

Kodiak Planning Area (Alaska) – Province Summary

2006 Oil and Gas Assessment

Location

The Kodiak Shelf Planning Area lies offshore of south central Alaska (fig. 1). The oil and gas assessment province within the planning area (fig. 2) comprises the Federal offshore lands area on the continental shelf and slope surrounding the Pacific coastline of the Kodiak archipelago, landward of the Aleutian trench. The shoreward (northwestern) boundary is the 3-mile limit, and the southeastern boundary is the 2,000 m isobath. The northeastern boundary with the Gulf of Alaska assessment area follows the border between the Kodiak and Gulf of Alaska OCS Planning Areas (fig. 1). It extends north from the 2000 m isobath to the edge of the Amatuli trough (fig. 2), a sea valley that transects the continental shelf seaward of the Kenai Peninsula, and then swings west into the gap between the Kenai Peninsula and the Kodiak Island group. The southwestern boundary of the Kodiak Shelf Planning Area is at 156° west longitude, which also marks the eastern edge of the Shumagin Shelf Planning area (fig. 1). The Kodiak shelf assessment area averages about 425 miles in length measuring northeast to southwest, and extends about 75 miles offshore to the southeast from Kodiak Island.

Leasing and Exploration History

There have been no lease sales held or OCS tracts leased in the Kodiak shelf assessment area. Consequently there have been no exploratory oil and gas wells drilled. However, there have been six stratigraphic test wells drilled in the assessment area (fig. 2). The first three wells (KSST-1, 2, and 4a) constituted the Kodiak Shelf Stratigraphic Test Program.

They were drilled in 1976 to shallow depths (4,000 feet or less) and obtained geologic information limited to the Pliocene-Pleistocene stratigraphic section. The remaining three wells (KSSD-1, 2, and 3) were drilled in 1977 under the Kodiak Shelf Stratigraphic Drilling Program. These wells penetrated to depths of 8,000 to 10,000 feet and acquired appreciably more data, encountering strata as old as the early to middle Eocene (data summary provided in Turner and others, 1987). There were gas shows in two different intervals in the early to middle Miocene section of KSSD-2.

Geologic Setting

The Kodiak shelf assessment area is underlain by a broad accretionary complex that extends seaward from the Border Ranges fault system to the Aleutian trench (fig. 2). Offshore in both the Kodiak shelf area and Shumagin shelf area to the southwest, the highly deformed rocks of the accretionary complex are truncated by a Miocene unconformity and overlain by Neogene strata that are relatively undeformed compared to the older strata. All of the undiscovered, conventionally recoverable oil and gas resources of the Kodiak and Shumagin shelf assessment areas are associated with the Neogene sequence. Older rocks are thought to offer negligible potential for conventionally recoverable hydrocarbon resources due to their structural complexity and lack of porosity and permeability.

Several Neogene forearc and trench-slope basin depocenters are superimposed on the accretionary complex, forming in response to northward subduction at the Aleutian Trench and stresses created by

right-lateral motion along the Border Ranges fault (fig. 2) and possibly the Contact fault trend. These depocenters are filled with Miocene and younger strata and occur along the continental shelf and edge of the adjacent continental slope.

Seismic Stratigraphy

Three major stratigraphic sequences, A, B, and C, were defined for the Kodiak and Shumagin shelf assessment areas by integrating offshore seismic data, onshore outcrop data, and data from the six stratigraphic test wells (fig. 2) drilled on the Kodiak shelf (Fisher, 1980; Bruns and others, 1985; Turner and others, 1987; Horowitz and others, 1989). These sequences are correlated with the regional onshore stratigraphy in fig. 3, and are described below.

Sequence A (Economic Basement): This sequence consists of a Cretaceous through Paleocene accretionary complex that underlies the continental shelf seaward of the Border Ranges fault. It includes the Chugach terrane and the Ghost Rocks Formation of the Prince William terrane (figs. 2, 3). These highly deformed rocks are metamorphosed and have no source-rock or reservoir-rock potential.

Sequence B (Source Rock): This sequence includes the Eocene to early Oligocene Sitkalidak Formation and equivalent offshore strata (fig. 3). These mostly volcanoclastic sedimentary rocks were deposited in a trench-slope setting, and are now generally highly deformed by subduction-related tectonism of the Kodiak and Shumagin shelf areas. Sequence B strata have a maximum thickness of less than 6,000 feet.

