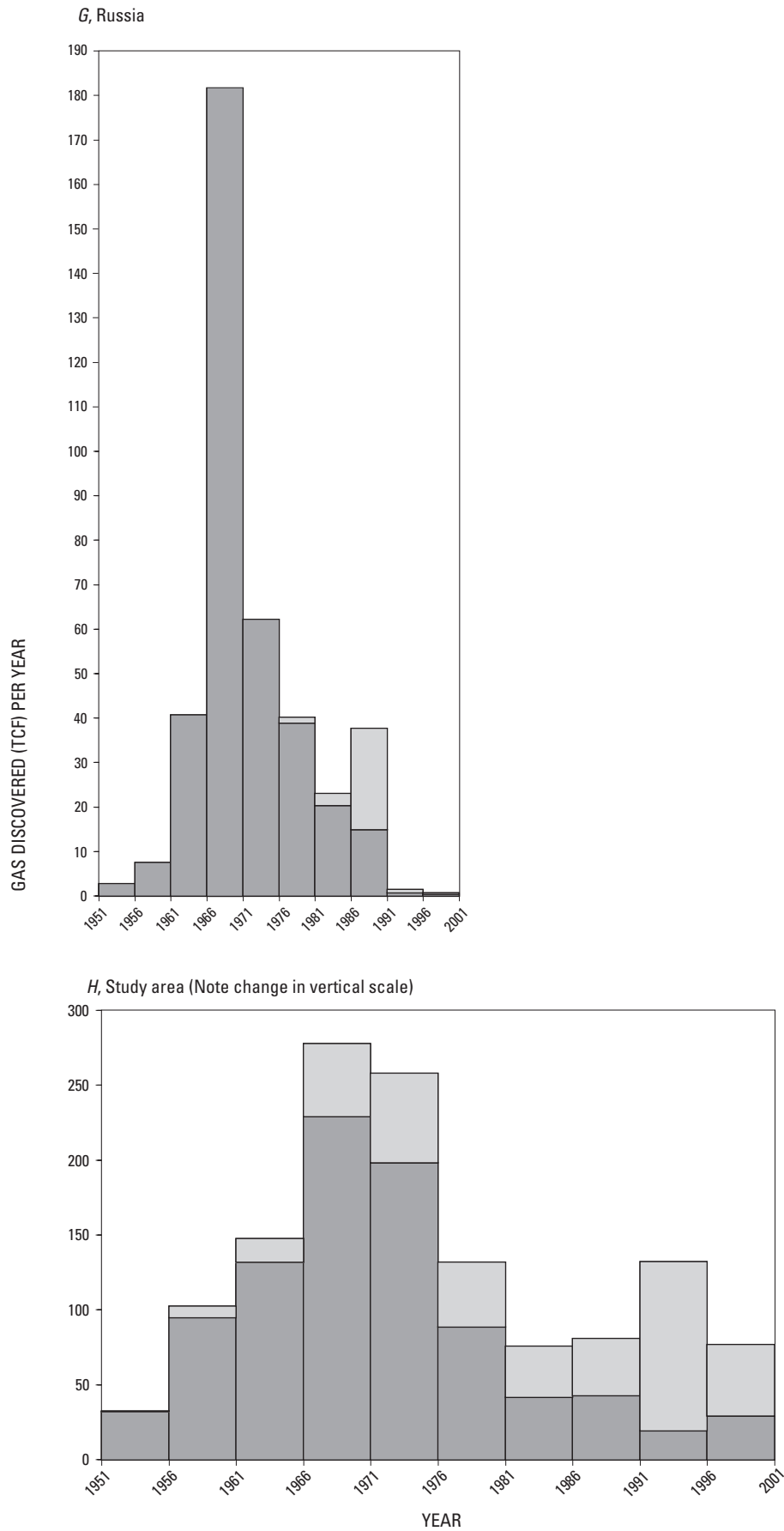
Figure 11. Continued.
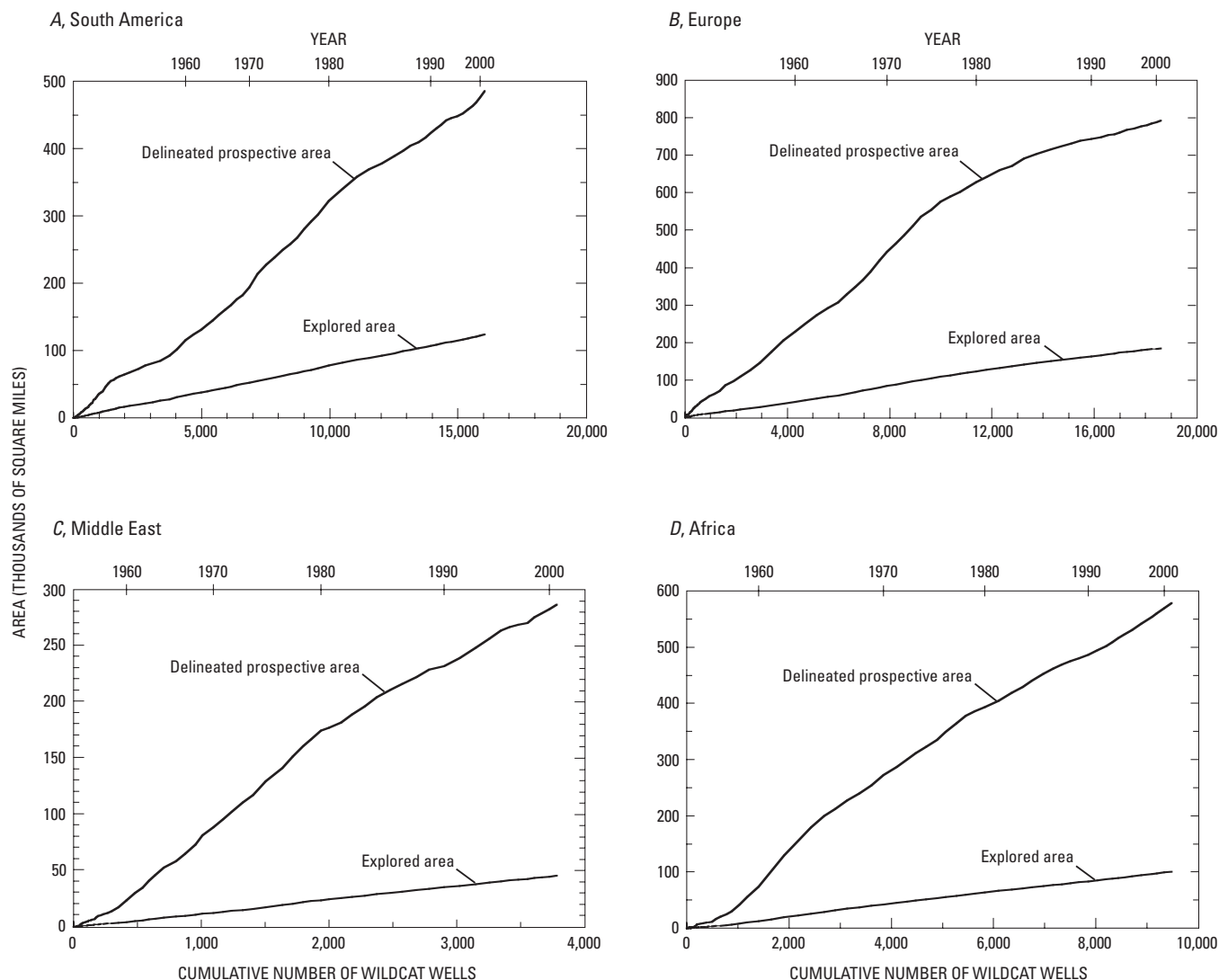
Figure 12. Graphs showing growth in delineated prospective area and explored area delineated by wells drilled through 2001 for seven regions and the whole study area: *A,* South America; *B,* Europe; *C,* Middle East; *D,* Africa; *E,* Asia; *F,* Southwestern Pacific; *G,* Russia; and *H,* Study area. The study area graph (fig. 12*H*) includes data for Mexico, Central America, and the Caribbean, as well as for the seven regions for which data are graphed in figures 12*A*–*G*. The regional graphs are at different scales and are derived from graphs in figures 16–57. The areas are arranged by the year they became prospective or explored, and the wells are also ordered by time. At the top axis of the graphs, the closer the 10-year markers are to each other, the smaller the number of the wildcat wells that were drilled in that decade. Calculation of delineated prospective area is explained in the text. Well data are from IHS Energy Group (2002). Only wildcat wells that have spud or completion dates and that have longitude and latitude coordinates are used in the growth calculations for this figure.
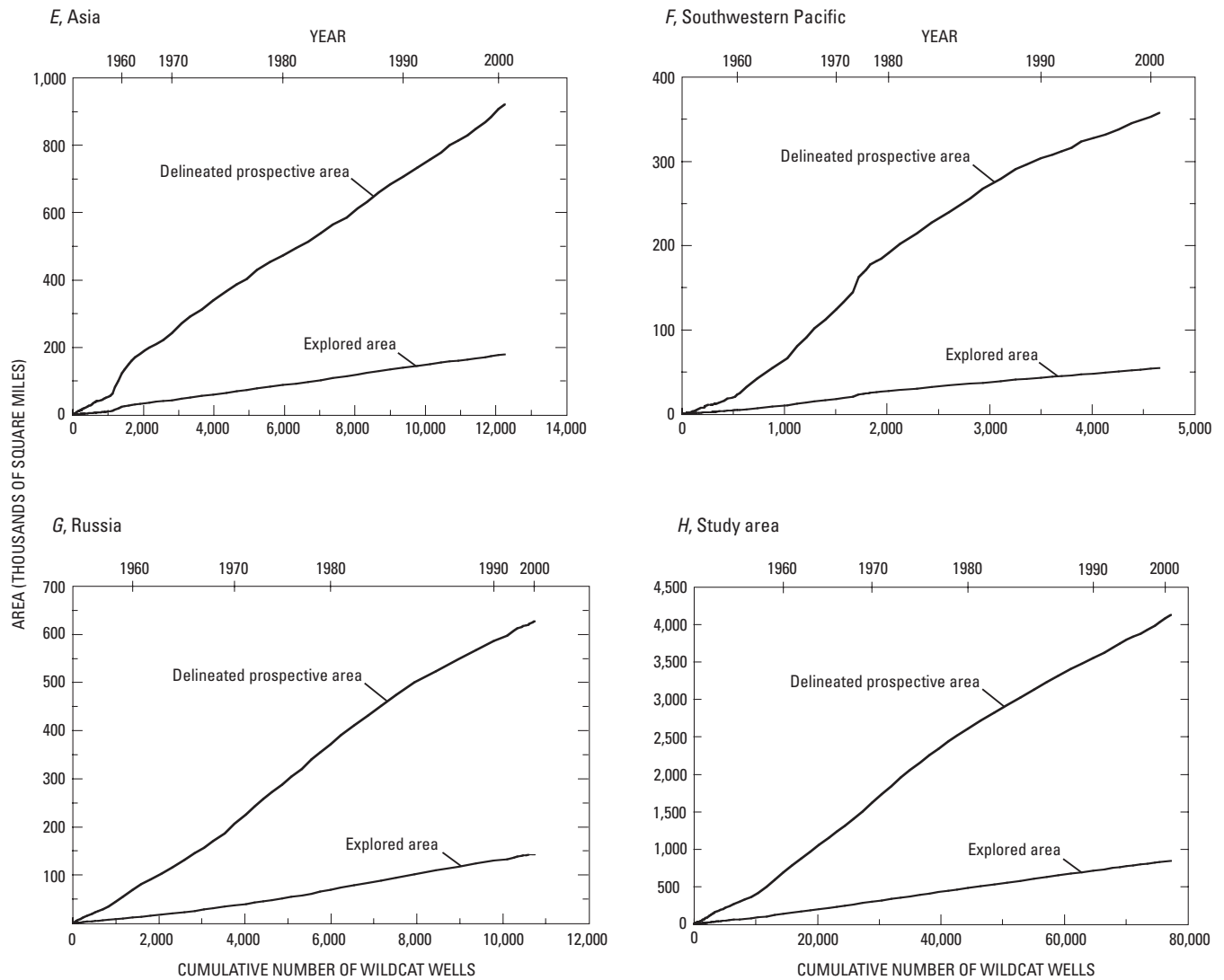
Figure 12. Continued.
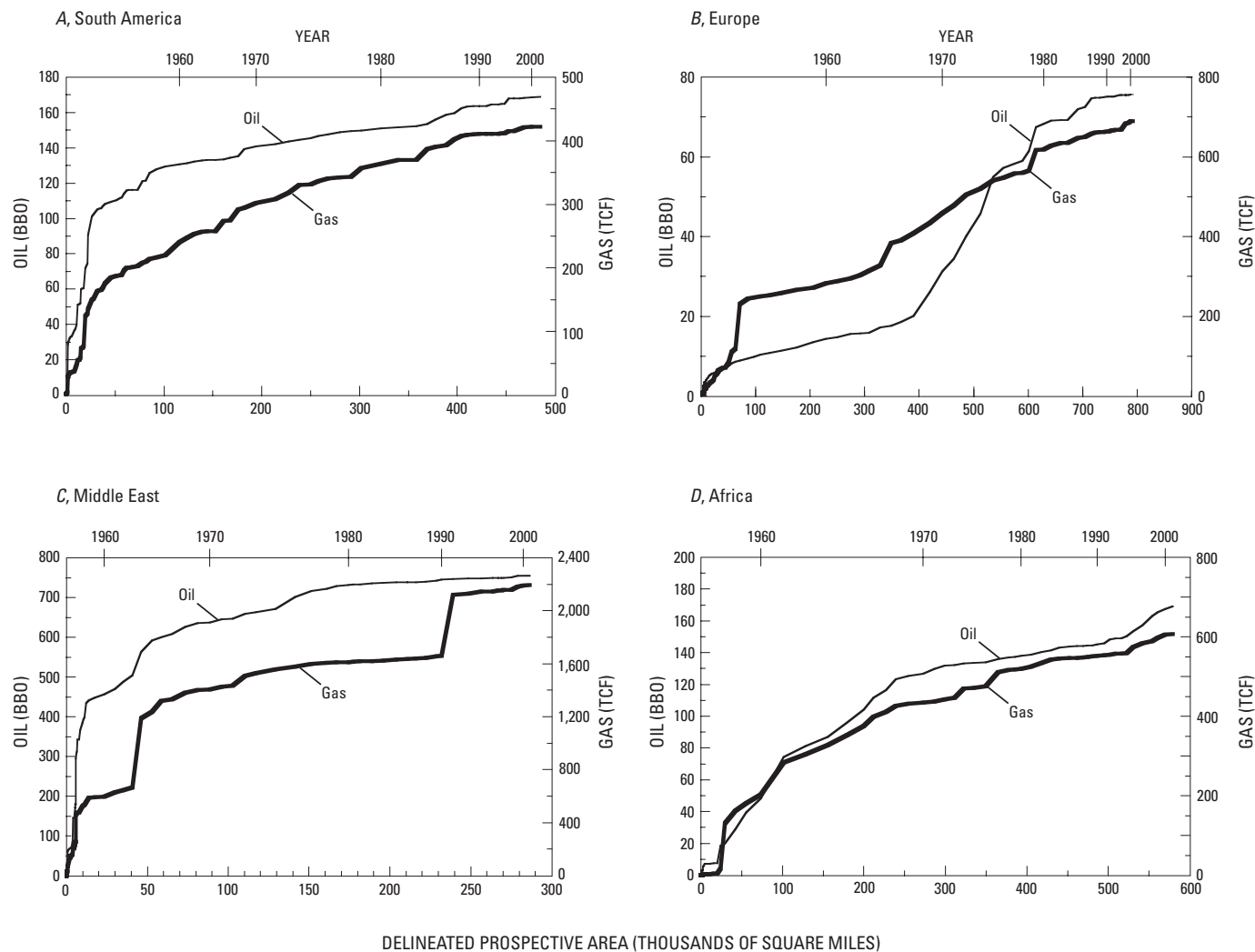
Figure 13.   Graphs showing cumulative recoverable oil and gas discoveries through 2001 plotted as a function of cumulative delineated prospective area for seven regions and the whole study area: A, South America; B, Europe; C, Middle East; D, Africa; E, Asia; F, Southwestern Pacific; G, Russia; and H, Study area. The study area graph (fig. 13H) includes data for Mexico, Central America, and the Caribbean, as well as for the seven regions for which data are graphed in figures 13A–G. The regional graphs are at different scales and are derived from graphs in figures 16–57. The oil and gas discoveries are graphed by the year that the field location was classified as part of the delineated prospective area, and the increments of prospective area are ordered by time. At the top axis of the graphs, the closer the 10-year markers are to each other, the lower the rate at which prospective area was added in that decade. Calculation of delineated prospective area is explained in the text. Discovery size estimates are from IHS Energy Group (2002). BBO, billions of barrels of oil (bbl $\times 10^9$); TCF, trillions of cubic feet (ft$^3 \times 10^{12}$).
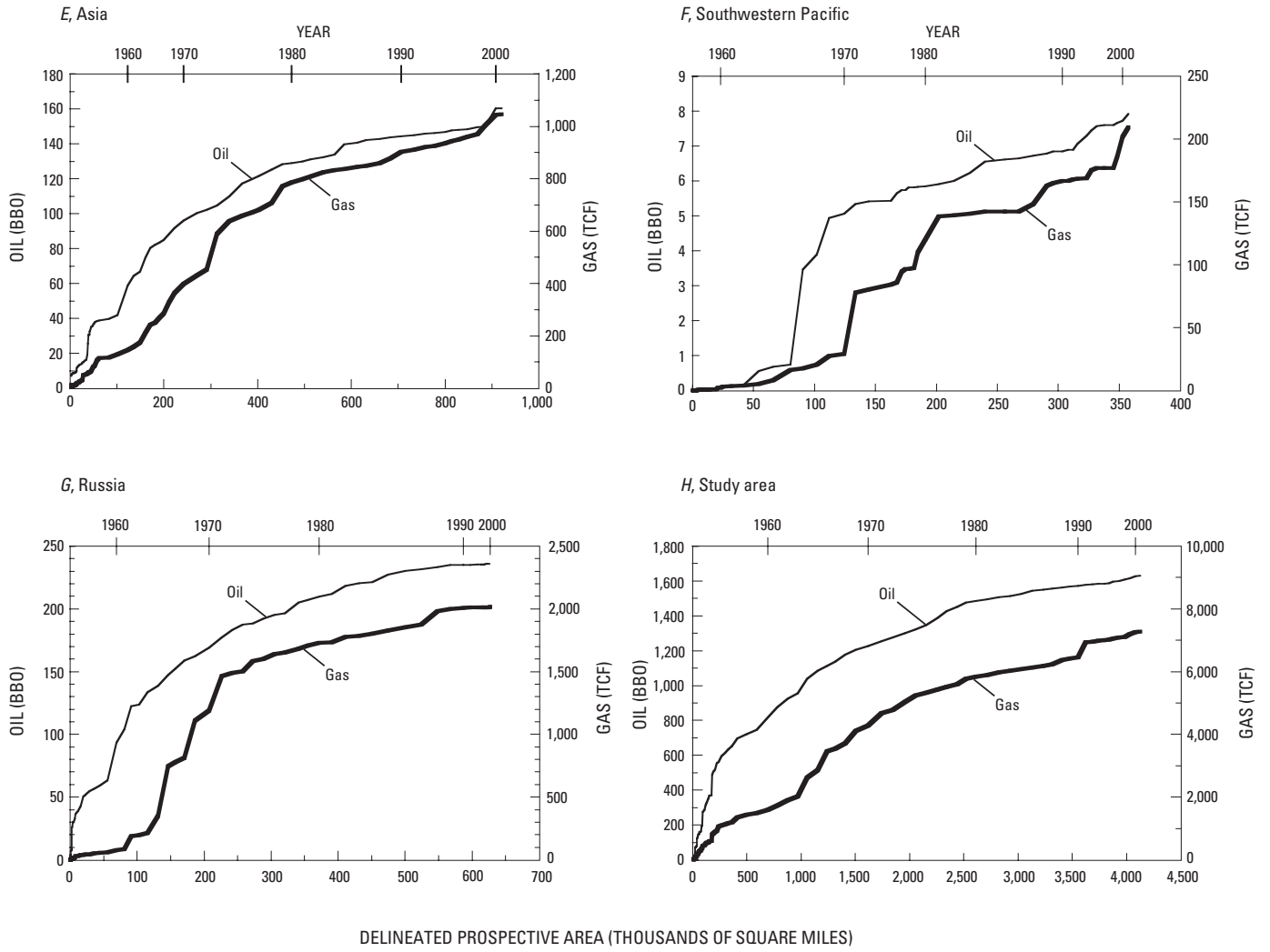
Figure 13. Continued.

By the end of 2001, the explored area was 23 percent of the delineated prospective area (table 7).

Middle East

In this Circular, the Middle East is considered to be the Arabian Peninsula, Iran, Iraq, Turkey, Cyprus, Lebanon, Jordan, Syria, Israel, Gaza Strip, and West Bank (figs. 28–32). Although some significant provinces (Red Sea Basin, Aegean, Levantine Basin, South Caspian Basin, Kura Basin, and Amu-Darya Basin) have resources both in the Middle East and in other regions (table 6), the tables and figures for the Middle East include only data for the part of each province in the Middle East.

The Middle East accounts for 46 percent of the oil and 30 percent of the gas discovered in the study area (table 4). The earliest discoveries in the most prolific oil provinces in the Middle East were made in the early 1900s (table 6 and fig. 8C). About 94 percent of the oil discovered in this region is contained in four provinces—Mesopotamian Foredeep Basin (figs. 29, 31, and 32), Greater Ghawar Uplift (fig. 29), Zagros Fold Belt (figs. 28, 30, 31, and 32), and Rub Al Khali Basin (figs. 29 and 32). Each of these provinces contains more than 20 BBO. Similarly, 85 percent of the gas discovered is contained in four provinces—Qatar Arch (figs. 29 and 32), Zagros Fold Belt (figs. 28, 30, 31, and 32), Mesopotamian Foredeep Basin (figs. 29, 31, and 32), and Greater Ghawar Uplift (fig. 29). Each of these provinces contains more than 120 trillion cubic feet (TCF) of gas.

Pre-1951 discoveries accounted for 37 percent of the oil and 20 percent of the gas discovered through 2001. After 1950, the peak 5-year period for annual oil discoveries was from 1961 through 1965 (fig. 9C). In terms of oil discovered per wildcat well, the peak 5-year period after 1950 was from 1951 through 1955 (fig. 10C). The peak period for annual gas discoveries was from 1991 through 1996 (fig. 11C). Nearly all the gas reported discovered during that period was offshore. The gas discovered in offshore areas was primarily nonassociated gas.

Figure 12C shows the delineated prospective area of the Middle East expanding steadily over time. Half of the delineated prospective area was added between 1976 and the end of 2001. Through 2001, the late half of the delineated prospective area contained only 8 percent of the oil and 22 percent of the gas discovered in the early half of the delineated prospective area (fig. 13C). The large change in gas is attributable to the addition of a giant offshore discovery in Iranian waters. The Iranian offshore gas field South Pars appears to be geologically associated with Qatar's North Field. South Pars became prospective in 1991, the year it was reported discovered.

By the end of 2001, the explored area was only 16 percent of the delineated prospective area (table 7). It has been the policy of the largest producers in this region, as members of the Organization of Petroleum Exporting Countries (OPEC), to drill and develop resources in a controlled manner. The yields shown in figure 13C for the late delineated prospective area likely understate resources actually found.

Africa

Although some significant provinces (Red Sea Basin, Levantine Basin, and Pelagian Basin) have resources both in Africa and in other regions (table 6), the tables and figures for Africa include only data for the part of each province in Africa. The continent of Africa accounts for about 10 percent of the discovered oil and 8 percent of the discovered gas in the study area (table 4). Most of the large commercial discoveries in Africa occurred after World War II (table 6 and fig. 8D). Four provinces—Niger Delta (figs. 36 and 42), Sirte Basin (fig. 37), West-Central Coastal (figs. 35 and 42), and Trias/Ghadames Basin (figs. 37 and 38)—account for 85 percent of the oil discovered in this region. The Niger Delta (figs. 36 and 42) contains about 194 TCF of gas and is the only African province having cumulative gas discoveries larger than 120 TCF. The Niger Delta accounts for 32 percent of the gas discovered in Africa. Four provinces—Niger Delta (figs. 36 and 42), Grand Erg/Ahnet Basin (fig. 38), Sirte Basin (fig. 37), and Nile Delta Basin (fig. 39)—account for 66 percent of the gas discovered through 2001.

The volumes assigned to pre-1951 discoveries of oil and gas are insignificant when compared with total oil and gas discovered. The peak 5-year period for annual oil discovered was from 1961 through 1965 (fig. 9D), whereas the peak 5-year period for oil discovered per wildcat well was from 1956 through 1960 (fig. 10D). The peak 5-year period for annual gas discovered was from 1956 through 1960 (fig. 11D). According to data used for figure 9D, more than three-fourths of the oil discovered during the period from 1996 through 2000 is offshore. The discoveries are primarily in the deep-water offshore areas of West Africa (figs. 35, 36, and 42). Both the annual oil discovery rate and per well discovery rate increased dramatically in that period.

The delineated prospective area doubled in size between 1971 and the end of 2001 (fig. 12D). The late delineated prospective area contains about 30 percent of the oil and 39 percent of the gas that was in the early area. Figure 12D shows the slope of the cumulative growth in delineated prospective area slightly increasing during the 1990s. Figure 13D shows that the delineated prospective area added during the 1990s had a higher petroleum endowment than the areas added during the previous two decades. During the 1990s, the newly delineated prospective area consisted primarily of the deep-water areas (deeper than 200 meters) off of West Africa (figs. 35, 36, and 42). Innovations in exploration and production technology allowed the commercial development of those resources. By the end of 2001, the explored area was 17 percent of the delineated prospective area (table 7).

Asia

In this Circular, Asia is considered to include countries of central Asia, China, Mongolia, Southeast Asia, the Indian Subcontinent, and the Far East (figs. 45–53) but to exclude Russia, which is discussed as a separate region (fig. 57). Although some significant provinces (Volga-Ural Region,

North Caspian Basin, Middle Caspian Basin, South Caspian Basin, Kura Basin, Amu-Darya Basin, and Bonaparte Gulf Basin) have resources both in Asia and in other regions (table 6), the tables and figures for Asia include only data for the part of each province in Asia.

Asia accounts for 10 percent of the oil and 14 percent of the gas discovered to date in the study area (table 4). The North Caspian Basin and South Caspian Basin (fig. 46) are the only provinces containing at least 20 BBO (table 6). The four most prolific provinces for oil are the North and South Caspian Basins (fig. 46), Bohaiwan Basin (fig. 45), and Songliao Basin (fig. 45). Together these four provinces account for 49 percent of the oil discovered in Asia. The Amu-Darya Basin (figs. 46 and 47) is the only province with total gas discoveries greater than 120 TCF. The four provinces having the largest volume of discovered gas are the Amu-Darya Basin (figs. 46 and 47), North Caspian Basin (fig. 46), Greater Sarawak Basin (figs. 52 and 53), and South Caspian Basin (fig. 46). Together these four account for 46 percent of the gas discovered in the region. The recovery size distribution for significant provinces appears to be more uniform for Asia than for other regions (fig. 8*E*).

Oil and gas in fields discovered prior to 1951 accounted for 15 percent of the oil and 2 percent of the gas discovered through 2001. After 1950, the 5-year period from 1971 through 1975 was the peak period for annual oil and annual gas discoveries (figs. 9*E* and 11*E*), although the period from 1956 through 1960 was the peak 5-year period for oil discovered per wildcat well (fig. 10*E*). Between 1960 and the end of 2001, about 42 percent of the oil and gas discovered was in offshore fields.

Figure 12*E* shows the delineated prospective area of Asia expanding at a constant rate since 1970. Half the delineated prospective area was added between 1979 and the end of 2001. Through 2001, oil discoveries in the late half of the prospective area amounted to 25 percent of the oil discovered in the early half (fig. 13*E*). The gas discovered in the late half of the prospective area amounted to 35 percent of the gas discovered in the early half (fig. 13*E*). By the end of 2001, the explored area accounted for almost 20 percent of the delineated prospective area (table 7).

Southwestern Pacific

In this Circular, the southwestern Pacific region is considered to include Australia, New Zealand, East Timor, and Papua New Guinea, along with several South Pacific island nations (figs. 54–56). Although the Bonaparte Gulf Basin has resources both in the southwestern Pacific region and Asia (table 6), the tables and figures for the southwestern Pacific include only data for the part of the province in the southwestern Pacific. The southwestern Pacific region accounts for less than half of 1 percent of the oil and about 3 percent of the gas discovered in the study area (table 4). The total amount of discovered oil is a modest 7.93 BBO. The total discovered natural gas is about 209 TCF, and almost half of the gas is in one province, the Northwest Shelf (table 6, fig. 55).

Nearly all of the volumes of commercial oil and gas were reported discovered after 1950. The peak 5-year period for annual oil discoveries and oil discovered per wildcat well was from 1966 through 1970 (figs. 9*F* and 10*F*), and the peak 5-year period for annual gas discoveries was from 1971 through 1975 (fig. 11*F*). About 80 percent of the oil and 87 percent of the gas discovered through 2001 are in offshore fields (table 4).

Figure 12*F* shows that the rate of growth in prospective area declined after 1969. Half the delineated prospective area was added between 1976 and the end of 2001. Through 2001, the discoveries in the late half of the prospective area contained 38 percent of the oil found in the early half and more than two times the gas found in the early half. The profile in the cumulative gas graph after 1979 (fig. 13*F*) shows a dramatic rise in gas yields in new additions to prospective area, probably indicating a shift in exploration toward gas-prone areas. By the end of 2001, the explored area amounted to only 15 percent of the prospective area (table 7).

Russia

Russia accounts for 14 percent of the oil and 28 percent of the gas discovered in the study area (table 4). Discovered Russian petroleum resources extend into both Europe and Asia (fig. 57). Russia shares the Dnieper-Donets Basin and the Azov-Kuban Basin (figs. 27 and 57) with Europe and the Volga-Ural Region, the North Caspian Basin, and the Middle Caspian Basin with Asia (figs. 46 and 57). The tables and figures for Russia include only data for the part of each province in Russia.

The resources in the West Siberian Basin (fig. 57) account for 59 percent of the discovered oil in Russia and 76 percent of the discovered gas (table 4). Moreover, available data indicate that the earliest discovery in the West Siberian Basin occurred in 1953 (table 6 and fig. 8*F*). The remoteness and hostile environment that characterize West Siberia undoubtedly delayed development of the oil and gas resources. Only the West Siberian Basin and the Volga-Ural Region have cumulative discoveries greater than 20 BBO, and together they account for 88 percent of the oil discovered in Russia. The four most prolific gas provinces—West Siberian Basin, South Barents Basin, Volga-Ural Region, and North Caspian Basin (all shown in fig. 57)—account for 91 percent of Russia's discovered gas.

Oil and gas in fields discovered prior to 1951 account for 14 percent of the oil and only 1 percent of the gas discovered. Since 1950, the 5-year period with the peak annual oil discovery rate was from 1961 through 1965 (fig. 9*G*), and the 5-year period with the peak discovery rate of oil per wildcat well was 1956 through 1960 (fig. 10*G*). The 5-year period from 1966 through 1970 was the period when the annual gas discovery rate peaked (fig. 11*G*). Although the reported volumes of total oil and gas in offshore discoveries are only a small fraction of Russia's total discoveries, the amount of offshore exploration effort expended has also been small.

Figure 12*G* shows a slowdown in the expansion of the delineated prospective area. Half the delineated prospective area was added between 1976 and the end of 2001. Through 2001, the oil and gas discovered in the late half of the prospective area amounted to only 21 and 23 percent of the oil and gas, respectively, discovered in the early half. The explored area accounts for about 23 percent of the prospective area delineated through 2001 (table 7). The gas profile shown in figure 13*G* indicates a slight increase in yield for gas in areas that became prospective during the late 1980s.

Study Area: Summary

Table 4 summarizes the study area statistics showing cumulative wildcat wells, total oil and gas discoveries, and offshore wells and oil and gas discoveries. After 1950, the 5-year peak annual oil discovery rate was from 1961 through 1965 (fig. 9*H*), and the peak oil discovery rate per wildcat well was from 1951 through 1955 (fig. 10*H*). The annual gas discovery rate peaked during the 5-year period from 1966 through 1970 (fig. 11*H*). In the study area, oil and gas discoveries prior to 1951 account for 27 percent of the oil and only 9 percent of the gas discovered through 2001. Between 1991 and the end of 2000, about 59 percent of the oil and 77 percent of the gas discovered in the study area were in offshore fields (figs. 9*H* and 11*H*).

The delineated prospective and explored areas along with cumulative oil and gas profiles were simply added across all 10 regions to obtain data for the study area figures, that is, figures 12*H* and 13*H*. The regional profiles were based on profiles at the country or country-group level provided in figures 16 through 57. Figure 12*H* shows how the rate of expansion of the delineated prospective area slowed during the 1990s. Specifically, for the decade from 1992 through 2001 in the study area, the prospective area expanded at a rate of about 50,000 squares miles per year while the explored area grew at the rate of about 11,000 square miles per year; in contrast, during the prior decade, prospective area had expanded at a rate of about 91,000 square miles per year while the explored area grew at the rate of about 22,000 square miles per year. Half of the delineated prospective area was added between 1974 and the end of 2001. Through 2001, the late half of the delineated prospective area contained 23 percent of the oil and 39 percent of the gas found in the early half. Through 2001, the explored area accounted for about 20 percent of the delineated prospective area (table 7).

For prospective areas delineated before 1980, with a few exceptions, the growth of cumulative oil and later gas increased very rapidly until just prior to 1980. Figure 13*H* shows that the shape of the time profile of cumulative oil discoveries per unit area added was constant between 1980 and the end of 2001, indicating that the newer delineated prospective area is at least as productive as the area added during the 1980s. From 1991 through 2000, offshore discoveries accounted for 59 percent of the oil and 77 percent of the gas discovered in the study area.

Table 7 summarizes prospective area, rate of increase per wildcat well during the last decade of data, and the relation between percentage of total prospective area delineated by 1982 and percentage of oil discovered through 2001 contained in area that became prospective by 1982. Without exception, for each region, the prospective area delineated by 1982 accounts for a disproportionate amount of the oil discovered through 2001. For example, although less than 66 percent of Russia's total prospective area was delineated by 1982, this area accounted for 92 percent of the oil discovered by 2001. For the entire study area, although the prospective area delineated by 1982 accounted for 68 percent of the prospective area delineated through 2001, it contained 92 percent of the study area's oil discovered through 2001.

Summary and Conclusions

At a broad scale, this Circular presents a summary of available data on oil and gas exploration in each country of the study area, which is the world excluding the United States and Canada. Exploration effort in terms of wildcat drilling and the magnitudes of the discovered oil and gas are presented. The maps show the historical exploration areas and the parts of the exploration areas having a drilling density that would preclude discoveries larger than a threshold volume of oil. The maps also indicate the delineated prospective areas that were added between 1990 and 2002 beyond the 200- and 1,000-meter (656- and 3,280-foot) bathymetric contours, which denote the high-cost and high-risk deepwater areas.

Graphs that summarize exploration yields in terms of discovered oil and gas by exploration area are also presented. The data in the maps and the associated graphs provide a visual summary of the degree of exploration maturity of an area. The introductory text summarizes exploration results of broad regions, and the country maps and country graphs (figs. 14–57) provide more detailed information.

Gas is rapidly becoming a commercial commodity, but there are still areas where it is not commercial. For most of the world, gas production is still demand limited. Although there are local supply shortfalls, no resource-based global supply shortfall seems imminent. In fact, it is likely that historical discoveries of gas in oil fields and gas in noncommercial gas fields have been underreported and, therefore, field size estimates should increase as fields are developed commercially.

According to economic theory that assumes competitive markets, resource prices should provide a signal of impending long-run supply difficulties. However, the production restrictions of OPEC produced conditions where international oil prices through 2001 did not reflect the marginal costs of production, and the prices varied substantially as the members of the cartel complied with or disregarded their production quotas. Such price swings make it extremely risky to enter high-cost areas and to explore for and produce high-cost resources. In order to predict the timing and potential magnitude of oil-supply shortfalls, some analysts (Hubbert, 1967) have used

exploration and discovery data in place of the unreliable price and economic signals with some success. However, for such analysis to be useful, exploration and discovery data must be sufficiently complete and the exploration process must be far enough along that the analyst can correctly interpret the trends.

World production of crude oil has exceeded the reported volumes of crude oil in new discoveries since 1980 (Masters and others, 1994; Attanasi and Freeman, 2004). In 2001, world crude oil production was almost 25 BBO. At the end of 1980, proved reserves in the study area were 591 BBO (DeGolyer and MacNaughton, 1981), but by the end of 2001, proved reserves in the study area were about 1,000 BBO (DeGolyer and MacNaughton, 2003). Between 1980 and the end of 2001, the gap between estimated crude oil in new discoveries and production increased, but the published estimate of world crude oil reserves also increased (Attanasi and Freeman, 2004). Because there are no international standards for computing crude oil reserves, it is difficult to determine whether published estimates of reserves are overstated, whether the reported estimates of new discoveries are understated, or whether the application of improved production technology to all fields has incrementally increased the recovery factors of in-place resources sufficiently to offset the apparent gap between reported oil in new discoveries and production.

Historically, 81 percent of the oil discovered through 2001 outside of the United States and Canada is located in one of the 16 significant provinces that have at least 20 BBO. Another 8 provinces have cumulative recoverable oil discoveries larger than 10 BBO (table 3), but some of these provinces are mature.

The wildcat drilling reported here is extensive. For exploration to add significant quantities to world reserves, provinces endowed with oil on the order of 20 BBO in yet-to-be-found fields must be identified, explored, and developed. To hold such quantities of oil, the province must contain at least a few very large accumulations that will likely be found early in the exploration process and be sufficiently large to pay for infrastructure and generate intense followup drilling.

If a partially explored province has not had such a large accumulation discovered to date, it is unlikely that additional intense exploration will uncover sufficient oil to significantly affect oil supply at a global scale. Nonetheless, additional discoveries will benefit the individual host countries or the companies that drill and produce the oil. The details of the individual provinces and country maps indicate how the combination of data on drilling locations, discovery volumes, and geologic information can provide an initial reconnaissance-type assessment of undiscovered resources.

The limitations of this analysis relate to the data and methods applied. The absence of a standard procedure to compute reserves makes comparisons across countries and time periods problematical. If there were a built-in conservative bias, such as those methods required by the U.S. Securities and Exchange Commission (Attanasi and Root, 1994), then the changes could be modeled and the estimates could be adjusted on the basis of age or development of the discovery.

Comparisons of reported field sizes over time show years with large changes in the estimates attached to certain regions, but there is little explanation in the drilling records.

A second limitation is that the algorithms that computed prospective area and explored area were two dimensional. A more general approach would have been a three-dimensional analysis, perhaps with depth slices. However, the extension of the analysis to consider the maps in terms of depth slices would probably have little effect on the principal conclusions of this study regarding the extent of exploration for oil. For many of the provinces in the study area, mobilization and demobilization of drilling rigs are so costly that operators have a strong incentive to test horizons thought to have commercial hydrocarbon potential that lie below and above the target horizon. Furthermore, as one drills deeper formations, the likelihood of finding oil typically declines. If hydrocarbons are found in the deeper formations, they are more likely to be nonassociated gas accumulations. Thus, hydrocarbons found in the future in untested formations below the exploration wells used in this study are not likely to reverse the global implications of the study. Examining the data by depth slices would provide some new information but would have to be interpreted in terms of where the basement rocks lie relative to drilling in each province; interpretation of the depth to basement is substantially beyond the scope of this analysis.

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Tables 5–7

[Figures 14–57 follow table 7]

Table 5. Wildcat wells by year, 1961–2001, for Mexico, the Caribbean, Central and South America, Europe, the Middle East, Africa, Asia, the southwestern Pacific, and Russia.

[Data are from IHS Energy Group (2002). Some entries in this table differ from similar entries in table 2 of Circular 1096 (Attanasi and Root, 1993) because the well classification system changed in 1996 and because selected data have been re-evaluated. Column denoted "Unkn" means year unknown; these wells are not plotted on graphs in figures 9–57. The computation of the delineated prospective area mapped in figures 14–57 used locations of all wildcat, exploration, and development wells, both successful and dry, except for wells with a missing or obviously incorrect location]

Area	Pre-1961	1961	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
									Mexico[1]													
Mexico	355	32	33	19	13	22	32	20	27	28	18	20	16	10	8	4	24	29	24	18	22	16
									Caribbean[2]													
Cuba	216	6	1	0	4	1	0	0	1	0	0	1	2	1	2	4	5	8	0	0	8	0
Barbados	8	0	0	0	0	0	8	2	0	0	1	2	0	0	0	0	0	0	1	0	0	0
Dominican Republic	22	3	0	0	0	0	0	2	0	6	1	0	0	0	0	0	0	0	0	3	0	1
Haiti.............................	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Jamaica.........................	4	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
Puerto Rico...................	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Antilles[3]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Total	262	9	1	0	4	1	8	4	1	6	3	4	2	2	2	4	5	12	1	3	8	2
									Central America[4]													
Guatemala	9	2	1	0	0	0	0	0	0	0	4	1	1	0	1	2	3	4	0	0	4	4
Belize	11	1	1	1	0	0	0	2	0	0	0	0	5	2	1	4	0	2	0	2	0	3
Costa Rica	19	0	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Honduras	6	0	0	1	0	2	4	1	0	1	0	1	3	3	0	1	0	0	2	0	2	0
Nicaragua	7	0	0	0	0	0	0	1	2	5	8	3	0	0	3	2	0	2	3	0	0	0
Panama..........................	18	1	4	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	1	1	0	1
Total	70	4	7	4	0	2	4	4	2	6	12	6	9	5	7	10	3	8	6	3	6	8
									South America													
Guyana	1	0	0	0	0	0	0	2	0	0	0	1	0	0	2	3	1	0	0	0	0	0
Suriname	2	0	0	0	1	1	6	1	5	3	4	1	0	0	0	1	0	0	1	0	0	1
French Guiana[5]..............	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
Chile.............................	146	11	18	15	16	14	15	14	17	20	19	18	33	21	29	21	19	6	13	7	13	25
Argentina.......................	763	82	101	54	50	82	76	78	68	59	104	127	97	124	93	62	67	90	55	51	66	75
Paraguay........................	9	0	0	0	0	0	0	3	0	0	0	11	5	0	0	1	1	3	3	1	0	1
Uruguay.........................	26	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0
Falkland Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ecuador	77	2	0	1	1	1	0	3	6	6	12	12	18	8	5	1	1	3	3	8	5	1
Colombia........................	394	33	19	24	23	19	20	18	21	21	19	18	18	18	19	10	15	17	21	21	27	55
Peru	114	15	3	5	0	7	3	7	6	4	12	5	12	14	14	37	11	8	8	1	4	7
Venezuela	2,438	102	88	57	48	52	38	25	27	41	39	49	75	66	90	57	54	48	50	67	176	161
Trinidad and Tobago	105	7	5	14	11	13	3	3	8	6	8	15	15	9	8	6	12	4	5	3	2	6
Bolivia..........................	61	11	17	10	11	9	13	14	13	2	4	3	7	4	4	6	13	9	9	8	4	14
Brazil.............................	240	48	53	60	47	53	53	69	62	54	50	58	57	59	60	73	86	73	97	113	134	177
Total	4,376	311	304	240	208	251	228	237	233	216	271	318	337	323	324	279	282	261	267	281	431	523

Table 5. Wildcat wells by year, 1961–2001, for Mexico, the Caribbean, Central and South America, Europe, the Middle East, Africa, Asia, the southwestern Pacific, and Russia.—Continued

Area	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	1999	2000	2001	Unkn	Total
Mexico[1]—Continued																						
Mexico	13	9	2	6	10	5	6	12	11	23	19	13	7	5	3	3	16	14	59	34	23	1,083
Caribbean[2]—Continued																						
Cuba	0	0	0	2	3	1	0	3	0	0	2	0	4	1	2	1	3	4	1	3	71	361
Barbados	0	0	8	5	1	0	0	2	3	1	0	0	0	0	0	0	0	0	0	0	31	73
Dominican Republic	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	3	2	49
Haiti................................	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Jamaica...........................	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Puerto Rico....................	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Lesser Antilles[3]	1	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	6
Total	6	0	8	7	4	1	0	6	5	1	2	0	4	3	4	1	3	4	2	6	104	515
Central America[4]—Continued																						
Guatemala	7	3	1	2	0	0	3	2	0	0	0	0	1	1	0	0	4	1	1	0	1	63
Belize	2	2	0	2	0	0	0	0	2	1	0	0	1	0	0	2	0	0	0	0	0	47
Costa Rica	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
Honduras	0	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	31
Nicaragua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	37
Panama...........................	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	32
Total	9	7	1	4	1	0	3	5	2	1	1	1	2	1	0	2	4	1	1	0	2	234
South America—Continued																						
Guyana	2	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	16
Suriname	3	6	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	52
French Guiana[5]..............	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Chile...............................	15	8	7	1	11	12	7	14	9	5	8	3	2	9	6	1	3	0	2	0	10	643
Argentina.......................	66	113	115	137	67	72	74	70	67	73	45	51	83	110	89	79	53	43	40	33	50	3,954
Paraguay........................	1	0	0	0	1	1	1	1	0	0	0	1	2	2	0	0	0	0	0	0	0	48
Uruguay..........................	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	48
Falkland Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	6
Ecuador	4	9	2	1	4	7	13	7	3	20	5	4	3	5	5	5	5	2	13	2	3	296
Colombia........................	62	24	38	48	45	55	80	52	42	34	26	33	23	12	13	15	14	15	17	15	35	1,548
Peru	6	15	18	3	2	7	2	3	0	0	3	2	2	4	4	9	10	5	3	1	9	405
Venezuela	155	82	132	149	95	14	38	17	6	7	15	18	21	18	39	30	21	18	16	8	8	4,755
Trinidad and Tobago	9	2	1	2	0	2	3	5	3	5	2	0	7	9	6	3	7	2	3	3	12	354
Bolivia............................	9	4	3	7	1	2	3	7	5	11	12	6	8	7	8	4	7	9	13	6	2	380
Brazil.............................	233	206	193	132	113	109	102	77	70	72	69	74	52	46	62	49	53	54	48	105	1	3,696
Total	565	469	509	484	343	283	323	253	205	228	185	193	203	222	232	195	179	148	156	173	154	16,203

[1]Well data for Mexico are known to be incomplete.

[2]No wildcat wells were reported for The Bahamas and Cayman Islands.

[3]For this Circular, the Lesser Antilles are Netherlands Antilles, British Virgin Islands, Martinique, Dominica, Grenada, Virgin Islands, Saint Kitts and Nevis, Antigua and Barbuda, Anguilla, Montserrat, Guadeloupe, Saint Lucia, Saint Vincent and the Grenadines, and Aruba.

