STRATIGRAPHIC DISTRIBUTION OF UNDISCOVERED OIL AND GAS RESOURCES IN THE CALIFORNIA OUTER CONTINENTAL SHELF

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INTRODUCTION

The Federal offshore area of California (the California Outer Continental Shelf, or OCS) is estimated to contain a large volume of undiscovered oil and gas resources based on an assessment by the Minerals Management Service (Dunkel and Piper 1997). The resources are estimated to exist in a variety of petroleum reservoir rocks (strata in which oil and gas accumulate) in many petroleum geologic plays (groups of geologically related accumulations) and assessment areas (groups of plays). Because plays are the basic unit for assessing undiscovered oil and gas, and most of the plays are defined on the basis of their reservoir-rock stratigraphy (the geologic age and lithology of strata), they provide a framework for understanding the stratigraphic distribution of the undiscovered resources and the petroleum potential of different reservoir rocks.

UNDISCOVERED RESOURCES

Approximately 10.4 billion barrels (Bbbl) of undiscovered oil and 16.6 trillion cubic feet (Tcf) of undiscovered gas are estimated to exist in the California OCS (risked mean estimates[1]). These resources, which may be outside and within known accumulations and can be recovered with conventional extraction techniques, are estimated to exist in 42 plays in 12 assessment areas.

The undiscovered oil resources include crude oil with a gravity greater than 10 °API and condensate (natural gas liquids). The undiscovered gas resources include associated gas (gas that exists in spatial association with oil) and nonassociated gas. Reservoir rocks in all plays in the California OCS are expected to contain oil and associated gas; some plays are also expected to contain nonassociated gas.

RESERVOIR ROCKS

Age and Lithology

The reservoir rocks in which undiscovered oil and gas may exist in the California OCS range in age from Cretaceous to Pleistocene (70 to 1 million years (Ma))[2], are primarily of marine sedimentary origin, and include a variety of lithologies (rock types). Although all of the plays in the California OCS include more than one lithology, the predominant lithology of reservoir rocks in most plays is either clastic or fractured siliceous.

Clastic reservoir rocks are composed of grains or fragments of sediment (clasts) that are bound together and in which petroleum generally accumulates in intergranular spaces. In the California OCS, clastic reservoir rocks include sandstone, siltstone, shale, and breccia; they range in age from Cretaceous to Pleistocene and are geographically widespread.

Fractured siliceous reservoir rocks include biochemically precipitated rocks and fine-grained clastic rocks that are very hard, dense, and brittle, and in which petroleum generally accumulates in cracks and fractures. In the California OCS, fractured reservoir rocks include biochemical rocks composed of siliceous minerals (chert and porcelanite) and carbonate minerals (limestone and dolomite), and fine-grained rocks with siliceous components (siliceous shale). Fractured siliceous rocks in the California OCS range in age from early to late Miocene (25 to 5 Ma) and exist in select areas.

Stratigraphic Groups

Reservoir rocks in the California OCS can be subdivided into three stratigraphic groups on the basis of their

[1]The estimates reflect the probability (risk) that petroleum does not exist and correspond to the statistical average (mean) value of a range of values in a probability distribution.

[2]The geologic ages of rocks (expressed in years) are approximate values and do not reflect precise absolute ages.

age and predominant lithology: Neogene clastic, Neogene fractured siliceous, and Paleogene-Cretaceous clastic.

Rocks of the Neogene clastic group consist primarily of Miocene and Pliocene (25 to 2 Ma) sandstone, siltstone, shale, and breccia; however, some rocks included in this group are as old as Cretaceous (more than 65 Ma) or as young as Pleistocene (less than 2 Ma). Neogene clastic rocks exist in all assessment areas of the California OCS and comprise 22 plays.

Rocks of the Neogene fractured siliceous group consist of Miocene chert, siliceous shale, porcelanite, dolomite, and limestone. They exist in eight assessment areas in the central and southern California OCS, and comprise nine plays.

Rocks of the Paleogene-Cretaceous clastic group consist primarily of Cretaceous to Oligocene (70 to 25 Ma) sandstone, siltstone, and shale; however, some rocks included in this group are as young as middle Miocene (less than 15 Ma). Paleogene-Cretaceous clastic rocks exist in ten assessment areas of the California OCS and comprise 11 plays.

