ALASKA FEDERAL OFFSHORE
Descriptions of Geologic Plays
1995 National Resource Assessment
U.S. Minerals Management Service

CHUKCHI SHELF ASSESSMENT PROVINCE
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PLAY ORGANIZATION

At the most fundamental level, plays are organized around the five major tectonostratigraphic sequences recognized beneath Chukchi shelf. These sequences define play groups that contain prospects involving reservoirs within the major sequences. We therefore recognize the Lower Ellesmerian, Upper Ellesmerian, Rift, Lower Brookian, and Upper Brookian play groups. Within each play group, plays are distinguished on the basis of paleogeographic setting (opposite sides of basin, with different sediment source terranes), reservoir facies (e.g., carbonates versus various types of clastic deposits), structural setting (trap type), play petroleum charging system, or reservoir fluid content (all gas plays are set aside). The distinguishing attributes of each play are given below with individual play descriptions.

Of the 22 plays proposed for Chukchi shelf assessment province, 15 were sampled by wells offshore or along the west coast of Arctic Alaska. Only 7 of the sampled plays, however, were actually in closed volumes (prospects) at the sites of the wells. Klondike well tested prospects in plays 5, 8, 12, and 13, encountering pooled oil in plays 5, 8, and 12. Burger well tested gas pools in plays 7 and 18. Popcorn well tested prospects in plays 3 and 7, encountering pooled gas in play 7. Crackerjack well tested a prospect in play 5, encountering pooled gas in play 5 and pooled oil in an unmapped stratigraphic trap in play 12.

PLAY DESCRIPTIONS

Play 1 (UACS0100[1]). Lower Ellesmerian Sequence—Endicott Clastics-Chukchi Platform:

Reservoir objectives primarily include Late Devonian(?) to Mississippian sandstones deposited in marginal marine to fluvial environments in Hanna trough during an early rift- or fault-driven phase of subsidence. Trap types on the east flank of Chukchi platform include early-formed horsts and stratigraphic wedges that were possibly disrupted by Paleocene transtensional

[1]*The "UA" Code is the "Unique Assessment Identifier" for each play, and is the principal guide to GRASP data files.*

faults. This play is charged by the Hanna trough play charging system, in which petroleum generated from Triassic sources in Hanna trough migrated laterally northward and westward beneath regional seals to traps on the Arctic and Chukchi platforms. Play 1 was not tested by any wells.

Play 2 (UACS0200). Lower Ellesmerian Sequence—Endicott Clastics-Arctic Platform: Reservoir objectives primarily include Late Devonian(?) to Mississippian sandstones deposited in marginal- to non-marine environments on the east side of Hanna trough during the early rift- or fault-driven phase of subsidence. Early-formed horst and stratigraphic wedge traps have been buried to greater depths than their Chukchi platform counterparts and are associated with higher levels of thermal maturity and poorer reservoir properties. The play is charged by the Hanna trough play charging system (described in play 1). Most identified prospects lie considerably deeper than the primary regional source rock (Shublik), and high thermal maturity of traps suggests the hydrocarbon endowment is largely dry gas. Play 2 is therefore modeled with a higher gas content than the other plays charged by the Hanna trough play charging system. Play 2 was not tested by any wells. Play 2 extends into western parts of Beaufort shelf assessment province and was there assessed as Beaufort shelf play UABS1800.

Play 3 (UACS0300). Lower Ellesmerian Sequence—Lisburne Carbonates: Reservoir objectives include Mississippian to Permian carbonates that were deposited on a stable marine shelf, with deeper water facies in the southeast part of the province in axial parts of Hanna trough. Porosity in Lisburne carbonates is associated with sparse porous zones in limestones and thin dolomite beds. No reef facies have been documented within the Lisburne carbonate assemblage, which ranges in age from Mississippian to Permian. The play is primarily charged by the Hanna trough play charging system (described in play 1), with minor contributions from interbedded organically-lean and gas-prone shales. Incomplete penetrations of the Lisburne carbonates occurred at Popcorn, Crackerjack, and Diamond wells, which encountered carbonates with porosities ranging from 0 to 14%. No hydrocarbons were encountered in Lisburne carbonates in these wells. Play 3 extends into western parts of Beaufort shelf assessment province and was there assessed as Beaufort shelf play UABS1900.

Play 4 (UACS0400). Ellesmerian Sequence—Overmature "Deep Gas" (Lower and Upper Ellesmerian Sequences): Reservoir objectives include all potential reservoirs in both Lower Ellesmerian and Upper Ellesmerian sequences (reservoir strata described in Plays 1,2,3,5, and 6). Prospects in the "Deep Gas" play occur at subsurface depths beneath the oil floor (2.0% vitrinite reflectance) and would contain only gas. High thermal maturities have a detrimental effect on reservoir properties and multi-cycle tectonic history combined with extremely deep burial at present (to 38,000 ft) result in high exploration risks for play 4. Play 4 was penetrated at Tunalik well in northwestern Alaska with no hydrocarbons present. At the level of Lower Ellesmerian rocks, play 4 extends into western parts of Beaufort shelf assessment province and was assessed there as Beaufort shelf play UABS2000.

Play 5 (UACS0500). Upper Ellesmerian Sequence—Sadlerochit Group-Chukchi Platform: Reservoir objectives include Late Permian to Triassic marine strata deposited on the western side of Hanna trough, mostly during a "sag" or thermal phase of subsidence that followed the fault-driven subsidence of Lower Ellesmerian sedimentation in Hanna trough. The only potential reservoirs encountered in wells are spiculitic siltstones and cherts offering sparse moldic porosity. More proximal (nearshore, littoral) sandstones postulated to have been deposited to the west may now be lost to unconformable truncation at Mesozoic unconformities. The possible loss of this reservoir facies forms a major risk element for Chukchi shelf play 5. Hydrocarbons are primarily derived from Triassic source beds of the Hanna trough play charging system (described in play 1), with migration paths to the west beneath regional seals into areally large stratigraphic traps. Early-formed stratigraphic traps were disrupted by late-stage wrench tectonics. Trap disruption may be an additional risk element for this play. Play 5 was penetrated by Crackerjack and Klondike wells, both of which encountered pooled hydrocarbons within the play sequence.

Play 6 (UACS0600). Upper Ellesmerian Sequence—Sadlerochit Group-Arctic Platform: Reservoir objectives primarily include Late Permian to Triassic marginal to shallow marine sandstones of the Sadlerochit Group that were deposited on the south-facing shelf that then existed on the Arctic platform. Diamond well, offshore on the east flank of Hanna trough, encountered over 500 feet of potential reservoir strata that are correlative to the Permian Echooka Formation. Primary trap styles include stratigraphic wedges and fault traps, with hydrocarbons migrating northward into traps from the Hanna trough play charging system (described in play 1) on the south. A prospect in play 6 was penetrated at Diamond well and found to be barren of hydrocarbons. Several wells also penetrated the play sequence (with no pooled hydrocarbons) in northwestern Alaska. Play 6 extends into western parts of Beaufort shelf assessment province and was assessed there as Beaufort shelf play UABS2100.

Play 7 (UACS0700). Rift Sequence—Active Margin Clastics: Reservoirs are primarily Late Jurassic to Early Cretaceous sandstones (equivalent to the Kuparuk Formation of Arctic Alaska) that were deposited in a zone of active faulting and flexural subsidence near an active rift margin which lay north of the hinge line along the south margin of North Chukchi basin. This tectonic environment produced a pattern of abrupt thickness changes among stratigraphic units making up the Rift sequence, and provides an opportunity for local development of reservoir sequences of great, potentially commercial, thicknesses. The inference of development of thick reservoirs in this play draws upon analogy to the abrupt expansion of Kuparuk sandstones from typical regional thicknesses of about 100 ft to the 450 gross feet observed in the fault-bounded depression hosting Point McIntyre field near Prudhoe Bay (AOGCC, 1993, p.102). In play 7, some sandstones may have been derived from local emergent uplifts. This play is charged by the Hanna trough play charging system (described in play 1). Three wells (Burger, Crackerjack, Popcorn) penetrated the play. Burger and Popcorn wells encountered gas (with condensate) in sandstones ranging up to 115 feet in thickness. Burger structure probably houses a multi-TCF gas pool, although no accurate estimate is yet available. At Crackerjack well, no sandstones are preserved within a Rift sequence highly abbreviated at the Lower Cretaceous unconformity (LCU).

Play 8 (UACS0800). Rift Sequence—Stable Marine Shelf: Reservoirs are primarily Late Jurassic to Early Cretaceous sandstones equivalent to the Kuparuk Formation of Arctic Alaska. Unlike the sandstones in the tectonically active rift zone (play 7) to the north, these rocks were instead deposited south of the rift zone on a tectonically stable shelf and slope that rimmed a deep water area in southernmost Hanna trough. Here, we anticipate fine-grained marine shelf sandstones that are thinner at the extremes and probably less continuous laterally than their counterparts in play 7. This play is charged by the Hanna trough play charging system (described in play 1). A prospect within play 8 was incidentally tested by Klondike well while drilling to a deeper objective (in play 5) and encountered pooled oil in a Kuparuk-equivalent sandstone 80 feet thick. Diamond well encountered no sandstones (only the Pebble Shale was present) and was barren of hydrocarbons. Play 8 is extends into large parts of Beaufort shelf assessment province and was assessed there as Beaufort shelf play UABS2200.

Play 9 (UACS0900). Rift Sequence—Overmature "Deep Gas": This play includes prospects that lie at subsurface depths beneath the oil preservation floor (2.0% vitrinite reflectance) and would contain only gas. Reservoir objectives would be primarily thin, basin-floor turbidite sandstones deposited in deep water areas south of the shelf and slope of play 8. However, in western Arctic Alaska, shelf deposits in the play sequence (e.g., at Tunalik well) enter the gas window as well. The anticipated hydrocarbon mix is 100% gas, probably derived from underlying, oil-expended Shubik source beds in gas-generating areas of the Hanna trough play charging system (described in play 1), or interbedded marine shales (Kingak Formation, Pebble Shale). High levels of thermal maturity are expected to have an adverse effect on reservoir properties, which primarily accounts for the small endowment of this play. Play 9 was penetrated at Tunalik well, which encountered pooled gas in a Kuparuk-equivalent sandstone within the play sequence.

Play 10 (UACS1000). Lower Brookian Sequence—Herald Arch and Thrust Zone: This play involves highly-deformed Cretaceous and older rocks that comprise acoustic basement beneath Herald arch and Herald thrust zone. Although fragments of axial areas of synclines are visible in some seismic profiles in Herald thrust zone, no traps can be reliably mapped. However, we speculate that viable anticlinal traps are present, but generally with steep flanks and small in size consistent with the small fold wavelengths suggested by seismically-visible synclines. High levels of thermal maturity suggest that any pooled hydrocarbons will be only gas (1.76 percent vitrinite reflectance in Jurassic argillite cored at the seafloor south of Herald fault; Fugro-McClelland, 1985, USGS-7). This play was tested at Eagle Creek and Akulik wells onshore, both of which recovered gas in drill stem tests from Nanushuk or Torok Formation sandstones.

Play 11 (UACS1100). Lower Brookian Sequence—Foreland Basin Foldbelt: Reservoir objectives are primarily deltaic sandstones of the Nanushuk Group deposited in Colville basin in Early Cretaceous time and subsequently deformed by north-verging Brooks Range deformation in earliest Paleocene time. Structural deformation increases toward the south, and broad unfaulted anticlines in the northern part of the play area grade into steep-limbed, thrust-faulted, and breached anticlines to the south. Potential reservoir sandstones in the folded sequence are

charged by the Colville basin play charging system in which traps receive hydrocarbons generated from underlying, thermally mature, gas-prone shales of the Torok and Pebble Shale Formations. Play 11 was not tested offshore. Onshore exploratory drilling of about 30 anticlinal prospects over about 50 years discovered 6 sites of pooled gas (Tungak Creek(?), Wolf Creek, Gubik, Meade, Square Lake, and East Umiat) and one oil field (Umiat) with estimated reserves of 70 million barrels (Thomas and others, 1991, table 2-5).

Play 12 (UACS1200). Lower Brookian Sequence—Torok Turbidites-Chukchi Platform Wrench Zone: Potential reservoirs are primarily turbidite sandstones within Lower Cretaceous Torok Formation shales deposited in a prodelta system on the shelf terrace between Colville and North Chukchi basins and on Chukchi platform. Prospects are fault traps and faulted anticlines along transtensional faults that were active in early Tertiary time. The transtensional faults lie in several discrete north-trending, densely-faulted zones. Several evaporite diapirs pierce this play in a narrow graben just west of Popcorn well. Play 12 therefore includes traps involving truncation of Torok Formation turbidites against diapir flanks. This play is charged by the Hanna trough play charging system (described in play 1), with some hydrocarbons possibly re-migrating into Brookian sandstones from deeper Ellesmerian stratigraphic traps disrupted by Paleocene faults. The play was penetrated at three wells, with pooled, recoverable oil apparently present (log interpretation) at Crackerjack and Klondike wells. No hydrocarbons were present in the play sequence at Popcorn well. A sequence of turbiditic sandstones over 400 ft thick was encountered at the base of the Torok Formation in Crackerjack well.

Play 13 (UACS1300). Lower Brookian Sequence—Nanushuk Topset-Chukchi Platform Wrench Zone: Potential reservoirs are primarily sandstones of the Albian-Cenomanian Nanushuk Group that were deposited in delta-plain and nearshore environments on the shelf terrace between Colville and North Chukchi basins and on Chukchi platform. Prospects are fault traps, faulted anticlines, and diapir-flank traps, as in underlying play 12. This play, like play 12, is charged by the Hanna trough play charging system (described in play 1), with some hydrocarbons possibly re-migrated out of deeper Ellesmerian stratigraphic traps disrupted by faults. The play was penetrated by three wells (Popcorn, Crackerjack, Klondike), which encountered only very sparse sandstones and no pooled hydrocarbons.

Play 14 (UACS1400). Sand Apron-North Chukchi High (Upper and Lower Brookian sequences): Potential reservoirs are inferred to consist primarily of shallow marine to fluvial sandstones of Early Cretaceous to Tertiary age that are hypothesized to have been deposited in littoral systems that fringed North Chukchi high, an area of recurrent uplift throughout Albian-Aptian (post-Brookian unconformity) and later time (Johnson, 1992). Play 14 therefore includes both Lower and Upper Brookian sequences. The play is probably charged primarily from the west by the North Chukchi basin play charging system (Lower Cretaceous to Tertiary Brookian shales generating gas and oil that rose along faults into shallow traps in North Chukchi basin and perhaps conducted up carrier beds to nearby structural uplifts like North Chukchi high). Play 14 extends into the Beaufort shelf assessment province and was assessed there as Beaufort shelf play UABS2300.

Play 15 (UACS1500). Lower Brookian Sequence—Cretaceous Topset-North Chukchi Basin: Potential reservoirs are hypothesized to be deltaic sandstones of Cretaceous (possibly Late Cretaceous?) age that concluded an early cycle (Beaufort margin rifting) of filling of North Chukchi basin. We speculate that these deposits represent the filling of the basin to baseline prior to renewed subsidence in Paleocene time. Traps are primarily north-trending horsts formed during early Tertiary time. The play is presumed to be charged by the North Chukchi basin play charging system (described in play 14). Neither the play nor any rocks correlative to the proposed Upper Cretaceous(?) reservoir sequence were tested by any well on Chukchi shelf.

Play 16 (UACS1600). Brookian Sequence (Upper and Lower Brookian)—Overmature "Deep Gas": Potential reservoir objectives include mostly Early Cretaceous and Tertiary sandstones in both Colville and North Chukchi basins that lie at depths below the oil floor at 2.0% vitrinite reflectance. Play 16 therefore includes mostly rocks of the Lower Brookian sequence, but also Upper Brookian rocks in a small, deep graben in North Chukchi basin. All pools within this play are modeled as consisting completely of gas. In Colville basin, the traps are primarily located in the undeformed plate below the regional decollement at the base of the foldbelt play (11). The subthrust plate probably consists of Torok Formation shales and turbiditic sandstones. This play was not tested by any well.

Play 17 (UACS1700). Lower Brookian Sequence—Torok Turbidites-Arctic Platform (Unstructured): This play addresses the unstructured area of the Arctic platform that lies south of Barrow arch, east of the wrench fault province of western Chukchi shelf (equivalent play 12), and north of the foldbelt (play 11). Play 17 overlaps western parts of the Beaufort shelf assessment province and was assessed there as Beaufort shelf play UABS2400. Potential reservoirs are turbidite sandstones within the Lower Cretaceous Torok Formation. Exploratory drilling has shown that sandstone is quite sparse within the Torok Formation in this play. Reservoir presence is therefore one important risk element for the play. Low-relief anticlines, possibly related to compaction, mounded fan complexes, and slope turbidites isolated within slope shales form the primary anticipated trap types, few of which are readily observable in seismic data. The play is modeled as predominately charged by the Hanna trough play charging system (described in play 1), although some contribution from the gas-rich Colville basin play charging system (described in play 11) is also possible. The play was tested by Burger and Diamond wells and several wells onshore. No pooled hydrocarbons were encountered in any well.

Play 18 (UACS1800). Lower Brookian Sequence—Nanushuk Topset-Arctic Platform (Unstructured): Like play 17, play 18 addresses the unstructured area of the Arctic platform that lies south of Barrow arch, east of the wrench fault province of western Chukchi shelf (equivalent play 13), and north of the foldbelt (play 11). Play 18 overlaps western parts of the Beaufort shelf assessment province and was assessed there as Beaufort shelf play UABS2500. Reservoir objectives include delta-plain and nearshore sandstones of the Lower Cretaceous Nanushuk Group. Low-relief anticlines possibly related to differential compaction and stratigraphic terminations of homoclinally-dipping sandstones form the primary trap types. Like play 17, the play is modeled as predominately charged by the Hanna trough play charging system,

OIL AND GAS ENDOWMENTS OF CHUKCHI SHELF PLAYS

Risked, Undiscovered, Conventionally Recoverable Oil and Gas

PLAY NO.	PLAY NAME (UAI * CODE)	OIL (BBO)			GAS (TCFG)		
		F95	MEAN	F05	F95	MEAN	F05
1.	Endicott-Chukchi Platform (UACS0100)	0.000	3.001	6.696	0.000	9.762	19.377
2.	Endicott-Arctic Platform (UACS0200)	0.000	0.002	0.006	0.000	0.035	0.133
3.	Lisburne Carbonates (UACS0300)	0.000	0.041	0.149	0.000	0.137	0.509
4.	Ellesmerian Deep Gas (UACS0400)	0.000	0.016	0.049	0.000	0.629	1.962
5.	Sadlerochit-Chukchi Platform (UACS0500)	0.257	0.537	1.098	1.478	2.993	5.823
6.	Sadlerochit-Arctic Platform (UACS0600)	0.000	0.660	1.818	0.000	1.935	5.314
7.	Rift - Active Margin (UACS0700)	2.385	4.136	7.770	5.314	8.547	14.204
8.	Rift - Stable Shelf (UACS0800)	0.910	1.645	3.121	3.118	5.026	8.193
9.	Rift - Deep Gas (UACS0900)	0.0003	0.003	0.007	0.012	0.108	0.269
10.	Herald Arch (UACS1000)	0.000	0.00002	0.00008	0.000	0.0006	0.003
11.	L. Brook. Foldbelt (UACS1100)	0.149	0.265	0.430	2.328	4.491	8.225
12.	L. Brook. Turbidites/Wrench Zn (UACS1200)	0.054	0.147	0.331	0.240	0.635	1.384
13.	L. Brook. Topset/Wrench Zn (UACS1300)	0.000	0.110	0.371	0.000	0.326	1.376
14.	N. Chukchi High/Sand Apron (UACS1400)	0.000	1.182	3.497	0.000	13.082	36.046
15.	L. Brook. Topset/N. Chukchi Basin (UACS1500)	0.000	0.099	0.283	0.000	1.491	4.564
16.	Brookian Deep Gas (UACS1600)	0.000	0.006	0.028	0.000	0.237	1.076
17.	L. Brookian/Turbidites/Arct. Plat. (UACS1700)	0.000	0.003	0.021	0.000	0.008	0.053
18.	L. Brookian/Topset/Arctic Platform (UACS1800)	0.000	0.045	0.173	0.000	0.034	0.121
19.	U. Brookian/Sag Phase/N. Chuk. Bsn. (UACS1900)	0.000	0.002	0.012	0.000	0.038	0.171
20.	U. Brookian/Turbidites/N.Chuk.Bsn. (UACS2000)	0.000	0.027	0.068	0.000	0.484	1.306
21.	U. Brookian/Paleovalleys (UACS2100)	0.000	0.886	2.283	0.000	1.637	3.961
22.	U. Brookian/Intervalley Highs (UACS2200)	0.000	0.204	0.697	0.000	0.203	0.740
	FASPAG AGGREGATION	***6.801***	***13.015***	***21.943***	***9.808***	***51.840***	***141.754***

* *Unique Assessment Identifier, code unique to play.*

although some contribution from the gas-rich Colville basin system is possible. The play was tested at Diamond and Burger wells. A gas-charged sandstone 36 feet thick was encountered at Burger well, which is located within several miles of the easternmost fault of a fault system that passes downward into the Burger gas pool. This fault may have formed a migration conduit for gas escaping upward from Kuparuk sandstones within the underlying Burger gas pool.

Play 19 (UACS1900). Upper Brookian Sequence—Upper Tertiary Sag Phase-North Chukchi Basin: Potential reservoirs include Eocene(?) and younger marine sandstones deposited in North Chukchi basin during the post-rift thermal or "sag" phase of basin subsidence. Some sandstones in this sequence may be associated with an Eocene regression marked by an unconformity at Popcorn well (Micropaleo Consultants, 1989) and widely observed and mapped in seismic data in North Chukchi basin (Lothamer, 1994). Prospects include fault traps, faulted anticlines, and diapir-flank traps, the latter in a graben west of Popcorn well. This play is charged by the North Chukchi basin play charging system (described in play 14). Play 19 was tested in a proximal setting by Popcorn well, which encountered only very sparse sandstone in the play sequence. Reservoir presence is therefore considered a major risk element for this play.

Play 20 (UACS2000). Upper Brookian Sequence—Lower Tertiary Turbidites-North Chukchi Basin: Potential reservoirs are mostly turbidite sandstones hypothesized to have been deposited within north-trending, faulted-bounded seafloor grabens formed during Paleocene transtensional rifting in North Chukchi basin. Play 20 is charged by the North Chukchi basin play charging system (described in play 14). This play was not tested by any well.

Play 21 (UACS2100). Upper Brookian Sequence—Lower Tertiary Paleovalley Fill: Potential reservoirs include fluvial sandstone reservoirs deposited in fault-bounded paleovalleys that emptied northward from Chukchi platform into North Chukchi basin in early Tertiary time. The fluvial sandstones lie at the base of a transgressive Paleocene-Eocene sequence that records progressive drowning of the valleys. Traps are primarily stratigraphic pinch-outs or fault truncations of the fluvial sandstones along the north-trending valley margins, as well as diapir-flank traps in a narrow graben west of Popcorn well. The play is modeled as predominantly charged by the Hanna trough play charging system (described in play 1), although some parts of the play extend north into North Chukchi basin and may be charged by that petroleum generation system (described in play 14). This play was tested at Popcorn, Crackerjack, and Klondike wells. All wells encountered highly porous sandstones, with the maximum observed thickness reaching 540 feet at Popcorn well. No pooled oil or gas were encountered in any Upper Brookian sandstones.

Play 22 (UACS2200). Upper Brookian Sequence—Tertiary Basal Transgressive Sand-Intervalley Uplifts: Potential reservoirs include transgressive-lag sandstone reservoirs deposited on wrench-fault-bounded structural ridges in Paleocene time. Because of the transgressive nature of the sandstones and the low inclination of flooding surfaces at the crests of intervalley uplifts, reservoirs are modeled as thin relative to play 21 (see discussion by Abbott, 1985, p. 158). The play is modeled as predominantly charged by the Hanna trough play charging

system. This play was not tested by any well.

