UNDISCOVERED OIL AND GAS RESOURCES OF U.S. ARCTIC ALASKA OUTER CONTINENTAL SHELVES

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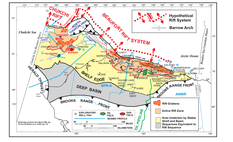
GEOLOGICAL MODELING

BASINS AND TECTONIC FEATURES

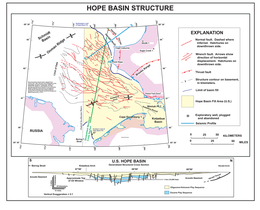
ELLESMERIAN SEQUENCE BASINS

RIFT SEQUENCE TECTONIC FEATURES



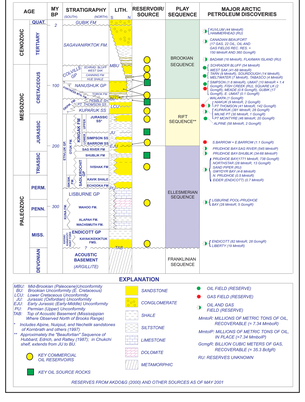
BROOKIAN SEQUENCE BASINS AND PLATFORMS

HOPE BASIN STRUCTURE



STRATIGRAPHIC COLUMNS

Stratigraphic Column
Chukchi Shelf, Beaufort Shelf, and Arctic Alaska



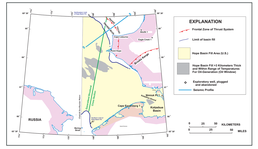
PLAY MAPS

ELLESMERIAN SEQUENCE PLAYS, ARCTIC ALASKA
Total Number of Offshore Plays = 9
Maximum Number of Undiscovered Offshore Oil and Gas Pools = 300
Mean Undiscovered Conventionally Recoverable Oil and Gas at $30/bbl ($5/bboe) and $1.75/Mcf ($.06/Mcfe), 1/1/2000, 95 Bcfe (1.075 bcf)

RIFT SEQUENCE PLAYS, ARCTIC ALASKA
Total Number of Offshore Plays = 4
Maximum Number of Undiscovered Offshore Oil and Gas Pools = 225
Mean Undiscovered Conventionally Recoverable Oil and Gas - 1.06 Bbbl, 2.261 mmbl, 341 Gcfe (12.06 bcf)
Mean Undiscovered Conventionally Recoverable Oil and Gas at $30/bbl ($5/bboe) and $1.75/Mcf ($.06/Mcfe), 1/1/2000, 2.26 Bbbl Oil (12.06 bcf)

BROOKIAN SEQUENCE PLAYS, ARCTIC ALASKA
Total Number of Offshore Plays = 20
Maximum Number of Undiscovered Offshore Oil and Gas Pools = 595
Mean Conventionally Recoverable Oil and Gas - 10.9 Bbbl 21.861 mmbl, 140 Tcfe (20.92 bcf)
Mean Undiscovered Conventionally Recoverable Oil and Gas at $30/bbl ($5/bboe) and $1.75/Mcf ($.06/Mcfe), 1/1/2000, 10.9 Bbbl Oil (20.92 bcf)

U.S. HOPE BASIN PLAYS
Total Number of Offshore Plays = 6
Maximum Number of Undiscovered Offshore Oil and Gas Pools = 150
Mean Undiscovered Conventionally Recoverable Oil and Gas at $30/bbl ($5/bboe) and $1.75/Mcf ($.06/Mcfe), 1/1/2000, 1.7 Bbbl Oil (9.2 bcf)



GEOLOGY OF PLAY SEQUENCES

ELLESMERIAN SEQUENCE: *Mississippian to Early Jurassic*

Ellesmerian rocks in the subsurface north of the Brooks Range are Mississippian to Early Jurassic in age. In the Brooks Range Ellesmerian-equivalent rocks are Devonian to Early Jurassic in age. The Ellesmerian sequence is bounded by the Devonian Antler Orogeny and the Jurassic rift event. The lower part of the basin collapsed. The relationship of the Ellesmerian-equivalent rocks of the Brooks Range to the Ellesmerian rocks in the North Slope subsurface is therefore speculative.

