# OCEANSIDE-CAPISTRANO BASIN

by Frank W. Victor

## LOCATION

The Oceanside-Capistrano Basin assessment area is the southernmost area in the Inner Borderland province (fig. 93). Most of the basin is located offshore; however, a small, partly exhumed portion of the basin exists onshore near Dana Point (fig. 105). This onshore area of the basin is referred to as the Capistrano syncline; it is bounded on the north by the Coast Ranges and extends about 10 miles in width from the San Joaquin Hills eastward to a generally north-south-trending boundary along which Cretaceous strata are exposed in outcrop. Offshore, the basin is bounded on the northwest by the Dana Point sill and extends southerly about 50 miles to the vicinity of La Jolla; it is bounded to the west by the Thirtymile bank and extends about 30 miles east into State waters. The entire basin is about 50 miles long and averages 30 miles in width and occupies an area of about 1,500 square miles. Water depth in the basin ranges from 0 (coastline) to about 3,000 feet.

Although the majority of the assessment area is in the Federal offshore area (which is the focus of this study), it includes some adjacent State offshore and onshore areas (fig. 105). These adjacent areas were included in this study to facilitate their assessment, which was based in part on information from the Federal offshore area.

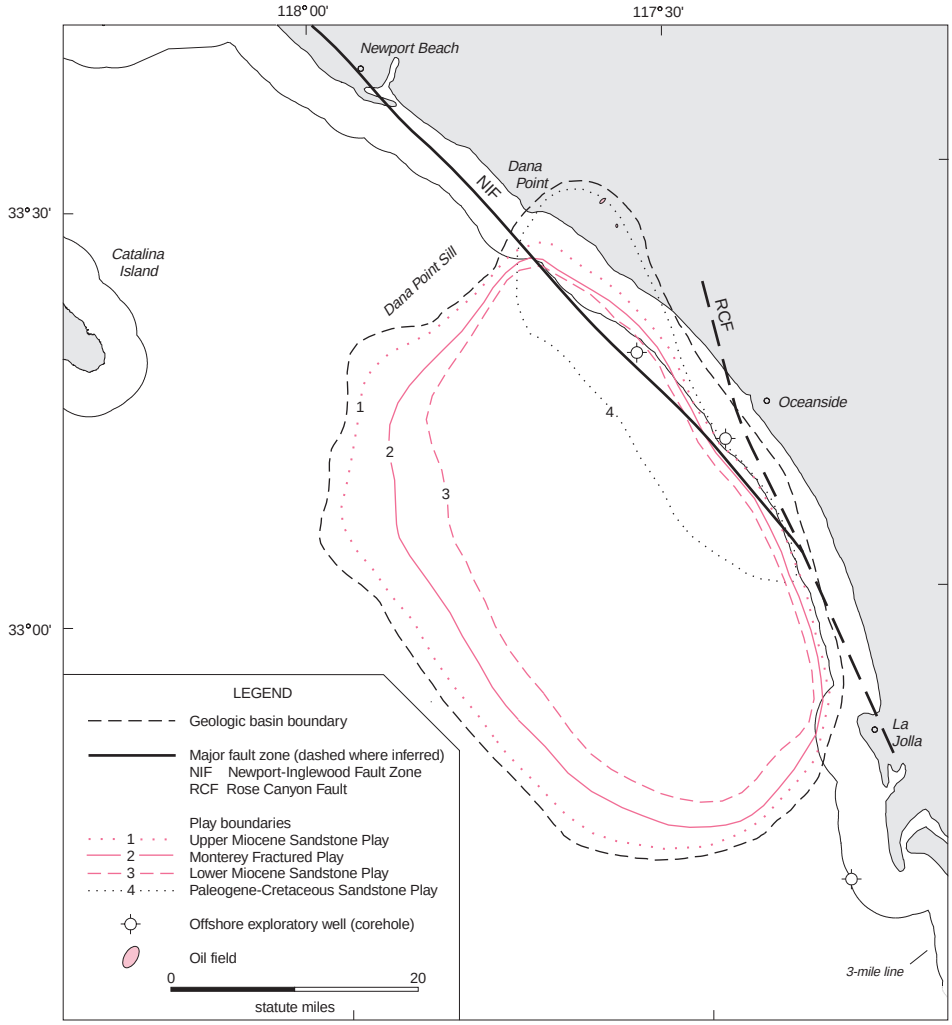


**Figure 105.** *Map of the Oceanside-Capistrano Basin assessment area showing petroleum geologic plays, offshore wells, and fields.*