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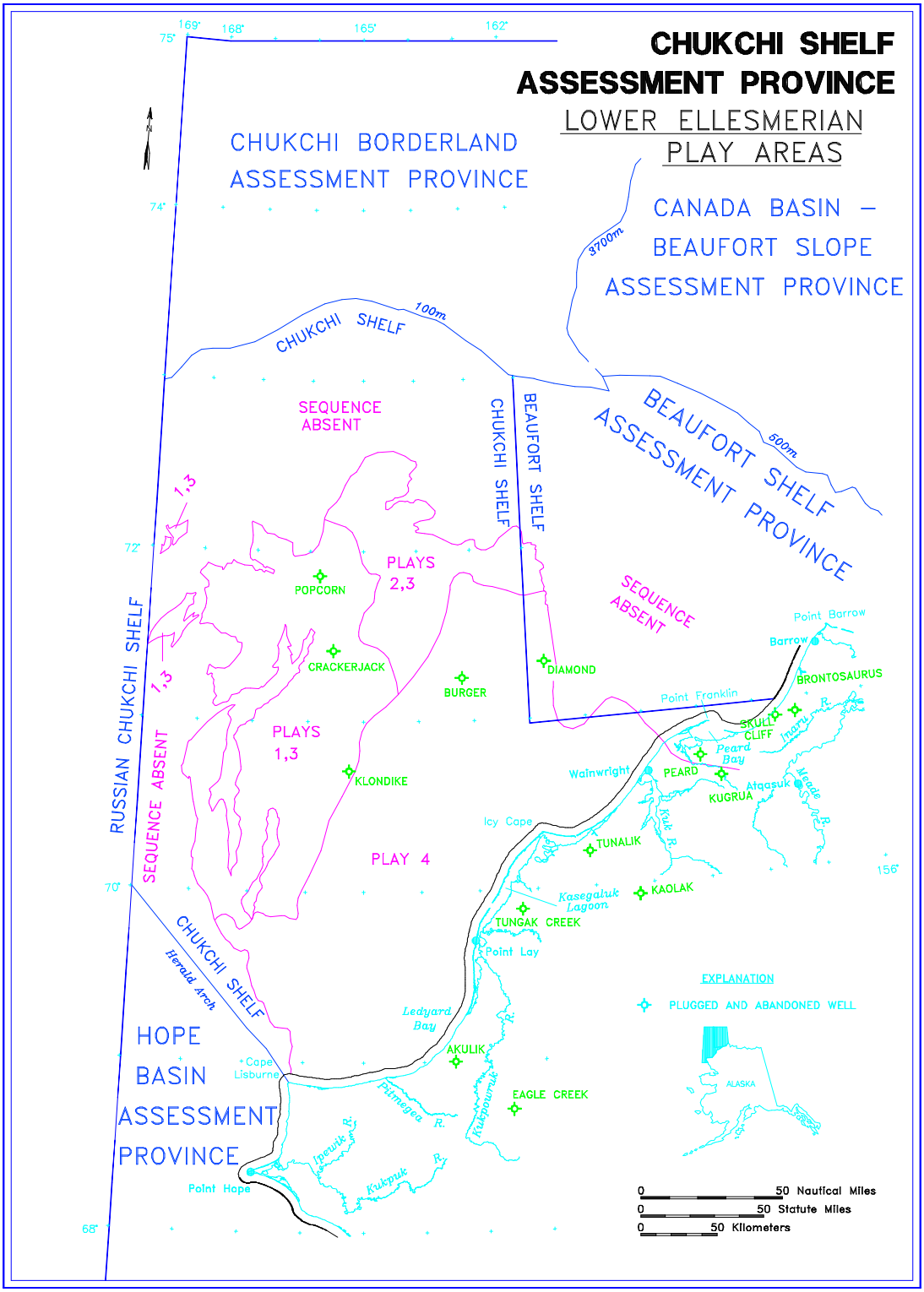
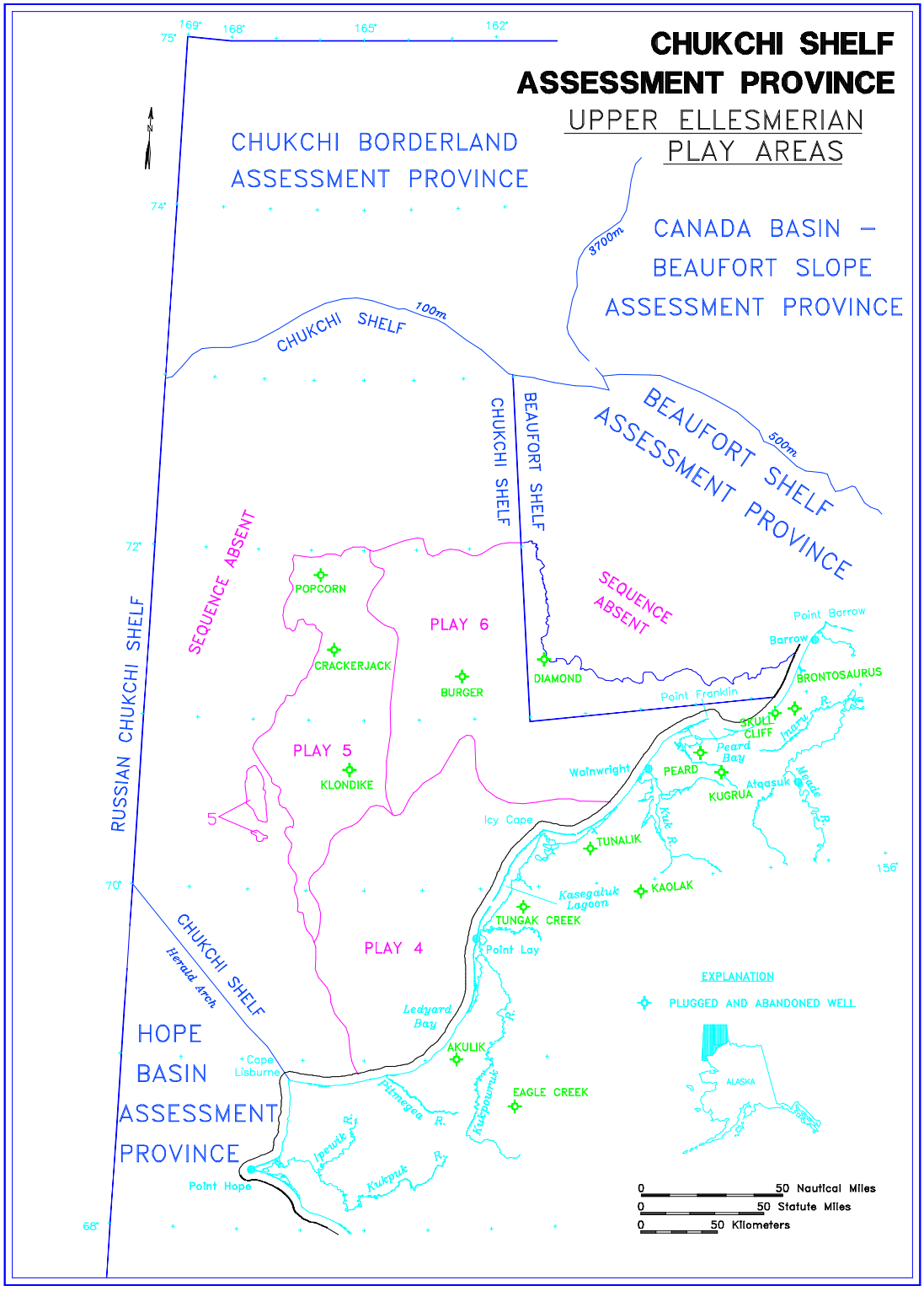
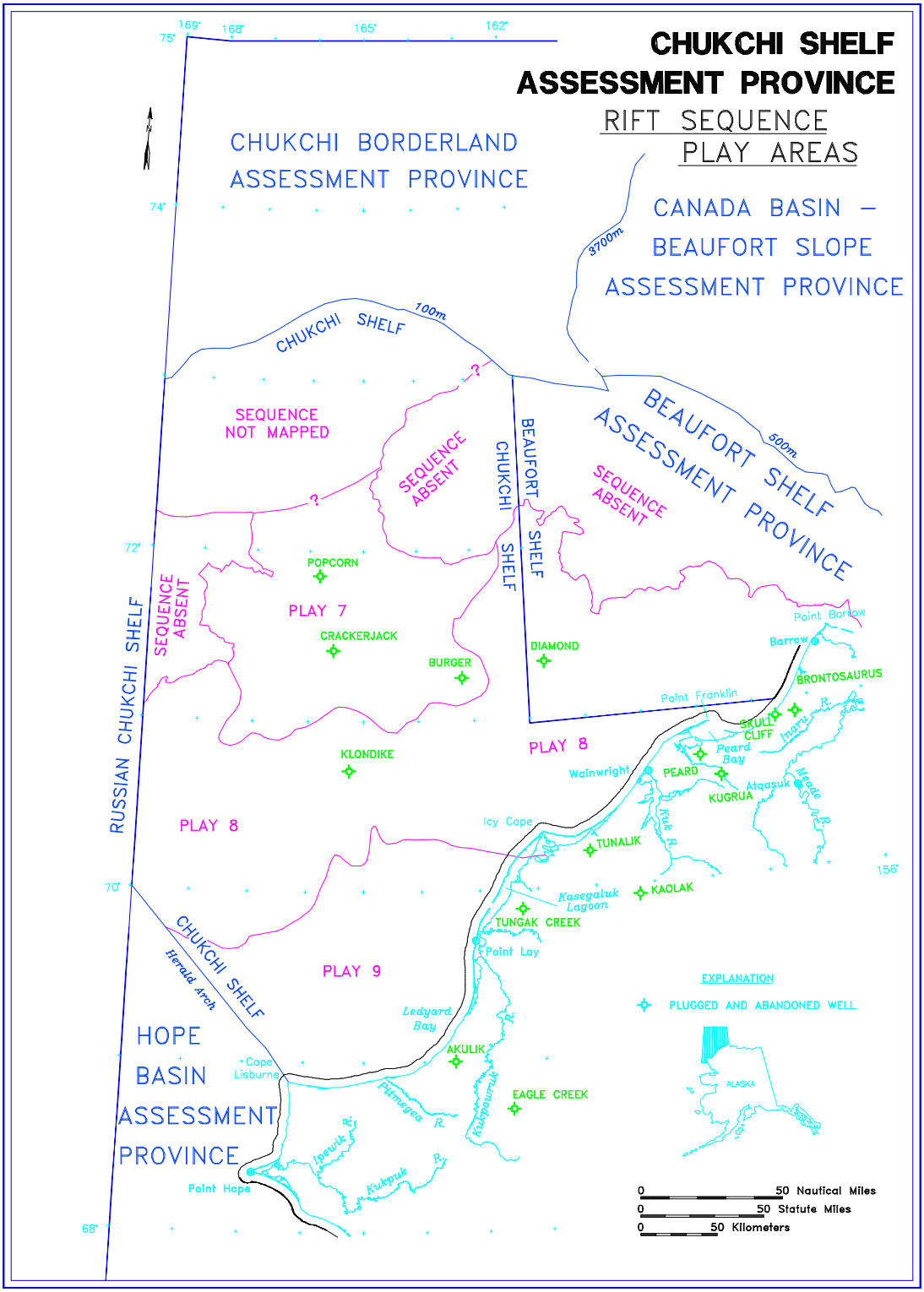
CHUKCHI SHELF - MAP FOR LOWER ELLESMERIAN PLAYS



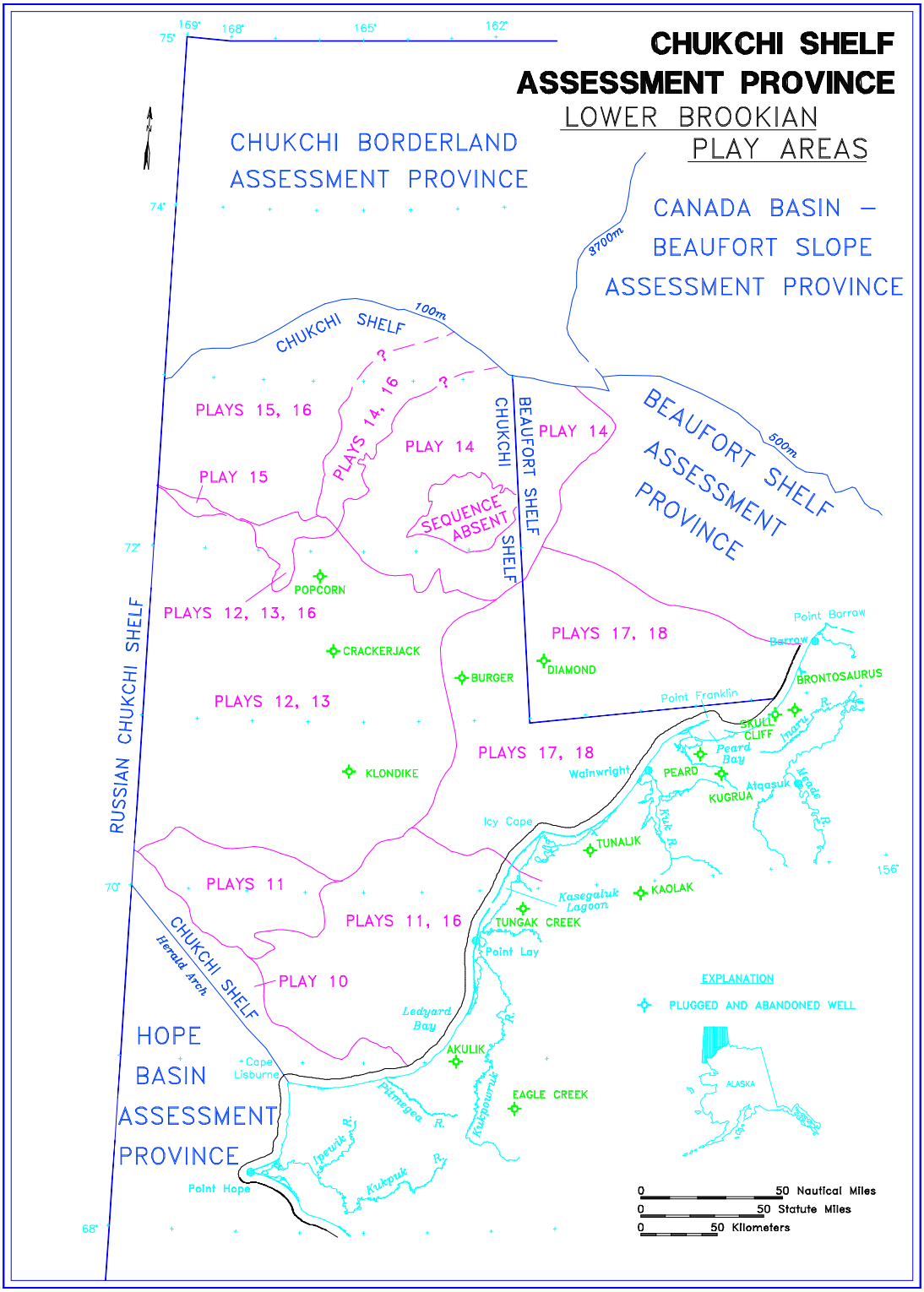
CHUKCHI SHELF - MAP FOR UPPER ELLESMERIAN PLAYS



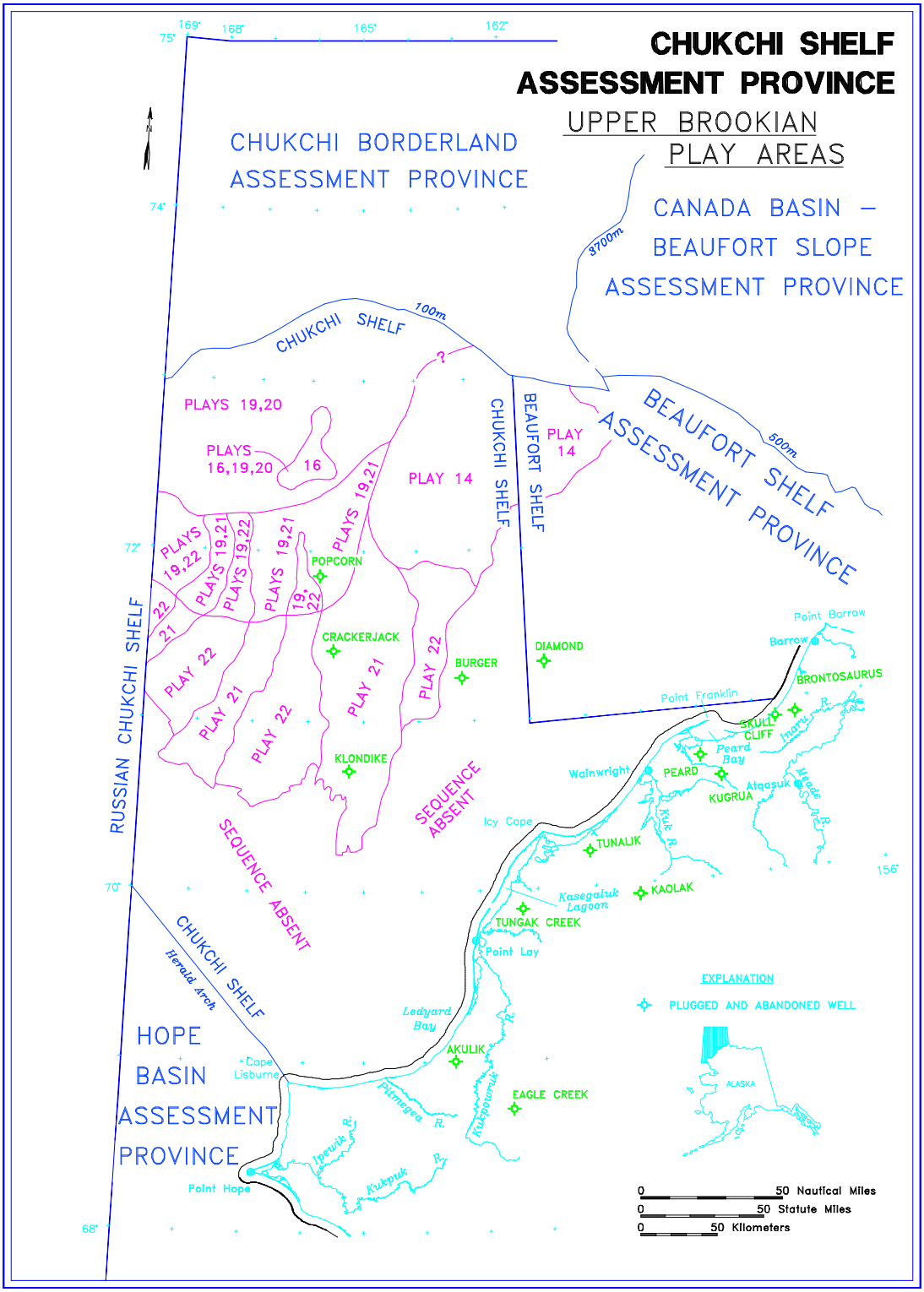
CHUKCHI SHELF - MAP FOR RIFT SEQUENCE PLAYS



CHUKCHI SHELF - MAP FOR LOWER BROOKIAN PLAYS



CHUKCHI SHELF - MAP FOR UPPER BROOKIAN PLAYS



EXPLANATION OF DATA TABLES FOR CHUKCHI SHELF ASSESSMENT PROVINCE

RESULTS

LOG-N PARAMS (PORE) Key mathematic parameters that describe log-normal probability distributions for volume of hydrocarbon-bearing rock, in acre-feet, for each play as reported in the **PORE** module of **GRASP**.

mu Natural logarithm of F50 value of log-normal distribution for volume of hydrocarbon-bearing rock, or "μ", for the subject play. **mu** = ln F50. [Note: distribution **mean** = $e^{(mu + 0.5[sig.\ sq.])}$.]

sig. sq. The variance of the log-normal distribution for volume of hydrocarbon-bearing rock, or "σ^2", for the subject play. **sig. sq.** = $\{\ln [0.5((F50/F16)+(F84/F50))]\}^2$.

N (MPRO) Number of hydrocarbon pools calculated for the plays by the **MPRO** module of **GRASP** from inputs for probability distributions of prospect numbers and geologic chances of success (approximately the product of play and prospect chances of success) . The maximum (**Max**) number of pools for each play was entered into the **MONTE1** module of **GRASP** to fix the number of pools aggregated to calculate play resources.

Reserves Sums of recoverable oil and gas volumes for pools within the play, including both proven and inferred reserve categories. A "prop" entry indicates that the reserve data are proprietary.

BCF Billions of cubic feet of gas, recoverable, at standard (surface) conditions (here fixed at a temperature of 60° Fahrenheit or 520° Rankine, and 14.73 psi atmospheric pressure).

MMB Millions of barrels of oil, recoverable, at standard (surface) conditions.

Undiscovered Potential Risked, undiscovered, conventionally recoverable oil and gas resources of the play, here reported at **Means** of probability distributions.

EXPLANATION OF DATA TABLES FOR CHUKCHI SHELF ASSESSMENT PROVINCE

Mean Pool Sizes of Ranks 1 to 3 Unrisked (or conditional) mean volumes of recoverable oil and gas in the three largest pools in the play.

PLAY INPUT DATA

F100.....F00 Fractiles for values within probability distributions entered to **GRASP** for calculations of play resources. Four-point distributions (F100, F50, F02, F00) generally indicate that calculations were conducted using log-normal mathematics. Eight-point distributions generally indicate that calculations were conducted using Monte Carlo mathematics. Choice of mathematic approach was in most cases the option of the assessor.

Prospect Area Maximum area of prospect closure, or area within spill contour, in acres. Probability distributions for prospect areas were generally based on distributions assembled independently for each play from large numbers of prospects mapped with seismic reflection data.

Trap Fill Trap fill fraction, or fraction of prospect area in which the reservoir is predicted to be saturated by hydrocarbons.

Pool Area Areal extent of hydrocarbon-saturated part of prospect, in acres. Calculated using **PRASS**, or **SAMPLER** module of **GRASP**, to integrate input probability distributions for prospect areas and trap fill fractions.

Pay Thickness Thickness of hydrocarbon-productive part of reservoir within pool areas, in feet. Probability distributions for prospect areas, trap fill fractions, and pay thicknesses are integrated in the **PORE** module of **GRASP**, to calculate a probability distribution for volume of hydrocarbon-bearing rock, in feet, within the play as reported above under **LOG-N PARAMS (PORE)** .

EXPLANATION OF DATA TABLES FOR CHUKCHI SHELF ASSESSMENT PROVINCE

Oil Yield (Recov. B/Acre-Feet) Oil, in barrels at standard (surface) conditions, recoverable from a volume of one acre-foot of oil-saturated reservoir in the subsurface. Oil yield probability distributions were generally calculated in a separate exercise using **PRASS** to integrate input probability distributions for porosities, oil saturations, oil shrinkage factors (or "Formation Volume Factors"), and oil recovery efficiencies.

Gas Yield (MMCF/Ac.-Ft.) Gas, in millions of cubic feet at standard (surface) conditions, recoverable from a volume of one acre-foot of gas-saturated reservoir in the subsurface. Distributions were generally calculated in a separate exercise using **PRASS** to integrate input probability distributions for porosities, gas saturations, reservoir pressures, reservoir temperatures (in degrees Rankine), gas deviation ("Z") factors, combustible fractions (that exclude noncombustibles such as carbon dioxide, nitrogen, etc.), and gas recovery efficiencies.

Solution Gas-Oil Ratio (CF/B) Quantity of gas dissolved in oil in the reservoir that separates from the oil when brought to standard (surface) conditions, in cubic feet recovered per barrel of produced oil.

Gas Cond. (B/MMCF) Quantity of liquids or condensate dissolved in gas in the reservoir that separates from the gas when brought to standard (surface) conditions, in barrels recovered per million cubic feet of produced gas.

Number of Prospects..... Probability distributions for numbers of prospects in plays, generally ranging from minimum values (F99) representing the numbers of mapped prospects, to maximum values (F00) that include speculative estimates for the numbers of additional prospects that remain unidentified (generally stratigraphic prospects, geophysically indefinite prospects, or prospects expected in areas with no seismic coverage).

EXPLANATION OF DATA TABLES FOR CHUKCHI SHELF ASSESSMENT PROVINCE

Probabilities for Oil, Gas, or Mixed Pools

Oil (OPROB) Fraction of hydrocarbon pools that consist entirely of oil, with no free gas present. Typically, an undersaturated oil pool.

Gas (GPROB) Fraction of hydrocarbon pools consisting entirely of gas, with no free oil present.

Mixed (MXPROB) Fraction of hydrocarbon pools that contain both oil and gas as free phases, the gas usually present as a gas cap overlying the oil.

Fraction of Net Pay to Oil (OFRAC) When a hydrocarbon pool is modeled as a mixed case, with both oil and gas present, the fraction of pool volume that is saturated by oil in the subsurface.

Play Chance Success Probability that the play contains at least one pool of technically-recoverable hydrocarbons (that would flow into a conventional wellbore in a flow test or during production).