[4]No wildcat wells were reported for El Salvador.

[5]French Guiana is listed separately although it is an overseas department of France.

Table 5. Wildcat wells by year, 1961–2001, for Mexico, the Caribbean, Central and South America, Europe, the Middle East, Africa, Asia, the southwestern Pacific, and Russia.—Continued

Area	Pre-1961	1961	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
Europe[6]																						
United Kingdom	201	8	3	7	7	28	31	41	36	55	30	31	34	56	74	86	67	78	37	39	38	55
Norway	0	0	0	0	0	0	1	5	10	13	7	10	15	13	13	15	19	7	14	15	20	20
Germany	1,207	56	56	25	64	38	61	35	50	46	37	33	29	29	28	26	31	33	35	34	31	49
Denmark	29	0	0	0	0	0	3	2	7	2	3	2	0	4	2	3	7	5	3	1	5	2
Netherlands	128	3	5	2	25	34	9	2	13	32	27	30	24	19	18	21	18	28	22	22	32	27
Ireland	0	0	2	3	0	0	0	0	0	0	0	3	2	3	4	7	5	6	16	8	2	10
Sweden	1	0	0	0	0	0	0	1	2	0	0	4	10	13	14	27	6	6	32	11	12	14
Belgium	1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Faroe Islands[7]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Svalbard[8]	0	0	0	0	0	0	1	1	0	0	0	1	2	2	2	1	0	1	0	0	0	0
Italy	713	82	100	90	75	48	57	28	30	48	33	40	45	28	22	26	30	25	64	42	55	75
Austria	76	13	9	12	11	13	14	8	16	20	17	26	16	14	15	37	20	39	20	22	18	20
France	807	103	97	101	75	58	30	26	13	25	13	8	10	11	9	10	13	13	16	22	22	38
Spain	128	14	17	22	11	15	18	13	16	10	8	12	6	18	8	17	19	16	18	15	22	22
Portugal	39	1	1	4	0	0	0	0	0	0	0	0	0	0	3	7	9	1	0	2	0	1
Switzerland	10	2	1	2	2	3	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	1
Malta	1	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	1	0
San Marino	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Romania	62	4	6	8	8	10	13	11	9	13	9	8	4	9	10	8	6	8	2	4	7	1
Ukraine	38	2	3	6	6	4	4	8	3	5	5	2	2	1	3	5	14	11	6	6	4	7
Belarus	0	0	0	0	0	1	0	2	0	0	0	0	2	1	0	1	4	3	2	3	2	1
Hungary	311	31	41	47	50	29	29	13	10	19	14	18	19	15	17	8	36	17	12	2	9	18
Albania	4	0	0	3	1	1	1	0	0	0	2	1	1	0	0	0	0	1	1	1	2	0
Serbia and Montenegro[9]	91	17	10	17	8	8	9	3	7	5	9	15	17	13	11	22	11	28	27	12	15	11
Poland	27	5	13	20	25	21	31	35	33	34	47	46	67	55	23	34	27	14	8	3	13	4
Czech Republic	9	2	3	2	2	2	5	2	4	2	3	3	3	7	3	6	6	5	5	2	4	3
Greece	11	6	7	5	3	2	0	8	0	0	2	1	1	3	3	0	2	5	3	5	5	8
Bulgaria	348	58	54	54	13	21	15	21	14	19	13	17	17	12	22	18	14	14	20	11	10	6
Lithuania	1	0	0	1	1	1	2	3	5	4	6	5	5	4	4	7	5	3	3	4	4	5
Slovakia	22	1	3	4	3	8	4	5	2	4	3	2	5	1	0	1	1	0	2	0	1	0
Slovenia	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	2	1
Latvia	0	0	0	0	1	1	3	6	5	4	2	2	0	0	0	0	0	0	0	0	0	0
Moldova	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bosnia and Herzegovina	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Croatia	28	1	3	2	3	2	4	5	3	4	4	3	1	12	6	5	0	5	8	9	7	10
Macedonia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	4,306	410	437	437	396	348	345	284	288	365	294	323	340	345	314	398	370	373	382	297	344	409

Table 5. Wildcat wells by year, 1961–2001, for Mexico, the Caribbean, Central and South America, Europe, the Middle East, Africa, Asia, the southwestern Pacific, and Russia.—Continued

Area	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	1999	2000	2001	Unkn	Total
									Europe[6]—Continued													
United Kingdom............	83	96	128	124	139	86	101	110	161	132	102	55	71	64	78	72	53	36	31	40	10	2,814
Norway........................	31	26	28	23	27	20	20	14	24	30	30	19	19	19	22	35	20	14	15	20	0	653
Germany......................	54	46	44	32	39	26	20	12	21	16	16	11	7	9	13	10	11	6	3	4	86	2,519
Denmark......................	4	10	5	13	3	4	3	4	1	3	6	1	0	1	1	6	3	2	9	6	0	165
Netherlands	41	40	33	40	29	26	24	28	35	40	26	20	10	22	24	28	26	13	7	17	0	1,070
Ireland	4	6	7	6	7	4	4	3	4	1	2	3	2	4	2	3	0	1	0	3	0	137
Sweden........................	14	12	11	15	0	4	11	12	26	12	0	1	0	0	0	0	0	0	0	0	11	282
Belgium........................	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	7
Faroe Islands[7]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4
Svalbard[8]	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	13
Italy	80	54	63	55	94	76	72	33	33	45	33	25	21	28	28	23	27	16	17	8	48	2,635
Austria.........................	21	16	23	12	9	12	18	5	12	5	7	5	6	9	9	14	5	5	9	4	63	725
France.........................	42	24	36	51	72	27	32	35	25	31	9	4	8	7	6	0	5	0	2	0	19	1,955
Spain...........................	10	19	10	20	17	12	8	8	4	6	0	3	1	3	1	5	3	4	4	3	5	591
Portugal.......................	2	3	0	1	0	0	3	0	2	0	0	1	0	1	0	0	1	1	0	0	0	83
Switzerland	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	29
Malta	2	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	12
San Marino...................	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Romania	4	6	8	2	6	2	2	7	4	4	9	7	8	14	10	18	16	11	3	9	12	382
Ukraine........................	7	8	7	7	3	8	7	4	7	9	9	5	3	4	1	4	3	4	2	0	1	248
Belarus	1	4	3	1	1	4	0	2	1	2	2	2	3	9	0	1	0	10	5	0	0	73
Hungary.......................	23	18	5	17	20	7	3	4	5	4	18	15	5	13	16	13	12	11	6	7	10	997
Albania........................	2	1	1	3	0	3	0	1	0	0	0	2	1	3	1	2	0	0	1	0	66	106
Serbia and Montenegro[9].	10	12	8	11	12	10	11	13	3	7	5	6	7	7	7	7	10	2	4	5	7	530
Poland	31	15	20	20	18	26	30	37	35	15	17	10	15	55	40	37	23	37	33	36	26	1,161
Czech Republic	5	6	5	5	4	0	1	1	0	2	3	2	2	2	3	2	5	3	4	6	12	156
Greece	11	7	7	4	2	3	4	3	1	0	1	0	0	1	0	0	2	0	4	2	0	132
Bulgaria.......................	10	19	14	16	23	19	18	10	8	1	4	6	10	4	5	0	3	1	1	2	14	979
Lithuania	4	4	6	3	4	5	6	2	4	2	1	0	2	0	0	1	0	0	1	2	0	120
Slovakia.......................	0	1	2	0	0	0	0	0	0	2	1	0	2	2	4	0	1	3	4	0	0	94
Slovenia.......................	1	0	0	1	1	1	0	0	1	3	0	0	0	0	0	0	0	0	0	1	50	79
Latvia	0	0	1	0	0	0	1	2	0	1	0	2	1	0	0	0	0	0	0	0	1	33
Moldova	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Bosnia and Herzegovina	0	0	2	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Croatia.........................	11	9	9	16	11	2	4	18	9	1	1	1	8	7	3	5	4	0	4	2	17	267
Macedonia....................	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4
Total	511	462	486	502	543	389	403	369	426	375	303	207	212	288	274	286	233	181	169	181	464	19,069

[6]No wildcat wells were reported for Andorra, Estonia, Finland, Gibraltar, Liechtenstein, Luxembourg, Monaco, or Montenegro. Greenland (which is part of Denmark) has seven wildcat wells, and Iceland has 22 stratigraphic test wells.

[7]Faroe Islands are part of Denmark.

[8]Svalbard is a group of islands in the Arctic Ocean north of and belonging to Norway.

[9]Data for Serbia and Montenegro are combined in the IHS Energy Group (2002) data.

Table 5. Wildcat wells by year, 1961–2001, for Mexico, the Caribbean, Central and South America, Europe, the Middle East, Africa, Asia, the southwestern Pacific, and Russia.—Continued

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Statistics of Petroleum Exploration in the World Outside the United States and Canada Through 2001

Area	Pre-1961	1961	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
Middle East																						
Turkey	93	34	18	11	13	30	31	21	29	12	35	20	24	30	33	42	43	22	21	9	23	22
Cyprus	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Saudi Arabia	15	0	0	3	1	2	4	8	7	4	4	7	5	5	6	5	4	3	5	5	6	2
Kuwait	11	1	4	12	1	2	5	1	0	0	2	1	2	1	0	0	1	1	0	0	0	0
Abu Dhabi[10]	4	0	3	0	4	2	4	3	8	8	12	9	1	8	10	5	6	2	5	7	1	5
'Ajman[10]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dubai[10]	1	0	0	0	2	1	1	0	1	0	0	1	1	0	0	3	5	1	0	2	2	1
Al Fujayrah[10]	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0
Umm al Qaywayn[10]	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	2	1	1	0	0	1
Ra's al Khaymah[10]	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	1	1	0	0	1	0
Sharjah[10]	1	0	0	1	1	1	0	1	0	0	0	1	0	1	1	1	0	0	1	0	2	1
Former Neutral Zone[11]	12	3	7	3	0	1	3	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Oman	26	1	2	3	4	1	8	2	3	6	3	11	12	11	3	9	10	8	9	14	14	15
Qatar	9	1	5	3	3	1	1	4	3	2	1	2	3	2	0	0	2	1	0	5	1	0
Yemen	0	0	3	0	1	1	0	0	0	0	0	0	0	0	1	0	4	2	1	2	3	4
Bahrain	2	1	1	0	0	1	1	0	0	0	0	0	1	1	0	1	0	0	1	0	1	0
Syria	19	1	4	3	0	0	1	0	2	0	0	0	0	0	2	3	13	6	9	6	3	5
Israel[12]	61	5	4	4	12	10	12	8	9	5	9	7	4	2	1	7	8	17	4	5	8	5
Jordan	4	0	0	1	0	0	0	0	0	0	2	5	1	0	1	0	0	0	1	0	0	0
Lebanon	3	1	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iraq	76	5	0	0	0	0	0	0	0	1	1	2	0	2	3	2	8	3	12	7	6	0
Iran	78	12	8	5	7	11	23	21	21	15	13	10	11	21	20	22	22	12	15	1	3	0
Total	415	65	59	51	50	65	96	71	83	56	84	78	66	84	81	100	129	81	85	63	75	61

Area	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	1999	2000	2001	Unkn	Total
									Middle East—Continued													
Turkey	32	26	18	24	25	27	34	36	31	27	21	24	21	13	12	11	10	16	15	13	3	1,055
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Saudi Arabia	2	3	2	0	0	0	0	2	4	2	3	3	2	2	1	3	2	2	2	0	1	137
Kuwait	0	0	2	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1	3	55
Abu Dhabi[10]	8	10	12	9	3	0	1	2	3	1	3	4	2	2	1	0	0	0	2	0	0	170
'Ajman[10]	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Dubai[10]	2	0	6	5	1	2	2	1	1	2	1	2	0	0	1	0	0	0	0	0	0	48
Al Fujayrah[10]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Umm al Qaywayn[10]	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Ra's al Khaymah[10]	2	1	2	2	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	19
Sharjah[10]	1	2	2	4	0	1	0	0	0	0	1	0	3	0	1	0	2	0	0	0	0	30
Former Neutral Zone[11]	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	35
Oman	20	18	37	23	32	22	23	18	29	39	18	16	15	13	20	24	15	20	11	12	0	600
Qatar	2	1	0	0	0	1	6	2	5	3	2	0	2	0	3	3	3	0	1	2	0	85
Yemen	3	1	3	12	16	21	15	16	15	21	38	28	21	20	13	11	9	4	12	13	1	315
Bahrain	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	16
Syria	3	1	5	12	19	8	21	15	16	23	30	20	12	11	11	11	3	7	6	7	20	338
Israel[12]	15	10	6	2	3	1	2	2	3	1	2	5	5	6	4	4	3	4	6	3	6	300
Jordan	1	2	5	1	1	4	5	5	4	3	2	3	6	0	0	0	2	0	0	1	0	60
Lebanon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Iraq	2	7	1	1	1	2	2	0	0	0	0	1	1	0	0	0	0	1	0	0	2	149
Iran	1	0	1	0	0	0	3	1	1	1	3	1	0	2	1	1	2	5	5	5	0	384
Total	96	84	102	96	105	89	116	100	113	123	125	109	90	70	68	68	54	59	60	57	37	3,819

[10]One of the seven United Arab Emirates.

[11]The former Neutral Zone was located between Kuwait and Saudi Arabia.

[12]Israel includes data for Gaza Strip and West Bank.

Table 5. Wildcat wells by year, 1961–2001, for Mexico, the Caribbean, Central and South America, Europe, the Middle East, Africa, Asia, the southwestern Pacific, and Russia.—Continued

Area	Pre-1961	1961	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
									Africa[13]													
Cote d'Ivoire	7	1	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	5	5	3	1	8
Ghana	4	0	0	0	0	0	0	3	0	0	9	1	1	1	1	4	0	1	1	1	0	1
Benin	0	0	0	0	0	0	0	0	1	1	4	0	0	2	0	0	0	0	0	0	0	0
Guinea-Bissau	1	3	0	0	0	0	0	0	2	3	0	0	0	1	0	0	0	0	0	0	0	0
Togo	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Senegal	20	9	3	0	0	0	2	3	2	3	4	3	1	0	0	1	2	1	0	0	0	0
The Gambia	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Guinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Sierra Leone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liberia	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
Ethiopia	17	0	0	1	0	1	0	0	0	0	0	0	2	3	3	0	0	0	0	0	0	0
Somalia	21	3	2	3	1	3	1	1	2	2	0	0	0	1	1	1	1	1	0	0	1	0
Eritrea	11	0	0	0	0	0	2	0	0	2	2	0	0	3	0	0	0	1	0	0	0	0
Kenya	2	1	1	1	1	0	0	1	1	0	0	2	0	0	0	1	2	0	1	0	0	2
Angola	53	10	4	9	4	16	9	15	46	25	13	30	13	6	28	10	0	6	4	3	2	11
Nigeria	95	16	9	21	32	61	65	83	35	21	24	54	55	42	49	37	18	29	29	32	32	26
Libya[14]	143	94	111	148	134	118	63	42	79	76	48	44	31	23	27	47	29	32	35	21	21	33
Tunisia[14]	64	1	7	4	5	6	6	10	5	3	4	11	13	8	16	7	8	8	7	13	15	31
Algeria	345	61	57	55	45	18	12	15	14	30	36	27	12	10	17	22	25	24	20	16	23	16
Morocco	245	17	10	2	8	7	12	11	5	13	1	6	5	3	3	5	5	3	4	7	10	11
Egypt	156	10	7	12	9	8	15	10	24	27	37	23	22	16	14	18	37	44	27	29	35	50
Mozambique	5	1	3	0	0	5	5	15	0	0	10	6	2	0	0	0	0	0	0	0	0	0
Tanzania	3	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	1	0	0
Burundi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Africa	1	0	0	0	0	8	2	4	3	11	13	18	11	17	2	15	15	11	10	5	7	8
Namibia	1	0	0	0	0	0	0	0	0	0	4	1	0	0	1	0	0	0	0	0	0	0
Lesotho	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Zambia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zimbabwe	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Gabon	108	8	14	4	1	7	9	10	11	21	12	11	17	13	15	17	14	16	12	19	16	21
Congo (Brazzaville)	11	1	2	2	0	0	0	0	0	1	2	3	6	6	6	4	0	0	5	6	7	11
Cameroon	15	0	0	0	0	1	0	4	0	1	6	2	4	2	3	7	4	24	13	14	18	18
Equatorial Guinea	0	0	0	0	0	0	0	1	5	0	0	1	0	0	0	0	0	0	0	0	0	0
Central African Republic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Congo (Kinshasa)	2	0	0	0	1	3	0	0	0	0	0	1	6	4	0	4	2	1	2	1	0	3
Sudan	0	1	3	2	0	0	0	0	0	0	0	0	0	0	0	1	2	1	4	5	1	10
Chad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	4	3	5	1	0	0
Mauritania	0	0	1	1	0	0	0	0	0	0	2	2	0	1	1	3	0	0	0	0	1	0
Niger	0	0	6	1	2	0	0	0	0	0	0	0	0	0	0	0	7	0	0	3	3	0
Mali	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Uganda	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Western Sahara	1	9	15	7	4	3	4	6	0	1	1	0	1	1	0	0	0	0	0	0	0	0
Madagascar	54	0	0	1	1	1	0	0	0	0	1	8	1	2	4	1	0	0	0	0	0	0
Mauritius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Total	1,413	247	256	274	248	266	207	234	235	243	235	256	206	166	200	214	170	212	184	182	194	262

Area	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	1999	2000	2001	Unkn	Total
									Africa[13]—Continued													
Cote d'Ivoire	8	1	6	2	0	0	0	0	0	0	0	1	0	0	2	3	5	2	1	1	0	66
Ghana	1	0	0	2	0	1	0	3	1	0	1	0	0	0	0	1	1	0	2	4	1	46
Benin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	11
Guinea-Bissau	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	14
Togo	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Senegal	1	0	1	0	0	0	1	2	0	0	0	4	0	0	1	1	2	0	1	0	13	81
The Gambia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Guinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sierra Leone	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Liberia	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Ethiopia	0	1	1	1	0	2	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	35
Somalia	3	0	2	2	0	1	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	58
Eritrea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	25
Kenya	1	0	0	2	1	0	3	4	1	0	1	1	0	0	0	0	0	0	0	0	0	30
Angola	21	22	9	16	15	16	17	12	17	20	11	10	9	8	13	11	21	9	19	8	25	626
Nigeria	29	26	16	15	18	16	26	26	37	25	26	26	13	17	32	22	17	8	10	9	6	1,285
Libya[14]	36	37	40	32	16	17	13	15	11	9	21	27	24	15	10	17	15	8	12	17	102	1,893
Tunisia[14]	20	10	12	12	5	12	7	7	6	10	13	10	6	14	10	10	11	5	7	4	15	458
Algeria	18	19	9	25	19	25	10	14	11	19	16	17	21	16	18	23	31	14	15	26	34	1,300
Morocco	8	4	4	7	4	8	2	0	1	2	2	3	0	0	0	0	2	0	4	1	60	505
Egypt	53	41	32	56	56	41	41	33	32	35	34	20	18	23	43	56	56	24	44	28	9	1,405
Mozambique	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	0	0	2	0	0	58
Tanzania	2	2	2	2	1	2	0	0	2	1	0	0	0	0	1	1	0	0	0	1	5	31
Burundi	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
South Africa	8	8	13	13	21	15	17	16	21	8	5	3	5	3	0	1	4	0	2	2	12	338
Namibia	0	0	0	0	0	0	0	0	0	1	0	0	1	3	1	0	1	1	0	0	0	15
Lesotho	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Zambia	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Zimbabwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Gabon	16	13	14	12	7	5	16	24	24	32	13	3	4	7	9	14	8	2	6	5	14	624
Congo (Brazzaville)	9	4	2	8	4	8	5	3	9	10	19	2	1	2	1	3	6	4	5	5	2	185
Cameroon	8	3	6	4	3	0	2	0	0	0	2	1	0	2	1	2	3	2	1	0	1	177
Equatorial Guinea	4	0	1	1	1	0	1	0	0	1	1	0	2	2	6	9	6	1	3	10	0	56
Central African Republic	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Congo (Kinshasa)	4	4	5	1	1	0	3	1	1	0	0	0	1	0	1	0	0	0	0	1	0	53
Sudan	11	10	3	7	2	1	0	4	0	0	0	0	1	1	3	11	10	14	13	12	1	134
Chad	0	0	0	3	3	0	0	1	1	1	0	0	2	0	0	0	0	0	0	0	0	30
Mauritania	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	3	0	18
Niger	2	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0	3	0	3	0	35
Mali	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Uganda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
Western Sahara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	54
Madagascar	0	0	0	4	3	2	0	0	1	1	2	1	0	0	0	0	0	0	0	1	0	89
Mauritius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4
Total	265	205	180	233	183	175	168	166	185	175	168	129	111	115	152	188	204	95	151	137	305	9,794

[13]No wildcat wells were reported for Botswana, Burkina Faso, Cape Verde, Comoros, Djibouti, Malawi, Reunion, Rwanda, Sao Tome and Principe, or Swaziland.

[14]Wildcat wells from jointly claimed area between Libya and Tunisia are listed under Libya.

Table 5. Wildcat wells by year, 1961–2001, for Mexico, the Caribbean, Central and South America, Europe, the Middle East, Africa, Asia, the southwestern Pacific, and Russia.—Continued

Area	Pre-1961	1961	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
										Asia[15]												
China	69	9	6	5	8	15	27	17	15	8	13	29	20	21	21	31	25	36	32	48	29	31
Mongolia	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kazakhstan	42	6	11	8	7	14	20	18	36	28	15	15	14	21	25	44	25	29	23	29	30	36
Azerbaijan	210	5	8	7	10	14	17	14	11	11	11	11	11	9	7	7	7	9	6	9	9	7
Turkmenistan	94	19	16	17	16	40	26	18	40	35	32	21	15	21	18	16	23	31	28	37	33	28
Uzbekistan	72	11	10	9	9	9	5	16	13	9	11	8	3	11	21	11	5	9	13	12	19	17
Georgia	65	0	4	5	1	4	4	2	5	10	7	5	5	4	16	10	3	9	6	13	13	8
Kyrgyzstan	26	0	2	1	4	6	4	2	4	6	1	1	1	3	2	0	2	0	3	0	0	0
Tajikistan	4	3	1	0	1	0	0	1	1	0	2	0	0	1	1	0	1	1	0	0	1	1
Armenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pakistan	86	2	2	1	3	2	2	2	2	3	1	4	2	4	5	4	2	3	2	3	2	7
Afghanistan	3	0	3	2	4	0	0	1	0	0	0	2	1	0	1	1	1	3	2	2	0	0
India	23	2	11	5	8	12	8	7	9	6	9	7	7	4	6	9	16	14	22	14	23	19
Bangladesh	15	0	2	1	0	1	0	1	0	2	1	0	0	0	0	0	6	3	1	0	0	4
Maldives	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Nepal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sri Lanka	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
Vietnam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	8	5	0
Burma	98	4	5	0	1	1	0	0	1	1	1	2	4	2	9	11	12	2	3	3	1	8
Thailand[16]	1	0	0	0	0	0	0	0	0	3	0	1	4	3	12	6	15	0	1	1	3	12
Cambodia	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0
Laos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Japan[17]	32	5	3	5	4	5	4	5	8	6	0	5	8	13	19	24	17	18	22	14	9	9
South Korea[17]	0	0	0	0	0	0	0	6	1	0	0	0	1	4	0	2	0	0	0	0	0	0
North Korea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1
Philippines	65	9	8	3	12	0	0	0	0	0	1	13	7	10	8	12	8	12	12	18	21	11
Taiwan	18	1	3	2	4	3	8	7	5	10	6	7	3	14	14	15	8	8	8	10	14	6
Indonesia	435	5	1	8	16	10	7	10	22	29	84	129	112	145	142	128	109	79	96	114	113	132
Malaysia[16]	70	7	5	3	1	0	2	10	13	23	45	21	24	23	8	20	3	10	17	36	21	27
Brunei	11	1	1	1	0	0	0	0	2	5	2	1	6	5	1	9	4	3	5	3	1	5
Total	1,440	89	102	83	109	136	134	137	188	195	242	282	249	318	340	364	295	279	302	375	348	371

Area	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	1999	2000	2001	Unkn	Total
									Asia[15]—Continued													
China	25	37	51	52	45	38	53	31	35	43	46	51	29	37	44	33	87	38	59	45	77	1,471
Mongolia	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	1	0	0	2	49	58
Kazakhstan	29	18	16	29	37	22	29	23	17	17	12	11	10	15	4	0	8	8	5	0	127	933
Azerbaijan	10	6	4	5	9	6	8	7	3	1	2	4	0	0	4	1	4	4	2	2	3	495
Turkmenistan	31	24	29	30	39	39	21	33	34	18	26	11	9	3	2	5	5	6	4	0	94	1,087
Uzbekistan	15	17	14	18	8	14	18	11	16	28	14	12	12	11	2	2	13	14	9	3	3	557
Georgia	14	10	11	9	8	4	8	10	5	7	3	2	0	2	0	0	0	0	1	0	2	295
Kyrgyzstan	0	4	0	0	0	2	2	0	1	0	0	0	0	0	0	0	0	0	2	0	0	79
Tajikistan	1	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
Armenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	3
Pakistan	3	10	15	15	12	6	19	18	13	9	16	23	14	22	22	20	23	1	9	8	0	422
Afghanistan	0	2	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	6	38
India	10	23	33	34	42	46	43	61	86	90	77	53	43	40	54	28	40	13	21	24	35	1,137
Bangladesh	2	0	0	0	1	0	4	1	2	0	0	0	0	1	2	1	3	1	1	0	0	56
Maldives	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Nepal	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sri Lanka	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Vietnam	0	0	0	1	0	0	2	4	5	11	2	13	20	15	16	10	3	1	0	4	50	175
Burma	5	6	11	9	8	3	3	4	4	9	9	5	4	7	5	4	4	1	1	3	40	314
Thailand[16]	15	25	16	12	2	15	12	2	10	6	9	11	11	4	6	14	7	7	8	4	0	258
Cambodia	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4	0	1	0	0	0	0	12
Laos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2
Japan[17]	9	7	9	11	12	7	8	8	6	7	7	7	4	3	6	2	3	3	2	0	23	379
South Korea[17]	0	1	0	0	0	1	0	3	2	4	0	2	0	0	0	0	1	0	0	0	0	28
North Korea	4	0	3	1	0	1	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	18
Philippines	15	3	1	0	0	3	6	6	3	7	4	3	5	2	4	2	4	2	1	0	4	305
Taiwan	6	7	4	5	3	1	1	1	0	3	2	6	1	1	6	2	4	0	1	0	49	277
Indonesia	136	155	120	134	74	54	92	73	80	100	89	80	57	59	71	86	63	53	75	56	161	3,794
Malaysia[16]	8	4	5	11	5	6	7	18	31	42	29	21	24	17	5	13	7	3	10	18	1	674
Brunei	5	2	10	3	2	2	6	12	4	2	1	2	2	1	1	5	3	0	2	6	1	138
Total	343	361	354	380	309	270	343	329	358	406	351	317	249	241	261	230	287	155	213	176	725	13,036

[15]No wildcat wells were reported for Bhutan or Singapore.

[16]Wildcat wells from Malaysia/Thailand Joint Development Area are listed under Malaysia.

[17]Wildcat wells from jointly claimed area between Japan and South Korea are listed under Japan.

Table 5. Wildcat wells by year, 1961–2001, for Mexico, the Caribbean, Central and South America, Europe, the Middle East, Africa, Asia, the southwestern Pacific, and Russia.—Continued

Area	Pre-1961	1961	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
Southwestern Pacific[18]																						
Papua New Guinea	53	0	1	1	1	1	0	4	8	3	2	2	1	5	2	3	2	1	1	0	1	0
Fiji	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
New Caledonia[19]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tonga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Australia[20]	460	16	65	103	133	142	93	78	70	90	93	58	73	49	42	21	14	15	49	44	70	106
East Timor[20]	2	2	0	0	0	0	0	0	0	2	4	3	3	0	0	1	0	0	0	0	0	0
New Zealand	77	3	3	4	10	5	3	4	3	9	10	10	9	2	1	4	6	2	8	1	4	5
Total	592	21	69	108	144	148	96	86	81	104	109	73	86	56	45	29	22	18	61	45	77	112
Russia																						
Russia	1,392	198	222	254	256	272	240	214	222	263	233	259	208	191	205	245	209	240	228	196	247	247
Grand total for study area																						
Grand total	14,621	1,386	1,490	1,470	1,428	1,511	1,390	1,291	1,360	1,482	1,501	1,619	1,519	1,500	1,526	1,647	1,509	1,513	1,540	1,463	1,752	2,011

Table 5. Wildcat wells by year, 1961–2001, for Mexico, the Caribbean, Central and South America, Europe, the Middle East, Africa, Asia, the southwestern Pacific, and Russia.—Continued

Area	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	1999	2000	2001	Unkn	Total
Southwestern Pacific[18]—Continued																						
Papua New Guinea.........	1	1	5	3	2	2	3	10	16	7	4	2	5	4	5	2	1	4	2	0	4	175
Fiji..................................	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
New Caledonia[19].............	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Tonga.............................	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Australia[20]......................	152	140	148	189	103	163	135	92	118	101	85	83	92	108	108	121	123	76	84	82	23	4,210
East Timor[20]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
New Zealand	2	7	16	15	16	9	10	5	6	3	4	7	2	3	6	4	9	4	10	6	0	327
Total	159	148	169	207	121	174	148	107	140	111	93	92	99	115	119	127	133	84	97	88	27	4,740
Russia—Continued																						
Russia............................	303	320	306	353	428	495	514	420	410	307	159	90	90	42	60	57	34	55	50	5	615	11,354
Grand total for study area—Continued																						
Grand total	2,270	2,065	2,117	2,272	2,047	1,881	2,024	1,767	1,855	1,750	1,406	1,151	1,067	1,102	1,173	1,157	1,147	796	958	857	2,456	79,847

[18]No wildcat wells were reported for French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia, Nauru, Northern Mariana Islands, Samoa, Solomon Islands, Tuvalu, or Vanuatu.

[19]New Caledonia is listed separately although it is an overseas territory of France.

[20]Wildcat wells from the Timor Gap Zone of Cooperation are listed under Australia.

Table 6.   Year of first discovery and cumulative recoverable oil and gas discovered through 2001 in the 173 significant petroleum provinces in the study area.

[Each significant province has at least one field containing 100 million barrels of recoverable oil or 600 billion cubic feet of recoverable gas. Some provinces (marked by two asterisks) have resources in more than one region, and the petroleum in each part of the province is apportioned to the correct region. Data are from IHS Energy Group (2002). Province names and code numbers are from U.S. Geological Survey (USGS) World Energy Assessment Team (2000). The provinces in this table are listed within each region by year of first discovery. The historical sequence by year of first discovery in each significant petroleum province is graphed for six regions in figure 8*A–F*. Province boundaries are mapped and data on oil and gas discoveries in significant provinces are given in figures 14–57 for all regions except Mexico. MMBO, millions of barrels (bbl × 10⁶) of oil; BCF, billions of cubic feet (ft³ × 10⁹)]

Petroleum province name and code (country)	Year of first discovery	Cumulative recoverable oil discovered through 2001 (MMBO)	Cumulative recoverable gas discovered through 2001 (BCF)
Mexico			
Tampico-Misantla Basin, 5301	1901	11,525	21,553
Saline-Comalcalco Basin, 5304	1904	3,452	3,820
Macuspana Basin, 5306	1905	36	6,245
Burgos Basin, 5300	1931	32	12,434
Villahermosa Uplift, 5305	1954	42,085	51,318
Total		57,130	95,370
Caribbean (fig. 14)			
Greater Antilles Deformed Belt, 6117 (Cuba)	1881	422	66
South America (figs. 8*A* and 16–24)			
Progreso Basin, 6083 (Ecuador and Peru)	1863	137	562
East Venezuela Basin, 6098 (Venezuela and Trinidad and Tobago)	1867	63,375	172,767
Talara Basin, 6081 (Peru)	1869	1,772	2,909
San Jorge Basin, 6058 (Argentina)	1907	4,015	4,491
Maracaibo Basin, 6099 (Colombia and Venezuela)	1914	54,878	52,930
Middle Magdelena, 6090 (Colombia)	1918	2,479	3,110
Neuquen Basin, 6055 (Argentina)	1922	3,431	24,868
Santa Cruz-Tarija Basin, 6045 (Argentina, Bolivia, and Paraguay)	1924	384	49,576
Cuyo Basin, 6051 (Argentina)	1932	1,396	275
Oran-Olmedo Basin, 6046 (Argentina)	1936	139	2,740
Reconcavo Basin, 6032 (Brazil)	1939	1,667	3,704
Ucayali Basin, 6040 (Peru)	1939	34	3,457
Magallanes Basin, 6059 (Argentina and Chile)	1945	1,356	27,963
Llanos Basin, 6096 (Colombia and Venezuela)	1948	4,911	7,941
Barinas-Apure Basin, 6097 (Venezuela)	1948	1,540	192
Upper Magdelena, 6089 (Colombia)	1949	1,057	830
Sergipe-Alagoas Basin, 6029 (Brazil)	1957	810	1,973
Putumayo-Oriente-Maranon Basin, 6041 (Colombia, Ecuador, and Peru)	1963	9,131	2,146
Guyana-Suriname Basin, 6021 (Suriname)	1965	154	0
Tobago Trough, 6103 (Venezuela and Trinidad and Tobago)	1971	20	20,614
Potigar Basin, 6027 (Brazil)	1973	822	1,763
Guajira Basin, 6095 (Colombia)	1973	0	4,695
Campos Basin, 6035 (Brazil)	1974	14,059	9,546
Foz do Amazonas Basin, 6022 (Brazil)	1976	0	885
Santos Basin, 6036 (Brazil)	1979	343	755
Cariaco Basin, 6102 (Venezuela)	1979	35	1,150
Madre dos Dios Basin, 6043 (Bolivia and Peru)	1984	1	12,810
Eastern Cordillera Basin, 6092 (Colombia)	1994	60	685
Total		168,006	415,337

Table 6. Year of first discovery and cumulative recoverable oil and gas discovered through 2001 in the 173 significant petroleum provinces in the study area.—Continued

Petroleum province name and code (country)	Year of first discovery	Cumulative recoverable oil discovered through 2001 (MMBO)	Cumulative recoverable gas discovered through 2001 (BCF)
Europe (figs. 8*B* and 25–27)			
Carpathian-Balkanian Basin, 4061 (Bulgaria, Moldova, and Romania)	1835	5,981	7,560
North Carpathian Basin, 4047 (Czech Republic, Hungary, Poland, Slovakia, and Ukraine)	1850	1,411	22,385
Northwest German Basin, 4035 (Denmark,* Germany, and Netherlands)	1856	2,283	157,398
Pannonian Basin, 4048 (Austria, Bosnia and Herzegovina,* Croatia, Hungary, Romania, Slovakia, Slovenia, Ukraine, and Serbia and Montenegro)	1856	1,523	14,692
Ireland-Scotland Platform, 4026 (Ireland and United Kingdom)	1876	18	3,591
Transylvanian Basin, 4057 (Romania and Ukraine)	1880	1	30,889
Azov-Kuban Basin,** 1108 (Ukraine)	1886	22	670
Po Basin, 4060 (Croatia, Italy, and San Marino*)	1890	320	21,974
Anglo-Paris Basin, 4040 (France and United Kingdom)	1896	841	522
Bohemia, 4046 (Austria, Czech Republic, Germany, and Slovakia)	1913	1,037	5,048
Tuscany-Latium-Paola, 4062 (Italy)	1915	1	1,497
Adriatic Basin, 4058 (Albania, Croatia, and Italy)	1918	542	1,385
Anglo-Dutch Basin, 4036 (Netherlands and United Kingdom)	1919	726	84,541
German-Polish Basin, 4033 (Germany and Poland)	1925	144	15,969
Alps, 4051 (Croatia, Italy, Macedonia,* and Serbia and Montenegro)	1933	1,078	6,883
Dnieper-Donets Basin,** 1009 (Ukraine)	1936	1,538	68,251
Irish Sea, 4030 (United Kingdom)	1939	219	8,479
Pyrenean Foothills-Ebro Basin, 4044 (France and Spain)	1939	118	12,758
Sicily, 4066 (Italy and Malta*)	1940	504	876
Lusitanian Basin, 4074 (Portugal)	1953	0	920
Aquitaine Basin, 4045 (France)	1954	375	27
Pripyat Basin, 1010 (Belarus)	1963	910	255
North Sea Graben, 4025 (Denmark, Germany, Netherlands, Norway, and United Kingdom)	1966	49,129	167,015
Iberic Cordillera, 4083 (Spain)	1967	299	178
Aegean,** 4075 (Greece)	1971	139	142
Faeroes-Shetland-Orkney Basin, 4019 (United Kingdom)	1977	1,460	2,279
Hammerfest-Varanger Basin, 4015 (Norway)	1981	292	11,755
Vestford-Helgeland, 4017 (Norway)	1981	3,717	36,729
Pelagian Basin,** 2048 (Italy)	1988	15	0
Total		74,643	684,668

Table 6.   Year of first discovery and cumulative recoverable oil and gas discovered through 2001 in the 173 significant petroleum provinces in the study area.—Continued

Petroleum province name and code (country)	Year of first discovery	Cumulative recoverable oil discovered through 2001 (MMBO)	Cumulative recoverable gas discovered through 2001 (BCF)
Middle East (figs. 8*C* and 28–32)			
Zagros Fold Belt, 2030 (Iran, Iraq, Syria, and Turkey)	1905	137,168	485,666
Greater Ghawar Uplift, 2021 (Bahrain, Qatar, and Saudi Arabia)..	1932	147,200	259,700
Widyan Basin-Interior Platform, 2023 (Iraq and Saudi Arabia)...	1938	17,795	14,700
Mesopotamian Foredeep Basin, 2024 (Iran, Iraq, Kuwait, former Kuwait-Saudia Arabia Neutral Zone, and Saudi Arabia)...	1938	326,458	295,452
Euphrates/Mardin, 2075 (Syria and Turkey)...	1940	1,086	2,778
Rub Al Khali Basin, 2019 (Iran, Oman, Qatar, Saudi Arabia, and United Arab Emirates)...	1954	101,284	212,000
Levantine Basin,** 2032 (Israel and Gaza Strip*)	1955	23	3,510
South Oman Salt Basin, 2011 (Oman)..	1956	2,805	888
South Caspian Basin,** 1112 (Iran)	1960	0	700
Fahud Salt Basin, 2016 (Oman)..	1962	4,661	10,558
Ghaba Salt Basin, 2014 (Oman)	1964	1,323	19,286
Kura Basin,** 1113 (Iran)	1967	1	0
Qatar Arch, 2022 (Iran and Qatar)..	1967	2,235	826,000
Amu-Darya Basin,** 1154 (Iran)	1968	0	13,990
Red Sea Basin,** 2071 (Saudi Arabia)...	1969	60	1,550
Central Oman Platform, 2015 (Oman)...	1971	125	7,747
East Flank Oman Sub-basin, 2012 (Oman)	1973	2,334	46
Anah Graben, 2089 (Syria)..	1982	456	148
Ma'Rib-Al Jawf/Masila Basin, 2004 (Yemen)..	1984	1,315	17,887
Khleisha Uplift, 2074 (Syria)..	1986	1,680	1,364
Aegean,** 4075 (Turkey)	1988	0	90
Interior Homocline-Central Arch, 2020 (Saudi Arabia)...	1989	5,525	17,200
Masila-Jeza Basin, 2009 (Yemen)..	1991	1,233	71
Total		754,767	2,191,331
Africa (figs. 8*D* and 33–44)			
Red Sea Basin,** 2071 (Egypt, Eritrea, and Sudan)	1907	10,014	7,230
Pelagian Basin,** 2048 (Libya and Tunisia)	1949	2,710	38,144
West-Central Coastal, 7203 (Angola, Cameroon, Congo (Brazzaville), Congo (Kinshasa), Equatorial Guinea, and Gabon)	1951	26,039	21,715
Benue, 7136 (Nigeria)..	1953	5	1,265
Mozambique Coastal, 7343 (Mozambique)..	1953	0	3,712
Grand Erg/Ahnet Basin, 2058 (Algeria)	1954	608	116,741
Niger Delta, 7192 (Cameroon, Equatorial Guinea, and Nigeria)	1954	51,130	193,561
Trias/Ghadames Basin, 2054 (Algeria, Libya, and Tunisia)..	1956	20,711	41,404
Illizi Basin, 2056 (Algeria and Libya)	1956	4,596	41,212
Hamra Basin, 2047 (Libya)..	1957	809	1,635
Sirte Basin, 2043 (Libya)..	1958	44,927	47,777
Senegal, 7013 (Guinea-Bissau, Mauritania, and Senegal)..	1959	340	108
Somali, 7255 (Ethiopia and Somalia)	1959	0	4,401
Nile Delta Basin, 2035 (Egypt)...	1966	2	42,775
North Egypt Basin, 2039 (Egypt)	1966	727	6,396
Abu Gharadiq Basin, 2038 (Egypt)...	1968	540	4,540
Gulf of Guinea, 7183 (Benin, Cote d'Ivoire, Ghana, Nigeria, and Togo)	1968	651	3,641
South African Coastal, 7363 (South Africa)...	1969	119	3,770
Tanzania Coastal, 7273 (Tanzania)	1974	0	1,765
Orange River Coastal, 7303 (Namibia and South Africa)	1974	0	20,815
Levantine Basin,** 2032 (Egypt)	1975	20	2,736
Sud, 7146 (Chad and Sudan)	1975	2,564	247
Murzuk Basin, 2045 (Libya)...	1978	2,174	433
Total		168,686	606,023

Table 6.   Year of first discovery and cumulative recoverable oil and gas discovered through 2001 in the 173 significant petroleum provinces in the study area.—Continued

Petroleum province name and code (country)	Year of first discovery	Cumulative recoverable oil discovered through 2001 (MMBO)	Cumulative recoverable gas discovered through 2001 (BCF)
Asia (figs. 8*E* and 45–53)			
Irrawaddy, 8048 (Burma)	1864	798	12,778
Niigata Basin, 3308 (Japan)	1867	86	2,670
Assam, 8034 (India)	1867	2,157	5,837
South Caspian Basin,** 1112 (Azerbaijan and Turkmenistan)	1869	21,028	70,645
Kura Basin,** 1113 (Azerbaijan and Georgia)	1869	524	278
Japan Volcanic Arc/Accreted Terrane, 3304 (Japan and South Korea)	1870	120	1,751
Taiwan Thrust and Fold Belt, 3151 (Taiwan)	1876	8	1,941
Sulaiman-Kirthar, 8025 (Pakistan)	1883	0	16,399
North Sumatra Basin, 3822 (Indonesia and Malaysia)	1885	736	30,668
East Java Basin, 3809 (Indonesia)	1888	976	6,503
South Sumatra Basin, 3828 (Indonesia)	1896	2,869	17,986
Junggar Basin, 3115 (China)	1897	8,430	4,840
Kutei Basin, 3817 (Indonesia)	1897	3,487	58,666
North Caspian Basin,** 1016 (Kazakhstan)	1898	21,615	93,628
Pamusian Tarakan Basin, 3606 (Indonesia)	1900	522	4,243
Fergana Basin, 1159 (Kyrgyzstan, Tajikistan, and Uzbekistan)	1901	781	1,631
Ordos Basin, 3128 (China)	1907	986	14,747
Baram Delta/Brunei-Sabah Basin, 3701 (Brunei and Malaysia)	1910	7,142	39,666
Ganges-Brahmaputra Delta, 8047 (Bangladesh and India)	1915	3	18,548
Tarim Basin, 3154 (China)	1918	1,523	16,458
Afghan-Tajik Basin, 1156 (Afghanistan, Uzbekistan, and Tajikistan)	1934	155	5,630
Kanto Basin, 3306 (Japan)	1935	0	1,359
Bintuni/Sulawati Province, 3805 (Indonesia)	1936	504	19,510
Barito Basin, 3804 (Indonesia)	1937	173	215
Middle Caspian Basin,** 1109 (Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan)	1939	5,354	9,426
Jiuquan Minle Wuwei Basin, 3114 (China)	1939	209	1
Sichuan Basin, 3142 (China)	1939	246	31,915
Central Sumatra Basin, 3808 (Indonesia)	1939	13,074	2,109
Northwest Java Basin, 3824 (Indonesia)	1939	3,434	11,460
Amu-Darya Basin,** 1154 (Afghanistan, Turkmenistan, and Uzbekistan)	1953	983	229,851
Qaidam Basin, 3131 (China)	1955	541	2,385
Indus, 8042 (India and Pakistan)	1957	339	24,067
Bombay, 8043 (India)	1958	7,325	27,979
Songliao Basin, 3144 (China)	1959	15,637	4,722
Bohaiwan Basin, 3127 (China)	1961	19,326	17,527
Greater Sarawak Basin, 3702 (Indonesia and Malaysia)	1962	900	89,219
North Ustyurt Basin, 1150 (Kazakhstan and Uzbekistan)	1964	2,589	4,122
Malay Basin, 3703 (Cambodia, Indonesia, Malaysia, Thailand, and Vietnam)	1969	3,907	62,462
Nanyang Basin, 3126 (China)	1971	711	0
Penyu/West Natuna Basin, 3825 (Indonesia and Malaysia)	1972	747	5,081
Thai Basin, 3507 (Thailand)	1973	211	15,228
Saigon Basin, 3505 (Vietnam)	1974	251	6,982
Yinggehai Basin, 3159 (China and Vietnam)	1975	19	11,909
Mekong/Cuulong/Vung Tau Basin, 3503 (Vietnam)	1975	2,064	3,375
Palawan Shelf, 3605 (Philippines)	1976	182	4,575
Pearl River Mouth Basin, 3130 (China)	1979	1,361	1,584
Krishna-Godavari, 8045 (India)	1979	331	3,518
Thailand Mesozoic Basin Belt, 3508 (Thailand)	1981	256	832
South Turgay Basin, 1167 (Kazakhstan)	1984	1,038	743
South China Continental Shelf Slope, 3181 (China and Vietnam)	1984	121	1,705
Sulawesi Accretionary Prism, 3829 (Indonesia)	1986	15	3,791
Volga-Ural Region,** 1015 (Kazakhstan)	1991	67	837
Luxi Jiaoliao Uplift, 3124 (China)	1993	774	154
Bonaparte Gulf Basin,** 3910 (Indonesia)	2000	0	1,800
Total		156,635	1,025,956

Table 6. Year of first discovery and cumulative recoverable oil and gas discovered through 2001 in the 173 significant petroleum provinces in the study area.—Continued

Petroleum province name and code (country)	Year of first discovery	Cumulative recoverable oil discovered through 2001 (MMBO)	Cumulative recoverable gas discovered through 2001 (BCF)
Southwestern Pacific (figs. 54–56)			
Taranaki Basin, 3031 (New Zealand)..	1867	419	7,096
Gippsland Basin, 3930 (Australia)...	1924	4,089	11,097
Northwest Shelf, 3948 (Australia)..	1954	1,806	96,607
New Guinea Foreland Basin-Fold Belt, 3966 (Papua New Guinea)....................	1956	518	11,310
Papuan Basin-Shelf Platform, 3969 (Papua New Guinea)...............................	1958	0	2,740
Bonaparte Gulf Basin,** 3910 (Australia)	1964	556	25,492
Eromanga Basin, 3924 (Australia)..	1964	301	9,923
Browse Basin, 3913 (Australia)	1971	121	38,751
Total		7,810	203,016
Russia (figs. 8*F* and 57)			
Azov-Kuban Basin,** 1108..	1864	1,929	21,087
Middle Caspian Basin,** 1109	1893	6,727	22,290
North Sakhalin Basin, 1322	1923	2,128	25,647
Timan-Pechora Basin, 1008...	1930	13,738	41,474
Volga-Ural Region,** 1015	1932	67,465	98,681
West Siberian Basin, 1174	1953	138,789	1,530,681
Angara-Lena Terrace, 1209...	1954	4	9,965
Lena-Vilyuy Basin, 1214	1956	0	13,763
North Caspian Basin,** 1016...	1958	47	93,196
Dnieper-Donets Basin,** 1009...	1959	21	825
Yenisey-Khatanga Basin, 1175	1965	4	9,386
Nepa-Botuoba Arch, 1210	1965	3,372	27,354
Baykit Arch, 1207...	1974	442	8,424
South Barents Basin, 1050..	1983	0	101,208
Ludlov Saddle, 1059	1990	0	2,740
Total		234,666	2,006,721
Grand total for significant provinces in the study area***			
Grand total		1,622,765	7,228,488

* The significant province extends into this country, but the country lacks discoveries in this province.