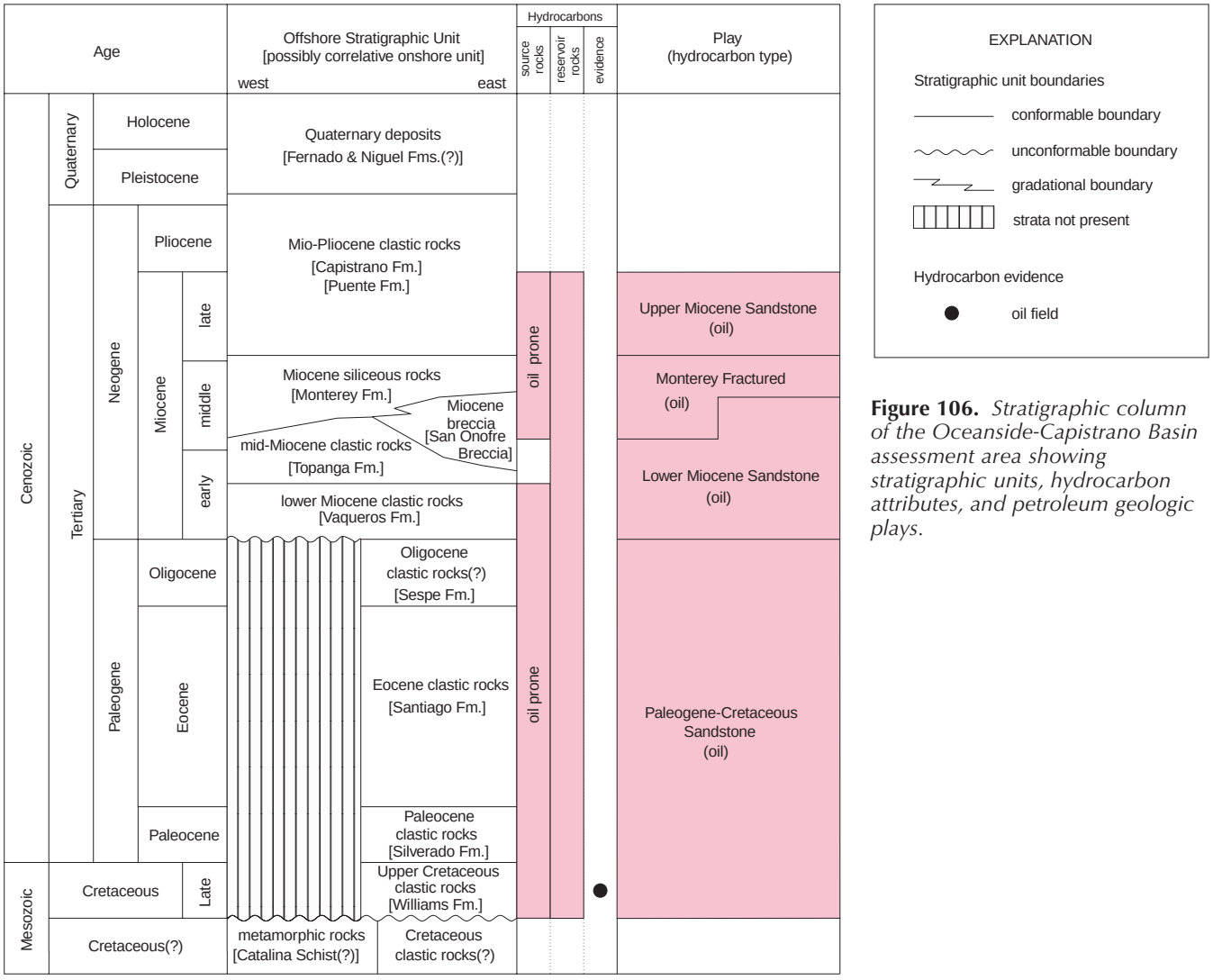


**Figure 106.** *Stratigraphic column of the Oceanside-Capistrano Basin assessment area showing stratigraphic units, hydrocarbon attributes, and petroleum geologic plays.*

## GEOLOGIC SETTING

The Oceanside-Capistrano basin is an asymmetrical structural trough filled with up to 11,000 feet of Cretaceous and Tertiary marine and nonmarine rocks (fig. 106). The northwest-trending Newport-Inglewood fault zone lies offshore near the eastern margin of the basin (fig. 105); the fault has been a major feature in the tectonic and structural evolution of the basin. Large, compressional, fault-bounded anticlines, faulted homoclines, and stratigraphic pinchouts west of the fault zone are evident on seismic-reflection profiles. Most of these structures are located in the Federal offshore area, but a few extend into the State offshore area; these structures are numerous and large enough to contain significant quantities of oil and gas. The Newport-Inglewood structural trend has major petroleum significance in the Oceanside-Capistrano basin since this is the same fault and structural trend along which several prolific oil fields exist in the onshore Los Angeles basin.

The Capistrano syncline is a flat-bottomed, north-south-trending structural trough formed by downwarping of the eastern part of the San Joaquin Hills on the west and down-to-the-west displacement of the Cristianitos fault zone on the east. The syncline is separated from the Los Angeles basin proper by the structurally high San Joaquin Hills and its northward extension into the subsurface. Up to 3,700 feet of middle and upper Miocene marine rocks overlie schist breccia and Paleogene and Cretaceous strata within the syncline (Wright, 1991).

## EXPLORATION

Exploration within the offshore part of the basin has been limited. Only two boreholes (the Mobil San Clemente #1 and Shell Oceanside #1 coreholes) have

been drilled offshore. The coreholes were drilled as stratigraphic tests in the 1960's and did not encounter any oil or gas. The Mobil San Clemente corehole penetrated Pliocene and Miocene rocks (presumably of the Capistrano and Monterey Formations, and the San Onofre Breccia). The Shell Oceanside corehole penetrated Pliocene rocks (presumably of the Capistrano Formation). No deep exploratory wells have been drilled in the basin.

A number of high-quality seismic-reflection surveys have been recorded offshore. Many of the profiles from these surveys extend into State waters.

Onshore, more than 60 exploratory wells have been drilled from the early 1950's to 1984. Two fields—the San Clemente and Cristianitos Creek fields—have been discovered. Collectively, these fields produced a very small quantity (less than 5 Mbbl) of high-gravity (45 to 54 °API) oil from the Upper Cretaceous Williams Formation in the late 1950's. Both fields were considered to be subcommercial and have been abandoned. One of the last wells was drilled in 1981 as an extension to the San Clemente field, and it was dry.

## PLAYS

Four petroleum geologic plays within the basin have been defined; the plays are defined on the basis of reservoir rock stratigraphy (fig. 106). The plays (and corresponding reservoir rock formations) are (1) the Upper Miocene Sandstone play (Capistrano Formation), (2) the Monterey Fractured play (Monterey Formation), (3) the Lower Miocene Sandstone play (San Onofre Breccia and Topanga and Vaqueros Formations), and (4) the Paleogene-Cretaceous Sandstone play (Williams, Silverado, Santiago, and Sespe(?) Formations).

The Upper Miocene Sandstone, Monterey Fractured, and Lower Miocene Sandstone plays are restricted to the offshore area of the basin; these plays are considered to be conceptual plays based on the absence of directly detected hydrocarbons. The Paleogene-Cretaceous Sandstone play exists onshore and offshore and is an established play because hydrocarbon accumulations have been discovered in the play onshore.

