

1995 National Assessment of United States Oil and Gas Resources

Assessment of the Pacific Outer Continental Shelf Region

EXECUTIVE SUMMARY

This report documents an assessment of the undiscovered oil and gas resources of the Pacific Outer Continental Shelf (OCS) Region of the United States (i.e., the Federal offshore areas of Washington, Oregon, and California). The assessment was performed as part of a national assessment of undiscovered oil and gas resources—in which the onshore and State offshore areas of the Nation were assessed by the U.S. Geological Survey (USGS) and the Federal offshore areas of the Nation were assessed by the Minerals Management Service (MMS)—in order to develop an updated appraisal of the location and volume of undiscovered resources.

The commodities that have been assessed consist of *oil* (including crude oil and condensate) and *natural gas* (including associated and nonassociated gas). Two categories of undiscovered resources have been assessed: *undiscovered conventionally recoverable resources* are those that can be removed from the subsurface with conventional extraction techniques; *undiscovered economically recoverable resources* are those undiscovered conventionally recoverable resources that can be extracted profitably under specified economic and technological conditions. Additionally, the *total resource endowment*—consisting of the sum of discovered and undiscovered resources—has been estimated.

The assessment of the Pacific OCS Region was performed by a team of MMS geoscientists in Camarillo, California, using a large volume and variety of proprietary and nonproprietary data (including geological, geochemical, geophysical, petroleum engineering, and economic data) available as of January 1, 1995. Data and interpretations from many of the nearly 1,100 wells and 200,000 miles of seismic-reflection profiles in the Region were used for the assessment.

For this assessment, the Region was subdivided into six assessment provinces: Pacific Northwest, Central California, Santa Barbara-Ventura Basin, Los Angeles Basin, Inner Borderland, and Outer Borderland (see front cover). The provinces encompass 21 geologic basins and areas in which sediments accumulated and hydrocarbons may have formed. Fifty *petroleum geological plays* (groups of geologically related hydrocarbon accumulations) have been defined and described in 13 assessment areas, and 46 of these plays have been formally assessed.

The principal procedural components of the assessment consisted of *petroleum geological analysis* to ascertain the areal and stratigraphic extent of potential petroleum source rocks, reservoir rocks, and traps; *play definition and analysis* to identify and describe the properties of plays; and *resource estimation* to develop estimates of the volume of undiscovered oil and gas resources, and the total resource endowment. Estimation of the volume of undiscovered conventionally recoverable resources was performed for each play by developing a pool-size distribution (describing the number and size of discrete hydrocarbon accumulations) of the play and statistically aggregating the estimated volume of resources in the undiscovered pools; estimates of undiscovered conventionally recoverable resources are expressed as probability

distributions to reflect their uncertainty. Estimation of the volume of undiscovered economically recoverable resources was performed for each assessment area by developing a field-size distribution (describing the number and size of fields, which may consist of multiple pools), and mathematically simulating the exploration and development of the area to determine the volume of undiscovered conventionally recoverable resources that can be extracted profitably; estimates of undiscovered economically recoverable resources are expressed as mean values for a range of economic scenarios. Estimation of the total resource endowment was performed by adding the estimated volume of discovered resources (from other studies) and the mean estimated volume of undiscovered conventionally recoverable resources from this assessment.

The total volume of undiscovered conventionally recoverable oil resources (including crude oil and condensate) of the Region as of January 1, 1995, is estimated to range from 9.0 to 12.6 Bbbl with a mean estimate of 10.7 Bbbl. Relatively large volumes of these oil resources (greater than 1 Bbbl) are estimated to exist in the Point Arena basin, Santa Barbara-Ventura basin, Bodega basin, and Oceanside-Capistrano basin. The total volume of undiscovered conventionally recoverable gas resources (including associated and nonassociated gas) in the Region is estimated to range from 15.2 to 23.2 Tcf with a mean estimate of 18.9 Tcf. Relatively large volumes of these gas resources (greater than 1 Tcf) are estimated to exist in the Santa Barbara-Ventura basin, Washington-Oregon area, Point Arena basin, Eel River basin, Bodega basin, Oceanside-Capistrano basin, and Cortes-Velero-Long area. Major contributors of undiscovered conventionally recoverable oil and gas resources are frontier and conceptual plays (in which hydrocarbon accumulations have not yet been discovered), oil plays (containing predominantly crude oil and associated gas), and plays having fractured siliceous reservoir rocks (e.g., Monterey Formation).

The total volume of undiscovered conventionally recoverable resources of the Region that is estimated to be economically recoverable at economic and technological conditions as of January 1, 1995 (i.e., at prices of \$18 per bbl of oil and \$2.11 per Mcf of gas), is 5.3 Bbbl of oil and 8.3 Tcf of gas (mean estimates). These resources include relatively large volumes of oil (greater than 1 Bbbl) and gas (greater than 1 Tcf) in the Santa Barbara-Ventura basin and Bodega basin. Larger volumes of resources are estimated to be economically recoverable at more favorable economic conditions.

The total resource endowment of the Region is estimated to be 12.8 Bbbl of oil and 22.1 Tcf of gas (mean estimates). This estimated endowment is composed of 2.1 Bbbl and 3.1 Tcf of discovered resources (including 680 MMbbl and 740 Bcf of cumulative production and 1.4 Bbbl and 2.4 Tcf of remaining reserves) and 10.7 Bbbl and 18.9 Tcf of undiscovered conventionally recoverable resources. Undiscovered resources are estimated to compose a major portion (approximately 85 percent on the basis of mean estimates) of the total oil and gas resource endowment of the Region.

Estimates of the volume of undiscovered conventionally recoverable oil and gas resources in the Region from this assessment are larger than estimates from previous MMS assessments, due primarily to the use of significantly different methodology and some additional data for this assessment. The increased estimates of the volume of undiscovered economically recoverable oil and gas resources in the Region from this assessment are attributed to the increased estimated volume of undiscovered conventionally recoverable resources.