In the subsurface north of the Brooks Range, Ellesmerian rocks rest unconformably upon deformed Devonian and metamorphosed, that are locally intruded by felsic plutons. Ellesmerian clastic rocks were derived from landmasses exposed to the north (Arctic Alaska Basin) and to the east and west (Nevin Trough). Ellesmerian rocks are as much as 2 km thick in the Nevin Trough, and as much as 1 km thick in the Arctic Alaska Basin. Ellesmerian rocks are absent in the Nevin Trough beneath Colville Basin. The rift event in northern Alaska is thought to be related to the northern Canadian Arch, generally located somewhat north of the Brooks Range. The rift event in northern Alaska is thought to be related to the Canadian Arch, which was active from the Mississippian-Pennsylvanian of widespread orthotectonic Laurentian Sea (Jakobson). Clastic sequences of Late Permian to Early Jurassic age generally reflect erosional unroofing of the Brooks Range. Ellesmerian rocks are absent in the Colville Basin because of Brookian erosional truncation and Brookian rift and post-rift thermal subsidence. Within the rift system, the Ellesmerian and the Brookian Sequences locally exceeds 4 kilometers between northern Alaska but are absent on the Barrow Arch and south of the Barrow Arch.

Important Ellesmerian Sequence reservoir formations include sandstones of the Ivishak Formation (Triassic), carbonates of the Lisburne Group (Mississippian to Permian), and sandstones of the Kuparuk Group (Mississippian). The Kuparuk Formation, which is the Ellesmerian-equivalent of the Prudhoe Bay Unit reservoir, is as much as 100 m thick in the Kuparuk River Unit. The Kuparuk Formation is as much as 30 m thick in the Colville Basin and the Angun Formation (Jurassic) form important oil sources. These oil sources are thermally mature to overmature over large areas beneath Colville Basin. Oil generated in the Colville Basin migrates north in Cretaceous-Tertiary time largely migrated toward the Barrow Arch (Arctic Alaska Basin) on prograding basin floors (Angun, Pebble Trough).

Solaur oil and gas pools have been discovered in the Ellesmerian Sequence with aggregate recoverable discovered resources of 7.08 Bbbl (million metric barrels) of oil, 2.0 Tcf of associated gas, and 0.1 Tcf of non-associated gas. Ellesmerian Sequence undiscovered resources represent 14% of the undiscovered recoverable endowment (1,000 Mmbl-energy-equivalent) of northern Alaska and the Arctic Offshore. The largest undiscovered Ellesmerian Sequence oil and gas pools are 400 Mmbl (56,000 barrels per day) and 2.0 Tcf (57 bcf), respectively.

In a high-price scenario ($30/bbl oil, $1.75/mcf gas), the nine offshore Ellesmerian Sequence plays are assessed with 210 Mmbl and 40 Bcfeq of (mean, risked) undiscovered conventionally recoverable oil and gas, respectively, or a total of 250 Mmbl-energy-equivalent. This represents 25% of the conventionally recoverable energy endowment of the Ellesmerian Sequence plays (1,000 Mmbl-energy-equivalent). The Ellesmerian Sequence locally exceeds 4 kilometers between northern Alaska but the high-price scenario yields 60Mbbl, 1,000 Mmbl-energy-equivalent).

RIFT SEQUENCE: *Early Jurassic to Early Cretaceous*

The rift Sequence* is present from origin from Early Jurassic to Early Cretaceous in age and extrapolate to the "Beaufortian Sequence" defined for the Beaufort margin by Hubbard, Shuster, Grantz, and Houtz (1985). The rift Sequence is bounded by the Jurassic rift event and the Brookian Orogeny. The rift Sequence is as much as 2 km thick in the Colville Basin and Chukchi Shelf and is absent in the Nevin Trough and Arctic Continental Margin Rift System.

The Rift Sequence was deposited when basins on the south flank of a 1,100-kilometer-long rift system that arbitrarily broke upon a Mesozoic plate and cooled - an overpassive-margin basin. Rift-related sediments were deposited in half grabens and sags. The rift Sequence is thickest in the Colville Basin and Chukchi Shelf and thinnest in the Nevin Trough. Low-relief, rift-related structures are common in the Colville Basin and Chukchi Shelf. The rift system extended northeast along the Beaufort margin to 142° West Longitude then was offset south along a northeasterly transform fault that links to a separate rift segment between the Canadian Arctic Islands and the Alaska North Slope. The Canadian rift segment is thought to be Jurassic to Early Cretaceous in age and to have formed when Greenland broke from Canada and established its modern plate margin along the Alpha Ridge.

Deposition of the Rift Sequence was controlled by a system of grabens, horsts, sags and graffins in a zone of rift-deformed crust that extends up to 200 kilometers south of the Hinge Line. The Hinge Line is the hypothetical boundary between rift-deformed crust and undeformed crust. The Hinge Line is a hypothetical line because the rift-related structures are not well defined south of the Hinge Line. The Hinge Line is as much as 100 kilometers north of the Barrow Arch. The Hinge Line is also the approximate boundary between Ellesmerian-deformed crust and the modern passive-margin basin