## RESOURCE ESTIMATES

### Undiscovered Conventionally Recoverable Resources

Play-specific estimates of undiscovered conventionally recoverable resources have been developed using the subjective assessment method, and these estimates have been statistically aggregated to estimate the total volume of resources in the assessment area. Select data used to develop the resource estimates are shown in appendix C. Estimates of the volume of resources in the Federal offshore, State offshore, and onshore portions of each play were subsequently calculated using a subjective area-proportionality factor, and the area-specific play estimates have been summed to estimate the total volume of resources in the respective portions of the assessment area.

As a result of this assessment, the total volume of undiscovered conventionally recoverable resources in the Oceanside-Capistrano Basin assessment area is estimated to be 1.11 Bbbl of oil and 1.30 Tcf of associated gas (mean estimates). This volume may exist in 51 fields with sizes ranging from approximately 95 Mbbl to 450 MMbbl of combined oil-

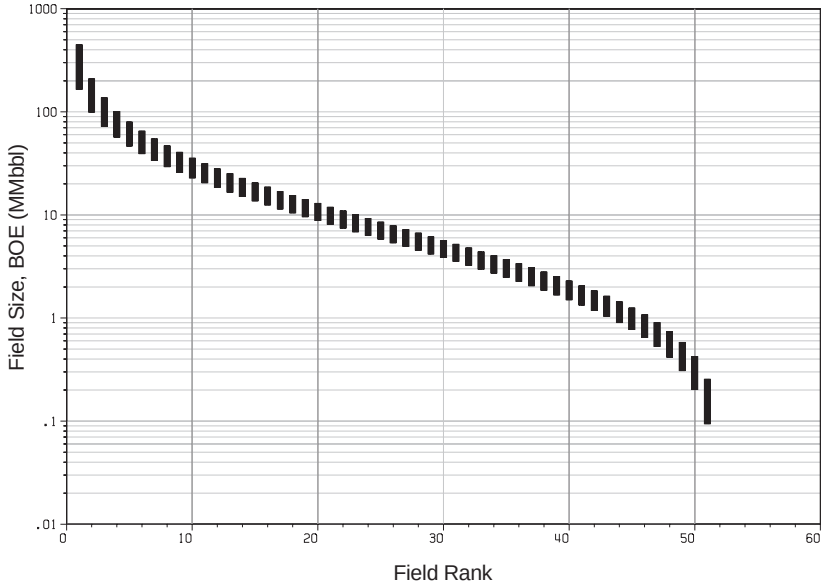


**Figure 107.** *Field-size rank plot of estimated undiscovered conventionally recoverable resources of the Oceanside-Capistrano Basin assessment area. Sizes of undiscovered fields are shown by bars; the top and bottom of a bar represent the 25th- and 75th-percentile value of a probability distribution, respectively.*

equivalent resources (fig. 107). The low, mean, and high estimates of resources in the assessment area are listed in table 36 and illustrated in figure 108.

The Federal offshore portion of the assessment area is expected to contain the majority of these fields and resources, or approximately 1.07 Bbbl of oil and 1.25 Tcf of associated gas (table 37). The State offshore portion of the assessment area is estimated to contain approximately 47 MMbbl of oil and 57 Bcf of associated gas. A negligible volume of resources is expected to exist in the onshore portion of the assessment area.

**Table 36.** *Estimates of undiscovered conventionally recoverable oil and gas resources in the Oceanside-Capistrano Basin assessment area as of January 1, 1995, by play. All estimates are risked values. The low, mean, and high estimates correspond to the 95th-percentile, mean, and 5th-percentile values of a probability distribution, respectively. Percentile values are not additive; some total mean values may not equal the sum of the component values due to independent rounding.*

| Play | Oil (MMbbl) | | | Gas (Bcf) | | | BOE (MMbbl) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Low | Mean | High | Low | Mean | High | Low | Mean | High |
| Upper Miocene Sandstone[1] | 0 | 514 | 1,191 | 0 | 274 | 648 | 0 | 563 | 1,304 |
| Monterey Fractured[1] | 0 | 387 | 768 | 0 | 452 | 983 | 0 | 467 | 935 |
| Lower Miocene Sandstone[1] | 0 | 208 | 711 | 0 | 568 | 2,466 | 0 | 309 | 1,116 |
| Paleogene-Cretaceous Sandstone[1] | 0 | 3 | 14 | 0 | 8 | 39 | 0 | 4 | 21 |
| *Total Assessment Area*[1] | *0* | *1,112* | *2,211* | *0* | *1,302* | *3,174* | *0* | *1,343* | *2,698* |

[1] Includes a small area and volume of resources in the State offshore and onshore area adjacent to the Federal offshore area.

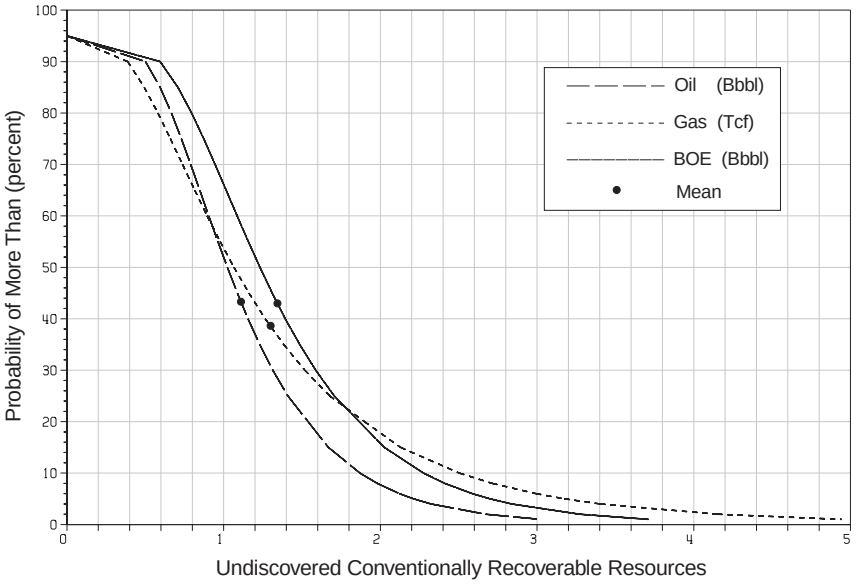


**Figure 108.** *Cumulative probability plot of estimated undiscovered conventionally recoverable resources of the Oceanside-Capistrano Basin assessment area.*

