PETROLEUM RESOURCE ASSESSMENT OF THE YUKON NORTH COAST, YUKON TERRITORY, CANADA

by
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March, 2001
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ISBN 1-55018-997-2

FOREWORD

On November 19, 1998, the Government of Canada transferred to the Government of Yukon the administrative legislative powers and responsibilities of managing onshore oil and gas resources. Yukon oil and gas resources are now governed under the Yukon *Oil and Gas Act*.

A study of the petroleum resources of the Old Crow Basin in the Yukon Territory was undertaken by Geological Survey of Canada (GSC) in response to a request from the Government of Yukon. Assessment of petroleum resource potential is important for forming regulatory policies for these resources and for providing a basis for planning and issuing exploration rights.

EXECUTIVE SUMMARY

This study was undertaken by the Geological Survey of Canada on behalf of the Yukon government as part of its ongoing oil and gas resources management program. The objective of the study was to investigate the hydrocarbon resource potential of the northern Arctic Coast in the Yukon Territory. A quantitative analysis was utilized to derive a numerical estimate of resources that may exist in the area. Due to the scarcity of defined pools with established reserves, probability distributions of reservoir parameters and marginal risk factors were employed to generate a range of hydrocarbon potential estimates. The predicted wide ranges of resource potential reveal the uncertainties involved in the analysis of frontier exploration plays.

Numerous regional tectonic and structural elements occur beneath the coastal lowland and shallow waters of the Beaufort Sea on the North Coast of the Yukon. The area west of the northern Richardson Mountains and extending into the Beaufort Sea consists of highly deformed strata of the Cordilleran Foldbelt. Structures, including compressional folds and strike-slip faults formed during the Laramide Orogeny, are underlain by older tectonic features such as the Cache Creek Uplift and Rapid Depression which originated as Mesozoic fault-bounded structures. North of Rapid Depression, several significant large-scale tectonic features, such as Blow River and Herschel highs, are cored by closely spaced anticlines. On the south flank of Herschel High, there lies a large synclinal structure filled with Eocene and younger strata called the Demarcation Subbasin.

The hydrocarbon potential volumes were derived using the Geological Survey of Canada's PETRIMES assessment methodology system. This resource study embraced analyses of six conceptual and immature plays, each of which incorporated estimations of field size parameters, numbers of prospects and exploration risks. The median estimate for total oil and gas potential for all coastal lowland plays are 39.8 million m^3 and 38.6 billion m^3, respectively. There are no discovered reserves in the Yukon portion of the assessment region. The assessment results indicate that four gas fields greater than 3,000 million m^3 (100 BCF) are expected in the region. No oil fields larger than 160 million m^3 (1 billion bbls.) are predicted beneath Yukon North Coast. Even though geological risk factors are substantial, significant gas potential is predicted for the Herschel play.

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INTRODUCTION

This study was undertaken by the Geological Survey of Canada on behalf of the Yukon Territorial Government as part of its ongoing oil and gas resource management program. The objective of this study was to investigate the hydrocarbon resource potential of the North Coast in the Yukon Territory (Fig. 1). A quantitative analysis was utilized to derive a numerical estimate of resources that may exist in the region. Due to the scarcity of defined pools with established reserves, probability distributions of reservoir parameters and marginal risk factors were adopted to generate a range of hydrocarbon potential estimates indicative of the uncertainties involved in the analysis of frontier conceptual and immature plays.

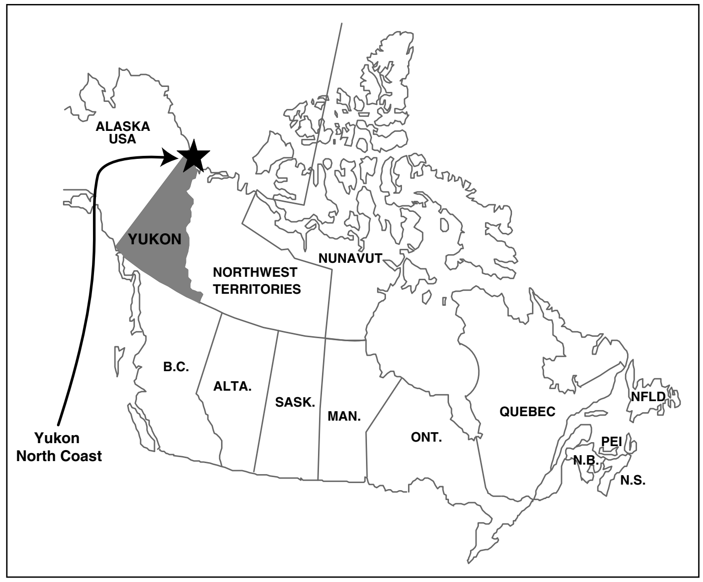


Figure 1. *Map of northwestern Canada showing study area location.*

Regional petroleum resource assessments have been prepared periodically for numerous sedimentary basins in Canada by the Geological Survey of Canada. These studies incorporate systematic basin analysis with subsequent statistical resource evaluations (Podruski, *et al.*, 1988; Wade, *et al.*, 1989; Sinclair, *et al.*, 1992; Reinson, *et al.*, 1993; Bird, *et al.*, 1994; Dixon, *et al.*, 1994; Hannigan, *et al.*, 1998, 1999; Hannigan, in press (a), (b) and (c)).

This report provides an overview of the petroleum geology of the Yukon North Coast region and presents quantitative estimates of the oil and gas resources contained therein. The geological and resource framework for the region will assist government agencies in evaluating land-use and moratorium issues and petroleum industry companies in pursuing future exploration opportunities.

ACKNOWLEDGEMENTS

The author would like to acknowledge staff at GSC-Calgary for their insight and geological expertise on this area, specifically, J. Dixon, J.R. Dietrich and K.G. Osadetz.

TERMINOLOGY

The terminology and procedures used in this report follow those outlined in Reinson, *et al*. (1993) and are summarized below.

Oil is defined as any naturally occurring liquid that, at the conditions under which it is measured or estimated, is primarily composed of hydrocarbon molecules and is readily producible from a borehole.

Natural gas is defined as any gas (at standard pressure and temperature, 101.33 kPa and 15oC) of natural origin, comprised mostly of hydrocarbon molecules, producible from a borehole (Potential Gas Committee, 1990). Natural gas may contain significant amounts of non-hydrocarbon gas such as H2S, CO2 or He. In this study, non-hydrocarbon gas was not considered due to lack of information on gas compositions in these basins.

Condensate is a mixture, mainly of pentanes and heavier hydrocarbons, that can be recovered from an underground reservoir that may be gaseous in its virgin reservoir state but is liquid at the conditions under which its volume is measured (Alberta Energy and Utilities Board, 1999).

Raw gas is unprocessed natural gas, containing methane, inert and acid gases, impurities and other hydrocarbons, some of which can be recovered as liquids. *Non-associated gas* is natural gas that is not in contact with oil in a reservoir. *Associated gas* is natural gas that occurs in oil reservoirs as free gas. *Solution gas* is natural gas that is dissolved in crude oil in reservoirs. In this report, insufficient information is available in order to differentiate non-associated, associated, and solution gas. All gas figures reported represent initial raw gas volumes.

Resource indicates all hydrocarbon accumulations known or inferred to exist. *Resource, resource endowment and endowment* are synonymous and can be used interchangeably. *Reserves* are that portion of the resource that has been discovered, while *potential* represents the portion of the resource that is not discovered but is inferred to exist. The terms *potential* and *undiscovered resources* are synonymous and may be used interchangeably.

Gas-in-place indicates the gas volume found in the ground, regardless of what portion is recoverable. *Initial in-place volume* is the gross volume of raw gas, before production. *Recoverable in-place volume* represents the volume expected to be recovered using current technology and costs. These definitions can be applied to oil volumes as well.

A *prospect* is defined as an untested exploration target within a single stratigraphic interval; it may or may not contain hydrocarbons. A prospect is not synonymous with an undiscovered pool. An undiscovered pool is a prospect that contains hydrocarbons but has not been tested as yet. A *pool* is defined as a discovered accumulation of oil or gas typically within a single stratigraphic interval that is separate, hydrodynamically or otherwise, from another hydrocarbon accumulation. A *field* consists of one or more oil and/or gas pools within a single structure or trap. Similar to most frontier regions, the assessment of petroleum resources of the Yukon North Coast is based on estimates of field rather than pool sizes. A *play* is defined as a family of pools and/or prospects that share a common history of hydrocarbon generation, migration, reservoir development and trap configuration.

Plays are grouped into two categories: *established* and *conceptual* plays. *Established plays* are demonstrated to exist due to the discovery of pools with established reserves. *Conceptual plays* are those that have no discoveries or reserves, but which geological analyses indicate may exist. Established plays are categorized further into *ma-ture* and *immature* plays depending on the adequacy of play data for statistical analysis. Mature plays are those plays that have sufficient numbers of discoveries within the discovery sequence so that the *discovery process model* of the PETRIMES assessment procedure is of practical use (Lee and Tzeng, 1989; Lee and Wang, 1990; Lee, 1993). Immature plays do not have a sufficient number of discoveries with established reserves to properly apply the model. Subjective probability play analysis was applied exclusively in this study due to the scarce number of discovered pools with established reserves.

METHOD AND CONTENT

This report incorporates two essential components, geological basin analysis and statistical assessment. Basin analysis fundamentally describes and characterizes the exploration play. Fields and prospects in a play form a natural geological population that can be delimited areally. Once a play is properly defined, a numerical and statistical resource assessment is undertaken using relevant geological data and information for that specific play.

RESOURCE ASSESSMENT PROCEDURE

The analysis of the North Coast area began with the compilation and synthesis of information on regional geology and hydrocarbon occurrence. This included a survey of pertinent publications.

The aim of this data compilation was to initiate basin analysis in order to provide background for the definition of hydrocarbon occurrence models. Play models in the study area were developed by examining the hydrocarbon systems and, when possible, using analogues to extrapolate certain parameters.

Play definition and estimation of reservoir parameters formed the input for a systematic statistical analysis which allowed a quantitative analysis of the undiscovered resource.

GEOLOGICAL PLAY DEFINITION

Definitions of play type and area are essential components of geological basin analysis preceding any numerical resource evaluation procedure. A properly defined play will possess a single population of pools and/or prospects that satisfies the assumption that geological parameters within a play can be approximated by a family of lognormal distributions. Mixed populations derived from improperly defined plays add uncertainty to the resource estimate. Pools and/or prospects in a specific play form a natural geological population characterized by one or more of the following: age, depositional model, structural style, trapping mechanism, geometry, and diagenesis. Prospects or areas within a basin or region can be assigned to specific plays on the basis of a commonality of some or all of these geological elements.

COMPILATION OF PLAY DATA

For conceptual and immature plays, probability distributions of reservoir parameters such as prospect area, reservoir thickness, porosity, trap fill and hydrocarbon fraction are needed. Prospect size can then be calculated using the standard "pool"- size equation. Seismic, well, and outcrop data prove particularly useful in identifying the limits for sizes of prospect area and reservoir thickness as well as porosity limits. Geochemical data are useful in identifying prospective areas as well as the composition of the hydrocarbon accumulations, ie. oil-vs.-gas proneness. Research in similar hydrocarbon-bearing basins is also important in order to provide reasonable constraints on reservoir parameters as well as contribute further information on other aspects of petroleum geology that may prove useful in the study.

SUBJECTIVE PROBABILITY ANALYSIS

There are several methods for estimating the quantity of hydrocarbons that may exist in a play, region or basin (White and Gehman, 1979; Masters, 1984; Rice, 1986; Lee, 1993). Petroleum assessments undertaken by the Geological Survey of Canada are currently based on probabilistic methods (Lee and Wang, 1990) that are developed in the Petroleum Exploration and Resource Evaluation System, PETRIMES (Lee and Tzeng, 1989). The immature and conceptual hydrocarbon plays defined in the North Coast region were analysed by applying a subjective probability approach to the various reservoir parameters. The lognormal option in PETRIMES was used since experience indicates that geological populations of pool parameters can adequately be represented by lognormal distributions.

Resource assessments in frontier regions use field-size estimates rather than pool-size predictions as derived from mature and immature play analysis in mature basins. A field consists of one or more oil/gas pools or prospects in a single structure or trap. Probability distributions of oil and gas field sizes are computed by combining probability distributions of reservoir parameters, including prospect area, reservoir thickness, porosity, trap fill, hydrocarbon fraction, oil shrinkage and gas expansion.

Probability distributions of oil and gas field sizes are then combined with estimates of numbers of prospects (from seismic and play area mapping) and exploration risks to calculate play potential and to estimate sizes of undiscovered fields.

Exploration risks at a play or prospect level are determined on the basis of the presence or adequacy of geological factors necessary for the formation of petroleum accumulations. Essential factors are reservoir, seal, source rock, timing of hydrocarbon generation, trap closure and preservation. Appropriate marginal probabilities are assigned to each geological parameter. The Yukon coastal plain plays are expected to exist (the low play-level risk of 1.0 was assigned to each play). Within each play, certain prospect-level risks are high and these are assigned appropriate risk factors. Exploration risk is an estimate, incorporating all risk factors, of the percentage of prospects within a play that are expected to contain hydrocarbon accumulations.

Uncertainties in oil and gas play potential and pool-size estimates of a given range of probabilities are necessarily greater than the ranges derived by discovery process analysis used for assessing mature plays. This is due to the nature of frontier assessment results and because few discovered pool sizes are available to constrain sizes of undiscovered accumulations.

REGIONAL GEOLOGY

Two distinct structural and genetic regional geological regimes are represented in northern Yukon. The vast majority of northern Yukon occupies a portion of the Cordilleran Orogen. An area of northeastern Yukon, specifically Peel Plateau, lies on the ancestral North American craton where little Phanerozoic deformation has taken place. This area of ancestral North America is known as the Interior Platform.

There are two major geological provinces lying within the Cordilleran Orogen of northern Yukon. They are separated by the northwest-trending Tintina fault. The area southwest of the fault consists of amalgamated and accreted geological terranes that contain younger, fairly complex assemblages of varying rock-types. The northeastern region, which is part of the morphogeological Frontal Belt, includes a thick assemblage of older sedimentary rocks deposited on the relatively stable ancient North America margin (Hart, 1999).

The western edge of the ancient North America craton extended far out into the ancient Pacific Ocean. This submerged continental shelf of crystalline basement rock is at least 1.7 billion years old and is present throughout northern Yukon beneath both the Interior Platform and the Cordilleran Orogen. These rocks, in part, provided the stable continental platform, upon which sediments, dominantly limestone and sandstone, were deposited over a period of a billion years (Hart, 1999). Shale, sandstone and chert accumulated in basinal regions of deeper water. Thus, the two depositional environments (platform and basin) gave rise to distinct sedimentary packages, dominated by limestone and shale, respectively. These shale and limestone packages are now in fault contact with each other. The Interior Platform amassed thicknesses of between 5 and 25 kilometres of dominant limestone and sandstone. Limestone accumulated during quiescent times in warm, shallow and clear water. The sandstone consists of detritus eroded from the Canadian Shield.

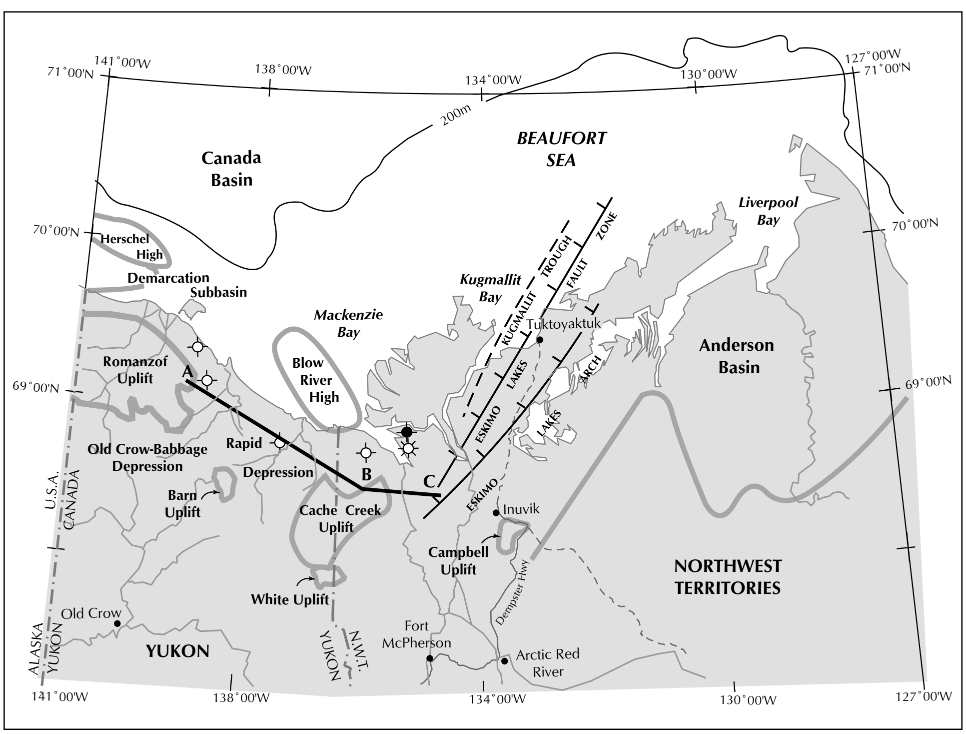
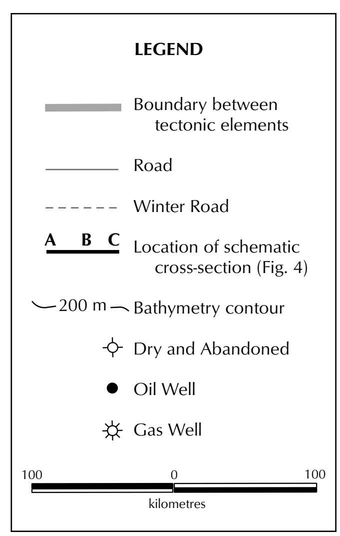


Figure 2. The major structural elements in the region (from Dixon, et al., 1994).



A complex folded and faulted terrain, part of the Frontal morphogeological belt of the Cordilleran Foldbelt, underlies the Arctic coastal region of northern Yukon. Structures such as compressional folds and strike-slip faults, formed during the Laramide Orogeny, are underlain by older tectonic features such as the Cache Creek Uplift and Rapid Depression which originated as Mesozoic fault-bounded structures. Other significant older tectonic and structural elements in the region are the Barn and Romanzof uplifts, Blow River and Herschel highs and the Demarcation Subbasin (Fig. 2; Dixon, *et al.*, 1994).

The Rapid Depression (Lane, 1998) is defined on the basis of its Albian fill, with older sediments bounding it to the east, west and south (Dixon, 1996a). To the north, the Blow River High contains Tertiary strata. The Depression is a structurally controlled trough which terminates up-plunge at the upper reaches of the Blow River (Norris, 1997a). Within the trough, more than 5,000 m of Lower Cretaceous turbiditic sandstone and conglomerate were deposited. On the flanks of the trough, this flyschoid succession thins dramatically where it lies unconformably on Ellesmerian units. On top of the flysch, more than 1,200 m of Upper Cretaceous and Tertiary clastics accumulated (Norris, 1997a).

The Cache Creek Uplift underlying southwest Mackenzie Delta is a fault-bounded entity containing rocks ranging in age from at least Middle Devonian to early Tertiary. Middle Devonian or older massive carbonate units in the core of the complex are overlain unconformably by Carboniferous and Permian limestone and sandstone (Norris, 1997a). Deformation in the core appears to be related to the Ellesmerian Orogeny. The Upper Paleozoic rocks are disconformably overlain by Jurassic and Cretaceous shales and sandstones on the northwestern flank of the structure, which, in turn, are covered by lower Tertiary strata (Norris, 1997a).

West of the Rapid Depression lies the Barn Uplift (Fig. 2). It is cored by highly compressed Lower Paleozoic strata, coeval with Road River Formation occurring within the Richardson Mountains to the south. The succession consists of shales, cherts, quartzites, siltstones and limestones (Dyke, 1974). These rocks are overlain unconformably by coarse clastics of the Early Carboniferous Kekiktuk Formation. The rocks in the Uplift are deformed into a series of highly folded, generally steeply dipping panels (Norris, 1997a).

The Romanzof Uplift underlies the British Mountains straddling the Canada-USA border. Isoclinally folded and thrust faulted strata of the Neruokpuk and Road River formations occur within the complex. In Canada, the northern limit of the uplift is in fault contact with the Rapid Depression (Norris, 1997a).

The tectonic elements in the offshore area are principally Late Cretaceous and Tertiary in origin (Dixon, 1996a). The Blow River and Herschel highs are cored by tightly folded Tertiary strata and both have structural elevations higher than the surrounding areas. The Herschel High also contains high-angle reverse faults. A prominent areally large synclinal structure on the south flank of the Herschel High is called the Demarcation Subbasin which is filled with Eocene and younger strata (Dixon, 1996a).

STRATIGRAPHY AND DEPOSITIONAL SETTING

Four major tectono-stratigraphic assemblages are recognized in the Mackenzie Delta–Beaufort Sea region. They include Inuvikian embracing Proterozoic strata, Franklinian encompassing Cambrian to Devonian strata, Ellesmerian which consists of Mississippian to upper Hauterivian rocks, and Brookian comprising upper Hauterivian to modern sediments. Major regional unconformities separate the four assemblages. Significant changes in tectonic regime and activity are designated by these regional unconformities. Another major unconformity is recognized lying beneath Upper Cretaceous strata dividing the Brookian assemblage into an upper and lower subdivision. Most of the oil and gas discovered to date in the Beaufort–Mackenzie area are found in the upper Brookian assemblage (Dixon, *et al.*, 1994).

Figure 3 depicts the stratigraphy and correlative relationships in the Beaufort Sea, Mackenzie Delta and Northern Yukon. Potential reservoir and source rocks in the assessment area are indicated. A schematic cross-section depicting the complex stratigraphic relationships within Upper Jurassic to Paleocene strata beneath the Yukon Arctic coastal plain is depicted in Fig. 4.

INUVIKIAN (PROTEROZOIC)

Interbedded quartzites, argillites, cherts, and limestones of the Hadrynian Neruokpuk Formation are exposed in the core and on the southwest flank of the Romanzof Uplift. The formation is interpreted to also occur beneath the Rapid Depression to the north and east (Norris and Dyke, 1997). Significant discoveries of Paleozoic fossils on the northern flank of the Romanzof Uplift has resulted in reinterpretation of the stratigraphy of the area where previously mapped Precambrian Neruokpuk Formation (Norris, 1981a, b) is now thought to represent strata equivalent to the Road River Group (Lane and Dietrich, 1996). Previous definitions of Neruokpuk strata have included all pre-Mississippian strata in northern Yukon and Alaska (such as, Brosge, *et al.*, 1962; Reed, 1968; Dutro, *et al.*, 1972; Sable, 1977). Lane (1991) argued that Neruokpuk strata should be limited to Proterozoic strata and restricted to the quartzite-dominant unit of that age. These Proterozoic sediments have undergone metamorphism and represent an effective economic basement in the region.

FRANKLINIAN (LOWER PALEOZOIC)

Paleogeographic reconstructions in northern Yukon indicate that Lower Paleozoic strata are generally represented by a basinal facies (Norford, 1997; Lane, 1998). Cambrian to Silurian phyllites, cherts, quartzites and volcanics unconformably overlie the metasedimentary Hadrynian Neruokpuk Formation. These rocks are coeval with Road River Group strata to the south but have sufficient differences in lithologies to warrant separate nomenclature. However, present knowledge of these strata is inadequate for formal nomenclature, so this assemblage of basinal rocks is unnamed (Norford, 1997). There are red and green cherty argillites, shales and phyllites, conglomerates, sandstones and minor limestones in the succession and they are interpreted to have substantial similarities to rocks in Selwyn Basin more than 1,000 km to the south (Cecile, 1988). Thicknesses in northern Yukon are unknown and the rocks are structurally complex. A major unconformity on top of the assemblage locally places Carboniferous, Jurassic or Lower Cretaceous rocks on the Franklinian succession. Lower Paleozoic basinal strata are probably overmature but may retain some potential as a source rock for gas.