**Some significant provinces have discoveries in more than one region, and the discoveries in each part of the province are apportioned to the correct region. These 13 provinces are summarized below:

– The Levantine Basin and Red Sea Basin are in both the Middle East and Africa.

– The South Caspian Basin, Kura Basin, and Amu-Darya Basin are in both the Middle East and Asia.

– The Aegean is in both the Middle East and Europe.

– The Middle Caspian Basin, North Caspian Basin, and Volga-Ural Region are in both Asia and Russia.

– The Bonaparte Gulf Basin is in both Asia and the southwestern Pacific.

– The Azov-Kuban Basin and Dnieper-Donets Basin are in both Russia and Europe.

– The Pelagian Basin is in both Europe and Africa.

***The total discoveries in the study area in <u>all</u> provinces are 1,630,000 MMBO and 7,275,000 BCF of gas (table 4); thus, most of the discoveries in the study area are in the 173 significant provinces, which contain 1,622,765 MMBO and 7,228,488 BCF of gas.

Table 7. Regional distribution in the study area of land area, delineated prospective area, and explored area through 2001, rate of addition to prospective area, 1992–2001, and percentages of total prospective area and oil discoveries delineated by 1982.

[Drilling data are from IHS Energy Group (2002). Land areas in square miles (mi²) are converted from areas in square kilometers in "The World Factbook 2001" (U.S. Central Intelligence Agency, 2001)]

Region	Land area (mi²)	Prospective area through 2001 (mi²)	Explored area through 2001 (mi²)	Rate of addition to prospective area, 1992–2001 (mi²/wildcat well)	Percentage of total prospective area delineated by 1982	Percentage of oil discoveries in area delineated by 1982
Mexico	761,602	45,970	9,820	23.2	81.7	95.8
Caribbean	88,640	19,358	3,464	66.5	84.9	100.0
Central America	202,232	15,022	1,830	151.6	75.4	100.0
South America	6,881,714	485,091	123,523	29.7	73.8	90.2
Europe*	2,260,379	791,839	184,400	18.8	83.4	91.5
Middle East	2,317,969	286,061	45,595	62.1	63.4	97.1
Africa	11,720,036	578,957	100,749	60.3	72.3	83.1
Asia	9,887,100	921,065	179,863	76.8	55.7	81.8
Southwestern Pacific	3,288,873	357,636	54,534	47.7	60.0	75.8
Russia	6,592,741	627,065	142,661	39.3	65.6	92.4
Whole study area..........	44,001,286	4,128,064	846,439	46.7	68.4	92.3

*Europe does not include data for Greenland or Iceland.

Figures 14–57

Introduction.—Figures 14–57 show delineated prospective area, explored area, and known petroleum provinces of the study area regions—the Caribbean (fig. 14), Central and South America (figs. 15–24), Europe (figs. 25–27), the Middle East (figs. 28–32), Africa (figs. 33–44), Asia (figs. 45–53), the southwestern Pacific (figs. 54–56), and Russia (fig. 57). Each figure includes a map, two graphs, and a summary of the exploration data. If significant provinces occur in the mapped area, then a table provides information on each significant province. Definitions of terms are provided below.

Maps.—All maps were drawn by using ArcView software (version 3.2, created by Environmental Systems Research Institute, Inc. (ESRI)) and were edited in Adobe Illustrator (version 10). Each map is shown in unprojected geographic coordinates, except for northern Europe (fig. 25) and Russia (two maps in fig. 57). These three maps are shown in equidistant conic projection to minimize distortion of distance over the near-polar areas. Scales are not provided, as the scale varies on unprojected maps.

Methods for computing and identifying delineated prospective areas and explored areas are explained in the text and are the same methods as those used in Attanasi and Root (1993). Recall that the *delineated prospective area* is described as the set of all (grid) points that are reasonably close to wells (producing or dry) and that are also inside the area drilled. Also recall that the *explored area* is defined as the area consisting of the points in the delineated prospective area that are within 2 miles of a well. The computation of delineated prospective area and explored area used locations of all wildcat, exploration, and development wells, both successful and dry, along with the locations of fields. All data except data for wells with a missing or obviously incorrect location were used because, for some areas, most of the wildcat well history, particularly prior to 1950, is missing. The dry and producing well locations and field locations may represent the only evidence of prior exploration. Use of all the data added

some redundancy to the computations but assured that no area that had been searched was excluded because of missing wildcat or exploration wells.

Landmass outlines and country boundaries are from the "Data & Maps Series Cntry98 File" (ESRI, 1998). Country names are from the "The World Factbook 2001" (U.S. Central Intelligence Agency (CIA), 2001). If only part of the country is shown, then no delineated prospective area was identified in the rest of the country. Selected major rivers and lakes are from the "ArcWorld 1:3M Rivers and Water Bodies Coverage" (ESRI, 1992).

Generalized bathymetric contour lines are shown at 200 and 1,000 meters (656 and 3,280 feet) below sea level. Contour lines were generated from the "ETOPO5 5-Minute-Gridded Elevation Data" (National Geophysical Data Center, 1998) by using ESRI's Arc/Info software (version 8.2). ETOPO5 is a raster dataset of worldwide land and sea-floor elevations at 5-minute spacing. Contour lines were then generalized in Arc/Info to smooth the lines and to reduce jagged features.

Petroleum province names, boundaries, and code numbers are from the "U.S. Geological Survey World Petroleum Assessment 2000" (U.S. Geological Survey World Energy Assessment Team, 2000). Of all the known petroleum provinces shown in figures 14–57, 173 are classified as significant because, by the end of 2001, they had at least one field containing 100 million barrels of crude oil or 600 billion cubic feet of gas (table 6).

Tables of significant petroleum provinces through 2001.—In figures 14–57, tables facing the maps provide information on the part of each significant province in a country, if there are reported discoveries for that significant province in that country. (Table 6 gives the total cumulative recoverable oil and gas volumes in each significant province in all the countries it occupies.) Data are from the "International Petroleum Exploration and Production Database" (IHS Energy Group, 2002), and the country order in the significant province tables follows the order in that database. Within each country, provinces are

listed alphabetically. The tables show year of first discovery, oil in large oil fields (containing at least 100 million barrels), oil in all oil fields, gas in oil fields, gas in gas fields, and gas in all fields. A field is classified as either oil or gas on the basis of its gas:oil ratio. A field having at least 20,000 cubic feet of gas per barrel of crude oil is classified as a gas field; otherwise, the field is classified as an oil field.

Graphs.—Two graphs are shown with each map in figures 14–57; the two types of graphs are described in the text section, "Tools for Analysis: Graphs," and generalized graphs are shown in figure 6. The first graph shows the growth of cumulative delineated prospective area and explored area, arranged by the year when the areas became prospective or explored, plotted against the cumulative number of wildcat wells drilled in the country or country group through 2001, where the wells are also ordered by time. The second graph shows cumulative recoverable oil and gas discoveries as functions of cumulative delineated prospective area, where the increments of prospective area are ordered by time. Dates are shown at the top of each graph. Data plotted are from IHS Energy Group (2002).

Only wildcat wells that have spud or completion dates and complete data indicating a location within the country or country group were used to construct graphs. Thus, cumulative wildcat well counts in the graphs are typically less than those in table 5, which includes wells without dates or coordinates.

For many wildcat wells drilled before 1950, data were not available, and, therefore, the delineated prospective areas and explored areas as of 1950 are underestimated in the graphs. Records of followup drilling after 1950 probably result in an overestimate of the rate of increase in the delineated prospective area. Nonetheless, the growth in delineated prospective area after 1970 is probably real and not an artifact of missing data.

Summaries of exploration data.—Land areas from the CIA (2001) in square kilometers were converted to square miles for ease in comparing this Circular with Circular 1096 (Attanasi and Root, 1993). Land areas for country groups may not add to the totals shown because of rounding. Computation of the delineated prospective area and the explored area is explained in the text. Wildcat wells and cumulative recoverable oil and gas discoveries through 2001 are from IHS Energy Group (2002). Only wildcat wells that have spud or completion dates and that have longitude and latitude coordinates are used in the calculation of the current rate of growth in delineated prospective area per wildcat. The current rate is computed as the rate of the expansion in the prospective area per wildcat for the last 10 percent of the wildcat wells drilled in the area.

The oil richness factor (cumulative oil discovered through 2001 divided by the number of square miles in the delineated prospective area) is shown and can be compared with the oil richness factors in Attanasi and Root (1993). The richness factors tend to be larger in areas where exploration has been concentrated in a small part of the prospective area (such as the Middle East).

EXPLANATION FOR MAPS IN FIGURES 14–57

Delineated prospective area

Explored area

Petroleum province boundary; province names, codes, and boundaries are from U.S. Geological Survey World Energy Assessment Team (2000)

Country boundary from Environmental Systems Research Institute (ESRI, 1998); country names are from U.S. Central Intelligence Agency (2001)

River from ESRI (1992)

Bathymetry contour at 200 meters (656 feet) from National Geophysical Data Center (1998)

Bathymetry contour at 1,000 meters (3,280 feet) from National Geophysical Data Center (1998)

UNITS USED IN FIGURES 14–57

BBO   billions of barrels of oil (bbl $\times$ 10^9)
BCF   billions of cubic feet (ft^3 $\times$ 10^9)
mi^2 square miles
MMBO   millions of barrels of oil (bbl $\times$ 10^6)
TCF   trillions of cubic feet (ft^3 $\times$ 10^{12})

Figure 14.   Map, graphs, and tables of data for oil and gas exploration through 2001 in the Caribbean. Parts of the Caribbean are Cuba, Barbados, The Bahamas, Bermuda, Cayman Islands, Dominican Republic, Haiti, Jamaica, Puerto Rico, and the Lesser Antilles. Bermuda is not shown on the map; it lacks delineated prospective area. For this study, the Lesser Antilles are considered to include Netherlands Antilles, British Virgin Islands, Martinique, Dominica, Grenada, Virgin Islands, Saint Kitts and Nevis, Antigua and Barbuda, Anguilla, Montserrat, Guadeloupe, Saint Lucia, Saint Vincent and the Grenadines, and Aruba.

Growth in delineated prospective area and explored

area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces

through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum province—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Cuba: Greater Antilles Deformed Belt, 6117..	1881	143	422	66	0	66

Exploration data

Country	Land area (mi²)
Cuba	42,803
Barbados	166
Bahamas..........................	5,382
Bermuda (not shown on map)	23
Cayman Islands..............	100
Dominican Republic	18,815
Haiti.................................	10,714
Jamaica...........................	4,243
Puerto Rico.....................	3,515
Lesser Antilles	2,909
Total	88,670

Delineated prospective area through 2001 .... 19,358 mi²
Explored area through 2001 .... 3,464 mi²
Wildcat wells through 2001.................................... 414 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)............. 48 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:
    Oil... 435 MMBO
    Gas... 87 BCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ .... 0.022 MMBO/mi²

Figure 14. Continued.

Figure 14. Caribbean

65

Figure 15.   Map, graphs, and table of data for oil and gas exploration through 2001 in Central America. Countries of Central America are Guatemala, Belize, Costa Rica, Honduras, Nicaragua, Panama, and El Salvador.

Figure 15. Central America 67

*Growth in delineated prospective area and explored
area through 2001, graphed by the year the areas
became prospective or explored*
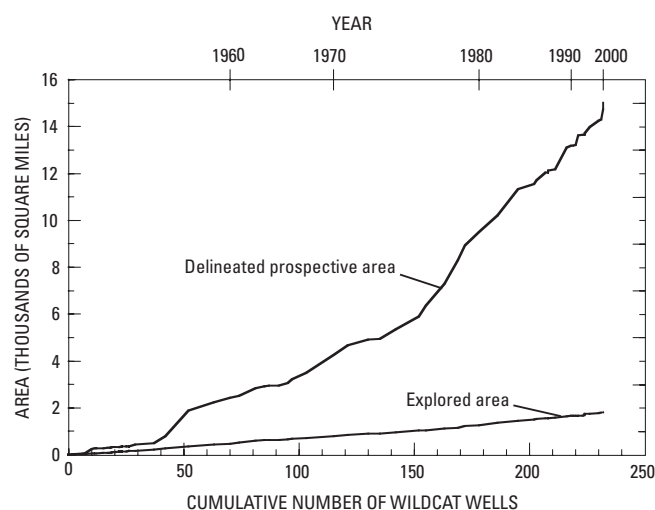
*Cumulative recoverable oil and gas discoveries in all provinces
through 2001, graphed by the year the field location
became part of the delineated prospective area*
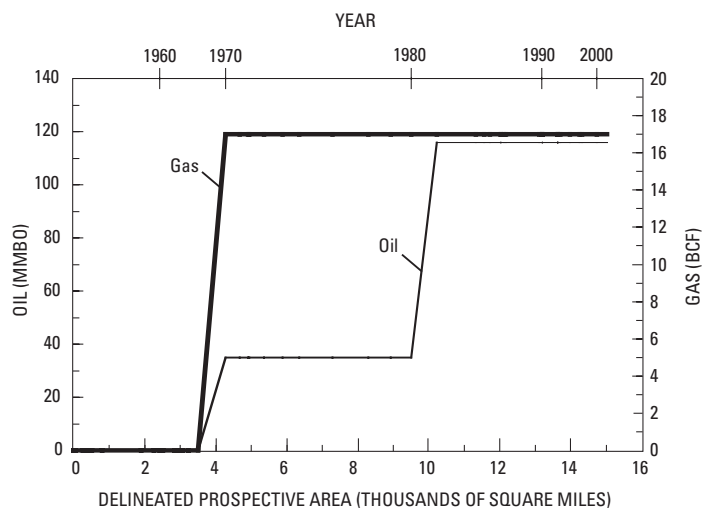
Exploration data

Country	Land area (mi²)
Guatemala	42,042
Belize	8,867
Costa Rica	19,730
Honduras...............................	43,278
Nicaragua	49,998
Panama..................................	30,193
El Salvador...........................	8,124
Total	202,232

Delineated prospective area through 2001........................ 15,022 mi²
Explored area through 2001... 1,830 mi²
Wildcat wells through 2001 .... 232 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 136 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 116 MMBO
    Gas... 17 BCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.008 MMBO/mi²

Figure 15. Continued.

Figure 16.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Suriname, Guyana, and French Guiana.

Figure 16. Suriname, Guyana, and French Guiana **69**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored
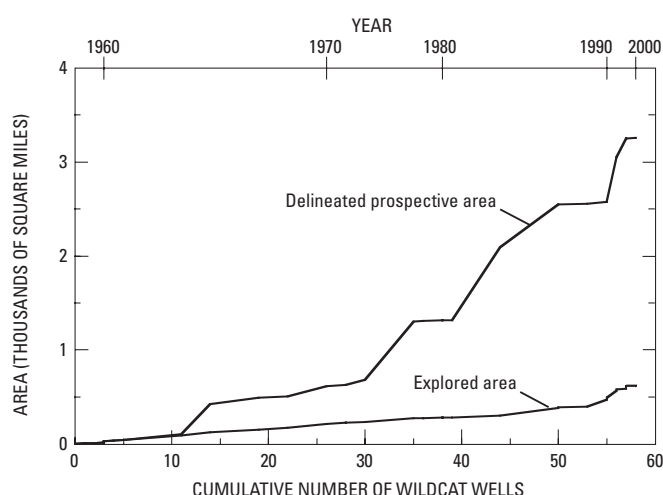
Cumulative recoverable oil discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
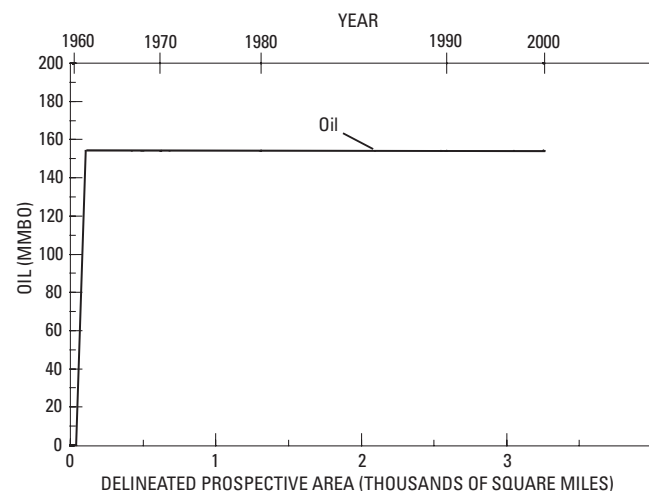
Significant petroleum province—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Suriname:						
Guyana-Suriname Basin, 6021	1965	153	154	0	0	0

Exploration data

Country	Land area (mi²)
Guyana	83,000
Suriname	63,039
French Guiana........................	35,135
Total	181,174

Delineated prospective area through 2001....................... 3,259 mi²
Explored area through 2001.. 613 mi²
Wildcat wells through 2001 .... 58 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 140 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil... 154 MMBO
    Gas.. 0
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ .... 0.047 MMBO/mi²

Figure 16. Continued.

Figure 17.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Chile.

Figure 17. Chile   71

*Growth in delineated prospective area and explored
area through 2001, graphed by the year the areas
became prospective or explored*

*Cumulative recoverable oil and gas discoveries in all provinces
through 2001, graphed by the year the field location
became part of the delineated prospective area*

Significant petroleum province—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Chile:						
Magallanes Basin, 6059..............................	1945	0	373	1,429	8,366	9,795

Exploration data

Country	Land area (mi²)
Chile.......................................	292,259

Delineated prospective area through 2001....................... 14,384 mi²
Explored area through 2001... 4,871 mi²
Wildcat wells through 2001 .... 633 wells
Current growth in delineated prospective area
   per wildcat (for last 10 percent of wells) .... 3 mi²/well
Reported discoveries through 2001 of cumulative
   recoverable crude oil and gas in all provinces:
      Oil... 373 MMBO
      Gas.. 9.836 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ .... 0.026 MMBO/mi²

Figure 17.   Continued.

Figure 18.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Argentina, Paraguay, Uruguay, and the Falkland Islands.

Figure 18. Argentina, Paraguay, Uruguay, and the Falkland Islands　　**73**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
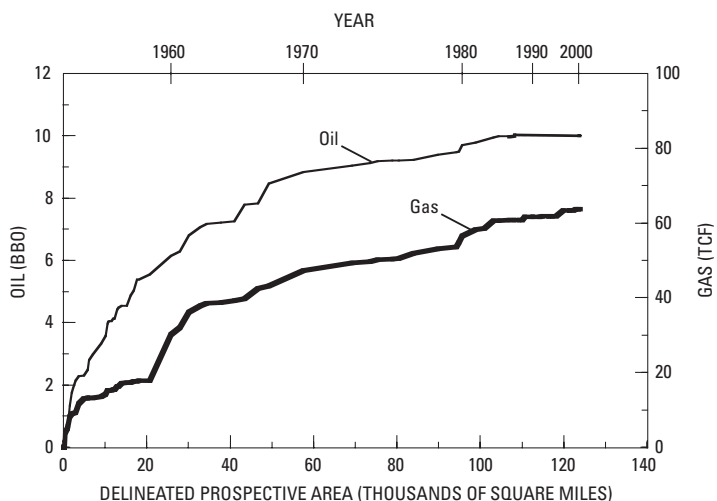
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Argentina:						
Cuyo Basin, 6051..	1932	987	1,396	246	29	275
Magallanes Basin, 6059..............................	1949	192	983	7,585	10,583	18,168
Neuquen Basin, 6055..................................	1922	1,858	3,431	5,813	19,055	24,868
Oran-Olmedo Basin, 6046	1936	0	139	212	2,528	2,740
San Jorge Basin, 6058.................................	1907	2,422	4,015	4,393	98	4,491
Santa Cruz-Tarija Basin, 6045	1926	0	50	17	12,727	12,744
Total		5,459	10,014	18,266	45,020	63,286
Paraguay:						
Santa Cruz-Tarija Basin, 6045	1959	0	0	0	15	15

Exploration data

Country	Land area (mi²)
Argentina................................	1,068,297
Paraguay................................	157,046
Uruguay.................................	68,039
Falkland Islands	4,700
Total	1,298,082

Delineated prospective area through 2001........................	124,099 mi²
Explored area through 2001...	37,406 mi²
Wildcat wells through 2001	3,994 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	17 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil...	10.015 BBO
Gas..	63.676 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.081 MMBO/mi²
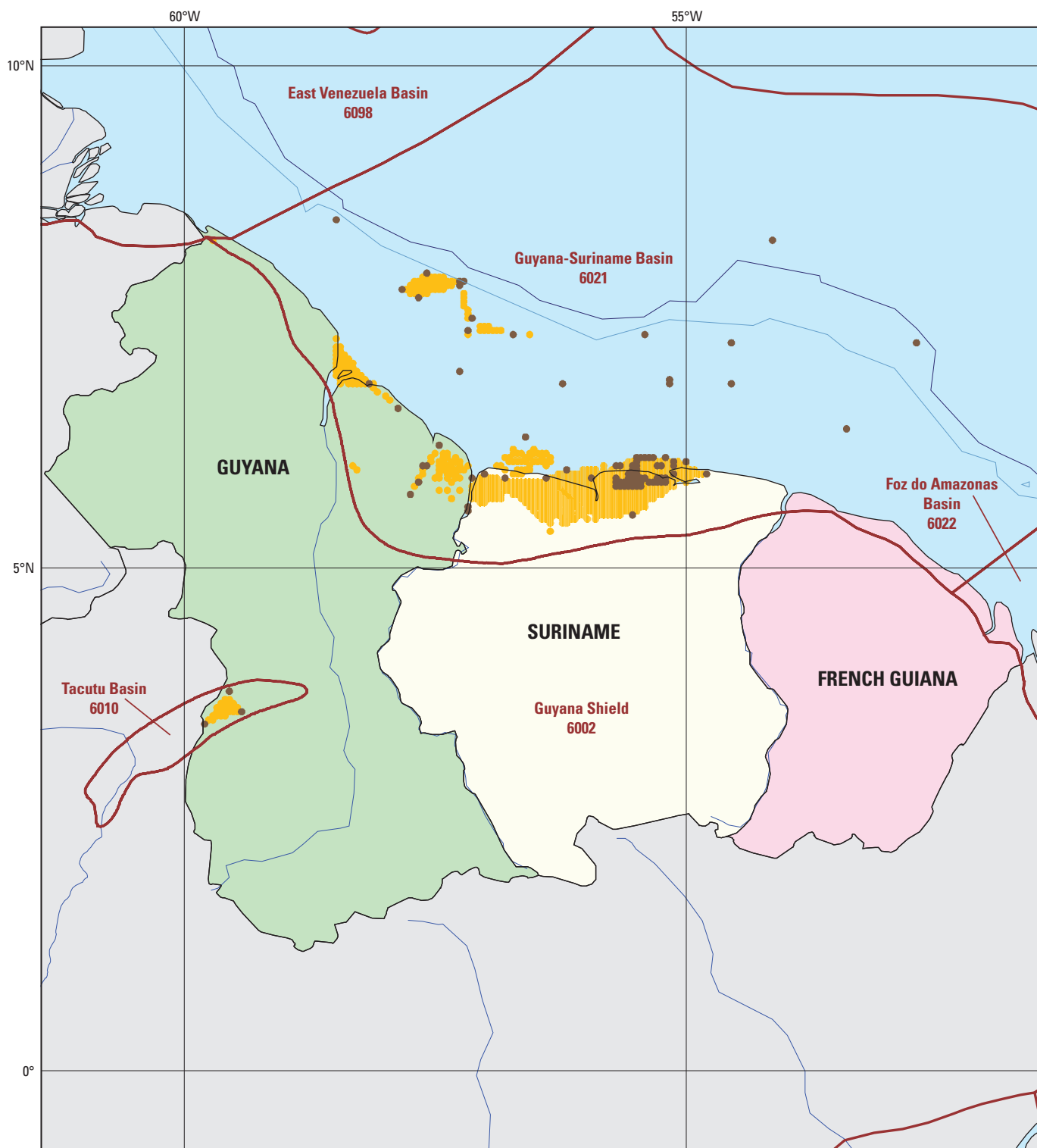
Figure 18.　Continued.
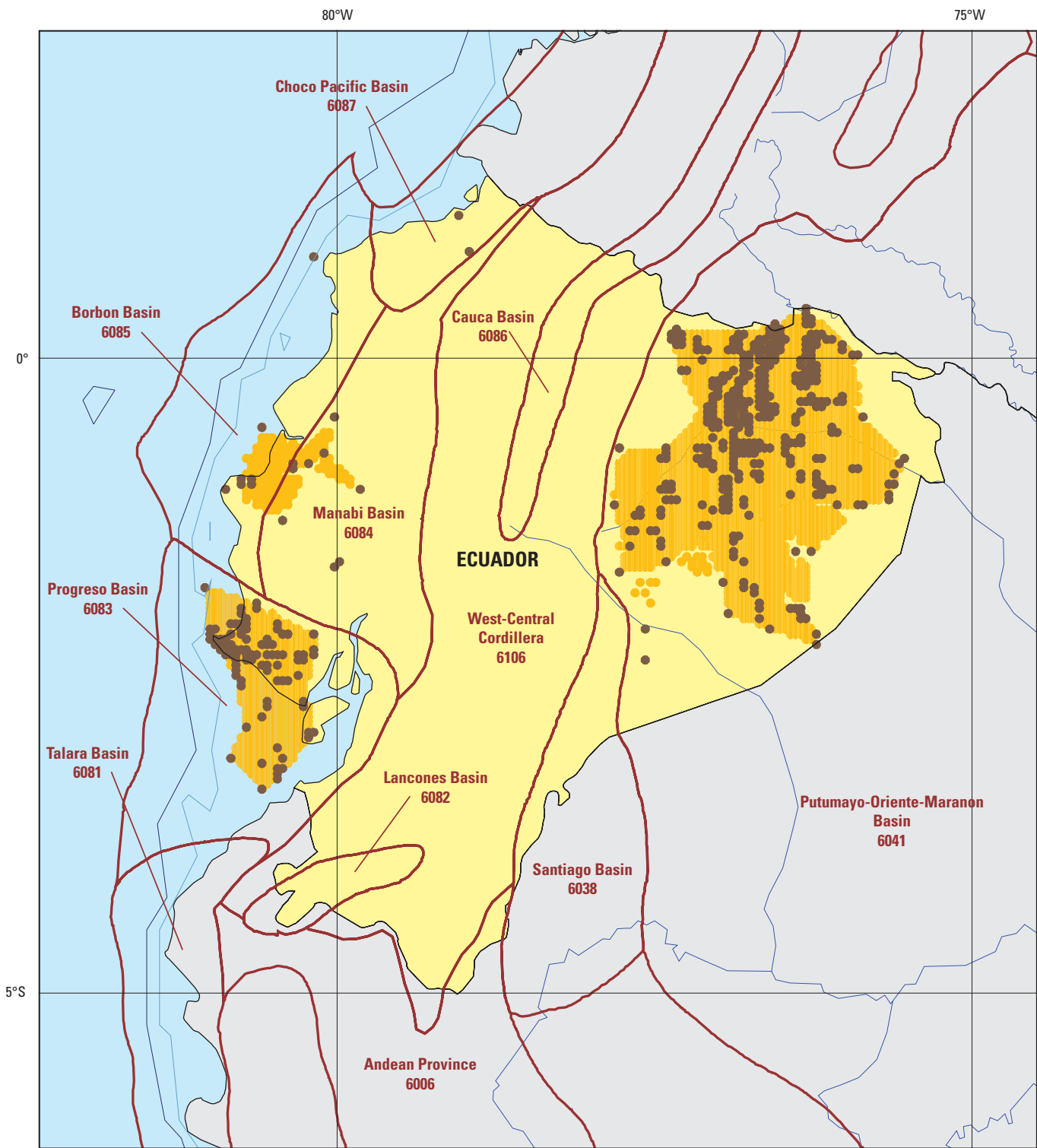
Figure 19.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Ecuador.

Figure 19. Ecuador   **75**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
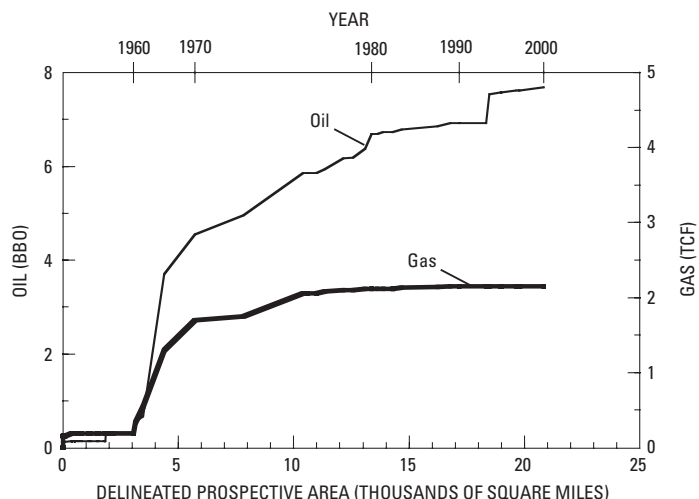
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Ecuador:						
Progreso Basin, 6083	1918	120	133	189	320	509
Putumayo-Oriente-Maranon Basin, 6041	1967	5,715	7,551	1,637	0	1,637
Total..		5,835	7,684	1,826	320	2,146

Exploration data

Country	Land area (mi²)
Ecuador	109,483

Delineated prospective area through 2001.......................	20,835 mi²
Explored area through 2001..	3,709 mi²
Wildcat wells through 2001	293 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	67 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil...	7.684 BBO
Gas..	2.146 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$	0.369 MMBO/mi²

Figure 19.   Continued.

Figure 20. Map, graphs, and tables of data for oil and gas exploration through 2001 in Colombia.

Figure 20. Colombia   **77**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
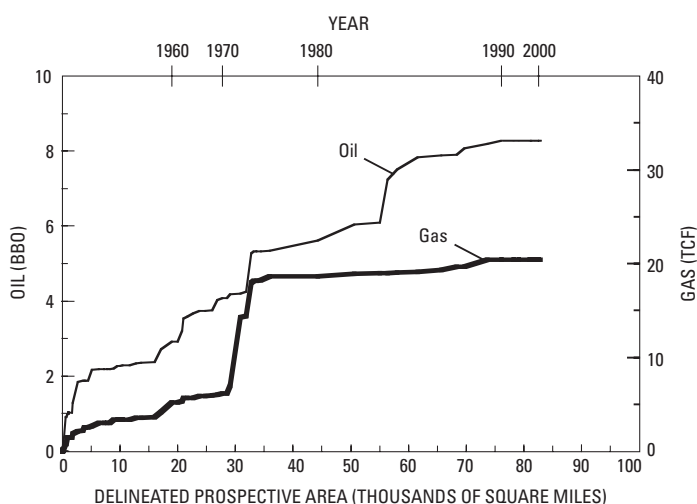
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Colombia:						
Eastern Cordillera Basin, 6092	1994	0	60	685	0	685
Guajira Basin, 6095	1973	0	0	0	4,695	4,695
Llanos Basin, 6096.....................................	1948	3,057	3,678	4,149	3,755	7,904
Maracaibo Basin, 6099	1920	410	472	559	355	914
Middle Magdalena, 6090	1918	1,983	2,479	2,908	202	3,110
Putumayo-Oriente-Maranon Basin, 6041 ...	1963	292	445	387	0	387
Upper Magdalena, 6089..............................	1949	292	1,057	499	331	830
Total		6,034	8,191	9,187	9,338	18,525

Exploration data

Country	Land area (mi²)
Colombia................................	439,734

Delineated prospective area through 2001 .... 82,941 mi²
Explored area through 2001 .... 14,398 mi²
Wildcat wells through 2001 .... 1,513 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 15 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 8.27 BBO
    Gas.. 20.408 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.100 MMBO/mi²

Figure 20. Continued.

Figure 21.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Peru.

Figure 21. Peru   79

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated rospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Peru:						
Madre dos Dios Basin, 6043........................	1984	0	0	0	12,800	12,800
Progreso Basin, 6083	1863	0	4	0	53	53
Putumayo-Oriente-Maranon Basin, 6041 ...	1971	535	1,135	122	0	122
Talara Basin, 6081......................................	1869	1,505	1,772	2,833	76	2,909
Ucayali Basin, 6040	1939	0	34	0	3,457	3,457
Total..		2,040	2,945	2,955	16,386	19,341

Exploration data

Country	Land area (mi²)
Peru	496,224

Delineated prospective area through 2001........................   17,825 mi²
Explored area through 2001...   3,302 mi²
Wildcat wells through 2001 ....   395 wells
Current growth in delineated prospective area
   per wildcat (for last 10 percent of wells) ....   101 mi²/well
Reported discoveries through 2001 of cumulative
   recoverable crude oil and gas in all provinces:
     Oil...   2.945 BBO
     Gas..   19.346 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ ....   0.165 MMBO/mi²

Figure 21.   Continued.

Figure 22. Map, graphs, and tables of data for oil and gas exploration through 2001 in Venezuela and Trinidad and Tobago.

Figure 22. Venezuela and Trinidad and Tobago 81

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
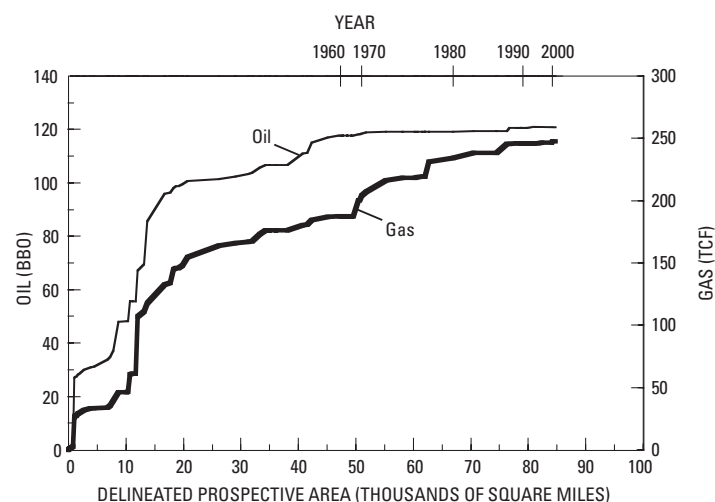
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Venezuela:						
Barinas-Apure Basin, 6097	1948	953	1,540	71	121	192
Cariaco Basin, 6102	1979	0	35	150	1,000	1,150
East Venezuela Basin, 6098	1913	55,525	59,686	122,833	16,236	139,069
Llanos Basin, 6096	1983	1,233	1,233	37	0	37
Maracaibo Basin, 6099	1914	53,306	54,406	51,180	836	52,016
Tobago Trough, 6103	1979	0	20	0	16,209	16,209
Total		111,017	116,920	174,271	34,402	208,673
Trinidad and Tobago:						
East Venezuela Basin, 6098	1867	2,800	3,689	5,906	27,792	33,698
Tobago Trough, 6103	1971	0	0	0	4,405	4,405
Total		2,800	3,689	5,906	32,197	38,103

Exploration data

Country	Land area (mi²)
Venezuela	352,143
Trinidad and Tobago	1,980
Total	354,123

Delineated prospective area through 2001 .... 84,754 mi²
Explored area through 2001 .... 30,163 mi²
Wildcat wells through 2001 .... 5,087 wells
Current growth in delineated prospective area
 per wildcat (for last 10 percent of wells) .... 15 mi²/well
Reported discoveries through 2001 of cumulative
 recoverable crude oil and gas in all provinces:
  Oil.. 120.799 BBO
  Gas... 247.496 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 1.425 MMBO/mi²
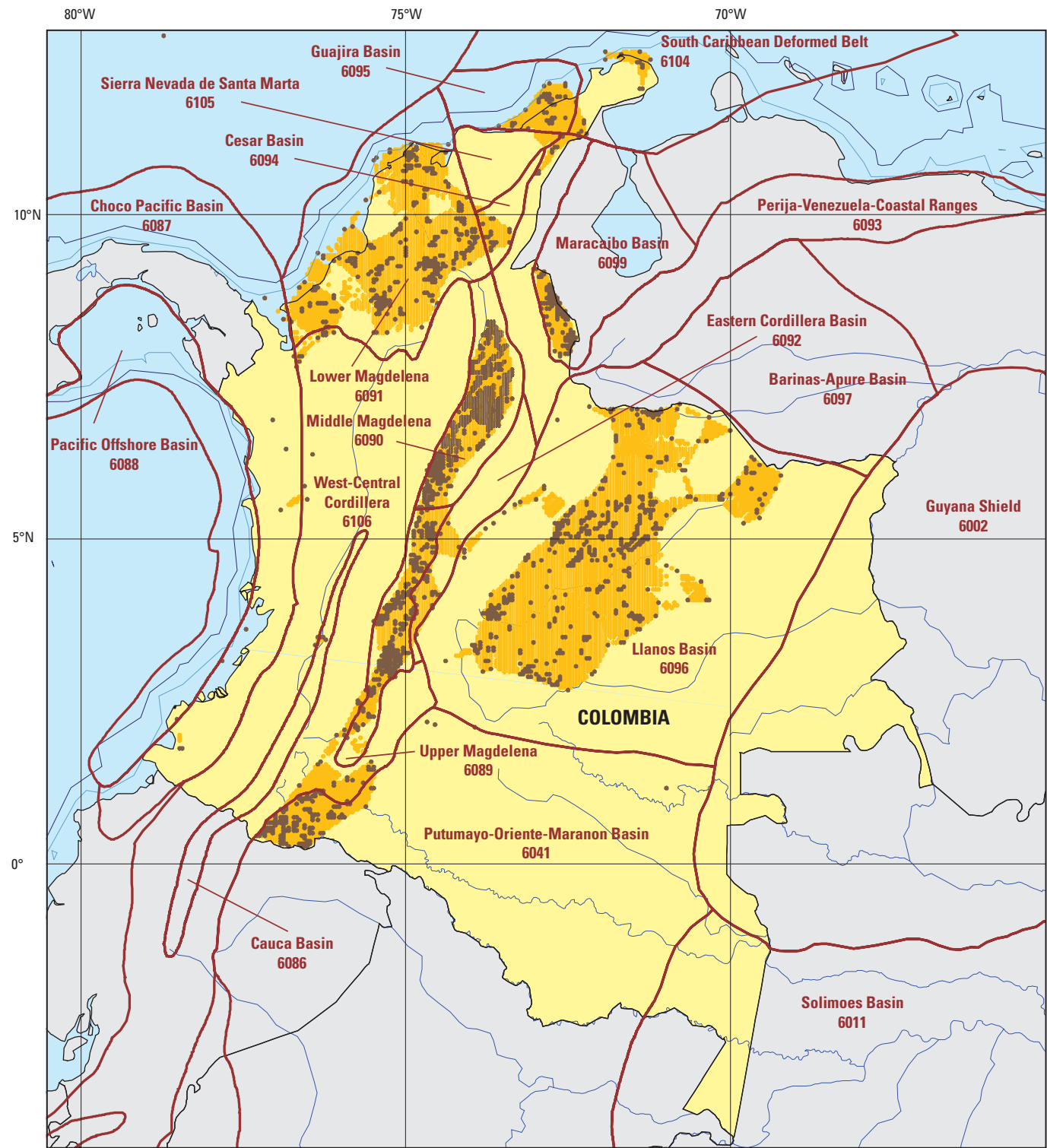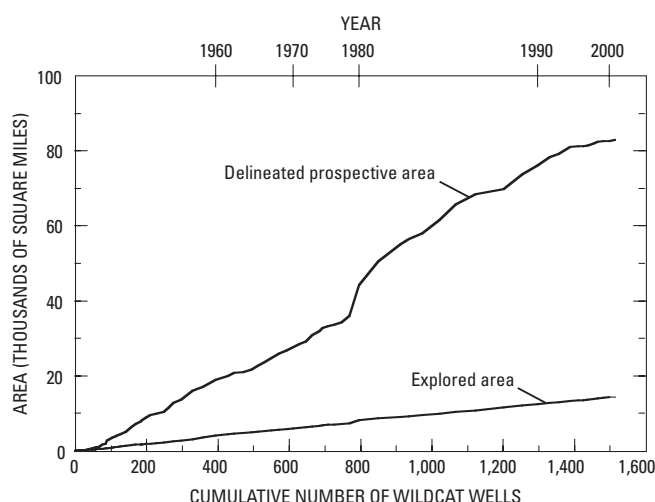
Figure 22. Continued.
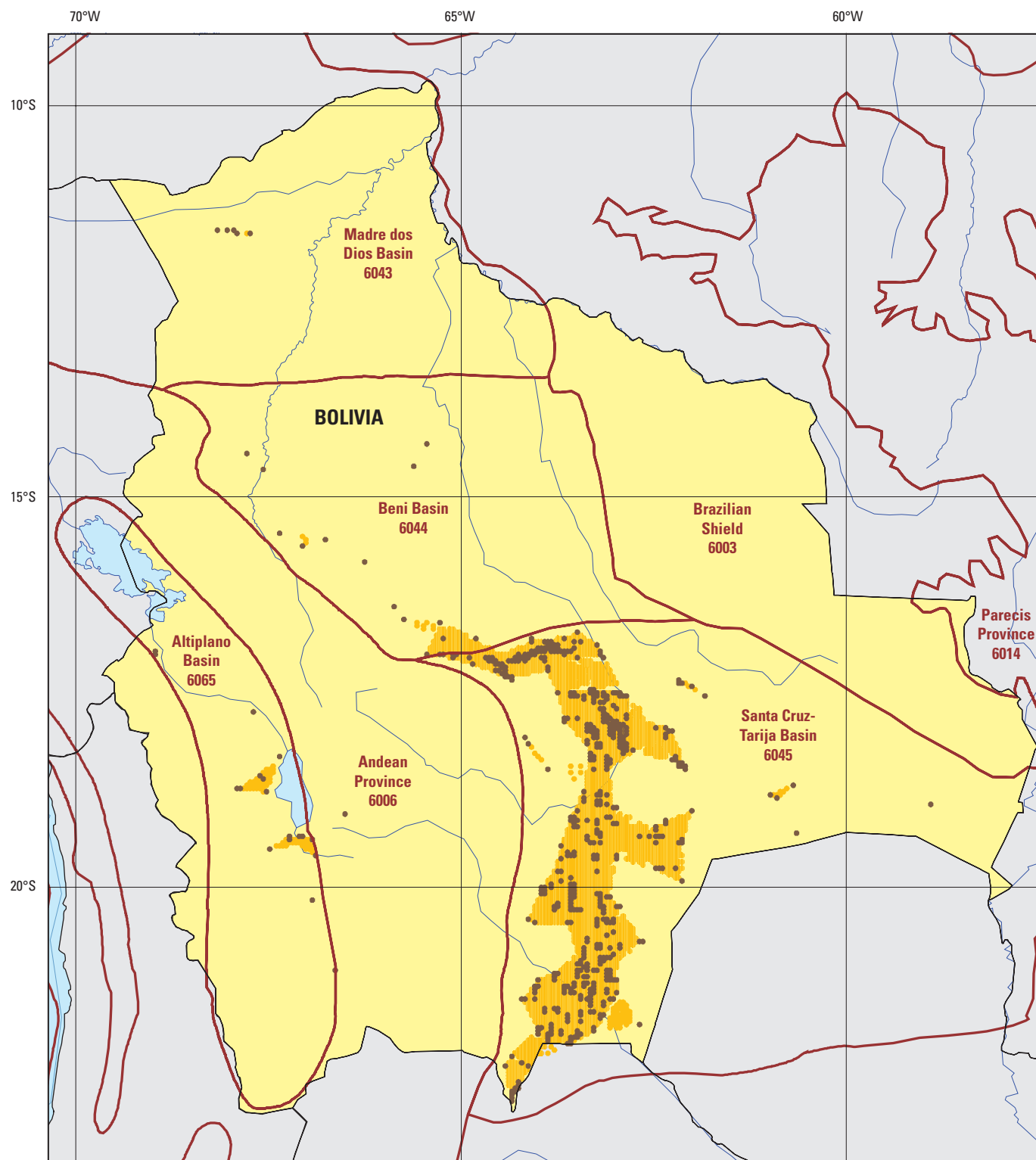
Figure 23.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Bolivia.