**Table 37.** *Estimates of undiscovered conventionally recoverable oil and gas resources in the Oceanside-Capistrano Basin assessment area as of January 1, 1995, by area. All estimates are risked mean values. Some total values may not equal the sum of the component values due to independent rounding.*

| Area | Oil (Bbbl) | Gas (Tcf) | BOE (Bbbl) |
|---|---|---|---|
| Onshore | | negligible | |
| State Offshore | 0.05 | 0.06 | 0.06 |
| Federal Offshore | 1.07 | 1.25 | 1.29 |
| *Total Assessment Area* | *1.11* | *1.30* | *1.34* |

### Undiscovered Economically Recoverable Resources

Estimates of undiscovered conventionally recoverable resources in the assessment area that may be economically recoverable under various economic scenarios have been developed using the economic assessment method. Select data used to develop the

**Table 38.** *Estimates of undiscovered economically recoverable oil and gas resources in the Oceanside-Capistrano Basin assessment area[1] as of January 1, 1995, by economic scenario. All estimates are risked mean values. The $18-per-barrel scenario is based on prices of $18 per bbl of oil and $2.11 per Mcf of gas; the $25-per-barrel scenario is based on prices of $25 per bbl of oil and $2.94 per Mcf of gas; the $50-per-barrel scenario is based on prices of $50 per barrel of oil and $5.87 per Mcf of gas.*

| Economic Scenario | Oil (MMbbl) | Gas (Bcf) | BOE (MMbbl) |
|---|---|---|---|
| $18 per barrel | 743 | 869 | 898 |
| $25 per barrel | 882 | 1,032 | 1,065 |
| $50 per barrel | 1,015 | 1,188 | 1,226 |

[1] Includes a small area and volume of resources in the State offshore and onshore area adjacent to the Federal offshore area.

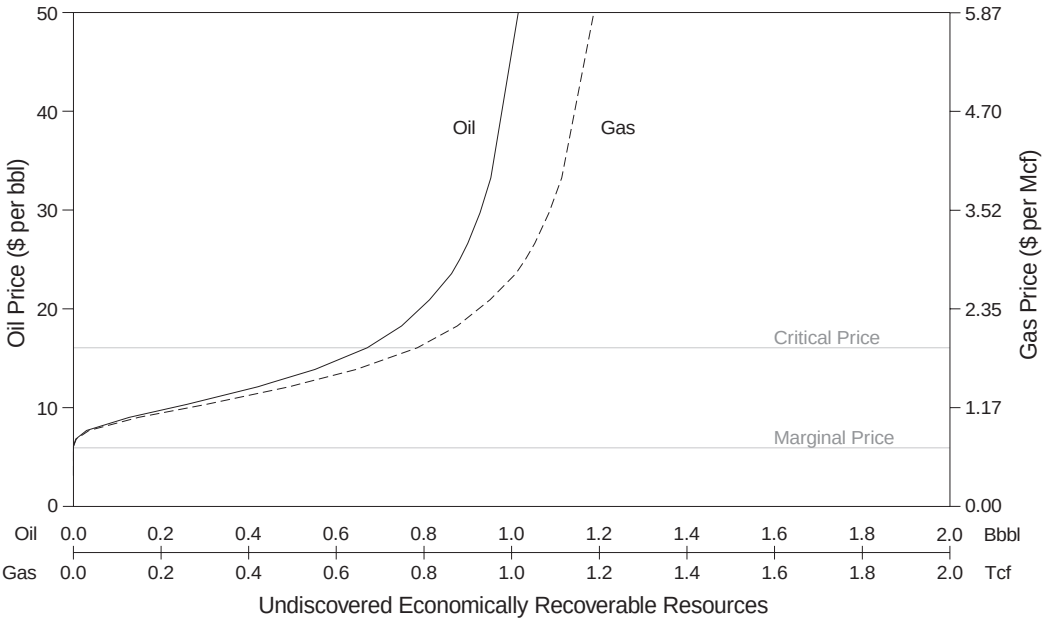


**Figure 109.** *Price-supply plot of estimated undiscovered economically recoverable resources of the Oceanside-Capistrano Basin assessment area.*

**Table 39.** *Estimates of the total endowment of oil and gas resources in the Oceanside-Capistrano Basin assessment area. Estimates of discovered resources (including cumulative production and remaining reserves) and undiscovered resources are as of January 1, 1995. Estimates of undiscovered conventionally recoverable resources are risked mean values. Some total values may not equal the sum of the component values due to independent rounding.*

| Resource Category | Oil (Bbbl) | Gas (Tcf) | BOE (Bbbl) |
|---|---|---|---|
| Cumulative Production[1] | <0.01 | <0.01 | <0.01 |
| Remaining Reserves[1] | | negligible | |
| Undiscovered Conventionally Recoverable Resources[1] | 1.11 | 1.30 | 1.34 |
| *Total Resource Endowment*[1] | *1.11* | *1.30* | *1.34* |

[1] Includes a small area and volume of resources in the State offshore and onshore area adjacent to the Federal offshore area.

resource estimates are shown in appendix D.

As a result of this assessment, 743 MMbbl of oil and 869 Bcf of associated gas are estimated to be economically recoverable from the Oceanside-Capistrano Basin assessment area under economic conditions existing as of this assessment (i.e., the $18-per-barrel economic scenario) (table 38). Larger volumes of resources are expected to be economically recoverable under increasingly favorable economic conditions (fig. 109).

The majority of undiscovered economically recoverable resources in the assessment area are expected to exist in the Federal and State offshore portions of the area.