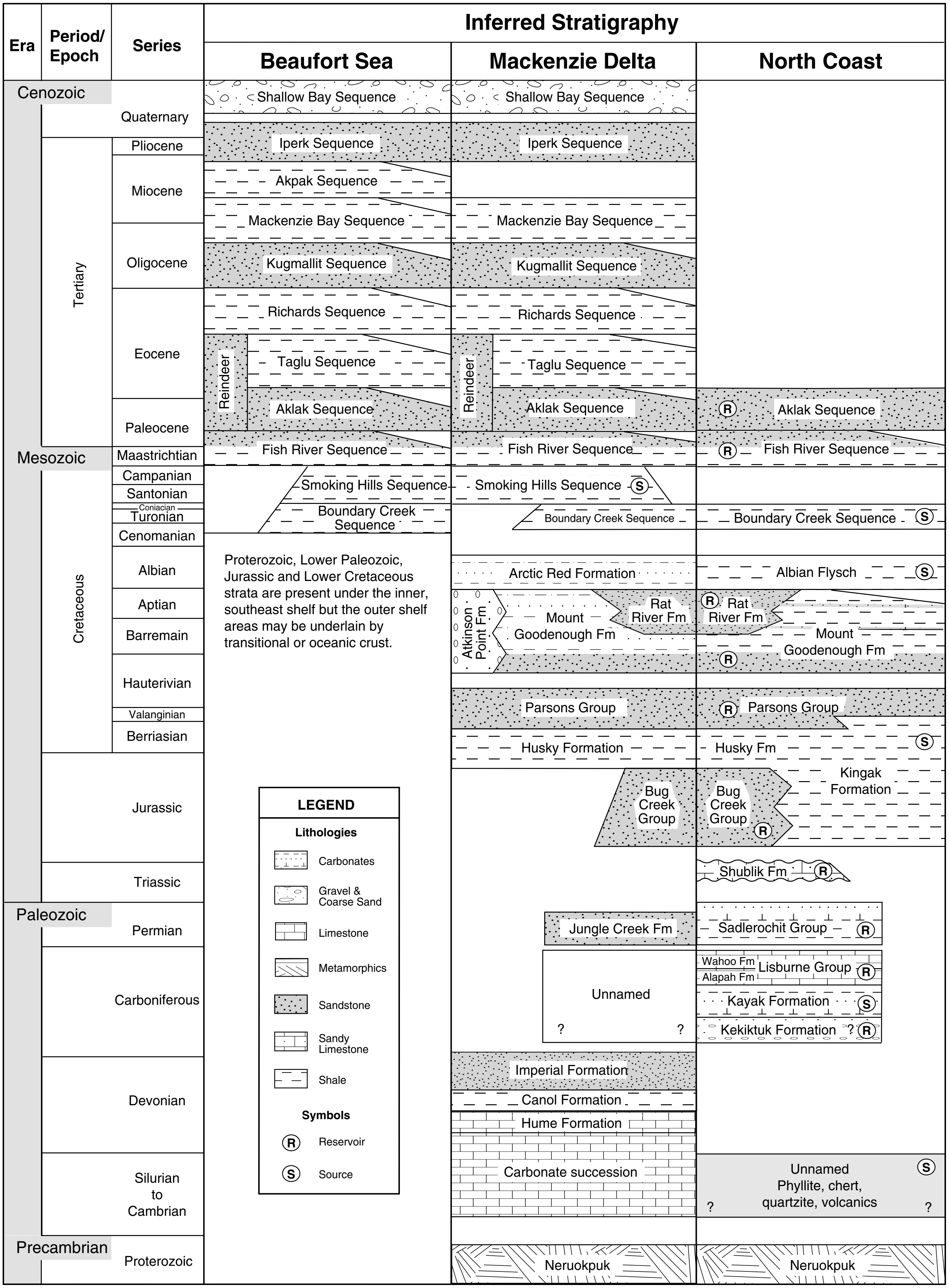


Figure 3. *Stratigraphic chart, Beaufort-Mackenzie area (from Dietrich and Dixon, 1997). Potential reservoirs and source rocks in northern Yukon are shown.*

ELLESMERIAN (CARBONIFEROUS TO MIDDLE HAUTERIVIAN)

The lowermost Carboniferous sediments are interbedded chert conglomerates and conglomeratic sandstones of the Kekiktuk Formation that unconformably overlie older strata in the area (Fig. 3; Richards, *et al.,* 1997). Chert, quartz and quartzite clasts are encased in a tight siliceous matrix. This poorly exposed laterally discontinuous unit is exposed in British and Barn mountains and likely occurs through most of northern Yukon. Permian and Carboniferous strata are truncated northeastwards by sub-Triassic and sub-Jurassic unconformities. The Kekiktuk Formation varies in thickness from one to 50 m, averaging about 25 m (Richards, *et al.*, 1997). Lithologies and regional relationships in the Kekiktuk Formation suggest deposition in braided stream and fan delta settings. An underlying regional subaerial erosion surface together with the overlying coastal plain facies of the Kayak Formation infers a continental environment during Kekiktuk deposition. The absence of marine fossils in most of the formation is also indicative of a terrestrial depositional setting. Locally derived, texturally immature sediments with conglomerate channel fills infer the braided stream/fan delta depositional setting (Richards, *et al.,* 1997). Kekiktuk conglomerates are identified as potential reservoir units in the Old Crow plain and on the Alaskan North Slope. Quality of reservoir is unknown beneath the coastal region of the Yukon.

Upper Visean siliciclastics and minor carbonates of the Kayak Formation conformably overlie Kekiktuk rocks. The Kayak Formation consists of basal sandstone with coal seams, a middle shale-dominated unit and an upper interval consisting of shale with subordinate limestone. Thicknesses range from 220 to 375 m in the study area. These clastic formations depict a transgressive, deepening-upward succession where coal-bearing siliciclastics of the basal unit, deposited in shoreline and coastal environments, succeeded fluvial and deltaic sediments in the underlying Kekiktuk Formation (Richards, *et al.,* 1997). Successive shale and carbonate units were deposited in shallow marine to intertidal environments. Coeval carbonate deposition of lowermost Lisburne Group took place in the British Mountains.

In northern Yukon, a widespread Carboniferous carbonate succession consisting of the Alapah and Wahoo formations of the Lisburne Group conformably overlies the

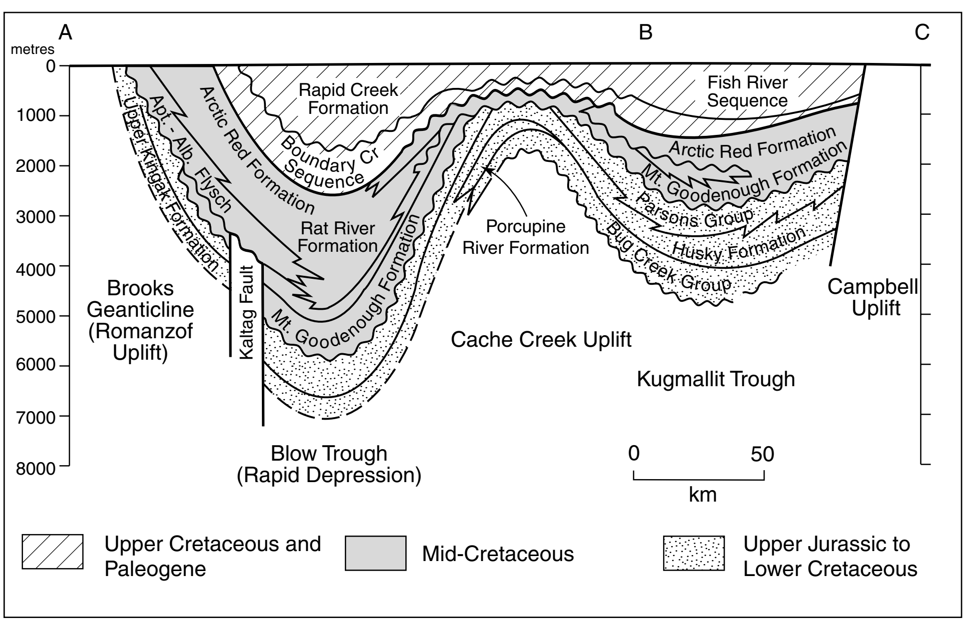


Figure 4. *Schematic cross-section (see Fig. 2 for location) illustrating three clastic assemblages in Upper Jurassic to Paleocene strata of Blow and Kugmallit troughs (after Yorath, 1991).*

Kayak Formation. The Alapah Formation is the thickest and most extensively preserved carbonate unit in northern Yukon. It is more than 1,300 m thick in the western British Mountains and thins to the northeast (Richards, *et al.*, 1997). Lower Alapah carbonates in the British Mountains consist of lime mudstones and wackestones, while skeletal lime grainstones and packstones dominate the upper part. The older carbonates were deposited in restricted to protected shelf environments, while upper Alapah rocks were laid down in a shelf margin setting. Another carbonate unit, called the Wahoo Formation, immediately overlies Alapah carbonates. This formation ranges in thickness from 130 to 225 m in the British Mountains (Richards, *et al.*, 1997). Lime grainstones and packstones dominate this cyclic succession. Deposition probably occurred on protected shelf to shelf margin marine environments. Carboniferous carbonates have been identified as prominent potential reservoir units on the Alaskan North Slope and in Eagle Plain. Dolomitic facies within Lisburne Group carbonates contain significant reserves of hydrocarbons at Prudhoe Bay.

An unconformity separates Carboniferous strata from overlying Permian strata. In the western British Mountains, there is a thin (~200 m), poorly known succession called the Sadlerochit Group that was deposited in a Permian basin which developed north of the Ancestral Aklavik Arch (Fig. 3; Richards, *et al.*, 1997). Local erosional remnants have been preserved in the British Mountains. Shales, sandstone and minor carbonate of the Sadlerochit Group also occur eastward in the Cache Creek Uplift and under southwestern Mackenzie Delta (Dixon, *et al.*, 1994). This unit likely contains a shallow marine facies, including shelf sandstones which may include potential reservoir horizons.

The unconformity-bounded Middle and Upper Triassic Shublik Formation is locally preserved in northwestern Yukon in British and Barn mountains. A nearshore, inner shelf depositional environment is interpreted for Shublik rocks in northern Yukon (Norris, 1997b). This nearshore facies is very heterogeneous with rapid lateral changes in lithology. Basal conglomerate and conglomeratic limestone grade into sandstone, limestone, siltstone, and chert from one exposure to another (Norris, 1997b). Only about 150 m of strata is preserved on the southwest flank of British Mountains. There may be potential for reservoir development among the coarse clastic units in this thin succession in northern Yukon. The Shublik Formation oversteps progressively older formations to the northeast and is erosionally truncated at the sub-Jurassic unconformity. These stratigraphic relationships infer that the southeastward extensions of Permian and Triassic reservoirs at Prudhoe Bay in Alaska do not reach into the Yukon Territory (Norris, 1997b).

Fundamental changes in depositional style and paleogeography took place at the commencement of Jurassic sedimentation. A series of northwestward prograding wedges originated from an arenaceous belt that developed on the southeastern margin of a Jurassic-Neocomian basin (‘Brooks-Mackenzie Basin’ in Poulton, 1997). These sandstone units grade laterally into shale-dominant units to the northwest and west, away from the exposed North American craton from which they were derived. Interdigitation of arenaceous and argillaceous units in the basin-marginal areas record numerous transgressive and regressive episodes in the overall subsiding shelf regime (Poulton, 1997). In ascending order, the formations within the arenaceous belt in northeastern Yukon and southern Mackenzie Delta are the Bug Creek Group consisting mostly of sandstone, Husky Formation which is shale-dominant, and the Parsons Group which contains the sandstone-dominant Martin Creek Formation, the shales of the McGuire Formation and the sandstone-rich Kamik Formation. In northwestern Yukon, the Bug Creek to McGuire interval is represented singly by the shale succession called the Kingak Formation. The arenaceous belt is interpreted to occur at the basin margin or within the inner shelf facies, while the argillaceous Kingak succession occupies the outer shelf to the northwest.

Jurassic Husky and Kingak shales have been recognized as potential source rocks in Beaufort-Mackenzie Basin and the Alaskan North Slope. Davies and Poulton (1989) report elevated Thermal Alteration Indices (T.A.I.) and vitrinite reflectance values in outcrop in the western Richardson Mountains. These source rocks have passed through the oil window making them overmature and resulting possibly in the generation of dry gas, which may still be taking place.

BROOKIAN (UPPER HAUTERIVIAN TO EOCENE)

A major regional unconformity occurs at the base of the Upper Hauterivian to Barremian Mount Goodenough Formation. Another major unconformity separates Upper Cretaceous strata from Lower Cretaceous rocks. The mid-Cretaceous unconformity distinguishes two tectono-stratigraphic sequences: a lower assemblage consisting of easterly to southeasterly craton-derived sediments deposited in shoreline and shelf environments, and an upper assemblage derived from the Cordilleran Orogen to the south and southwest. The younger assemblage consists of Upper Cretaceous sediments deposited in a cratonic foreland basin overlain by Tertiary rocks that accumulated in a subsiding continental margin (Dixon, 1997).

Upper Hauterivian and Barremian strata are embodied by the shale-dominant Mount Goodenough Formation. This unit is present throughout northern Yukon and in the subsurface of Mackenzie Delta and the Beaufort Sea. A basal sandstone is locally developed which may contain reservoir facies. This sandstone is especially well-developed adjacent to and upon positive tectonic elements such as the Cache Creek and Romanzof uplifts. Gradationally overlying Mount Goodenough shales in the northern Richardson Mountains are interbedded sandstones and shales of the Rat River Formation. This formation is Barremian to Aptian in age. The basin margin, or shoreline facies, of the Rat River Formation grades laterally to the northwest into the shale-dominant shelf area represented by the Mount Goodenough Formation.

Late Aptian and Albian rocks are designated Albian Flysch in northern Yukon. Thick accumulations of Albian sediment were deposited in grabens and half-grabens such as Blow Trough in the Rapid Depression (Dixon, 1997). Within the Albian Flysch succession, shale is dominant but there are also significant stratal intervals containing sandstone and conglomerate derived from the ancestral Brooks Geanticline to the west. These flysch deposits also underlie the Yukon North Coast to the northwest. The flysch was deposited as sediment gravity-flow deposits in slope, submarine and basinal environments (Dixon, *et al.*, 1994).

The major unconformity separating Lower and Upper Cretaceous strata marks a profound change from the deep-water basins, mud-rich shelf areas and poorly defined foreland basins prominent during Albian time, to the post-Albian emergence of well-defined foreland basins filled with coarse clastics from the Cordilleran Orogen (Dixon, 1997). This unconformity is especially prominent west of Richardson Mountains where shales containing thin beds of bentonite of the Boundary Creek sequence abruptly overlie the Albian Flysch. These shales were deposited within outer shelf to slope environments (Dixon, *et al.*, 1994). The Boundary Creek shales are rich in organic matter, averaging 3 to 5% TOC. The slightly younger Smoking Hills strata present in Mackenzie Delta and the Beaufort Sea are especially rich in organic matter, but are eroded west of Richardson Mountains. The Maastrichtian to Paleocene Fish River Sequence unconformably overlies the Boundary Creek Sequence in northern Yukon. This unconformity marks a significant shift from cratonic sedimentation to continental margin deposition.

The late Maastrichtian-Tertiary continental margin deposits consist of a series of prograding deltaic complexes. The earliest delta complex was centred over the western Beaufort shelf, whereas subsequent delta centres tended to shift eastward (Dixon, 1997). The earliest delta is defined by the Fish River Sequence in northern Yukon. The younger late Paleocene-early Eocene Aklak sequence, conformably lying on top of Fish River strata, is also centred in the western part of the Beaufort Sea. Both the Fish River and Aklak sequences form an extensive belt of sandstone-rich strata.

Every Tertiary sequence contains a thick succession of interbedded sandstone and shale at the basin margins, distributed in delta plain and delta front deposits. Basinward, the amount of shale increases. The early to middle Eocene Taglu sequence is centred under Richards Island with deltaic deposits extending westward into the shallow waters of Beaufort Shelf in northern Yukon (Dietrich and Dixon, 1997). A thin cover of late Pleistocene-Holocene Shallow Bay basinal shales is present on the northern Yukon continental shelf overlying a Late Miocene unconformity (Dietrich and Dixon, 1997).

STRUCTURAL GEOLOGY

To the west of the Richardson Mountains and extending into western Beaufort Sea, highly deformed strata of the Cordilleran Foldbelt occur (Norris, 1981a, b; Lane and Dietrich, 1996). These compressional and strike-slip structures were formed in late Cretaceous to Tertiary time during the Laramide Orogeny. The arcuate trend of the offshore fold and thrust belt is marked onshore by the eastward to southeastward strike of structures in northwestern Yukon, while further east in Blow Trough and in the Richardson Mountains, the structures trend north-south. Brookian deformation taking place during Eocene time produced these prominent structures which overprint Paleozoic compressional and Jurassic-Cretaceous extensional structures in the study area (Lane and Dietrich, 1996). Tertiary extensional faults are also common throughout the Beaufort-Mackenzie Basin. Older structural features, such as the Rapid Depression and Cache Creek Uplift, probably originated as Mesozoic fault-bounded structures. In the Blow Trough, the rift setting is not apparent due to the lack of preservation of associated structures. Chevron folds and local thrust faults, which may be contiguous with Brookian structures interpreted offshore (Lane, 1988), are present. Blow River and Herschel highs are large-scale tectonic features cored by closely spaced anticlines (Fig. 2).

Rocks on the Yukon North Coast were extensively deformed during Paleocene to early Eocene time (Lane, 1998). Folds and thrust faults observed in Paleocene outcrop (Norris, 1981a), as well as continuity of structures with known Eocene structures offshore, constrain this major deformational event.

PETROLEUM GEOLOGY

EXPLORATION HISTORY

Seismic survey activity in the Mackenzie Delta area in the early 1960s delineated large structures in favourable stratigraphic sections. These early surveys led to the drilling of two dry wells in 1962. Further exploration resulted in the initial discovery of oil in Cretaceous sandstones at Atkinson Point in 1969. In 1970, a major gas find was made in Kamik sands at Parsons Lake and in the same year oil was discovered in carbonates at Mayogiak. In 1977, the focus of exploration switched offshore to Tertiary targets. In the Beaufort-Mackenzie region, 53 oil and gas discoveries, both onshore and offshore, have been made. Forty-four of these discoveries occur in the Tertiary basin. A total of 247 wells has been completed to date in the Beaufort-Mackenzie region. Drilling on the Yukon North Coast to the west has been very limited. Three wells were completed showing no hydrocarbons and limited reservoir potential.

RESERVOIRS

CARBONIFEROUS

A gas discovery was made in Carboniferous carbonates at Unak L-28 in west-central Mackenzie Delta. This discovery exhibits an instance when the generally poor primary porosity development of Carboniferous carbonates was enhanced by fracture development in the south delta. Dolomitized facies and leached zones adjacent to unconformities occasionally produce porous horizons in marine Upper Carboniferous Alapah and Wahoo carbonate formations of the Lisburne Group. There have been discoveries of hydrocarbons in equivalent rocks on the Alaskan North Slope and in southern Eagle Plain (Hamblin, 1990). Porosity development in the subsurface of the Yukon is unknown but surface exposures indicate that primary porosity is generally poor. Secondary porosity development may be significant but patchy.

A possible reservoir interval that may be present in the Yukon Arctic coastal region is the Lower Carboniferous Kekiktuk Formation (Fig. 3). This formation, containing quartz, chert, quartzite and granitic clasts, generally occurs in a tight siliceous matrix. Even though porosity development in this unit is commonly poor in the subsurface, leaching has produced significant reservoirs in Alaska, specifically at the Endicott Field (Craig, *et al.*, 1985). Primary porosity is very low or absent, but secondary, patchy porosity development may occur.

PERMO-TRIASSIC

Permian and Middle to Upper Triassic potential reservoir strata, represented by Echooka sandstones of the Sadlerochit Group and coarse clastics of the Shublik Formation, respectively, exhibit good porosity development in Eagle Plain and the Alaskan North Slope. Paleogeographic reconstructions (Bamber and Waterhouse, 1971) indicate that these potential reservoir units may occur beneath the North Coast of the Yukon. Young (1981) considers the Sadlerochit Formation to be a prime prospect for future hydrocarbon discoveries in northern Yukon. Primary and secondary porosity may develop in both conglomerate and sandstone units.

JURASSIC

Northwest-prograding clastic wedges of the Jurassic arenaceous belt, located in northern Richardson Mountains and in the subsurface beneath southern Mackenzie Delta, have potential as reservoir rock. Bug Creek sandstones in the area retain fair potential as reservoir-quality rock, although these rocks are typically tight and no discoveries have been made. Porosity exceeds 10% in some of the cleaner facies but there is low permeability in the coarse clastics (Northern Oil and Gas Directorate, 1995a). To the northwest along the Yukon North Coast, the Jurassic Brooks-Mackenzie Basin deepens, whereupon finer-grained clastics are deposited, substantially reducing reservoir potential.

CRETACEOUS

Hauterivian Kamik sandstones of the Parsons Group are excellent potential reservoir horizons in the Mackenzie Delta. Both oil and gas have been recovered from this thick, extensively developed unit. Average porosity at Parsons Lake is 15%. Kamik sands in the Yukon Territory occupy a sandy inner to mid-shelf belt which likely has inferior reservoir qualities compared to the interpreted beach and inner shelf environment of the Delta to the east (Dixon, 1986).

There is a thin basal sandstone with local lenses of coarser material in the Mount Goodenough Formation that seems to be fairly persistent throughout the area. A minor oil discovery was made in this interval proving the reservoir potential in this strata. Late Barremian to Aptian Rat River sands, which are interpreted as representing a regressive pulse, contain excellent potential reservoir horizons in western Mackenzie Delta, as indicated by the gas discovery at Unak L-28 (Dixon, 1986).

There is little or no reservoir potential in Upper Cretaceous strata. Albian sedimentation is dominated by fine-grained deep-water clastics deposited during increased rifting and subsidence. Blow Trough, a depositional precursor of the Rapid Depression, extended over a large area of northern Yukon and provided a major site for Albian deposition. Cenomanian to Turonian Boundary Creek rocks also comprise a shale-rich basinal sequence, indicating poor reservoir potential.

TERTIARY

Most Tertiary reservoirs occur offshore but there is some potential for reservoir occurrence along the Arctic coastal plain, if trapping conditions are favourable. Oil staining occurs in similar Tertiary sands in Alaska. Sandstone members in the Maastrichtian-Lower Paleocene Fish River Sequence are potential reservoirs. The Fish River deltaic complex seems to be centred over the western part of the Mackenzie Delta, specifically in the Mackenzie Bay area (Dixon and Dietrich, 1996). The bulk of the sandstone-dominant part of the sequence underlies the western Beaufort shelf which remains to be tested by drillholes. Deltaic rocks of the overlying Paleocene-Lower Eocene Aklak Sequence are recognized in the western Beaufort Sea shelf area. Oil and gas have been recovered from this sequence further east in the Mackenzie Delta area. Delta-front deposits of the Aklak sequence at Adlartok in Yukon offshore waters to the north are characterized by highly variable porosity and permeability due to grain size. Coarser beds exhibit a porosity range of 20 to 24% while finer-grained laminated units vary from 15 to 18% (Northern Oil and Gas Directorate, 1995b).

SEALS

The laterally and vertically extensive Jurassic and Lower Cretaceous Kingak shale provides excellent top seal for Upper Paleozoic and Triassic reservoir strata. Additional Lower Cretaceous marine shale-rich units such as the Mount Goodenough Formation and the Albian Flysch are effective top seals for potential Cretaceous sandstone reservoirs. Another efficient top seal for all pre-Tertiary reservoirs in northern Yukon is the widespread Boundary Creek shale-rich sequence. Intraformational shales form localized top and lateral seals for Tertiary reservoirs.

Numerous unconformities in the study area seal underlying reservoir units by juxtaposing permeable and impermeable formations. Young (1981) indicated that the pre- Upper Triassic unconformity in northern Yukon may effectively seal older strata in broad areas and numerous updip traps may be developed along the edges of pre-Upper Triassic structures.

TRAPS

A variety of structural, stratigraphic and combination traps occur within Phanerozoic sedimentary strata throughout the region. Pre-Laramide traps are more favourable for accumulating hydrocarbons since the primary episode of hydrocarbon generation probably took place in Mesozoic and Tertiary time when maximum load was imposed. In southern Mackenzie Delta, trap types are dominantly structural where closure often occurs against normal faults. Further west, thrust faults complicate the pre-existing pattern of tilted fault blocks. Along the Yukon North Coast, numerous structural features have been recognized. There are broad anticlinal features, domes, and normal and reverse faults, along with horst and graben structures. In Herschel and Blow River Highs, folds are closely spaced and have large amplitudes. Reverse fault traps are also present. Unconformity-related combination traps occur throughout the assessment area.

SOURCE ROCKS

Numerous potential source rocks for oil and gas have been identified in the Beaufort-Mackenzie region. Upper Cretaceous mudstones and shales of the Boundary Creek Sequence are considered to be significant source rock for oil. The sequence is rich in organic matter with TOC ranging from 3 to 5%. The richer oil-prone Smoking Hills Sequence (2 to 10% TOC) has been eroded in western Mackenzie Delta and does not appear to extend into the Yukon Territory (Dixon, 1996b). Smoking Hills-sourced oil constitutes the Kugpik O-13 Cretaceous discovery and there are reasonable expectations that Smoking Hills-sourced oils may have migrated further west into Yukon Territory.

The Jurassic Kingak and Husky shale succession is a significant gas-prone source rock in the area. Langhus (1980) indicates that the terrestrially dominant organic matter present in these rocks is consistent with a gas-prone source rock which may have provided the charge for gas accumulations at Parsons Lake. At Unak L-28, gas was recovered from both Carboniferous carbonates and the Lower Cretaceous Rat River Formation. It is believed that gas for both of these accumulations is derived from the Jurassic-Cretaceous shale succession.