Figure 23. Bolivia   83

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
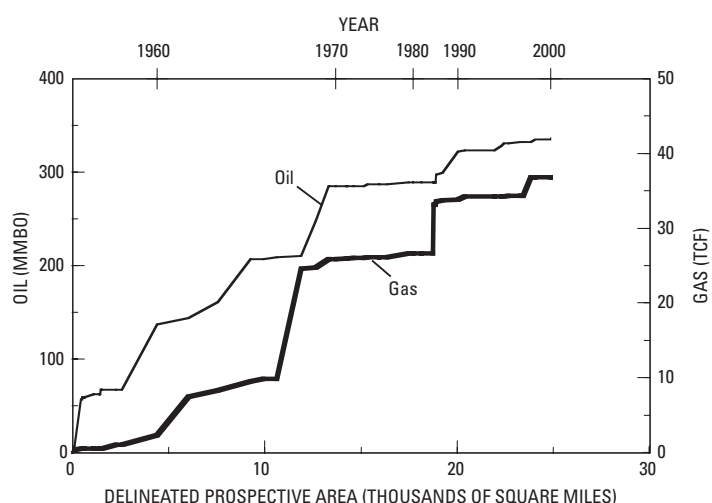
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Bolivia:						
Madre dos Dios Basin, 6043	1991	0	1	10	0	10
Santa Cruz-Tarija Basin, 6045	1924	0	334	1,868	34,949	36,817
Total		0	335	1,878	34,949	36,827

Exploration data

Country	Land area (mi²)
Bolivia....................................	424,162

Delineated prospective area through 2001.......................	24,858 mi²
Explored area through 2001...	4,089 mi²
Wildcat wells through 2001	378 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	41 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil..	336 MMBO
Gas...	36.827 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$	0.014 MMBO/mi²

Figure 23.   Continued.
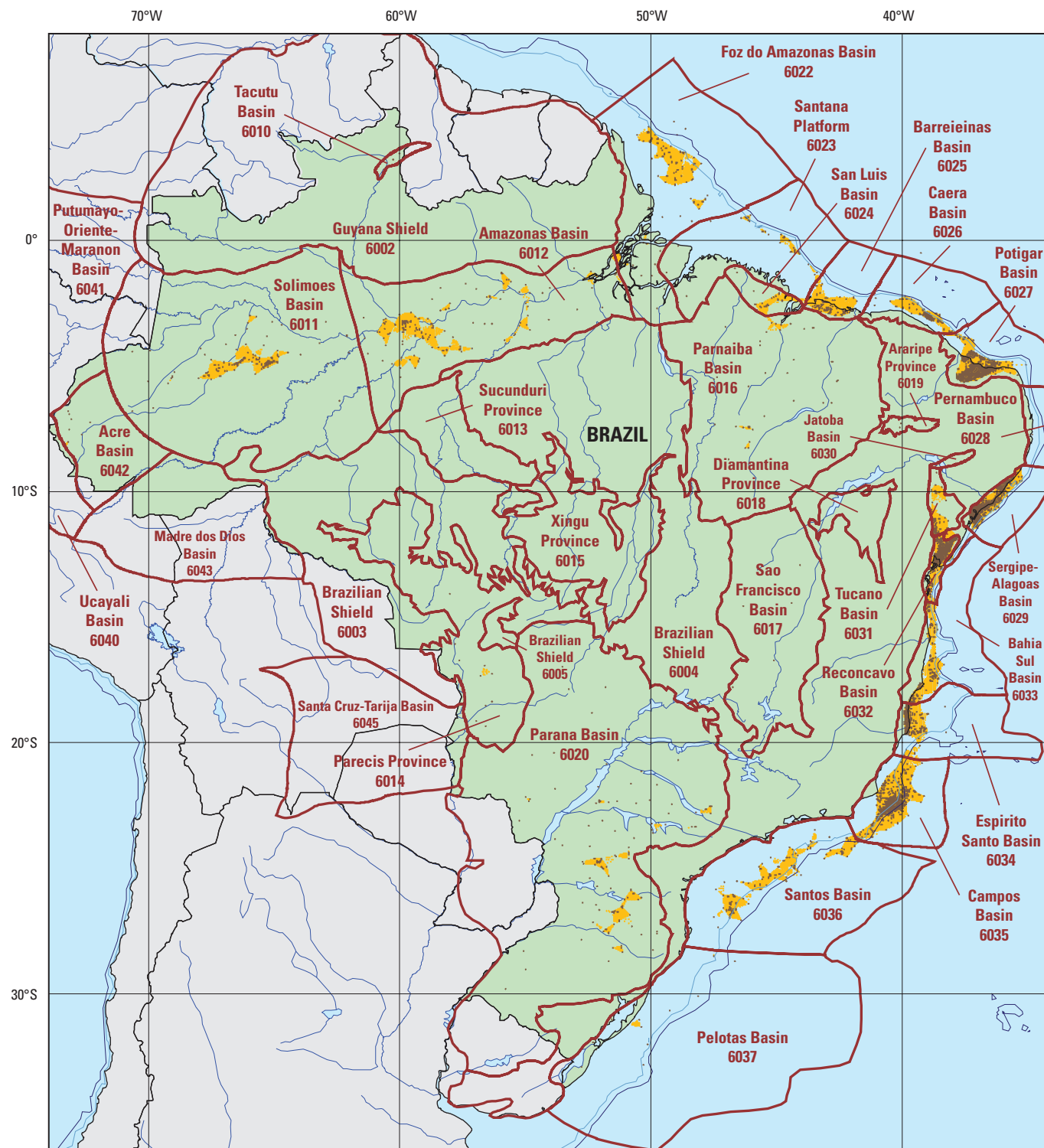
Figure 24.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Brazil.

Figure 24. Brazil   85

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Brazil:						
Campos Basin, 6035	1974	12,897	14,059	9,339	207	9,546
Foz do Amazonas Basin, 6022...................	1976	0	0	0	885	885
Potigar Basin, 6027	1973	320	822	806	957	1,763
Reconcavo Basin, 6032..............................	1939	1,100	1,667	2,557	1,147	3,704
Santos Basin, 6036.....................................	1979	150	343	232	523	755
Sergipe-Alagoas Basin, 6029......................	1957	330	810	1,506	467	1,973
Total		14,797	17,701	14,440	4,186	18,626

Exploration data

Country	Land area (mi²)
Brazil.....................................	3,286,473

Delineated prospective area through 2001.......................	112,136 mi²
Explored area through 2001...	24,972 mi²
Wildcat wells through 2001	3,695 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	54 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil...	18.192 BBO
Gas..	22.422 TCF

$$\text{Richness} \left(\frac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right) .... \quad 0.162 \text{ MMBO/mi}^2$$

Figure 24. Continued.

EXPLANATION

1 Belgium	3 Faroe Islands	5 Germany	7 Luxembourg	9 Norway	11 United Kingdom
2 Denmark	4 Finland	6 Ireland	8 Netherlands	10 Sweden	

Figure 25. Maps, graphs, and tables of data for oil and gas exploration through 2001 in the northern part of Western Europe. For this figure, the parts mapped are the United Kingdom, Norway, Germany, Denmark, Netherlands, Ireland, Sweden, Belgium, Faroe Islands, Finland, Luxembourg, and Svalbard. The Faroe Islands are a self-governing overseas administrative division of Denmark. Svalbard (a territory of Norway) is a group of islands in the Arctic Ocean; see the separate small map. Data for Greenland and Iceland are not mapped and are not included in the exploration data; they had no discoveries through 2001.

Figure 25. Northern Part of Western Europe **87**
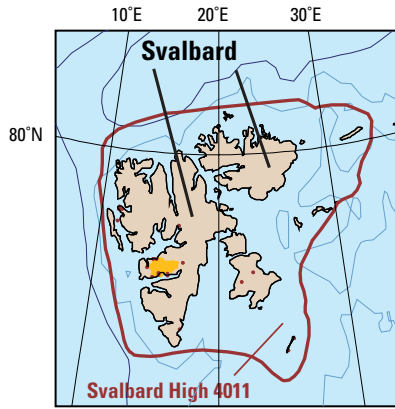
Map of oil and gas exploration through
2001 in Svalbard.

Growth in delineated prospective area and explored
area through 2001, graphed by the year the areas
became prospective or explored
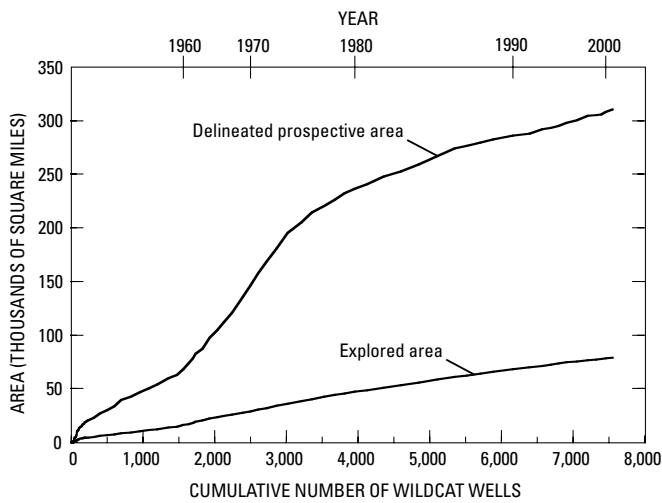
Cumulative recoverable oil and gas discoveries in all provinces
through 2001, graphed by the year the field location
became part of the delineated prospective area

Figure 25. Continued.

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
United Kingdom:						
Anglo-Dutch Basin, 4036	1919	0	78	19	53,776	53,795
Anglo-Paris Basin, 4040	1896	490	544	217	178	395
Faeroes-Shetland-Orkney Basin, 4019.......	1977	1,241	1,460	879	1,400	2,279
Ireland-Scotland Platform, 4026	1876	0	0	0	80	80
Irish Sea, 4030...	1939	0	219	390	8,089	8,479
North Sea Graben, 4025.............................	1969	20,145	25,146	28,315	23,694	52,009
Total		21,876	27,447	29,820	87,217	117,037
Norway:						
Hammerfest-Varanger Basin, 4015	1981	0	292	190	11,565	11,755
North Sea Graben, 4025.............................	1968	18,793	21,926	29,143	73,000	102,143
Vestford-Helgeland, 4017	1981	3,325	3,717	8,953	27,776	36,729
Total		22,118	25,935	38,286	112,341	150,627
Germany:						
Bohemia, 4046	1930	0	1	0	322	322
German-Polish Basin, 4033	1925	0	24	38	8,732	8,770
North Sea Graben, 4025.............................	1974	0	0	0	450	450
Northwest German Basin, 4035	1856	911	2,029	1,311	34,525	35,836
Total		911	2,054	1,349	44,029	45,378
Denmark:						
North Sea Graben, 4025.............................	1966	1,672	1,916	2,574	5,185	7,759
Netherlands:						
Anglo-Dutch Basin, 4036	1952	120	648	613	30,133	30,746
North Sea Graben, 4025.............................	1968	0	141	620	4,035	4,655
Northwest German Basin, 4035	1943	253	254	400	121,162	121,562
Total		373	1,043	1,633	155,330	156,963
Ireland:						
Ireland-Scotland Platform, 4026	1971	0	18	16	3,495	3,511

Figure 25.   Continued.

Figure 25. Northern Part of Western Europe   89

Exploration data

Country	Land area (mi²)
United Kingdom....................	94,525
Norway...................................	125,181
Germany................................	137,846
Denmark................................	16,639
Netherlands	16,033
Ireland	27,135
Sweden..................................	173,731
Belgium.................................	11,780
Faroe Islands	540
Finland	130,127
Luxembourg..........................	998
Svalbard	23,957
Total	758,494

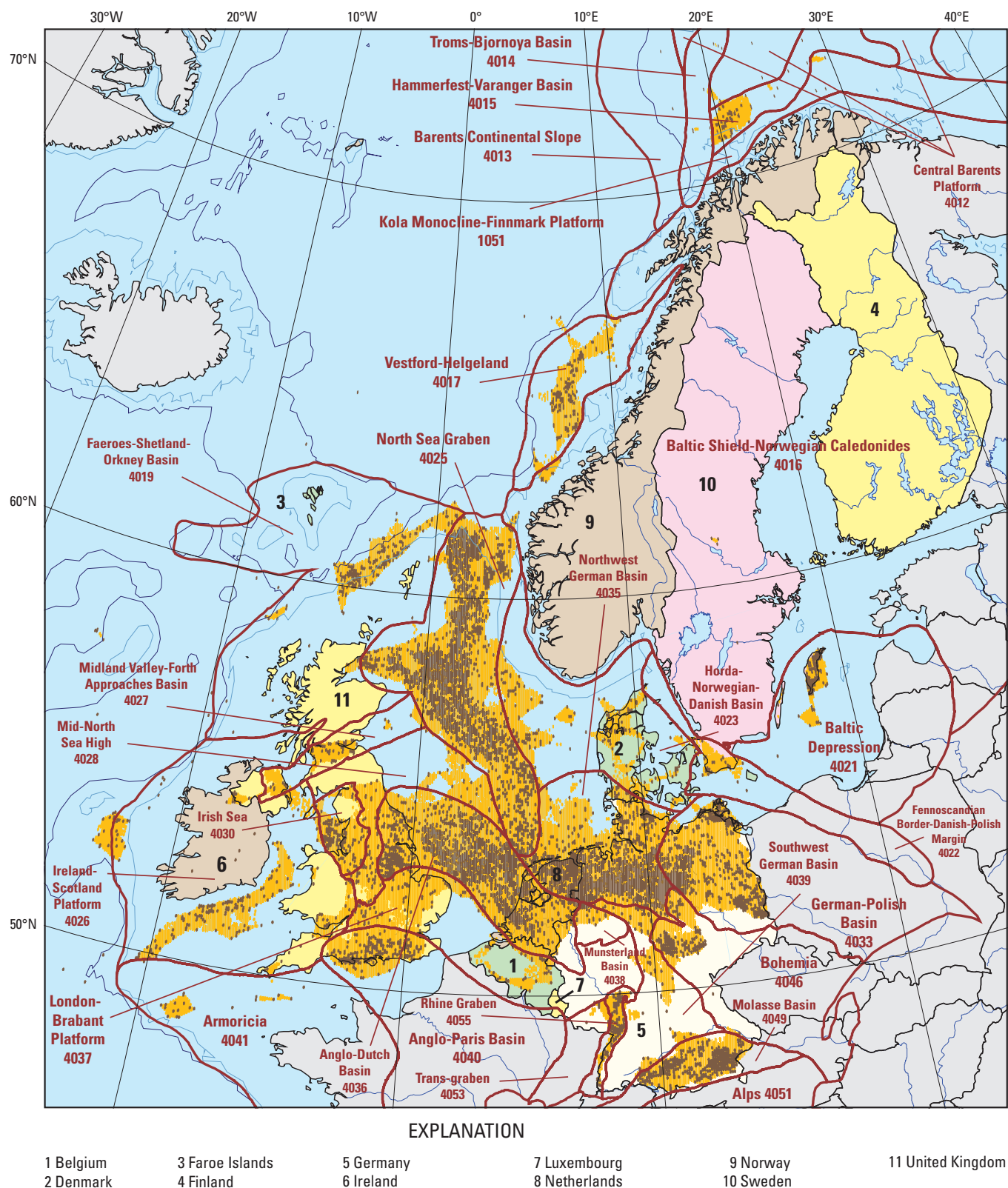|	
Delineated prospective area through 2001	310,575 mi²
Explored area through 2001	79,074 mi²
Wildcat wells through 2001	7,551 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	19 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil..	58.72 BBO
Gas...	484.757 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$	0.189 MMBO/mi²

Figure 25. Continued.

Figure 26. Map, graphs, and tables of data for oil and gas exploration through 2001 in the southern part of Western Europe. For this figure, the parts mapped are Italy, Austria, France, Spain, Portugal, Switzerland, Andorra, Liechtenstein, Malta, Monaco, San Marino, and Gibraltar (an overseas territory of the United Kingdom).

Figure 26. Southern Part of Western Europe **91**

London-Brabant
Platform
4037

Rhine Graben
4055

North Carpathian
Basin
4047

Southwest
German Basin
4039

Bohemia
4046

50°N

Transgraben
4053

Jura
4052

Molasse Basin
4049

AUSTRIA

Pannonian Basin
4048

SWITZERLAND

ITALY

LIECHTENSTEIN

Po Basin
4060

Alps
4051

45°N

Bresse
Depression
4054

MONACO

SAN MARINO

Lion-Camargue
4056

Adriatic Basin
4058

Provence Basin
4068

Tuscany-
Latium-
Paola
4062

Corsican-
Sardinian Basins
4067

40°N

Tyrrhenian Basin
4069

Apulia Platform
4059

Sicily
4066

MALTA

35°N

Pelagian Basin
2048

Figure 26. Continued.

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
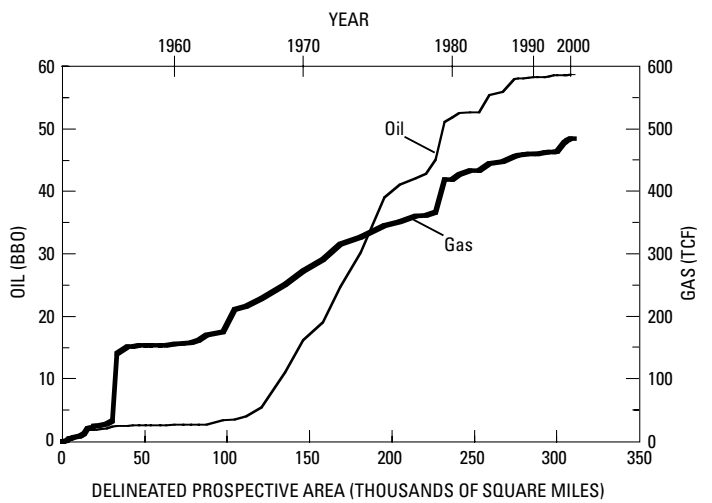

Figure 26. Continued.

Figure 26. Southern Part of Western Europe   93

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Italy:						
Adriatic Basin, 4058	1980	0	39	0	225	225
Alps, 4051...	1933	750	1,077	1,078	5,790	6,868
Pelagian Basin, 2048.................................	1988	0	15	0	0	0
Po Basin, 4060..	1890	250	320	120	21,111	21,231
Sicily, 4066	1940	335	504	85	791	876
Tuscany-Latium-Paola, 4062......................	1915	0	1	0	1,497	1,497
Total..		1,335	1,956	1,283	29,414	30,697
Austria:						
Bohemia, 4046..	1930	545	803	1,782	1,313	3,095
Pannonian Basin, 4048	1982	0	0	0	1	1
Total		545	803	1,782	1,314	3,096
France:						
Anglo-Paris Basin, 4040............................	1954	0	297	7	120	127
Aquitaine Basin, 4045	1954	220	375	27	0	27
Pyrenean Foothills-Ebro Basin, 4044.........	1939	0	118	80	12,153	12,233
Total		220	790	114	12,273	12,387
Spain:						
Iberic Cordillera, 4083	1967	160	299	92	86	178
Pyrenean Foothills-Ebro Basin, 4044	1980	0	0	0	525	525
Total		160	299	92	611	703
Portugal:						
Lusitanian Basin, 4074	1953	0	0	0	920	920

Exploration data

Country	Land area (mi²)
Italy	116,305
Austria.....................	32,378
France......................	211,208
Spain	194,897
Portugal	35,672
Switzerland	15,942
Andorra	181
Liechtenstein...........	62
Malta	122
Monaco	1
San Marino...............	24
Gibraltar	3
Total	606,793

Delineated prospective area through 2001....................... 224,886 mi²
Explored area through 2001.. 45,596 mi²
Wildcat wells through 2001 .... 5,892 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 10 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 3.969 BBO
    Gas... 49.1 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.018 MMBO/mi²
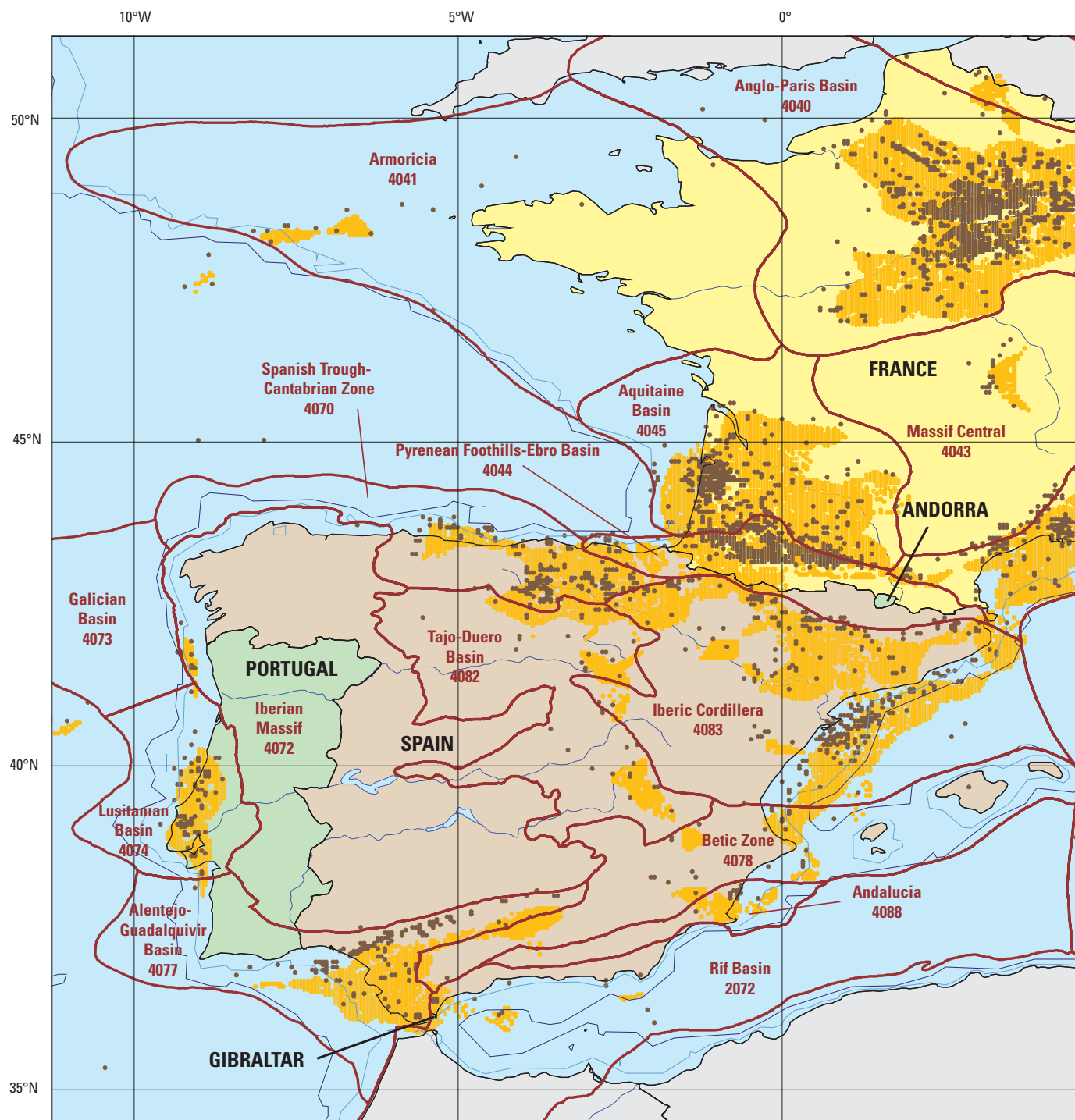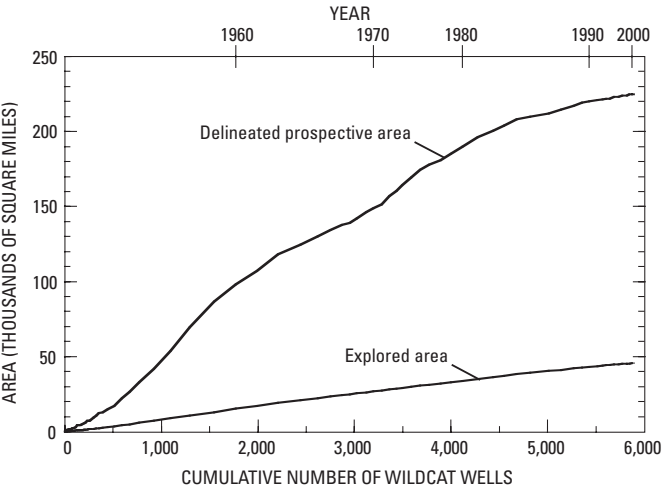
Figure 26.   Continued.

Figure 27. Map, graphs, and tables of data for oil and gas exploration through 2001 in Eastern Europe. For this figure, the parts mapped are Romania, Ukraine, Belarus, Hungary, Albania, Serbia and Montenegro, Croatia, Poland, Czech Republic, Greece, Bulgaria, Slovakia, Slovenia, Moldova, Lithuania, Latvia, Bosnia and Herzegovina, Estonia, and Macedonia.

Figure 27. Eastern Europe **95**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored
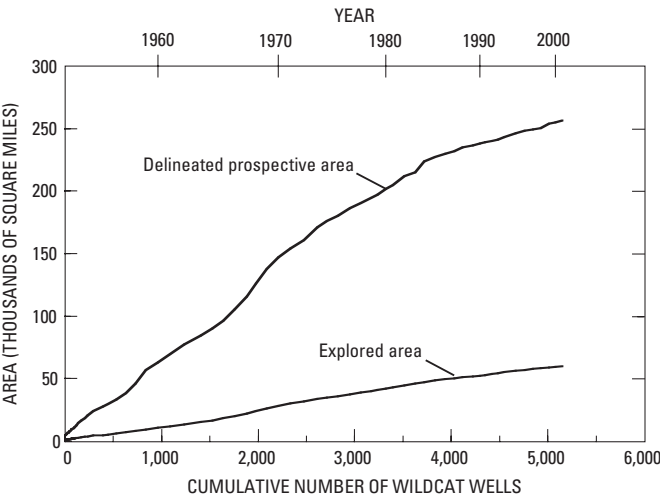
Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
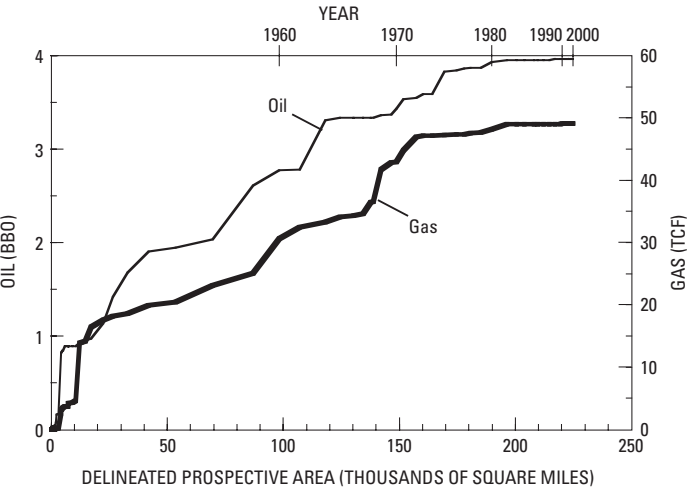
Figure 27. Continued.

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

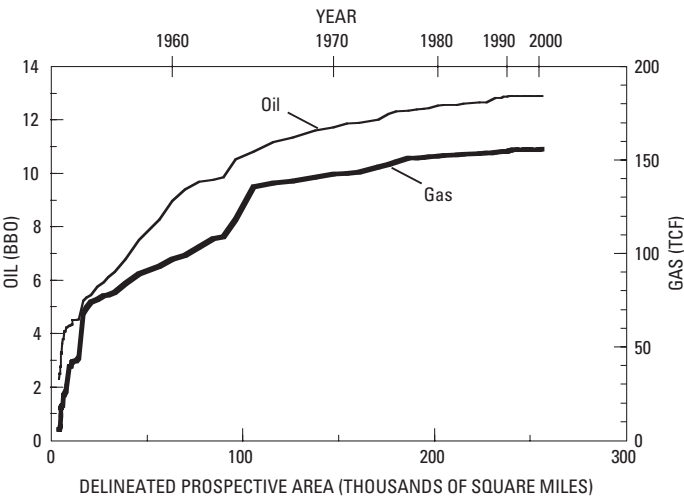| Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Romania:						
Carpathian-Balkanian Basin, 4061	1835	2,575	5,932	4,052	3,307	7,359
Pannonian Basin, 4048.................................	1956	129	389	215	297	512
Transylvanian Basin, 4057..........................	1880	0	1	0	30,877	30,877
Total		2,704	6,322	4,267	34,481	38,748
Ukraine:						
Azov-Kuban Basin, 1108............................	1886	0	22	8	662	670
Dnieper-Donets Basin, 1009.......................	1936	885	1,538	4,472	63,779	68,251
North Carpathian Basin, 4047....................	1860	702	1,264	3,172	11,704	14,876
Pannonian Basin, 4048	1960	0	0	0	2	2
Transylvanian Basin, 4057..........................	1962	0	0	0	12	12
Total		1,587	2,824	7,652	76,159	83,811
Belarus:						
Pripyat Basin, 1010....................................	1963	248	910	255	0	255
Hungary:						
North Carpathian Basin, 4047....................	1937	0	11	5	1	6
Pannonian Basin, 4048.................................	1936	391	752	3,874	5,727	9,601
Total		391	763	3,879	5,728	9,607
Albania:						
Adriatic Basin, 4058	1918	203	503	860	300	1,160
Serbia:						
Alps, 4051...	1977	0	1	5	5	10
Pannonian Basin, 4048.................................	1949	0	376	622	806	1,428
Total		0	377	627	811	1,438
Croatia:						
Adriatic Basin, 4058	1983	0	5	0	0	0
Alps, 4051...	1979	0	0	0	5	5
Pannonian Basin, 4048.................................	1856	391	817	948	2,092	3,040
Po Basin, 4060	1977	0	0	0	743	743
Total		391	822	948	2,840	3,788
Poland:						
German-Polish Basin, 4033	1961	0	120	428	6,771	7,199
North Carpathian Basin, 4047....................	1853	0	136	96	7,019	7,115
Total		0	256	524	13,790	14,314
Czech Republic:						
Bohemia, 4046..	1920	0	178	374	155	529
North Carpathian Basin, 4047	1908	0	0	0	77	77
Total		0	178	374	232	606
Greece:						
Aegean, 4075	1971	120	139	90	52	142
Bulgaria:						
Carpathian-Balkanian Basin, 4061	1949	0	46	43	158	201
Slovakia:						
Bohemia, 4046..	1913	0	55	163	939	1,102
North Carpathian Basin, 4047....................	1850	0	0	0	311	311
Pannonian Basin, 4048.................................	1958	0	0	0	53	53
Total		0	55	163	1,303	1,466
Slovenia:						
Pannonian Basin, 4048.................................	1942	0	6	23	32	55
Moldova:						
Carpathian-Balkanian Basin, 4061	1957	0	3	0	0	0

Figure 27. Continued.

Figure 27. Eastern Europe   **97**

Exploration data

Country	Land area (mi²)
Romania	91,699
Ukraine	233,089
Belarus	80,154
Hungary	35,919
Albania	11,100
Serbia and Montenegro*	39,517
Croatia	21,831
Poland	120,728
Czech Republic	30,450
Greece	50,942
Bulgaria	42,822
Slovakia	18,859
Slovenia	7,820
Moldova	13,067
Lithuania	25,174
Latvia	24,938
Bosnia and Herzegovina	19,741
Estonia	17,462
Macedonia	9,781
Total	895,093

Delineated prospective area through 2001 .... 256,378 mi²
Explored area through 2001 .... 59,730 mi²
Wildcat wells through 2001 .... 5,153 wells
Current growth in delineated prospective area
    per wildcat (for last 10 percent of wells) .... 20 mi²/well
Reported discoveries through 2001 of cumulative
    recoverable crude oil and gas in all provinces:
        Oil.. 12.898 BBO
        Gas.. 155.707 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.050 MMBO/mi²

*Montenegro became independent on June 3, 2006, and is shown separately on the map in figure 27. The data for Serbia and Montenegro are combined in the tables because they were combined in IHS Energy Group (2002).

Figure 27.   Continued.
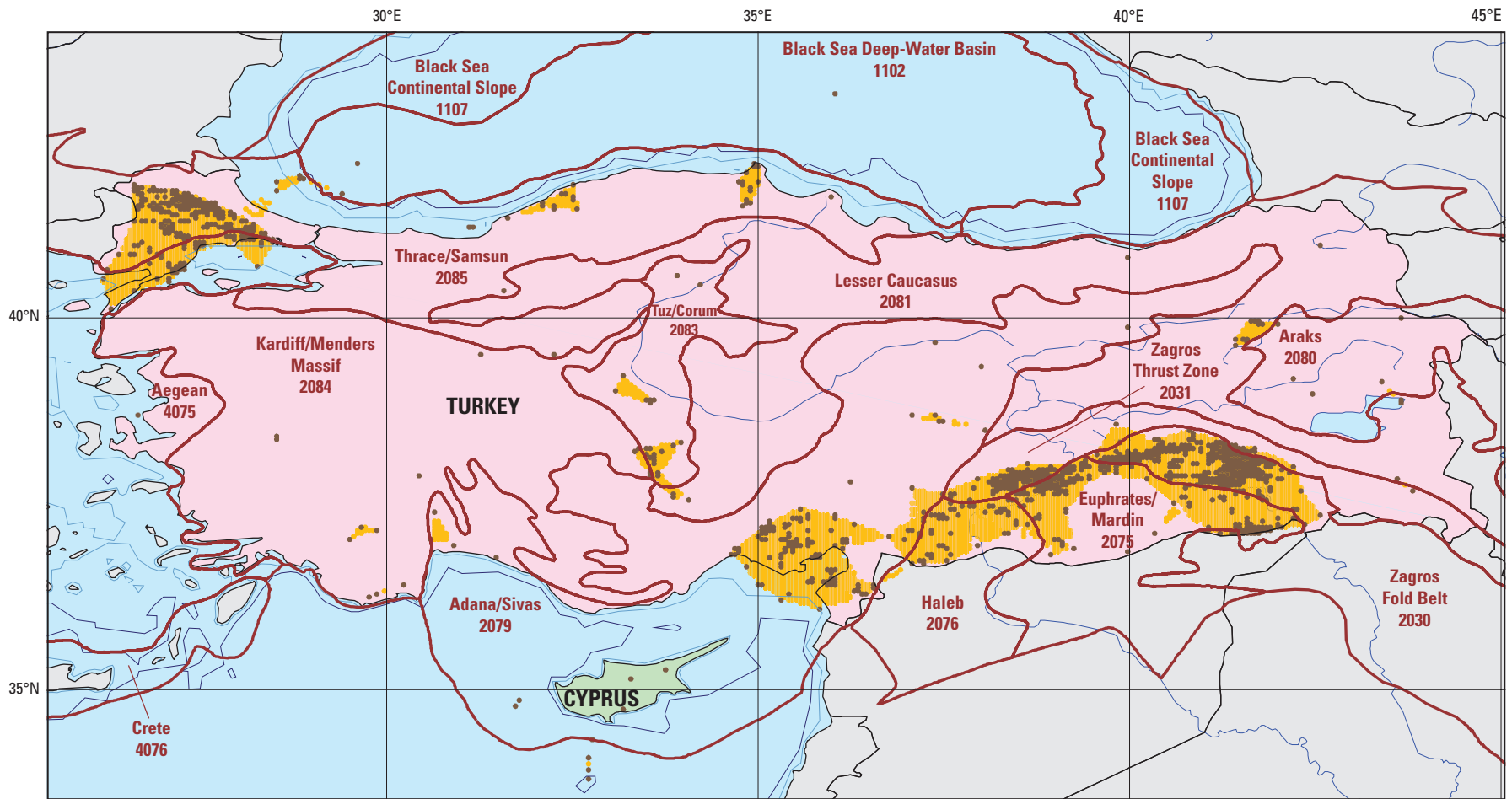
Figure 28. Map, graphs, and tables of data for oil and gas exploration through 2001 in Turkey and Cyprus.

Growth in delineated prospective area and explored

area through 2001, graphed by the year the areas became prospective or explored
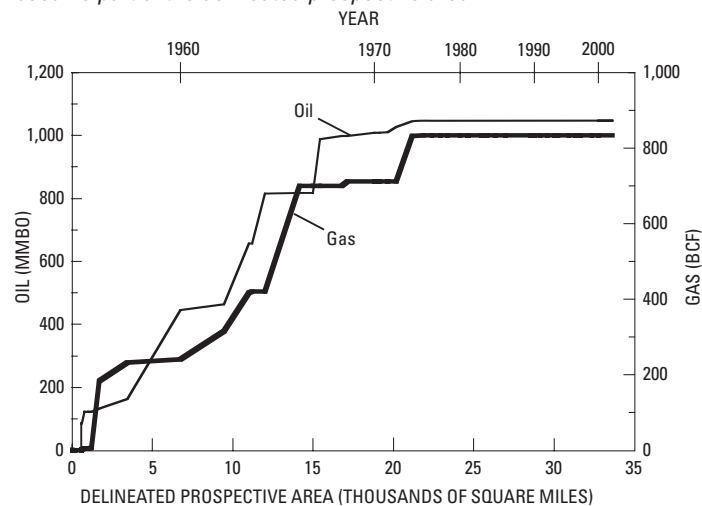
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Turkey:						
Aegean, 4075	1988	0	0	0	90	90
Euphrates/Mardin, 2075.........................	1958	0	284	133	12	145
Zagros Fold Belt, 2030	1945	185	565	9	281	290
Total		185	849	142	383	525

Cumulative recoverable oil and gas discoveries in all provinces

through 2001, graphed by the year the field location became part of the delineated prospective area

Exploration data

Country	Land area (mi²)
Turkey	301,382
Cyprus	3,571
Total	304,954

Delineated prospective area through 2001............... 33,649 mi²
Explored area through 2001..................................... 7,830 mi²
Wildcat wells through 2001 .... 1,054 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 38 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
  Oil.. 1.048 BBO
  Gas.. 834 BCF
  Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$........ 0.031 MMBO/mi²

Figure 28. Continued.

Figure 28. Turkey and Cyprus   99
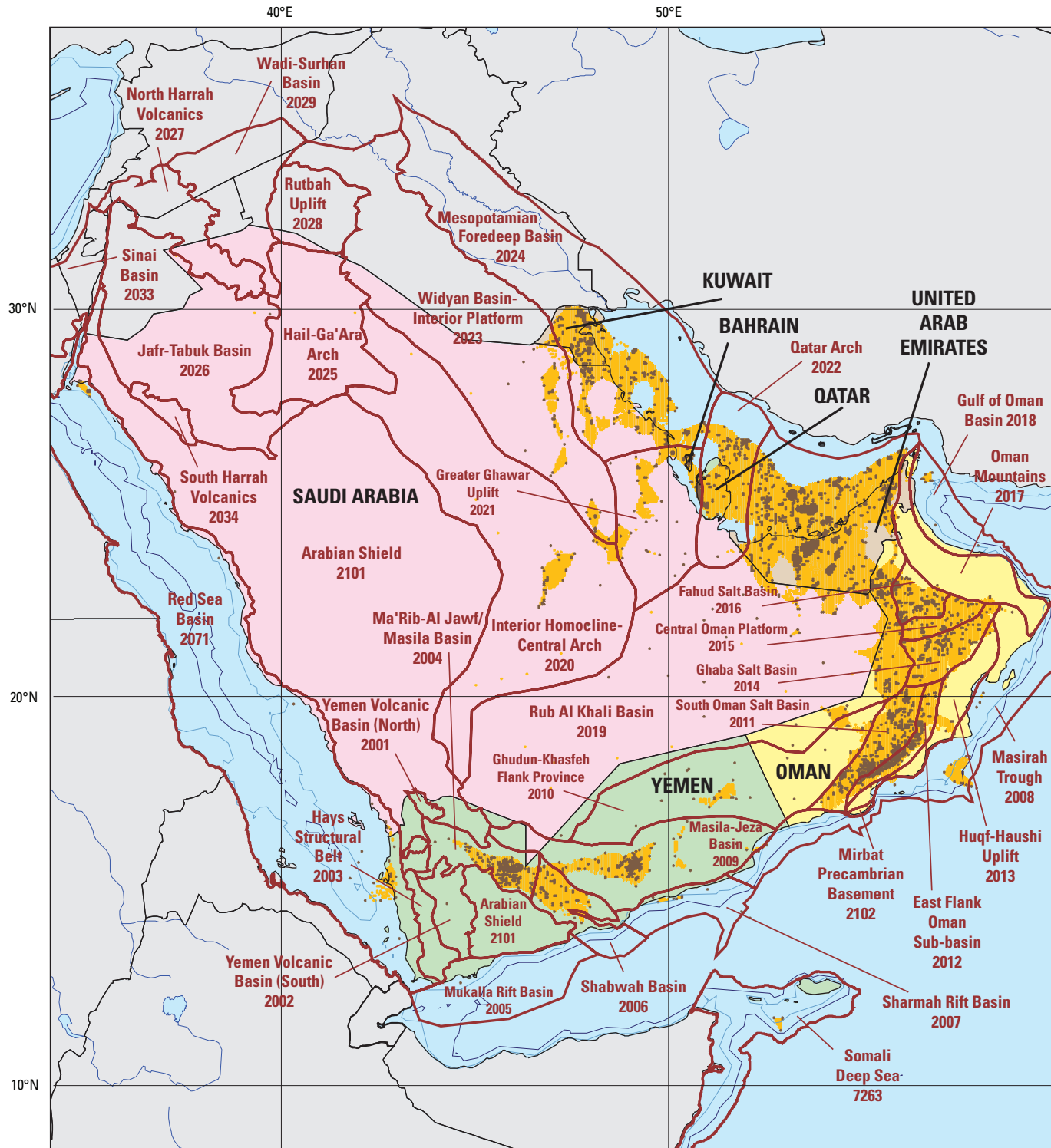
Figure 29. Map, graphs, and tables of data for oil and gas exploration through 2001 in the Arabian Peninsula. For this figure, the parts mapped are Saudi Arabia, Kuwait, United Arab Emirates, Oman, Qatar, Yemen, and Bahrain. Outlines of the seven individual emirates of the United Arab Emirates (UAE) are not shown on the map, but significant provinces are listed for six of them; the seven are Abu Dhabi, Dubai, Sharjah, Ra's al Khaymah, Umm al Qaywayn, 'Ajman, and Al Fujayrah. The former Kuwait-Saudi Arabia Neutral Zone contains resources according to the IHS Energy Group (2002), and so it is listed in the significant provinces table, but it is not mapped because it is not mentioned in "The World Factbook 2001" (CIA, 2001).

Figure 29. Arabian Peninsula   **101**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored
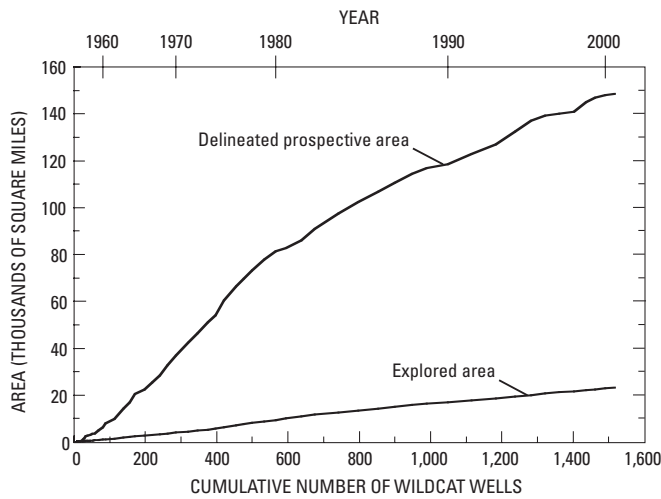
Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Figure 29.   Continued.

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

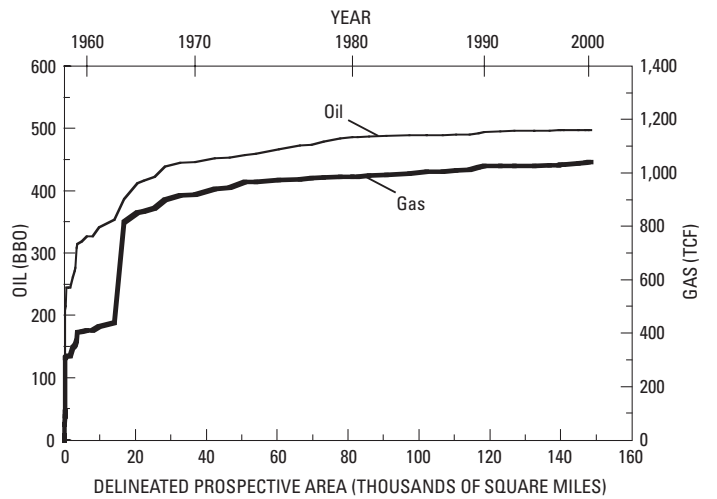| Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Saudi Arabia:						
Greater Ghawar Uplift, 2021	1938	140,850	140,850	233,000	3,400	236,400
Interior Homocline-Central Arch, 2020......	1989	5,500	5,525	11,150	6,050	17,200
Mesopotamian Foredeep Basin, 2024.........	1940	118,800	118,891	66,493	0	66,493
Red Sea Basin, 2071	1969	0	60	0	1,550	1,550
Rub Al Khali Basin, 2019............................	1967	15,950	15,987	26,500	6,000	32,500
Widyan Basin-Interior Platform, 2023........	1957	15,914	15,980	8,990	3,000	11,990
Total		297,014	297,293	346,133	20,000	366,133
Kuwait:						
Mesopotamian Foredeep Basin, 2024.........	1938	85,198	85,248	60,135	0	60,135
UAE - Abu Dhabi:						
Rub Al Khali Basin, 2019............................	1954	70,105	71,728	137,595	5,415	143,010
UAE - Dubai:						
Rub Al Khali Basin, 2019............................	1966	4,060	4,130	2,460	4,000	6,460
UAE - Sharjah:						
Rub Al Khali Basin, 2019............................	1972	110	110	900	5,900	6,800
UAE - Ra's al Khaymah:						
Rub Al Khali Basin, 2019............................	1972	0	56	500	135	635
UAE - Umm al Qaywayn:						
Rub Al Khali Basin, 2019............................	1976	0	0	0	100	100
UAE - 'Ajman:						
Rub Al Khali Basin, 2019............................	1983	0	0	0	1	1
Former Kuwait-Saudi Arabia Neutral Zone:						
Mesopotamian Foredeep Basin, 2024.........	1953	12,375	12,560	12,470	0	12,470
Oman:						
Central Oman Platform, 2015	1971	0	125	120	7,627	7,747
East Flank Oman Sub-basin, 2012..............	1973	1,351	2,334	46	0	46
Fahud Salt Basin, 2016	1962	4,460	4,661	6,500	4,058	10,558
Ghaba Salt Basin, 2014..............................	1964	601	1,323	2,460	16,826	19,286
Rub Al Khali Basin, 2019............................	1969	719	1,063	1,060	1,714	2,774
South Oman Salt Basin, 2011	1956	1,626	2,805	858	30	888
Total		8,757	12,311	11,044	30,255	41,299
Qatar:						
Greater Ghawar Uplift, 2021	1940	5,300	5,300	10,800	0	10,800
Qatar Arch, 2022..	1971	815	835	1,000	350,000	351,000
Rub Al Khali Basin, 2019............................	1960	4,187	4,327	10,907	0	10,907
Total		10,302	10,462	22,707	350,000	372,707
Yemen:						
Ma'Rib-Al Jawf/Masila Basin, 2004...........	1984	1,146	1,315	6,301	11,586	17,887
Masila-Jeza Basin, 2009	1991	854	1,233	6	65	71
Total		2,000	2,548	6,307	11,651	17,958
Bahrain:						
Greater Ghawar Uplift, 2021	1932	1,050	1,050	12,500	0	12,500

Figure 29.   Continued.