### Total Resource Endowment

As of this assessment, cumulative production from the onshore portion of the assessment area was 4.6 Mbbl of oil and 11 MMcf of gas; remaining reserves were estimated to be negligible. These discovered resources (all of which are from the Paleogene-Cretaceous Sandstone play) and the aforementioned undiscovered conventionally recoverable resources collectively compose the area's estimated total resource endowment of 1.11 Bbbl of oil and 1.30 Tcf of gas (table 39).

## ACKNOWLEDGMENTS

Jim Crouch is acknowledged for sharing his knowledge and insight regarding the Oceanside-Capistrano basin. Larry Beyer was helpful in providing onshore information. Acknowledgment is also due to Bill Kou who performed the seismic interpretive mapping of the offshore part of the basin.

## ADDITIONAL REFERENCES

Crouch, 1993
Crouch, Bachman, and Associates, Inc., 1989a
Crouch and Suppe, 1993
Vedder, 1987

# UPPER MIOCENE SANDSTONE PLAY

## PLAY DEFINITION

The Upper Miocene Sandstone play of the Oceanside-Capistrano Basin assessment area is a conceptual play consisting of accumulations of oil and associated gas in upper Miocene sandstones of the Capistrano Formation. The play exists over most of the offshore portion of the basin (in Federal and State waters) but does not exist onshore (fig. 105). It encompasses an area of about 1,300 square miles; the depth to reservoir rocks in the play ranges from about 1,200 to 5,500 feet below the seafloor.

## PETROLEUM GEOLOGIC CHARACTERISTICS

The primary petroleum source rocks for this play are within the Monterey Formation (fig. 106). Mudstones and shales within the lower part of the Capistrano Formation may also have source potential for this play. The type and amount of organic matter within Monterey rocks of the Oceanside-Capistrano basin are largely unknown; however, Monterey rocks in other California coastal basins are rich in organic matter, and similar rocks are presumed to exist in the Oceanside-Capistrano basin. The depth at which thermal maturation may have occurred is also unknown. The Monterey is buried between 5,000 and 8,500 feet (corresponding to temperatures of about 185 to 270 °F, respectively) and, therefore, may have been buried sufficiently to permit petroleum generation.

Potential reservoir rocks in this play are upper Miocene channel and fan turbidite sandstones of the Capistrano Formation (fig. 106); these are probably stratigraphically equivalent to Puente Formation sandstones and lower "Repetto" strata in the Los Angeles basin (see Los Angeles Basin province summary). The Capistrano Formation contains very sand-rich units that are regionally extensive across the offshore part of the Oceanside-Capistrano basin; rocks of this formation are exposed in outcrops onshore from the San Joaquin Hills to south of San Clemente. The Mobil San Clemente corehole penetrated over 3,000 feet of this section, which is sand-rich and of potentially excellent reservoir quality. A number of channel and lobate features (interpreted to be fans) are imaged on offshore seismic-reflection profiles; similar features are exposed in coastal outcrops at Dana Point and San Clemente. Based on basin geometry, these channel and fan deposits were probably depositionally restricted to the basin trough where stacking of multiple reservoir sandstones is likely.

A large number of structural traps—including small to large anticlines and faulted anticlines—within the Capistrano Formation are evident from seismic mapping. The dominant structural trend is along the Newport-Inglewood fault zone. Channel and fan facies outside the Newport-Inglewood structural trend afford excellent opportunities for stratigraphic entrapment.

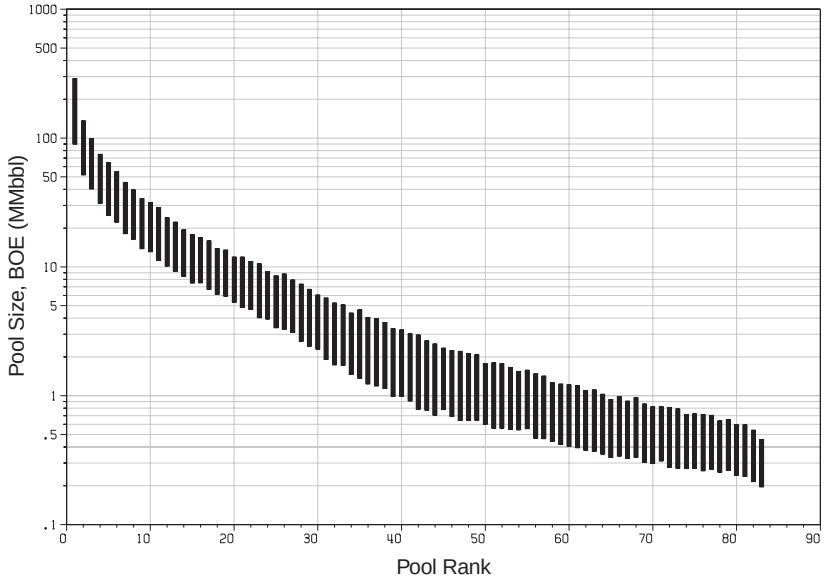


**Figure 110.** *Pool-size rank plot of estimated undiscovered conventionally recoverable resources of the Upper Miocene Sandstone play, Oceanside-Capistrano Basin assessment area. Sizes of undiscovered pools are shown by bars; the top and bottom of a bar represent the 25th- and 75th-percentile values of a probability distribution, respectively.*

## EXPLORATION

Both of the coreholes drilled in the offshore part of the basin penetrated rocks of this play. No shows of hydrocarbons were encountered.

## RESOURCE ESTIMATES

### Undiscovered Conventionally Recoverable Resources

Estimates of undiscovered conventionally recoverable resources in the play have been developed using the subjective assessment method with a combination of play-specific and analog data. Select data used to develop the resource estimates are shown in appendix C.

The size and number of prospects in the play were estimated from seismic mapping. Conservatively modified analog data from Puente producing zones in the Los Angeles basin were used to estimate the net-pay thickness, oil recovery factor, and gas-to-oil ratio for this play.

As a result of this assessment, the play is expected to contain 514 MMbbl of oil and 274 Bcf of associated gas (mean estimates). This volume of undiscovered conventionally recoverable resources may exist in as many as 83 pools with sizes ranging from approximately 195 Mbbl to 290 MMbbl of combined oil-equivalent resources (fig. 110). The low, mean, and high estimates of resources in the play are listed in table 36.