Oil and gas found in Tertiary deltaic reservoirs in the central Beaufort region are most likely derived from the basal portion of the Richards shale sequence (Brooks, 1986). However, to the west, specifically at Adlartok, oil geochemistry indicates that the Richards-type biomarker is not present. Oil at Adlartok may have been derived from Paleocene shales. Organic matter is not particularly concentrated in these Tertiary prodelta depositional environments (infrequently exceeding 2% TOC), but the source rock intervals are thick. Tertiary-derived oils are generally good quality (ranging from 25 to 35° API). There are also significant condensate volumes associated with some of the onshore gas discoveries.

Argillites and shales of the unnamed Cambrian to Silurian succession coeval with Road River Formation basinal shales may be locally organic-rich in the Arctic coastal plain area. Link, *et al*., (1989), however, rated the overall source rock potential of this formation in northern Yukon as poor. Hydrocarbons generated by Road River-equivalent strata were available for migration during Devonian to Carboniferous time well before the significant Laramide deformational event. Lower Paleozoic strata in this area are overmature and possibly supermature, but may retain limited potential for gas generation. In southern Mackenzie Delta, the Lower Paleozoic shales have moderate organic quality but poor source potential due to low TOC (Link, *et al*., 1989).

Carboniferous shales are reported to be an important source rock in surrounding areas, specifically beneath the Alaskan North Slope and in Eagle Plain (Craig, *et al*., 1985; Link, *et al*., 1989; Utting, 1989). In the Alaskan North Slope area, Kayak Formation shales are lean and gas-prone with some potential for oil generation. In Eagle Plain, the equivalent Carboniferous shales are characterized as fair to good source rocks for gas with some oil potential (Link, *et al*., 1989). Comparable shales found in the Yukon North Coast area, therefore, are expected to have at least fair potential to generate gas if maturities are equivalent. Thermal maturities of these rocks are likely high and probably well beyond the oil window. No Kayak samples have reported vitrinite reflectance values of less than 2.5% and Thermal Alteration Indices (TAIs) range from 3+ to 5 in British and Barn mountains south of the North Coast (Cameron, *et al*., 1986; Utting, 1989).

Although the Late Triassic Shublik Formation is considered to be a significant oil source at Prudhoe Bay (Claypool and Magoon, 1985), the high-energy carbonate facies, occurring only in extreme northwestern Yukon, is unlikely to be a source rock of comparable quality.

TIMING OF HYDROCARBON GENERATION

There are numerous Tertiary organic-rich horizons that exhibit hydrocarbon source rock potential in the Beaufort-Mackenzie area such as occurrences in Boundary Creek, Smoking Hills and Richards sequences. Maximum burial probably occurred during middle Eocene time when hydrocarbons were likely generated. Several stages of Tertiary contractional deformation are identified in Tertiary sediments in nearshore areas of the Yukon North Coast. Maturity of organic-rich Tertiary sediments was likely reached contemporaneously with later stages of the Laramide orogeny and previous to subsequent pulses of tectonic deformation. At least some structures formed during the early stages of the Laramide deformation were available for accumulating hydrocarbons.

Modelling by Link and Bustin (1989) of Paleozoic and Mesozoic source rocks in northern Yukon indicate that they passed through the 'oil window' before the end of Mesozoic time. This implies that the most effective trapping configurations for pre-Tertiary hydrocarbons are structures formed previous to the Late Cretaceous–Tertiary Laramide orogeny, when hydrocarbons generated during the period of active oil migration were trapped in pre-Mesozoic traps. Seeking Paleozoic and Mesozoic targets based on Laramide anticlinal structures may not represent the most efficient exploration strategy for this region. Pre-Tertiary traps and reservoirs are more favourable sites for accumulation of hydrocarbons generated during late Paleozoic to Mesozoic times.

Stratigraphically trapped Jurassic sandstone and Paleozoic sandstone and carbonate reservoirs on the Yukon North Coast are located updip of the Tertiary hydrocarbon kitchen buried in the deep sedimentary pile to the north beneath the Tertiary deltas.

HYDROCARBON SHOWS

The most direct indication of oil and gas potential in a frontier region are hydrocarbon pools and shows. Hydrocarbon shows and recoveries have been made in Paleozoic carbonates, Lower Cretaceous sandstones and Tertiary sandstones in the Beaufort-Mackenzie region. All Paleozoic and Lower Cretaceous reservoirs are found in southern Mackenzie Delta and along the Arctic coastal plain, and Tertiary discoveries are mostly concentrated in the central Beaufort-Mackenzie Basin. West Beaufort Sea shows potential with the discovery of oil at Adlartok in Paleocene and Eocene sands.

Limited discoveries have been made in Paleozoic carbonate reservoirs: a total of three hydrocarbon accumulations throughout the basin. Oil was discovered in the eastern portion of the basin, while at Unak L-28 in southwestern Mackenzie Delta, gas was recovered from Paleozoic reservoirs. The Unak trap features closure against a thrust fault. The gas is likely derived from overlying Jurassic and Cretaceous shale.

Oil and gas has also been recovered from Lower Cretaceous sandstones throughout the onshore portion of the Beaufort-Mackenzie Basin. Oil is found in the Parsons Group sands, the Atkinson Point Formation and the Mount Goodenough Formation. In western Mackenzie Delta, the Kugpik O-13 well produced oil from the Parsons Group sandstone reservoir. Smoking Hills shales are interpreted to contain oil-prone organic matter for Cretaceous reservoirs. Gas was found in the Lower Cretaceous Rat River sandstone at Unak L-28. Source for Cretaceous Unak gas is unknown although the thick Jurassic-Cretaceous shale succession certainly has potential.

Most of the hydrocarbon discoveries in the basin occur in Tertiary strata. Widespread and thick deltaic coarse clastic deposits provide ample potential reservoir horizons. Interbedded and widespread organic-rich shale layers provide significant oil and gas source material. Oil and gas have been recovered from the Fish River, Aklak, Taglu, Kugmallit and Mackenzie Bay sequences. There seems to be a general trend of oil-prone hydrocarbons occurring basinward, although numerous deviations off this trend have been observed from discoveries made. Richards shales and organic-rich horizons in Paleocene shales are possible oil sources. The Tertiary succession is dominated by Type III terrestrial organic matter. Conventionally, this type of organic matter produces gas. In Beaufort-Mackenzie, large volumes of oil are encountered in Tertiary reservoirs as well as significant quantities of gas. Snowdon and Powell (1979) suggested that these oils were generated from resin-rich terrestrial organic matter. The resinous matter can also generate hydrocarbons at lower levels of organic maturity which is consistent with the interpreted thermal regime (Dixon, *et al.*, 1994). No Tertiary discoveries have been made in the Yukon portion of the North Coast study area. Oil was recovered from Paleocene and Eocene reservoirs at Adlartok in Yukon waters north of the study area.

HYDROCARBON ASSESSMENT

The Yukon North Coast petroleum resource assessment was undertaken in order to generate quantitative estimates of total oil and gas potential and possible sizes of undiscovered fields. Hydrocarbon assessments of basins or regions are usually based on analyses of a number of exploration plays. In the North Coast region, six exploration plays were defined based on various petroleum geological considerations such as structural style, dominant reservoir lithology and thermal maturity. Three immature and three conceptual oil and gas plays were identified in the study area. The conceptual and immature plays had sufficient information to attempt a statistical analysis in order to obtain ranges of estimates of resource potential and sizes of individual undiscovered fields.

Table 1. *Hydrocarbon potential in Yukon North Coast assessment region.*

Play Name	Expected number of fields (mean)	Median play potential (million m^3)	Remaining median play potential (million m^3)	Median of largest field size (million m^3)	Median of largest remaining field size (million m^3)
Oil Plays					
South Delta–Mesozoic	4	2.8	2.4	1.5	0.7
Herschel	5	34.6	34.6	15.5	15.5
All oil plays	9	39.8*			
Gas Plays					
South Delta–Mesozoic	8	2,040	1,217	750	391
South Delta–Paleozoic	15	6,661	6,370	1,720	1,720
Herschel	5	16,095	16,095	7,146	7,146
Yukon Coastal Plain	3	8,463	8,463	5,998	5,998
All gas plays	31	38,565*			
Condensate volumes	**Average liquid content (m^3/million m^3) (million m^3)**	**Median play potential (million m^3)**	**Remaining median play potential**		
South Delta–Paleozoic	10.7	0.71	0.68		

* The total oil and gas potential are statistically derived. They are retrieved from the basin empirical distribution in Appendix 2. The median total of basin potential is the value at 50%.

Table 2. *Hydrocarbon play potential in Yukon Territory*

Play Name	Remaining median play potential (in-place) (million m^3)	Median of largest remaining field size (in-place) (million m^3)	Play potential in Yukon (Scenario 1) (million m^3)	Play potential in Yukon (Scenario 2) (million m^3)
Oil Plays				
South Delta–Mesozoic	2.4	0.7	0.74	0.04
Herschel	34.6	15.5	31	15.5
Gas Plays				
South Delta–Mesozoic	1,217	391	412	21
South Delta–Paleozoic	6,370	1,720	1,836	116
Herschel	16,095	7,146	14,395	7,249
Yukon Coastal Plain	8,463	5,998	8,463	N/A

Scenario 1: Largest undiscovered field is assumed to occur in the Yukon Territory.
Scenario 2: Largest undiscovered field is assumed to occur outside the Yukon Territory.

SOUTH DELTA–MESOZOIC OIL AND GAS PLAY

HYDROCARBON PLAYS

Play definition

The South Delta-Mesozoic play encompasses all oil and gas prospects occupying structural and stratigraphic traps involving reservoirs in Jurassic and Lower Cretaceous sandstones underlying the southern part of the Mackenzie Delta (Figs. 5, 6). The play area is bounded to the east by the Caribou Hills, west by the northern Richardson Mountains, south by the Eskimo Lakes Fault Zone and north by the Kugpik area in the Mackenzie Delta. Most of the play area occurs in the Northwest Territories with the remainder occupying a small portion of northeastern Yukon North Coast (Fig. 5). About 2.5% of the play area occurs in the Yukon Territory.

Geology

A thick succession of interlayered shale- and sandstone-dominant strata of Jurassic to Early Cretaceous age underlies the play area. Thickness of the prospect succession varies from 10 to 1500 m and occurs at depths ranging from 10 to 3,750 m. Numerous potential reservoirs are present in the play, such as Bug Creek Group, Parsons Group, basal sandstone of the Mount Goodenough Formation and the Rat River Formation (Fig. 3).

There are two major unconformities within the succession that prove crucial in delineating reservoir units in the play area due to the truncation of reservoir horizons. At the base of the Mount Goodenough Formation, a major unconformity signifies an erosional episode that has removed substantial strata of the Parsons Group in the south especially adjacent to the Eskimo Lakes Fault Zone and next to the Cache Creek Complex (Fig. 2). The other unconformity separating Upper from Lower Cretaceous strata

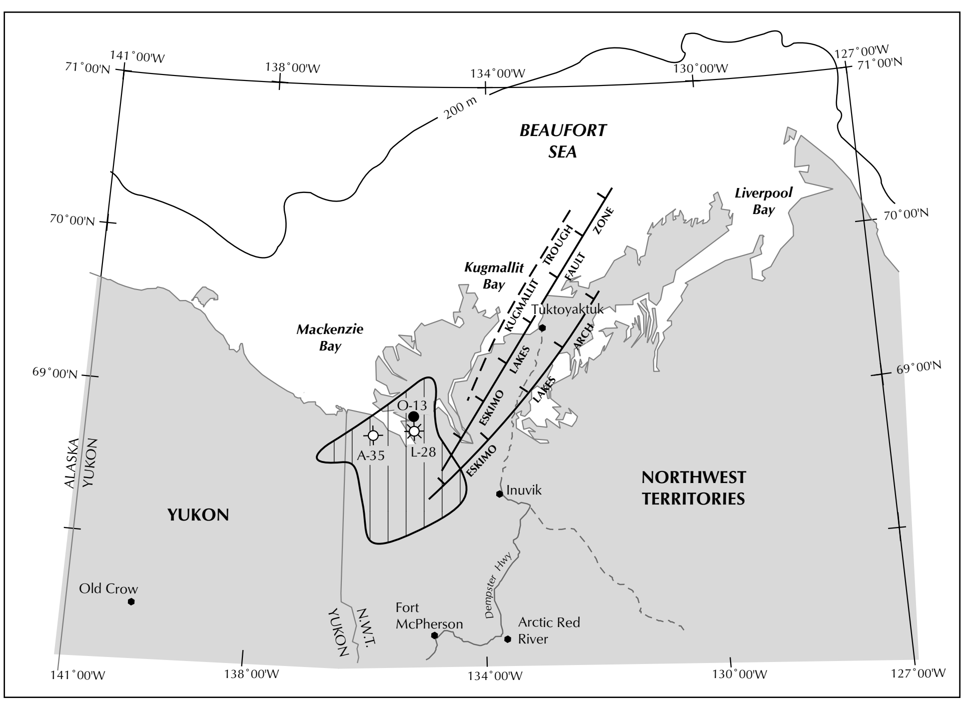
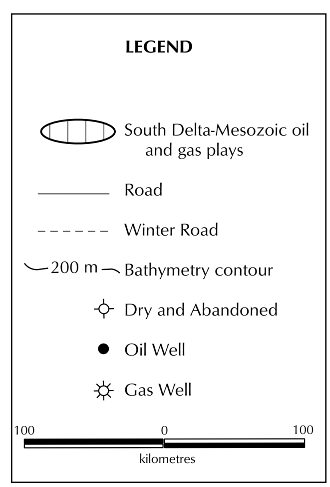


Figure 5. *South Delta–Mesozoic oil and gas plays (from Dixon, et al., 1988). Wells discussed in report are shown (1–Kugpik O-13, 2–Unak L-28, 3–Ulu A-35).*



has removed Hauterivian to Albian strata in the northern part of the play area, placing Upper Cretaceous strata directly on top of Parsons Group sands.

Sandstones of the Lower to Middle Jurassic Bug Creek Group have fair reservoir potential in the area. These coarse units were deposited as shelf sandstones prior to rifting and subsidence. Porosity exceeds 10% in the cleaner facies, but permeability is low. The distribution of the Group is profoundly affected by the two unconformities and there is also a depositional pinchout to the east.

The thickest and most widespread potential reservoir interval is the Berriasian to Hauterivian Parsons Group. Formations within the Group are Martin Creek, McGuire and Kamik units. Originally, this Group underlay the whole play area but erosion has locally removed strata and modified thickness trends. One oil pool and gas show were discovered in Kamik sands in the Kugpik O-13 well and oil was recovered during a drill-stem test in a Kamik reservoir unit in the Unak L-28 well.

The late Barremian to early Aptian Rat River Formation consists of a set of coarsening-upward sequences characteristic of marine bars or shoals. Prospective strata are limited to the northwestern portion of the play area due to erosion and facies change to argillaceous rocks further south and northeast. One gas pool at Unak L-28 has been discovered in the Rat River Formation.

The Albian Flysch is not generally regarded as containing significant reservoir-quality sands but a gas show was noted in these strata in the Fish River B-60 well.

Dominant trap types in the play are structural with closure against faults representing the most common configuration (Fig. 6). Normal fault traps are important but Unak L-28 shows repeated Mesozoic units which imply thrust faulting complicating the arrangement of tilted fault blocks. Thrust faults are only present in the northwestern part of the play area although seismic reflection data of poor quality in other parts of the play area may mask thrust faults and their related closures (Dixon, *et al.*, 1994).

The Upper Cretaceous Boundary Creek and Smoking Hills sequences are the richest oil-prone source rocks in the region. Erosion, however, has removed this rock from southern parts of the play area. Total organic carbon (TOC) in Boundary Creek/Smoking Hills

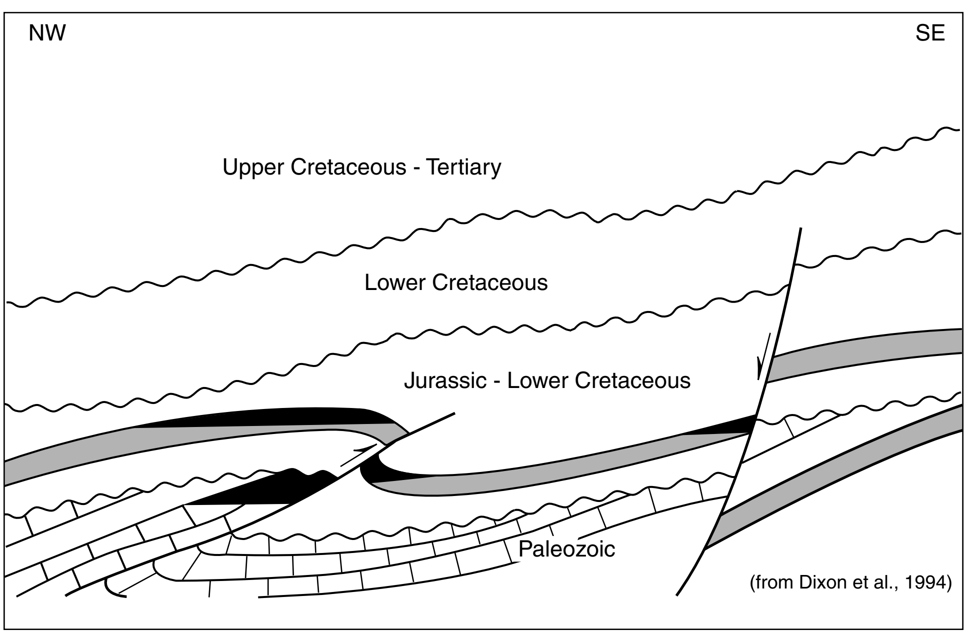
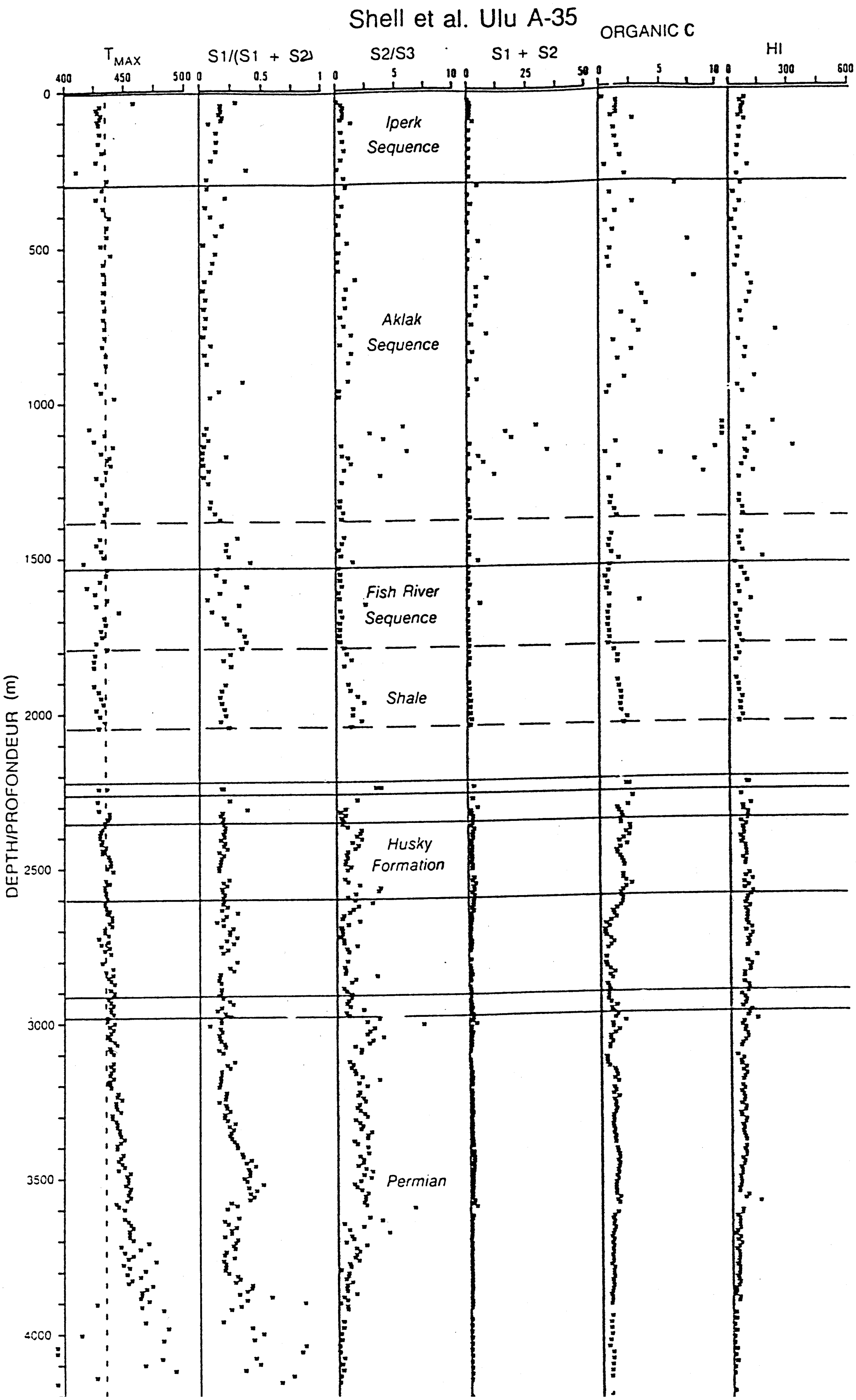
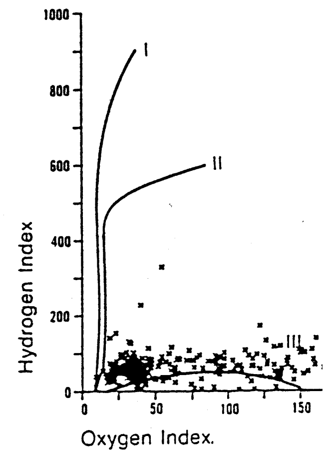


Figure 6. *Schematic sketch of the trap-types in the South Delta–Mesozoic oil and gas plays (from Dixon, et al., 1994).*





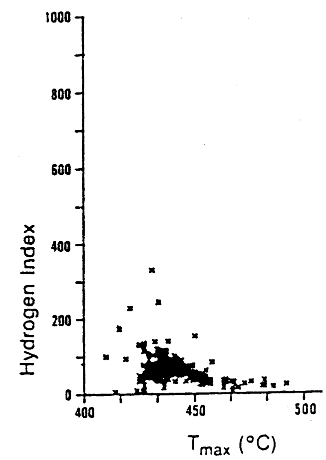
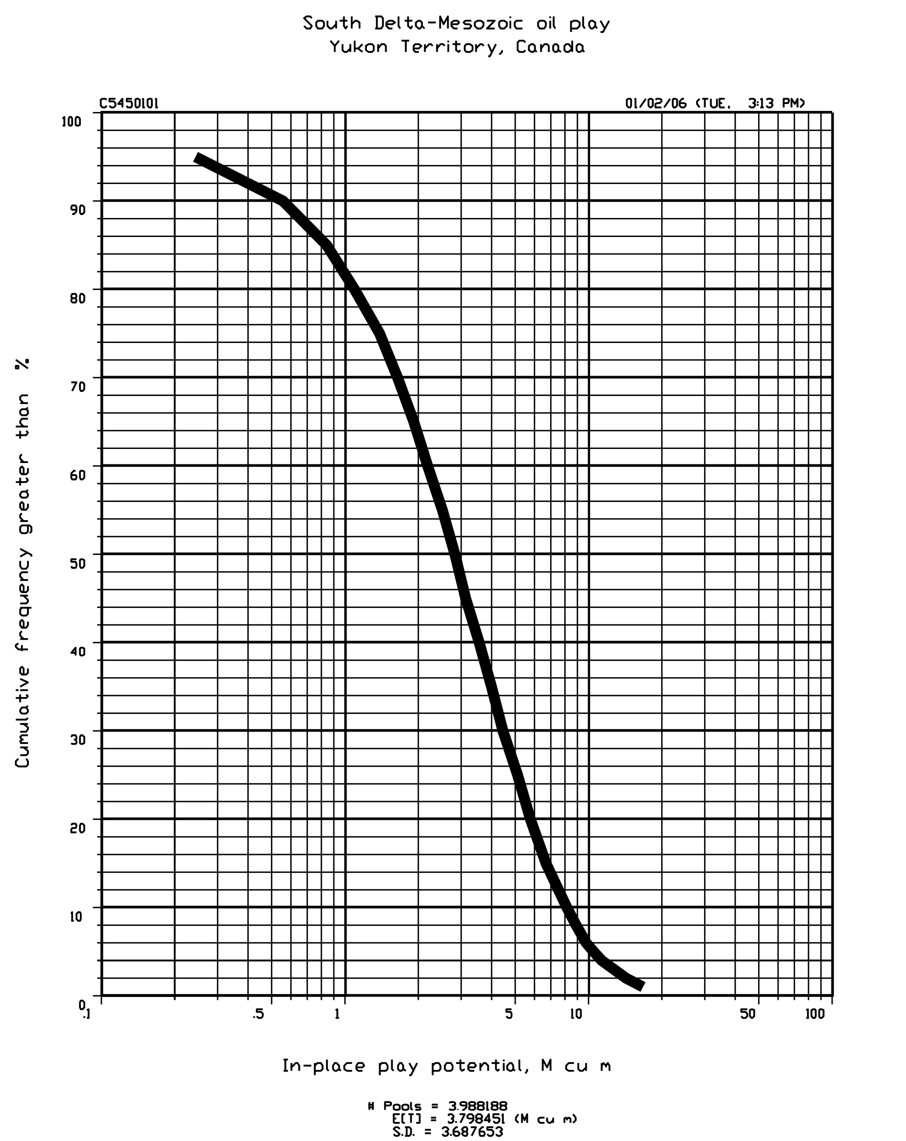


Figure 7. *Rock-eval/TOC analyses for Ulu A-35 well (from Snowdon, 1990).*

sequences range from 2 to 10%. Another potential oil source is found in organic-rich marine shales of the Albian Arctic Red Formation which are coeval with the Albian Flysch succession (Fig. 3). These rocks are immature due to shallow burial in the area. Terrestrially derived organic matter, generally indicative of gas-prone source material, predominate in Jurassic and Lower Cretaceous shales. The Ulu A-35 well represents one of the 14 wells penetrating the succession. A Rock-eval/TOC analysis was completed on this well (Fig. 7; Snowdon, 1990; 1996). The well was collared in the Plio-Pleistocene Iperk Sequence and penetrated the lower Tertiary sequence, specifically Aklak and Fish River sequences, as well as Cretaceous, Jurassic and Permian strata. The Tertiary succession is marginally mature to mature with the top of the conventional oil window occurring at a depth of 1,370 m. Basal Tertiary, Cretaceous, Jurassic and upper Permian strata occur within the conventional oil window. Depths greater than 3,500 m have samples that are overmature. Hydrogen indices (HI) and TOC values decline accordingly with increases in maturity. The Smoking Hills and Boundary Creek TOC values in the well are somewhat lower than values obtained elsewhere in the basin (averages of 2.33

Figure 8. *Estimate of in-place oil potential of the South Delta–Mesozoic play. Median value of probabilistic assessment is 2.8 million m*^{3} *of in-place oil distributed in 4 fields.*



and 1.95%, respectively). Husky Formation TOC average values in the well (1.95%) are comparable to Smoking Hills and Boundary Creek sequence total values. Hydrogen index values in Husky shales are only slightly lower than Cretaceous units (Snowdon, 1996).