Prospect Chance Success The fraction of prospects within the play that are predicted to contain hydrocarbon pools, given the condition that at least one pool of technically-recoverable hydrocarbons occurs within the play.

Play Type (E-F-C) Play classification scheme.

E **Established** play, in which significant numbers of fields have been discovered, providing the assessor with data for pool size distributions and reservoirs sufficient to allow the assessor to model the play with confidence.

F **Frontier** play, where exploration activities are at an early stage. Some wells have already been drilled to test the play concept but no commercial fields have been established.

EXPLANATION OF DATA TABLES FOR CHUKCHI SHELF ASSESSMENT PROVINCE

C	**Conceptual** play, hypothesized by analysts based on the subsurface geologic knowledge of the area. Such plays remain hypothetical and the play concept has not been tested.

CHUKCHI SHELF

				Log-N Params.							
				PORE		N (MPRO)		Reserves		Undiscovered Potentia	
Play				Ac/Ft	Ac/Ft	No. Pools		Gas	Oil	Gas	Oil
No.	Area	UAI Code	Name	mu	sig. sq.	Mean	Max	(BCF)	(MMB)	(BCF)	(MMB)
1	CHUKCHI	UACS0100	Endicott Clastics-Chuk. Plat.	13.931	1.441	22	89	- -	- -	9762	3001
2	CHUKCHI	UACS0200	Endicott Clastics-Arct. Plat.	12.174	2.018	0.3	7	- -	- -	35	2
3	CHUKCHI	UACS0300	Lisburne Carbonates	12.724	1.347	2	18	- -	- -	137	41
4	CHUKCHI	UACS0400	Ellesmerian "Deep Gas"	12.836	0.963	9	61	- -	- -	629	16
5	CHUKCHI	UACS0500	Sadlerochit Gp.-Chuk. Plat.	13.452	1.468	13	33	- -	- -	2993	537
6	CHUKCHI	UACS0600	Sadlerochit Gp.-Arct. Plat.	13.638	1.055	6	28	- -	- -	1935	660
7	CHUKCHI	UACS0700	Rift Seq.-Active Margin Clastics	13.150	1.883	31	78	- -	- -	8547	4136
8	CHUKCHI	UACS0800	Rift Seq.-Stable Marine Shelf	13.081	1.632	27	76	- -	- -	5026	1645
9	CHUKCHI	UACS0900	Rift Seq.-"Deep Gas"	11.694	0.473	4	17	- -	- -	108	3
10	CHUKCHI	UACS1000	Herald Arch, Thrust Zone	10.525	0.418	0.2	8	- -	- -	1	0
11	CHUKCHI	UACS1100	Foreland Foldbelt	13.097	1.405	17	42	- -	- -	4491	265
12	CHUKCHI	UACS1200	Torok Turbs.-Chuk. Wrench Zn.	12.430	1.357	10	39	- -	- -	635	147
13	CHUKCHI	UACS1300	Nanushuk-Chuk. Wrench Zn.	12.342	1.476	2	19	- -	- -	326	110
14	CHUKCHI	UACS1400	Sand Apron - N. Chuk. High	13.971	2.343	7	33	- -	- -	13082	1182
15	CHUKCHI	UACS1500	L.Brook. Topset-N. Chuk. Bsn.	12.182	1.543	15	54	- -	- -	1491	99
16	CHUKCHI	UACS1600	Brookian "Deep Gas"	12.547	0.846	3	36	- -	- -	237	6
17	CHUKCHI	UACS1700	Torok Turbs.-Arct. Plat.	12.669	0.337	0.2	5	- -	- -	8	3
18	CHUKCHI	UACS1800	Nanushuk-Arct. Plat.	12.232	0.640	1	8	- -	- -	34	45
19	CHUKCHI	UACS1900	U.Brookian Sag Seq.-N. Chuk. Bsn.	10.978	1.352	1	10	- -	- -	38	2
20	CHUKCHI	UACS2000	U. Brookian Turbs.-N. Chuk. Bsn.	12.063	0.932	6	36	- -	- -	484	27
21	CHUKCHI	UACS2100	U. Brookian-Paleovalley Fill	13.034	1.059	5	34	- -	- -	1637	886
22	CHUKCHI	UACS2200	U. Brookian-Intervalley Highs	12.026	1.305	3	20	- -	- -	203	204

CHUKCHI SHELF

		MEAN POOL SIZES OF RANKS 1 TO 3											
		Pool #1		Pool #2		Pool #3		INPUT DATA					
PLAY		Gas	Oil	Gas	Oil	Gas	Oil	Prospect Area (Acres)					
No.	Name	(BCF)	(MMB)	(BCF)	(MMB)	(BCF)	(MMB)	F100	F95	F75	F50	F25	F05
1	Endicott Clastics-Chuk. Plat.	3022	924	1742	541	1151	347	302			18650		
2	Endicott Clastics-Arct. Plat.	123	6	32	2	20	1	42			6430		
3	Lisburne Carbonates	149	42	66	19	35	10	242			11150		
4	Ellesmerian "Deep Gas"	286	7	140	4	117	3	472			12480		
5	Sadlerochit Gp.-Chuk. Plat.	1035	189	525	98	317	58	220			16160		
6	Sadlerochit Gp.-Arct. Plat.	1077	369	601	210	378	129	280			9730		
7	Rift Seq.-Active Margin Clastics	2383	1108	1216	580	766	358	120			13300		
8	Rift Seq.-Stable Marine Shelf	1375	421	732	230	468	143	117			11150		
9	Rift Seq.-"Deep Gas"	48	1	25	1	21	1	1670			13930		
10	Herald Arch, Thrust Zone	3	0	1	0	1	0	420			3000		
11	Foreland Foldbelt	1569	39	755	19	551	14	304			13220		
12	Torok Turbs.-Chuk. Wrench Zn.	226	57	112	30	66	17	200			9240		
13	Nanushuk-Chuk. Wrench Zn.	335	124	140	55	74	27	110			7610		
14	Sand Apron - N. Chuk. High	9418	231	3011	590	1798	313	40			8590		
15	L.Brook. Topset-N. Chuk. Bsn.	1042	26	275	29	219	20	70			5090		
16	Brookian "Deep Gas"	235	6	114	3	92	2	280			6540		
17	Torok Turbs.-Arct. Plat.	52	18	36	13	28	10	1370			7400		
18	Nanushuk-Arct. Plat.	48	60	27	35	19	24	560			6820		
19	U.Brookian Sag Seq.-N. Chuk. Bsn.	95	2	20	5	13	3	70			4500		
20	U. Brookian Turbs.-N. Chuk. Bsn.	305	8	111	10	80	7	120			3420		
21	U. Brookian-Paleovalley Fill	904	499	474	267	288	159	160			4840		
22	U. Brookian-Intervalley Highs	218	203	100	95	56	52	140			7770		

CHUKCHI SHELF

		INPUT DATA											
PLAY		Prospect Area (Acres)			Trap Fill (Dec. Frac.)								
No.	Name	F02	F01	F00	F100	F95	F75	F50	F25	F05	F02	F01	F00
1	Endicott Clastics-Chuk. Plat.	181800		1151000	0.08			0.43			0.68		1.00
2	Endicott Clastics-Arct. Plat.	103500		985000	0.08			0.43			0.68		1.00
3	Lisburne Carbonates	92400		514000	0.08			0.43			0.68		1.00
4	Ellesmerian "Deep Gas"	77000		330000	0.08			0.43			0.68		1.00
5	Sadlerochit Gp.-Chuk. Plat.	173600		1190000	0.08			0.43			0.68		1.00
6	Sadlerochit Gp.-Arct. Plat.	69400		341000	0.08			0.43			0.68		1.00
7	Rift Seq.-Active Margin Clastics	176500		1437000	0.08			0.43			0.68		1.00
8	Rift Seq.-Stable Marine Shelf	138000		1100000	0.08			0.43			0.68		1.00
9	Rift Seq.-"Deep Gas"	45000		116000	0.08			0.43			0.68		1.00
10	Herald Arch, Thrust Zone	8000		22000	0.12			0.25			0.35		0.50
11	Foreland Foldbelt	106200		575000	0.12			0.25			0.35		0.50
12	Torok Turbs.-Chuk. Wrench Zn.	77600		436000	0.08			0.43			0.68		1.00
13	Nanushuk-Chuk. Wrench Zn.	78300		519000	0.08			0.43			0.68		1.00
14	Sand Apron - N. Chuk. High	172600		1900000	0.17			0.66			0.87		1.00
15	L.Brook. Topset-N. Chuk. Bsn.	55400		384000	0.09			0.25			0.38		0.60
16	Brookian "Deep Gas"	37100		152000	0.08			0.43			0.68		1.00
17	Torok Turbs.-Arct. Plat.	18800		40000	0.08			0.43			0.68		1.00
18	Nanushuk-Arct. Plat.	27100		83000	0.08			0.43			0.68		1.00
19	U.Brookian Sag Seq.-N. Chuk. Bsn.	45000		292000	0.09			0.25			0.38		0.60
20	U. Brookian Turbs.-N. Chuk. Bsn.	21500		95000	0.09			0.25			0.38		0.60
21	U. Brookian-Paleovalley Fill	32140		149000	0.08			0.43			0.68		1.00
22	U. Brookian-Intervalley Highs	71250		430000	0.08			0.43			0.68		1.00

CHUKCHI SHELF

		INPUT DATA													
PLAY		Pool Area (Acres)									Pay Thickness (Feet)				
No.	Name	F100	F95	F75	F50	F25	F05	F02	F01	F00	F100	F95	F75	F50	F25
1	Endicott Clastics-Chuk. Plat.	120			8020			81800		538000	30			140	
2	Endicott Clastics-Arct. Plat.	17			2770			46200		453000	10			70	
3	Lisburne Carbonates	95			4800			42000		241000	23			70	
4	Ellesmerian "Deep Gas"	183			5370			35000		157000	18			70	
5	Sadlerochit Gp.-Chuk. Plat.	90			6950			78000		550000	34			100	
6	Sadlerochit Gp.-Arct. Plat.	110			4190			31500		162000	100			200	
7	Rift Seq.-Active Margin Clastics	50			5700			79000		665000	14			90	
8	Rift Seq.-Stable Marine Shelf	50			4800			62000		492000	34			100	
9	Rift Seq.-"Deep Gas"	610			5990			21100		59000	6			20	
10	Herald Arch, Thrust Zone	90			750			2400		6300	17			50	
11	Foreland Foldbelt	60			3250			30200		184000	25			150	
12	Torok Turbs.-Chuk. Wrench Zn.	80			3980			35000		205000	10			63	
13	Nanushuk-Chuk. Wrench Zn.	40			3270			35200		242000	18			70	
14	Sand Apron - N. Chuk. High	20			5840			127500		1550000	60			200	
15	L.Brook. Topset-N. Chuk. Bsn.	20			1300			15000		109000	40			150	
16	Brookian "Deep Gas"	110			2810			16900		73000	34			100	
17	Torok Turbs.-Arct. Plat.	490			3180			9000		21000	34			100	
18	Nanushuk-Arct. Plat.	210			2930			12560		41000	18			70	
19	U.Brookian Sag Seq.-N. Chuk. Bsn.	20			1170			11760		76000	16			50	
20	U. Brookian Turbs.-N. Chuk. Bsn.	30			870			5700		26000	66			200	
21	U. Brookian-Paleovalley Fill	60			2080			14600		71000	50			220	
22	U. Brookian-Intervalley Highs	60			3340			32100		201000	16			50	

CHUKCHI SHELF

		INPUT DATA															
PLAY		Pay Thickness (Feet)				Oil Yield (Recov. B/Acre-Foot)								Gas Yield (MMCF/Ac.-Ft)			
No.	Name	F05	F02	F01	F00	F100	F95	F75	F50	F25	F05	F01	F00	F100	F95	F75	F50
1	Endicott Clastics-Chuk. Plat.		320		700	3	16	32	53	86	177	292	813	0.015	0.070	0.142	0.232
2	Endicott Clastics-Arct. Plat.		150		350	2	11	23	39	65	137	231	668	0.005	0.030	0.065	0.110
3	Lisburne Carbonates		190		430	2	7	14	23	37	73	118	314	0.006	0.029	0.059	0.098
4	Ellesmerian "Deep Gas"		150		280	- -	- -	- -	- -	- -	- -	- -	- -	0.001	0.011	0.030	0.058
5	Sadlerochit Gp.-Chuk. Plat.		180		290	2	9	16	25	39	75	117	293	0.020	0.077	0.146	0.229
6	Sadlerochit Gp.-Arct. Plat.		370		610	6	25	47	73	114	215	335	833	0.017	0.081	0.170	0.285
7	Rift Seq.-Active Margin Clastics		250		570	11	38	69	103	156	282	427	997	0.025	0.108	0.212	0.340
8	Rift Seq.-Stable Marine Shelf		180		290	5	18	34	53	83	157	247	618	0.013	0.065	0.139	0.236
9	Rift Seq.-"Deep Gas"		38		65	- -	- -	- -	- -	- -	- -	- -	- -	0.004	0.024	0.058	0.107
10	Herald Arch, Thrust Zone		92		150	- -	- -	- -	- -	- -	- -	- -	- -	0.001	0.003	0.009	0.020
11	Foreland Foldbelt		400		890	6	20	32	45	65	110	160	330	0.036	0.107	0.178	0.255
12	Torok Turbs.-Chuk. Wrench Zn.		170		380	2	8	16	26	43	87	143	396	0.006	0.037	0.087	0.158
13	Nanushuk-Chuk. Wrench Zn.		150		280	7	30	58	93	147	287	458	1192	0.007	0.052	0.130	0.245
14	Sand Apron - N. Chuk. High		370		650	8	33	66	107	174	348	567	1535	0.007	0.049	0.125	0.239
15	L.Brook. Topset-N. Chuk. Bsn.		310		560	1	5	11	18	31	65	110	324	0.009	0.052	0.118	0.209
16	Brookian "Deep Gas"		180		290	- -	- -	- -	- -	- -	- -	- -	- -	0.003	0.019	0.049	0.094
17	Torok Turbs.-Arct. Plat.		180		290	6	19	33	48	70	122	179	392	0.031	0.097	0.165	0.238
18	Nanushuk-Arct. Plat.		150		280	47	113	170	225	300	448	597	1070	0.006	0.028	0.057	0.094
19	U.Brookian Sag Seq.-N. Chuk. Bsn.		93		155	15	47	81	117	170	291	424	916	0.050	0.165	0.290	0.429
20	U. Brookian Turbs.-N. Chuk. Bsn.		370		610	2	9	17	26	41	78	122	305	0.025	0.095	0.176	0.269
21	U. Brookian-Paleovalley Fill		500		970	33	100	168	240	344	577	829	1740	0.044	0.190	0.379	0.612
22	U. Brookian-Intervalley Highs		93		155	65	145	212	276	359	524	683	1176	0.085	0.221	0.346	0.471

CHUKCHI SHELF

PLAY		INPUT DATA															
		Gas Yield (MMCF/Ac.-Ft)				Solution Gas Oil Ratio (CF/B)								Gas Cond. (B/MMCF)			
No.	Name	F25	F05	F01	F00	F100	F95	F75	F50	F25	F05	F01	F00	F100	F95	F75	F50
1	Endicott Clastics-Chuk. Plat.	0.382	0.777	1.279	3.546	260	750	1200	1500	2000	3200	4200	8000	20	35	42	52
2	Endicott Clastics-Arct. Plat.	0.189	0.408	0.702	2.127	170	520	800	1100	1500	2300	3100	7000	20	35	42	52
3	Lisburne Carbonates	0.162	0.336	0.560	1.591	230	750	1300	1700	2300	3800	5200	10000	20	35	42	52
4	Ellesmerian "Deep Gas"	0.115	0.305	0.605	2.454	- -	- -	- -	- -	- -	- -	- -	- -	10	17	22	25
5	Sadlerochit Gp.-Chuk. Plat.	0.358	0.679	1.067	2.680	1000	1800	2200	2500	3000	3800	4200	5000	20	35	42	52
6	Sadlerochit Gp.-Arct. Plat.	0.477	1.000	1.684	4.879	220	600	900	1200	1600	2500	3100	6000	20	35	42	52
7	Rift Seq.-Active Margin Clastics	0.544	1.069	1.720	4.541	190	420	590	730	900	1300	1600	3000	20	35	42	52
8	Rift Seq.-Stable Marine Shelf	0.400	0.856	1.181	4.361	250	680	1000	1300	1800	2700	3600	7000	20	35	42	52
9	Rift Seq.-"Deep Gas"	0.196	0.469	0.865	3.024	- -	- -	- -	- -	- -	- -	- -	- -	10	17	22	25
10	Herald Arch, Thrust Zone	0.045	0.141	0.317	1.646	- -	- -	- -	- -	- -	- -	- -	- -	10	17	22	25
11	Foreland Foldbelt	0.364	0.609	0.874	1.829	800	980	1050	1100	1200	1250	1300	1500	10	17	22	25
12	Torok Turbs.-Chuk. Wrench Zn.	0.285	0.665	1.206	4.074	280	700	1050	1300	1800	2600	3600	7000	20	35	42	52
13	Nanushuk-Chuk. Wrench Zn.	0.461	1.149	2.181	8.081	100	400	720	1100	1700	3000	4500	10000	20	35	42	52
14	Sand Apron - N. Chuk. High	0.458	1.166	2.248	8.598	800	1700	2200	2800	3300	4400	5500	9000	10	17	22	25
15	L.Brook. Topset-N. Chuk. Bsn.	0.368	0.832	1.476	4.758	100	380	700	1100	1700	3200	5000	10000	10	17	22	25
16	Brookian "Deep Gas"	0.180	0.459	0.885	3.387	- -	- -	- -	- -	- -	- -	- -	- -	10	17	22	25
17	Torok Turbs.-Arct. Plat.	0.345	0.585	0.849	1.814	900	1020	1070	1100	1120	1140	1200	1300	20	35	42	52
18	Nanushuk-Arct. Plat.	0.155	0.318	0.526	1.474	490	530	550	570	590	600	620	680	20	35	42	52
19	U.Brookian Sag Seq.-N. Chuk. Bsn.	0.635	1.115	1.656	3.716	100	270	400	540	700	1140	1450	3000	10	17	22	25
20	U. Brookian Turbs.-N. Chuk. Bsn.	0.414	0.767	1.182	2.865	3000	3700	3900	4000	4300	4700	5000	5700	10	17	22	25
21	U. Brookian-Paleovalley Fill	0.988	1.967	3.190	8.573	100	270	410	590	780	1300	1700	3400	20	35	42	52
22	U. Brookian-Intervalley Highs	0.643	1.005	1.375	2.610	130	230	300	330	400	500	600	900	20	35	42	52

CHUKCHI SHELF

		INPUT DATA											
PLAY		Gas Cond. (B/MMCF)				Number of Prospects in Play							
No.	Name	F25	F05	F01	F00	F99	F95	F75	F50	F25	F05	F01	F00
1	Endicott Clastics-Chuk. Plat.	55	68	75	100	35	40	50	59	67	81	96	140
2	Endicott Clastics-Arct. Plat.	55	68	75	100	10	11	13	16	17	20	23	30
3	Lisburne Carbonates	55	68	75	100	39	40	43	48	52	56	63	78
4	Ellesmerian "Deep Gas"	28	35	40	50	86	100	125	150	185	240	285	430
5	Sadlerochit Gp.-Chuk. Plat.	55	68	75	100	32	33	36	40	43	49	52	64
6	Sadlerochit Gp.-Arct. Plat.	55	68	75	100	32	35	39	42	46	50	55	64
7	Rift Seq.-Active Margin Clastics	55	68	75	100	33	34	41	46	52	63	70	99
8	Rift Seq.-Stable Marine Shelf	55	68	75	100	24	27	34	40	46	57	66	96
9	Rift Seq.-"Deep Gas"	28	35	40	50	16	18	22	24	27	32	36	48
10	Herald Arch, Thrust Zone	28	35	40	50	2	3	6	8	13	23	36	102
11	Foreland Foldbelt	28	35	40	50	57	59	67	72	79	88	93	114
12	Torok Turbs.-Chuk. Wrench Zn.	55	68	75	100	41	44	57	66	77	96	115	164
13	Nanushuk-Chuk. Wrench Zn.	55	68	75	100	93	98	105	120	130	150	160	186
14	Sand Apron - N. Chuk. High	28	35	40	50	54	62	73	80	90	105	115	153
15	L.Brook. Topset-N. Chuk. Bsn.	28	35	40	50	60	63	68	70	73	79	81	91
16	Brookian "Deep Gas"	28	35	40	50	47	55	69	80	91	110	130	188
17	Torok Turbs.-Arct. Plat.	55	68	75	100	3	4	6	6	7	9	10	15
18	Nanushuk-Arct. Plat.	55	68	75	100	9	10	11	13	14	17	19	27
19	U.Brookian Sag Seq.-N. Chuk. Bsn.	28	35	40	50	20	22	27	30	33	40	44	60
20	U. Brookian Turbs.-N. Chuk. Bsn.	28	35	40	50	12	14	18	21	26	33	40	60
21	U. Brookian-Paleovalley Fill	55	68	75	100	27	30	40	48	57	68	89	135
22	U. Brookian-Intervalley Highs	55	68	75	100	13	15	18	20	22	26	30	39

CHUKCHI SHELF

PLAY		INPUT DATA						
		Probabilities for Oil, Gas, or Mixed Pools			Fraction of Net	Play	Prospect	
		Oil	Gas	Mixed	Pay to Oil	Chance	Chance	Play Type
No.	Name	(OPROB)	(GPROB)	(MXPROB)	(OFRAC)	Success	Success	E - F - C
1	Endicott Clastics-Chuk. Plat.	0.00	0.00	1.00	0.70	0.72	0.51	C
2	Endicott Clastics-Arct. Plat.	0.00	0.90	0.10	0.70	0.40	0.05	C
3	Lisburne Carbonates	0.00	0.00	1.00	0.70	0.49	0.10	C
4	Ellesmerian "Deep Gas"	0.00	1.00	0.00	0.00	0.54	0.10	C
5	Sadlerochit Gp.-Chuk. Plat.	0.00	0.00	1.00	0.70	1.00	0.32	C
6	Sadlerochit Gp.-Arct. Plat.	0.00	0.00	1.00	0.70	0.60	0.24	C
7	Rift Seq.-Active Margin Clastics	0.00	0.00	1.00	0.70	1.00	0.64	C
8	Rift Seq.-Stable Marine Shelf	0.00	0.00	1.00	0.70	1.00	0.64	C
9	Rift Seq.-"Deep Gas"	0.00	1.00	0.00	0.00	1.00	0.15	C
10	Herald Arch, Thrust Zone	0.00	1.00	0.00	0.00	1.00	0.02	C
11	Foreland Foldbelt	0.36	0.64	0.00	0.00	1.00	0.23	C
12	Torok Turbs.-Chuk. Wrench Zn.	0.00	0.00	1.00	0.70	1.00	0.14	C
13	Nanushuk-Chuk. Wrench Zn.	0.00	0.00	1.00	0.70	0.49	0.04	C
14	Sand Apron - N. Chuk. High	0.34	0.43	0.23	0.50	0.64	0.13	C
15	L.Brook. Topset-N. Chuk. Bsn.	0.34	0.43	0.23	0.50	0.50	0.42	C
16	Brookian "Deep Gas"	0.00	1.00	0.00	0.00	0.30	0.12	C
17	Torok Turbs.-Arct. Plat.	0.00	0.00	1.00	0.70	0.50	0.05	C
18	Nanushuk-Arct. Plat.	0.00	0.00	1.00	0.70	1.00	0.06	C
19	U.Brookian Sag Seq.-N. Chuk. Bsn.	0.34	0.43	0.23	0.50	0.40	0.05	C
20	U. Brookian Turbs.-N. Chuk. Bsn.	0.34	0.43	0.23	0.50	0.64	0.40	C
21	U. Brookian-Paleovalley Fill	0.00	0.00	1.00	0.70	0.70	0.15	C
22	U. Brookian-Intervalley Highs	0.00	0.00	1.00	0.70	0.48	0.28	C

EXPLANATION OF CHUKCHI SHELF PLAY SUMMARIES

This section consists of page-size compilations of graphics that summarize the results of ***GRASP*** modeling of the undiscovered, conventionally recoverable oil and gas endowments of each of the plays identified and assessed in the province. Each play summary features a plot for risked cumulative probability distributions for oil, gas, and BOE (gas in oil-equivalent barrels added to oil), a table of results, and a plot showing ranked sizes (oil and gas shown separately) of individual hypothetical pools. These three components of the play summaries are each described below.