The majority of these pools and resources, or approximately 494 MMbbl of oil and 263 Bcf of associated gas, are expected to exist in the Federal offshore portion of the play. The remaining pools and resources, or approximately 20 MMbbl of oil and 11 Bcf of associated gas, are expected to exist in the State offshore portion of the play.

# MONTEREY FRACTURED PLAY

## PLAY DEFINITION

The Monterey Fractured play of the Oceanside-Capistrano Basin assessment area is a conceptual play consisting of accumulations of oil and associated gas in middle to upper Miocene fractured rocks of the Monterey Formation. The play exists over most of the offshore portion of the basin (in Federal and State waters) but does not exist onshore (fig. 105). It encompasses an area of about 1,000 square miles; the depth to reservoir rocks in the play ranges from about 3,400 to 8,500 feet below the seafloor.

## PETROLEUM GEOLOGIC CHARACTERISTICS

The Monterey Formation is considered to be both source rock and reservoir rock for this play (fig. 106) by analogy with Monterey rocks in the offshore Santa Barbara-Ventura and Santa Maria basins and the onshore San Joaquin basin. The type and amount of organic matter within Monterey rocks of the Oceanside-Capistrano basin are largely unknown; however, Monterey rocks in other California coastal basins are rich in organic matter, and similar rocks are presumed to exist in the Oceanside-Capistrano basin. The depth at which thermal maturation may

have occurred is also unknown. The Monterey is buried between 5,000 and 8,500 feet (corresponding to temperatures of about 185 to 270 °F, respectively) and, therefore, may have been buried sufficiently to permit petroleum generation.

Potential reservoir rocks in this play include fractured shale, dolomitic limestone, sandstone, siltstone, and chert of the Monterey Formation (fig. 106). Monterey rocks in the offshore Oceanside-Capistrano basin have been penetrated by one corehole; the corehole and offshore seismic data suggest that the Monterey section is more than 1,500 feet thick in most of the play area. Onshore, Monterey strata outcrop along the coast from Newport Beach to Oceanside where they are described as calcareous, siliceous, and phosphatic (Crouch, 1993). The outcrop data indicate that Monterey rocks are much dirtier (clays and mudstones) than in the offshore Santa Barbara-Ventura and Santa Maria basins; therefore, porosity and permeability of Monterey reservoir rocks may be diminished in this basin.

The Newport-Inglewood fault zone has created a number of small to large anticlines, fault traps, and subthrust traps within the basin. The potential for stratigraphic entrapment in this play is considered to be minor.

## EXPLORATION

One of the coreholes (Mobil San Clemente) drilled in the offshore part of the basin penetrated rocks of the Monterey Formation. No shows of hydrocarbons were encountered.

## RESOURCE ESTIMATES

### Undiscovered Conventionally Recoverable Resources

Estimates of undiscovered conventionally recoverable resources in the play have been developed using the subjective assessment method with a combination of play-specific and analog data. Select data used to develop the resource estimates are shown in appendix C.

The volume and number of prospects in the play were estimated from seismic mapping. Conservatively modified analog data from Monterey producing zones in the offshore Santa Barbara-Ventura and Santa Maria basins were used to estimate the oil recovery factor and gas-to-oil ratio for this play.

As a result of this assessment, the play is estimated to contain 387 MMbbl of oil and 452 Bcf of associated gas (mean estimates). This volume of undiscovered conventionally recoverable resources may exist in as many as 76 pools with sizes ranging from approximately 40 Mbbl to 290 MMbbl of combined oil-equivalent resources (fig. 111). The low, mean, and high estimates of resources in the play are listed in table 36.

The majority of these pools and resources, or approximately 371 MMbbl of oil and 435 Bcf of associated gas, are expected to exist in the Federal offshore portion of the play. The remaining pools and resources, or approximately 16 MMbbl of oil and 17 Bcf of associated gas, are expected to exist in the State offshore portion of the play.

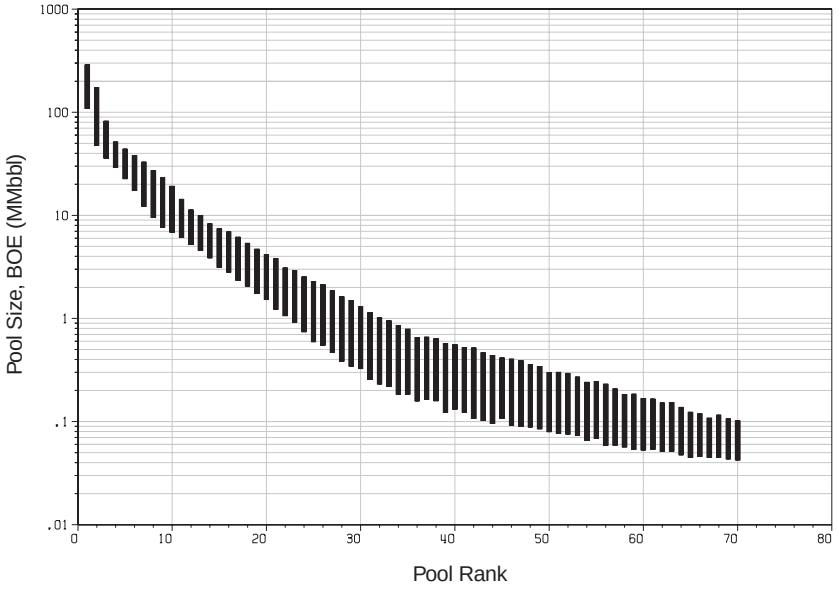


**Figure 111.** *Pool-size rank plot of estimated undiscovered conventionally recoverable resources of the Monterey Fractured play, Oceanside-Capistrano Basin assessment area. Sizes of undiscovered pools are shown by bars; the top and bottom of a bar represent the 25th- and 75th-percentile values of a probability distribution, respectively.*

# LOWER MIOCENE SANDSTONE PLAY

## PLAY DEFINITION

The Lower Miocene Sandstone play of the Oceanside-Capistrano Basin assessment area is a conceptual play consisting of accumulations of oil and associated gas in lower to middle Miocene clastic rocks of the San Onofre Breccia, Topanga Formation, and Vaqueros Formation. The play exists offshore in the eastern two-thirds of the basin (in Federal and State waters) but does not exist onshore (fig. 105). It encompasses an area of about 700 square miles; the depth to reservoir rocks in the play ranges from about 5,200 to 9,800 feet below the seafloor.