Sequence C (Reservoir Rock): This sequence consists almost entirely of offshore

equivalents of the Miocene Narrow Cape Formation and the Plio-Pleistocene Tugidak Formation (fig. 3). These rocks are principally Neogene sandstones and shales that were deposited at inner to outer neritic depths. They are more quartz-rich than underlying strata. Isolated deposits of sediments equivalent to the non-marine late Oligocene Sitkinak Formation (fig. 3) may also be included at the base of the sequence, although Oligocene age strata have not been positively identified offshore (Turner and others, 1987).

Sequence C strata unconformably overlie sequence B, and in places are in unconformable contact directly with the underlying sequence A strata. Sequence C strata range from 2,000 to 20,000 feet in thickness. They typically thicken to the south, and thicken locally within structurally controlled basins on the shelf.

Reservoir Formations and Potential Traps

The sediment accumulations that cover the shelf and fill the Neogene depocenters (Sequence C strata) appear to consist of marine turbidite-related sands, silts, and shales deposited in deltaic complexes that prograded onto the shelf area (Turner and others, 1987). Reservoir rocks consist largely of Neogene prodeltaic turbidite sand packages associated with marine shelf distributary fan and channel deposition. Potential hydrocarbon traps consist of thrust-faulted and normal-faulted anticlines formed by Neogene tectonism, and possible stratigraphic traps formed by buried channels, lateral pinchouts and facies changes in the deltaic/turbidite environment. Seals consist of shaly units draping the turbidite sand sequences.

Source Rock Potential

Sequence B rocks are the best potential regional hydrocarbon sources, although

COST well samples show them to be organically lean (Turner and others, 1987). The woody-herbaceous nature of the organic material in samples collected from this source interval where it is less deeply buried in the Kodiak KSSD COST wells (fig. 2) suggests that it is markedly gas-prone and that the hydrocarbon endowment is largely thermogenic dry gas.

Potential hydrocarbon source rock units within the Neogene section (Sequence C) are thermally immature, organically lean, and gas-prone, with predominantly woody-herbaceous constituents. However, these constituents may form the basis of a secondary potential source of gas for the play by facilitating biogenic gas generation in the less deeply buried parts of the sequence - similar to the sourcing of the gas that is produced in upper Cook Inlet.

Migration

Thermogenic gas generated in Sequence B sediments buried deeply beneath Neogene depocenters (>20,000 feet) and shallower biogenic gas from Sequence C source rocks would migrate upward and laterally into structural and stratigraphic traps within and surrounding the Neogene basins.

Oil and Gas Resources of the Kodiak Shelf Assessment Area

The 2006 oil and gas assessment of the Kodiak shelf assessment area identified only one play, the Neogene Structural play, which was quantitatively assessed using the GRASP computer model. The Kodiak shelf assessment area is forecast to offer mean undiscovered technically recoverable resources of 375 Mmboe (tbl.1). Detailed results by commodity are presented in tables 3 and 4. Assessment results are shown graphically in figure 4.

| Kodiak OCS Planning Area, 2006 Assessment, Undiscovered Technically-Recoverable Oil & Gas | | | |
|--|--------------------|-------------|------------|
| Assessment Results as of November 2005 | | | |
| Resource Commodity (Units) | Resources * | | |
| | F95 | Mean | F05 |
| BOE (Mmboe) | 0 | 375 | 1,551 |
| Total Gas (Tcfg) | 0.000 | 1.840 | 7.618 |
| Total Liquids (Mmbo) | 0 | 48 | 196 |
| Free Gas** (Tcfg) | 0.000 | 1.840 | 7.618 |
| Solution Gas (Tcfg) | 0.000 | 0.000 | 0.000 |
| Oil (Mmbo) | 0 | 0 | 0 |
| Condensate (Mmbc) | 0 | 48 | 196 |

* Risked, Technically-Recoverable
 ** Free Gas Includes Gas Cap and Non-Associated Gas
 F95 = 95% chance that resources will equal or exceed the given quantity
 F05 = 5% chance that resources will equal or exceed the given quantity
 BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas
 Mmb = millions of barrels
 Tcf = trillions of cubic feet

Table 1

The area is considered to be gas prone, and the mean resource distribution is predicted to be 1.84 Tcf of gas and 48 Mmb of condensate. At mean values, gas comprises 87 percent of the undiscovered resource endowment. At fractile F05 (5% chance), gas resources range up to 7.62 Tcf and condensate resources range up to 196 Mmb.