Risked Cumulative Probability Distributions for Plays

Each play summary provides, at page top, cumulative probability distributions for risked, undiscovered endowments of conventionally recoverable oil, gas, and BOE. Oil and BOE quantities are shown in billions of barrels (B bbl). Gas quantities are reported in trillions of cubic feet (Tcf). Resource quantities are plotted against "Cumulative frequency greater than %." A cumulative frequency value represents the probability that the play resource endowment will exceed the quantity associated with the frequency value along one of the curves (fig. 0.1). Cumulative frequency values along the curves decrease as resource quantities increase. Accordingly, the cumulative frequencies, or "probabilities for exceedance," of small resource quantities are high, and conversely, the probabilities for exceedance of large resource quantities are low.

The cumulative probability distributions are risked and curves are truncated approximately at the output play chance. In most plays, the output play chance is equal to the input play chance for success. However, in plays with very small numbers of pools, the output play chance may be significantly **lower** than the input play chance for success.

The output play chance is derived from MPRO, a module within ***GRASP*** which uses inputs for geologic chance of success to convert probability distributions for numbers of ***prospects*** to probability distributions for numbers of ***pools***. The output play chance is obtained as a mathematic extrapolation to the probability at which the numbers of pools meets or exceeds zero. In plays with 5 or more pools at the mean, this probability usually equals the input play chance for success. In plays with less than 5 pools at the mean, the zero-pool probability (or output play chance) may be much less than the input play chance. Deviation between the output play chance and the input play chance is greatest in those plays with mean numbers of pools less than unity. Such highly risky plays contribute very little resources to overall province endowments.

Identification numbers beginning with "UA" in the graphics labels are codes unique to each of the plays in the ***GRASP*** data bases.

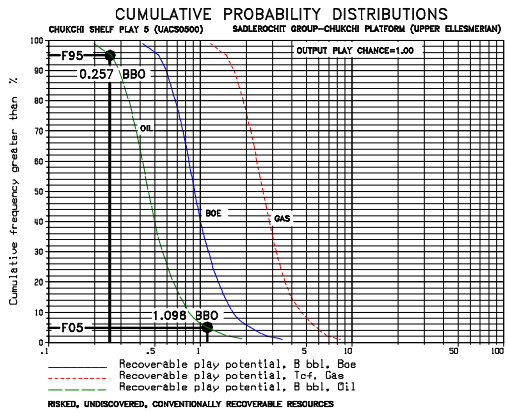
Table for Risked Play Resource Endowments

Each play summary provides, at page center, a table for risked, undiscovered play endowments of oil, gas, and BOE in billions of barrels of oil (BBO) or trillions of cubic feet of gas (TCFG). Quantities are reported at the **mean**, **F95** (a low estimate having a 95-percent frequency of exceedance), and **F05** (a high estimate having a 5-percent frequency of exceedance). Tabulated resource quantities are risked and therefore correspond to points on the cumulative probability distributions shown at page top. For plays with chances for success (play level) less than 0.95, the risked resource quantities reported at **F95** are zero.

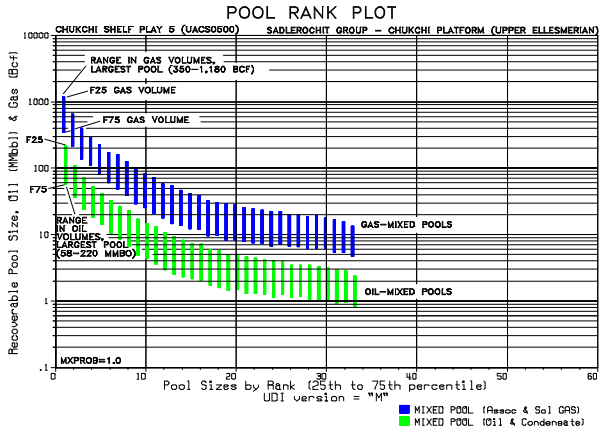
Ranked Pool Size Distributions for Plays

Each play summary provides, at page bottom, a plot showing pool sizes ranked according to size in BOE. The numbers of pools shown in the rank plots correspond to the maximum numbers of pools estimated to occur within the plays. Each pool in a pool rank plot is represented by a pair of adjoining vertical bars. The left bar of each pair represents the range (from **F75** to **F25** in the output probability distribution) of gas recoverable from the pool, and may include non-associated gas from an all-gas pool or associated gas from a gas cap and/or solution gas from oil, depending on pool type. The right bar of each pair represents the range (from **F75** to **F25**) of petroleum liquids recoverable from the same pool, and may include free oil, condensate from a gas cap, or condensate from a gas-only pool.

Volumes are shown in millions of barrels (MMbbl) of oil and billions of cubic feet (Bcf) of gas.



CHUKCHI SHELF PLAY 5 (UACS0500)			
FRACTILES	F95	MEAN	F05
GAS (TCFG)	1.478	2.993	5.823
OIL (BBO)	0.257	0.537	1.098
BOE (BBO)	0.530	1.069	2.125



The upper graph and the table report the volumes of risked, undiscovered, conventionally recoverable resources for the play. The graph, called a ***cumulative probability distribution***, shows three curves (oil, BOE, and gas) and reports the output play chance at upper right. The output play chance for Chukchi shelf play 5 is 1.0, meaning that there is a 100-percent chance that at least one hydrocarbon pool exists somewhere within the play. To illustrate how to read the graphs, dots have been placed on the ***oil*** curve at cumulative frequency values (vertical axis) of 95-percent and 5-percent. The corresponding oil quantities are 0.257 and 1.098 billions of barrels of oil. Thus, for Chukchi shelf play 5, there is a 95-percent chance that at least 0.257 billion barrels of oil are present and a 5-percent chance that more than 1.098 billion barrels are present. These same oil quantities are listed at F95 and F05 in the table.

The lower graph provides information about pool volumes and is called a ***pool rank plot***. This graph shows two sets of vertical bars, representing the quantities of oil and gas occurring ***together*** in 33 pools, the maximum number estimated to occur within this play. All pools in play 5 are modeled as mixed, that is, containing oil with a gas cap; other plays may also have all-gas or all-oil pools and show six separate commodities. Each pair of gas-oil bars in the play 5 pool rank plot shows the volume of oil in the pool and the volume of gas in the cap. The vertical bars extend across a range of possible volumes for each pool. The lower end of each bar represents the F75 resource quantity, meaning that the pool, if it exists, has a 75-percent chance of exceeding the corresponding resource quantity. Likewise, the upper end of each bar represents the F25 resource quantity. In Chukchi play 5, the largest pool offers oil volumes in the range from about 58 (F75) to 220 (F25) million barrels and gas volumes in the range from 350 (F75) to 1,180 (F25) billion cubic feet.

Figure 0.1: Sample play summary, Chukchi shelf play 5.

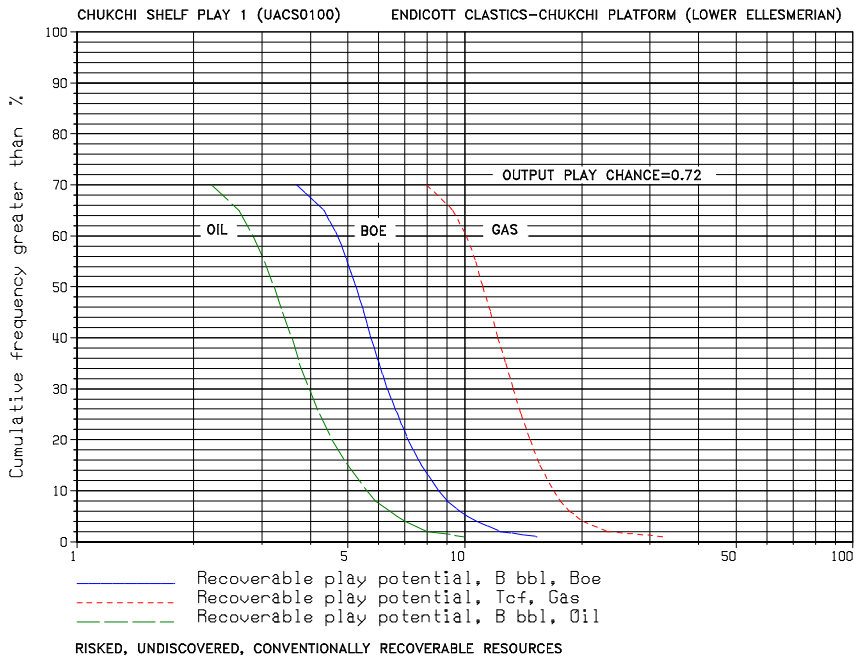
Extreme sizes outside the range between F75 and F25 volumes are not shown, but all pools offer (at low probabilities) high-side potential that may be several multiples of their median sizes (F50 or centers of vertical bars). For example, the largest pool in the pool rank plot in figure 0.1 shows F75-F25 ranges in oil volumes from 58 to 220 millions of barrels and gas volumes from 350 to 1,180 billions of cubic feet. But, these ranges do not capture the largest possible sizes of pool rank 1. This same pool has a 5-percent chance of containing over 600 million barrels of oil and 3,070 billion cubic feet of gas, or a 1-percent chance of containing over 1,140 million barrels of oil and 6,180 billion cubic feet of gas!

Although it might be interesting to portray the improbable yet extreme-high potential sizes of pools, choosing fractiles ranging up to F01 results in an uninformative plot where all pools nearly reach the top

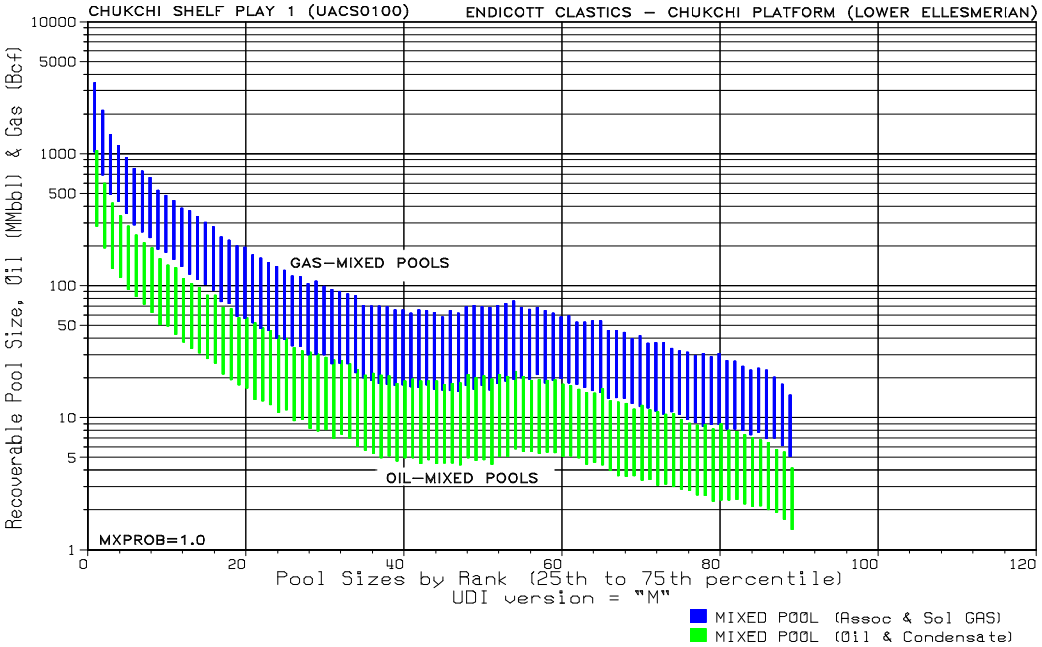
of the plot. For this presentation, a range based on F75-F25 values was chosen for visual clarity while still giving some impression of variance or spread.

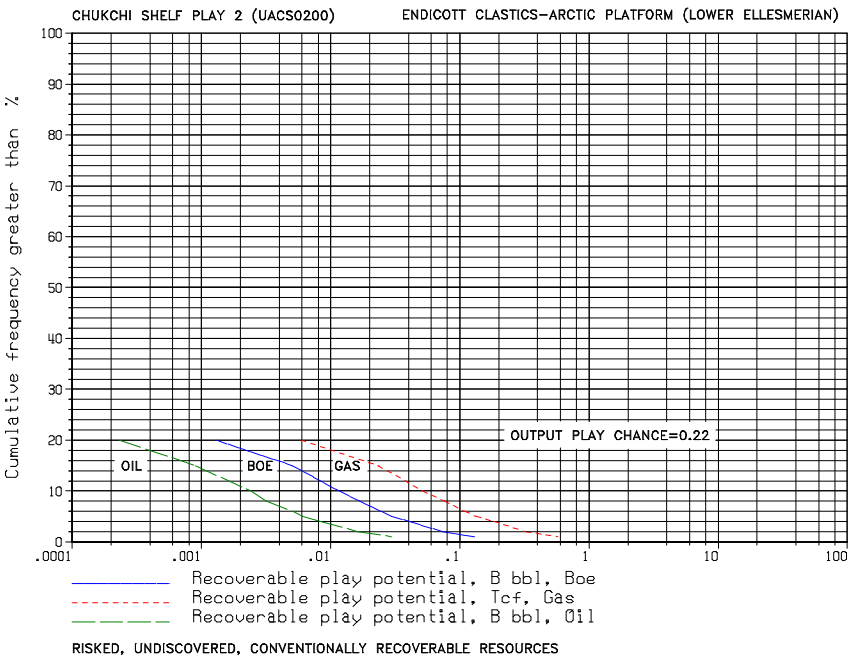
Pool volumes shown in the ranked plots are conditional upon success at the play level (i.e., a hydrocarbon pool existing ***somewhere*** within the play). The sizes of the pools posted in the rank plot have not been "risked", or multiplied against play chance of success. Therefore, except where the play chance of success equals 1.0, the sum of the mean sizes of the pools in the rank plot will exceed the risked mean play endowment that is reported in the table at page center. In fact, several of the largest pools, or even just the largest pool, may post conditional resources exceeding the risked play endowment.

Designation of pool types (oil-only, versus oil with gas cap, versus gas-only) within the play model was controlled by three data entries. Each play was assigned probabilities for (or frequencies of) occurrence of any of three pool types within the play—"OPROB" for oil-only pools, "GPROB" for gas-only pools, and "MXPROB" for mixed (oil and gas cap) pools. As the model recognizes only these three pool types, these three probability values always sum to 1.0. The three probability values control frequency of pool type sampling during ***GRASP*** runs, and, with a random number generator in ***GRASP***, ultimately dictate the sequence of pool types that appear in the play pool rank plots. The OPROB, GPROB, and/or MXPROB values that were used in the play models are posted, as appropriate, in the lower left corner of each pool rank plot.

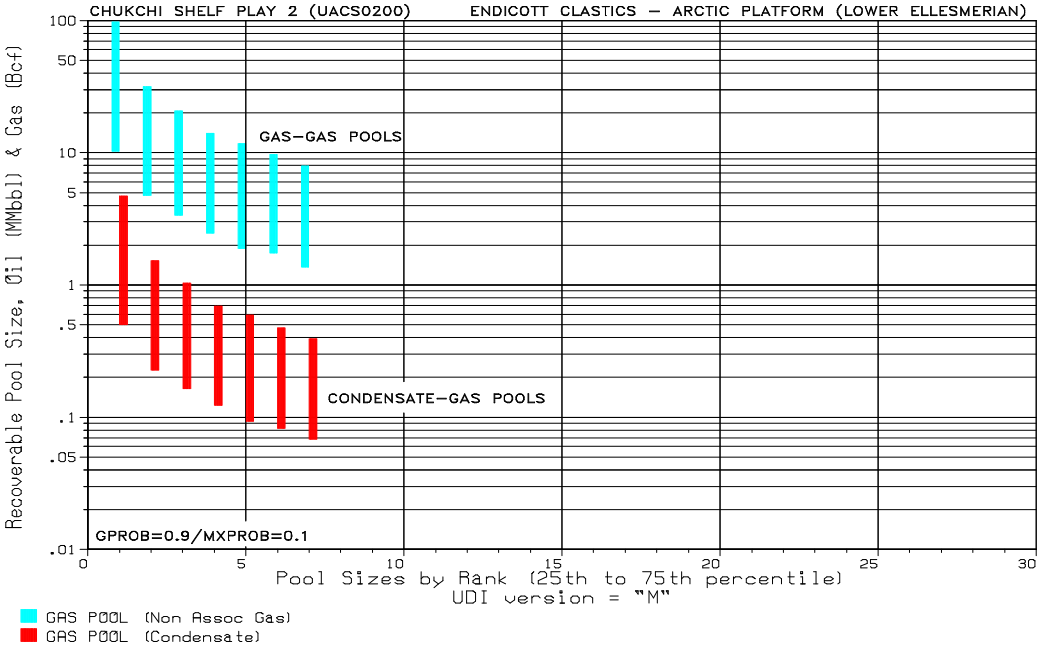


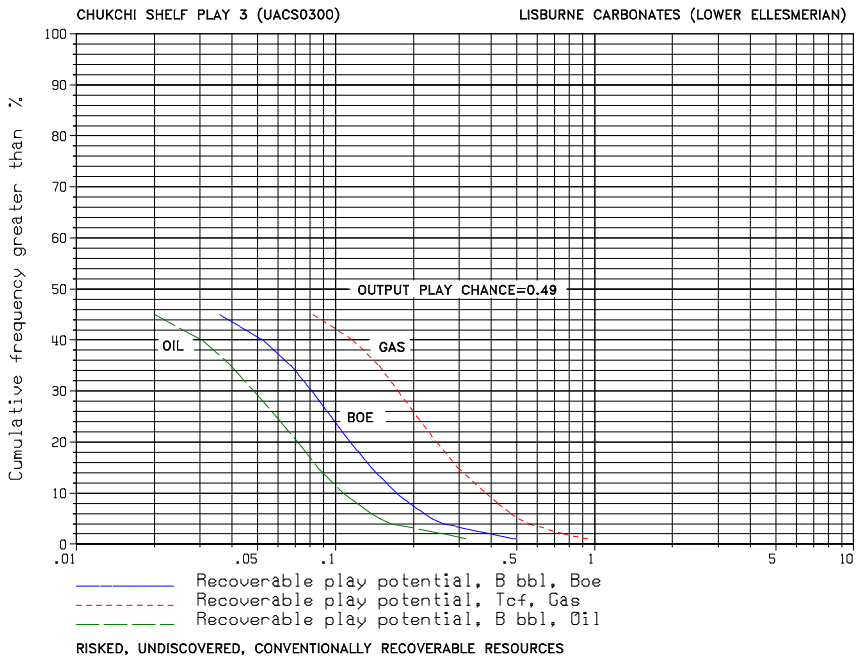
CHUKCHI SHELF PLAY 1 (UACS0100)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**9.762**	**19.377**
OIL (BBO)	**0.000**	**3.001**	**6.696**
BOE (BBO)	**0.000**	**4.738**	**10.140**



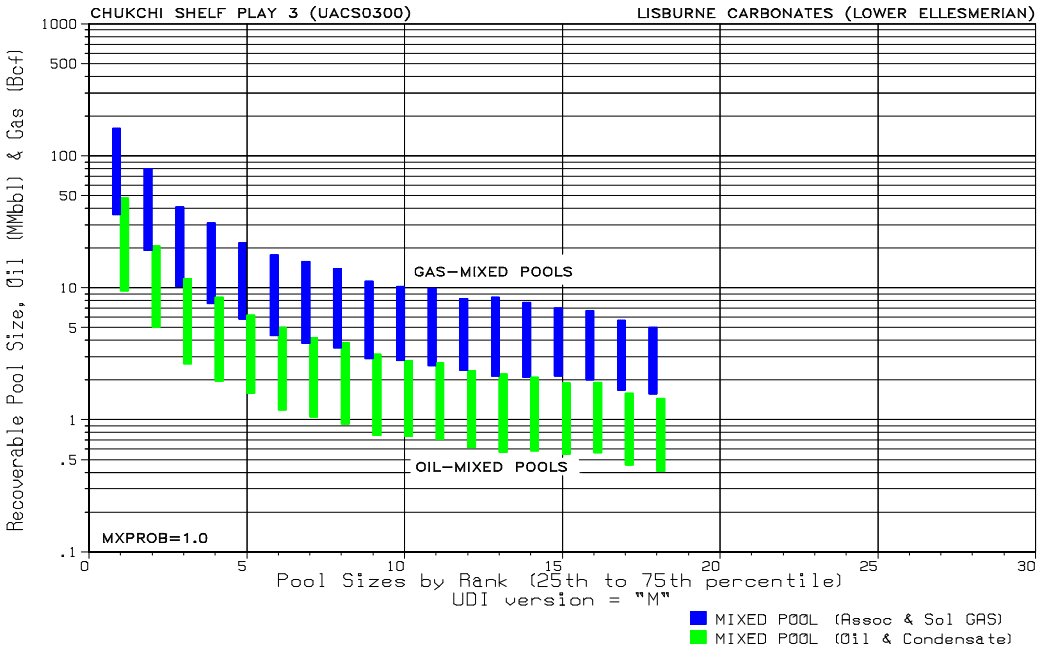


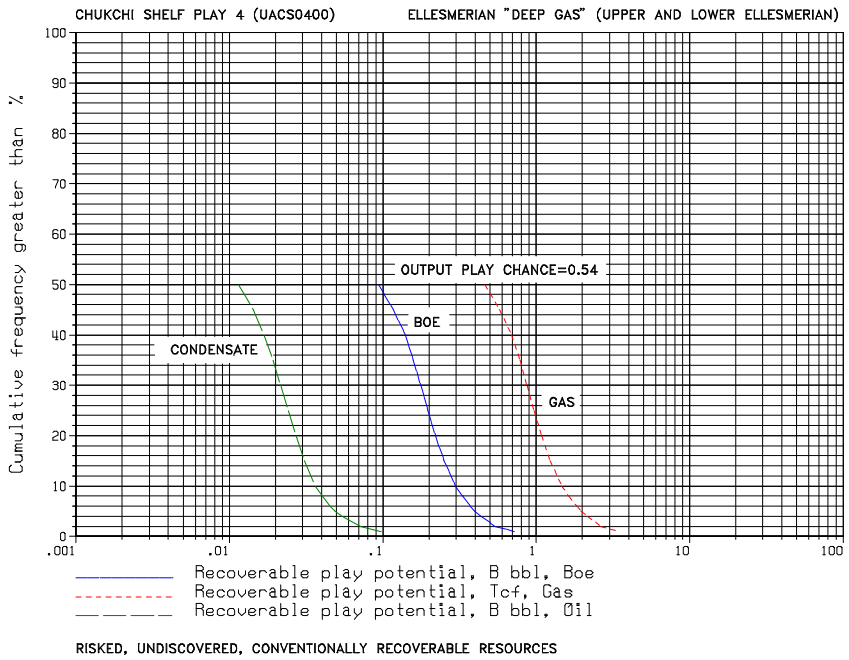
CHUKCHI SHELF PLAY 2 (UACS0200)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.035**	**0.133**
OIL (BBO)	**0.000**	**0.002**	**0.006**
BOE (BBO)	**0.000**	**0.008**	**0.030**