Exploration risks

All of the Yukon North Coast immature and conceptual plays are inferred to exist (implicated by a play-level marginal probability of 1.0). However, within each play, geological risk factors at the prospect level are evaluated in order to derive the exploration risk for the entire play. Significant prospect-level risks associated with this play are presence of closure, and adequate porosity, source and preservation (Appendix 1). Closure risk is related to significant difficulty in mapping and interpreting closures against thrust faults in the Unak area. Well-cemented sandstones are common in the play making porosity generally low and increasing the risk for reservoir facies in certain prospects. High risk was assigned to source since potential source material may be eroded and

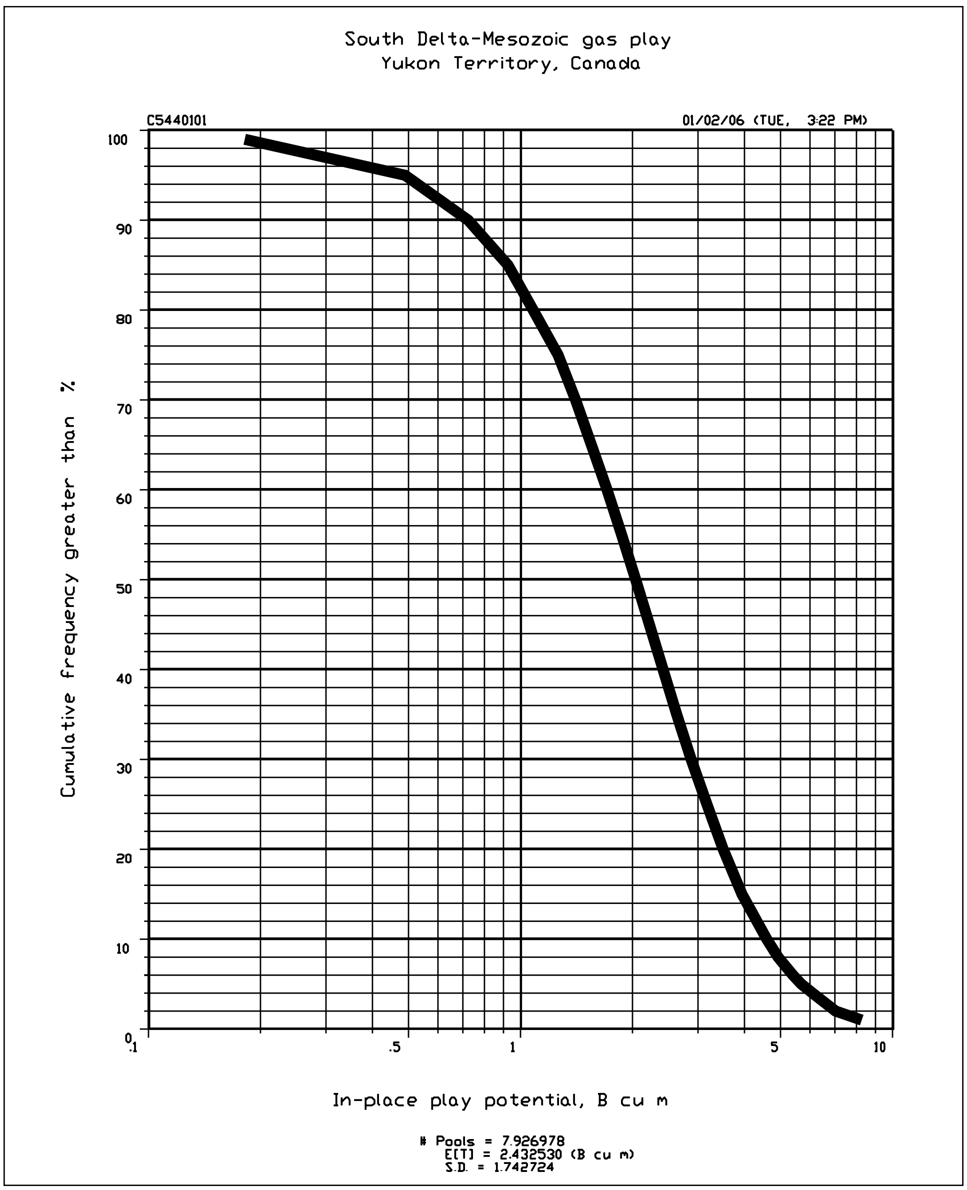


Figure 9. *Estimate of in-place gas potential of the South Delta–Mesozoic play. Median value of probabilistic assessment is 2.0 billion m*^{3} *of in-place gas distributed in 8 fields.*

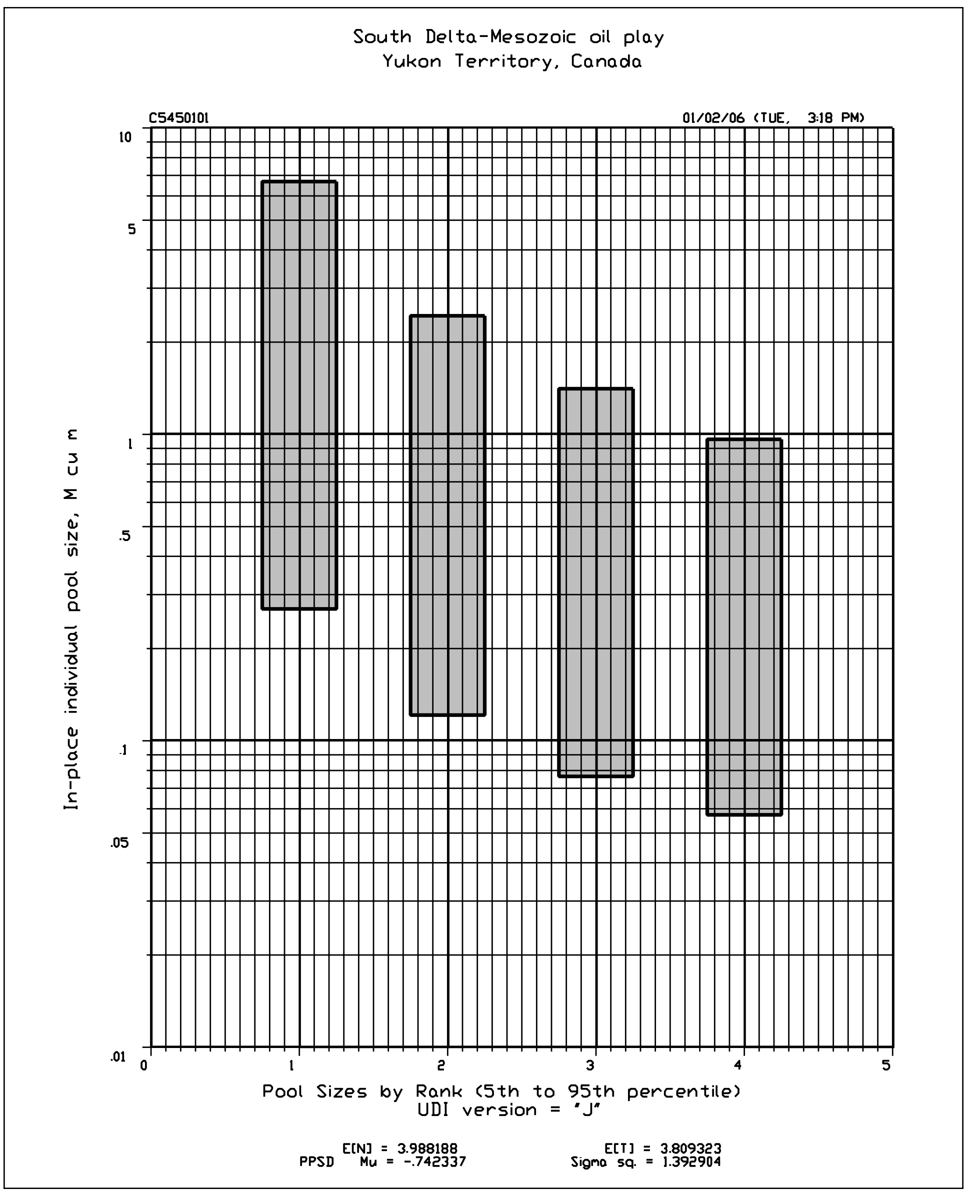
removed over large portions of the play area. Cretaceous erosional events may also remove reservoir facies in parts increasing the risk of adequate preservation in the play.

On the other hand, low risk, or high marginal probability, was assigned to seal and timing (Appendix 1). Thick shale successions separate sandy formations providing effective top seal for most of the prospects. Most structures, particularly closures against normal faults, seem to have formed previous to the main episode of hydrocarbon generation when maximum burial was achieved, thus, providing structural traps before hydrocarbon migration took place. Younger thrust fault structures in the north, however, may have post-dated the main episode of hydrocarbon generation.

Play potential

The South Delta–Mesozoic play has estimated in-place median oil and gas resource values of 2.8 million m³ and 2.0 billion m³, respectively (50 percentile values in Figs. 8, 9; Table 1). If the 95 and 5 upper percentiles representing the range of expected resource are specified,

Figure 10. *Field-size-by-rank plot of the South Delta–Mesozoic oil play. Median value of the largest predicted field size is 2.4 million m³ of in-place oil.*



then there is a 90% chance that the resource potential of oil resides within the range of 0.2 to 10.5 million m^3 in-place (Fig. 8). The range for in-place natural gas of expected resource potential is 0.5 to 5.7 billion m^3 in-place (Fig. 9). In the Kugpik O-13 well, one oil pool has been discovered. It has an in-place volume of 6.7 million m^3. The in-place median play potential conditioned on this discovery is reduced to 2.4 million m^3. Similarly, one gas pool was discovered in the play at Unak L-28, containing an in-place volume of 1,578 million m^3. The conditioned median potential for gas resource is 1.2 billion m^3.

The mean value of the number of predicted fields for the oil play is four. The largest field is expected to contain 1.5 million m^3 of oil (median value of first box in Fig. 10, Table 1). The Kugpik O-13 pool, with a volume of 6.7 million m^3, matches with the fifth upper percentile of the largest predicted field size (see Appendix 2 for computation outputs). Therefore, the largest pool or field has already been discovered and three more fields are predicted. The median of the largest remaining field size is 0.7 million m^3 in-place (median value of second box in Fig. 10; Appendix 2). No fields with volumes greater than 160 million m^3 of oil are predicted to occur in this clastic play. This threshold value,

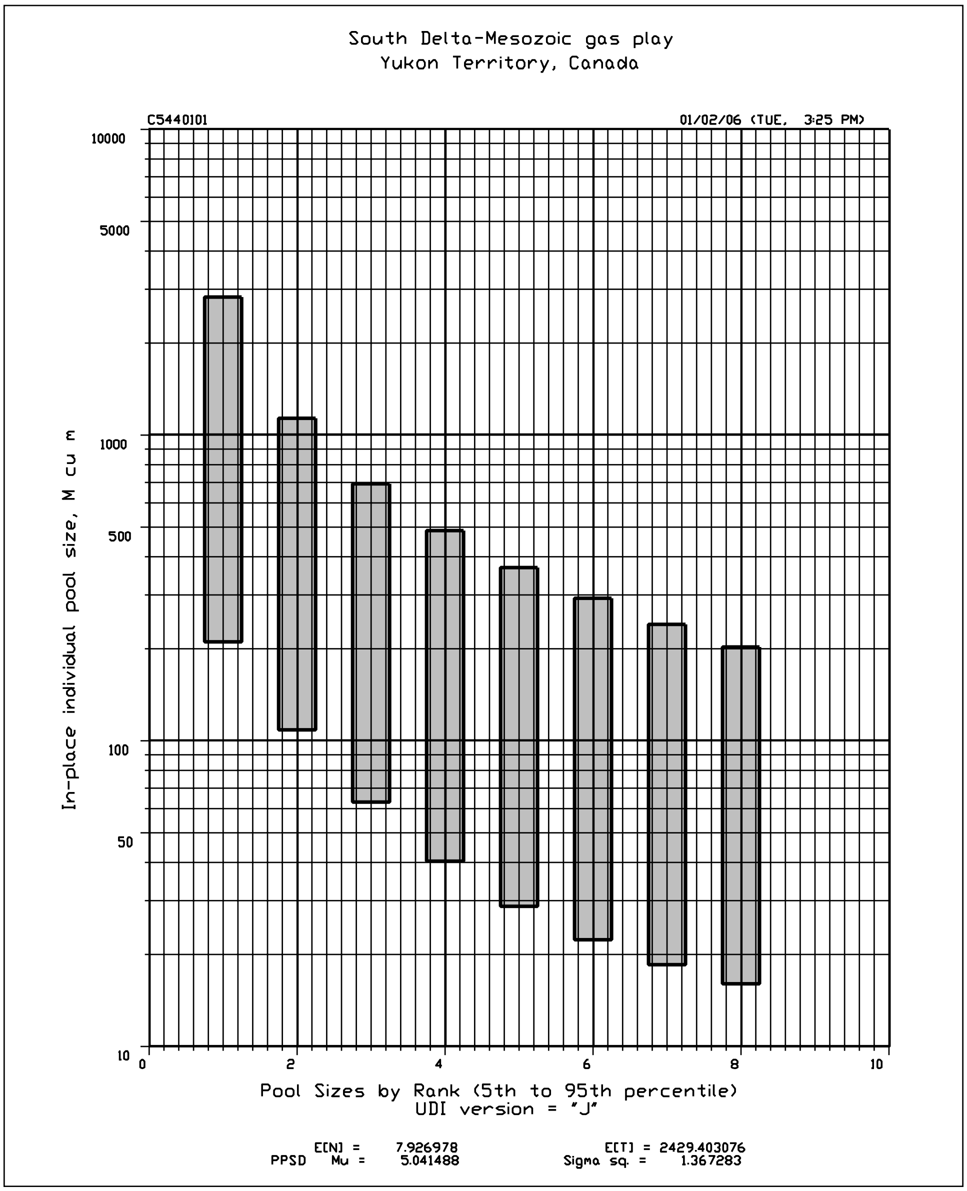


Figure 11. *Field-size-by-rank plot of the South Delta–Mesozoic gas play. Median value of the largest predicted field size is 750 million m3 of in-place gas.*

160 million m^3 (1 billion bbls), is an arbitrary in-place oil volume defined as the minimum individual field size needed in a specified play on a stand alone basis in a frontier region of Canada that may spark interest among explorationists for initiation of exploration activities in that region.

In the gas play, the expected number of natural gas fields is 8. The median in-place size of the largest predicted field size is 750 million m^3 of gas (Fig. 11, Table 1). The discovered gas pool at Unak L-28 with a volume of 1,578 million m^3 lies well within the 95/5 upper percentile range for the largest predicted field size. The largest gas field, therefore, has been discovered in the play and seven smaller fields are predicted. The largest remaining field has a median estimate of 391 million m^3 (Fig. 11, Appendix 2). A threshold volume of 3,000 million m^3 or 100 BCF has been arbitrarily defined as a minimum field size needed to spark sufficient interest for exploration of a single play in a frontier region. No fields of this minimum size are predicted for this play.

The method employed in this study where oil and gas assessments of the same play are run separately, does not reveal how the oil and gas is distributed among the twelve predicted fields of both plays. It is not known what proportion of individual oil and gas accumulations occur as saturated or undersaturated pools in the same prospect or as separate pools in different prospects.

Hydrocarbon plays in this assessment area often occupy areas spanning political boundaries such as the Yukon/Northwest Territories and Yukon/Alaska borders. If it can be assumed that the hydrocarbon resource is evenly distributed throughout the total play area, the proportion of resource occurring in the Yukon can be estimated by comparing play areas among the various political jurisdictions. The location of the largest remaining field cannot be determined, so two scenarios are proposed; scenario 1 where the largest field is assumed to occur in the Yukon, and scenario 2 where the largest field is present outside the Yukon Territory. Table 2 itemizes the diminished oil and gas potential for the North Coast region in the Yukon Territory under the two proposed scenarios. Only about 2.5% of the play area of the South Delta–Mesozoic oil and gas play is located in the Yukon (Fig. 5), so the amount of oil and gas predicted if the largest undiscovered field is assumed to occur in the Yukon is 0.74 million m^3 and 412 million m^3, respectively (Scenario 1). If, however, the largest remaining field is assumed to reside in the Northwest Territories, then the potential is reduced substantially to 0.04 million and 21 million m^3 of oil and gas, respectively (Scenario 2; Table 2).

SOUTH DELTA–PALEOZOIC GAS PLAY

HYDROCARBON PLAYS

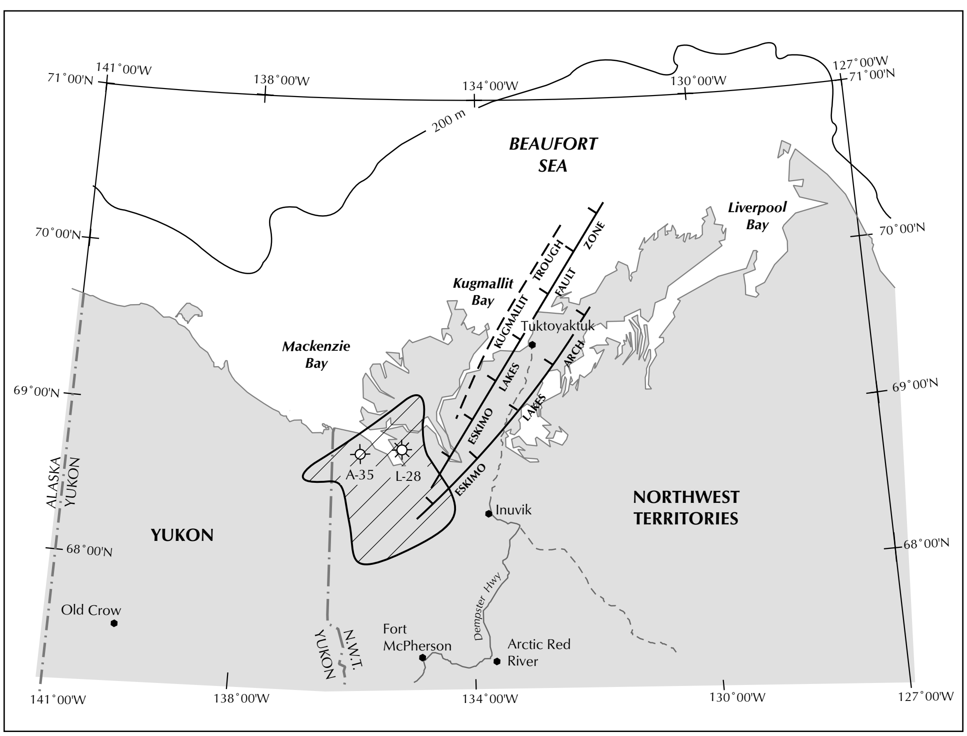
Play definition

This exploration play contains all structures and prospects occurring in Upper Carboniferous to Permian reservoir strata in the southern Mackenzie Delta (Fig. 12). The play area coincides with the South Delta–Mesozoic oil and gas play (Figs. 5, 12). Gas is the principal hydrocarbon. Only 2.5% of the play area occurs in the Yukon Territory.

Geology

Prospective targets in this Upper Paleozoic succession are dolomitic facies and leached zones adjacent to unconformities within marine limestones of the Upper Carboniferous Lisburne Group as well as local coarser strata among interbedded sandstones and shales of the Permian Sadlerochit Group. The prospect succession may attain thicknesses up to 500 m and it occurs at depths ranging from 1,200 to 4,000 m. Ten wells have penetrated Paleozoic strata in the play area resulting in one discovered gas pool at Unak L-28 occurring in Lisburne carbonates. Condensate was also recovered from Carboniferous strata in the same well. Porosity and permeability of the Upper Paleozoic succession is generally poor, but sufficient secondary porosity development resulting from fracturing has created some reservoir potential.

Structural traps are likely dominant, with closure against normal faults most common (Fig. 13). In the northwestern part of the play area including the area in the Yukon Territory, thrust faulting is present which complicates the tilted fault block pattern. Unconformity-related stratigraphic traps are also likely present. Marine shales in Jurassic and Lower Cretaceous strata provide effective top seal for these traps in Paleozoic strata. Most of these structures developed during the Laramide orogeny. Hydrocarbon



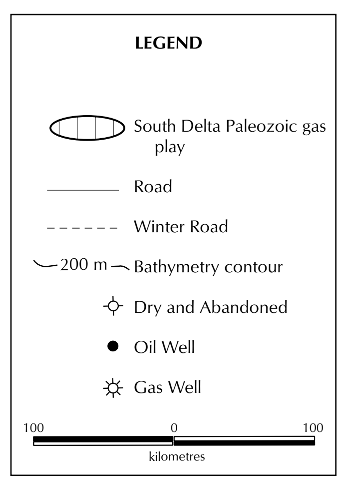


Figure 12. *South Delta–Paleozoic gas play (from Dixon, et al., 1988). Wells discussed in report are shown (1–Unak L-28, 2–Ulu A-35).*

generation likely occurred during the latter stages of the orogeny when maximum burial was achieved. Therefore, most structures were formed previous to or contemporaneous with the main episode of hydrocarbon generation. Younger thrust-related structures seem to have developed subsequent to the main phase of hydrocarbon generation. Renewed burial of organic-rich sediments by thrusting episodes may have induced a secondary phase of thermogenic gas generation.

Beneath the Mackenzie Delta, Upper Paleozoic source rocks have not been identified. The juxtaposition of Paleozoic reservoir against Mesozoic organic-rich shales by faulting produces favourable trapping configurations. In the Ulu A-35 well (Fig. 7), Rock-eval analyses indicate that Upper Permian strata lie within the lower portion of the conventional oil window, meaning that organic matter occurring in Lower Permian strata is overmature (Snowdon, 1990, 1996). This implies that any hydrocarbon generated from Paleozoic source rock in the area is likely dry gas only. In the well, most organic matter seems to be terrestrially derived (Type III; Fig. 7). Type III organic matter usually indicates gas-prone strata. HI and TOC values also decrease with depth as maturity increases. Little or no oil is expected in this play.

Exploration risks

Heightened risk factors integrated into the analysis of this exploration play are presence of closure and adequacy of porosity (Appendix 1). Porosity development is generally poor and inadequate reservoir quality may be widespread. Closure integrity may be affected by erosion. Adequate seal, timing, preservation and source are expected for most prospects in this play.