Figure 29. Arabian Peninsula   103

Exploration data

Country	Land area (mi²)
Saudi Arabia..........................	756,981
Kuwait...................................	6,880
United Arab Emirates	32,000
Oman....................................	82,031
Qatar.....................................	4,416
Yemen	203,849
Bahrain.................................	239
Total	1,086,397

Delineated prospective area through 2001.......................	148,008 mi²
Explored area through 2001..	23,425 mi²
Wildcat wells through 2001	1,512 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	66 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil...	497.533 BBO
Gas..	1,041.381 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 3.362 MMBO/mi²
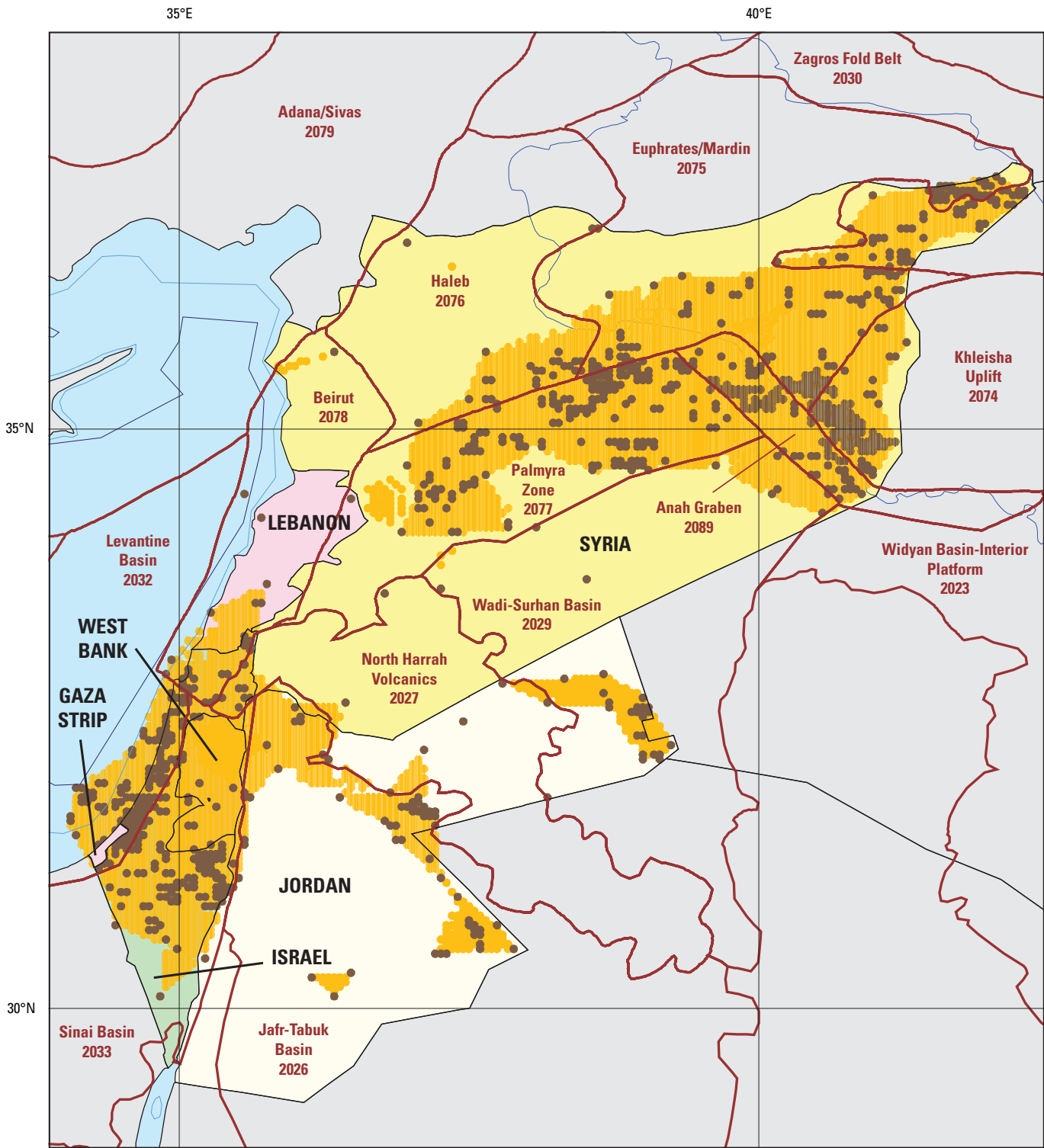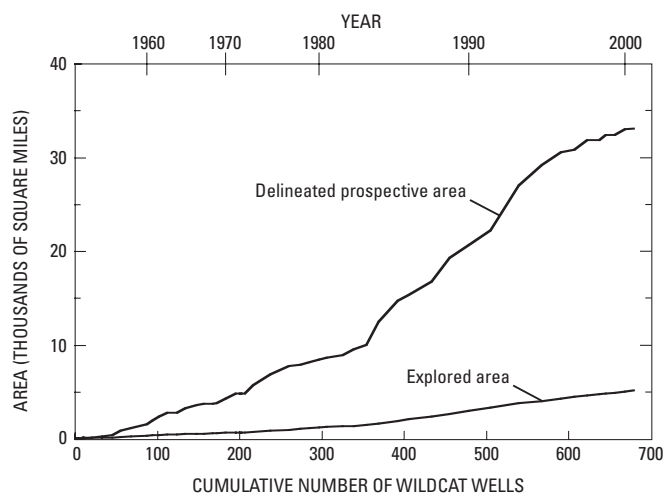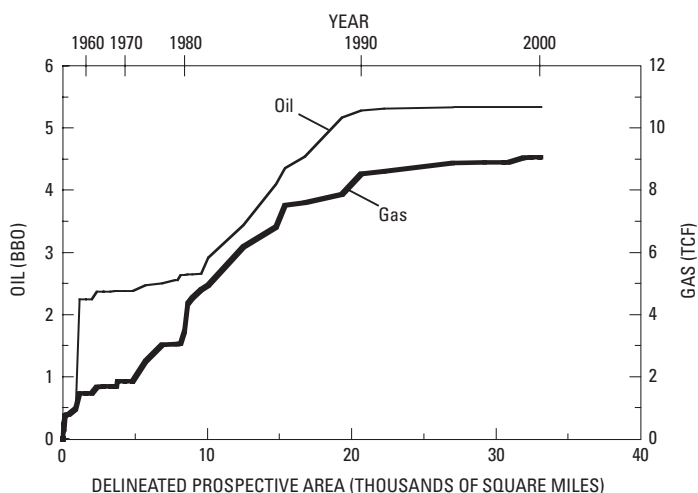
Figure 29.   Continued.

Figure 30.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Syria, Israel, Jordan, Lebanon, Gaza Strip, and the West Bank.

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Syria:						
Anah Graben, 2089	1982	351	456	148	0	148
Euphrates/Mardin, 2075............................	1940	365	802	1,421	1,212	2,633
Khleisha Uplift, 2074.................................	1986	1,022	1,680	1,364	0	1,364
Zagros Fold Belt, 2030	1956	2,099	2,206	912	74	986
Total		3,837	5,144	3,845	1,286	5,131
Israel:						
Levantine Basin, 2032.................................	1955	0	23	0	3,510	3,510

Exploration data

Country	Land area (mi²)
Syria	71,498
Israel...............................	8,019
Jordan.............................	35,637
Lebanon...........................	4,015
Gaza Strip.......................	139
West Bank	2,263
Total...........................	121,571

Delineated prospective area through 2001 .... 33,118 mi²
Explored area through 2001.. 5,169 mi²
Wildcat wells through 2001 .... 679 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 22 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil... 5.326 BBO
    Gas... 9.057 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.161 MMBO/mi²

Figure 30.   Continued.

Figure 31. Map, graphs, and tables of data for oil and gas exploration through 2001 in Iraq.

Figure 31. Iraq   **107**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Iraq:						
Mesopotamian Foredeep Basin, 2024.........	1949	87,985	88,875	58,645	3,300	61,945
Widyan Basin-Interior Platform, 2023........	1938	1,695	1,815	210	2,500	2,710
Zagros Fold Belt, 2030	1905	30,199	31,015	30,697	9,100	39,797
Total		119,879	121,705	89,552	14,900	104,452

Exploration data

Country	Land area (mi²)
Iraq	168,754

Delineated prospective area through 2001 .... 18,647 mi²

Explored area through 2001 .... 2,894 mi²

Wildcat wells through 2001 .... 147 wells

Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 124 mi²/well

Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:

    Oil... 121.705 BBO

    Gas.. 104.452 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 6.527 MMBO/mi²
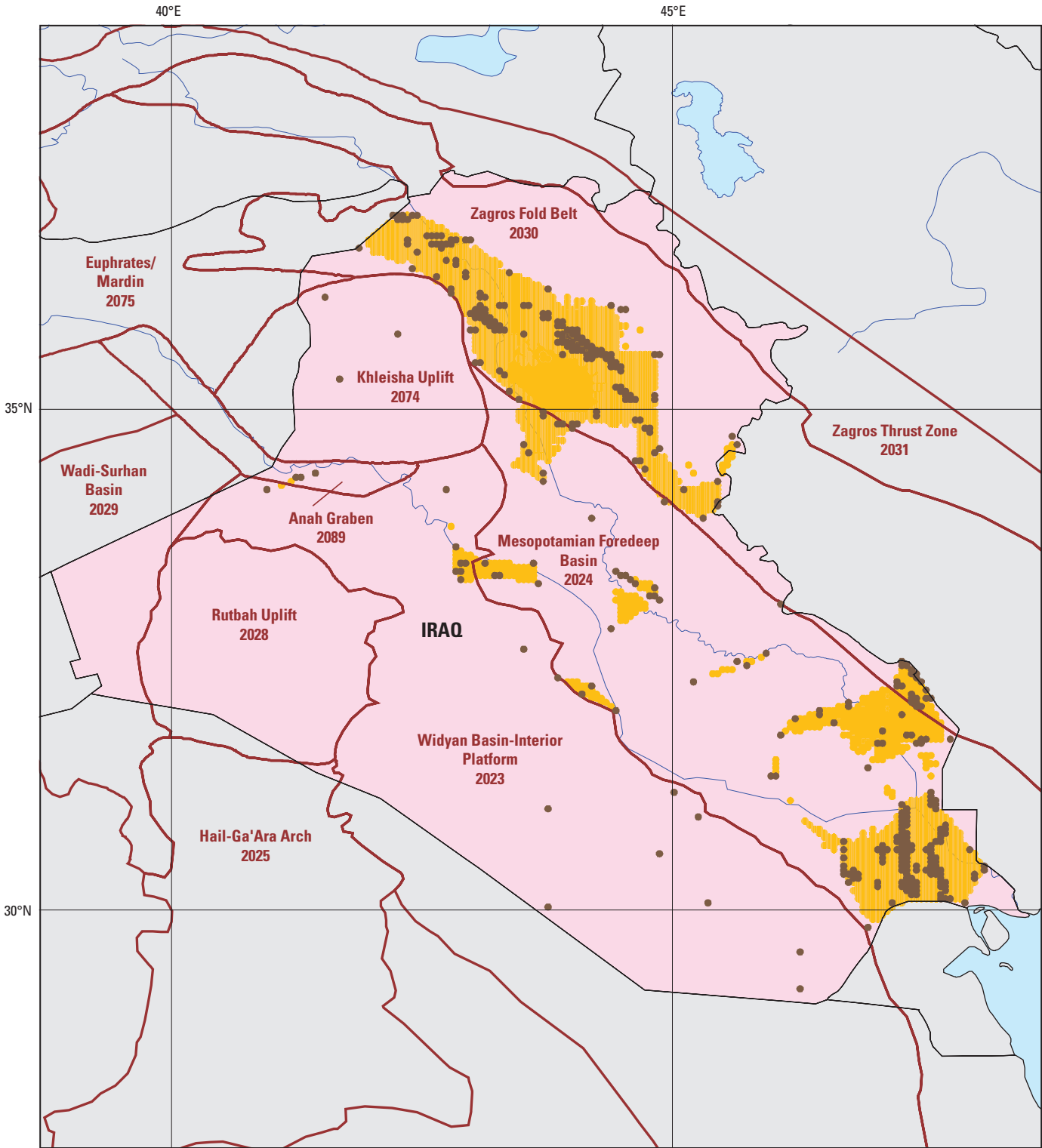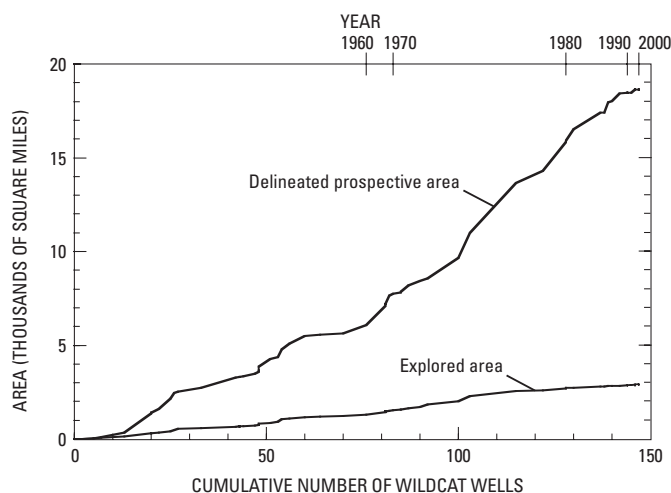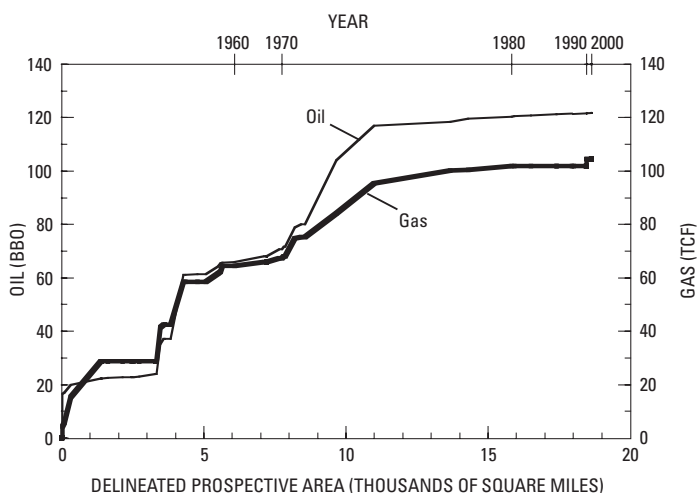
Figure 31. Continued.

Figure 32.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Iran.

Figure 32. Iran 109

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Iran:						
Amu-Darya Basin, 1154	1968	0	0	0	13,990	13,990
Kura Basin, 1113	1967	0	1	0	0	0
Mesopotamian Foredeep Basin, 2024.........	1960	20,566	20,884	23,559	70,850	94,409
Qatar Arch, 2022..	1967	0	1,400	0	475,000	475,000
Rub Al Khali Basin, 2019..........................	1965	3,883	3,883	6,768	2,045	8,813
South Caspian Basin, 1112	1960	0	0	0	700	700
Zagros Fold Belt, 2030	1908	100,729	103,382	264,050	180,543	444,593
Total		125,178	129,550	294,377	743,128	1,037,505

Exploration data

Country	Land area (mi²)
Iran	636,293

Delineated prospective area through 2001........................ 52,639 mi²

Explored area through 2001... 6,277 mi²

Wildcat wells through 2001 .... 384 wells

Current growth in delineated prospective area
per wildcat (for last 10 percent of wells) .... 253 mi²/well

Reported discoveries through 2001 of cumulative
recoverable crude oil and gas in all provinces:

    Oil... 129.561 BBO

    Gas... 1,038.260 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$.......... 2.461 MMBO/mi²
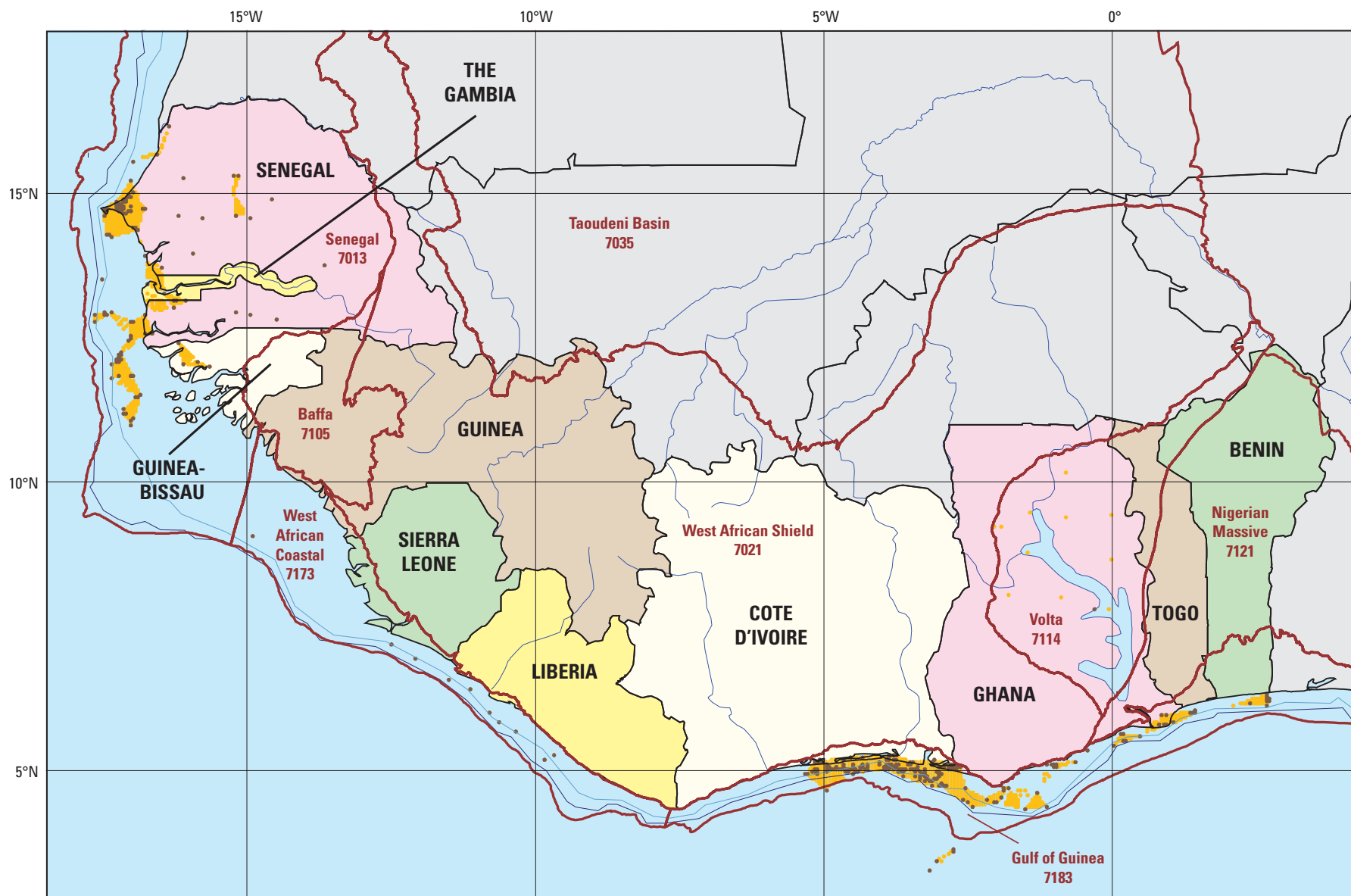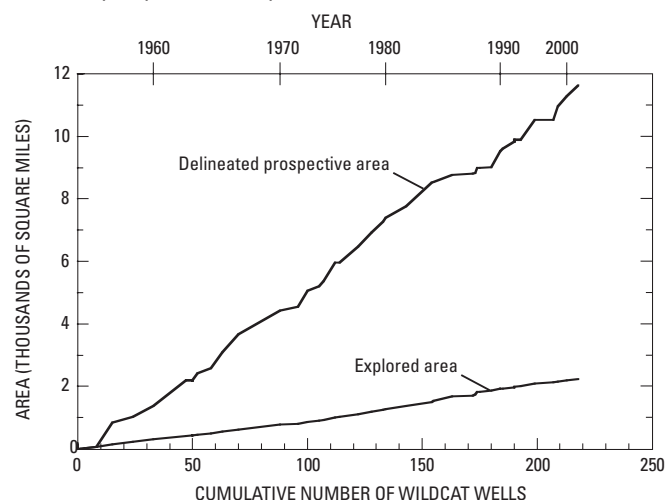
Figure 32. Continued.

Figure 33. Map, graphs, and tables of data for oil and gas exploration through 2001 in Cote d'Ivoire, Ghana, Benin, Guinea-Bissau, Togo, Senegal, The Gambia, Guinea, Sierra Leone, Liberia, and Cape Verde (not mapped).

Growth in delineated prospective area and explored
area through 2001, graphed by the year the areas

became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces

through 2001, graphed by the year the field location
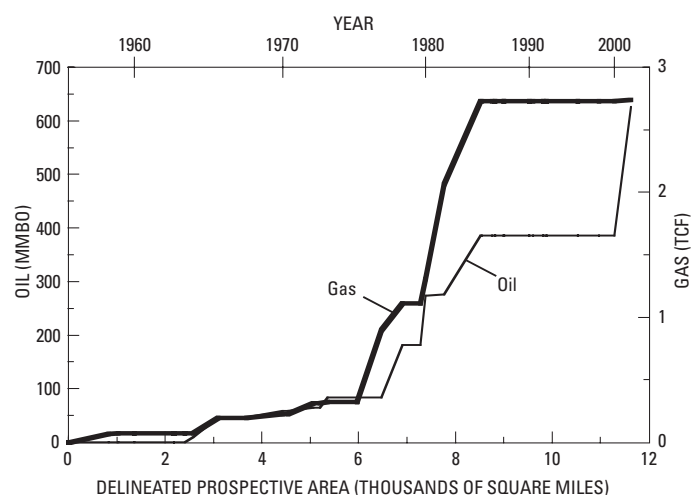became part of the delineated prospective area

Figure 33. Continued.

Significant petroleum provinces—Year of first discovery and cumulative recoverable
oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Cote d'Ivoire:						
Gulf of Guinea, 7183	1972	350	472	631	1,655	2,286
Ghana:						
Gulf of Guinea, 7183	1970	0	100	245	12	257
Benin:						
Gulf of Guinea, 7183	1968	0	41	88	0	88
Guinea-Bissau:						
Senegal, 7013	1967	0	10	0	0	0
Togo:						
Gulf of Guinea, 7183	1970	0	3	0	0	0
Senegal:						
Senegal, 7013	1959	0	0	0	108	108

Exploration data

Country	Land area (mi^2)
Cote d'Ivoire	124,502
Ghana	92,100
Benin	43,483
Guinea-Bissau	13,946
Togo	21,925
Senegal	75,749
The Gambia.....................	4,363
Guinea.............................	94,925
Sierra Leone	27,699
Liberia	43,000
Cape Verde (not shown on map)	1,557
Total...........................	543,249

Delineated prospective area through 2001 .... 11,626 mi^2
Explored area through 2001................................... 2,233 mi^2
Wildcat wells through 2001 .... 218 wells
Current growth in delineated prospective area
per wildcat (for last 10 percent of wells) .... 58 mi^2/well
Reported discoveries through 2001 of cumulative
recoverable crude oil and gas in all provinces:
Oil.. 626 MMBO
Gas... 2.739 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.054 MMBO/mi^2

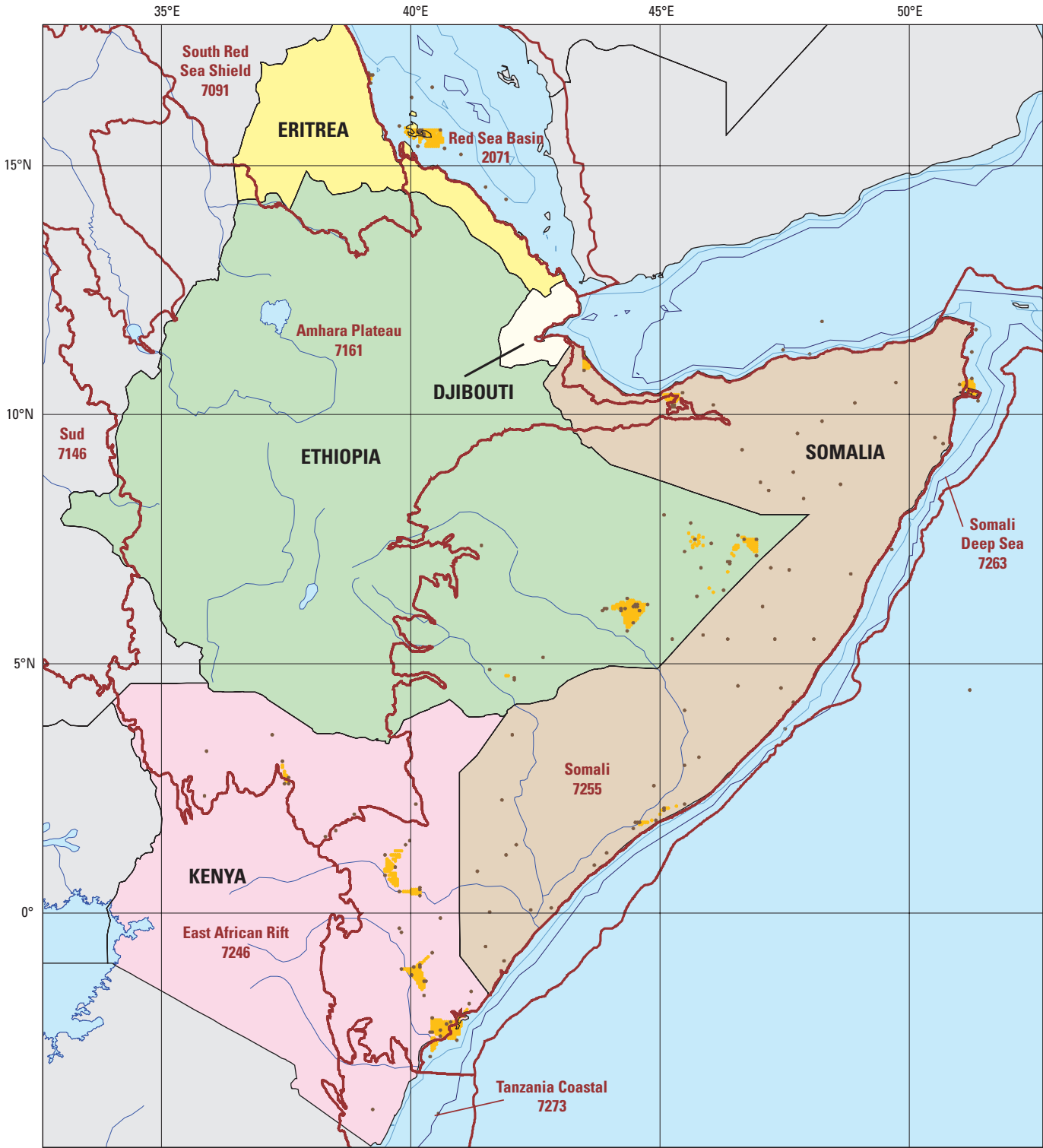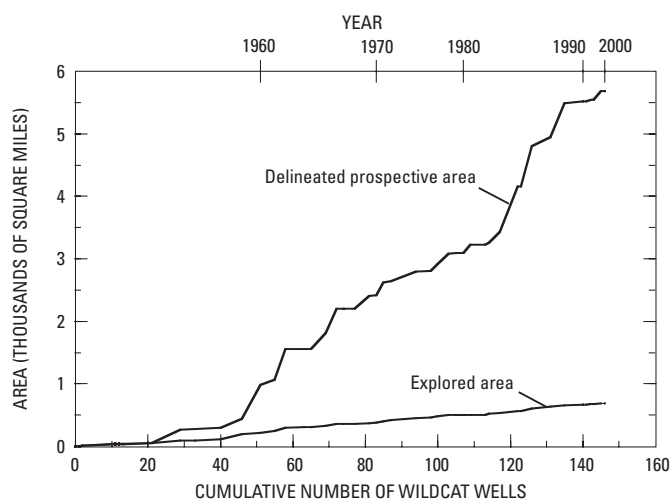**Figure 33. Cote d'Ivoire, Ghana, Benin, and Neighboring Countries   111**

Figure 34. Map, graphs, and tables of data for oil and gas exploration through 2001 in Ethiopia, Somalia, Eritrea, Kenya, and Djibouti.

Figure 34. Ethiopia, Somalia, Eritrea, Kenya, and Djibouti **113**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
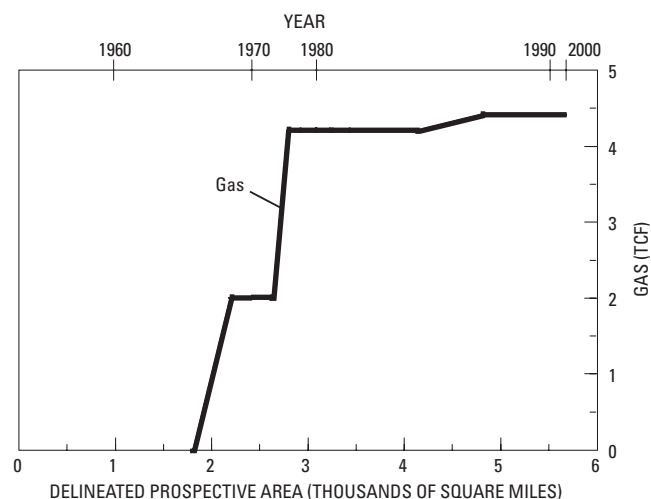
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Ethiopia:						
Somali, 7255	1973	0	0	0	2,401	2,401
Somalia:						
Somali, 7255	1959	0	0	0	2,000	2,000
Eritrea:						
Red Sea Basin, 2071	1970	0	0	0	5	5

Exploration data

Country	Land area (mi²)
Ethiopia	435,184
Somalia	246,200
Eritrea	46,842
Kenya	224,961
Djibouti	8,494
Total	961,681

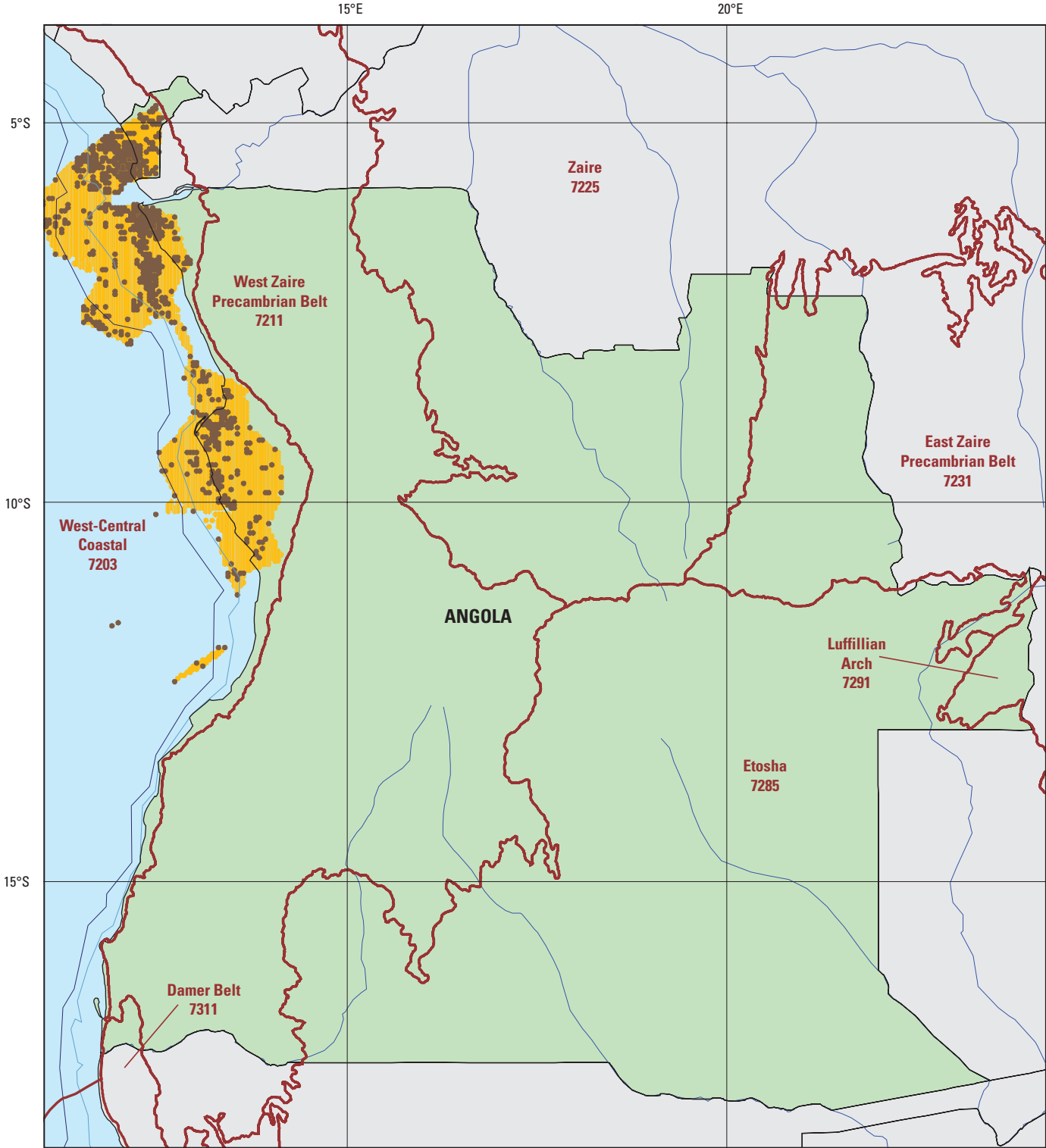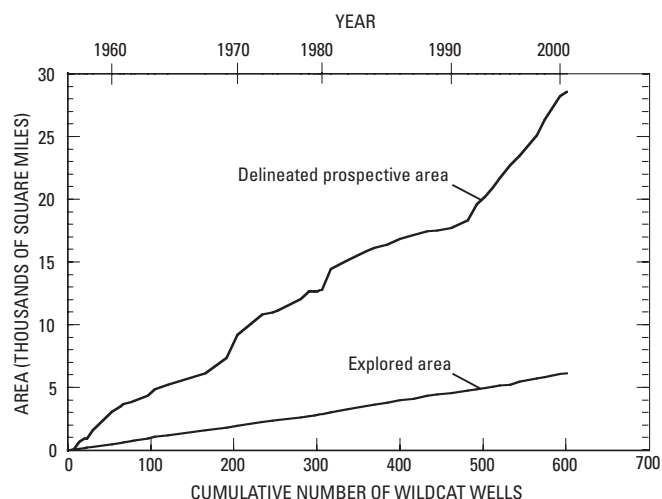|	
Delineated prospective area through 2001	5,680 mi²
Explored area through 2001	682 mi²
Wildcat wells through 2001	146 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	17 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil	0
Gas	4.406 TCF

Figure 34. Continued.

Figure 35. Map, graphs, and tables of data for oil and gas exploration through 2001 in Angola.

Figure 35. Angola **115**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum province—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Angola:						
West-Central Coastal, 7203.........................	1955	14,307	16,977	14,300	1,336	15,636

Exploration data

Country	Land area (mi²)
Angola....................................	481,351

Delineated prospective area through 2001....................... 28,581 mi²
Explored area through 2001... 6,144 mi²
Wildcat wells through 2001 .... 601 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 89 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 16.977 BBO
    Gas.. 15.636 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ .... 0.594 MMBO/mi²

Figure 35. Continued.
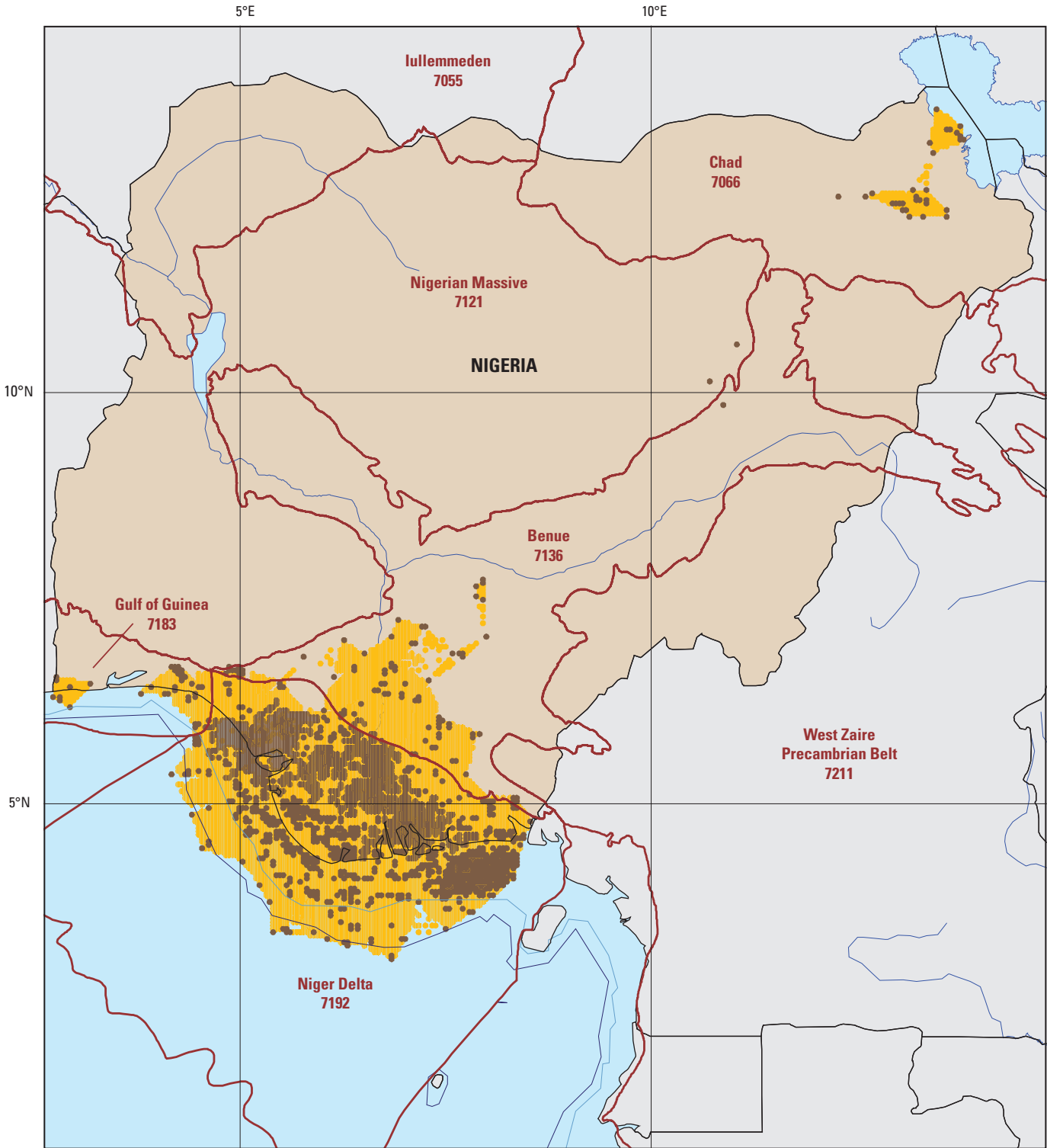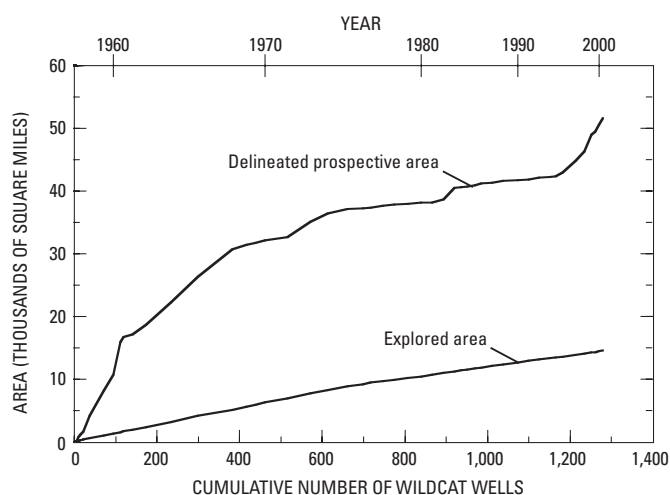
Figure 36.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Nigeria.

Figure 36. Nigeria   **117**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
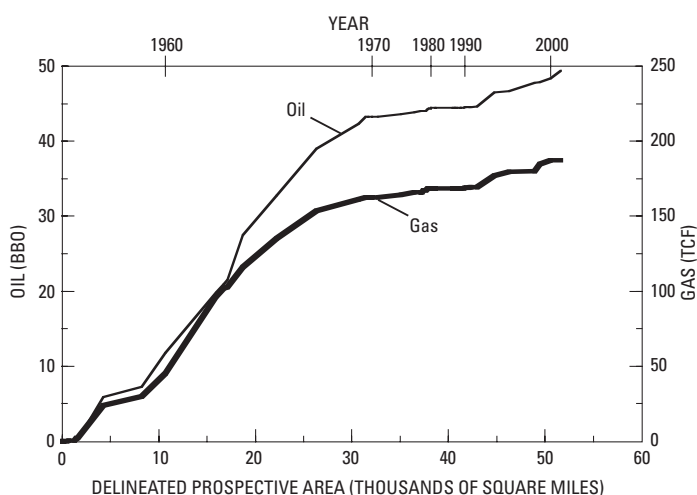
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Nigeria:						
Benue, 7136	1953	0	5	35	1,230	1,265
Gulf of Guinea, 7183	1981	0	35	10	1,000	1,010
Niger Delta, 7192	1954	40,174	49,369	128,272	56,877	185,149
Total		40,174	49,409	128,317	59,107	187,424

Exploration data

Country	Land area (mi²)
Nigeria....................................	356,667

Delineated prospective area through 2001	51,649 mi^2
Explored area through 2001	14,567 mi^2
Wildcat wells through 2001	1,279 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	81 mi^2/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil..	49.409 BBO
Gas..	187.424 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$	0.957 MMBO/mi^2

Figure 36.   Continued.
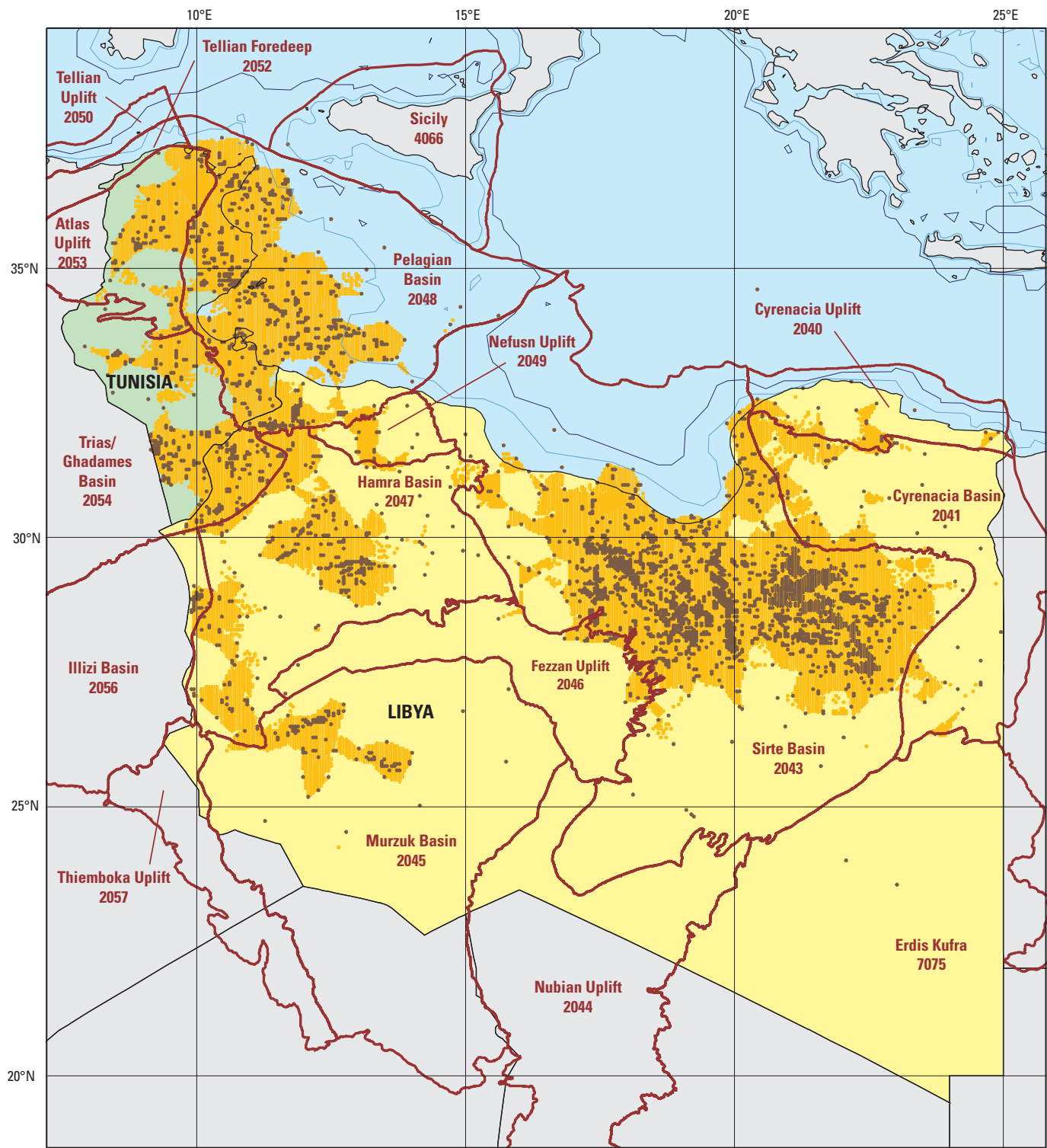
Figure 37.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Libya and Tunisia.