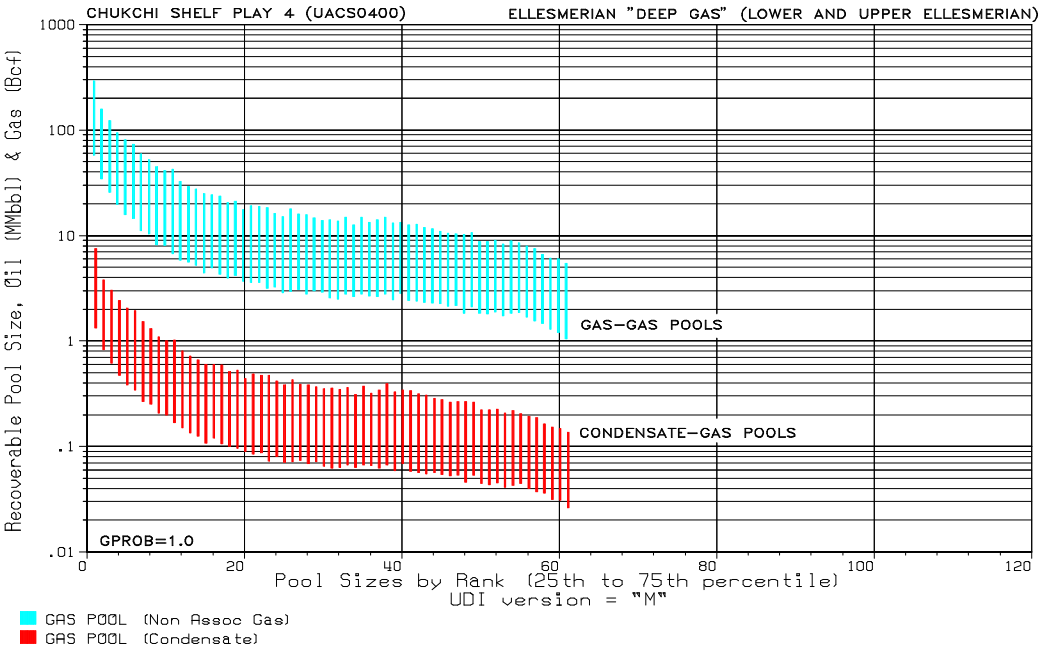


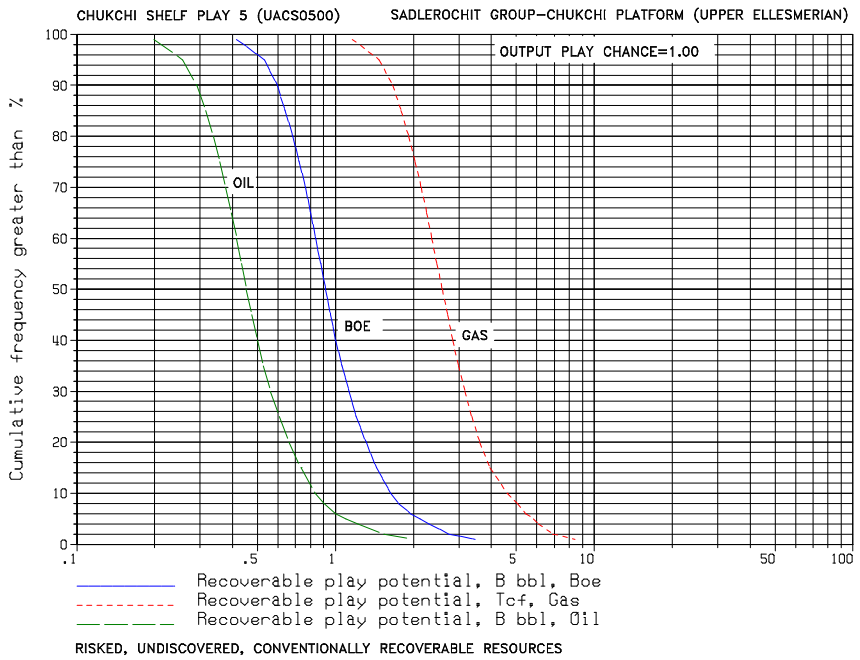
CHUKCHI SHELF PLAY 3 (UACS0300)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.137**	**0.509**
OIL (BBO)	**0.000**	**0.041**	**0.149**
BOE (BBO)	**0.000**	**0.065**	**0.236**



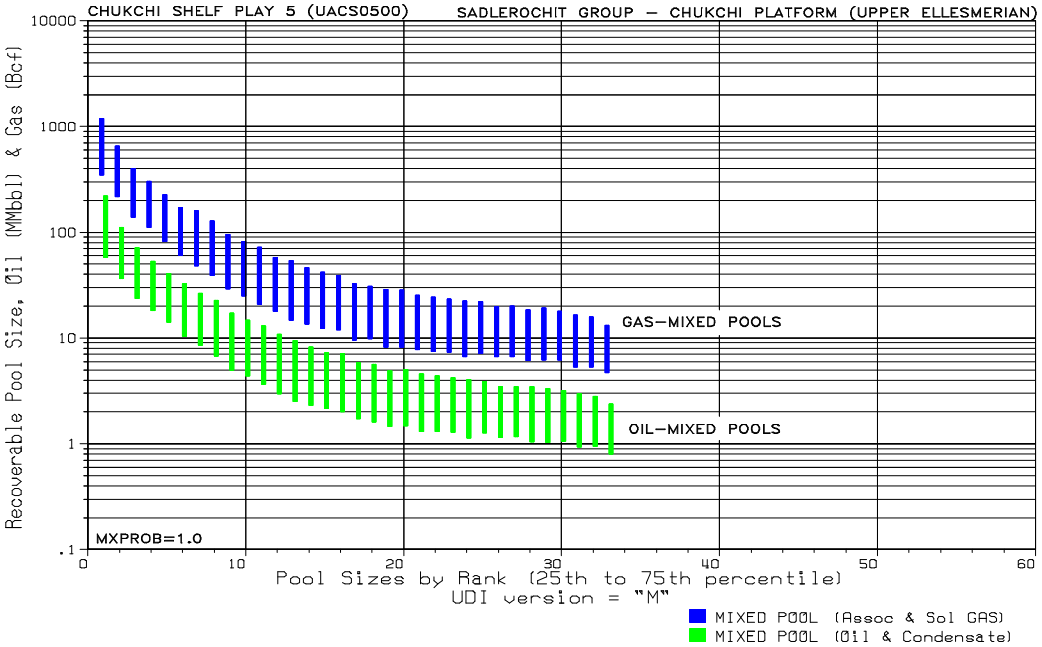


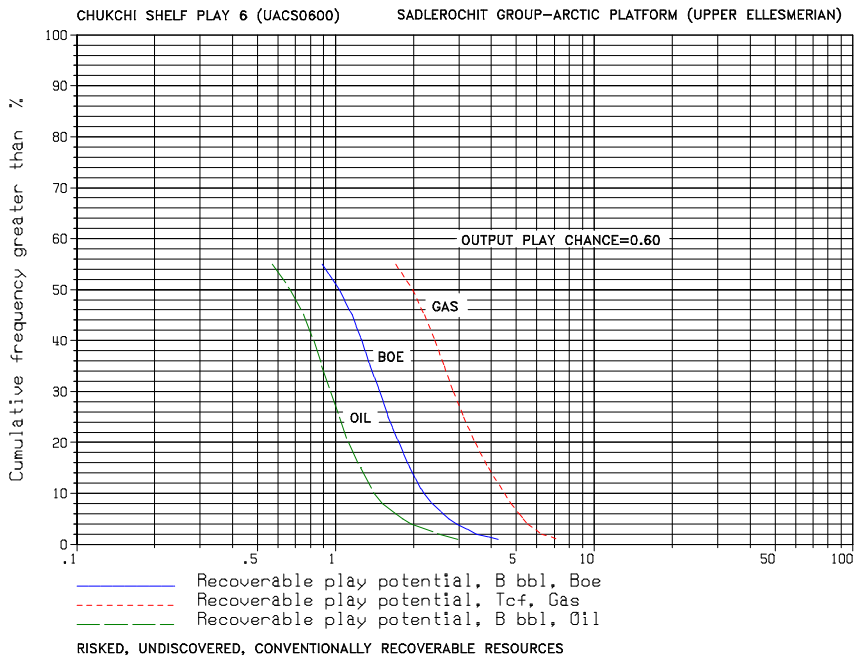
CHUKCHI SHELF PLAY 4 (UACS0400)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.629**	**1.962**
OIL (BBO)	**0.000**	**0.016**	**0.049**
BOE (BBO)	**0.000**	**0.128**	**0.399**



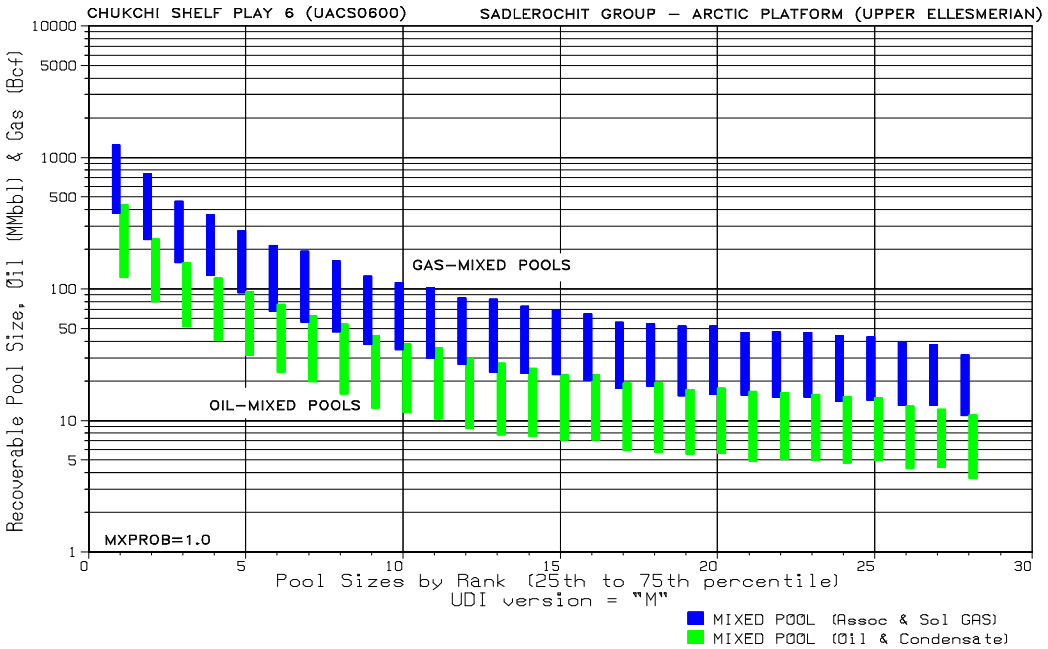


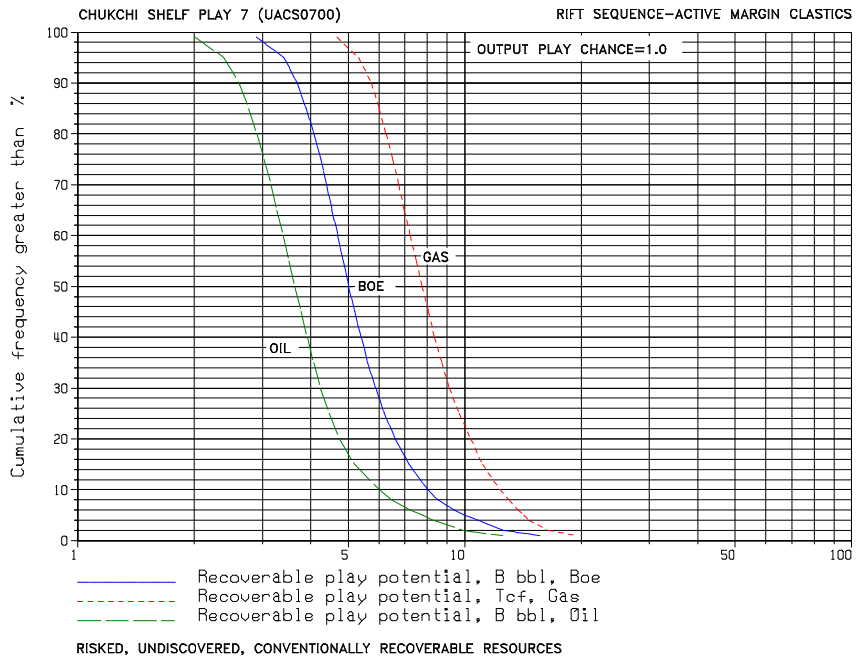
CHUKCHI SHELF PLAY 5 (UACS0500)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**1.478**	**2.993**	**5.823**
OIL (BBO)	**0.257**	**0.537**	**1.098**
BOE (BBO)	**0.530**	**1.069**	**2.125**



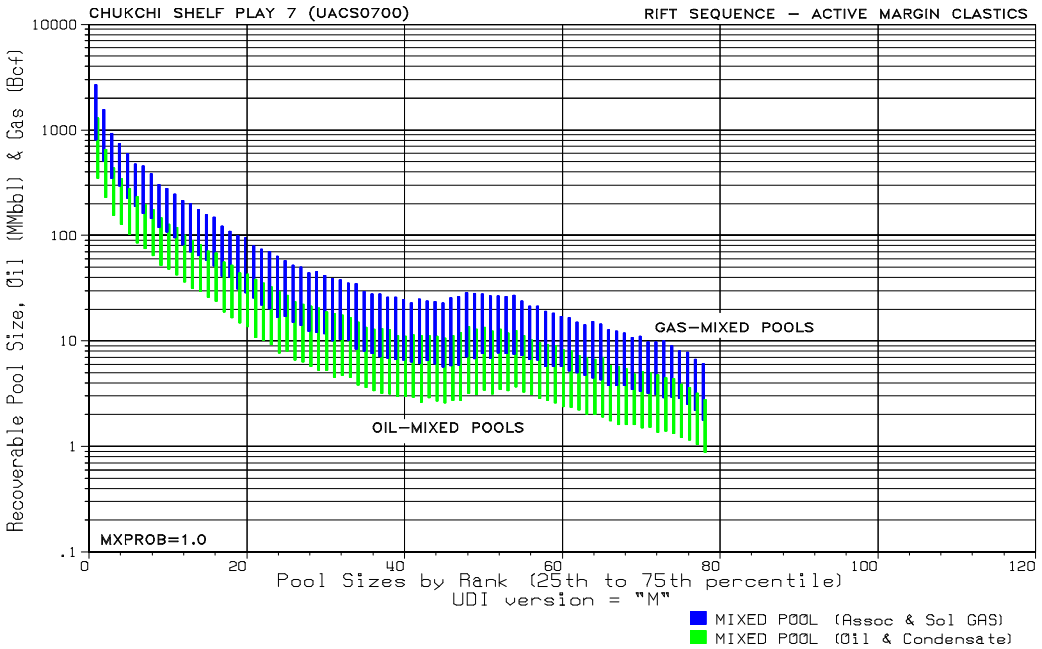


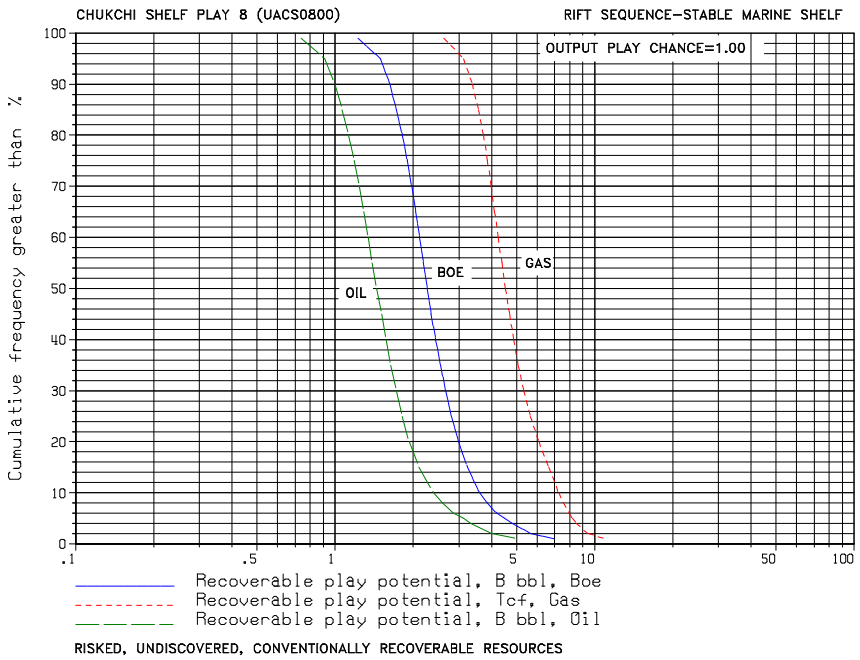
CHUKCHI SHELF PLAY 6 (UACS0600)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**1.935**	**5.314**
OIL (BBO)	**0.000**	**0.660**	**1.818**
BOE (BBO)	**0.000**	**1.005**	**2.737**



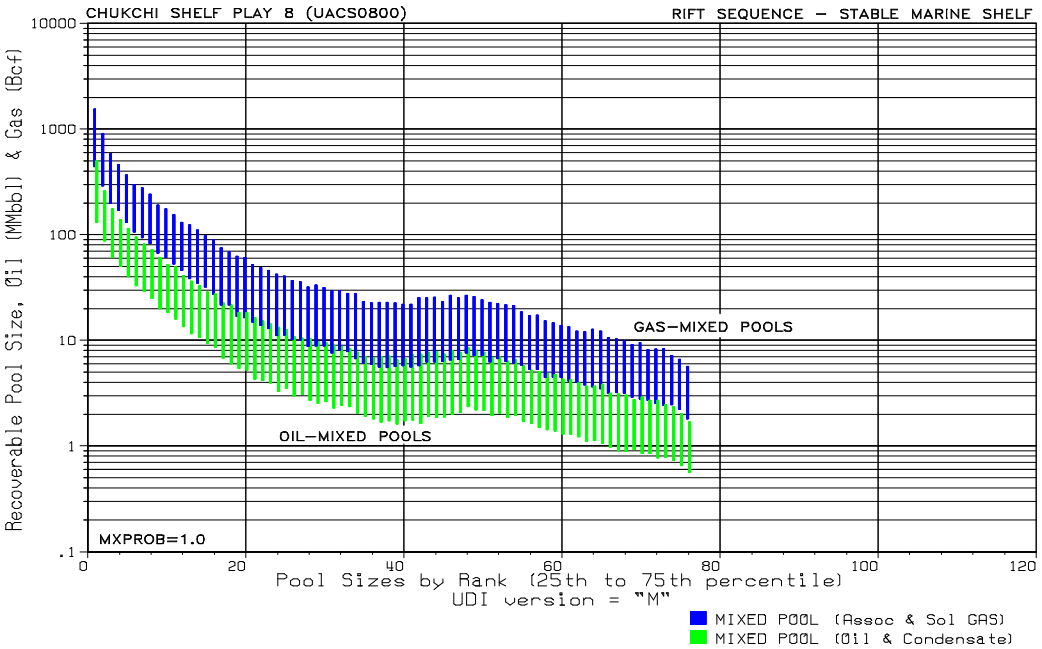


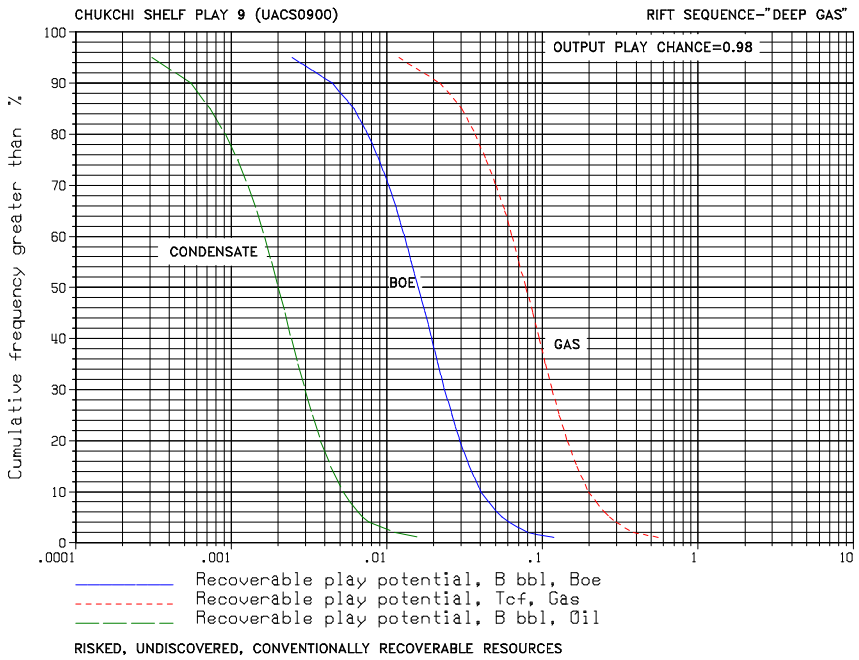
CHUKCHI SHELF PLAY 7 (UACS0700)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**5.314**	**8.547**	**14.204**
OIL (BBO)	**2.385**	**4.136**	**7.770**
BOE (BBO)	**3.410**	**5.656**	**9.968**



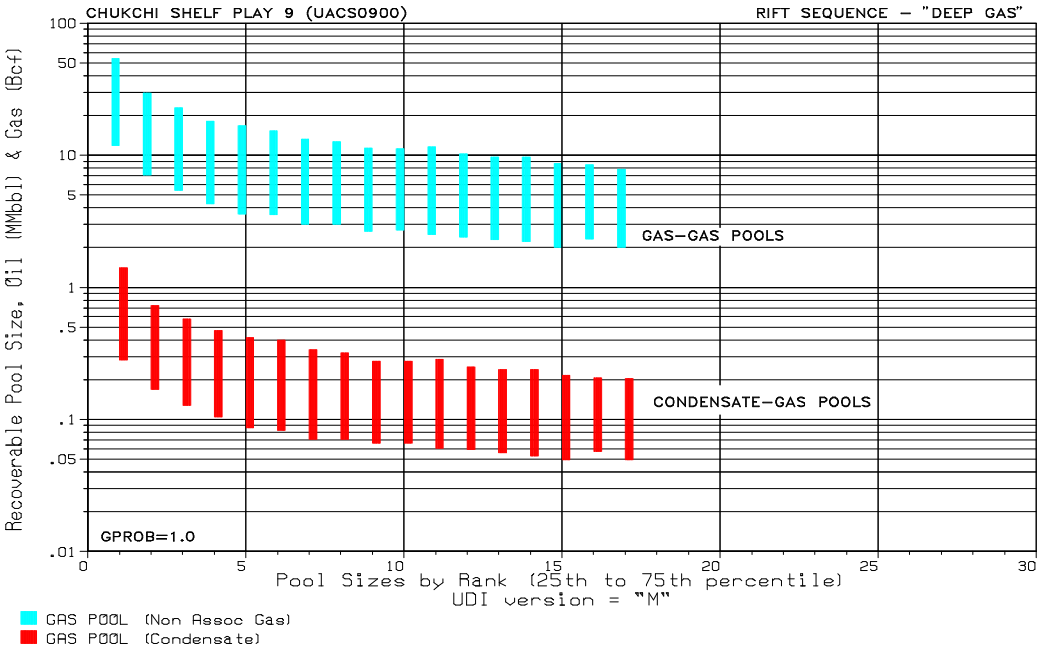


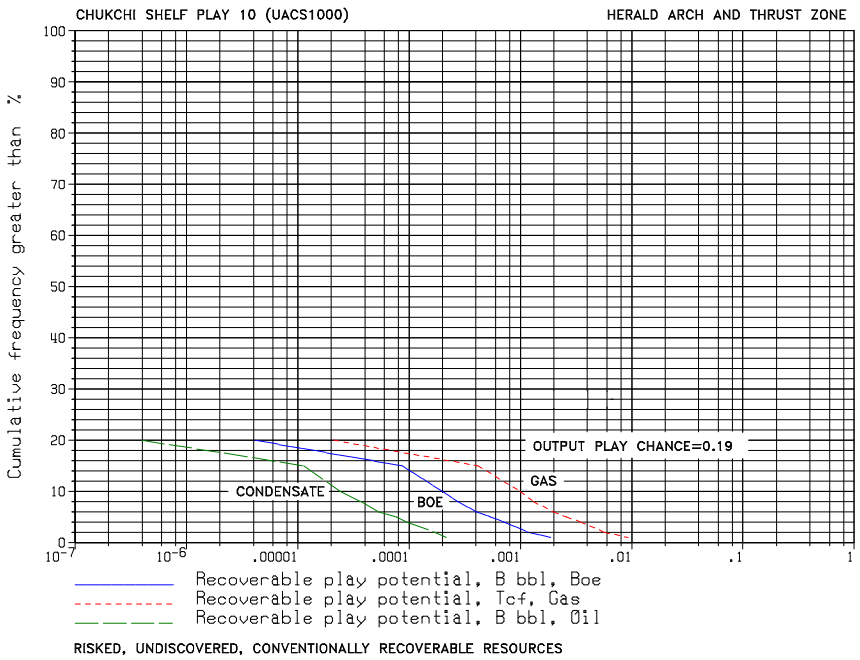
CHUKCHI SHELF PLAY 8 (UACS0800)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**3.118**	**5.026**	**8.193**
OIL (BBO)	**0.910**	**1.645**	**3.121**
BOE (BBO)	**1.492**	**2.539**	**4.487**