Play potential

This play has an estimated median resource potential of 6.7 billion m³ of in-place natural gas (Fig. 14; Table 1). The range of estimates for resource potential is 1.7 to 16.5 billion m³ in-place. The expected number of gas fields in the play is 15 (mean value) with the largest field having a volume of 1.7 billion m³ (Fig. 15; Table 1). No fields are expected with volumes greater than three billion m³ in this play (Appendix 2). One

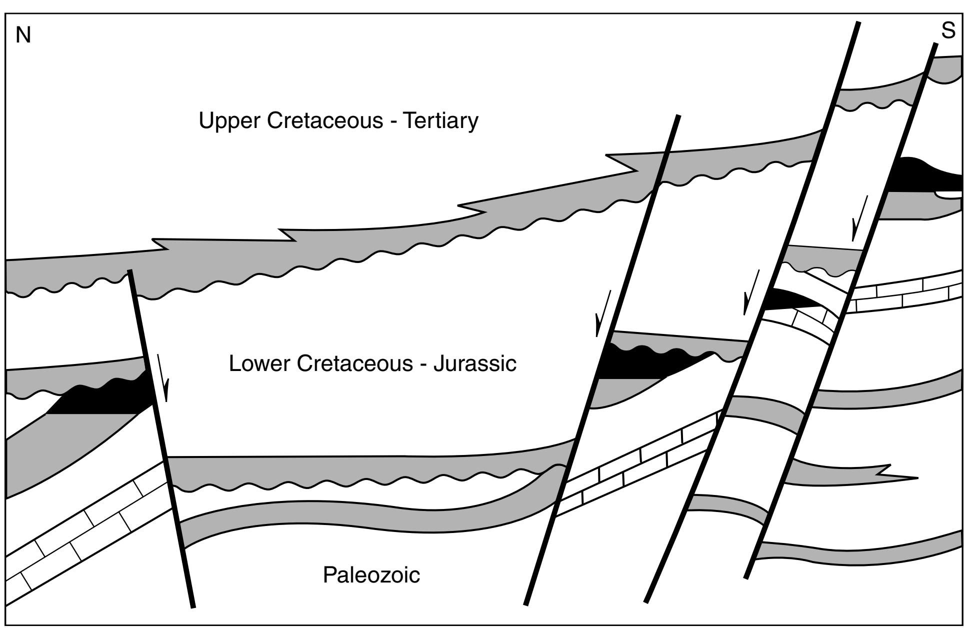


Figure 13. *Schematic sketch of the trap-types in the South Delta-Paleozoic gas play (from Dixon, et al., 1994).*

gas pool was discovered at Unak L-28 in the Northwest Territories having an initial in-place volume of 311 million m^3. This pool was discovered in Carboniferous carbonates. The expected median estimate of the play potential conditioned on this discovery is 6.4 billion m^3 (Appendix 2). The gas discovery matches closely with the median volume retrieved for the seventh largest predicted field size. Six larger field sizes, therefore, are predicted to occur in this play. Condensate was also recovered at Unak in Carboniferous carbonates. An average liquid content of 10.7 cubic metres of condensate per million cubic metres of gas in the Unak gas pool gives a median potential of 0.71 million m^3 of condensate in the play. Remaining median potential, discounting the Unak discovery, is 0.68 million m^3 (Table 1).

Only 2.5% of the play area is defined in the Yukon Territory (Fig. 12). If the largest undiscovered field is assumed to occur within this small area, then the play potential in the Yukon is 1.8 billion m^3 (Scenario 1; Table 2). If the undiscovered field remains to be found in Northwest Territories (which is much more likely), the play potential in the Yukon is much reduced, to 116 million m^3 in-place (Scenario 2; Table 2).

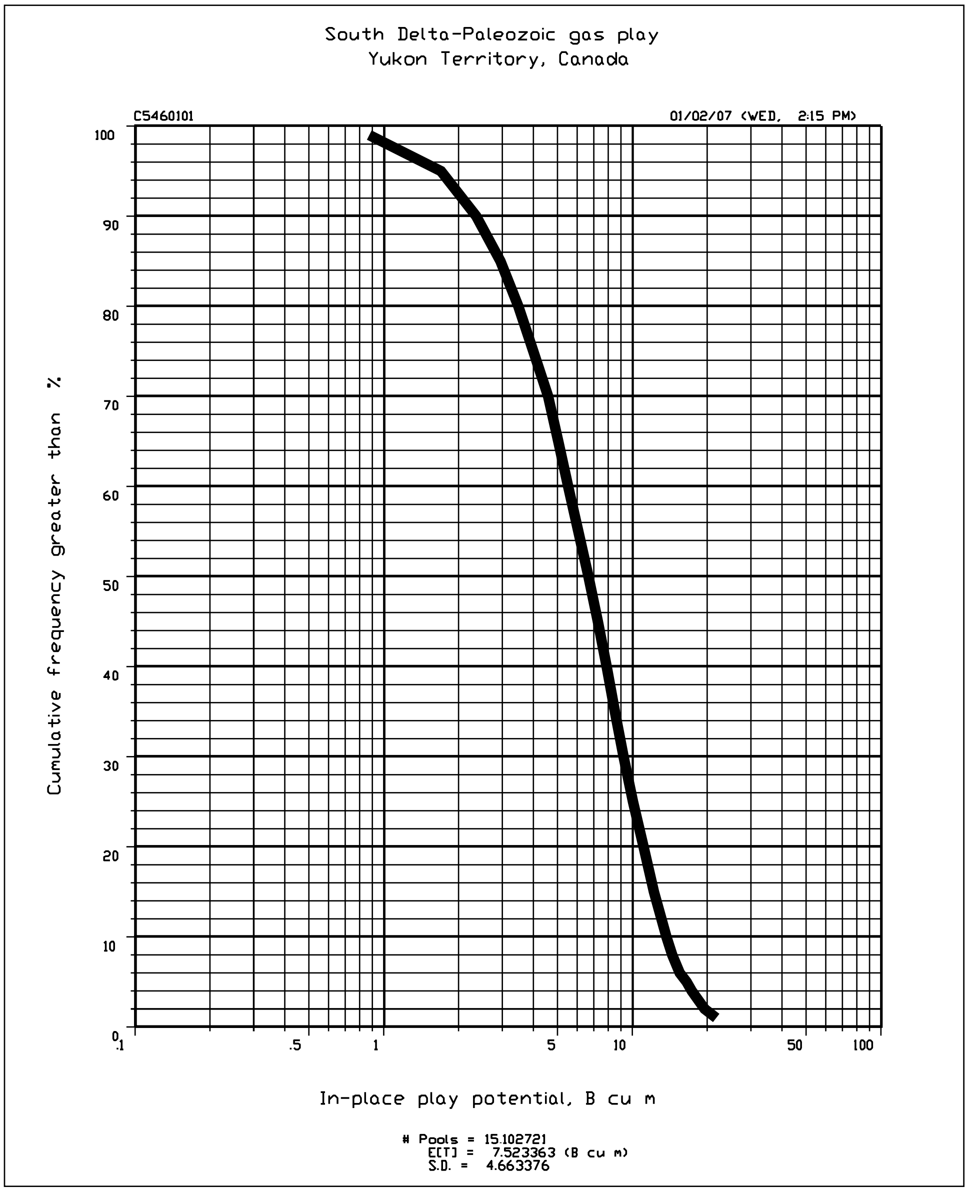


Figure 14. *Estimate of in-place gas potential of the South Delta–Paleozoic play. Median value of probabilistic assessment is 6.7 billion m^3 of in-place gas distributed in 15 fields.*

HERSCHEL OIL AND GAS PLAY

HYDROCARBON PLAYS

Play definition

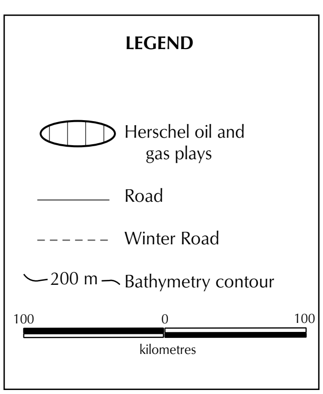
The Herschel play includes all Paleocene to Early Eocene Fish River and Aklak sequence oil and gas prospects present in Herschel and Blow River highs (Figs. 2, 16). These two structural complexes, containing highly deformed Tertiary strata, occur beneath the shallow waters of the southwestern Beaufort shelf. The Blow River High extends onshore beneath the coastal plain near the Yukon-Northwest Territory boundary. The Herschel High continues westwards into Alaska offshore waters. Much of the play area occurs in the Yukon Territory (about 81%) (Fig. 16).

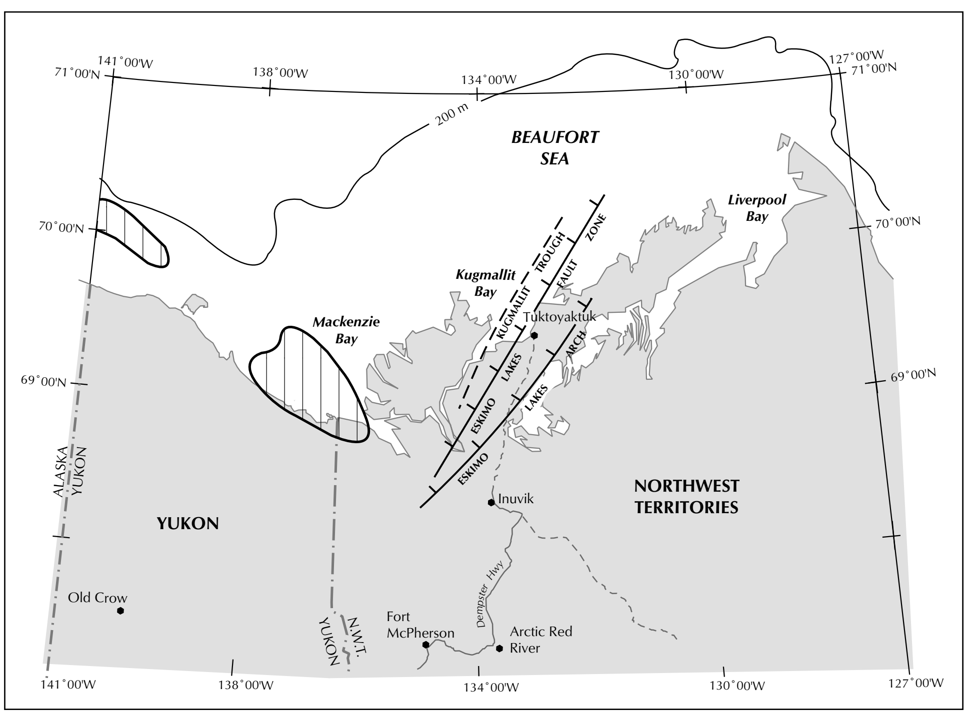
Geology

Paleocene and Early Eocene strata are intensely folded and faulted within cores of two structurally elevated complexes that form part of the west Beaufort Tertiary fold belt. High-amplitude, closely spaced folds and reverse faults represent the most common structural trap type in the play (Fig. 17). Sandstones may subcrop unconformities forming small stratigraphic traps. Within these deformed Tertiary strata, potential reservoir units include delta-front and delta plain sandstones. Thickness of this succession ranges from 5,000 to 7,000 m in the play area. Depths of prospects vary from 1,500 to 8,000 m. Deep erosion of sub-middle Eocene strata has occurred over the crests of these highs. No wells and no hydrocarbon shows are recorded in the play.

Several stages of Tertiary contractional deformation have been identified within the play area. A major tectonic pulse, affecting lower Tertiary strata, commenced in Early Eocene and culminated in Middle Eocene time. Folds and thrust faults were formed at this time. Post middle Eocene deformation significantly overprinted this earlier stage

Figure 16. *Herschel oil and gas plays (from Dixon, et al., 1988).*





of deformation. Identifiable deformational stages occur in late Eocene, Oligocene and late Miocene time. Maturation of potential hydrocarbon sources was reached prior to completion of structural deformation. Maximum burial likely took place at about 85 Ma, previous to the start of Laramide deformation at 78 Ma. Migration of hydrocarbons was initially controlled by depositional geometries. Hydrocarbons trapped during these initial stages may have subsequently re-migrated into anticlinal and fault-related traps following deformational episodes.

Oil and gas source rocks are found in Upper Cretaceous Boundary Creek and upper Eocene Richards shales. Oil-prone strata are also found in the lower Fish River sequence. The organic matter is dominantly Type III terrestrial-dominated material. The organic matter is mature, however, TOC values are generally quite low with many intervals containing only 1–2% TOC. Conventionally, Type III organic matter generates gas but the oils interpreted to be derived from these organic-rich horizons may be produced from resin-rich terrestrial organic matter.

Exploration risks

Significant risk factors attributed to the Herschel play are the presence of closure and adequate seal and source (Appendix 1). Lack of seal and closures are related to the deep erosion of Fish River and Reindeer strata over the structurally elevated features. Steep internal structural dips severely reduce closure areas, which result in reduced potential.

Play potential

Estimates of potential for the Herschel oil play indicate a median in-place volume of 34.6 million m^3 (Fig. 18; Table 1). Predicted resource potential for gas in the Herschel play is 16.1 billion m^3 (median volume) (Fig. 19; Table 1). Predictive ranges of oil and gas resource potential vary from 2.8 to 107.9 million m^3 and 1.3 to 49.5 billion m^3, respectively. The mean number of predicted fields in both plays is 5.

The largest individual field sizes predicted for oil and gas are 15.5 million m^3 and 7.1 billion m^3, respectively (Figs. 20, 21; Table 1). No oil fields greater than 160 million m^3

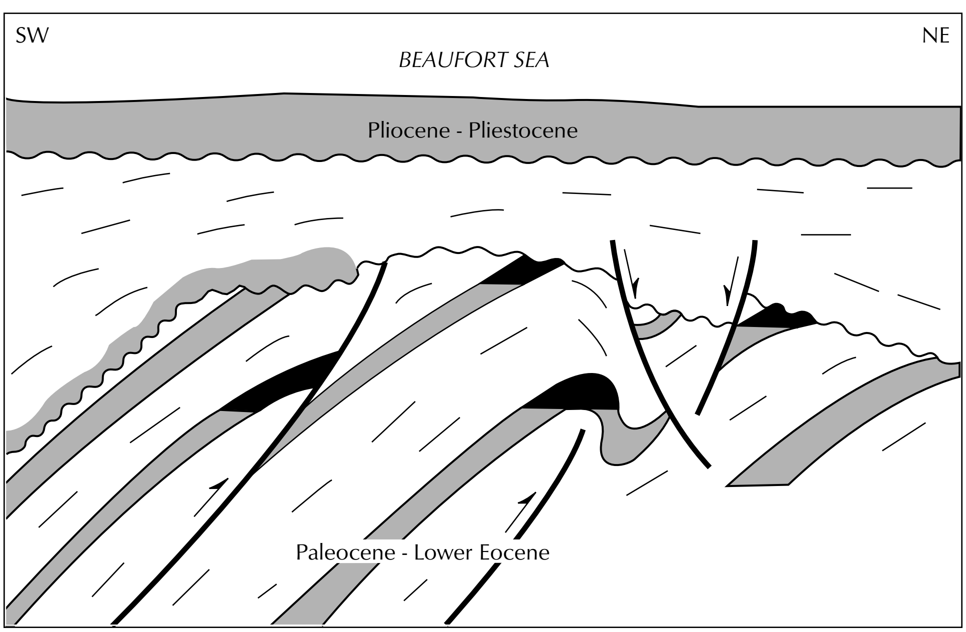


Figure 17. *Schematic sketch of the trap-types in the Herschel play (from Dixon, et al., 1994).*

are expected to be present in the Herschel or Blow River highs. However, two gas fields with median estimates greater than 3 billion m³ have been predicted.

About 81% of the play area occurs in the Yukon Territory. Under Scenario 1, where the largest undiscovered field is assumed to occur in the Yukon, the expected play potential for oil and gas is 31 million m³ and 14.4 billion m³, respectively (Table 2). If, however, the largest predicted field is presumed to occur either in the Northwest Territories or Alaska, the potential is reduced to 15.5 million m³ oil and 7.2 billion m³ gas (Table 2).

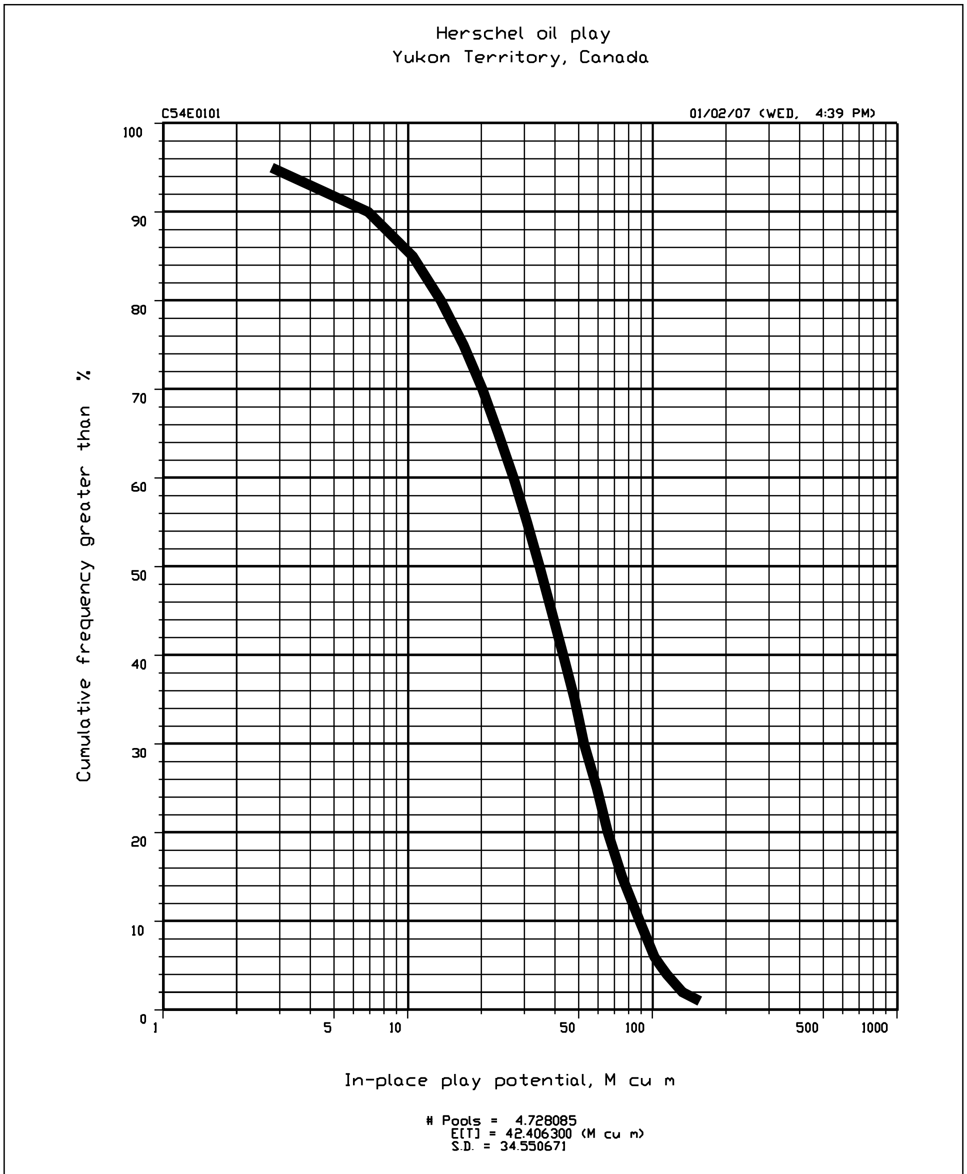


Figure 18. *Estimate of in-place oil potential of the Herschel play. Median value of probabilistic assessment is 34.6 million m³ of in-place oil distributed in 5 fields.*

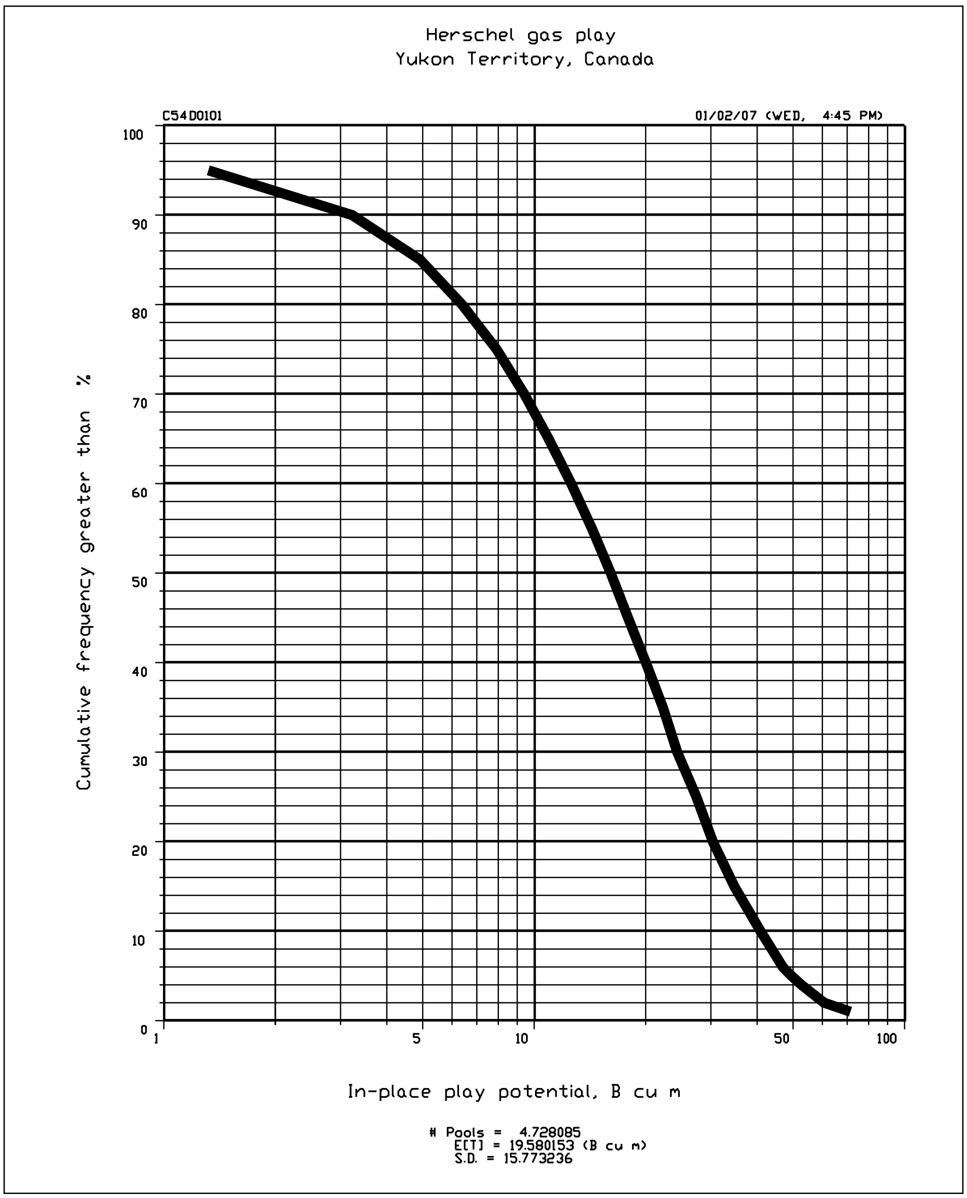
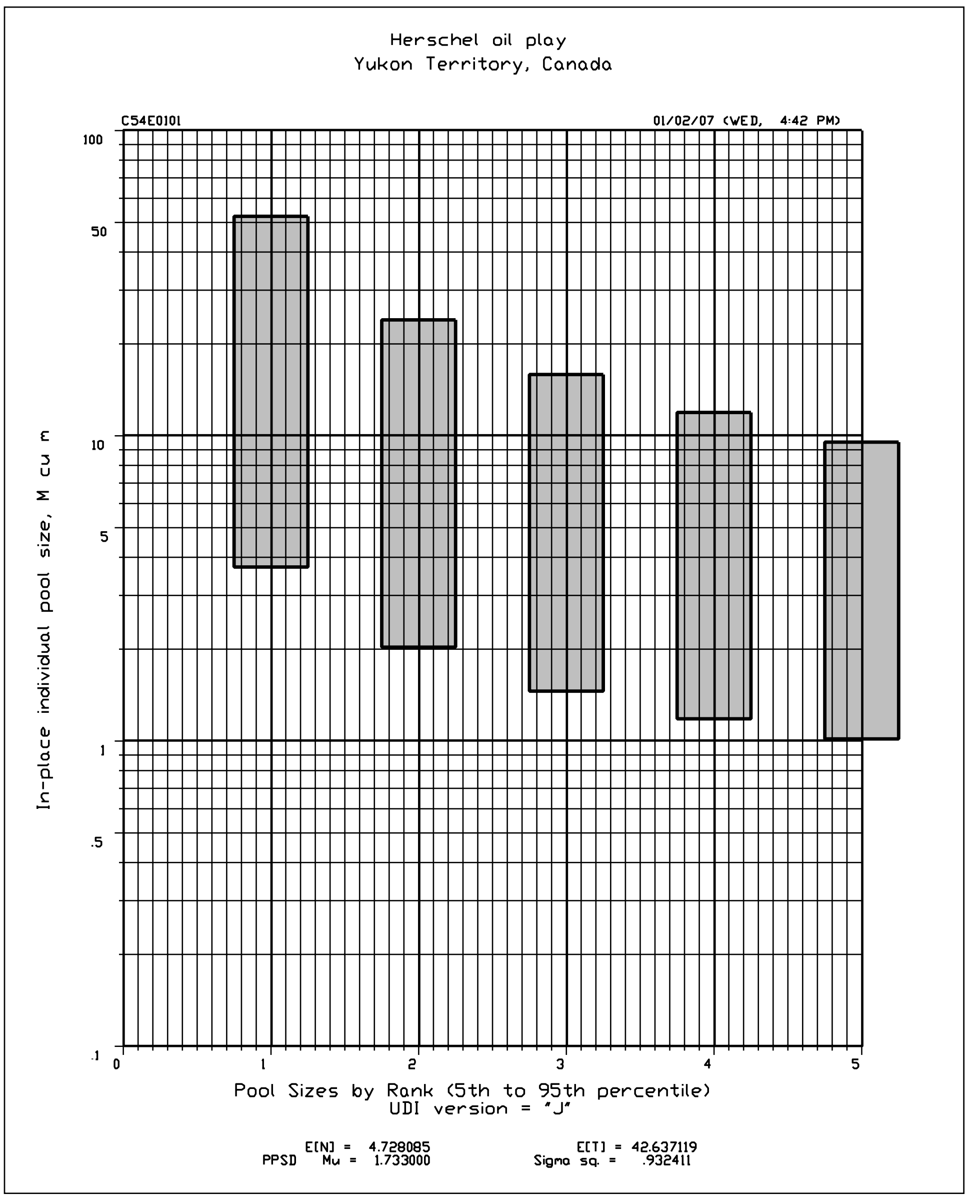