| Kodiak OCS Planning Area, Alaska, 2006 Assessment, Conditional BOE Sizes of Ten Largest Pools | | | | |
|--|-------------|-------------------------|------|------|
| Assessment Results as of November 2005 | | | | |
| Pool Rank | Play Number | BOE Resources * (Mmboe) | | |
| | | F95 | Mean | F05 |
| 1 | 1 | 72 | 387 | 1218 |
| 2 | 1 | 41 | 164 | 376 |
| 3 | 1 | 28 | 102 | 227 |
| 4 | 1 | 19 | 72 | 168 |
| 5 | 1 | 14 | 54 | 119 |
| 6 | 1 | 10 | 42 | 94 |
| 7 | 1 | 7 | 34 | 76 |
| 8 | 1 | 5 | 27 | 62 |
| 9 | 1 | 4 | 23 | 52 |
| 10 | 1 | 3 | 19 | 45 |

* Conditional, Technically-Recoverable, Millions of Barrels Energy-Equivalent (Mmboe), from "PSRK.out" file

F95 = 95% chance that resources will equal or exceed the given quantity

F05 = 5% chance that resources will equal or exceed the given quantity

BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas

Table 2

The Neogene Structural play in the Kodiak shelf assessment area is estimated to contain a maximum of 50 pools. These are predicted to be entirely gas pools. The largest pool in the Kodiak shelf assessment area contains a mean conditional resource of 387 Mmboe (tbl. 2), with a maximum (F05) conditional resource of 1218 Mmboe. Converting these volumes to an all-gas case, the largest pool in the Kodiak shelf assessment area contains a mean conditional resource of 2.2 Tcfge, with a maximum (F05) conditional resource of 6.8 Tcfge. Only 3 pools in the Kodiak shelf assessment area have mean conditional resources exceeding 100 Mmboe (or 0.562 Tcfge).

References Cited

Bruns, T.R., von Heune, R., Cullota, R.C., and Lewis, S.D., 1985, Summary geologic report for the Shumagin Outer Continental Shelf (OCS) planning area, Alaska: U.S. Geological Survey Open-File Report 85-32, 58 p.

Fisher, M.A., 1980, Petroleum geology of the Kodiak Shelf, Alaska: American Association of Petroleum Geologists Bulletin, v. 64, p. 1140-

1157.

Horowitz, W.L., Steffy, D.A., and Hoose, P.J., 1989, Geologic report for the Shumagin planning area, western Gulf of Alaska: U.S. Minerals Management Service OCS Report MMS 89-0097, 148 p.

Turner, R.F. (ed.), Lynch, M.B., Conner, T.A., Hallin, P.J., Hoose, P.J., Martin, G.C., Olson, D.L., Larson, J.A., Flett, T.O., Sherwood, K.W., and Adams, A.J., 1987, Geological and operational summary, Kodiak shelf stratigraphic test wells, Alaska: U.S. Minerals Management Service OCS Report MMS 87-0109, 341 p.

Links to Summaries for Individual Plays and Appended Items

- [Play 1, Neogene Structural Play, Kodiak Shelf, Assessment Summary](#)
- [Kodiak Plays-Assessment Results by Commodity \(Excel Format\)](#)
- [Kodiak Plays-Input Data Tables \(Excel Format\)](#)
- [Kodiak Plays-Pool Size Models \(Txt Format\)](#)
- [Kodiak Plays-Simulation Pools-Statistics \(Excel Format\)](#)
- [Kodiak Province-Assessment Results \(Excel Format\)](#)

2006 Assessment Results for Kodiak OCS Planning Area

Risked, Undiscovered, Technically Recoverable Oil and Gas Resources, as of November 2005