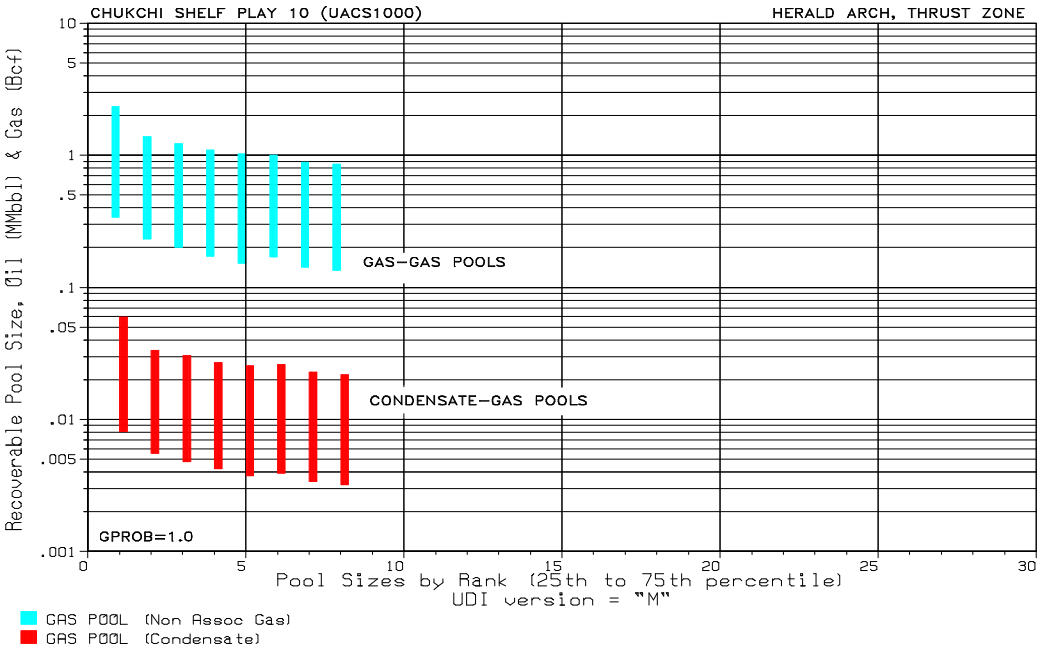


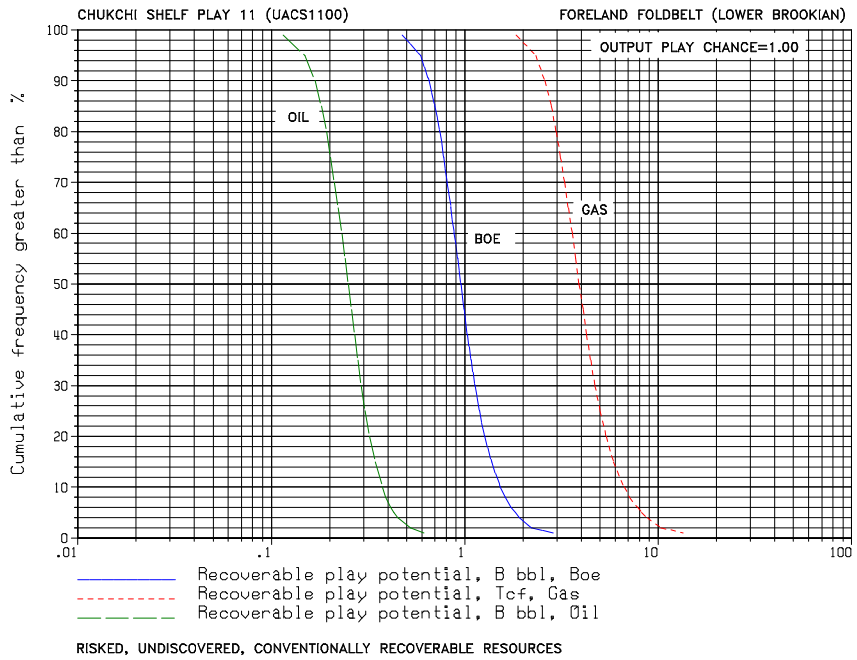
CHUKCHI SHELF PLAY 9 (UACS0900)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.012**	**0.108**	**0.269**
OIL (BBO)	**0.0003**	**0.003**	**0.007**
BOE (BBO)	**0.002**	**0.022**	**0.055**



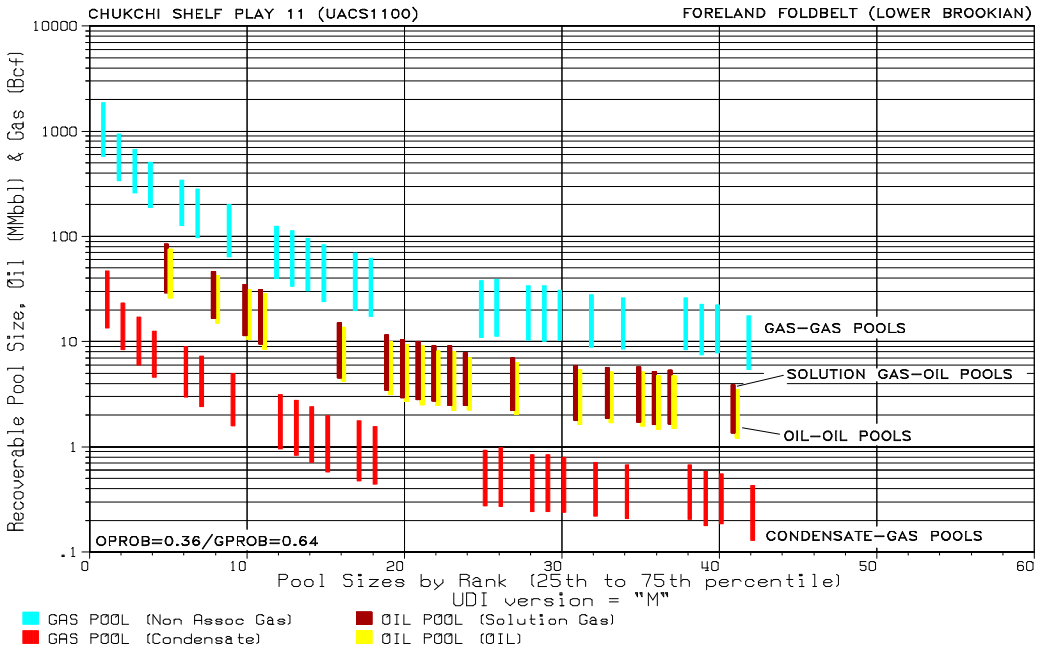


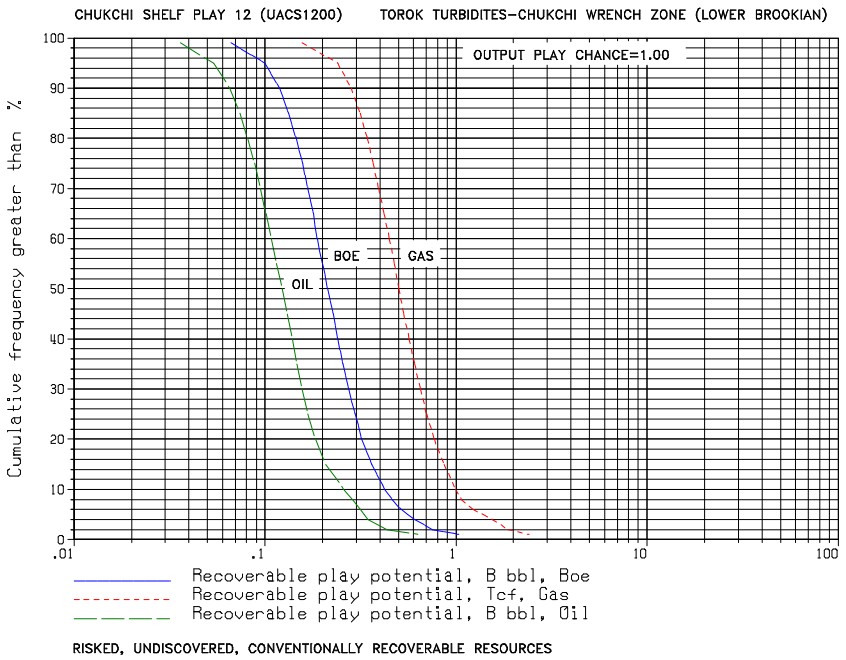
CHUKCHI SHELF PLAY 10 (UACS1000)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.0006**	**0.003**
OIL (BBO)	**0.000**	**0.00002**	**0.00008**
BOE (BBO)	**0.000**	**0.0001**	**0.0005**



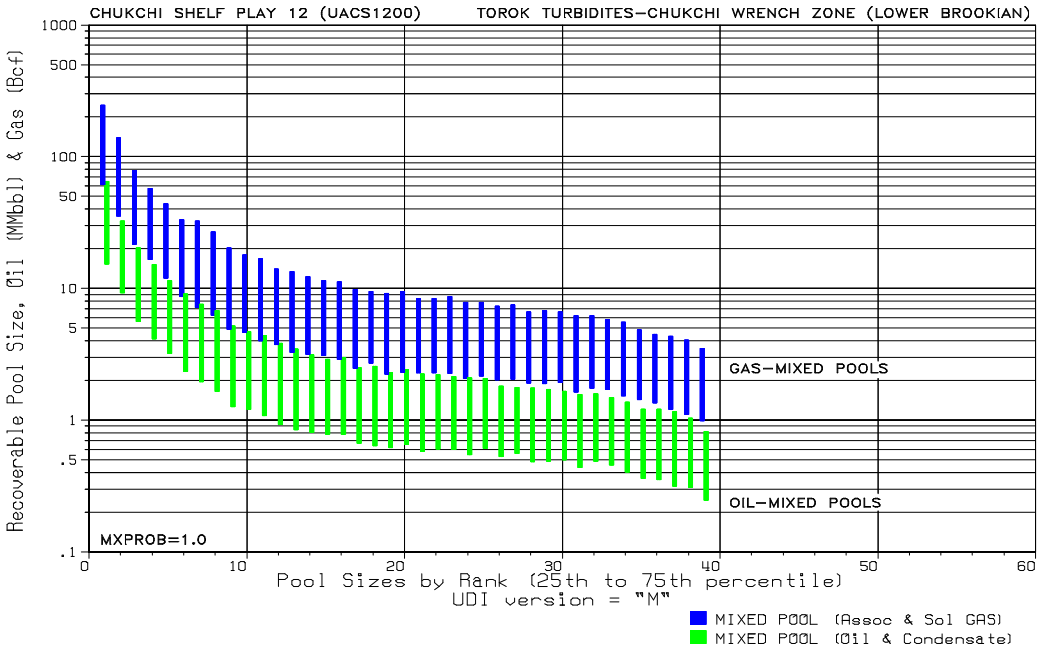


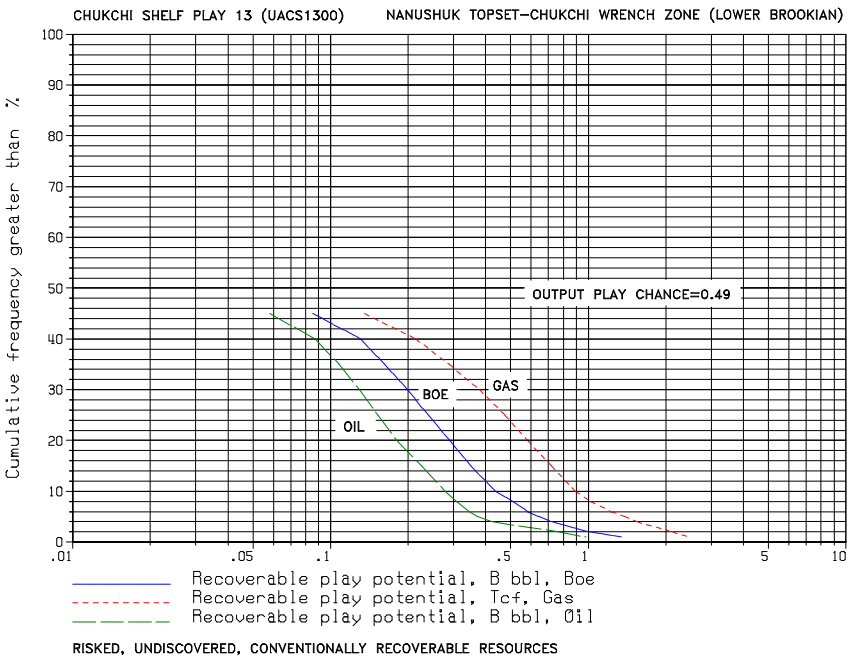
CHUKCHI SHELF PLAY 11 (UACS1100)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**2.328**	**4.491**	**8.225**
OIL (BBO)	**0.149**	**0.265**	**0.430**
BOE (BBO)	**0.590**	**1.065**	**1.821**



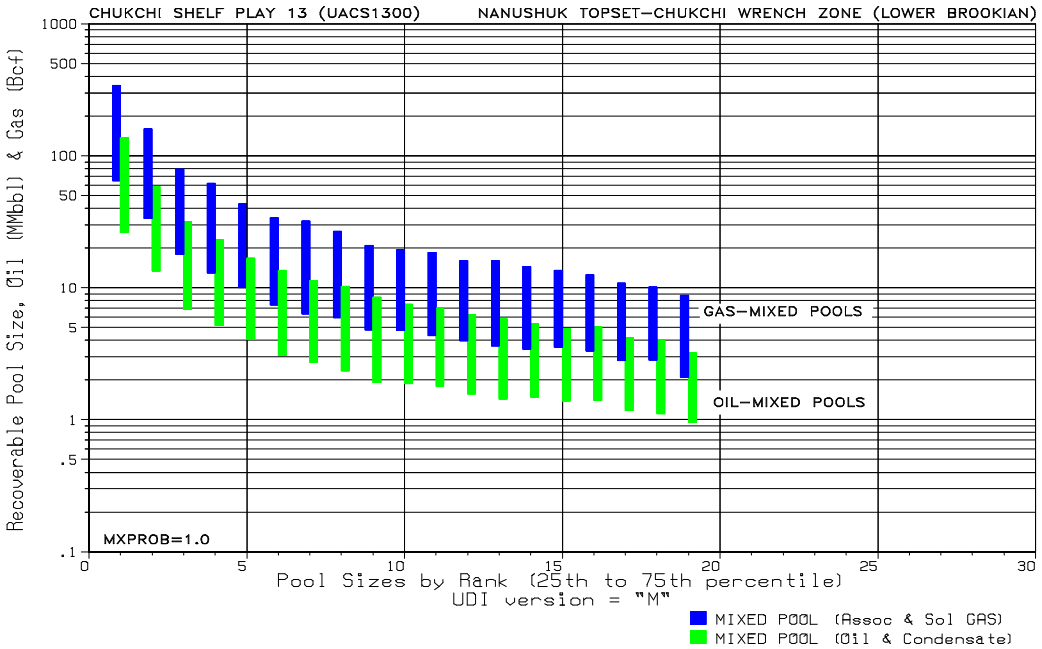


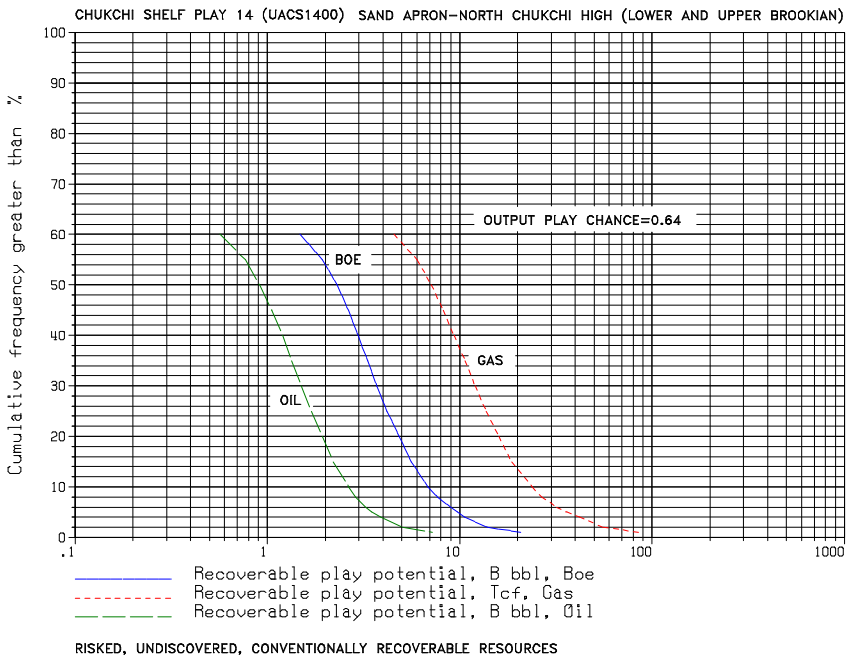
CHUKCHI SHELF PLAY 12 (UACS1200)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.240**	**0.635**	**1.384**
OIL (BBO)	**0.054**	**0.147**	**0.331**
BOE (BBO)	**0.100**	**0.261**	**0.556**



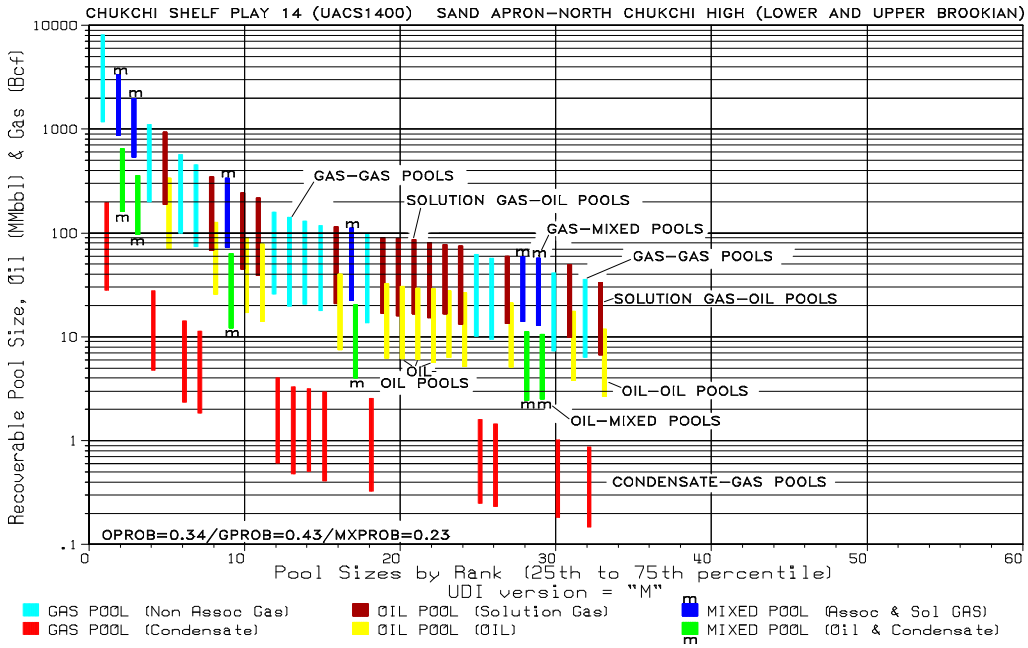


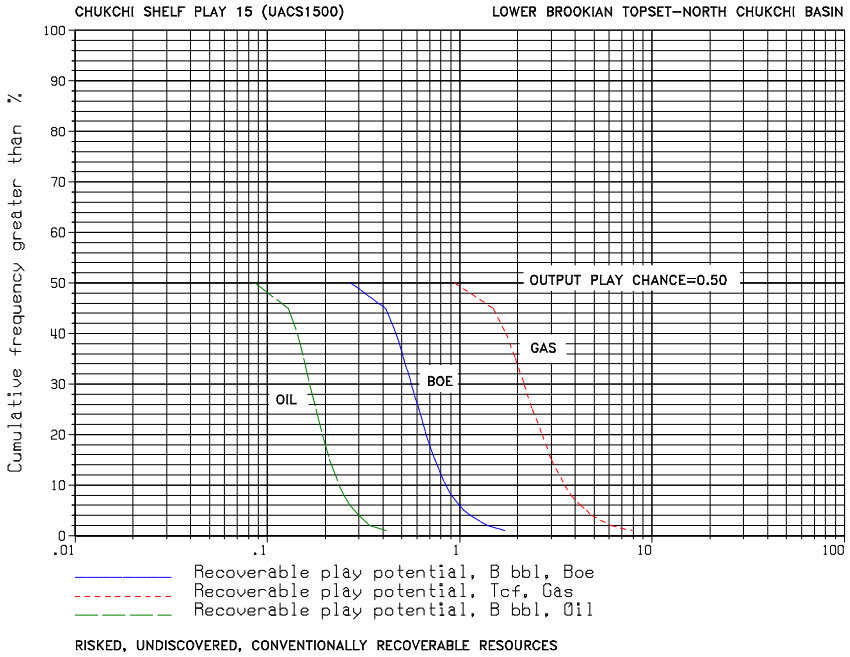
CHUKCHI SHELF PLAY 13 (UACS1300)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.326**	**1.376**
OIL (BBO)	**0.000**	**0.110**	**0.371**
BOE (BBO)	**0.000**	**0.168**	**0.642**



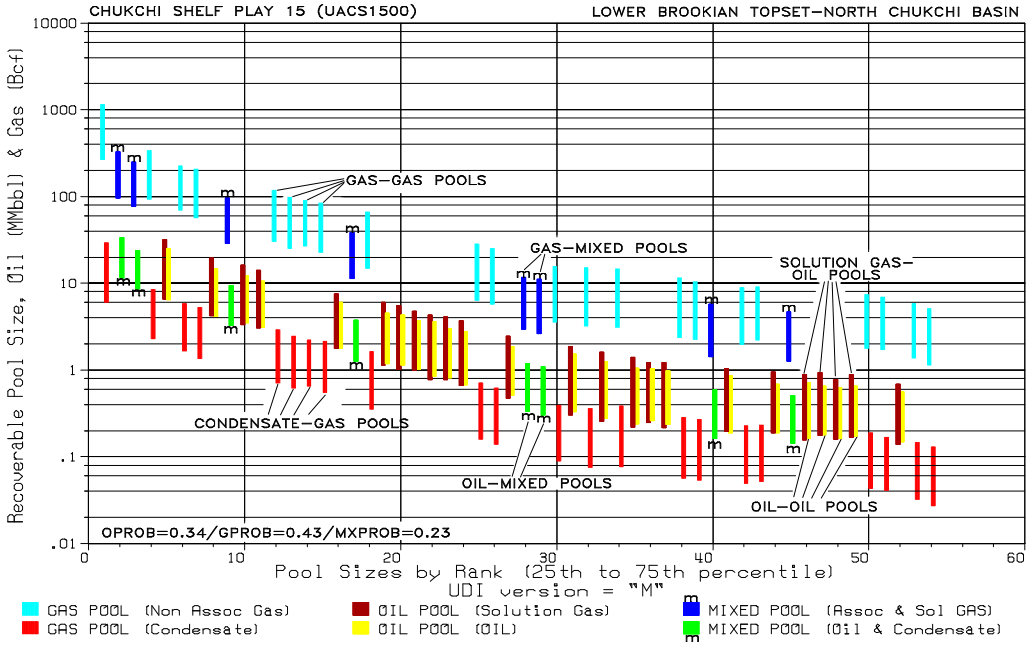


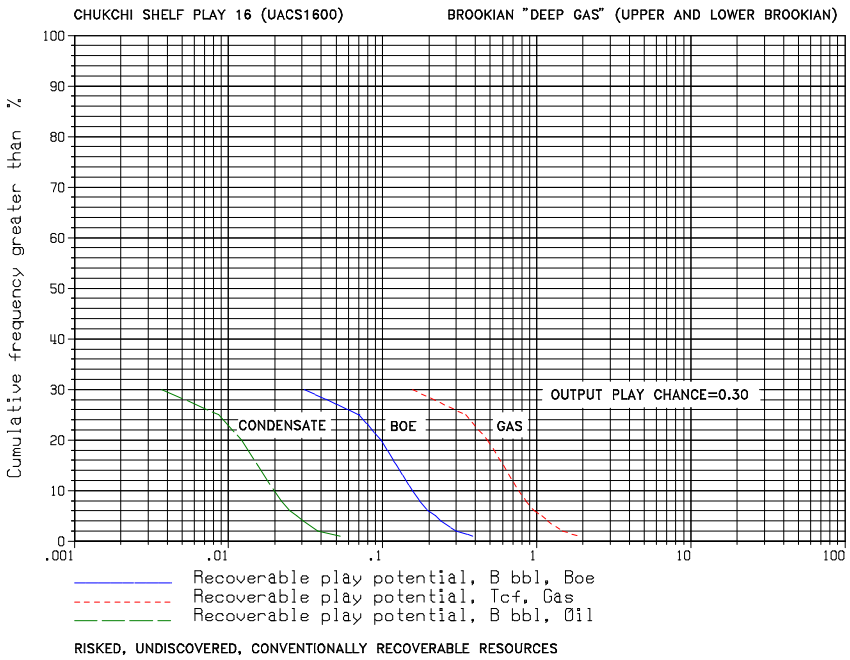
CHUKCHI SHELF PLAY 14 (UACS1400)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**13.082**	**36.046**
OIL (BBO)	**0.000**	**1.182**	**3.497**
BOE (BBO)	**0.000**	**3.510**	**9.761**