## PETROLEUM GEOLOGIC CHARACTERISTICS

Potential source rocks for this play are the Monterey Formation, lower Miocene shales in the Vaqueros Formation, and Eocene shales in the Santiago Formation(?) (fig. 106). The type and amount of organic matter within Monterey rocks of the Oceanside-Capistrano basin are largely unknown; however, Monterey rocks in other California coastal basins are rich in organic matter, and similar rocks are presumed to exist in the Oceanside-Capistrano basin. The Monterey is buried between 5,000 and 8,500 feet (corresponding to temperatures of about 185 to 270 °F, respectively) and, therefore, may have been buried sufficiently to permit petroleum generation.

Potential reservoir rocks in this play include sandstones, siltstones, and conglomerates of the Vaqueros and Topanga Formations and the San Onofre Breccia (fig. 106). Based on onshore wells and outcrops, the Vaqueros Formation consists of shallow-marine sandstone, siltstone, and conglomerate; the Topanga Formation consists of deep-marine turbidite sandstone, siltstone, conglomerate, breccia, and shale; and the San Onofre Breccia consists of conglomeratic breccia, conglomerate, and sandstones. The San Onofre Breccia exists in extremely lenticular bodies in coastal outcrops with coarse sandtones that were deposited in submarine fan channels. The medium- to coarse-grained sandstones within the San Onofre Breccia could be excellent reservoir rocks. Porosity and permeability should be preserved within these rocks due to the moderate depths of burial.

A number of small to large anticlines, fault traps, and subthrust traps within this play are evident from seismic mapping; most of these features exist along the Newport-Inglewood fault zone. Some potential for stratigraphic entrapment exists where strata pinch out along the western margin of the play.

## EXPLORATION

The San Onofre Breccia was penetrated by one of the coreholes (Mobil San Clemente) drilled in the offshore part of the basin; however, no shows of hydrocarbons were encountered. The Vaqueros and Topanga Formations were not penetrated by either of the coreholes. Vaqueros strata are evident on seismic-reflection profiles and pinch out westerly across the basin.

The formations included in this play are productive in several areas of the onshore and offshore Los Angeles and Santa Barbara-Ventura basins. However, no hydrocarbons have been discovered in these formations in the onshore part of the Oceanside-Capistrano basin.

## RESOURCE ESTIMATES

### Undiscovered Conventionally Recoverable Resources

Estimates of undiscovered conventionally recoverable resources in the play have been developed using the subjective assessment method with a combination of play-specific and analog data. Select data used to develop the resource estimates are shown in appendix C.

The volume and number of prospects in the play were estimated from seismic mapping. Analog data from Vaqueros, Sespe, and Alegria producing zones in the offshore Santa Barbara-Ventura basin were used to estimate the net-pay thickness, oil recovery factor, and gas-to-oil ratio for this play.

As a result of this assessment, the play is estimated to contain 208 MMbbl of oil and 568 Bcf of associated gas (mean estimates). This volume of undiscovered conventionally recoverable resources may exist in as many as 74 pools with sizes ranging from approximately 60 Mbbl to 310 MMbbl of combined oil-equivalent resources (fig. 112). The low, mean, and high estimates of resources in the play are listed in table 36.

The majority of these pools and resources, or approximately 200 MMbbl of oil and 546 Bcf of associated gas, are expected to exist in the Federal offshore portion of the play. The remaining pools and resources, or approximately 8 MMbbl of oil and 22 Bcf of associated gas, are expected to exist in the State offshore portion of the play.

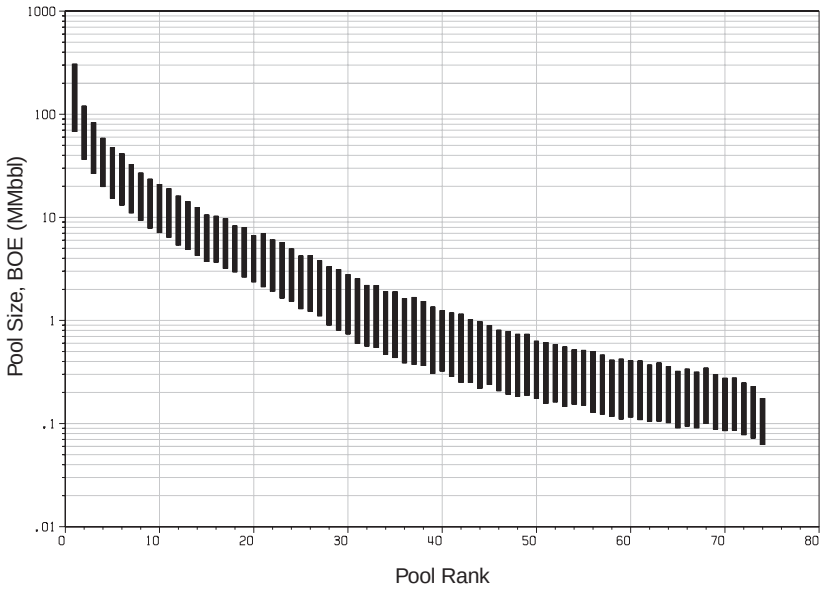


**Figure 112.** *Pool-size rank plot of estimated undiscovered conventionally recoverable resources of the Lower Miocene Sandstone play, Oceanside-Capistrano Basin assessment area. Sizes of undiscovered pools are shown by bars; the top and bottom of a bar represent the 25th- and 75th-percentile values of a probability distribution, respectively.*

## PALEOGENE-CRETACEOUS SANDSTONE PLAY

### PLAY DEFINITION

The Paleogene-Cretaceous Sandstone play of the Oceanside-Capistrano Basin assessment area is an established play consisting of accumulations of oil and associated gas in Upper Cretaceous and Paleogene sandstones. The play exists onshore and offshore (in Federal and State waters) along the eastern margin of the basin (fig. 105). It encompasses an area of about 400 square miles. The depth to reservoir rocks in the play onshore ranges from about 2,000 to 5,000 feet below the surface; offshore, the depth to reservoir rocks ranges from about 8,000 to 10,500 feet below the seafloor.