Figure 37. Libya and Tunisia   **119**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Libya:						
Hamra Basin, 2047	1957	150	809	121	1,514	1,635
Illizi Basin, 2056	1964	213	213	3,340	1,600	4,940
Murzuk Basin, 2045	1978	1,805	2,174	433	0	433
Pelagian Basin, 2048	1959	1,585	1,840	12,831	22,295	35,126
Sirte Basin, 2043	1958	40,919	44,927	31,867	15,910	47,777
Trias/Ghadames Basin, 2054	1961	0	254	170	45	215
Total		44,672	50,217	48,762	41,364	90,126
Tunisia:						
Pelagian Basin, 2048..................................	1949	350	870	880	2,138	3,018
Trias/Ghadames Basin, 2054	1964	750	848	1,354	253	1,607
Total		1,100	1,718	2,234	2,391	4,625

Exploration data

Country	Land area (mi^2)
Libya	679,359
Tunisia....................................	63,170
Total	742,529

Delineated prospective area through 2001 .... 190,467 mi^2

Explored area through 2001 .... 27,801 mi^2

Wildcat wells through 2001 .... 2,233 wells

Current growth in delineated prospective area per wildcat (for last 10 percent of wells) .... 66 mi^2/well

Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:

Oil... 51.960 BBO

Gas... 94.807 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.273 MMBO/mi^2
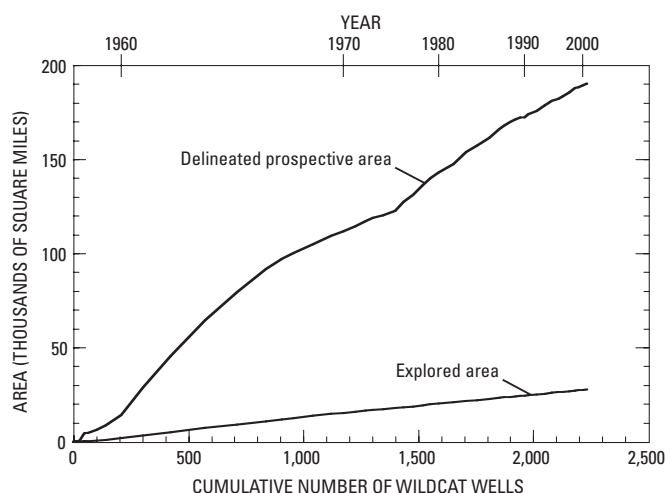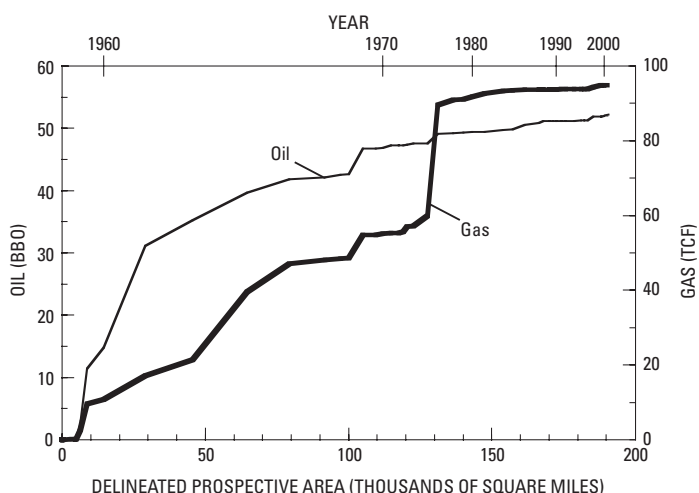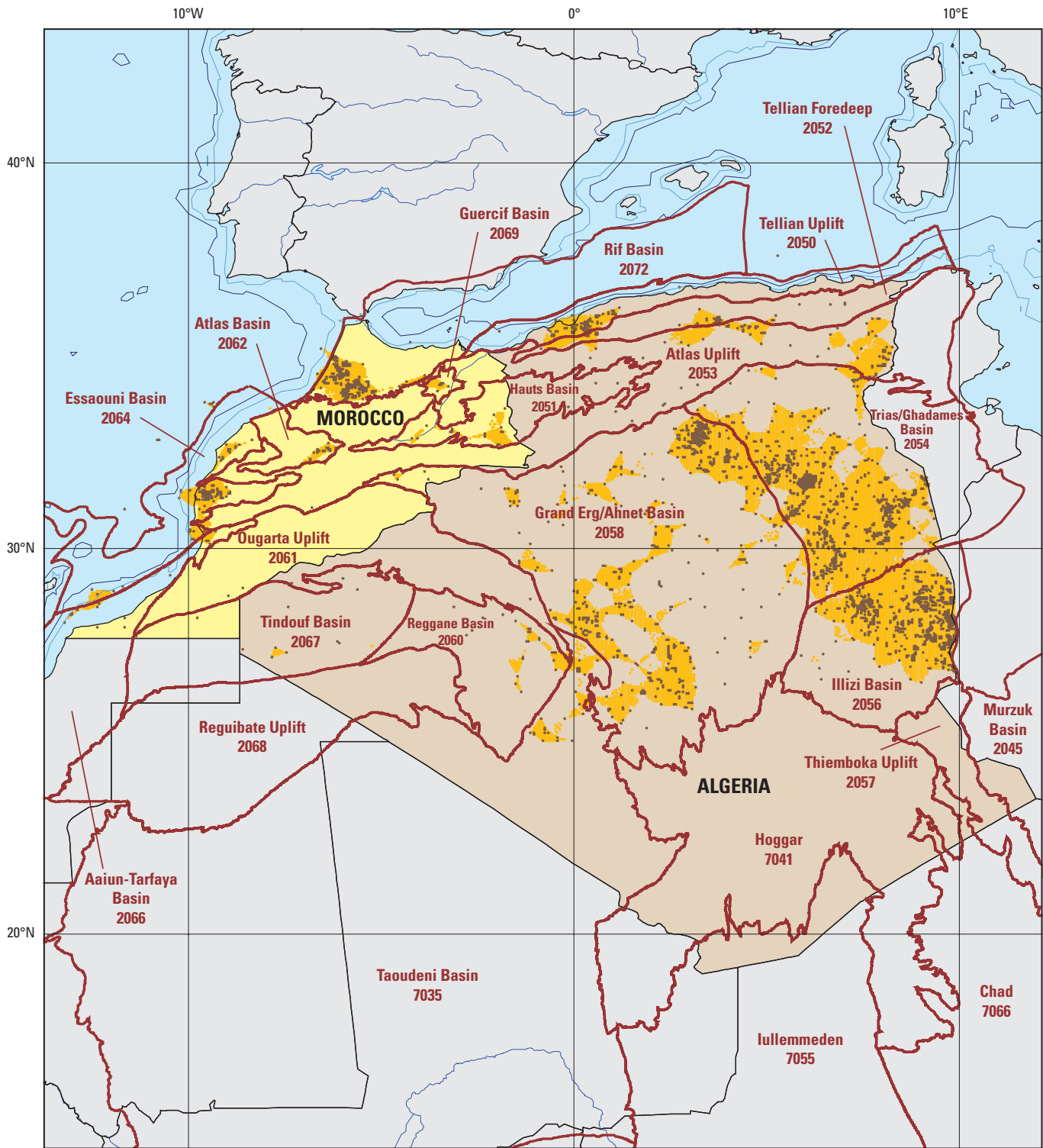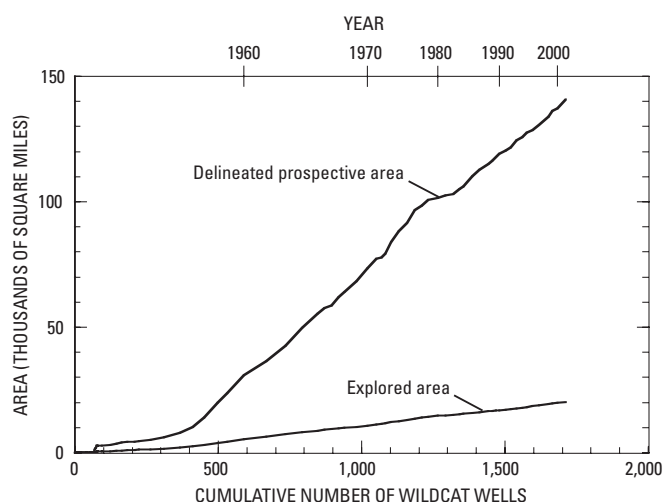
Figure 37. Continued.

Figure 38. Map, graphs, and tables of data for oil and gas exploration through 2001 in Algeria and Morocco.

Figure 38. Algeria and Morocco   **121**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
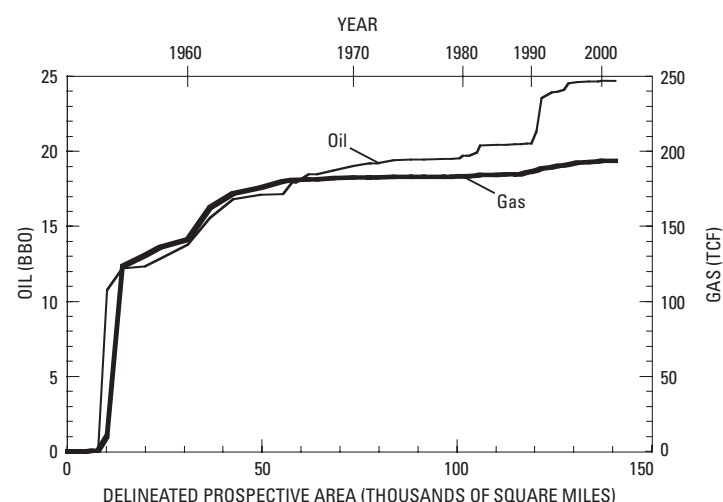
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Algeria:						
Grand Erg/Ahnet Basin, 2058.....................	1954	325	608	566	116,175	116,741
Illizi Basin, 2056...	1956	3,270	4,383	16,335	19,937	36,272
Trias/Ghadames Basin, 2054	1956	17,917	19,609	23,985	15,597	39,582
Total		21,512	24,600	40,886	151,709	192,595

Exploration data

Country	Land area (mi²)
Algeria....................................	919,591
Morocco	172,413
Total	1,092,004

Delineated prospective area through 2001....................... 140,790 mi²

Explored area through 2001... 20,219 mi²

Wildcat wells through 2001 .... 1,711 wells

Current growth in delineated prospective area
per wildcat (for last 10 percent of wells) .... 96 mi²/well

Reported discoveries through 2001 of cumulative
recoverable crude oil and gas in all provinces:

Oil... 24.688 BBO

Gas.. 193.52 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.175 MMBO/mi²

Figure 38.   Continued.

Figure 39. Map, graphs, and tables of data for oil and gas exploration through 2001 in Egypt.

Figure 39. Egypt **123**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Egypt:						
Abu Gharadiq Basin, 2038.........................	1968	114	540	1,632	2,908	4,540
Levantine Basin, 2032................................	1975	0	20	13	2,723	2,736
Nile Delta Basin, 2035..............................	1966	0	2	0	42,775	42,775
North Egypt Basin, 2039............................	1966	0	727	912	5,484	6,396
Red Sea Basin, 2071	1907	8,502	10,014	5,270	1,105	6,375
Total		8,616	11,303	7,827	54,995	62,822

Exploration data

Country	Land area (mi²)
Egypt......................................	386,660

Delineated prospective area through 2001........................ 61,775 mi²
Explored area through 2001... 11,688 mi²
Wildcat wells through 2001 .... 1,386 wells
Current growth in delineated prospective area
    per wildcat (for last 10 percent of wells) .... 36 mi²/well
Reported discoveries through 2001 of cumulative
    recoverable crude oil and gas in all provinces:
        Oil.. 11.425 BBO
        Gas... 62.827 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ .... 0.185 MMBO/mi²
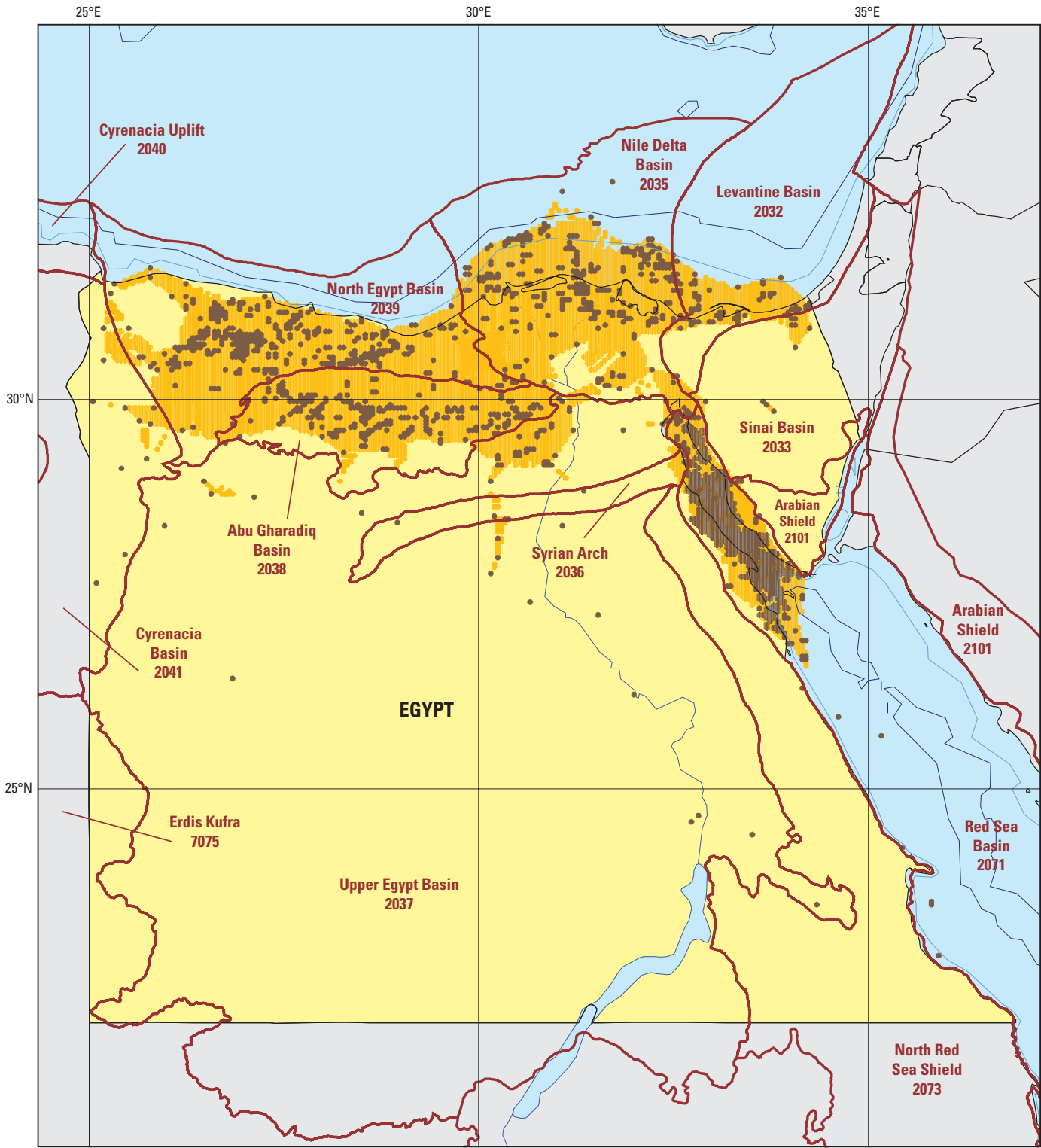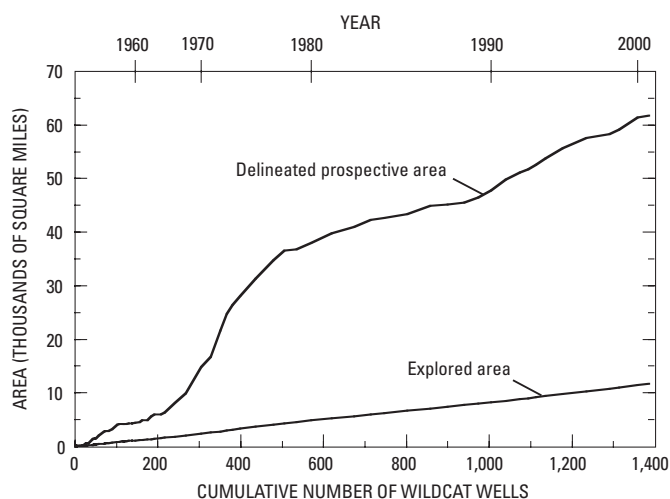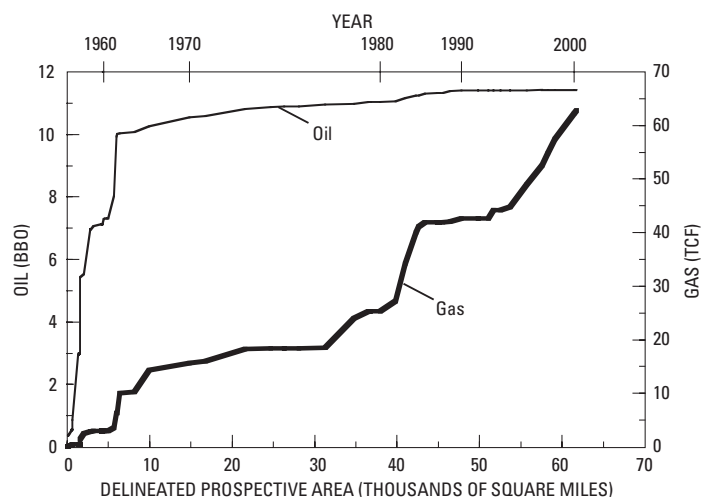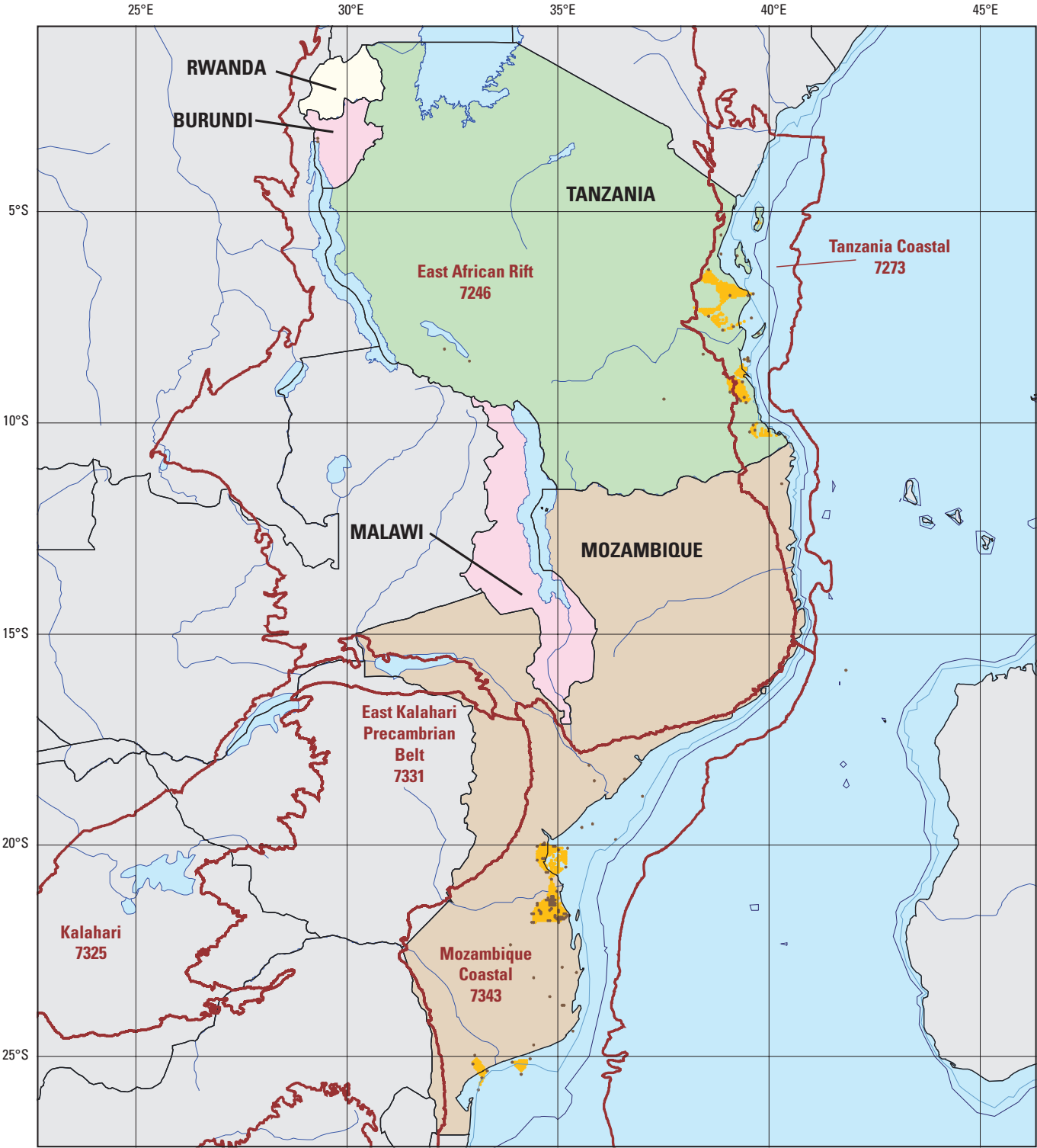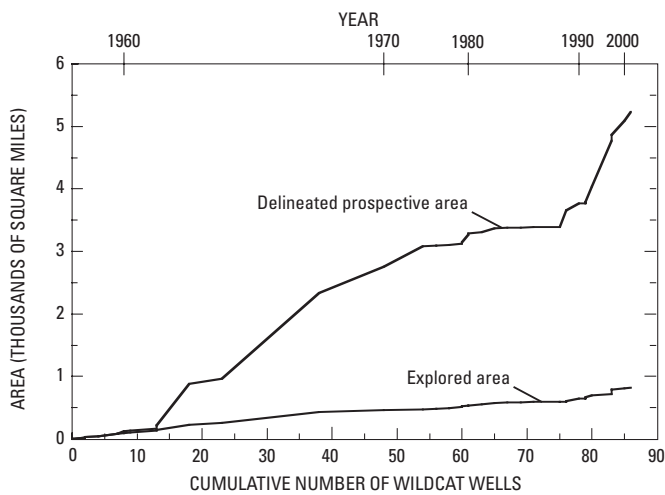
Figure 39. Continued.

Figure 40.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Mozambique, Tanzania, Burundi, Malawi, and Rwanda.

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
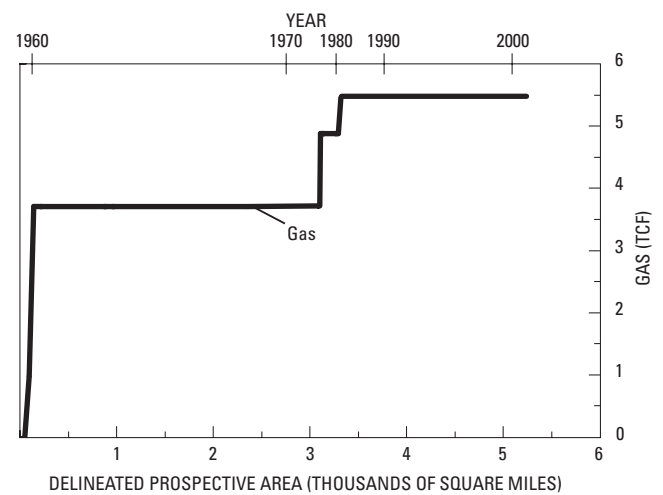
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Mozambique:						
Mozambique Coastal, 7343	1953	0	0	0	3,712	3,712
Tanzania:						
Tanzania Coastal, 7273	1974	0	0	0	1,765	1,765

Exploration data

Country	Land area (mi²)
Mozambique	309,494
Tanzania	364,898
Burundi	10,745
Malawi	45,745
Rwanda	10,169
Total	741,052

Delineated prospective area through 2001 .... 5,237 mi²
Explored area through 2001 .... 815 mi²
Wildcat wells through 2001 .... 86 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 183 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 0
    Gas.. 5.477 TCF

Figure 40.   Continued.

Figure 41.   Map, graphs, and tables of data for oil and gas exploration through 2001 in South Africa, Namibia, Botswana, Lesotho, Swaziland, Zambia, and Zimbabwe.

Figure 41. South Africa, Namibia, and Neighboring Countries   127

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

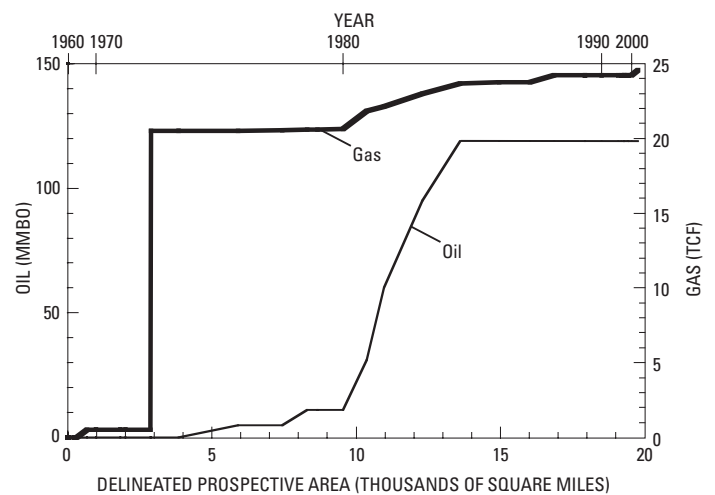| Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
South Africa:						
Orange River Coastal, 7303	1987	0	0	0	815	815
South African Coastal, 7363	1969	<u>0</u>	<u>119</u>	<u>368</u>	<u>3,402</u>	<u>3,770</u>
Total		0	119	368	4,217	4,585
Namibia:						
Orange River Coastal, 7303	1974	0	0	0	20,000	20,000

Exploration data

Country	Land area (mi²)
South Africa	471,008
Namibia	318,694
Botswana	231,803
Lesotho	11,720
Swaziland	6,704
Zambia	290,585
Zimbabwe	<u>150,803</u>
Total	1,481,317

Delineated prospective area through 2001 .... 19,784 mi²
Explored area through 2001 .... 3,152 mi²
Wildcat wells through 2001 .... 345 wells
Current growth in delineated prospective area
   per wildcat (for last 10 percent of wells) .... 22 mi²/well
Reported discoveries through 2001 of cumulative
   recoverable crude oil and gas in all provinces:
      Oil .... 119 MMBO
      Gas .... 24.585 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.006 MMBO/mi²
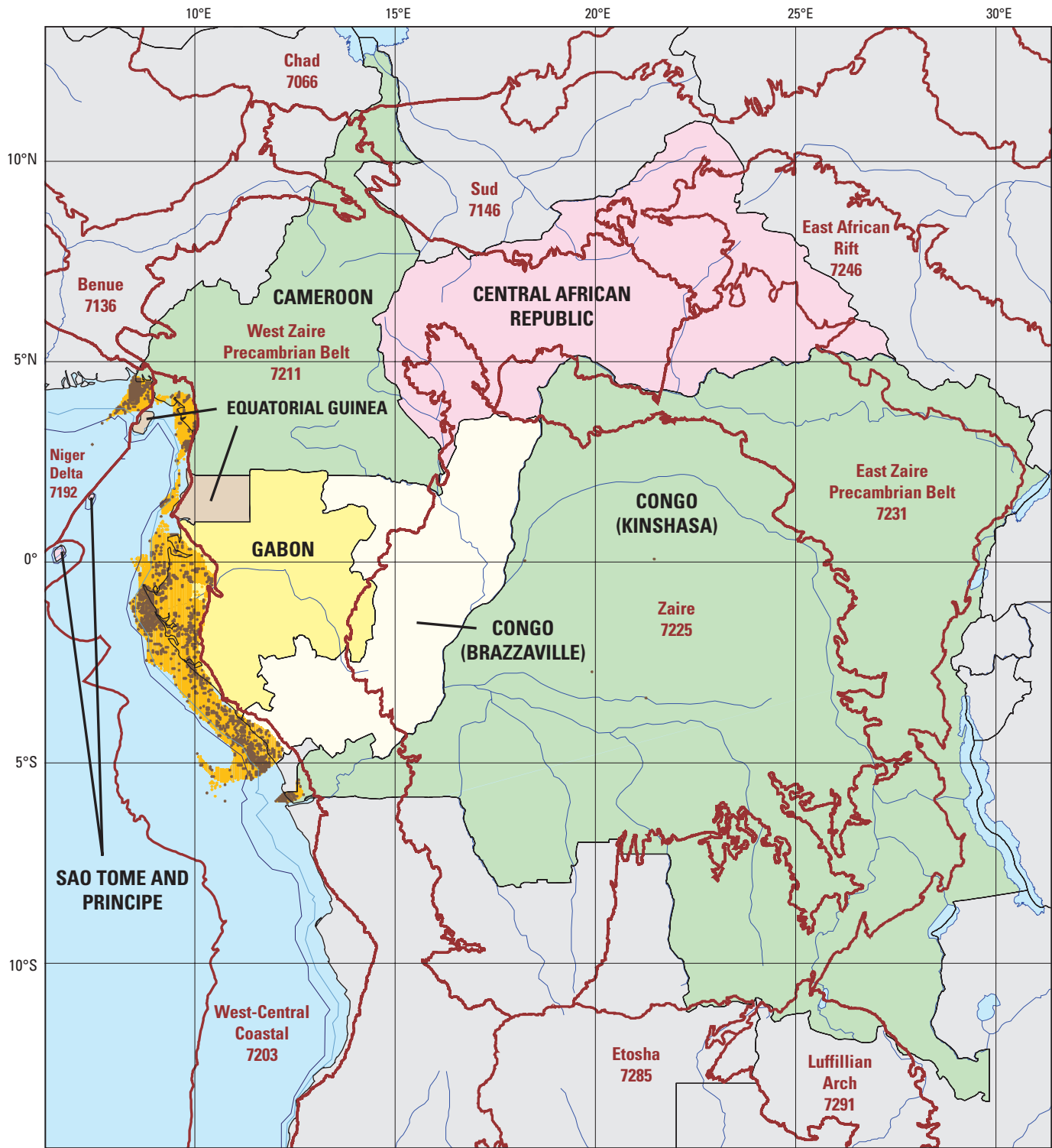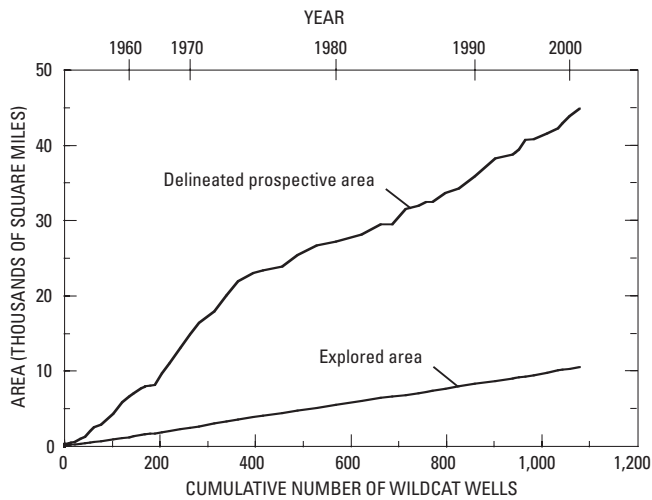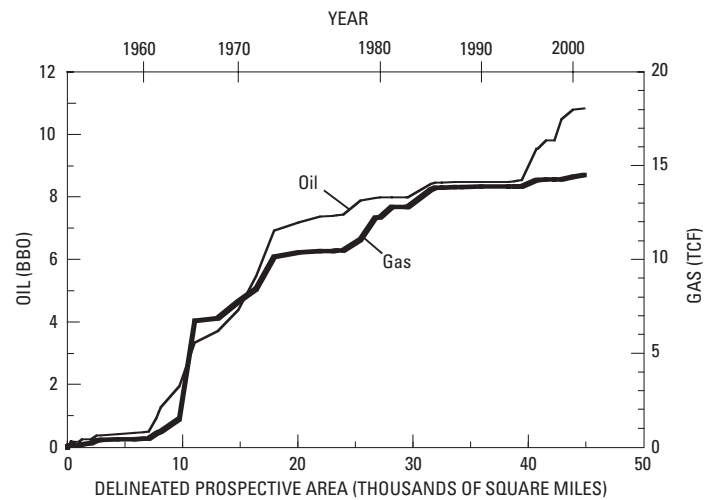
Figure 41. Continued.

Figure 42. Map, graphs, and tables of data for oil and gas exploration through 2001 in Gabon, Republic of the Congo (Brazzaville), Cameroon, Equatorial Guinea, Democratic Republic of the Congo (Kinshasa), Central African Republic, and Sao Tome and Principe.

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Gabon:						
West-Central Coastal, 7203.........................	1951	2,596	4,549	1,500	246	1,746
Republic of the Congo (Brazzaville):						
West-Central Coastal, 7203.........................	1957	2,722	3,414	2,362	775	3,137
Cameroon:						
Niger Delta, 7192..	1967	445	1,276	1,620	1,674	3,294
West-Central Coastal, 7203.........................	1954	0	19	43	1,029	1,072
Total		445	1,295	1,663	2,703	4,366
Equatorial Guinea:						
Niger Delta, 7192..	1984	350	485	178	4,940	5,118
West-Central Coastal, 7203.........................	1999	650	724	31	0	31
Total		1,000	1,209	209	4,940	5,149
Democratic Republic of the Congo (Kinshasa):						
West-Central Coastal, 7203.........................	1964	135	356	93	0	93

Exploration data

Country	Land area (mi^2)
Gabon.....................................	103,346
Congo (Brazzaville)	132,046
Cameroon...............................	183,568
Central African Republic	240,534
Congo (Kinshasa)...................	905,564
Equatorial Guinea	10,831
Sao Tome and Principe	386
Total	1,576,275

Delineated prospective area through 2001 .... 44,866 mi^2
Explored area through 2001... 10,527 mi^2
Wildcat wells through 2001 .... 1,079 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 42 mi^2/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 10.823 BBO
    Gas.. 14.491 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.241 MMBO/mi^2
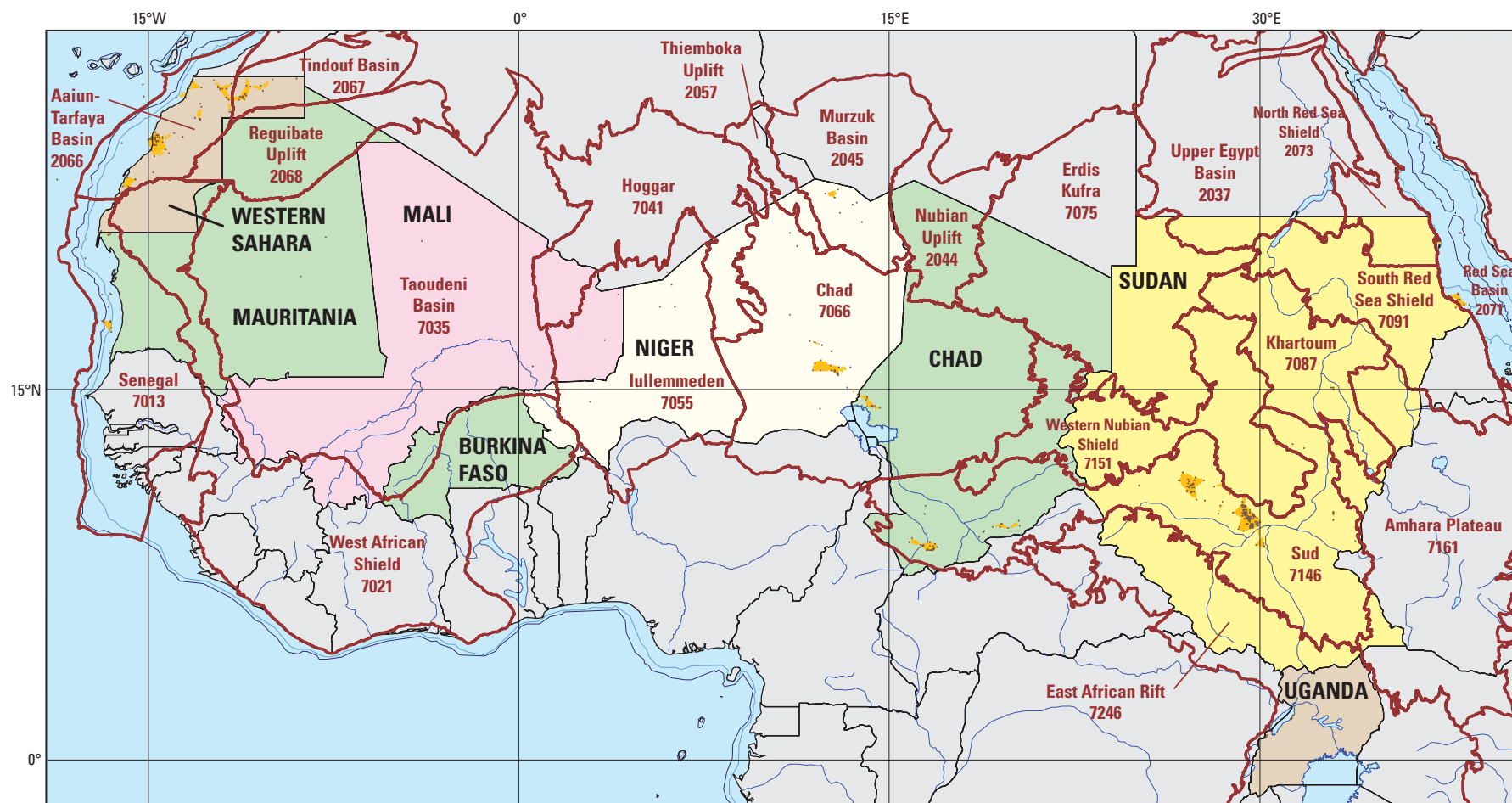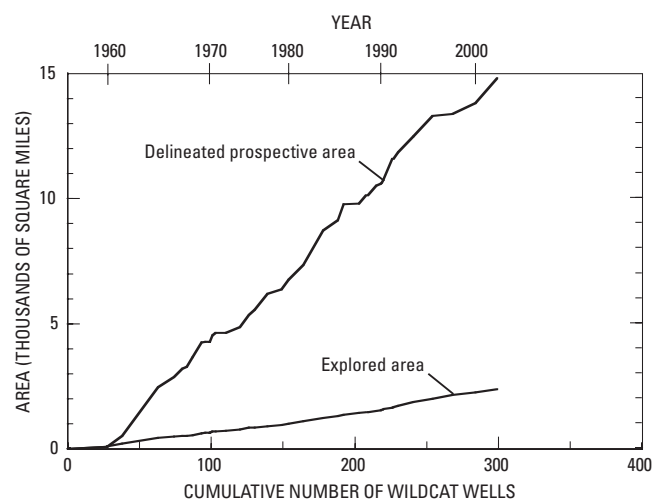
Figure 42.   Continued.

Figure 43. Map, graphs, and tables of data for oil and gas exploration through 2001 in Sudan, Chad, Mauritania, Niger, Burkina Faso, Mali, Uganda, and Western Sahara.

Growth in delineated prospective area and explored

area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces

through 2001, graphed by the year the field location became part of the delineated prospective area
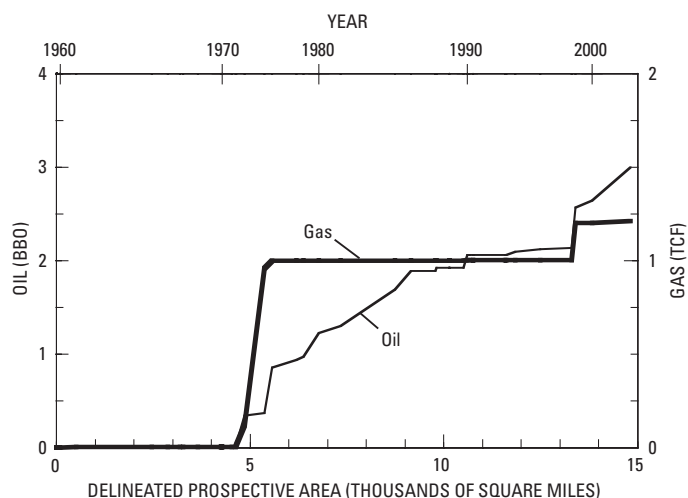

Figure 43. Continued.

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Sudan:						
Red Sea Basin, 2071	1963	0	0	0	850	850
Sud, 7146	1979	785	1,511	207	0	207
Total..		785	1,511	207	850	1,057
Chad:						
Sud, 7146	1975	900	1,053	40	0	40
Mauritania:						
Senegal, 7013	2001	330	330	0	0	0

Exploration data

Country	Land area (mi²)
Sudan...............................	967,494
Chad	495,753
Mauritania........................	397,954
Niger	489,189
Burkina Faso	105,869
Mali..................................	478,764
Uganda	91,135
Western Sahara.................	102,703
Total.............................	3,128,861

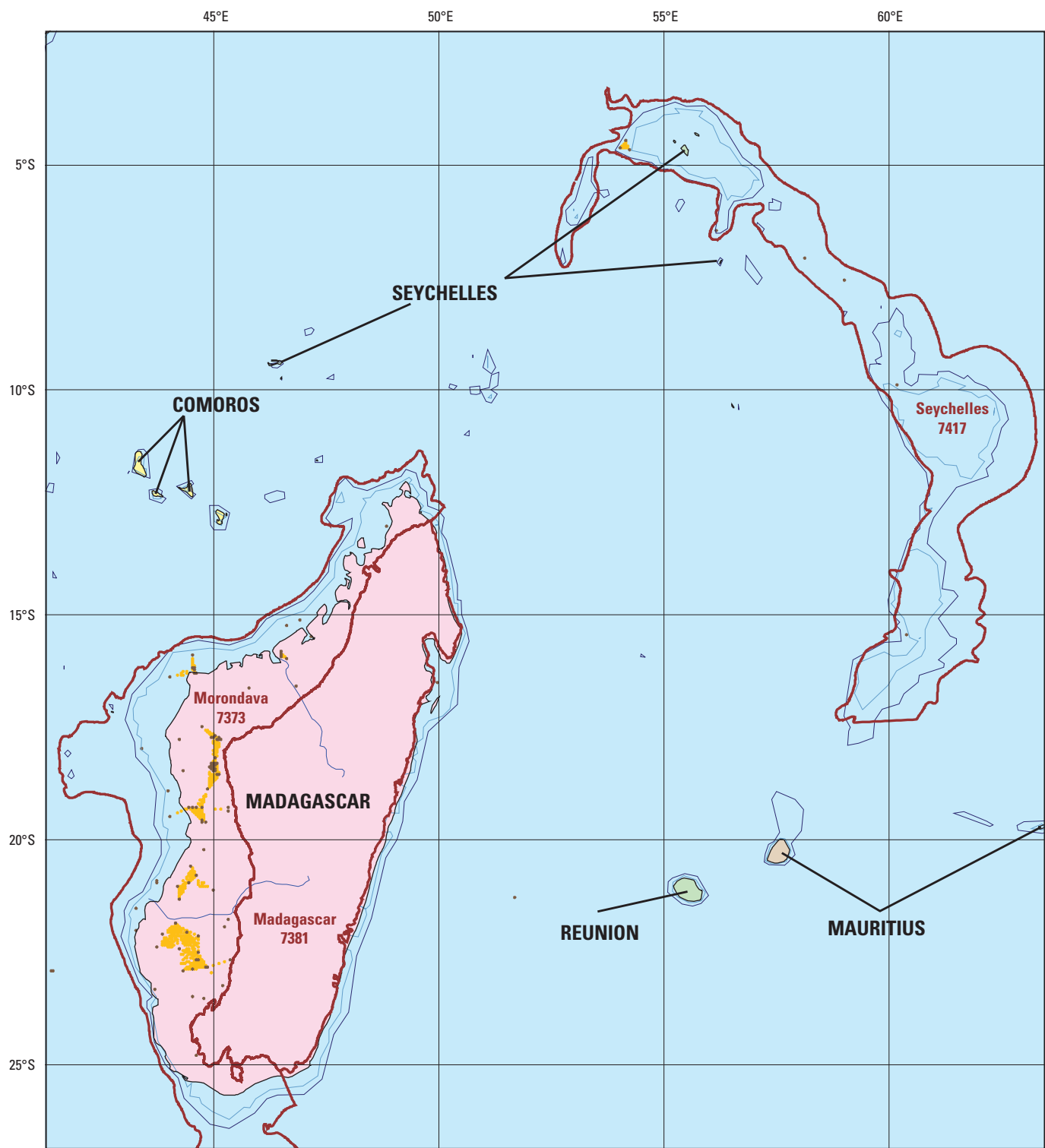|	
Delineated prospective area through 2001	14,821 mi²
Explored area through 2001	2,386 mi²
Wildcat wells through 2001	299 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	67 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil...	2.999 BBO
Gas..	1.211 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ ....0.202 MMBO/mi²	

Figure 44.   Map, graphs, and table of data for oil and gas exploration through 2001 in Madagascar, Comoros, Mauritius, Seychelles, and Reunion (an overseas department of France).