| Play Number | Play Name | BOE Resources (Mmbo) | | | Oil Resources (Mmbo) | | | Gas-Condensate Liquid Resources (Mmbo) | | | Free* Gas Resources (Tcfg) | | | Solution Gas Resources (Tcfg) | | | Total Liquid Resources (Mmbo) | | | Total Gas Resources (Tcfg) | | |
|---------------------------|--------------------|----------------------|------------|--------------|----------------------|----------|----------|--|-----------|------------|----------------------------|--------------|--------------|-------------------------------|--------------|--------------|-------------------------------|-----------|------------|----------------------------|--------------|--------------|
| | | F95 | Mean | F05 | F95 | Mean | F05 | F95 | Mean | F05 | F95 | Mean | F05 | F95 | Mean | F05 | F95 | Mean | F05 | F95 | Mean | F05 |
| 1 | Neogene Structural | 0 | 375 | 1,551 | 0 | 0 | 0 | 0 | 48 | 196 | 0.000 | 1.840 | 7.618 | 0.000 | 0.000 | 0.000 | 0 | 48 | 196 | 0.000 | 1.840 | 7.618 |
| Sum of All Plays** | | 0 | 375 | 1,551 | 0 | 0 | 0 | 0 | 48 | 196 | 0.000 | 1.840 | 7.618 | 0.000 | 0.000 | 0.000 | 0 | 48 | 196 | 0.000 | 1.840 | 7.618 |

* Free gas, occurring as gas caps associated with oil and as oil-free gas pools (non-associated gas).

** Values as reported out of Basin Level Analysis-Geologic Scenario aggregation module in GRASP, "Volume Ordered" aggregation option. Total liquids and total gas values were obtained by summing resource values for means and fractiles of component commodities. Play resource values are rounded and may not sum to totals reported from basin aggregation.

BOE, total energy, in millions of barrels (5,620 cubic feet of gas per barrel of oil, energy-equivalent); Mmbo, millions of barrels of oil or liquids; Tcfg, trillions of cubic feet of natural gas

Table 3. Summary of Kodiak shelf province assessment results for ultimate technically recoverable resources (UTRR), 2006 assessment.

Province Resources - Technically Recoverable, Risked, By Product

Geological Resources Assessment Program-GRASP-Version 8.29.2005

The Current UAI AAAAAM
 is for
 World Level - World Level Resources
 Country Level - UNITED STATES OF AMERICA
 Region Level - MMS - ALASKA REGION
Basin Level - KODIAK

Basin Level Aggregation of Risked, Technically Recoverable Resources By Product (Province Aggregation ".out" file)

Volume Ordered (Play Aggregation Method)
 RandomSeed = 191062
 Number of Trials = 10000

| Greater Than Percentage | BOE (Mboe) | Oil (Mbo) | Condensate (Mbc) | Solution Gas (Mmcf) | Free (Gas Cap & Nonassociated) Gas (Mmcf) |
|-------------------------|--------------|-----------|------------------|---------------------|---|
| 99 | 0 | 0 | 0 | 0 | 0 |
| 98 | 0 | 0 | 0 | 0 | 0 |
| 97 | 0 | 0 | 0 | 0 | 0 |
| 96 | 0 | 0 | 0 | 0 | 0 |
| 95 | 0 | 0 | 0 | 0 | 0 |
| 90 | 0 | 0 | 0 | 0 | 0 |
| 85 | 0 | 0 | 0 | 0 | 0 |
| 80 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 |
| 70 | 0 | 0 | 0 | 0 | 0 |
| 65 | 0 | 0 | 0 | 0 | 0 |
| 60 | 0 | 0 | 0 | 0 | 0 |
| 55 | 0 | 0 | 0 | 0 | 0 |
| 50 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 |
| 40 | 53,712.24 | 0.00 | 6,833.83 | 0.00 | 263,456.66 |
| 35 | 376,300.57 | 0.00 | 46,668.84 | 0.00 | 1,852,530.34 |
| 30 | 526,957.39 | 0.00 | 66,546.19 | 0.00 | 2,587,510.94 |
| 25 | 668,532.72 | 0.00 | 84,811.54 | 0.00 | 3,280,513.03 |
| 20 | 817,832.52 | 0.00 | 101,810.63 | 0.00 | 4,024,043.05 |
| 15 | 989,772.07 | 0.00 | 125,880.82 | 0.00 | 4,855,068.79 |
| 10 | 1,201,083.93 | 0.00 | 153,139.76 | 0.00 | 5,889,446.26 |
| 5 | 1,551,124.14 | 0.00 | 195,617.66 | 0.00 | 7,617,946.44 |
| 4 | 1,662,184.06 | 0.00 | 212,679.91 | 0.00 | 8,146,213.31 |
| 3 | 1,821,454.34 | 0.00 | 236,398.07 | 0.00 | 8,908,016.21 |
| 2 | 2,067,164.97 | 0.00 | 272,810.17 | 0.00 | 10,084,273.93 |
| 1 | 2,472,522.08 | 0.00 | 318,088.87 | 0.00 | 12,107,914.62 |
| Mean | 375,463.37 | 0.00 | 48,037.17 | 0.00 | 1,840,135.23 |
| Rep | 375,820.75 | 0.00 | 41,134.86 | 0.00 | 1,880,934.74 |
| Min | 0 | 0 | 0 | 0 | 0 |
| Max | 4,866,184.70 | 0 | 677,233.87 | 0 | 23,541,903.61 |

Table 4. Detailed report of ultimate technically recoverable resources (UTRR) by commodity, as reported in province aggregation file by GRASP computer model, 2006 assessment.