RESOURCE DISTRIBUTION

The estimated volume of undiscovered oil and gas resources in reservoir rocks of each stratigraphic group in the California OCS is listed in Table 1.

Oil

The largest aggregate volume of undiscovered oil (5.96 Bbbl) is estimated to exist in Neogene fractured siliceous rocks. This volume is far more than in Neogene clastic rocks (3.11 Bbbl) and in Paleogene-Cretaceous clastic rocks (1.29 Bbbl), and more than in all clastic rocks combined (4.40 Bbbl). Although only nine plays have Neogene fractured siliceous rocks, they are estimated to contain more than one half of all the undiscovered oil. Neogene fractured siliceous rocks are also estimated to contain the largest individual (play-specific) volumes of undiscovered oil; five plays having these rocks are each estimated to contain more than 500 million barrels. Plays having Neogene clastic and Paleogene-Cretaceous clastic rocks are estimated to have smaller individual volumes of undiscovered oil.

Gas

The largest aggregate volume of undiscovered gas (6.73 Tcf) is estimated to exist in Neogene clastic rocks. This volume is slightly more than in Neogene fractured siliceous rocks (6.32 Tcf) and is far more than in Paleogene-Cretaceous clastic rocks (3.59 Tcf). Large individual volumes of undiscovered gas (more than 500 billion cubic feet) are estimated to exist in plays of all three stratigraphic groups; however, more plays having Neogene fractured siliceous and Neogene clastic rocks are estimated to have large individual volumes.

The volumetric proportion of gas to oil varies among the plays of each stratigraphic group; however, some general distinctions among the groups provide insight regarding their relative gas potential. Nonassociated and associated gas are expected to exist in Neogene clastic and Paleogene-Cretaceous clastic rocks in six plays. The proportion of gas to oil in these rocks is relatively high (more than 4,000 cubic feet (cf) of gas per barrel (bbl) of oil). Associated gas (without nonassociated gas) is expected to exist in rocks of all stratigraphic groups in 36 plays. The proportion of gas to oil in these rocks varies significantly, but is generally greater in Paleogene-Cretaceous clastic rocks (1,400 to 3,000 cf per bbl) than in Neogene clastic rocks (400 to 2,700 cf per bbl) and in Neogene fractured siliceous rocks (900 to 1,300 cf per bbl).

CONCLUSIONS

Neogene fractured siliceous rocks have the greatest potential for undiscovered oil in the California OCS, and are estimated to contain more than one half of the undiscovered oil and more than one third of the undiscovered gas (all

Table 1. Estimates of undiscovered oil and gas resources in the California Outer Continental Shelf, by stratigraphic group of reservoir rocks. All estimates are risked mean values.

Stratigraphic Group (Primary Reservoir Rocks)	Number of Plays	Oil		Gas	
		Bbbl	(%)	Tcf	(%)
Neogene Clastic[a] (Miocene and Pliocene sandstone, siltstone, shale, and breccia)	22	3.11	(30.1)	6.73	(40.4)
Neogene Fractured Siliceous (Miocene chert, siliceous shale, porcelanite, dolomite, and limestone)	9	5.96	(57.5)	6.32	(38.0)
Paleogene-Cretaceous Clastic (Cretaceous to Oliogcene sandstone, siltstone, and shale)	11	1.29	(12.4)	3.59	(21.6)
Total[a]	42	10.36	(100.0)	16.64	(100.0)

[a] Includes a small area and volume of resources in the Federal offshore area of southernmost Oregon.

of which is associated gas). Neogene clastic rocks have the greatest gas potential, and are estimated to contain nearly one half of the undiscovered gas (associated and nonassociated gas) and nearly one third of the undiscovered oil. Paleogene-Cretaceous clastic rocks have appreciably less oil and gas potential than the Neogene rocks; however, the relative proportion of gas (associated and nonassociated gas) to oil in these rocks is generally greater than in the Neogene rocks.

LITERATURE CITED

Dunkel, C. A. and K. A. Piper (eds.). 1997. 1995 National Assessment of United States Oil and Gas Resources—Assessment of the Pacific Outer Continental Shelf Region. OCS Report MMS 97-0019. Minerals Management Service, Camarillo, California.

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