Figure 19. *Estimate of in-place gas potential of the Herschel play. Median value of probabilistic assessment is 16.1 billion m*^{3} *of in-place oil distributed in 5 fields.*

Figure 20. *Field-size-by-rank plot of the Herschel oil play. Median value of the largest predicted field size is 15.5 million m³ of in-place oil.*



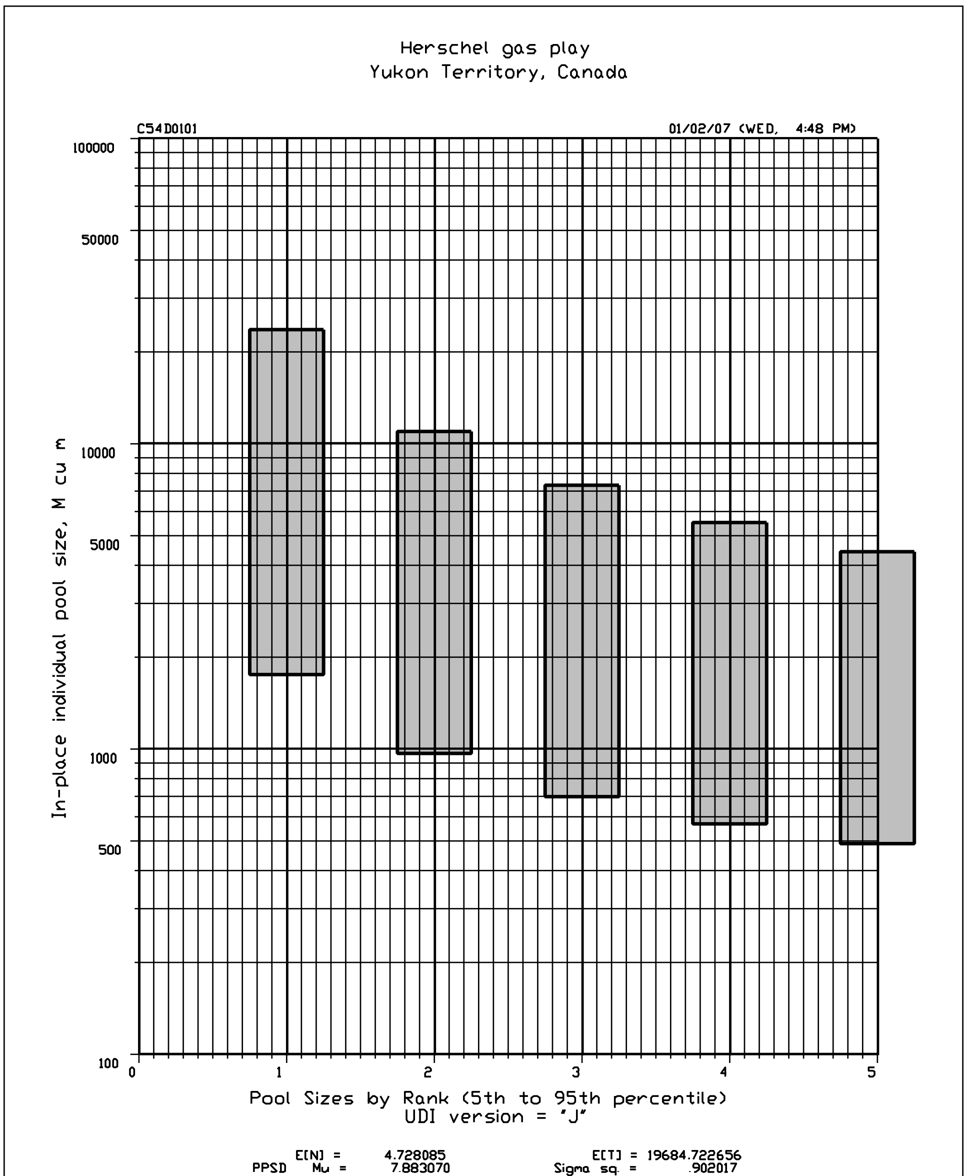


Figure 21. *Field-size-by-rank plot of the Herschel gas play. Median value of the largest predicted field size is 7.1 billion m*^{3} *of in-place gas.*

YUKON COASTAL PLAIN GAS PLAY

HYDROCARBON PLAYS

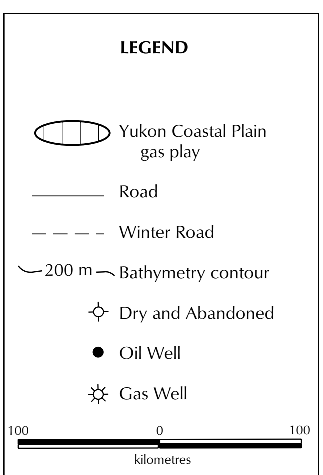
Play definition

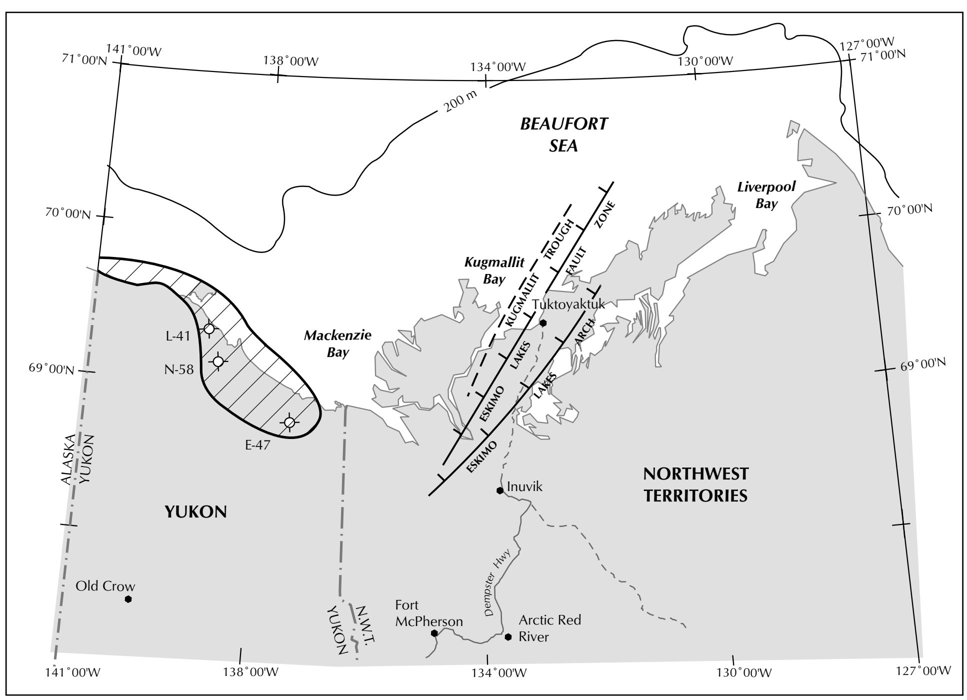
This conceptual play includes all pre-Cenomanian natural gas traps along the Yukon coastal plain extending from the northern end of the Richardson Mountains westwards to the British Mountains (Fig. 22). The play area also includes a narrow strip of inshore waters of the Beaufort Sea. It extends southward to the Barn Mountains and includes the upper reaches of the Blow River. Figure 22 shows the play may extend into Alaska to the west. However, insufficient information is available to accurately map the play boundary extensions in Alaska. Therefore, in this play assessment, all of the predictions obtained assume the play occurs exclusively in the Yukon. Gas is expected to be the principal hydrocarbon in the play.

Geology

The coastal plain play basically occupies the Rapid Depression along the Arctic coast of northern Yukon (Fig. 2). The precursory Blow Trough occupies the Rapid Depression between Cache Creek Uplift and Barn Mountains. There is a thick Mesozoic accumulation of clastic sediments in the Rapid Depression. Interbedded shale and sandstone of Jurassic to Albian age occupy the depression. These Mesozoic strata attain thicknesses of 5,000 to 10,000 m. Surrounding mountains expose Paleozoic to Proterozoic sedimentary strata. In the Barn and British mountains (Romanzof Uplift), Lower Paleozoic basinal shales, sandstone, thin-bedded carbonates and chert, Carboniferous Kayak and Kekiktuk clastic sediments and Lisburne carbonates, and Permian clastics and carbonates of the Sadlerochit Group are exposed. The thickness of the total prospect succession, including Mesozoic and Paleozoic strata, may be on the order of 5,000 to 15,000 m. Depths of this prospect succession may range from surface to 18,000 m.

Figure 22. *Yukon coastal plain gas play (from Dixon, et al., 1988). Wells discussed in the report are shown (1–Roland Bay L-41, 2–Spring River N-58, 3–Blow River E-47).*





In the Rapid Depression, Jurassic through Valanginian strata contain dominant shales of the Kingak Formation. Both the prograding clastic wedges of the sandstone-rich Bug Creek Group and the Martin Creek Formation in the Blow Trough shale-out to the west. Kamik sands are more widespread in northern Yukon except in the British Mountains to the west where an equivalent shale facies has been deposited. Late Barremian-Aptian Rat River Formation sandstones are only present on the eastern side of the Blow Trough. To the west, Rat River sands have been removed by erosion. Sediment gravity-flow deposits consisting of interbedded conglomerate, sandstone and shale of Albian age occur in the Blow Trough.

Even though the potential reservoir facies in the play seem numerous, the clastics are generally well-cemented with silica resulting in tight, low-quality reservoirs. Carbonates also exhibit low porosity characteristics but fracturing can be extensive.

Surface mapping and seismic interpretation indicate that the area is structurally complex with numerous trapping configurations occurring in association with thrust faults, normal and strike-slip faults and associated folds (Fig. 23). The major episode of deformation seems to have taken place during the Laramide orogeny, although older events have affected present trends. This implies that at least some of the structures formed prior to hydrocarbon generation and migration. Maximum burial depth when hydrocarbon generation was optimal occured during Tertiary time, so pre-existing structural traps would have captured migrating gas.

Three wells have been drilled in the play area, all in the early 1970s. All wells were dry and abandoned. Blow River E-47 in the Blow Trough stopped drilling in Albian Flysch at a depth of 4,267 m. Spring River N-58 completed drilling in Paleozoic strata at 2,136 m. The third well is designated as Roland Bay L-41 and was drilled to a total depth of 2,752 m, bottoming in Jurassic Kingak Formation. This well penetrated about 2,000 m of Jurassic and Lower Cretaceous strata of the Kingak and Mount Goodenough formations (Fig. 24, Dietrich, 1986). These dominant shale successions are unconformably overlain by the organic-rich Boundary Creek Sequence. The high vitrinite reflectance profile for all Cretaceous and Jurassic strata indicates overmature organic matter (Fig. 24). Any potential source rock, therefore, regardless of its organic type, will produce dry gas

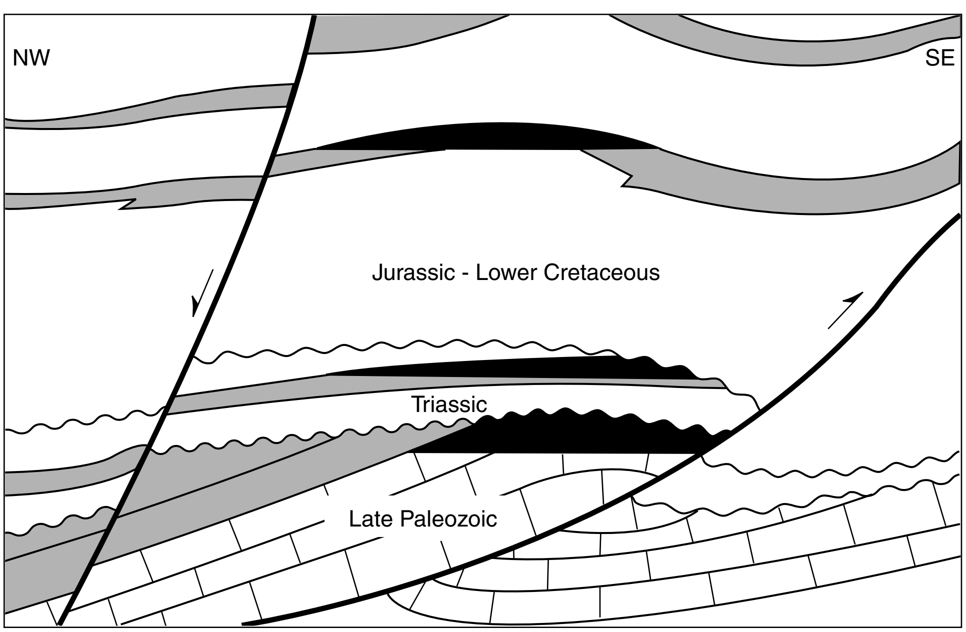


Figure 23. *Schematic sketch of the trap-types in the Yukon coastal plain play (from Dixon, et al., 1994).*

only. Subsequent to completion of these wells, a moratorium on drilling in the area was imposed, culminating in 1987 with the establishment of a national park extending from Babbage River westward to the Alaskan border.

Many similarities are evident when comparing the Yukon coastal plain play with the Folded Ellesmerian/Pre-Mississippian play in the Arctic National Wildlife Refuge in Alaska (Dolton, *et al.*, 1987). By using the Alaskan play as an analog in this particular play assessment, some reservoir parameters and risk factors can be used.

Exploration risks

Significant marginal probabilities were assigned to presence of closure, adequate porosity, timing and preservation at the prospect level (Appendix 1). The risk for closure occurs when insufficient deformation occurs in fault-related traps for complete closure. Porosity has a high risk of being inadequate due to the well-cemented nature of many of the clastic units. Timing was considered to be a significant risk factor due to the

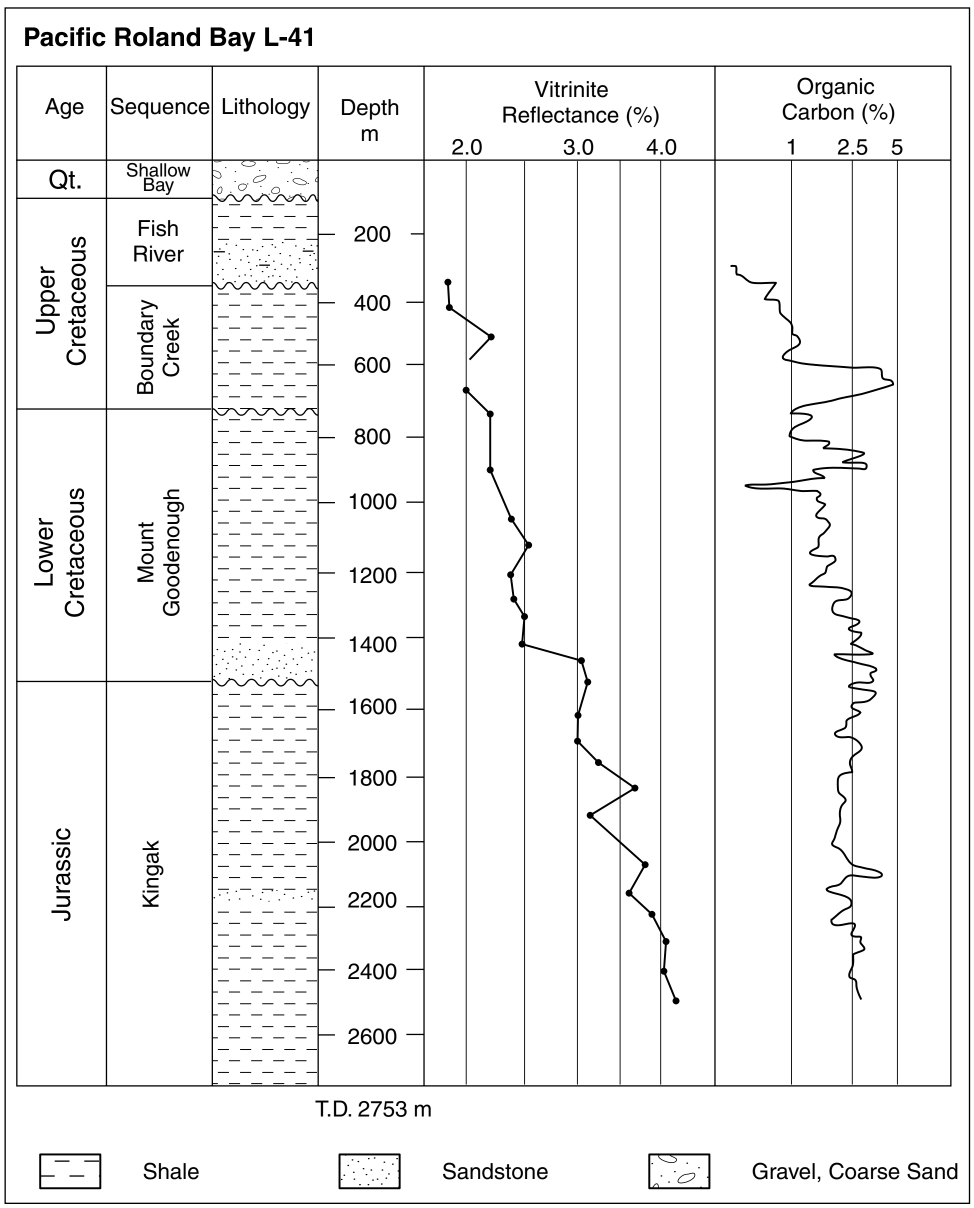


Figure 24. *Geological and geochemical summary of the Roland Bay L-41 well (from Dietrich, 1986).*

contemporaneous relationship of the Laramide deformational episode with a major period of hydrocarbon generation during maximum burial. Some structures were not formed before the main hydrocarbon migration episode. Uplift and deep erosion of pre-Cenomanian reservoirs during the mid-Tertiary is reflected in the high risk assigned to adequate preservation. Source and seal is most likely adequate in most prospects for gas accumulation due to the thick Jurassic and Lower Cretaceous shale succession occurring throughout the play area.

Play potential

The Yukon coastal plain play is expected to have a resource potential for gas of 8.5 billion m^3 in-place at the median value (Fig. 25; Table 1). The largest predicted field size is 5.6 billion m^3 (Fig. 26; Table 1). Three gas fields are expected in this play. Two of three fields are expected to be larger than the arbitrary 3.0 billion m^3 selected as minimum significant field size for natural gas accumulations in frontier regions of Canada. These potential volumes are applicable to the Yukon Territory only.

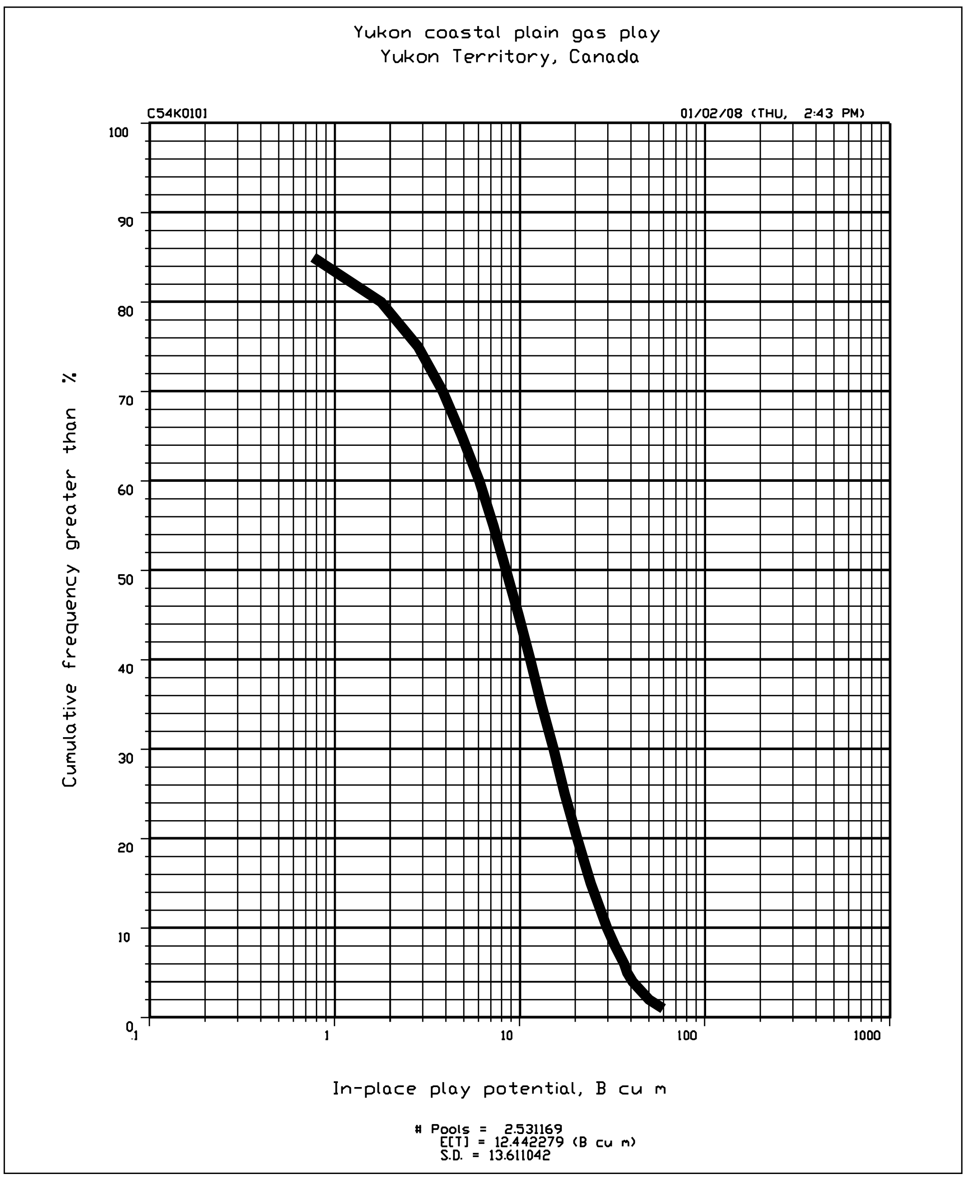


Figure 25. *Estimate of in-place gas potential of the Yukon coastal plain play. Median value of probabilistic assessment is 8.5 billion m^3 of in-place oil distributed in 3 fields.*

DISCUSSION OF ASSESSMENT RESULTS

RESOURCE POTENTIAL

The in-place median estimate of total oil potential for the North Coast region (including all immature and conceptual plays) is 39.8 million m^3 (250 million bbls) (Table 1; Fig. 27). (Note that the total median estimate for all oil plays is not arithmetically derived by summing the hydrocarbon potentials of individual plays. This number is derived using statistical techniques). High confidence (95% probability) and speculative (5% probability) estimates of total oil potential are 6.7 and 111 million m^3 (42 and 698 million barrels), respectively (Fig. 27). Individual field-size estimates in each play display similar probability-dependent variations. The wide range of estimates of total potential and field sizes are typical of frontier region assessments and reflect the geological uncertainties in quantifying lightly explored or conceptual exploration plays.