Figure 44. Madagascar, Comoros, Mauritius, Seychelles, and Reunion   **133**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored
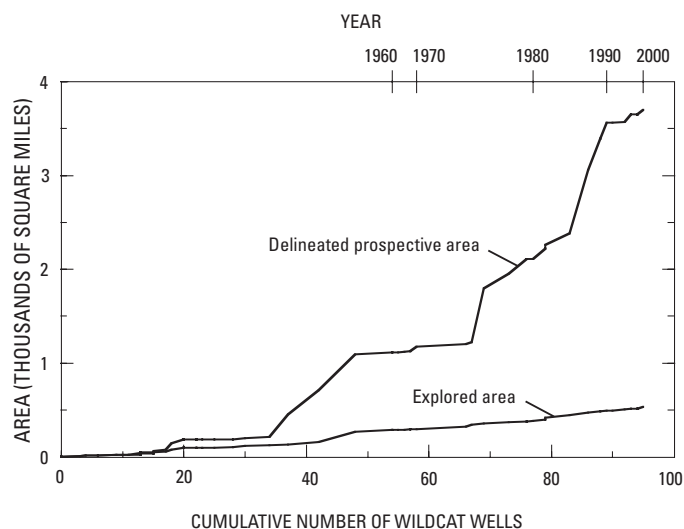
Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
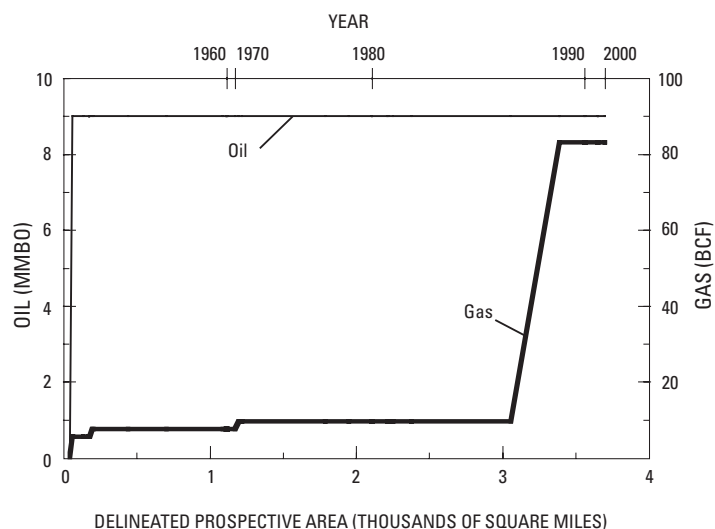
Exploration data

Country	Land area (mi²)
Madagascar	226,656
Comoros.................................	838
Mauritius	718
Seychelles	176
Reunion	972
Total	229,360

Delineated prospective area through 2001 .... 3,701 mi²
Explored area through 2001 .... 535 mi²
Wildcat wells through 2001 .... 95 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 71 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 9 MMBO
    Gas... 83 BCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ .... 0.002 MMBO/mi²
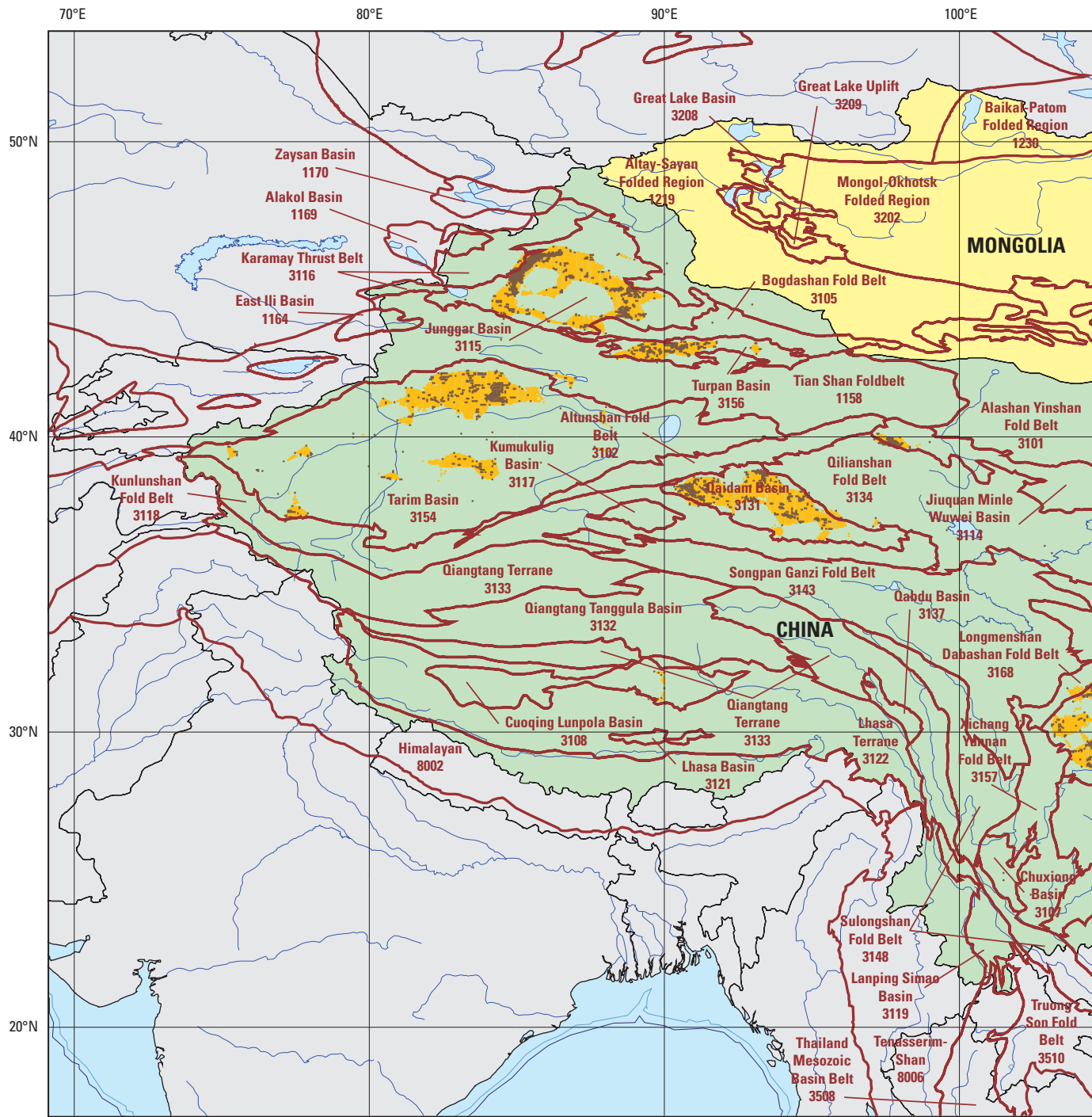
Figure 44.   Continued.

Figure 45.   Map, graphs, and tables of data for oil and gas exploration through 2001 in China and Mongolia.
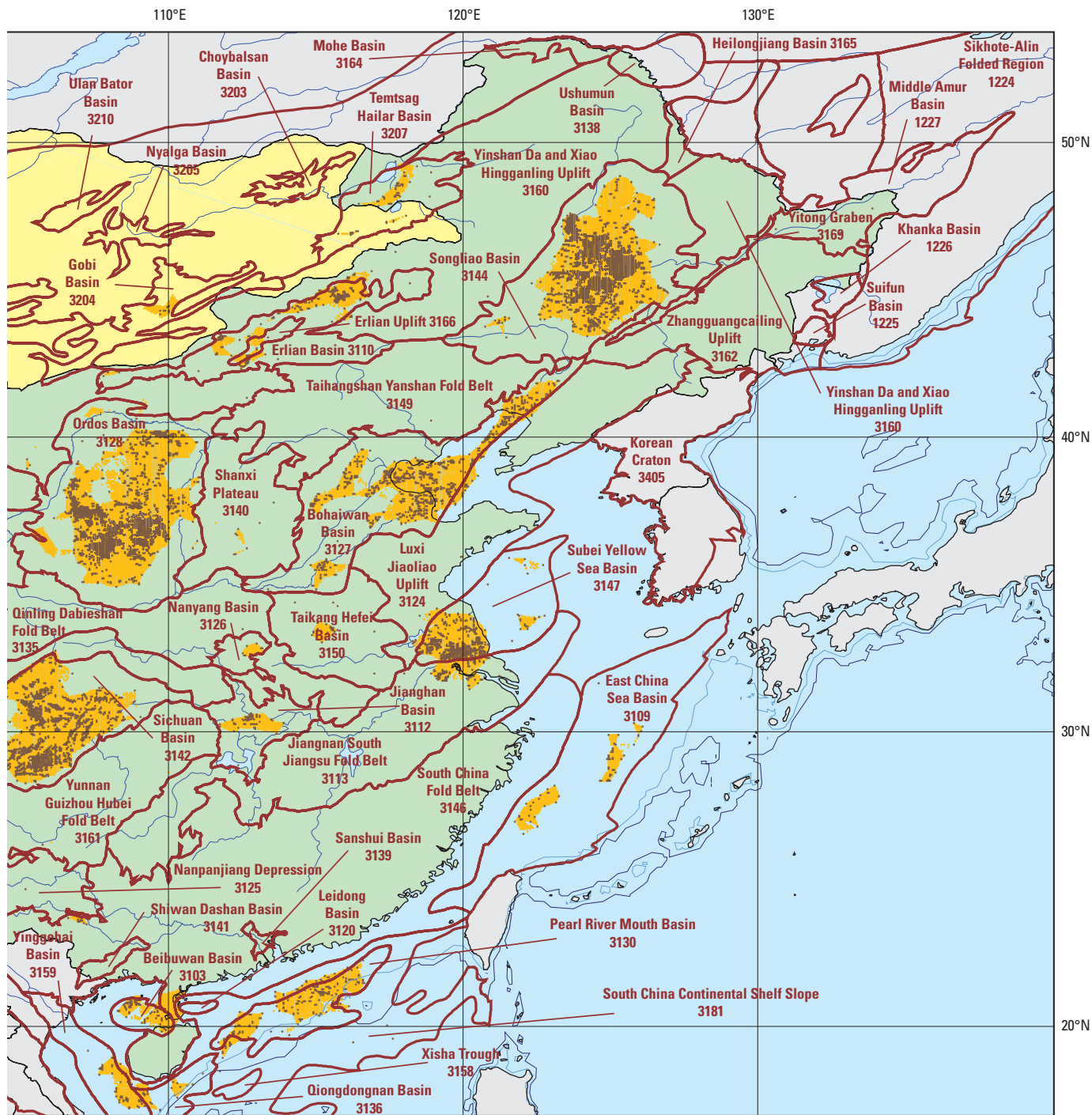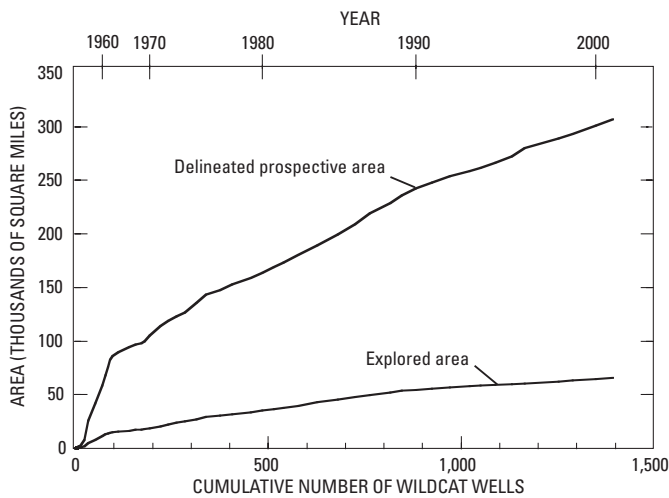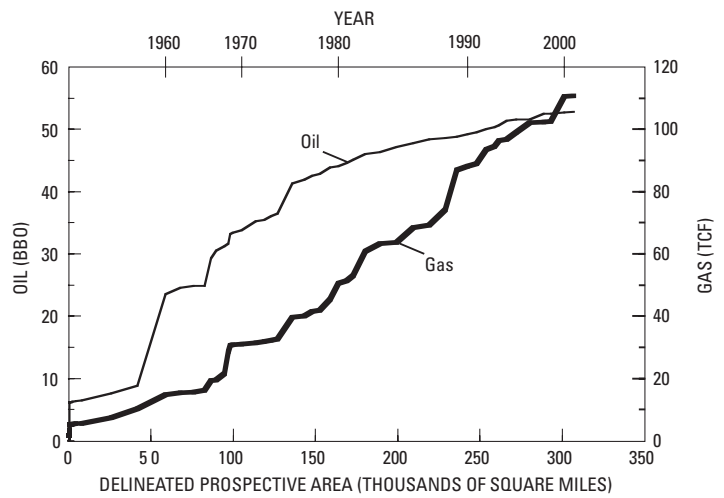
Figure 45. Continued.

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
China:						
Bohaiwan Basin, 3127	1961	13,988	19,326	10,091	7,436	17,527
Jiuquan Minle Wuwei Basin, 3114	1939	160	209	1	0	1
Junggar Basin, 3115....................................	1897	7,915	8,430	2,500	2,340	4,840
Luxi Jiaoliao Uplift, 3124	1993	650	774	154	0	154
Nanyang Basin, 3126	1971	600	711	0	0	0
Ordos Basin, 3128.......................................	1907	640	986	111	14,636	14,747
Pearl River Mouth Basin, 3130...................	1979	635	1,361	524	1,060	1,584
Qaidam Basin, 3131....................................	1955	300	541	229	2,156	2,385
Sichuan Basin, 3142....................................	1939	0	246	263	31,652	31,915
Songliao Basin, 3144	1959	14,380	15,637	2,817	1,905	4,722
South China Continental Shelf						
Slope, 3181	1984	0	121	205	0	205
Tarim Basin, 3154.......................................	1918	332	1,523	2,409	14,049	16,458
Yinggehai Basin, 3159	1983	0	0	0	10,810	10,810
Total...		39,600	49,865	19,304	86,044	105,348

Figure 45.   Continued.

Figure 45. China and Mongolia   137

Exploration data

Country	Land area (mi²)
China	3,705,390
Mongolia	604,247
Total	4,309,637

Delineated prospective area through 2001	307,184 mi²
Explored area through 2001	65,488 mi²
Wildcat wells through 2001	1,394 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	135 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil	52.763 BBO
Gas	110.696 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$	0.172 MMBO/mi²

Figure 45. Continued.
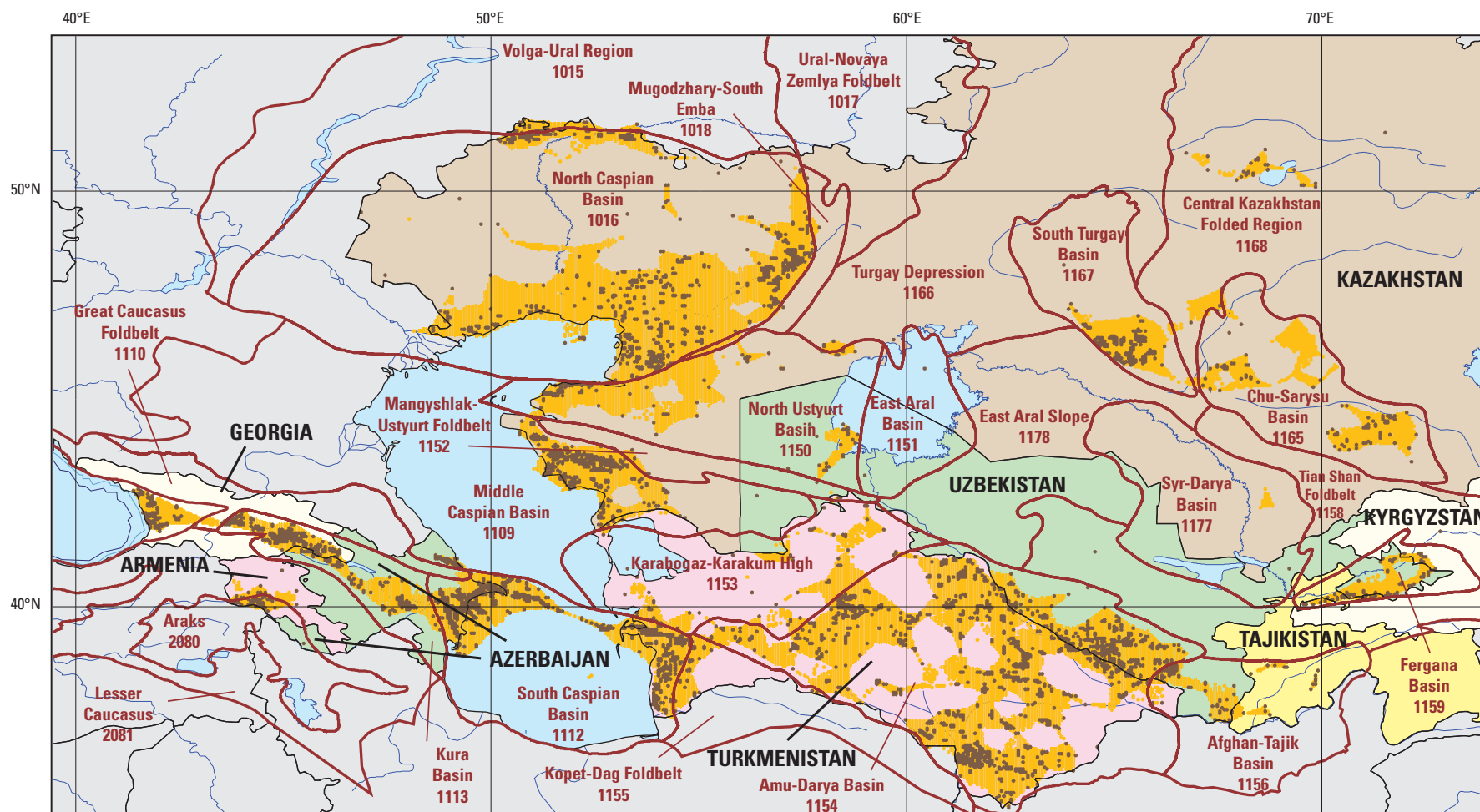
Figure 46. Map, graphs, and tables of data for oil and gas exploration through 2001 in Kazakhstan, Azerbaijan, Turkmenistan, Uzbekistan, Georgia, Kyrgyzstan, Tajikistan, and Armenia.

Growth in delineated prospective area and explored
  area through 2001, graphed by the year the areas

 became prospective or explored
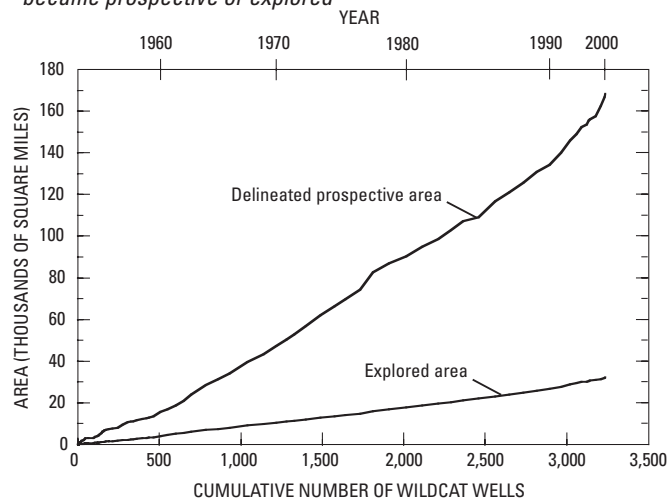
Cumulative recoverable oil and gas discoveries in all provinces

 through 2001, graphed by the year the field location
 became part of the delineated prospective area

Figure 46.   Continued.

Figure 46. Kazakhstan, Azerbaijan, and Neighboring Countries   **139**

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

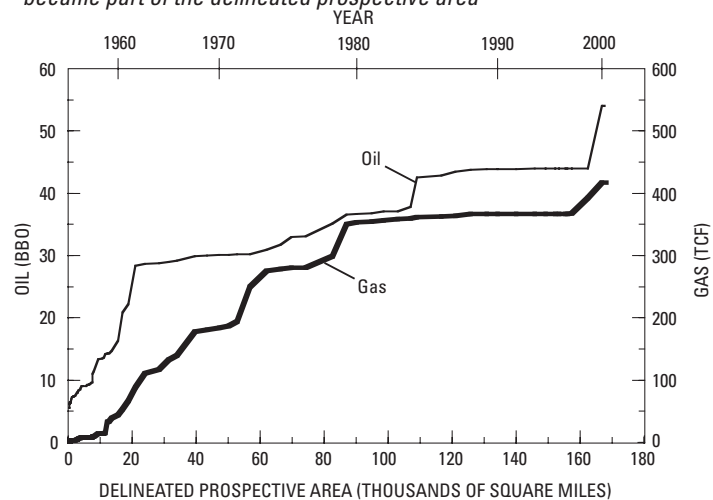| Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Kazakhstan:						
Middle Caspian Basin, 1109	1961	4,761	5,211	3,980	3,546	7,526
North Caspian Basin, 1016	1898	18,565	21,615	39,961	53,667	93,628
North Ustyurt Basin, 1150	1964	2,408	2,588	1,864	1,892	3,756
South Turgay Basin, 1167	1984	667	1,038	725	18	743
Volga-Ural Region, 1015	1991	0	67	835	2	837
Total		26,401	30,519	47,365	59,125	106,490
Azerbaijan:						
Kura Basin, 1113	1873	0	155	17	0	17
Middle Caspian Basin, 1109	1939	128	143	249	47	296
South Caspian Basin, 1112	1869	16,310	17,072	14,642	35,038	49,680
Total		16,438	17,370	14,908	35,085	49,993
Turkmenistan:						
Amu-Darya Basin, 1154	1959	0	81	360	135,945	136,305
Middle Caspian Basin, 1109	1973	0	0	0	4	4
South Caspian Basin, 1112	1933	3,421	3,956	11,017	9,948	20,965
Total		3,421	4,037	11,377	145,897	157,274
Uzbekistan:						
Afghan-Tajik Basin, 1156	1934	0	97	21	4,937	4,958
Amu-Darya Basin, 1154	1953	400	790	5,938	82,609	88,547
Fergana Basin, 1159	1931	180	513	233	231	464
Middle Caspian Basin, 1109	1964	0	0	0	1,600	1,600
North Ustyurt Basin, 1150	1968	0	1	0	366	366
Total		580	1,401	6,192	89,743	95,935
Georgia:						
Kura Basin, 1113	1869	223	369	198	63	261
Kyrgyzstan:						
Fergana Basin, 1159	1901	104	229	866	7	873
Tajikistan:						
Afghan-Tajik Basin, 1156	1949	0	51	76	174	250
Fergana Basin, 1159	1908	0	39	49	245	294
Total		0	90	125	419	544

Figure 46.   Continued.

Exploration data

Country	Land area (mi²)
Kazakhstan	1,049,151
Azerbaijan	33,436
Turkmenistan	188,456
Uzbekistan	172,741
Georgia	26,911
Kyrgyzstan	76,641
Tajikistan	55,251
Armenia	11,506
Total	1,614,093

Delineated prospective area through 2001 .... 168,262 mi²
Explored area through 2001 .... 32,179 mi²
Wildcat wells through 2001 .... 3,237 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 104 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil .... 54.065 BBO
    Gas .... 416.610 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.321 MMBO/mi²

Figure 46. Continued.
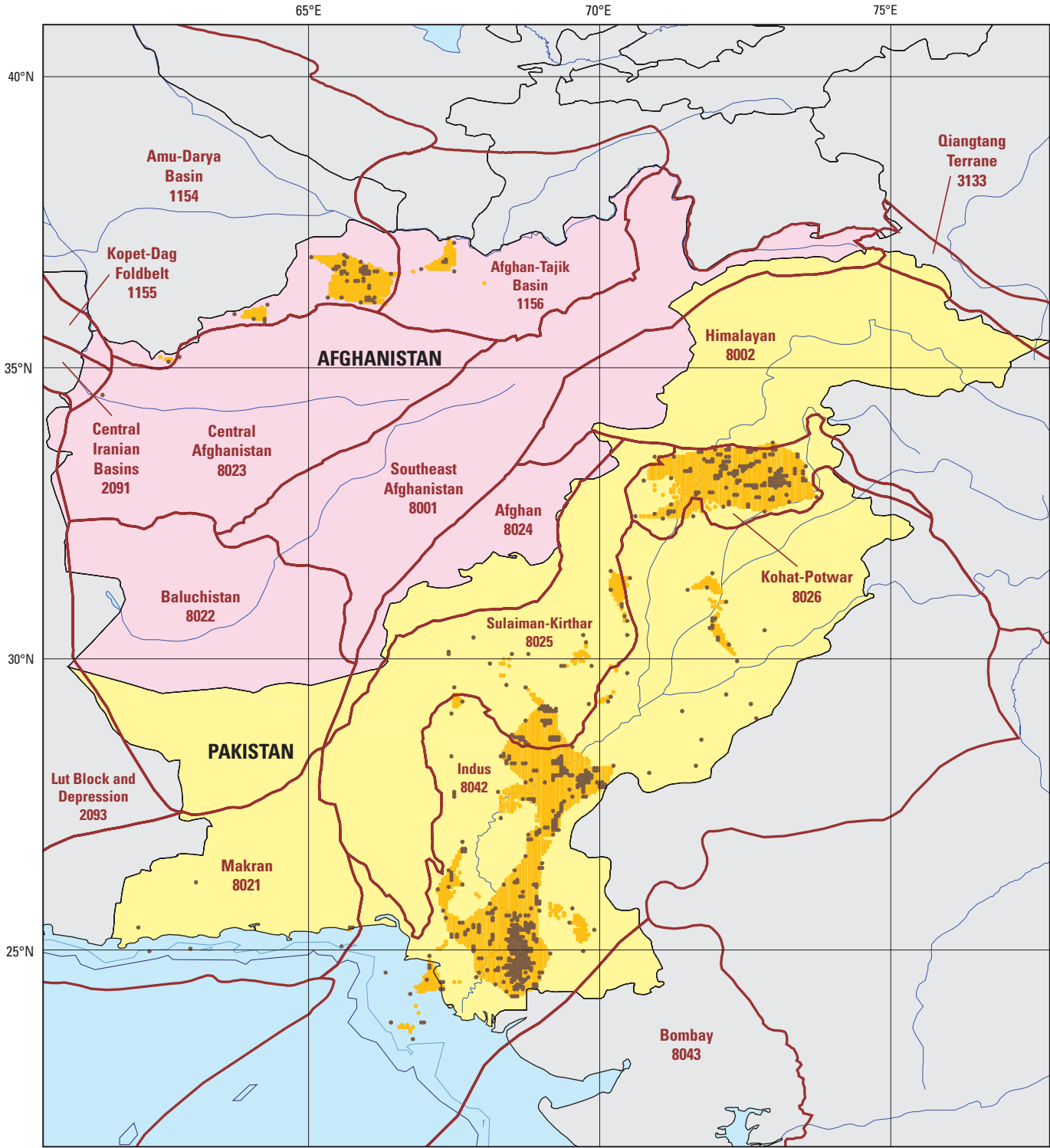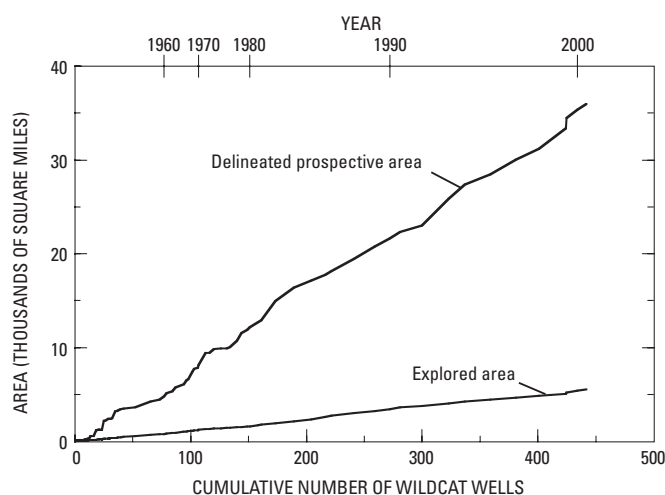
Figure 46. Kazakhstan, Azerbaijan, and Neighboring Countries   141

Figure 47.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Pakistan and Afghanistan.

Figure 47. Pakistan and Afghanistan   **143**

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
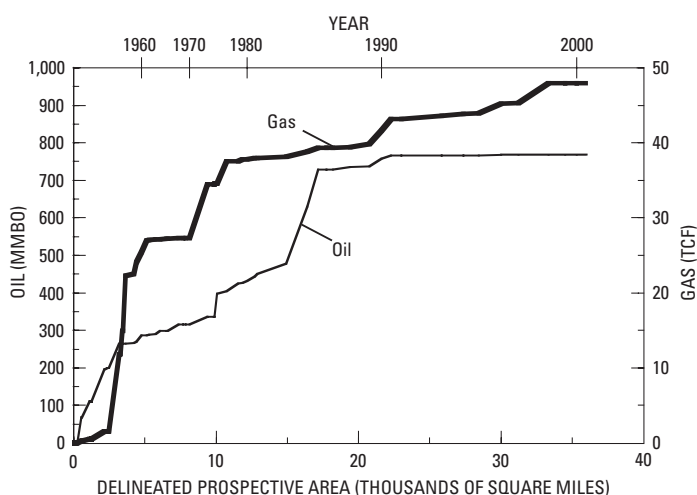
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Pakistan:						
Indus, 8042....................................	1957	0	299	328	23,580	23,908
Sulaiman-Kirthar, 8025............................	1883	0	0	0	16,399	16,399
Total		0	299	328	39,979	40,307
Afghanistan:						
Afghan-Tajik Basin, 1156........................	1960	0	7	10	412	422
Amu-Darya Basin, 1154	1959	0	112	100	4,899	4,999
Total		0	119	110	5,311	5,421

Exploration data

Country	Land area (mi²)
Pakistan	310,402
Afghanistan.....................	250,000
Total	560,402

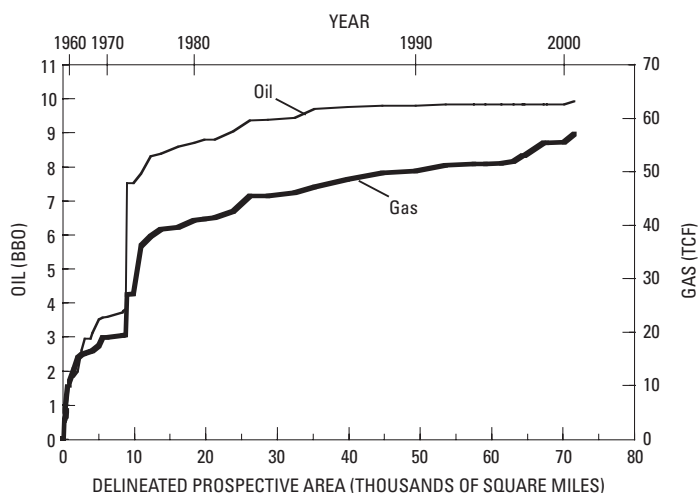|	
Delineated prospective area through 2001........................	35,953 mi²
Explored area through 2001...	5,534 mi²
Wildcat wells through 2001	442 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells)	115 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:	
Oil..	768 MMBO
Gas...	47.988 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$	0.021 MMBO/mi²

Figure 47. Continued.

Figure 48. Map, graphs, and tables of data for oil and gas exploration through 2001 in India, Bangladesh, Bhutan, Maldives, Nepal, and Sri Lanka.

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
India:						
Assam, 8034..	1867	1,717	2,157	5,286	551	5,837
Bombay, 8043	1958	6,075	7,325	15,081	12,898	27,979
Ganges-Brahmaputra Delta, 8047...............	1915	0	1	0	843	843
Indus, 8042..	1967	0	40	0	159	159
Krishna-Godavari, 8045.............................	1979	223	331	427	3,091	3,518
Total		8,015	9,854	20,794	17,542	38,336
Bangladesh:						
Ganges-Brahmaputra Delta, 8047...............	1923	0	2	0	17,705	17,705

Exploration data

Country	Land area (mi²)
India	1,269,340
Bangladesh......................	55,598
Bhutan	18,147
Maldives..........................	116
Nepal	54,363
Sri Lanka.........................	25,332
Total	1,422,896

Delineated prospective area through 2001 .... 71,557 mi²
Explored area through 2001... 14,577 mi²
Wildcat wells through 2001 .... 1,163 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 67 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 9.923 BBO
    Gas.. 57.126 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$.......... 0.139 MMBO/mi²
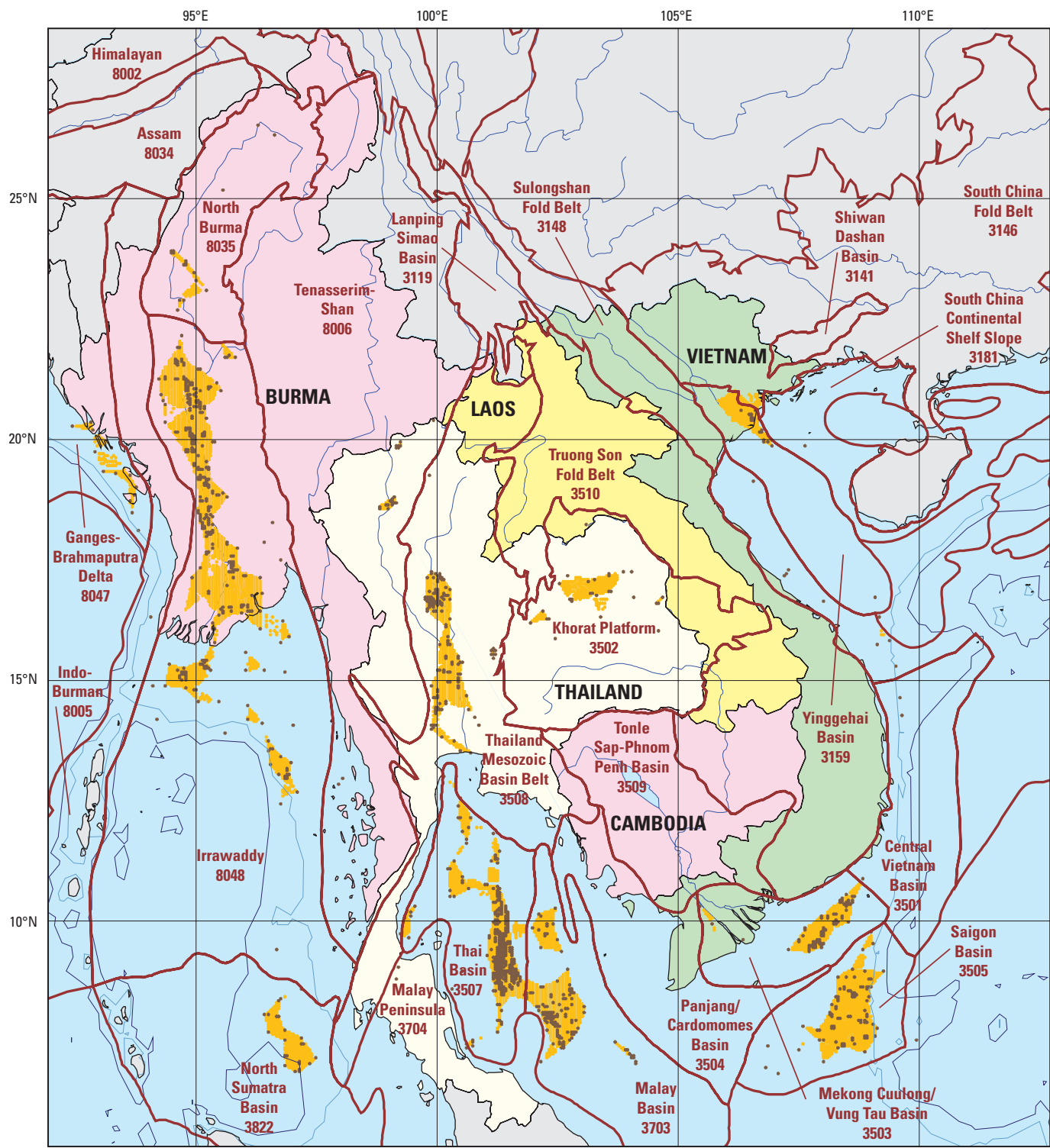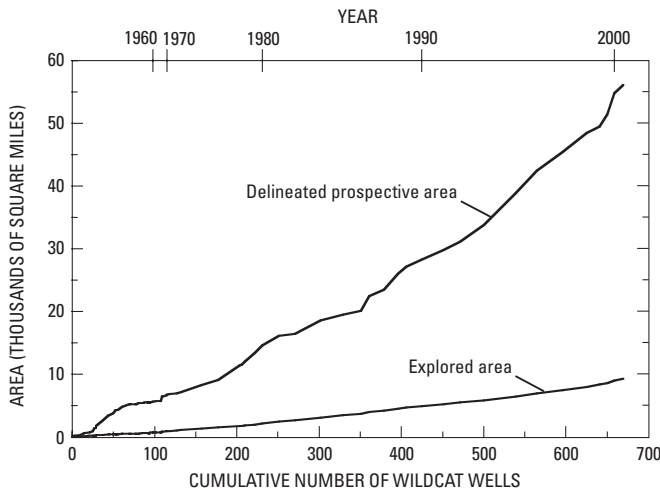
Figure 48.   Continued.

Figure 49.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Vietnam, Burma, Thailand, Cambodia, and Laos.

Figure 49. Vietnam, Burma, Thailand, Cambodia, and Laos   147

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area
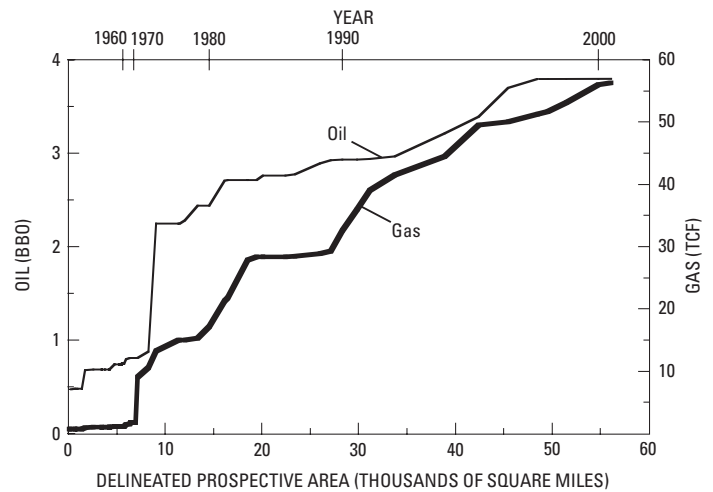
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Vietnam:						
Malay Basin, 3703	1994	0	82	395	1,675	2,070
Mekong/Cuulong/Vung Tau Basin, 3503	1975	1,710	2,064	2,255	1,120	3,375
Saigon Basin, 3505	1974	111	251	1,110	5,872	6,982
South China Continental Shelf Slope, 3181	1991	0	0	0	1,500	1,500
Yinggehai Basin, 3159	1975	0	19	0	1,099	1,099
Total		1,821	2,416	3,760	11,266	15,026
Burma:						
Irrawaddy, 8048	1864	649	798	1,226	11,552	12,778
Thailand:						
Malay Basin, 3703	1973	0	27	117	10,347	10,464
Thai Basin, 3507	1973	0	211	1,218	14,010	15,228
Thailand Mesozoic Basin Belt, 3508	1981	240	256	812	20	832
Total..		240	494	2,147	24,377	26,524
Cambodia:						
Malay Basin, 3703	1994	0	1	0	75	75

Exploration data

Country	Land area (mi²)
Vietnam	127,243
Burma..............................	261,969
Thailand	198,456
Cambodia	69,900
Laos.................................	91,429
Total	748,997

Delineated prospective area through 2001 .... 56,096 mi²
Explored area through 2001 .... 9,274 mi²
Wildcat wells through 2001 .... 670 wells
Current growth in delineated prospective area
   per wildcat (for last 10 percent of wells) .... 169 mi²/well
Reported discoveries through 2001 of cumulative
   recoverable crude oil and gas in all provinces:
   Oil.. 3.794 BBO
   Gas... 56.316 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.068 MMBO/mi²
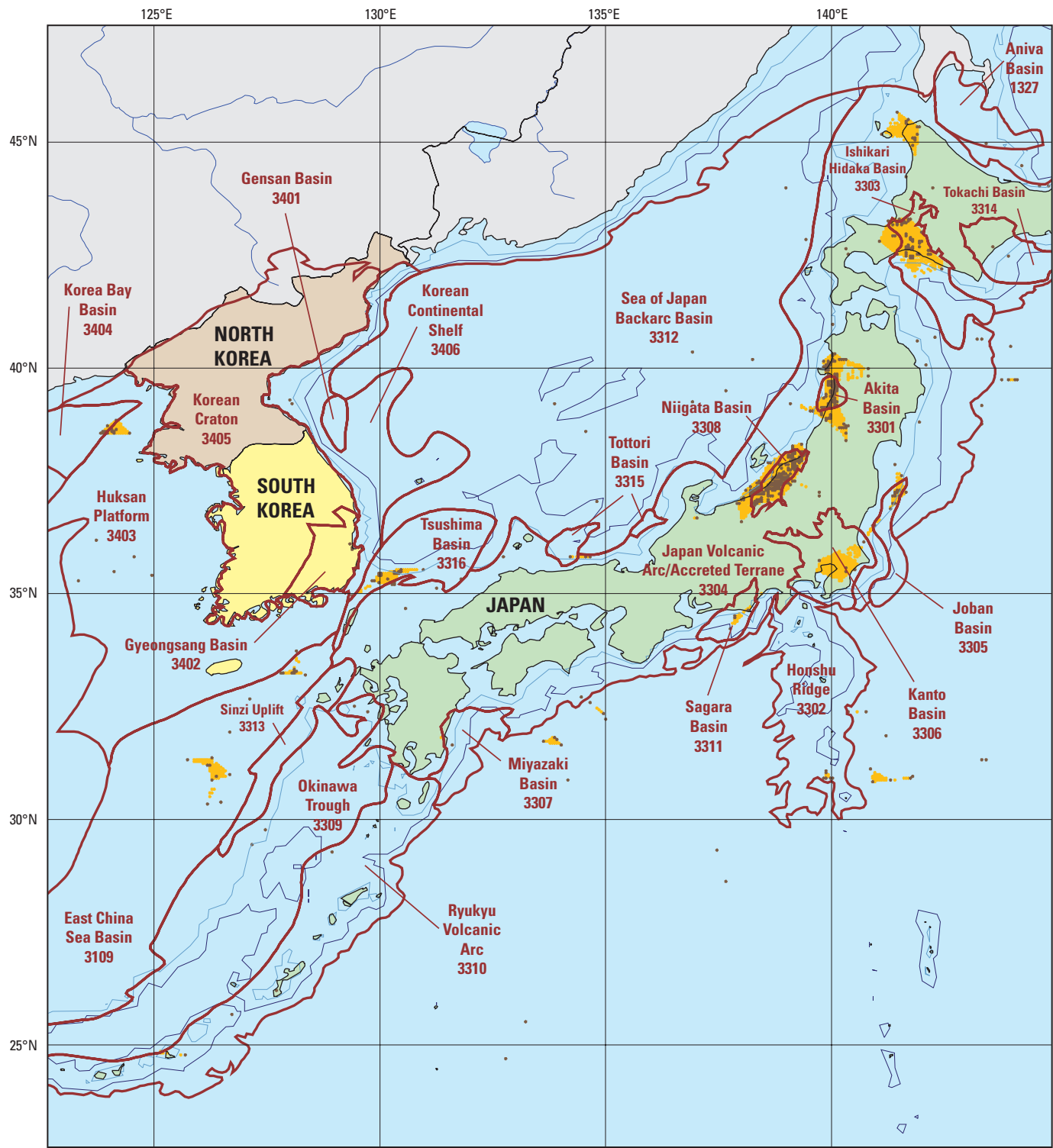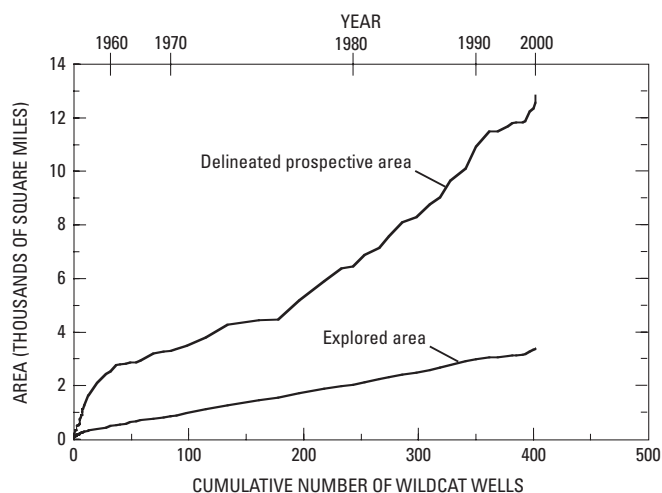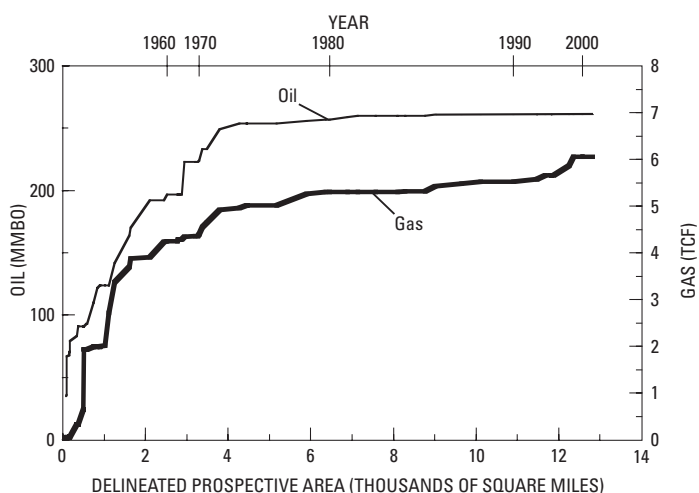
Figure 49.   Continued.

Figure 50. Map, graphs, and tables of data for oil and gas exploration through 2001 in Japan, South Korea, and North Korea.

Figure 50. Japan, South Korea, and North Korea   149

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Japan:						
Japan Volcanic Arc/Accreted Terrane, 3304	1870	0	120	87	1,564	1,651
Kanto Basin, 3306.....................................	1935	0	0	0	1,359	1,359
Niigata Basin, 3308....................................	1867	0	86	297	2,373	2,670
Total..		0	206	384	5,296	5,680
South Korea:						
Japan Volcanic Arc/Accreted Terrane, 3304	1987	0	0	0	100	100

Exploration data

Country	Land area (mi²)
Japan	145,882
South Korea............................	38,023
North Korea............................	46,541
Total	230,446

Delineated prospective area through 2001........................ 12,818 mi^2

Explored area through 2001.. 3,403 mi^2

Wildcat wells through 2001 .... 402 wells

Current growth in delineated prospective area per wildcat (for last 10 percent of wells) .... 33 mi^2/well

Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:

Oil... 261 MMBO

Gas.. 6.057 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.020 MMBO/mi^2
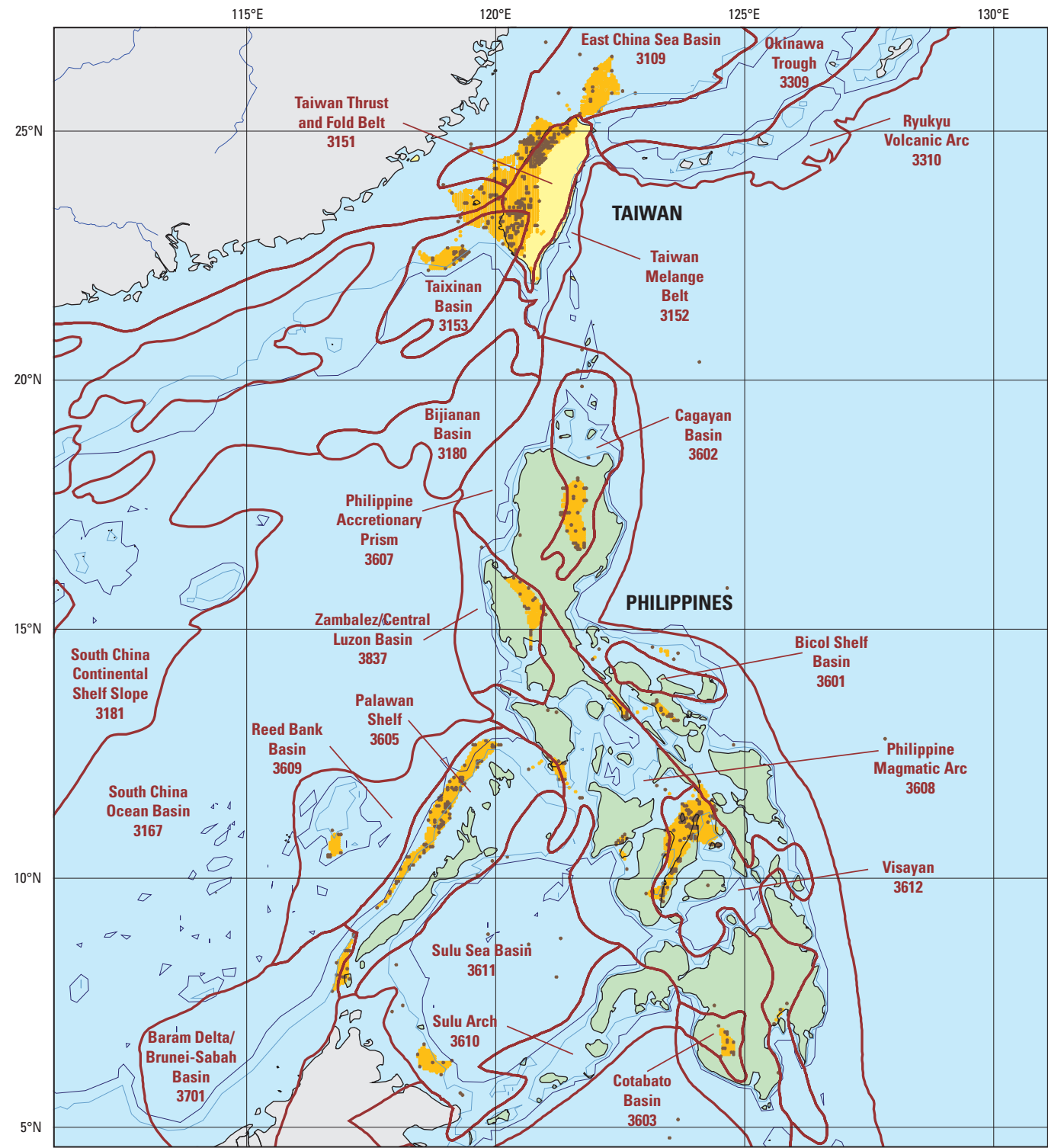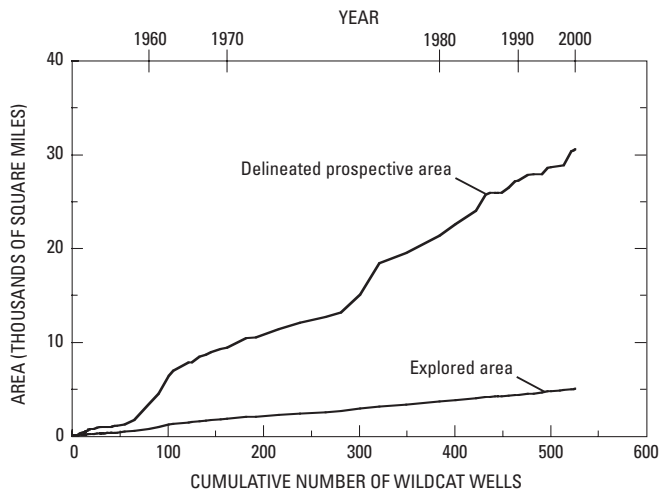
Figure 50.   Continued.