Offshore strata included in this play are presumably equivalent to onshore strata of the Upper Cretaceous Williams Formation, Paleocene Silverado Formation, Eocene Santiago Formation, and Oligocene Sespe Formation (fig. 106). These strata outcrop onshore from San Clemente to La Jolla and have been penetrated by numerous exploratory wells in the Capistrano syncline. Oligocene strata are predicted to exist offshore based on extrapolation of onshore outcrop and well data southward using seismic-reflection profiles. The Cretaceous and Paleogene strata are depositionally restricted to the eastern area of the basin where they extend slightly west of the Newport-Inglewood fault zone.

### PETROLEUM GEOLOGIC CHARACTERISTICS

Potential petroleum source rocks for this play are Upper Cretaceous and Paleogene shales (fig. 106). Although the thermal history of these rocks should be sufficient to generate oil and gas, the volume of source rock may be lacking (the type and amount of organic matter are unknown); as a result, the amount of oil and gas generated from these rocks is expected to be small.

Potential reservoir rocks in this play include sandstones and conglomerates of the Williams, Silverado, Santiago, and Sespe Formations (fig. 106). Based on onshore wells and outcrops, the Williams Formation consists primarily of thin shallow-marine sandstone; the Silverado Formation consists of nonmarine sandstone and conglomerate; the Santiago Formation consists of marine sandstone, conglomerate, and mudstone; and the Sespe Formation consists of nonmarine sandstone, conglomerate, and mudstone. Sandstones of these units should have fair to good porosity and permeability, although the reservoirs are expected to be thin.

The dominant trap types in this play are small anticlinal folds and fault traps. Although seismic profiles have been used to determine the offshore extent of the play, the quality of the profiles in this

deep section is very poor; therefore, the profiles are inconclusive for mapping structures and trends.

## EXPLORATION AND DISCOVERY STATUS

Two fields have been discovered in the onshore part of this play. Collectively, the San Clemente and Cristianitos Creek fields produced a very small quantity (less than 5 Mbbl) of high-gravity (45 to 54 °API) oil and gas from the Upper Cretaceous Williams Formation in the late 1950's. Both fields were considered to be subcommercial and have been abandoned.

Neither of the coreholes drilled in the offshore part of the basin penetrated rocks of this play.

## RESOURCE ESTIMATES

### Undiscovered Conventionally Recoverable Resources

Estimates of undiscovered conventionally recoverable resources in the play have been developed using the subjective assessment method with a combination of play-specific and analog data. Select data used to develop the resource estimates are shown in appendix C.

The volume and number of prospects in the play were estimated from seismic mapping. Analog data from Eocene and Oligocene producing zones in the offshore Santa Barbara-Ventura basin and the onshore Los Angeles and San Joaquin basins were used to estimate the net-pay thickness, oil recovery factor, and gas-to-oil ratio for this play.

As a result of this assessment, the play is estimated to contain 3 MMbbl of oil and 8 Bcf of associated gas (mean estimates). This volume of undiscovered conventionally recoverable resources may exist in as many as 27 pools with sizes ranging from approximately 40 Mbbl to 8 MMbbl of combined oil-equivalent resources (fig. 113). The low, mean, and high estimates of resources in the play are listed in table 36.

The majority of these pools and resources, or approximately 3 MMbbl of oil and 7 Bcf of associated gas, are expected to exist in the State offshore portion of the play. The remaining pools and resources, which are negligible, are expected to exist in the onshore and Federal offshore portions of the play.

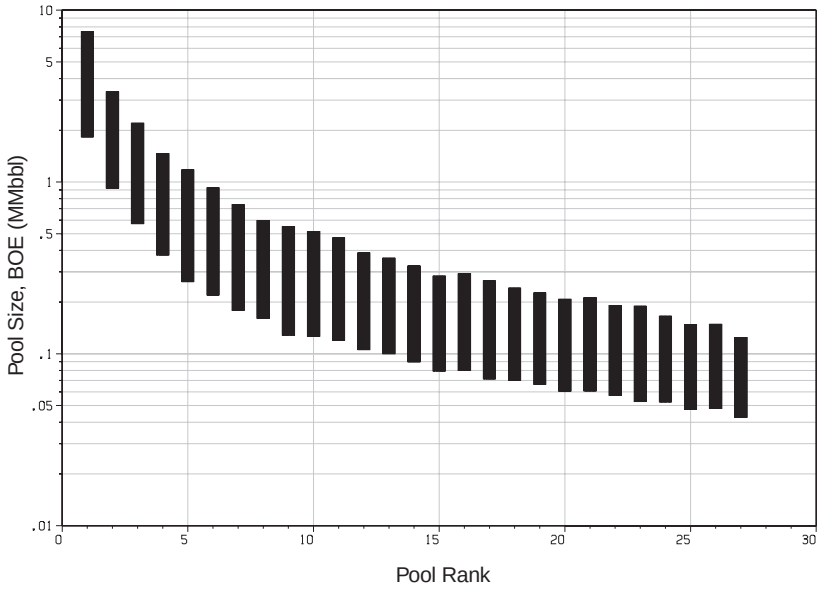


**Figure 113.** *Pool-size rank plot of estimated undiscovered conventionally recoverable resources of the Paleogene-Cretaceous Sandstone play, Oceanside-Capistrano Basin assessment area. Sizes of undiscovered pools are shown by bars; the top and bottom of a bar represent the 25th- and 75th-percentile values of a probability distribution, respectively.*