The median natural gas potential for all plays in the North Coast region is 38.6 billion m^3 (1.4 TCF) (Fig. 28; Table 1). The high confidence and speculative estimates for all gas

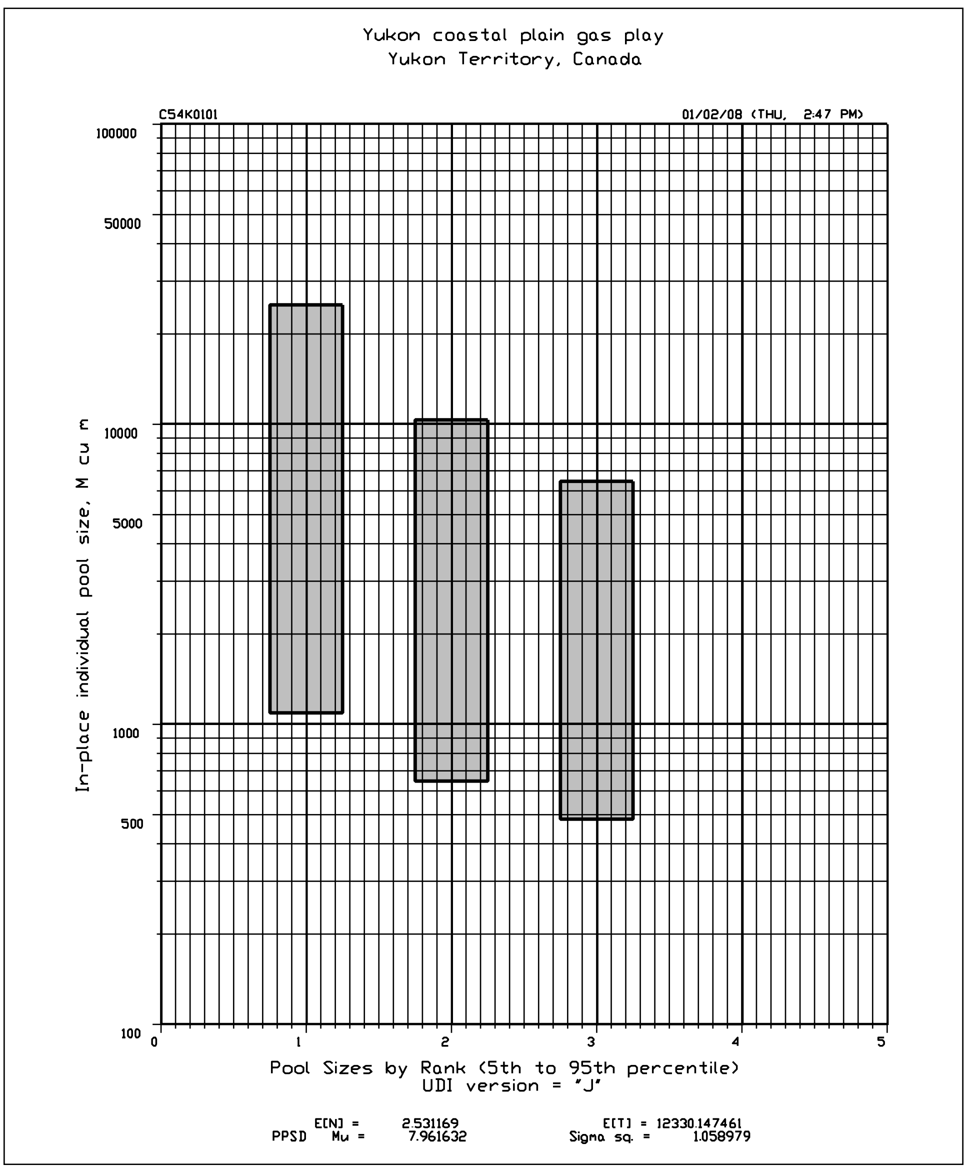


Figure 26. *Field-size-by-rank plot of the Yukon coastal plain gas play. Median value of the largest predicted field size is 6.0 billion m^3 of in-place gas.*

plays in the assessment area is 14.5 and 81.8 billion m^3 in-place (0.5 and 2.9 TCF) (Fig. 28).

Condensate occurs in a single play (South Delta–Paleozoic) where the median potential is expected to be 0.71 million m^3 or 4.5 million barrels (Table 1).

RESOURCE DISTRIBUTIONS

The greatest oil potential or volume occurs in the Herschel play (Table 1). The largest individual oil field is expected to occur in the same play, having a median size estimate of 15.5 million m^3 (97 million barrels) of in-place oil. The Herschel play also has the largest gas potential and field size in the North Coast assessment (16.1 and 7.1 billion m^3, respectively; equivalent to 0.6 and 0.25 TCF).

Taking into consideration the expected potential in the Yukon Territory alone under the two proposed scenarios (Table 2), it is clear that the Herschel play is the most significant oil and gas play with respect to both resource potential and field sizes. Under Scenario 1 where the largest predicted field is expected to occur in the Yukon Territory, 97% of the

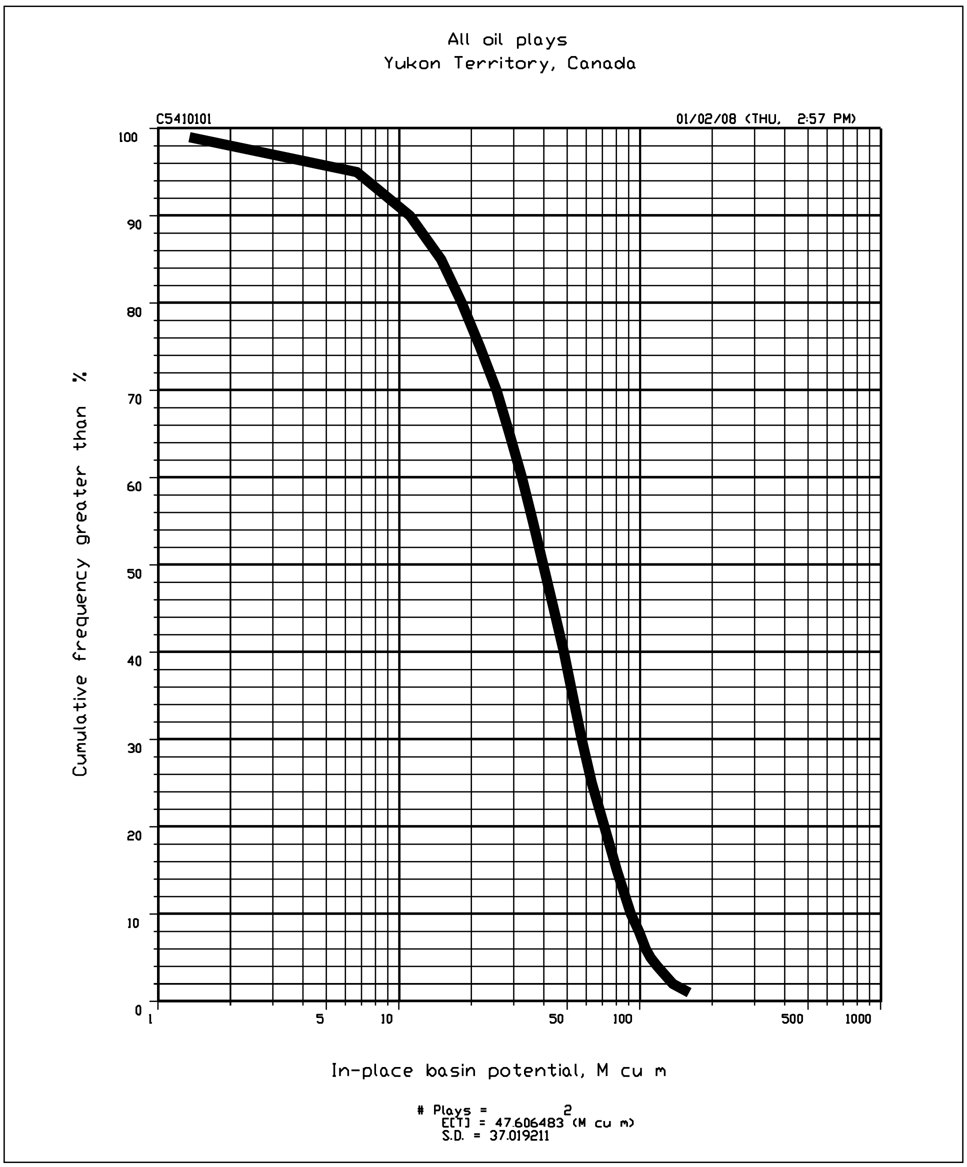
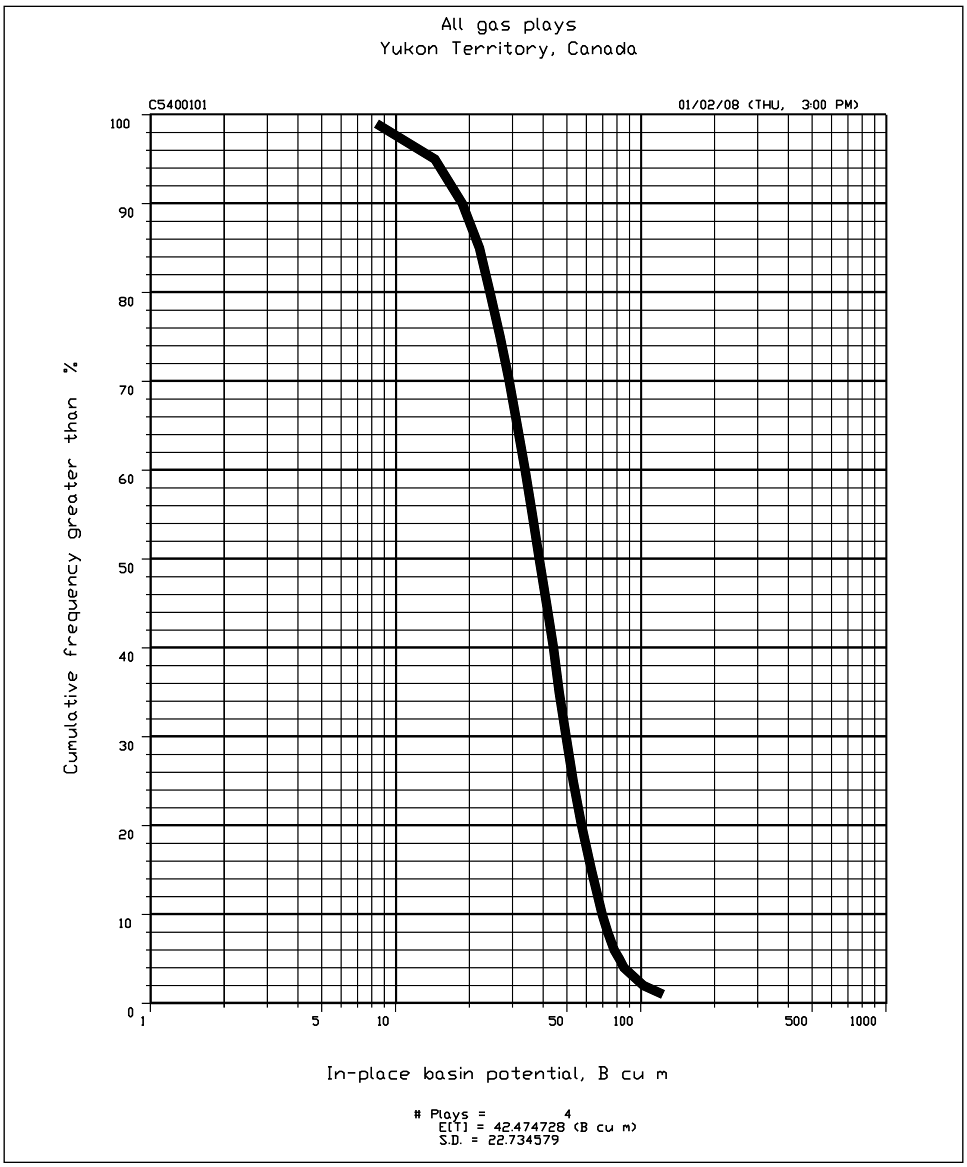


Figure 27. *Estimate of total oil potential for the North Coast area. Median value of probabilistic assessment is 39.8 million m^3 of in-place oil distributed in 9 fields.*

oil resource and 57% of the gas resource occur in the Herschel play. When the largest field is assumed to lie outside Yukon's borders, then the proportion of gas in the Herschel play changes substantially, mostly because of the elimination of the Yukon coastal plain play in the calculation. Under Scenario 2, 98% of both the oil and gas resource occurs in the Herschel play. In any case, these calculations indicate the importance of the Herschel play in this particular assessment area. This single play, consisting of highly deformed Tertiary reservoirs and occurring disproportionately in offshore areas, infers the much greater expected oil and gas potential in the offshore region compared to onshore areas, at least in the Yukon part of the basin. No doubt, if all the other offshore plays were included as part of the assessment, this relationship would become more obvious. The relative richness of offshore plays probably reflects the proximity to the hydrocarbon kitchen adjacent to very porous and widespread Tertiary delta complexes.

Figure 28. *Estimate of total gas potential for the North Coast area. Median value of probabilistic assessment is 38.6 billion m³ of in-place oil distributed in 31 fields.*



ASSESSMENT RESULTS AND EXPLORATION HISTORY

The exploration risks calculated in this assessment suggest success rates for exploratory drilling in the North Coast area of the Yukon should average about 1 in 7. The absence of discoveries among the 3 wells drilled to date in Yukon Territory is reasonable. Historically, the first significant hydrocarbon in a frontier region is often preceded by many unsuccessful exploration wells due to incomplete knowledge of the petroleum geology in the area. This predicted success rate seems to be reasonably comparable to other frontier regions in northern Yukon (Hannigan, *et al*., 1999; Hannigan, in press(a), (b), and (c)). The reconnaissance nature of the seismic data and the lack of wells, along with the inherent difficulty in estimating numbers of prospects associated with both structural and stratigraphic traps, make the presumption of the number of prospects quite arbitrary. Incorporating relevant future exploration data, such as improved and dense seismic survey coverage or exploratory drilling, will provide a greater degree of confidence in hydrocarbon potential estimates.

CONCLUSIONS

The hydrocarbon resource potential of the Yukon North Coast area has been evaluated through regional hydrocarbon play assessments. The quantitative assessments were derived using the Geological Survey of Canada's (PETRIMES) assessment methodology system. The Arctic coastal region of northern Yukon is underlain by a complex folded and faulted terrain: part of the Frontal morphogeological belt of the Cordilleran Fold Belt. Major tectonic and structural elements in the assessment region are the Rapid Depression, Cache Creek, Barn and Romanzof uplifts, Blow River and Herschel highs and Demarcation Subbasin. Structures such as compressional folds and strike-slip faults that were formed during the Laramide Orogeny are underlain by older tectonic features such as the Cache Creek Uplift and the Rapid Depression which originated as Mesozoic fault-bounded structures. North of the Rapid Depression are several significant large-scale tectonic features, such as the Blow River and Herschel highs and the Demarcation Subbasin.

The petroleum resource assessments include analyses of six immature and conceptual oil and gas plays, each of which incorporated the calculation or estimation of field-size parameters, numbers of prospects and exploration risks. Hydrocarbon volumes reported for these plays are total statistical estimates of the resource present 'in the ground', not the volumes that are economically producible. Individual field-size determinations are important in identifying which plays are attractive for future exploration programs.

The potential for significant hydrocarbon accumulations in the North Coast assessment region is derived by the combined presence of numerous and diverse trapping configurations, good to excellent petroleum source rocks in favourable stratal positions and reservoir-quality strata in parts of the stratigraphic succession. However, significant risks associated with lack of porosity development in Paleozoic and Mesozoic strata, and thermal maturity considerations, reduce overall hydrocarbon potential. Significant gas potential is predicted for the Herschel play in the study area. The complex geology and anticipated high exploration risks associated with all defined exploration plays in the region suggest that considerable seismic survey work and exploration drilling are required to properly evaluate the North Coast hydrocarbon potential.

The median estimate for total gas potential for all North Coast plays is 38.6 billion m^3 of in-place gas (Fig. 28; Table 1). Four fields with median sizes greater than 3 billion m^3 of in-place gas are expected in two plays, two each in the Herschel and Yukon coastal plain plays.

Total potential for oil in all North Coast plays is predicted to be 39.8 million m^3 in-place (Fig. 27; Table 1). No oil field sizes greater than 160 million m^3 are predicted to occur in the region.

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APPENDIX 1

INPUT DATA FOR NORTH COAST HYDROCARBON ASSESSMENTS

The following tables present the probability distributions of reservoir parameters, number of prospects, and marginal probabilities of geological risk factors used as input for the various immature and conceptual statistical analyses discussed in this paper. These estimates are based on subjective opinion, partly constrained by reservoir data and information from analogous hydrocarbon-bearing basins.

1. SOUTH DELTA–MESOZOIC OIL PLAY

Table 1.1a. Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles 1.00	Probability in upper percentiles 0.50	Probability in upper percentiles 0.01	Probability in upper percentiles 0.00
Area of pool	km^2	0.11	0.7	27	34
Net pay	m	1	17	102	114
Porosity	decimal fraction	0.05	0.1	0.15	0.2
Oil saturation	decimal fraction	0.35	0.5	0.6	0.65
Oil formation volume factor	1.02	1.25	1.45	1.53	

Table 1.1b. Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Presence of closure	0.6		x
Presence of porosity	0.50		x
Adequate seal	0.9		x
Adequate timing	0.8		x
Adequate source	0.66		x
Adequate preservation	0.7		x

Table 1.1c Probability distribution for number of prospects

Geological variable	Probability in upper percentiles 0.99	Probability in upper percentiles 0.5	Probability in upper percentiles 0.00
Number of prospects	29	35	59

2. SOUTH DELTA–MESOZOIC GAS PLAY

Table 1.2a. Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles 1.00	Probability in upper percentiles 0.50	Probability in upper percentiles 0.01	Probability in upper percentiles 0.00
Area of pool	km^2	0.11	0.7	27	34
Net pay	m	1	17	102	114
Porosity	decimal fraction	0.05	0.1	0.15	0.2
Gas saturation	decimal fraction	0.45	0.65	0.85	0.9
Gas formation volume factor	0.003	0.005	0.006	0.007	

Table 1.2b. Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Presence of closure	0.6		x
Presence of porosity	0.50		x
Adequate seal	0.9		x
Adequate timing	0.8		x
Adequate source	0.66		x
Adequate preservation	0.7		x

Table 1.2c. Probability distribution for number of prospects

Geological variable	Probability in upper percentiles 0.99	Probability in upper percentiles 0.5	Probability in upper percentiles 0.00
Number of prospects	58	70	118

3. SOUTH DELTA–PALEOZOIC GAS PLAY

Table 1.3a. Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles 1.00	Probability in upper percentiles 0.50	Probability in upper percentiles 0.01	Probability in upper percentiles 0.00
Area of pool	km^2	0.11	0.7	27	32
Net pay	m	4	22	87	96
Porosity	decimal fraction	0.05	0.1	0.2	0.25
Gas saturation	decimal fraction	0.6	0.85	0.9	0.95
Gas formation volume factor	0.002	0.005	0.007	0.008	

Table 1.3b. Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Presence of closure	0.6		x
Presence of porosity	0.5		x
Adequate seal	0.9		x
Adequate timing	0.8		x
Adequate source	0.8		x
Adequate preservation	0.8		x

Table 1.3c. Probability distribution for number of prospects

Geological variable	Probability in upper percentiles 0.99	Probability in upper percentiles 0.5	Probability in upper percentiles 0.00
Number of prospects	46	95	200

4. HERSCHEL OIL PLAY

Table 1.4a. Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles 1.00	Probability in upper percentiles 0.50	Probability in upper percentiles 0.01	Probability in upper percentiles 0.00
Area of pool	km^2	0.5	5	21	50
Net pay	m	3	40	200	500
Porosity	decimal fraction	0.03	0.17	0.28	0.32
Hydrocarbon saturation	decimal fraction	0.4	0.52	0.6	0.62
Oil fraction	decimal fraction	0	0.4	0.72	1
Oil formation volume factor	1.13	1.25	1.35	1.37	

Table 1.4b. Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Presence of closure	0.7		x
Presence of porosity	0.90		x
Adequate seal	0.6		x
Adequate timing	0.8		x
Adequate source	0.7		x
Adequate preservation	0.8		x

Table 1.4c. Probability distribution for number of prospects

Geological variable	Probability in upper percentiles 0.99	Probability in upper percentiles 0.5	Probability in upper percentiles 0.00
Number of prospects	10	25	50

5. HERSCHEL GAS PLAY

Table 1.5a. Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles 1.00	Probability in upper percentiles 0.50	Probability in upper percentiles 0.01	Probability in upper percentiles 0.00
Area of pool	km^2	0.5	5	21	50
Net pay	m	3	40	200	500
Porosity	decimal fraction	0.03	0.17	0.28	0.32
Hydrocarbon saturation	decimal fraction	0.4	0.52	0.6	0.62
Gas fraction	decimal fraction	0	0.6	0.85	1
Gas formation volume factor	0.003	0.004	0.005	0.006	

Table 1.5b. Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Presence of closure	0.7		x
Presence of porosity	0.90		x
Adequate seal	0.6		x
Adequate timing	0.8		x
Adequate source	0.7		x
Adequate preservation	0.8		x

Table 1.5c. Probability distribution for number of prospects

Geological variable	Probability in upper percentiles 0.99	Probability in upper percentiles 0.5	Probability in upper percentiles 0.00
Number of prospects	10	25	50

6. YUKON COASTAL PLAIN GAS PLAY

Table 1.6a. Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles 1.00	Probability in upper percentiles 0.50	Probability in upper percentiles 0.01	Probability in upper percentiles 0.00
Area of closure	km^2	1	9	60	185
Reservoir thickness	m	1.5	75	220	400
Trap fill	decimal fraction	0.01	0.25	0.62	1
Porosity	decimal fraction	0.03	0.1	0.17	0.22
Gas saturation	decimal fraction	0.6	0.85	0.9	0.95
Gas formation volume factor	0.002	0.005	0.007	0.008	

Table 1.6b. Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Presence of closure	0.7		x
Presence of porosity	0.65		x
Adequate seal	0.8		x
Adequate timing	0.6		x
Adequate source	0.8		x
Adequate preservation	0.6		x

Table 1.6c. Probability distribution for number of prospects

Geological variable	Probability in upper percentiles 0.99	Probability in upper percentiles 0.5	Probability in upper percentiles 0.00
Number of prospects	5	25	40

APPENDIX 2

OUTPUT FOR NORTH COAST HYDROCARBON ASSESSMENTS

The following text presents the output generated by the PETRIMES hydrocarbon assessment program using the conceptual play analysis procedure. For each play, the PPSD, MPRO, PSRK, PSUM and PPPS modules are presented. PPSD generates the pool-size distribution using the lognormal simulation. MPRO generates the number of pools distribution and risks for the play. PSRK gives the individual pool sizes by rank and PSUM indicates the Monte Carlo simulation for the pool-ksize distribution. Immature plays with discoveries have an additional module (PPPS) which generates the play potential conditioned on the sum of discovered reserves. (Note: In text, field sizes are indicated rather than pools. In frontier conceptual plays, insufficient geological and engineering information is available to define individual pool accumulations in single structures). A PSUM module for total oil and gas potential on a basin-scale is also presented.