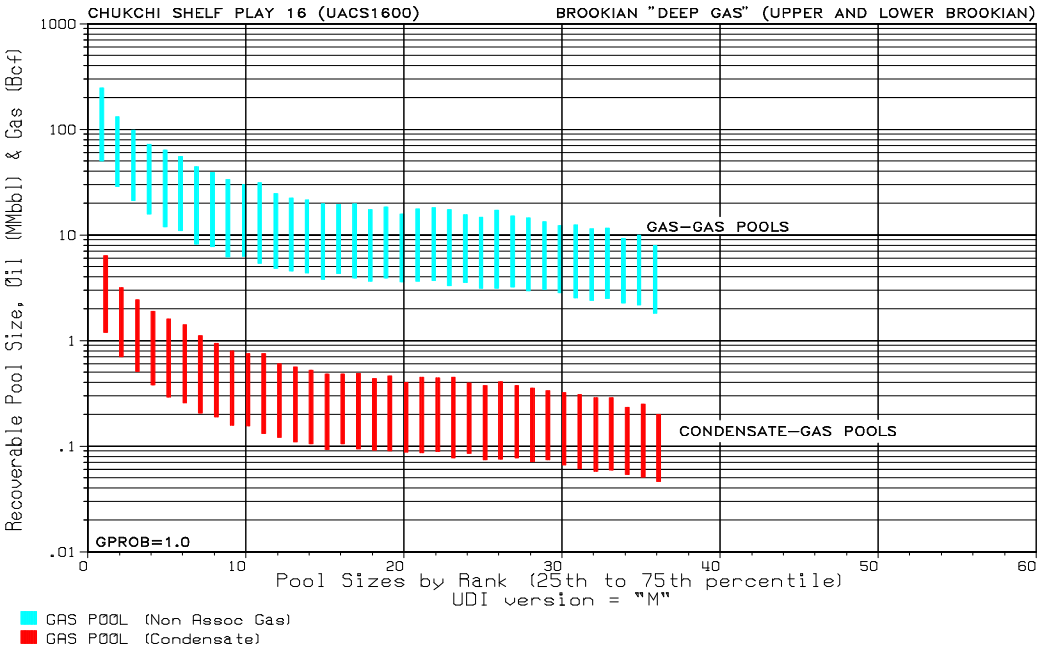


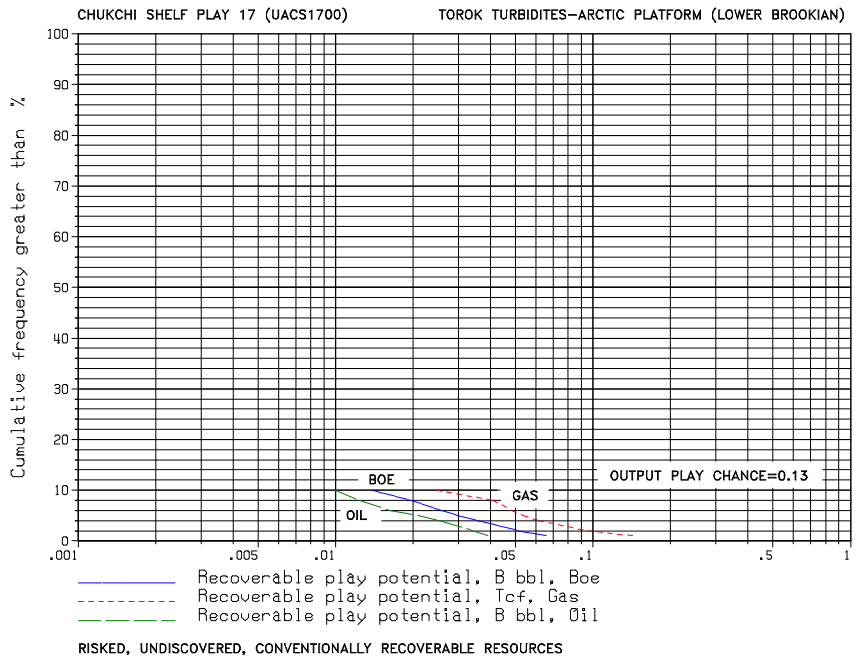
CHUKCHI SHELF PLAY 15 (UACS1500)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**1.491**	**4.564**
OIL (BBO)	**0.000**	**0.099**	**0.283**
BOE (BBO)	**0.000**	**0.365**	**1.051**



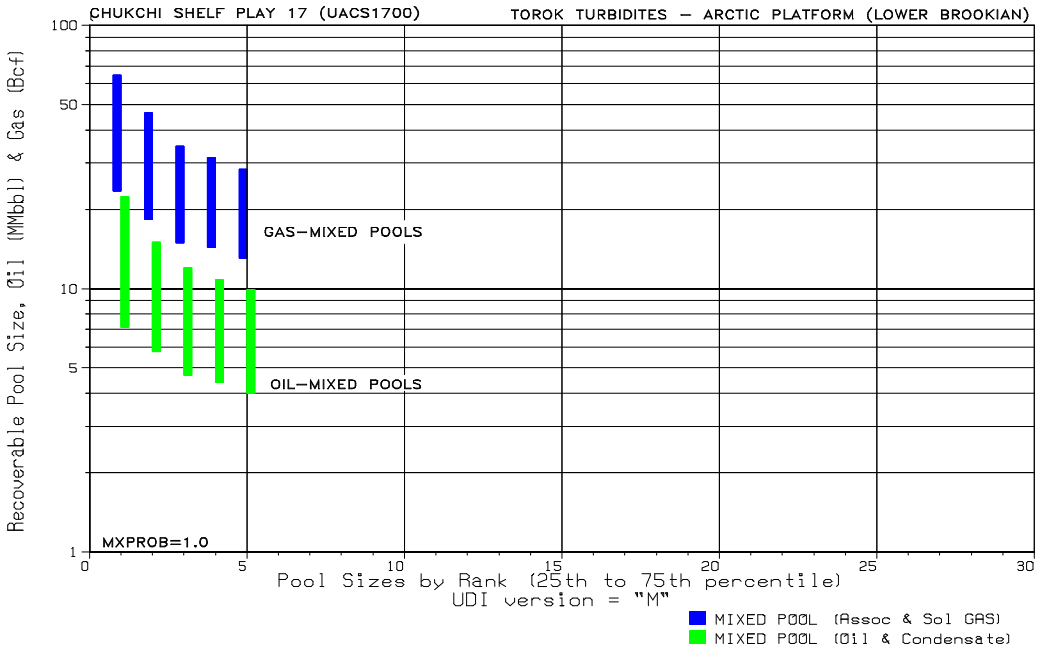


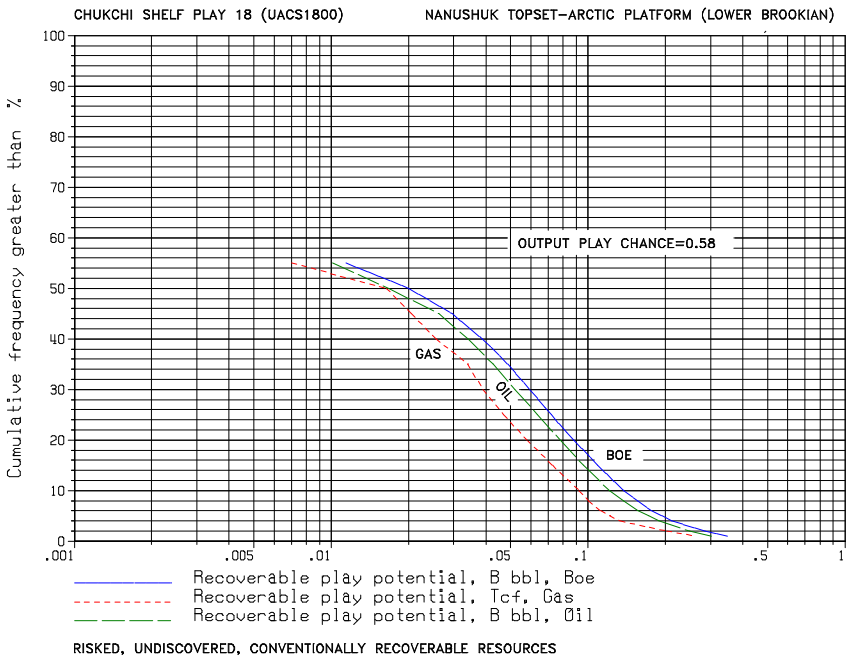
CHUKCHI SHELF PLAY 16 (UACS1600)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.237**	**1.076**
OIL (BBO)	**0.000**	**0.006**	**0.028**
BOE (BBO)	**0.000**	**0.048**	**0.220**



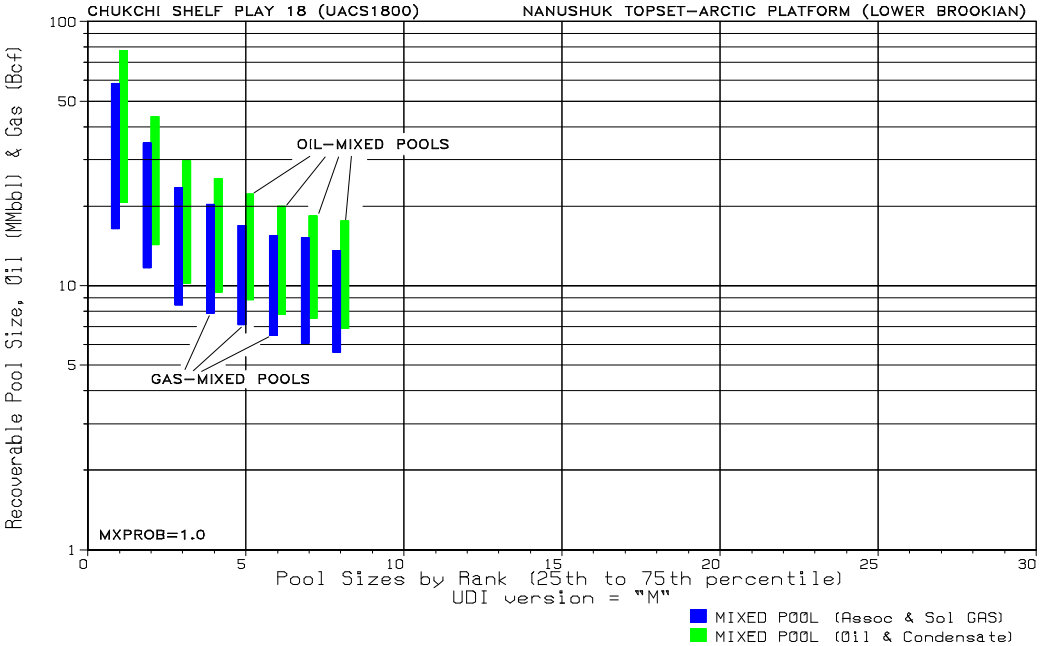


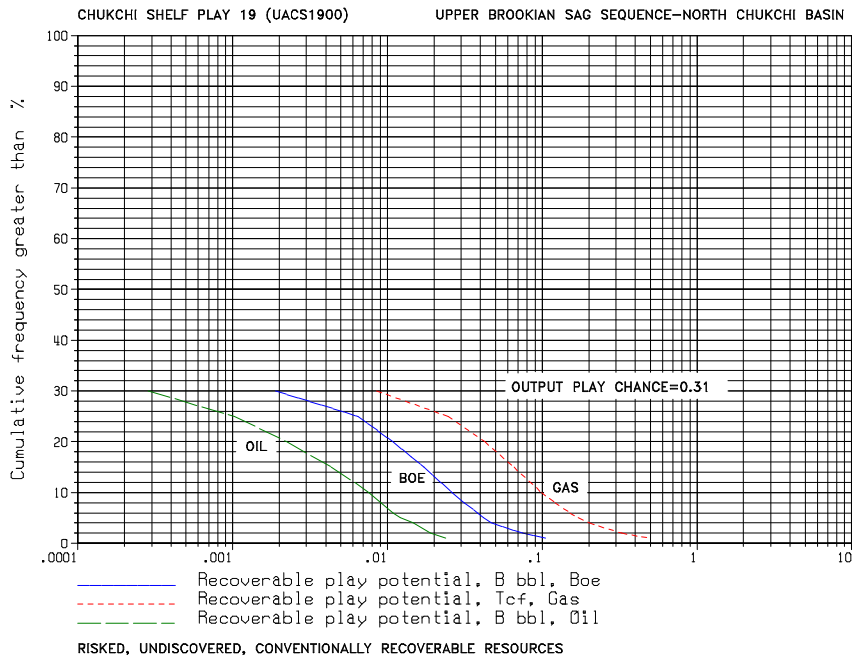
CHUKCHI SHELF PLAY 17 (UACS1700)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.008**	**0.053**
OIL (BBO)	**0.000**	**0.003**	**0.021**
BOE (BBO)	**0.000**	**0.004**	**0.030**



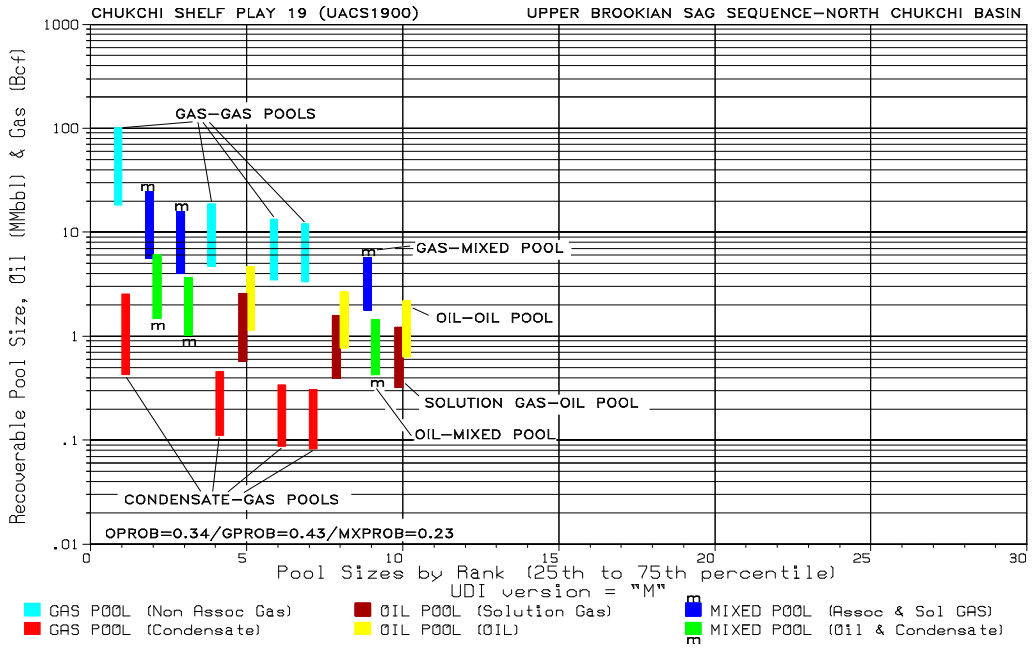


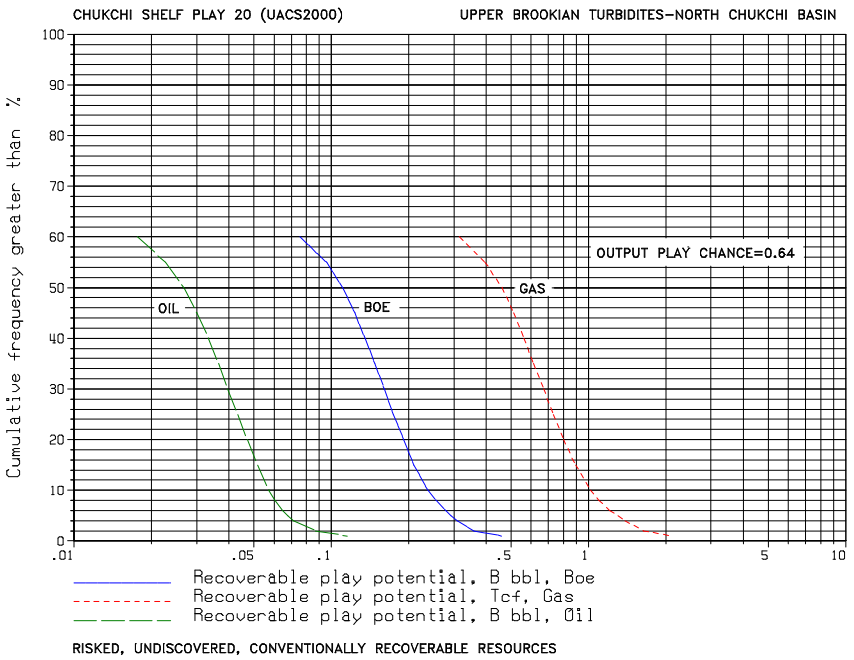
CHUKCHI SHELF PLAY 18 (UACS1800)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.034**	**0.121**
OIL (BBO)	**0.000**	**0.045**	**0.173**
BOE (BBO)	**0.000**	**0.051**	**0.194**



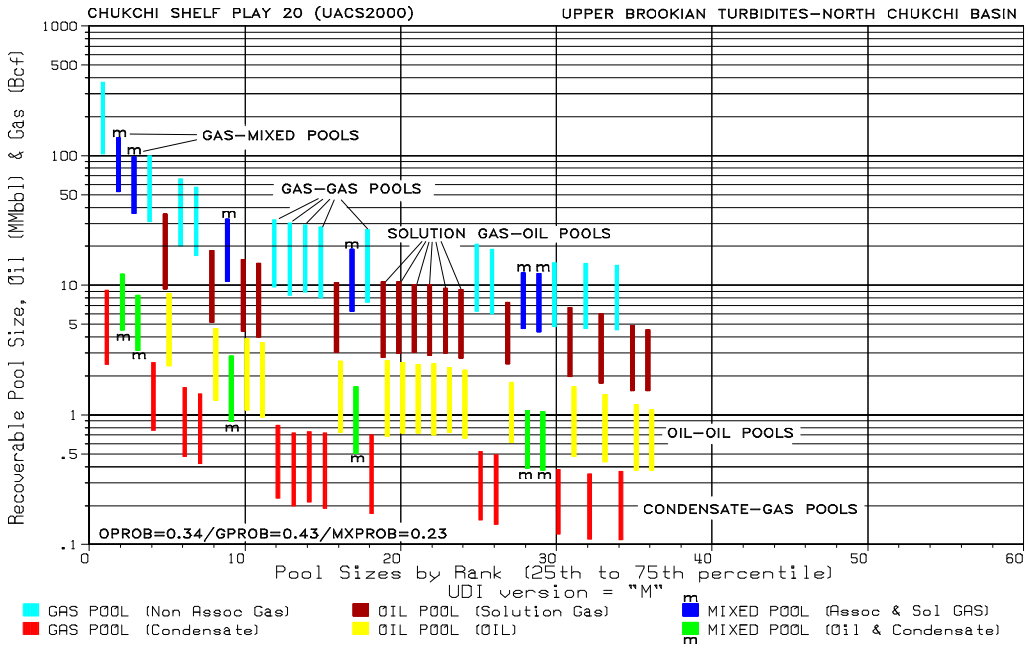


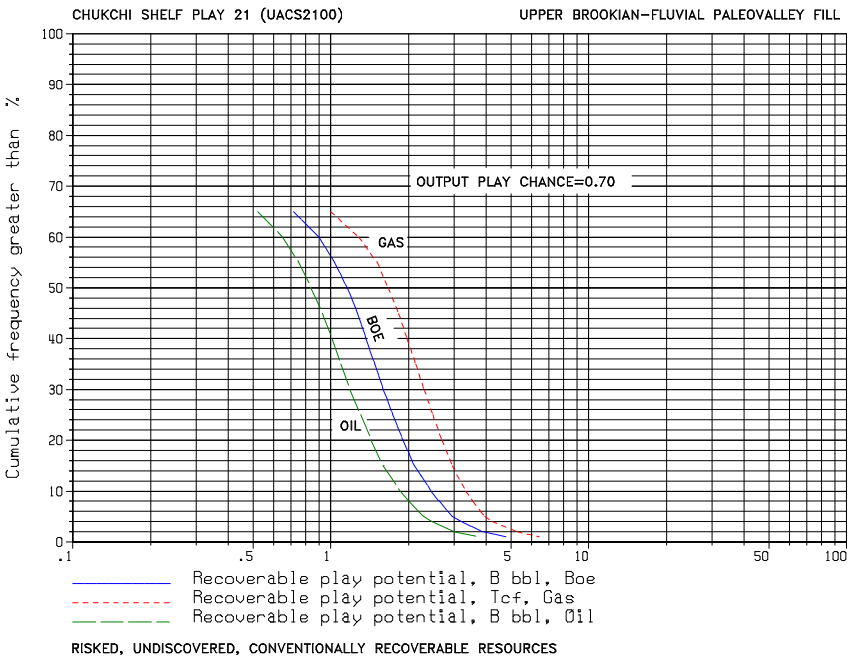
CHUKCHI SHELF PLAY 19 (UACS1900)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.038**	**0.171**
OIL (BBO)	**0.000**	**0.002**	**0.012**
BOE (BBO)	**0.000**	**0.009**	**0.042**



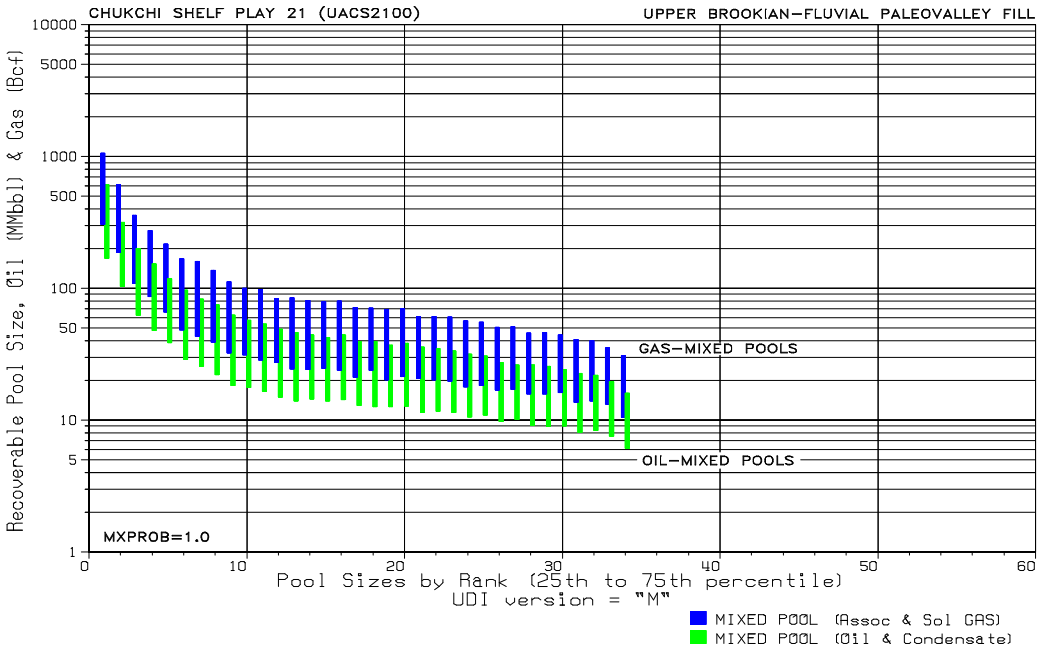


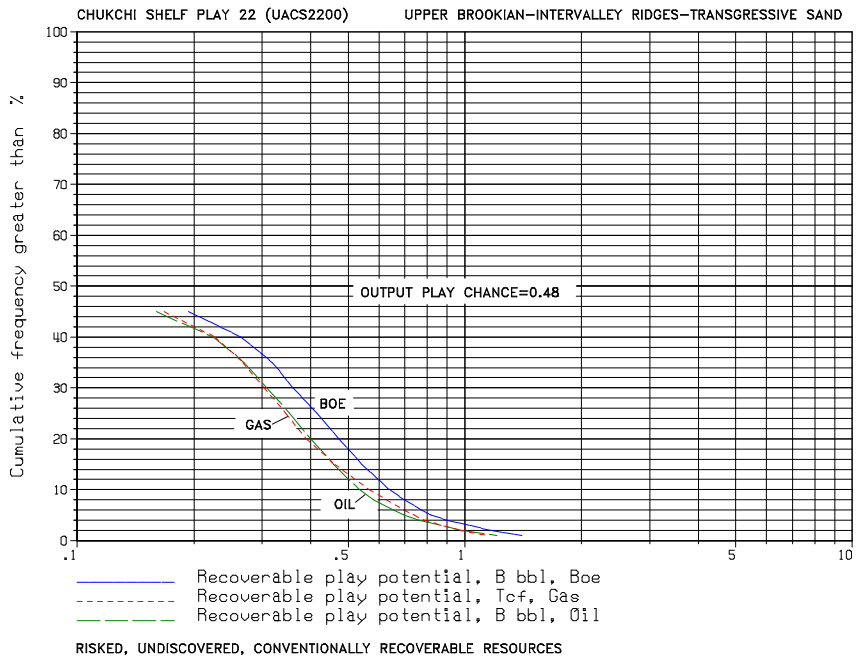
CHUKCHI SHELF PLAY 20 (UACS2000)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.484**	**1.306**
OIL (BBO)	**0.000**	**0.027**	**0.068**
BOE (BBO)	**0.000**	**0.113**	**0.293**