2006 Kodiak Assessment Province and Alaska OCS

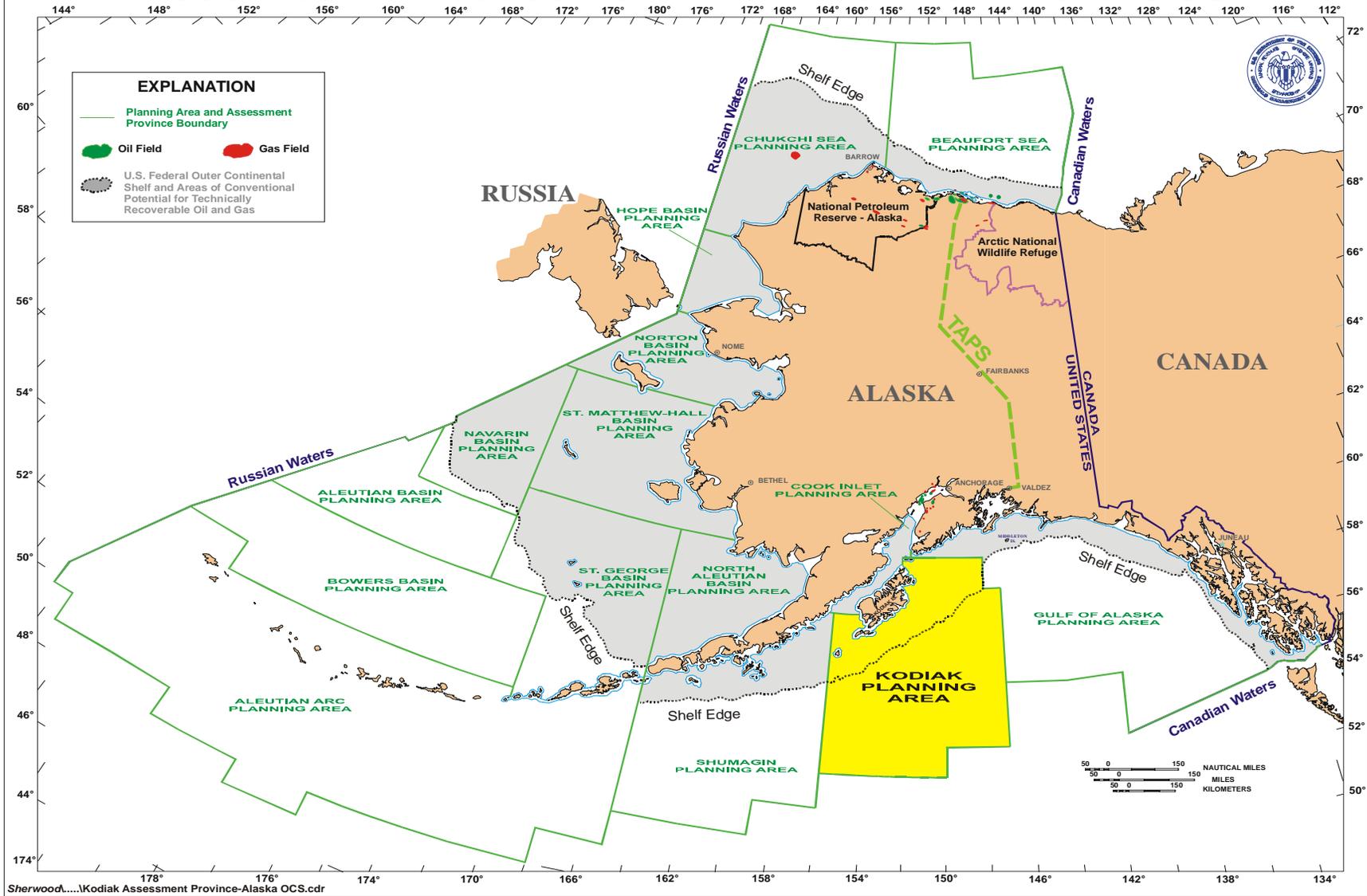


Figure 1. Location of Kodiak Planning Area and 2006 Kodiak shelf assessment province.