Figure 51. Map, graphs, and tables of data for oil and gas exploration through 2001 in the Philippines and Taiwan.

Figure 51. Philippines and Taiwan **151**

Growth in delineated prospective area and explored
area through 2001, graphed by the year the areas
became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces
through 2001, graphed by the year the field location
became part of the delineated prospective area
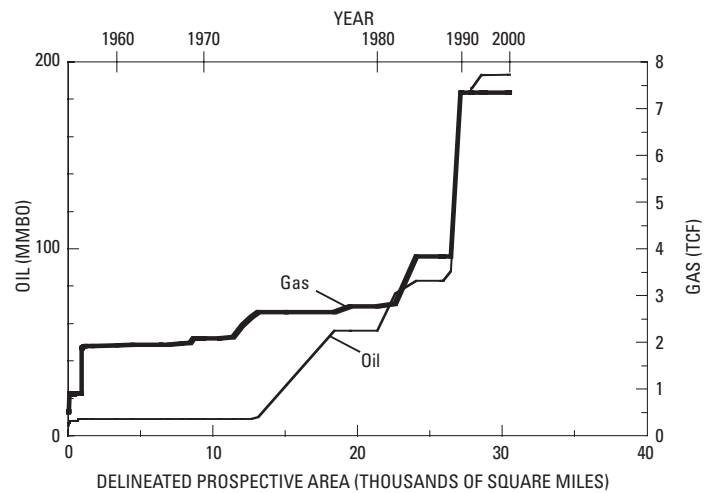
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Philippines:						
Palawan Shelf, 3605....................................	1976	0	182	36	4,539	4,575
Taiwan:						
Taiwan Thrust and Fold Belt, 3151.............	1876	0	8	0	1,941	1,941

Exploration data

Country	Land area (mi²)
Philippines.............................	115,830
Taiwan...................................	13,892
Total	129,722

Delineated prospective area through 2001........................ 30,553 mi²
Explored area through 2001.. 5,045 mi²
Wildcat wells through 2001 .... 526 wells
Current growth in delineated prospective area
per wildcat (for last 10 percent of wells) .... 55 mi²/well
Reported discoveries through 2001 of cumulative
recoverable crude oil and gas in all provinces:
Oil... 193 MMBO
Gas.. 7.341 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ .... 0.006 MMBO/mi²

Figure 51. Continued.

Figure 52.   Map, graphs, and tables of data for oil and gas exploration through 2001 in Indonesia.

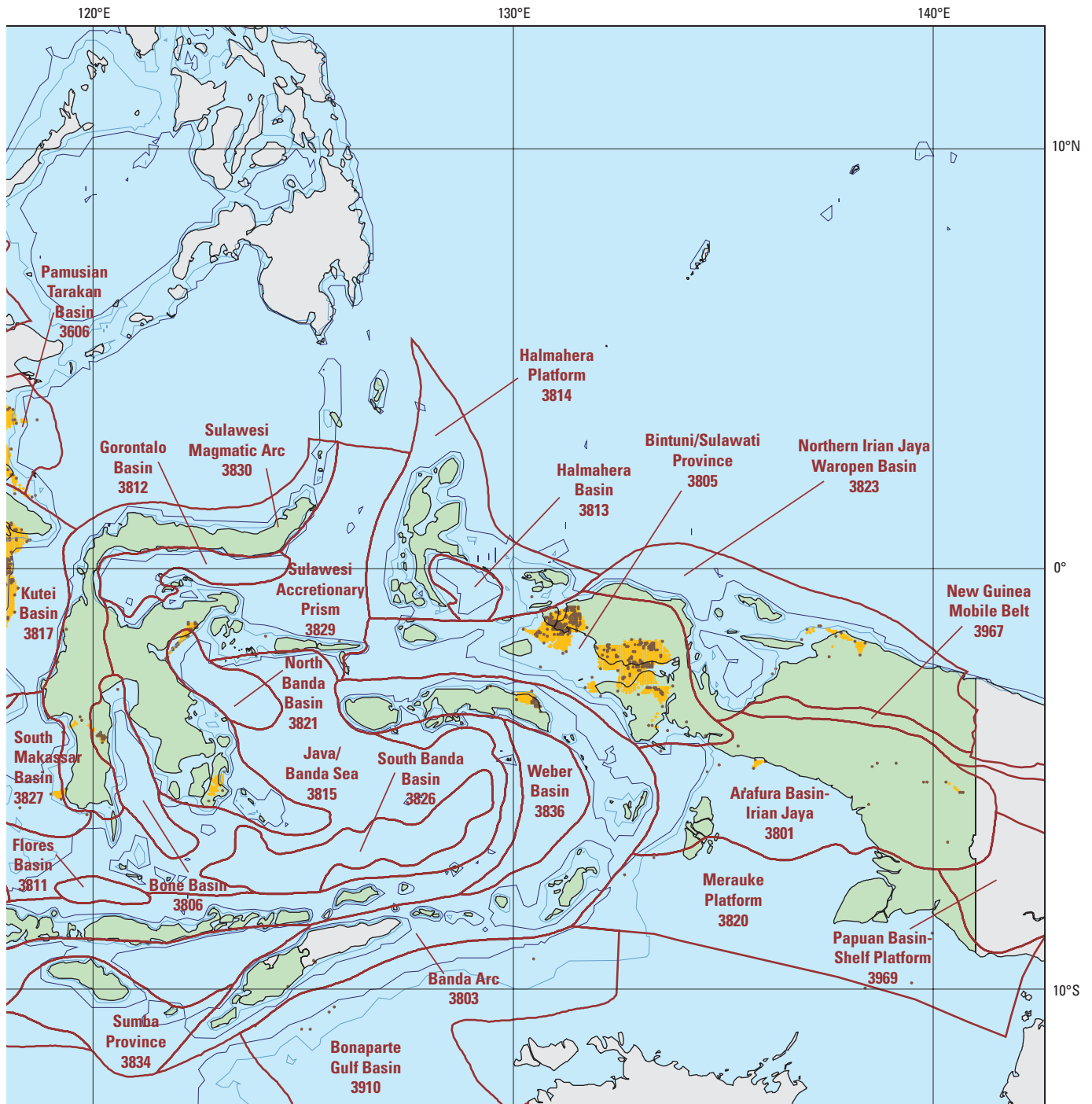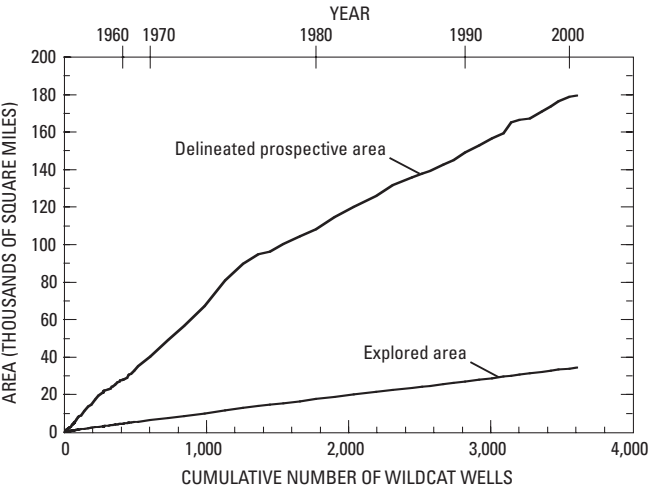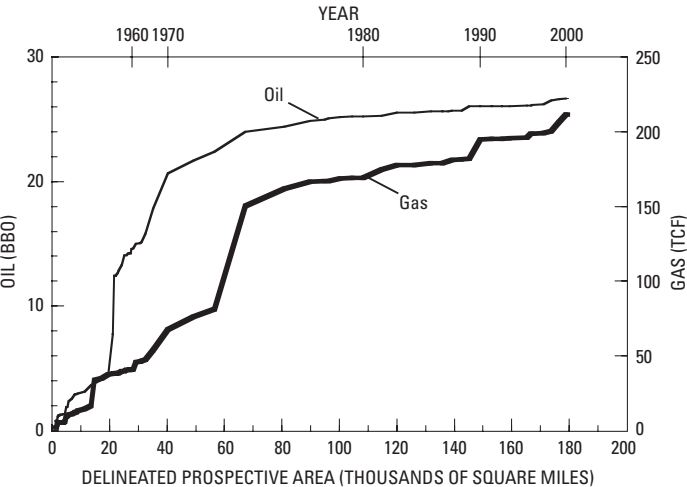**Figure 52. Indonesia** **153**

Figure 52. Continued.

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Indonesia:						
Barito Basin, 3804	1937	143	173	210	5	215
Bintuni/Sulawati Province, 3805	1936	195	504	248	19,262	19,510
Bonaparte Gulf Basin, 3910.........................	2000	0	0	0	1,800	1,800
Central Sumatra Basin, 3808	1939	10,989	13,074	1,416	693	2,109
East Java Basin, 3809...................................	1888	380	976	1,667	4,836	6,503
Greater Sarawak Basin, 3702.......................	1970	0	20	25	46,395	46,420
Kutei Basin, 3817...	1897	2,417	3,487	10,121	48,545	58,666
Malay Basin, 3703	1982	0	45	0	930	930
North Sumatra Basin, 3822..........................	1885	292	736	1,968	28,695	30,663
Northwest Java Basin, 3824.........................	1939	1,652	3,434	5,043	6,417	11,460
Pamusian Tarakan Basin, 3606	1900	350	522	814	3,429	4,243
Penyu/West Natuna Basin, 3825.................	1972	320	678	1,628	3,420	5,048
South Sumatra Basin, 3828..........................	1896	1,069	2,869	5,113	12,873	17,986
Sulawesi Accretionary Prism, 3829............	1986	0	15	0	3,791	3,791
Total..		17,807	26,533	28,253	181,091	209,344

Figure 52.   Continued.

Figure 52. Indonesia 155

Exploration data

Country	Land area (mi²)
Indonesia.........................	741,097

Delineated prospective area through 2001....................... 179,462 mi²
Explored area through 2001.. 34,465 mi²
Wildcat wells through 2001 .... 3,608 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 36 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 26.675 BBO
    Gas... 211.433 TCF

Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$ .... 0.149 MMBO/mi²
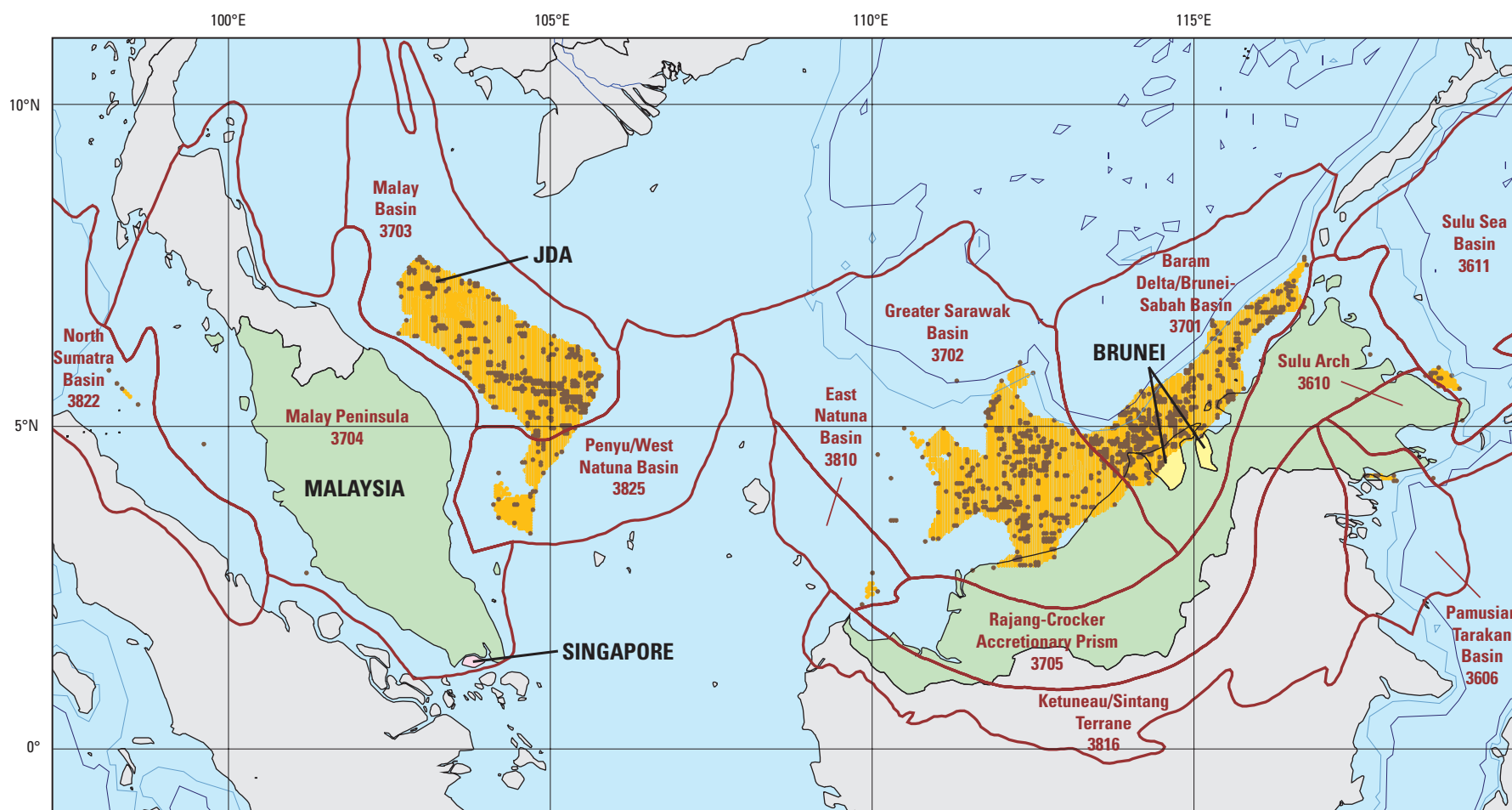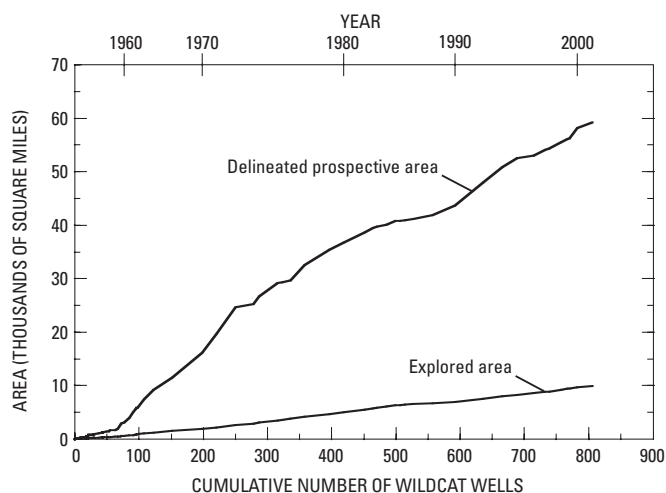
Figure 52. Continued.

Figure 53. Map, graphs, and tables of data for oil and gas exploration through 2001 in Malaysia, Brunei, and Singapore. In the table of significant provinces, discoveries in the Malaysia-Thailand Joint Development Area (JDA) are included with discoveries in the Malay Basin of Malaysia.
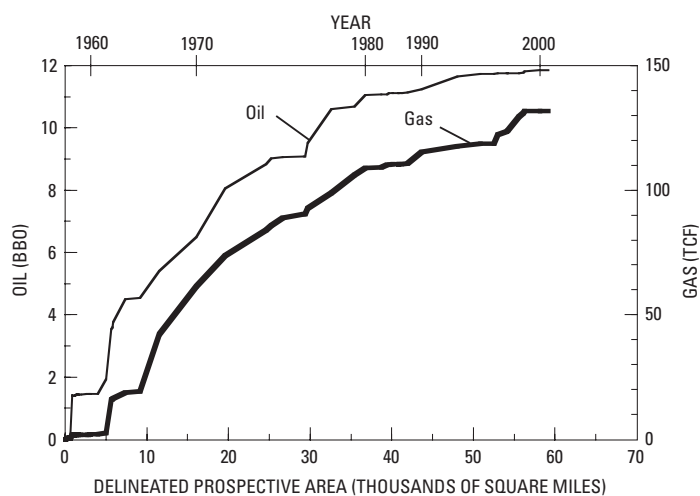
Figure 53. Continued.

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Malaysia:						
Baram Delta/Brunei-Sabah						
Basin, 3701	1910	2,449	3,292	8,411	8,245	16,656
Greater Sarawak Basin, 3702.................	1962	342	880	1,934	40,865	42,799
Malay Basin, 3703 (includes JDA)	1969	2,384	3,752	12,648	36,275	48,923
North Sumatra Basin, 3822....................	1989	0	0	0	5	5
Penyu/West Natuna Basin, 3825	1973	0	69	30	3	33
Total..		5,175	7,993	23,023	85,393	108,416
Brunei:						
Baram Delta/Brunei-Sabah						
Basin, 3701	1914	3,416	3,850	19,622	3,388	23,010

Exploration data

Country	Land area (mi²)
Malaysia...........................	127,317
Brunei...............................	2,228
Singapore	250
Total...........................	129,794

Delineated prospective area through 2001 .... 59,180 mi²
Explored area through 2001 .... 9,898 mi²
Wildcat wells through 2001 .... 806 wells
Current growth in delineated prospective area per wildcat (for last 10 percent of wells) .... 70 mi²/well
Reported discoveries through 2001 of cumulative recoverable crude oil and gas in all provinces:

    Oil... 11.848 BBO
    Gas.. 131.806 TCF
    Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ .... 0.200 MMBO/mi²

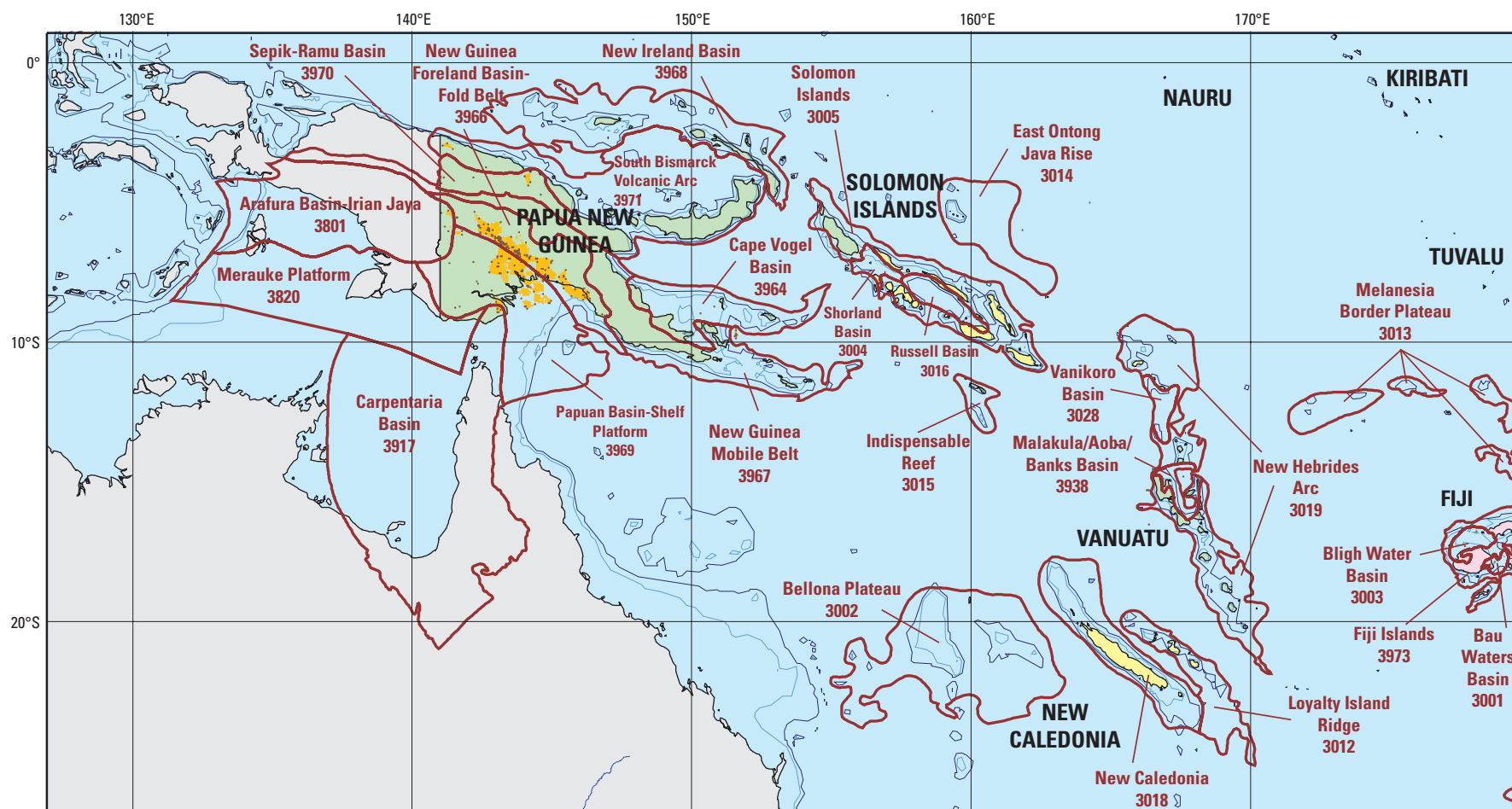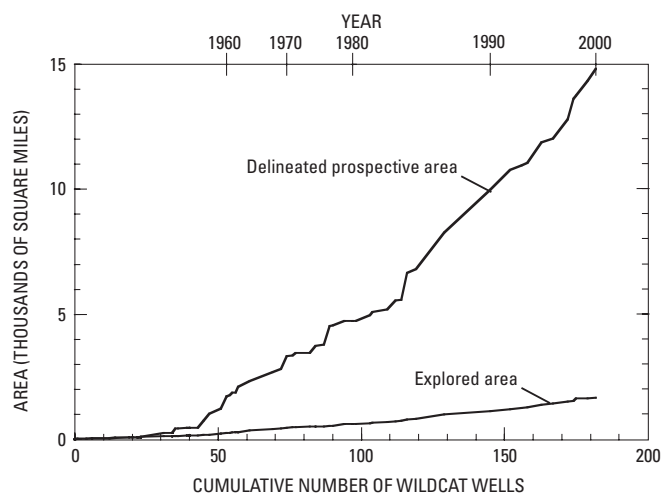**Figure 53. Malaysia, Brunei, and Singapore**

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Figure 54. Map, graphs, and tables of data for oil and gas exploration through 2001 in Papua New Guinea, Fiji, New Caledonia (an overseas territory of France), Solomon Islands, Vanuatu, French Polynesia, Guam, Marshall Islands, Micronesia, Northern Mariana Islands, and Tonga. Six of these areas have delineated prospective areas and no discoveries but are outside the limits of the map: French Polynesia, Guam, Marshall Islands, Micronesia, Northern Mariana Islands, and Tonga. For completeness, three areas are labeled on the map, although they lack petroleum exploration: Nauru, Kiribati, and Tuvalu.
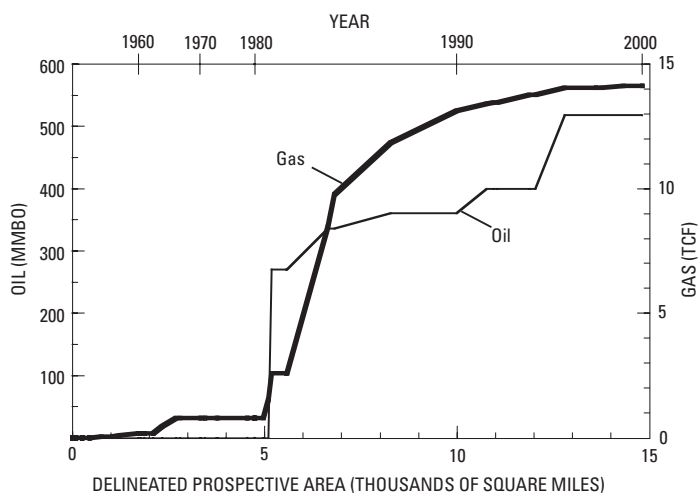
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Papua New Guinea:						
New Guinea Foreland Basin-Fold Belt, 3966..	1956	270	518	1,990	9,320	11,310
Papuan Basin-Shelf Platform, 3969	1958	0	0	0	2,740	2,740
Total..		270	518	1,990	12,060	14,050

Exploration data

Cumulative recoverable oil and gas discoveries in all provinces

through 2001, graphed by the year the field location became part of the delineated prospective area

Country	Land area (mi²)
Papua New Guinea...........	178,703
Fiji.....................................	7,054
New Caledonia.................	7,359
Solomon Islands...............	10,985
Vanuatu	4,710
French Polynesia*............	1,609
Guam*..............................	212
Marshall Islands*	70
Micronesia*......................	271
Northern Mariana Islands*	184
Tonga*..............................	289
Total	211,446

*Not shown on map.

Delineated prospective area through 2001 .... 14,819 mi²
Explored area through 2001 .... 1,672 mi²
Wildcat wells through 2001 .... 182 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 185 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 518 MMBO
    Gas... 14.125 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ ...... 0.035 MMBO/mi²
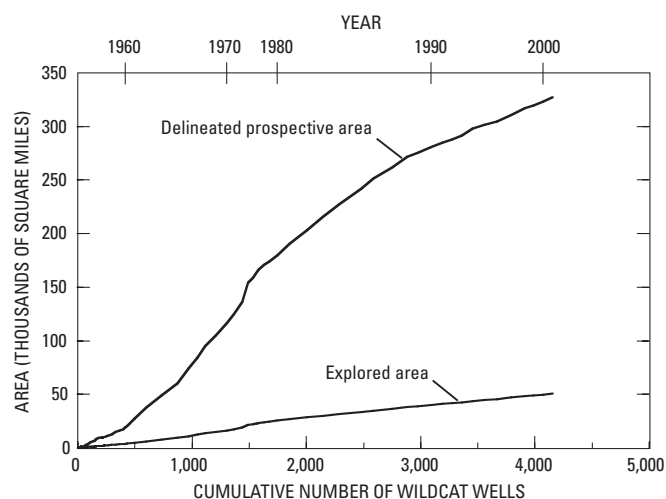
Figure 54. Continued.

Figure 54. Papua New Guinea, Fiji, and Neighboring Countries   159

Figure 55. Map, graphs, and tables of data for oil and gas exploration through 2001 in Australia and East Timor. The countries shared the Timor Gap Zone of Cooperation.

Figure 55. Australia and East Timor 161

Growth in delineated prospective area and explored

area through 2001, graphed by the year the areas became prospective or explored
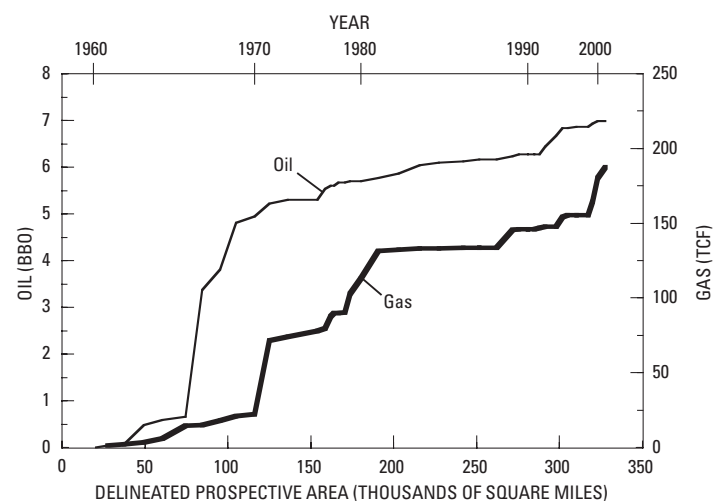
Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Australia:						
Bonaparte Gulf Basin, 3910................	1964	230	447	483	20,085	20,568
Browse Basin, 3913	1971	0	121	173	38,578	38,751
Eromanga Basin, 3924	1964	0	301	1,105	8,818	9,923
Gippsland Basin, 3930	1924	3,776	4,089	2,229	8,868	11,097
Northwest Shelf, 3948	1954	964	1,806	1,365	95,242	96,607
Total		4,970	6,764	5,355	171,591	176,946
Timor Gap Zone of Cooperation:						
Bonaparte Gulf Basin, 3910................	1974	0	109	46	4,878	4,924

Cumulative recoverable oil and gas discoveries in all provinces

through 2001, graphed by the year the field location became part of the delineated prospective area


Exploration data

Country	Land area (mi²)
Australia..........................	2,967,896
East Timor......................	5,794
Total	2,973,690

Delineated prospective area through 2001 .... 327,504 mi²
Explored area through 2001 .... 50,576 mi²
Wildcat wells through 2001 .... 4,155 wells
Current growth in delineated prospective area
   per wildcat (for last 10 percent of wells) .... 47 mi²/well
Reported discoveries through 2001 of cumulative
   recoverable crude oil and gas in all provinces:
     Oil.. 6.988 BBO
     Gas... 187.546 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ ...... 0.021 MMBO/mi²

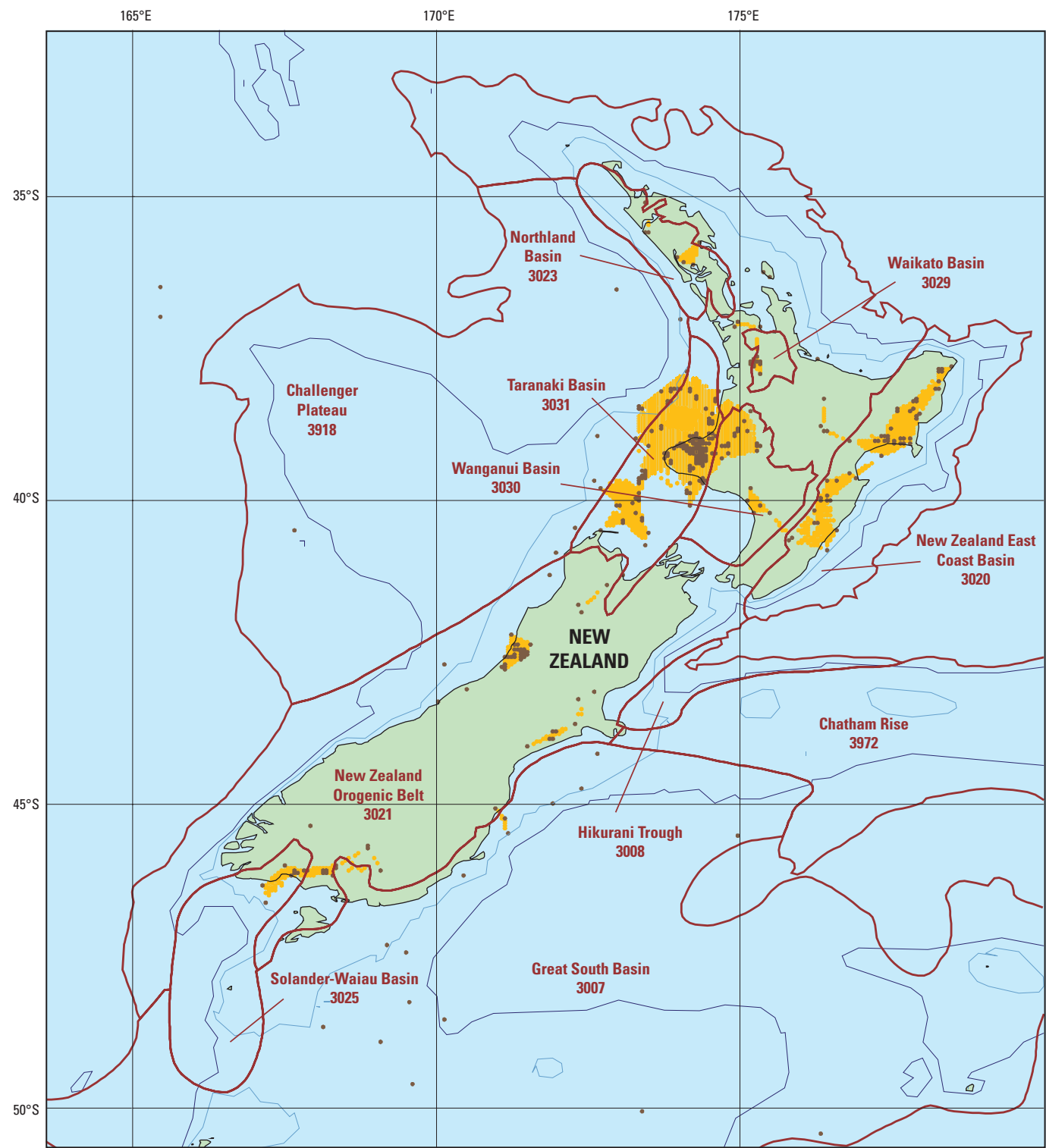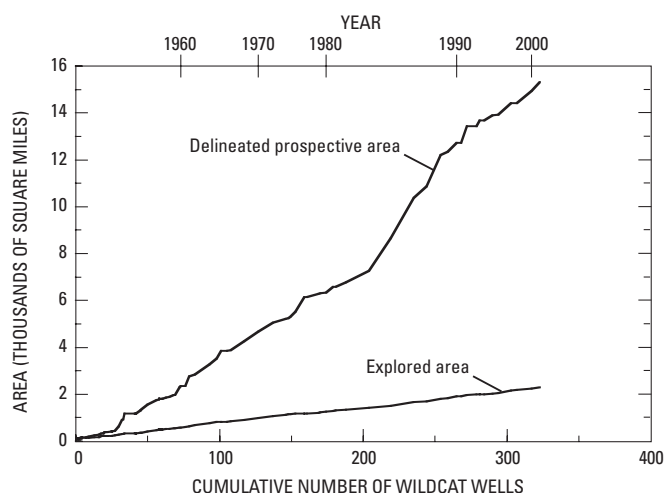**Figure 55.** Continued.

Figure 56.   Map, graphs, and tables of data for oil and gas exploration through 2001 in New Zealand.

Figure 56. New Zealand   **163**

*Growth in delineated prospective area and explored
area through 2001, graphed by the year the areas
became prospective or explored*

*Cumulative recoverable oil and gas discoveries in all provinces
through 2001, graphed by the year the field location
became part of the delineated prospective area*
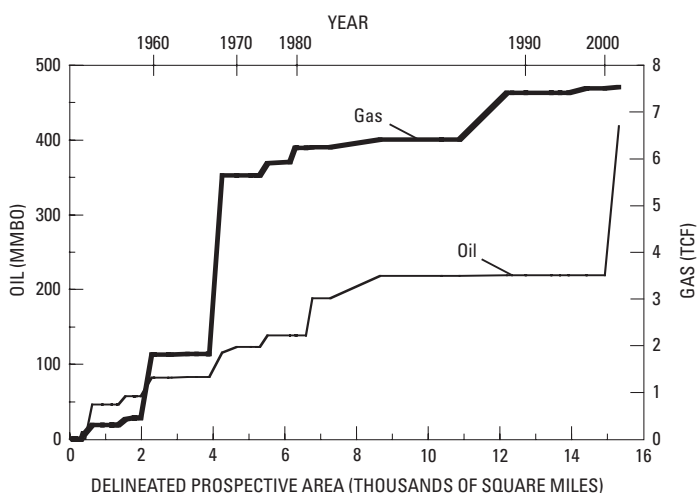
Significant petroleum province—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
New Zealand:						
Taranaki Basin, 3031...................................	1867	200	419	552	6,544	7,096

Exploration data

Country	Land area (mi²)
New Zealand	103,737

Delineated prospective area through 2001...................... 15,313 mi²
Explored area through 2001.. 2,286 mi²
Wildcat wells through 2001 .... 323 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 48 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil... 419 MMBO
    Gas.. 7.536 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}}\right)$ .... 0.027 MMBO/mi²
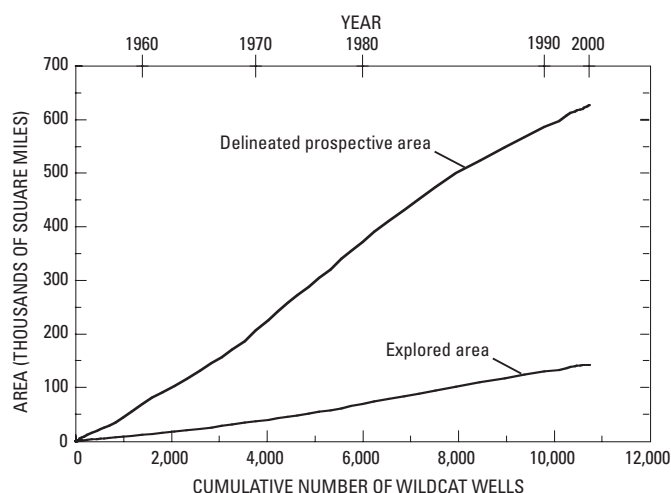
Figure 56.   Continued.

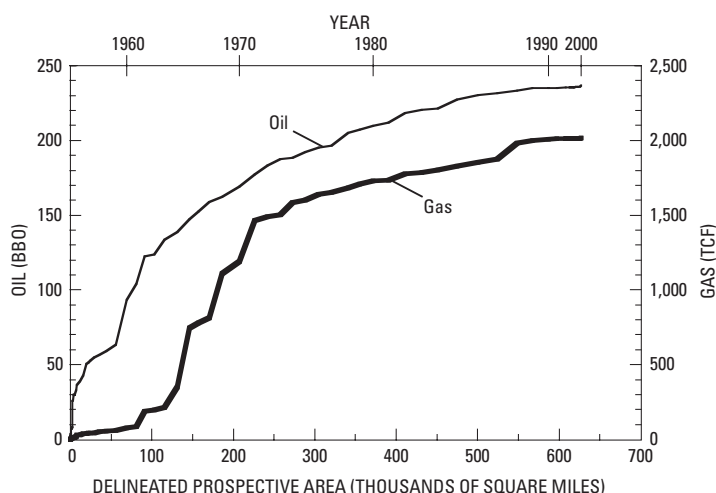*Russia in Europe (the map of Russia in Asia is on p. 166–167)*

Figure 57.   Maps, graphs, and tables of data for oil and gas exploration through 2001 in Russia. Separate maps show exploration in the part of Russia in Europe and the part of Russia in Asia. The graphs and data tables in this figure show data for all of Russia.

Figure 57. Russia   165

Growth in delineated prospective area and explored area through 2001, graphed by the year the areas became prospective or explored

Cumulative recoverable oil and gas discoveries in all provinces through 2001, graphed by the year the field location became part of the delineated prospective area

Significant petroleum provinces—Year of first discovery and cumulative recoverable oil and gas discovered through 2001

Significant petroleum province	Year of first discovery	Oil in large fields (MMBO)	Oil in all fields (MMBO)	Gas in oil fields (BCF)	Gas in gas fields (BCF)	Gas in all fields (BCF)
Russia:						
Angara-Lena Terrace, 1209..........................	1954	0	4	0	9,965	9,965
Azov-Kuban Basin, 1108............................	1864	1,068	1,929	4,770	16,317	21,087
Baykit Arch, 1207..	1974	365	442	3,211	5,213	8,424
Dnieper-Donets Basin, 1009.......................	1959	0	21	8	817	825
Lena-Vilyuy Basin, 1214	1956	0	0	0	13,763	13,763
Ludlov Saddle, 1059	1990	0	0	0	2,740	2,740
Middle Caspian Basin, 1109.......................	1893	4,933	6,727	6,840	15,450	22,290
Nepa-Botuoba Arch, 1210	1965	2,946	3,372	15,410	11,944	27,354
North Caspian Basin, 1016	1958	0	47	20	93,176	93,196
North Sakhalin Basin, 1322	1923	1,376	2,128	8,701	16,946	25,647
South Barents Basin, 1050..........................	1983	0	0	0	101,208	101,208
Timan-Pechora Basin, 1008........................	1930	9,943	13,738	6,849	34,625	41,474
Volga-Ural Region, 1015	1932	52,388	67,465	22,919	75,762	98,681
West Siberian Basin, 1174	1953	124,984	138,789	149,610	1,381,071	1,530,681
Yenisey-Khatanga Basin, 1175	1965	0	4	0	9,386	9,386
Total		198,003	234,666	218,338	1,788,383	2,006,721

Exploration data

Country	Land area (mi²)
Russia....................................	6,592,741

Delineated prospective area through 2001........................ 627,065 mi²
Explored area through 2001... 142,661 mi²
Wildcat wells through 2001 .... 10,738 wells
Current growth in delineated prospective area
  per wildcat (for last 10 percent of wells) .... 42 mi²/well
Reported discoveries through 2001 of cumulative
  recoverable crude oil and gas in all provinces:
    Oil.. 236.533 BBO
    Gas... 2,015.312 TCF
Richness $\left(\dfrac{\text{total oil discoveries}}{\text{total delineated prospective area}} \right)$.......... 0.377 MMBO/mi²

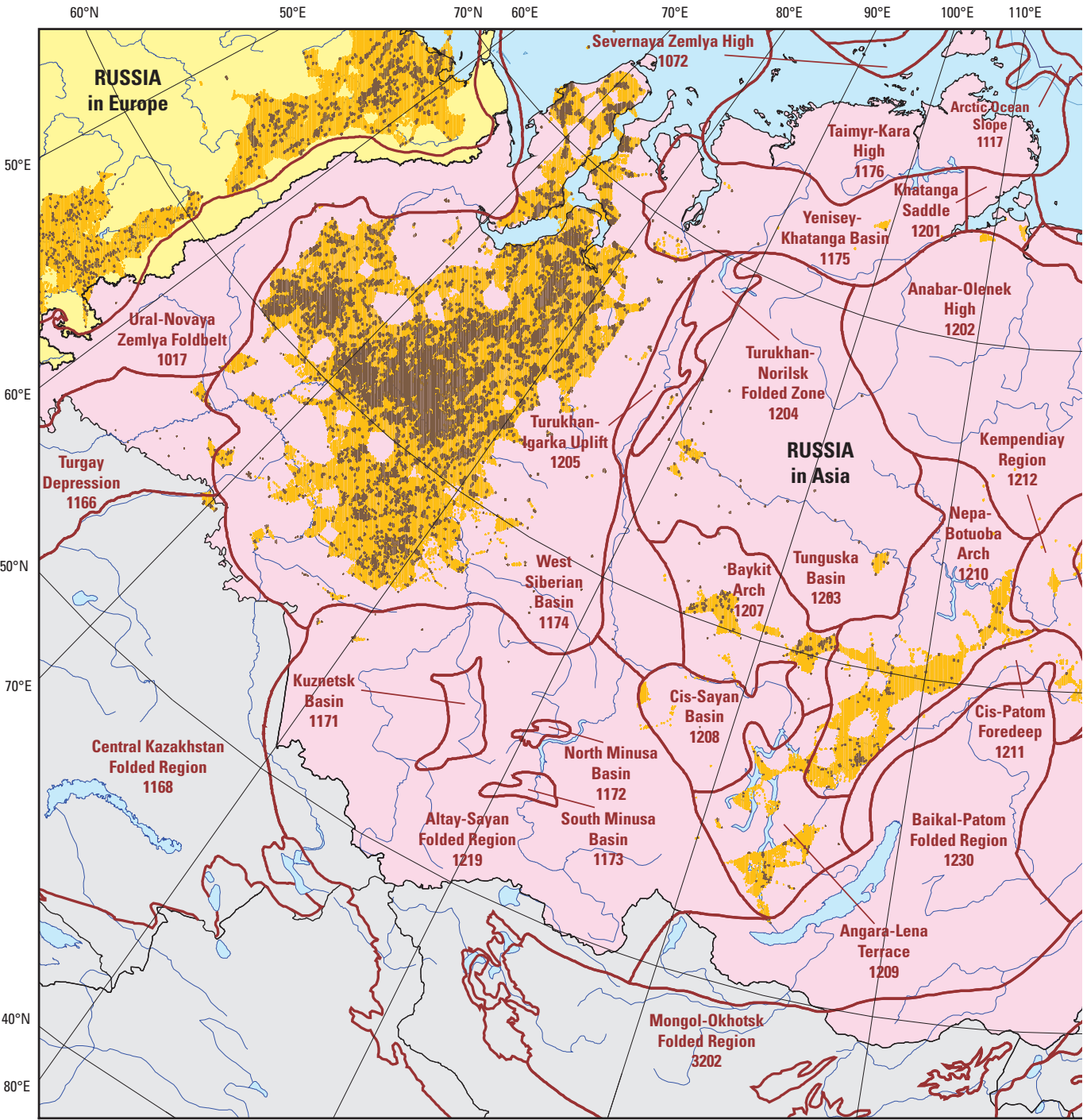**Figure 57.**   Continued.

Russia in Asia

Figure 57.   Continued.

Figure 57. Russia   167

Russia in Asia—Continued

Figure 57. Continued.