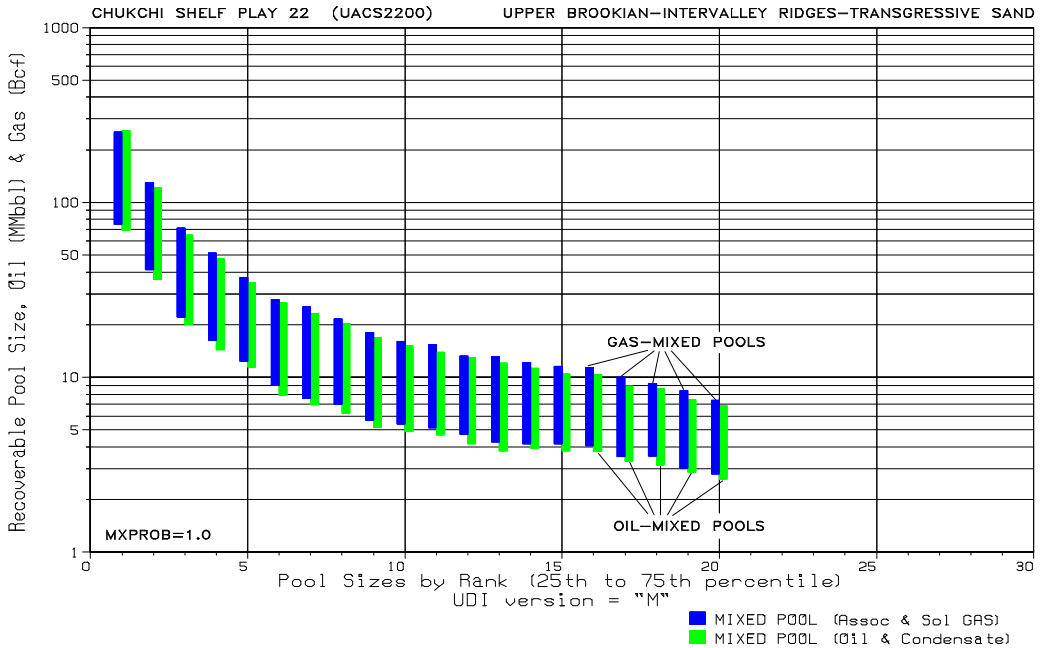


CHUKCHI SHELF PLAY 21 (UACS2100)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**1.637**	**3.961**
OIL (BBO)	**0.000**	**0.886**	**2.283**
BOE (BBO)	**0.000**	**1.177**	**2.953**





CHUKCHI SHELF PLAY 22 (UACS2200)			
FRACTILES	**F95**	**MEAN**	**F05**
GAS (TCFG)	**0.000**	**0.203**	**0.740**
OIL (BBO)	**0.000**	**0.204**	**0.697**
BOE (BBO)	**0.000**	**0.240**	**0.816**



ECONOMIC RESULTS, CHUKCHI SHELF PROVINCE

(James D. Craig)

INTRODUCTION

This section summarizes the results of economic modeling using the *PRESTO-5* (*P*robabilistic *R*esource *EST*imates-*O*ffshore, version 5) computer program. The economic assessment results are influenced, to a large degree, by the undiscovered, conventionally recoverable oil and gas resources assessed using the *GRASP (G*eologic *R*esource *AS*sessment *P*rogram) computer model. The conventionally recoverable results are discussed in separate .pdf files (*Summaries of Play Results, with Cumulative Probability and Ranked Pool Plots*).

Each province summary page includes three illustrations: (1) cumulative probability plots for risked, conventionally recoverable resource distributions (oil, gas, and BOE); (2) a table comparing risked, mean, conventionally recoverable resources with the risked, mean, economically recoverable resources at current commodity prices; and (3) a price-supply graph displaying economically recoverable resource curves.

The province summary page is followed by a table reporting play-specific, economically recoverable resource estimates for two representative price scenarios: a Base Price scenario ($18/bbl-oil, $2.11/MCF-gas) representing current market conditions; and a High Price scenario ($30/bbl-oil, $3.52/MCF-gas).

PROVINCE SUMMARY PAGE

Risked Cumulative Probability Distributions

The province summary page provides, at page top, cumulative probability distributions for risked, undiscovered endowments of conventionally recoverable oil, gas, and BOE, where resource quantities are plotted against "cumulative frequency greater than %." A cumulative frequency represents the probability that the resource endowment is equal or greater than the volume associated with that frequency value along one of the curves. For example, a 95% probability represents a 19 in 20 chance that the resource will equal, or be higher than, the volume indicated. Cumulative frequency values typically decrease as resource quantities increase. An expanded description of cumulative probability plots is given in "*Summaries of Play Results, with Cumulative Probabilities and Ranked Pool Plots* " provided as a separate .pdf file.

Table of Risked Play Resources

The province summary page provides, at page center, a table comparing the total conventionally recoverable endowment and the smaller quantity of economically recoverable resources that could be profitably extracted under current economic and engineering conditions. Current prices are represented as $18 per barrel of oil and $2.11 per MCF of gas, where gas price is linked to oil price by energy equivalency and discount-value factors (5.62 MCF per barrel; 0.66 value discount). Conventional resource volumes correspond to points on the cumulative probability distributions (at page top). Economic resource volumes correspond to points along the mean price-supply curve (at page bottom). Resources listed as negligible (negl) have volumes lower than the significant figures shown. Not Available (N/A) means that these resources are unlikely to be produced in the foreseeable future because of reservoir conditions or the lack of a viable transportation infrastructure.

The ratio of economic to conventional resources indicates the proportion of the total undiscovered endowment that is profitable to produce under current commodity prices with proven engineering technology. However, for production to occur, commercial discoveries must be made, and the analysis does not imply discovery rates. Given the size and geologic complexity of the offshore provinces, exploration will require extensive drilling, and considering the relatively low chance of commercial success and the high cost of exploration wells, many of these frontier provinces are not likely to be thoroughly tested in the foreseeable future. The ratio of economic to conventional resources should be regarded as an opportunity indicator, rather than as a direct scaling factor for readily available hydrocarbon reserves.

Price-Supply Curves

The province summary page includes, at page bottom, a graph showing price-supply curves representing Low, Mean , and High resource production scenarios. Price-supply curves illustrate how volumes of economically recoverable resources increase as a function of commodity price. Characteristically, increases in commodity price result

in corresponding increases in economically recoverable resource volumes. The economic resource volumes represent oil and gas, as yet undiscovered, that could be recovered profitably given the modeled economic and engineering parameters. At very high prices, the mean curve approaches the mean total resource endowment estimated by *GRASP*. The price-supply curves do not imply that these resources will be discovered or produced within a specific time frame, only that the opportunity exists for commercial production at levels controlled by commodity prices.

The price-supply curves were generated by the *PRESTO-5* computer program, which simulates the exploration, development, production, and transportation of pooled hydrocarbons in geologic plays within a petroleum province. Economic viability depends on the interaction of many factors defining the size and location of the hydrocarbon pools, the reservoir engineering characteristics, and economic variables relating expenditures to income from future production streams. The economic simulation is quite complex, owing to the complexities in the state of nature, and requires a sophisticated analytical model.

The following is a brief overview of the *PRESTO-5* modeling process. Geologic parameters (for example, reservoir thickness, pool area, risk) used by the *GRASP* computer model to determine conventionally recoverable resources are transferred into the *PRESTO-5* model through an interface program. Economic viability is determined by performing a discounted cash flow analysis on the expenses and modeled production stream for each pool simulated in a given trial. A Monte Carlo (random sampling) process selects engineering parameters (for example, production rate profiles, well spacing, platform installation scheduling), and cost variables (for example, platforms, wells, pipelines) from ranged distributions. Each simulation trial models the expenses, scheduling, and production for pools "discovered" within a particular play. The sampling process is repeated for productive pools in all geologic plays, and the economic resources are aggregated to the province level. The development simulation process is repeated, typically for 1000 trials, at given set of prices (oil and gas prices are linked). After the specified number of trials are completed for the first set of oil and gas prices, a new set of prices is selected and another round of simulation trials is run. This process continues for approximately 30 iterations, yielding a range of economic resource volumes tied to commodity prices. The results for all runs are given as probability distributions, where selected probability levels can be displayed as continuous price-supply curves.

These analyses determine the resource volumes that are commercially viable under a specific set of current economic and engineering assumptions. No attempt was made to upgrade engineering technology or development strategies that might be implemented in response to higher commodity prices.

The price-supply curves provided in this report are based on the most likely development scenario tailored for each particular province. All provinces were modeled on a stand-alone basis, with engineering assumptions designed for the primary hydrocarbon substance (oil or gas) identified by the *GRASP* analysis. Generally, the secondary hydrocarbon is less economically viable and places an extra burden on the primary hydrocarbon substance. For provinces without existing oil and gas infrastructure, the modeling scenarios were designed assuming that the primary substance would drive initial development in a particular province. Oil-prone provinces were modeled as "oil-only" production, with gas reinjected for reservoir pressure maintenance to maximize oil recovery. Gas-prone provinces were modeled with both gas and oil production because natural gas-liquids (or condensates) are not reinjected. Often the volume of condensates in gas-prone provinces exceeds any volume of non-associated crude oil. All hydrocarbon liquids are commingled in production and transportation systems.

This economic analysis assumes 1995 as the base year. Higher nominal commodity prices in the future (price increases only at the rate of inflation) do not result in higher estimated volumes of economically recoverable resources, whereas higher real commodity prices (increases above the rate of inflation) do increase the economically recoverable resources. The economic model assumes that commodity price and infrastructure costs were inflated equally at an assumed 3% annual inflation rate (flat real price and cost paths). The price-supply curves can be used to project economic resource volumes relative to future price if appropriate discounting back to the 1995 base year is made to account for real price and real costs changes in the intervening years.

The price-supply graph usually contains three curves, corresponding to Low, Mean, and High resource production levels. The Low resource case represents a 95% probability (19 in 20 chance) that the resources are equal to, or exceed, the volumes derived from the price-supply curves. The High resource case represents the 5% exceedance level (1 in 20 chance). The Mean resource case represents the average. In high-cost and high-risk provinces, where there are no economically recoverable resources at the 95% probability level, no "Low" curve is displayed. An apparent anomaly is observed in some cases where the lower tail of the "Mean" price-supply curve indicates

economic resources greater than the "High" (5% probability) curve. This situation occurs at low prices where the probability of economic success drops below 5%, and the Mean curve is obtained from the few productive trials occurring at probabilities below 5%.

A few additional observations concerning price-supply curves are noteworthy. Following established convention for price-supply curves, these graphs are rotated from the usual mathematical display of X-Y plots. Although shown along the vertical (Y) axis, price is the independent variable and resource is the dependent variable. In many of the gas-prone basins, price-supply curves will display an abrupt step below which no risked economically recoverable resources are modeled. This step corresponds to the minimum resource value required to overcome the cost of production and transportation infrastructure. Because of the distances to Asian markets, the assumed destination for Alaska gas production, natural gas must be converted to liquid form for transportation by ships. The infrastructure associated with conversion into liquefied natural gas (or LNG) does not lend itself to incremental additions for grassroots projects; therefore, an abrupt "cost-hurdle" created by large LNG and marine terminal installations must be overcome by significant resource volumes.

Finally, the reader must be aware that these price-supply curves are models of risked hydrocarbon resources. Both the geologic risk that the resources are pooled and recoverable as well as the economic risk that development is profitable under the assumed economic and technologic conditions are factored into the reported results. This means that although very low resource volumes are reported as "economically recoverable", these low volumes, in fact, do not correspond to actual quantities of oil or gas. At low prices, risk is dominated by economic factors associated with engineering cost and reservoir performance variables. At high prices, risk is dominated by geologic factors related to volumetric variables. **Risked price-supply curves are most appropriately used to define the comparative potential of petroleum provinces under changing price and probability conditions.** They do not predict the timing of resource discovery or rate of conversion of undiscovered resources to future production. As previously stated, future production of the modeled economically recoverable resources will require extensive exploration programs. In the Alaska offshore, future leasing and exploration activities are likely to be driven by "high-side potential", combining perceptions of greater rewards at higher risk, higher future commodity prices, and innovative technology to reduce costs.

TABLE FOR PLAY RESOURCE DISTRIBUTIONS

The risked mean contribution for each geologic play in the province is tabulated under two hypothetical price conditions. The Base Price ($18 per barrel-oil; $2.11 per MCF-gas) represents current economic conditions. The High Price ($30 per barrel-oil; $3.52 per MCF-gas) represents a situation where real price has increased significantly from current levels. Other economic parameters (for example, discount rate and corporate tax rate) were equal in both scenarios, as were engineering technology and cost assumptions. The play number, name, and *UAI* (*U*nique *A*ssessment *I*dentifier code) provide a link to the data presented in other sections of this report. Hydrocarbon substances are distinguished as oil (includes crude oil and gas-condensate liquids), gas (includes non-associated, associated, and dissolved gas), and BOE (gas volume is converted to barrel of oil equivalent and added to oil volume).

CHUKCHI SHELF MODELING RESULTS

The Chukchi shelf province was modeled for the production of oil, and the scenario relied on existing infrastructure on the North Slope and the Trans-Alaska Pipeline System (TAPS). Chukchi oil production was transported by TAPS and delivered by tankers to U.S. West Coast (Los Angeles) markets.

No Chukchi shelf gas resources are reported as economic. This decision is based on two considerations. First, the huge gas known reserves (25-35 TCFG) on the North Slope remain undeveloped, and no gas transportation infrastructure is present to carry gas to outside markets. Second, if a future liquefied natural gas (LNG) market warrants the large investment (approaching $15 billion) required for development, the proven onshore gas reserves are likely to fill the new gas transportation system for decades. The economic assessment assumed that solution gas recovered from oil fields will be used as fuel for facilities or reinjected to maximize oil recovery. Non-associated gas pools will not be developed until there is excess capacity in the future gas transportation system. At present, a gas pipeline and LNG plant for North Slope gas production is being considered for the year 2005-2010 time frame.

Under Base Price conditions ($18 per barrel), 1.14 BBO of risked mean economically recoverable oil is estimated for the Chukchi shelf province, placing it second (below the Beaufort shelf province) among all Alaska offshore assessment provinces. However, only 9% of the huge conventionally recoverable oil resources (13.02 BBO), and none of the conventionally

recoverable gas resources (51.84 TCFG), are economically viable at current prices. At High Price conditions ($30.00 per barrel), the Chukchi shelf province could hold economic resources ranging from 2.8 BBO (Mean resource case) to 6.2 BBO (High resource case).

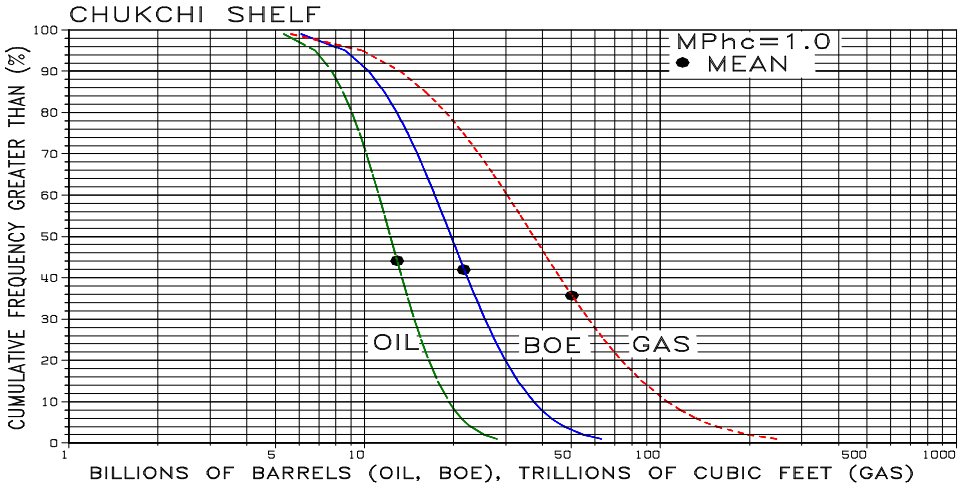
The economic oil resources are contained in few of the 22 geologic plays identified on the Chukchi shelf. For the Base Price ($18), 4 plays contain 90% of the economic oil resources. At the High Price ($30), these same 4 plays contain 86% of the economic oil resources. Two of these plays (Rift-Active Margin, Play 7; U. Brookian-Paleovalleys, Play 21) were tested by exploration wells with favorable, although non-commercial, results. The other two plays (Endicott-Chukchi Platform, Play 1; N. Chukchi High-Sand Apron, Play 14) remain untested by wells and are considered speculative.

The multi-billion barrel, high-side potential and existing infrastructure on the North Slope are two important factors which may attract future exploration efforts to the Chukchi shelf, despite the formidable costs and logistics of operating in this Arctic offshore setting.

Economic Results for Chukchi shelf assessment province. (A) Cumulative frequency distributions for **risked, undiscovered conventionally recoverable resources** ; (B) Table comparing results for conventionally and economically recoverable oil and gas; (C) Price-supply curves for **risked, economic oil** at low (F95), mean, and high (F05) resource cases.

BOE, total oil and gas in energy-equivalent barrels; MPhc, marginal probability for occurrence of pooled hydrocarbons in basin; BBO, billions of barrels; TCFG, trillions of cubic feet.

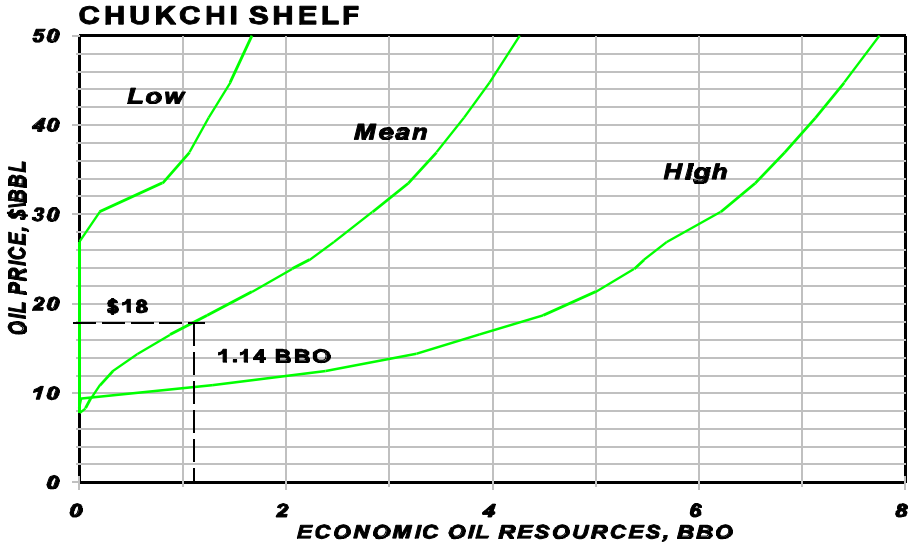
A.



B.

CHUKCHI SHELF PROVINCE		
RESOURCE TYPE	**MEAN OIL (BBO)**	**MEAN GAS (TCFG)**
CONVENTIONALLY RECOVERABLE	**13.02**	**51.84**
ECONOMICALLY RECOVERABLE ($18)	**1.14**	**N/A**
RATIO ECONOMIC/CONVENTIONAL	**0.09**	**N/A**

C.



OIL AND GAS RESOURCES OF CHUKCHI SHELF PLAYS

Risked, Undiscovered, Economically Recoverable Oil and Gas

PLAY NO.	PLAY NAME (UAI * CODE)	BASE PRICE			HIGH PRICE		
		OIL	GAS	BOE	OIL	GAS	BOE
1.	Endicott-Chukchi Platform (UACS0100)	0.169	n/a	0.169	0.459	n/a	0.459
2.	Endicott-Arctic Platform (UACS0200)	0.000	n/a	0.000	0.000	n/a	0.000
3.	Lisburne Carbonates (UACS0300)	0.000	n/a	0.000	0.000	n/a	0.000
4.	Ellesmerian Deep Gas (UACS0400)	0.000	n/a	0.000	0.000	n/a	0.000
5.	Sadlerochit-Chukchi Platform (UACS0500)	0.001	n/a	0.001	0.005	n/a	0.005
6.	Sadlerochit-Arctic Platform (UACS0600)	0.035	n/a	0.035	0.129	n/a	0.129
7.	Rift - Active Margin (UACS0700)	0.495	n/a	0.495	1.170	n/a	1.170
8.	Rift - Stable Shelf (UACS0800)	0.069	n/a	0.069	0.233	n/a	0.233
9.	Rift - Deep Gas (UACS0900)	0.000	n/a	0.000	0.000	n/a	0.000
10.	Herald Arch (UACS1000)	0.000	n/a	0.000	0.000	n/a	0.000
11.	L. Brook. Foldbelt (UACS1100)	negl	n/a	negl	0.003	n/a	0.003
12.	L. Brook. Turbidites/Wrench Zn (UACS1200)	0.000	n/a	0.000	negl	n/a	negl
13.	L. Brook. Topset/Wrench Zn (UACS1300)	0.001	n/a	0.001	0.005	n/a	0.005
14.	N. Chukchi High/Sand Apron (UACS1400)	0.153	n/a	0.153	0.329	n/a	0.329
15.	L. Brook. Topset/N. Chukchi Basin (UACS1500)	0.000	n/a	0.000	negl	n/a	negl
16.	Brookian Deep Gas (UACS1600)	0.000	n/a	0.000	0.000	n/a	0.000
17.	L. Brookian/Turbidites/Arct. Plat. (UACS1700)	0.000	n/a	0.000	0.000	n/a	0.000
18.	L. Brookian/Topset/Arctic Platform (UACS1800)	0.000	n/a	0.000	negl	n/a	negl
19.	U. Brookian/Sag Phase/N. Chuk. Bsn. (UACS1900)	0.000	n/a	0.000	0.000	n/a	0.000
20.	U. Brookian/Turbidites/N.Chuk.Bsn. (UACS2000)	0.000	n/a	0.000	0.000	n/a	0.000
21.	U. Brookian/Paleovalleys (UACS2100)	0.211	n/a	0.211	0.489	n/a	0.489
22.	U. Brookian/Intervalley Highs (UACS2200)	0.002	n/a	0.002	0.023	n/a	0.023
	TOTAL	***1.136***	***n/a***	***1.136***	***2.845***	***n/a***	***2.845***

* *Unique Assessment Identifier, code unique to play.*

OIL is in billions of barrels (BBO). **GAS** is in trillion cubic feet (TCF).
BOE is barrel of oil equivalent barrels, where 5,260 cubic feet of gas = 1 equivalent barrel-oil

For direct comparisons among provinces, two prices are selected from a continuum of possible price/resource relationships illustrated on price-supply curves. **BASE PRICE** is defined as $18.00 per barrel for oil and $2.11 per thousand cubic feet for gas. **HIGH PRICE** is defined as $30.00 per barrel for oil and $3.52 per thousand cubic feet for gas. Both economic scenarios assume a 1995 base year, flat real prices and development costs, 3% inflation, 12% discount rate, 35% Federal corporate tax, and 0.66 gas price discount.

Shaded columns indicate the most likely substances to be developed in this province. Economic viability is indicated on price-supply curves which aggregate the play resources in each province.

N/A refers to “not available”. Associated gas will be reinjected for pressure maintenance to maximize oil recovery or as fuel for production facilities. Coproduction of gas resources is not economically feasible because of the lack of a gas transportation system and over 25 TCF of proven and undeveloped gas reserves on the North Slope.