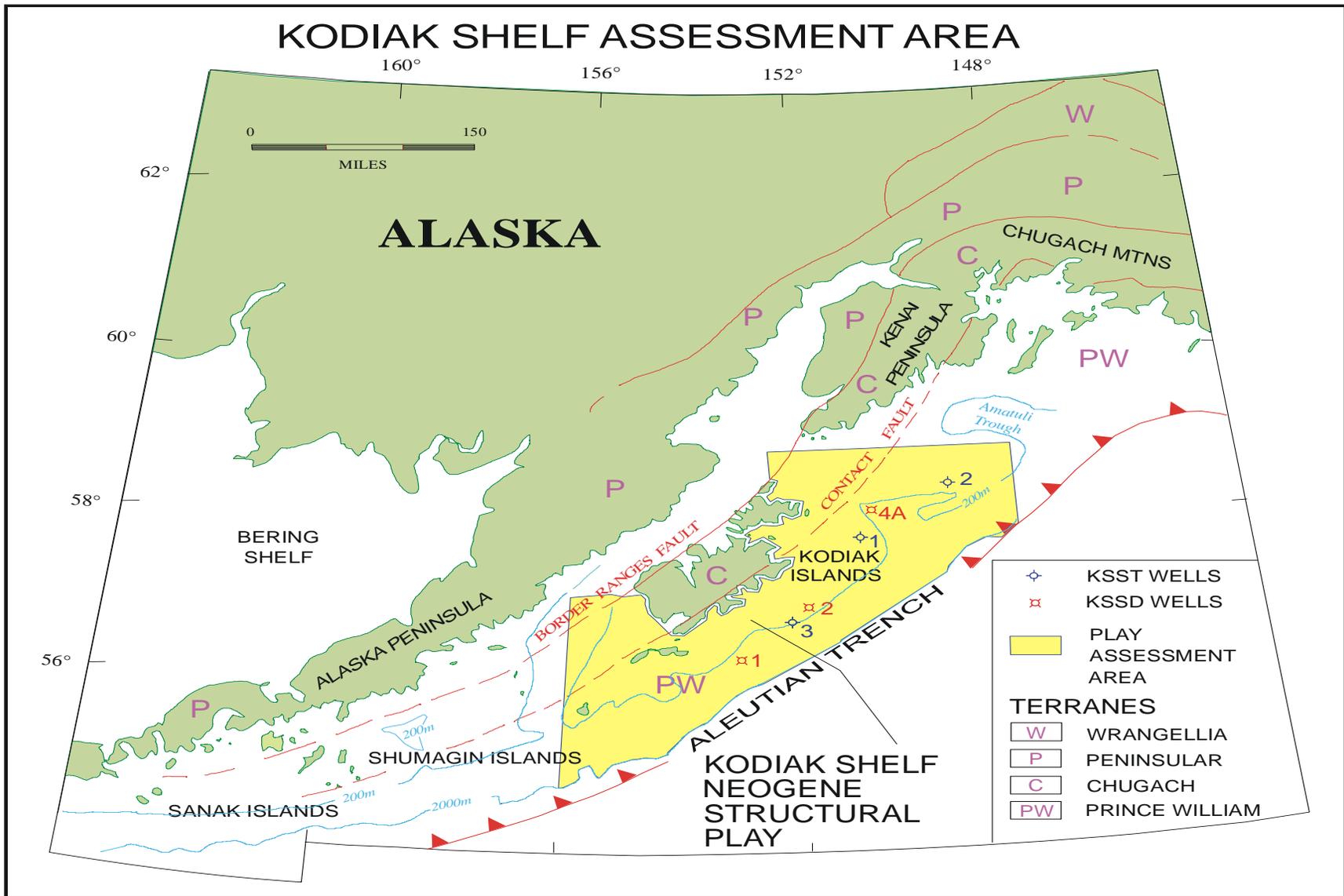


Figure 2. Map showing the location of the Kodiak shelf assessment area and its only play, the Neogene Structural play. Assessment of the area is based on onshore geologic data in the Kodiak Island area, data from 6 COST wells (3 KSST wells and 3 KSSD wells) drilled offshore of Kodiak Island in 1975 and 1976, and on three major seismic stratigraphic intervals delineated in the offshore section.

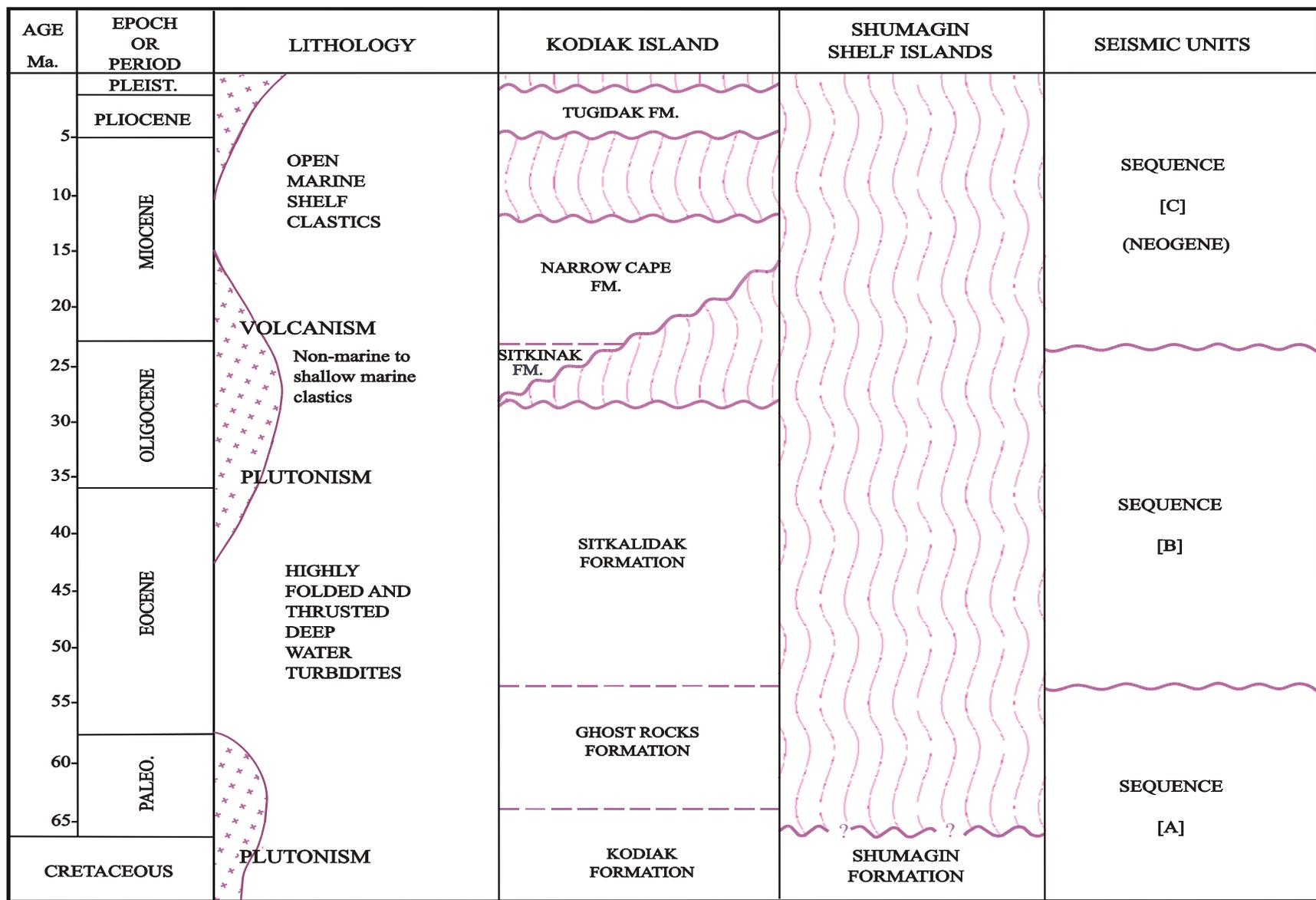


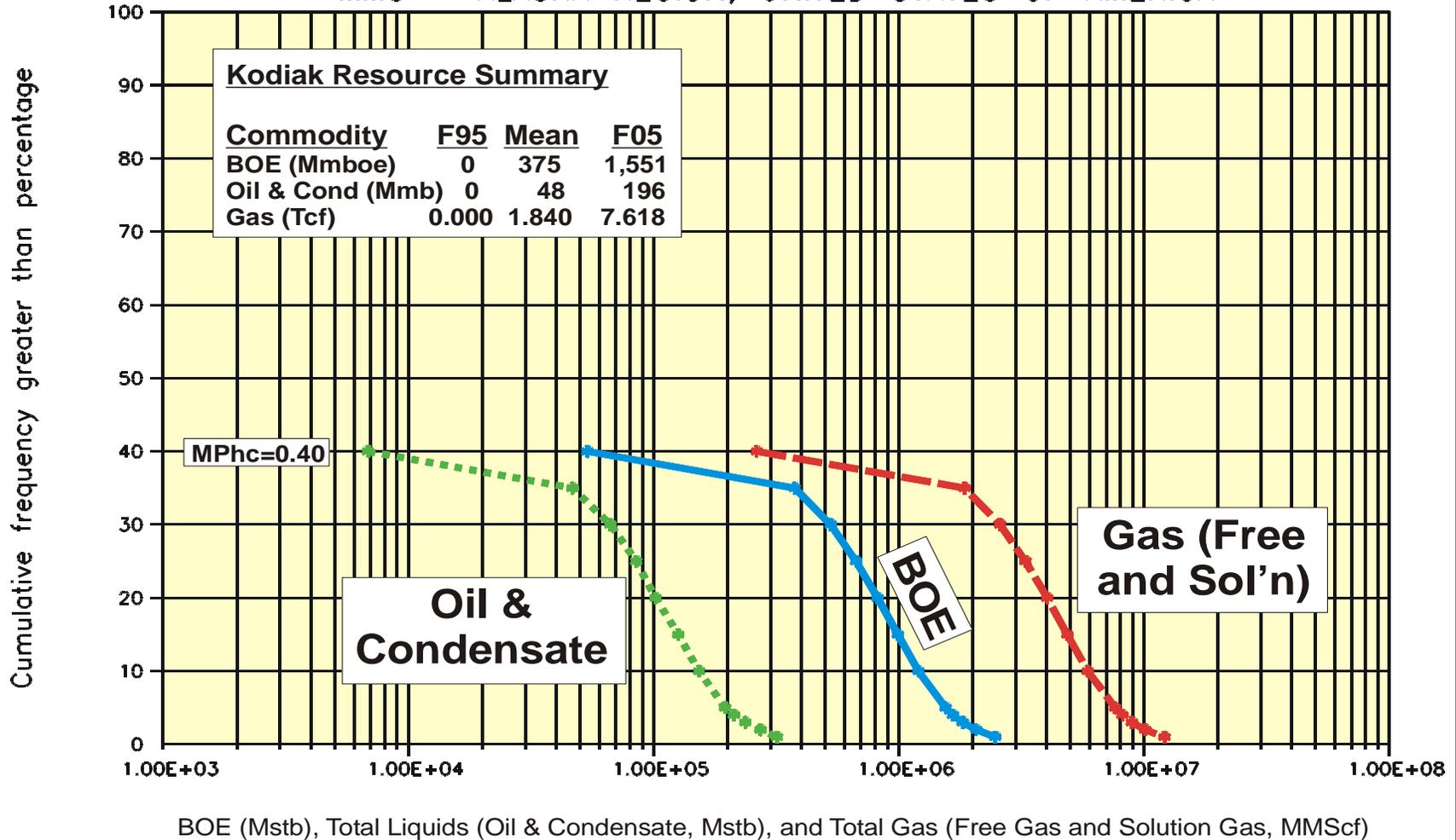
Figure 3. Diagram correlating onshore geologic events and stratigraphy with corresponding offshore seismic sequences. All the estimated technically recoverable OCS hydrocarbon resource in the Kodiak shelf area is expected to be found in Neogene sandstone units of seismic sequence C.

Oil & Condensate, BOE, and Gas Resources

(Risked, Undiscovered, Technically Recoverable)

KODIAK SHELF

MMS – ALASKA REGION, UNITED STATES OF AMERICA



SherwoodL...Kodiak-CumulativeGraph-BOE-Oil-Gas.cdr

Figure 4. Cumulative probability plot for undiscovered, technically recoverable oil and gas resources for the Kodiak Planning Area and assessment province, 2006 assessment.