PETRIMES MODULE PPSD

```
PROSPECT OR POOL SIZE DISTRIBUTION USING
LOGNORMAL OR MONTE CARLO SIMULATION
****************************************

UAI        C5450101
PLAY       South Delta-Mesozoic oil play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, FEB  2, 2001,  9:40 AM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB?           >    Y
   OIL (O) OR GAS (G) ?                  >    O
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO HONOR A PERCENTILE?    > Y
   UPPER PERCENTILE TO BE HONORED?       > .10000E-01

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Oil In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Input Constant(s)
   -----------------

   No input constant.

C) Summary
   -------

   Variable                       Lognormal Approximation

   IN-PLACE     mu     =-.74234     MEAN   = .95515
   POOL SIZE    sig. sq= 1.3929     S.D.   = 1.6617
   (DERIVED)    99.99% = .59073E-02 60.00% = .35298     15.00% = 1.6175
                99.00% = .30564E-01 55.00% = .41039     10.00% = 2.1601
                95.00% = .68316E-01 50.00% = .47600      8.00% = 2.4991
                90.00% = .10489     45.00% = .55210      6.00% = 2.9821
                85.00% = .14008     40.00% = .64189      5.00% = 3.3166
                80.00% = .17629     35.00% = .75008      4.00% = 3.7578
                75.00% = .21473     30.00% = .88388      2.00% = 5.3737
                70.00% = .25634     25.00% = 1.0552      1.00% = 7.4131
                65.00% = .30207     20.00% = 1.2853       .01% = 38.355

D) Pool Size Equation
   ------------------

   NO. OF GEO-VARIABLES= 5

   POOL SIZE =        1.00000
               * AREA OF      * NET PAY      * POROSITY     * HYDROCARBON
                 POOL                                         SATURATION

              ------------------------------------------------------------
                 OIL FMN
                 VOLUME
                 FACTOR
```

```
GEOLOGICAL VARIABLES
--------------------
A) Variables Used
   -------------

   VARIABLE     UNIT OF      O/G VERSION TYPE NO. OF   UAI
                MEASUREMENT                   POINTS
                SYMBOL                        USED

   AREA OF         sq km     Oil    1      2      4   C5450101
   POOL

   NET PAY          m        Oil    1      2      4   C5450101

   POROSITY       dec  fr    Oil    1      2      4   C5450101

   HYDROCARBON    dec  fr    Oil    1      2      4   C5450101
   SATURATION

   OIL FMN                   Oil    1      2      4   C5450101
   VOLUME
   FACTOR

B) Summary
   -------

   Variable                       Lognormal Approximation

   AREA OF      mu     =-.35667     MEAN   = 1.2066
   POOL         sig. sq= 1.0890     S.D.   = 1.6941
                99.99% = .14441E-01 60.00% = .53738     15.00% = 2.0645
                99.00% = .61770E-01 55.00% = .61397     10.00% = 2.6663
                95.00% = .12579     50.00% = .70000      8.00% = 3.0331
                90.00% = .18378     45.00% = .79808      6.00% = 3.5460
                85.00% = .23734     40.00% = .91184      5.00% = 3.8955
                80.00% = .29085     35.00% = 1.0465      4.00% = 4.3503
                75.00% = .34627     30.00% = 1.2099      2.00% = 5.9686
                70.00% = .40498     25.00% = 1.4151      1.00% = 7.9326
                65.00% = .46824     20.00% = 1.6847       .01% = 33.930

   NET PAY      mu     = 2.8332     MEAN   = 19.375
                sig. sq= .26154     S.D.   = 10.593
                99.99% = 2.5378     60.00% = 14.934     15.00% = 28.883
                99.00% = 5.1733     55.00% = 15.942     10.00% = 32.740
                95.00% = 7.3304     50.00% = 17.000      8.00% = 34.875
                90.00% = 8.8270     45.00% = 18.128      6.00% = 37.650
                85.00% = 10.006     40.00% = 19.352      5.00% = 39.425
                80.00% = 11.054     35.00% = 20.703      4.00% = 41.618
                75.00% = 12.040     30.00% = 22.229      2.00% = 48.595
                70.00% = 13.001     25.00% = 24.002      1.00% = 55.864
                65.00% = 13.959     20.00% = 26.144       .01% = 113.88

   POROSITY     mu     =-2.3026     MEAN   = .10174
                sig. sq= .34487E-01 S.D.   = .19058E-01
                99.99% = .50125E-01 60.00% = .95404E-01 15.00% = .12122
                99.00% = .64920E-01 55.00% = .97693E-01 10.00% = .12687
                95.00% = .73678E-01 50.00% = .10000      8.00% = .12981
                90.00% = .78821E-01 45.00% = .10236      6.00% = .13347
                85.00% = .82492E-01 40.00% = .10482      5.00% = .13572
                80.00% = .85531E-01 35.00% = .10742      4.00% = .13842
                75.00% = .88227E-01 30.00% = .11023      2.00% = .14643
                70.00% = .90721E-01 25.00% = .11334      1.00% = .15404
                65.00% = .93094E-01 20.00% = .11692       .01% = .19950
```

```
HYDROCARBON  mu     =-.69315     MEAN   = .50124
SATURATION   sig. sq= .49477E-02 S.D.   = .35301E-01
             99.99% = .38491     60.00% = .49117     15.00% = .53781
             99.00% = .42453     55.00% = .49560     10.00% = .54717
             95.00% = .44537     50.00% = .50000      8.00% = .55194
             90.00% = .45690     45.00% = .50444      6.00% = .55778
             85.00% = .46485     40.00% = .50899      5.00% = .56133
             80.00% = .47126     35.00% = .51374      4.00% = .56552
             75.00% = .47683     30.00% = .51879      2.00% = .57771
             70.00% = .48189     25.00% = .52429      1.00% = .58889
             65.00% = .48663     20.00% = .53049       .01% = .64950

OIL FMN      mu     = .22314     MEAN   = 1.2518
VOLUME       sig. sq= .29385E-02 S.D.   = .67910E-01
FACTOR       99.99% = 1.0218     60.00% = 1.2330     15.00% = 1.3222
             99.00% = 1.1019     55.00% = 1.2415     10.00% = 1.3399
             95.00% = 1.1434     50.00% = 1.2500      8.00% = 1.3489
             90.00% = 1.1661     45.00% = 1.2585      6.00% = 1.3599
             85.00% = 1.1817     40.00% = 1.2673      5.00% = 1.3666
             80.00% = 1.1943     35.00% = 1.2764      4.00% = 1.3744
             75.00% = 1.2051     30.00% = 1.2860      2.00% = 1.3972
             70.00% = 1.2150     25.00% = 1.2965      1.00% = 1.4180
             65.00% = 1.2242     20.00% = 1.3083       .01% = 1.5292
```

C) Covariance Matrix

```
VARIABLE

AREA OF         1.08899
POOL

NET PAY          .00000     .26154

POROSITY         .00000     .00000     .03449

HYDROCARBON      .00000     .00000     .00000     .00495
SATURATION

OIL FMN          .00000     .00000     .00000     .00000     .00294
VOLUME
FACTOR
```

D) Correlation Matrix

```
VARIABLE

AREA OF       1.00000
POOL

NET PAY        .00000    1.00000

POROSITY       .00000     .00000    1.00000

HYDROCARBON    .00000     .00000     .00000    1.00000
SATURATION

OIL FMN        .00000     .00000     .00000     .00000    1.00000
VOLUME
FACTOR
```

PETRIMES MODULE MPRO

NO. OF POOLS DISTRIBUTION AND RISKS

```
UAI        C5450101
PLAY       South Delta-Mesozoic oil play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   WED, JAN 17, 2001, 12:12 PM
```

USER SUPPLIED PARAMETERS

```
   DO YOU WANT TO STORE ON DB?          >   Y
   OIL (O) OR GAS (G) ?                 >   O
```

A) Risks

```
               GEOLOGICAL FACTOR               MARGINAL PROBABILITY
               -----------------               --------------------

PLAY LEVEL     Overall Play Level Risk       =       1.00

PROSPECT LEVEL Presence of Closure         ( 1)       .60
               Presence of Porosity        ( 3)       .50
               Adequate Seal               ( 4)       .90
               Adequate Timing             ( 5)       .80
               Adequate Source             ( 6)       .66
               Adequacy of Recovery        ( 9)       .70
               --------------------------------------------------
               Overall Prospect Level Risk   =        .10

EXPLORATION RISK:                            =        .10
```

B) No. of Prospects Distribution

```
Minimum      =    29
Maximum      =    59
Mean         =   39.97
S.D.         =    9.07
```

Frequency	No. of Prospects
99.00	29
95	30
90	31
80	32
75	32
60	34
50	35
40	40
25	47
20	50
10	55
5	57
1	59
0	59

C) No. of Pools Distribution

```
Minimum      =     0
Maximum      =    17
Mean         =    3.99
S.D.         =    2.10
```

Frequency	No. of Pools
97.88	0
95	1
90	1
80	2
75	2
60	3
50	4
40	4
25	5
20	6
10	7
5	8
1	10
0	1

Note: The no. of pools distribution is saved in the database with UDI= 6201OB4

PETRIMES MODULE PSRK

```
INDIVIDUAL POOL SIZES BY RANK
WHERE N IS A RANDOM VARIABLE
****************************

UAI        C5450101
PLAY       South Delta-Mesozoic oil play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   TUE, JAN 23, 2001, 12:20 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB ?         > Y
   DO YOU WANT TO USE MPRO OUTPUT?      > Y
   MIN. AND MAX. POOL RANKS?            >     1     4
   DO YOU USE LOGNORNAL ASSUMPTION?     > Y
   DO YOU WANT TO USE PPSD OUTPUT?      > Y

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Oil In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   --------------------------------
   Summary      mu     =-.74234     MEAN   = .95515
   Statistics   sig. sq= 1.3929     S.D.   = 1.6617

   Upper        99.99% = .59073E-02 60.00% = .35298     15.00% = 1.6175
   Percentiles  99.00% = .30564E-01 55.00% = .41039     10.00% = 2.1601
                95.00% = .68316E-01 50.00% = .47600      8.00% = 2.4991
                90.00% = .10489     45.00% = .55210      6.00% = 2.9821
                85.00% = .14008     40.00% = .64189      5.00% = 3.3166
                80.00% = .17629     35.00% = .75008      4.00% = 3.7578
                75.00% = .21473     30.00% = .88388      2.00% = 5.3737
                70.00% = .25634     25.00% = 1.0552      1.00% = 7.4131
                65.00% = .30207     20.00% = 1.2853       .01% = 38.355

C) No. of Pools Distribution
   -------------------------
   Lower Support     =   0
   Upper Support     =  17
   Expectation       =   3.99
   Standard Deviation=   2.10

D) Pool Sizes By Rank
   ------------------

   Pool Rank                      Distribution

        1     MEAN   = 2.2504     S.D.   = 2.8140     P(N>=r)= .97882
              99%    = .10481     75%    = .78069     10%    = 4.7286
              95%    = .26939     50%    = 1.4679      5%    = 6.6840
              90%    = .41474     25%    = 2.7018      1%    = 13.140

        2     MEAN   = .90190     S.D.   = .83927     P(N>=r)= .89821
              99%    = .50141E-01 75%    = .36188     10%    = 1.8576
              95%    = .12133     50%    = .67353      5%    = 2.4376
              90%    = .18819     25%    = 1.1677      1%    = 4.0505

        3     MEAN   = .53469     S.D.   = .46272     P(N>=r)= .74551
              99%    = .34026E-01 75%    = .22023     10%    = 1.0970
              95%    = .76540E-01 50%    = .41050      5%    = 1.4094
              90%    = .11591     25%    = .70567      1%    = 2.2203

        4     MEAN   = .37112     S.D.   = .30938     P(N>=r)= .55203
              99%    = .26794E-01 75%    = .15664     10%    = .75721
              95%    = .57328E-01 50%    = .28836      5%    = .96375
              90%    = .84734E-01 25%    = .49222      1%    = 1.4812

E) The mean of the potential =  3.6164
```

PETRIMES MODULE PSUM

```
MONTE CARLO SUM SIMULATION
POOL SIZE DISTRIBUTION
*************************

UAI        C5450101
PLAY       South Delta-Mesozoic oil play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   TUE, JAN 23, 2001, 12:22 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE IN DATA BASE ?   >    Y
   OIL (O) OR GAS (G) ?                  >    O
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO USE MPRO OUTPUT?       >    Y
   DO YOU ASSUME LOGNORMAL DISTRIBUTION? >    Y
   DO YOU WANT TO USE PPSD OUTPUT?       >    Y
   DO YOU COMPUTE CONDITIONAL POTENTIAL? >    N

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Oil In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   --------------------------------
   Summary      mu     =-.74234     MEAN   = .95515
   Statistics   sig. sq= 1.3929     S.D.   = 1.6617

   Upper        99.99% = .59073E-02 60.00% = .35298     15.00% = 1.6175
   Percentiles  99.00% = .30564E-01 55.00% = .41039     10.00% = 2.1601
                95.00% = .68316E-01 50.00% = .47600      8.00% = 2.4991
                90.00% = .10489     45.00% = .55210      6.00% = 2.9821
                85.00% = .14008     40.00% = .64189      5.00% = 3.3166
                80.00% = .17629     35.00% = .75008      4.00% = 3.7578
                75.00% = .21473     30.00% = .88388      2.00% = 5.3737
                70.00% = .25634     25.00% = 1.0552      1.00% = 7.4131
                65.00% = .30207     20.00% = 1.2853       .01% = 38.355

C) NO. OF POOLS DISTRIBUTION
   ------------------------------
   Lower Support     =    0
   Upper Support     =   17
   Expectation       =      3.98819
   Standard Deviation=      2.09991


D) Summary Statistics for 4000 Simulations
   --------------------------------------

   Play Resource:    (    M cu m  )
   ------------------------------
     Minimum     = .0000000E+00Maximum           = 47.66905
     Expectation = 3.798451    Standard Deviation= 3.687653

   EMPERICAL DISTRIBUTION:
   ----------------------
```

Greater than Percentage	Play Potential
100.00	.00000E+00
95.00	.24337
90.00	.55668
85.00	.84104
80.00	1.0941
75.00	1.3875
70.00	1.6443
65.00	1.9165
60.00	2.1850
55.00	2.5113
50.00	2.8268
45.00	3.1302
40.00	3.5563
35.00	3.9955
30.00	4.4510
25.00	5.1129
20.00	5.7703
15.00	6.6875
10.00	8.1451
8.00	8.8912
6.00	9.7734
5.00	10.497
4.00	11.326
2.00	14.251
1.00	16.738
.01	46.342
.00	47.536

PETRIMES MODULE PPPS

PLAY POTENTIAL CONDITION ON
TOTAL SUM OF DISCOVERED RESERVE
****

```
UAI        C5450101
PLAY       South Delta-Mesozoic oil play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   TUE, JAN 23, 2001, 12:35 PM
```

USER SUPPLIED PARAMETERS

```
------------------------
   DO YOU WANT TO STORE IN DATA BASE?  >    Y
   OIL (O) OR GAS (G)?                 >    O
   BRITISH OR S.I. UNIT OF MEASUREMENT?>   SI
   RECOVERABLE RESOURCES?              >    N
   CONDITION VALUE AND ITS UNIT?       >    6.7000     19
```

A) Basic Information

```
   -----------------
   TYPE OF RESOURCE      =Oil In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)
```

B) PLAY RESOURCE DISTRIBUTION

```
   ------------------------------

   Summary      MEAN   = 3.7985     S.D.   = 3.6877
   Statistics     M cu m

   Upper       100.00% = .00000E+00 55.00% = 2.5113     10.00% = 8.1451
   Percentiles  95.00% = .24337     50.00% = 2.8268      8.00% = 8.8912
                90.00% = .55668     45.00% = 3.1302      6.00% = 9.7734
                85.00% = .84104     40.00% = 3.5563      5.00% = 10.497
                80.00% = 1.0941     35.00% = 3.9955      4.00% = 11.326
                75.00% = 1.3875     30.00% = 4.4510      2.00% = 14.251
                70.00% = 1.6443     25.00% = 5.1129      1.00% = 16.738
                65.00% = 1.9165     20.00% = 5.7703       .01% = 46.342
                60.00% = 2.1850     15.00% = 6.6875       .00% = 47.536
```

C) Summary Statistics for 5000 Simulations

```
---------------------------------------

Play Potential:   (    M cu m  )
------------------------------
  Minimum     = .5783903E-03Maximum           = 40.52534
  Expectation = 4.371518    Standard Deviation= 6.344550

EMPERICAL DISTRIBUTION:
----------------------

  Greater than    Play
  Percentage      Potential
  ------------    -----------
     100.00         .57839E-03
      99.00         .43201E-01
      95.00         .20000
      90.00         .39156
      85.00         .60200
      80.00         .83888
      75.00         1.0402
      70.00         1.2497
      65.00         1.5095
      60.00         1.7966
      55.00         2.0800
      50.00         2.3751
      45.00         2.6841
      40.00         2.9948
      35.00         3.5396
      30.00         4.1592
      25.00         4.9526
      20.00         6.1670
      15.00         7.2779
      10.00         8.8598
       8.00         9.5118
       6.00         13.113
       5.00         17.099
       4.00         21.722
       2.00         30.495
       1.00         34.259
        .01         40.276
        .00         40.500
```

PETRIMES MODULE PPSD

```
PROSPECT OR POOL SIZE DISTRIBUTION USING
LOGNORMAL OR MONTE CARLO SIMULATION
***************************************

UAI        C5440101
PLAY       South Delta-Mesozoic gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, FEB  2, 2001, 10:31 AM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB?           >    Y
   OIL (O) OR GAS (G) ?                  >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO HONOR A PERCENTILE?    > Y
   UPPER PERCENTILE TO BE HONORED?       > .10000E-01

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Input Constant(s)
   -----------------

   No input constant.

C) Summary
   -------

   Variable                         Lognormal Approximation

   IN-PLACE     mu     = 5.0415     MEAN   = 306.47
   POOL SIZE    sig. sq= 1.3673     S.D.   = 524.12
   (DERIVED)    99.99% = 1.9993     60.00% = 115.04     15.00% = 519.78
                99.00% = 10.189     55.00% = 133.56     10.00% = 692.30
                95.00% = 22.604     50.00% = 154.70      8.00% = 799.87
                90.00% = 34.569     45.00% = 179.19      6.00% = 952.89
                85.00% = 46.043     40.00% = 208.04      5.00% = 1058.7
                80.00% = 57.822     35.00% = 242.75      4.00% = 1198.2
                75.00% = 70.302     30.00% = 285.62      2.00% = 1707.8
                70.00% = 83.789     25.00% = 340.42      1.00% = 2348.9
                65.00% = 98.586     20.00% = 413.89       .01% = 11970.

D) Pool Size Equation
   ------------------

   NO. OF GEO-VARIABLES= 5

   POOL SIZE =        1.00000
                * AREA OF      * NET PAY      * POROSITY     * HYDROCARBON
                  POOL                                          SATURATION

              ------------------------------------------------------------
                  GAS FMN
                  VOLUME
                  FACTOR
```



```
GEOLOGICAL VARIABLES
--------------------
A) Variables Used
   --------------

   VARIABLE     UNIT OF      O/G VERSION TYPE NO. OF   UAI
                MEASUREMENT                   POINTS
                SYMBOL                        USED

   AREA OF         sq km    Gas    1      2      4   C5440101
   POOL

   NET PAY           m      Gas    1      2      4   C5440101

   POROSITY       dec  fr   Gas    1      2      4   C5440101

   HYDROCARBON    dec  fr   Gas    1      2      4   C5440101
   SATURATION

   GAS FMN                  Gas    1      2      4   C5440101
   VOLUME
   FACTOR

B) Summary
   -------

   Variable                         Lognormal Approximation

   AREA OF      mu     =-.35667     MEAN   = 1.1866
   POOL         sig. sq= 1.0555     S.D.   = 1.6241
                99.99% = .15336E-01 60.00% = .53958     15.00% = 2.0302
                99.00% = .64138E-01 55.00% = .61522     10.00% = 2.6116
                95.00% = .12918     50.00% = .70000      8.00% = 2.9650
                90.00% = .18762     45.00% = .79646      6.00% = 3.4579
                85.00% = .24135     40.00% = .90811      5.00% = 3.7932
                80.00% = .29483     35.00% = 1.0400      4.00% = 4.2289
                75.00% = .35007     30.00% = 1.1997      2.00% = 5.7737
                70.00% = .40843     25.00% = 1.3997      1.00% = 7.6398
                65.00% = .47117     20.00% = 1.6619       .01% = 31.950

   NET PAY      mu     = 2.8332     MEAN   = 19.375
                sig. sq= .26154     S.D.   = 10.593
                99.99% = 2.5378     60.00% = 14.934     15.00% = 28.883
                99.00% = 5.1733     55.00% = 15.942     10.00% = 32.740
                95.00% = 7.3304     50.00% = 17.000      8.00% = 34.875
                90.00% = 8.8270     45.00% = 18.128      6.00% = 37.650
                85.00% = 10.006     40.00% = 19.352      5.00% = 39.425
                80.00% = 11.054     35.00% = 20.703      4.00% = 41.618
                75.00% = 12.040     30.00% = 22.229      2.00% = 48.595
                70.00% = 13.001     25.00% = 24.002      1.00% = 55.864
                65.00% = 13.959     20.00% = 26.144       .01% = 113.88

   POROSITY     mu     =-2.3026     MEAN   = .10174
                sig. sq= .34487E-01 S.D.   = .19058E-01
                99.99% = .50125E-01 60.00% = .95404E-01 15.00% = .12122
                99.00% = .64920E-01 55.00% = .97693E-01 10.00% = .12687
                95.00% = .73678E-01 50.00% = .10000      8.00% = .12981
                90.00% = .78821E-01 45.00% = .10236      6.00% = .13347
                85.00% = .82492E-01 40.00% = .10482      5.00% = .13572
                80.00% = .85531E-01 35.00% = .10742      4.00% = .13842
                75.00% = .88227E-01 30.00% = .11023      2.00% = .14643
                70.00% = .90721E-01 25.00% = .11334      1.00% = .15404
                65.00% = .93094E-01 20.00% = .11692       .01% = .19950
```

```
HYDROCARBON  mu     =-.43078     MEAN   = .65248
SATURATION   sig. sq= .76305E-02 S.D.   = .57105E-01
             99.99% = .46971     60.00% = .63577     15.00% = .71159
             99.00% = .53047     55.00% = .64290     10.00% = .72699
             95.00% = .56301     50.00% = .65000      8.00% = .73488
             90.00% = .58116     45.00% = .65717      6.00% = .74455
             85.00% = .59374     40.00% = .66455      5.00% = .75044
             80.00% = .60393     35.00% = .67225      4.00% = .75741
             75.00% = .61281     30.00% = .68047      2.00% = .77773
             70.00% = .62090     25.00% = .68945      1.00% = .79647
             65.00% = .62849     20.00% = .69959       .01% = .89950

GAS FMN      mu     =-5.2983     MEAN   = .50203E-02
VOLUME       sig. sq= .81160E-02 S.D.   = .45320E-03
FACTOR       99.99% = .35765E-02 60.00% = .48872E-02 15.00% = .54893E-02
             99.00% = .40546E-02 55.00% = .49437E-02 10.00% = .56119E-02
             95.00% = .43114E-02 50.00% = .50000E-02  8.00% = .56747E-02
             90.00% = .44548E-02 45.00% = .50569E-02  6.00% = .57518E-02
             85.00% = .45543E-02 40.00% = .51154E-02  5.00% = .57986E-02
             80.00% = .46349E-02 35.00% = .51766E-02  4.00% = .58542E-02
             75.00% = .47052E-02 30.00% = .52419E-02  2.00% = .60162E-02
             70.00% = .47693E-02 25.00% = .53132E-02  1.00% = .61658E-02
             65.00% = .48294E-02 20.00% = .53938E-02   .01% = .69900E-02
```

C) Covariance Matrix

```
----------------

VARIABLE

AREA OF         1.05551
POOL

NET PAY          .00000     .26154

POROSITY         .00000     .00000     .03449

HYDROCARBON      .00000     .00000     .00000     .00763
SATURATION

GAS FMN          .00000     .00000     .00000     .00000     .00812
VOLUME
FACTOR
```

D) Correlation Matrix

```
-----------------

VARIABLE

AREA OF       1.00000
POOL

NET PAY        .00000    1.00000

POROSITY       .00000     .00000    1.00000

HYDROCARBON    .00000     .00000     .00000    1.00000
SATURATION

GAS FMN        .00000     .00000     .00000     .00000    1.00000
VOLUME
FACTOR
```

PETRIMES MODULE MPRO

NO. OF POOLS DISTRIBUTION AND RISKS

```
**********************************
UAI        C5440101
PLAY       South Delta-Mesozoic gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   MON, JAN 22, 2001,  2:08 PM
```

USER SUPPLIED PARAMETERS

```
------------------------
   DO YOU WANT TO STORE ON DB?          >   Y
   OIL (O) OR GAS (G) ?                 >   G
```

A) Risks

```
   -----
                 GEOLOGICAL FACTOR               MARGINAL PROBABILITY
                 -----------------               --------------------
   PLAY LEVEL    Overall Play Level Risk       =       1.00
   PROSPECT LEVEL Presence of Closure         ( 1)       .60
                 Presence of Porosity         ( 3)       .50
                 Adequate Seal                ( 4)       .90
                 Adequate Timing              ( 5)       .80
                 Adequate Source              ( 6)       .66
                 Adequate Preservation        ( 8)       .70
                 ----------------------------------------------------
                 Overall Prospect Level Risk   =         .10
   EXPLORATION RISK:                           =         .10
```

B) No. of Prospects Distribution

```
   ----------------------------
   Minimum      =    58
   Maximum      =   118
   Mean         =   79.44
   S.D.         =   18.14
   Frequency   No. of Prospects
   ---------   ----------------
     99.00          58
       95           59
       90           61
       80           63
       75           64
       60           68
       50           70
       40           80
       25           94
       20           99
       10          109
        5          114
        1          118
        0          118
```

C) No. of Pools Distribution

```
   ------------------------
   Minimum      =     0
   Maximum      =    27
   Mean         =    7.93
   S.D.         =    3.23
   Frequency   No. of Pools
   ---------   ------------
     99.93          0
       99           2
       95           3
       90           4
       80           5
       75           6
       60           7
       50           8
       40           8
       25          10
       20          11
       10          12
        5          14
        1          17
        0          27
```

```
Note: The
no. of pools
distribution
is saved in
the database
with UDI=
6201GB4
```

PETRIMES MODULE PSRK

```
INDIVIDUAL POOL SIZES BY RANK
WHERE N IS A RANDOM VARIABLE
*****************************

UAI        C5440101
PLAY       South Delta-Mesozoic gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, FEB  2, 2001, 10:38 AM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB ?          > Y
   DO YOU WANT TO USE MPRO OUTPUT?       > Y
   MIN. AND MAX. POOL RANKS?             >      1     8
   DO YOU USE LOGNORNAL ASSUMPTION?      > Y
   DO YOU WANT TO USE PPSD OUTPUT?       > Y

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   --------------------------------
   Summary      mu     = 5.0415     MEAN   = 306.47
   Statistics   sig. sq= 1.3673     S.D.   = 524.12

   Upper        99.99% = 1.9993     60.00% = 115.04     15.00% = 519.78
   Percentiles  99.00% = 10.189     55.00% = 133.56     10.00% = 692.30
                95.00% = 22.604     50.00% = 154.70      8.00% = 799.87
                90.00% = 34.569     45.00% = 179.19      6.00% = 952.89
                85.00% = 46.043     40.00% = 208.04      5.00% = 1058.7
                80.00% = 57.822     35.00% = 242.75      4.00% = 1198.2
                75.00% = 70.302     30.00% = 285.62      2.00% = 1707.8
                70.00% = 83.789     25.00% = 340.42      1.00% = 2348.9
                65.00% = 98.586     20.00% = 413.89       .01% = 11970.

C) No. of Pools Distribution
   -------------------------
   Lower Support     =   0
   Upper Support     =  27
   Expectation       =   7.93
   Standard Deviation=   3.23
```

```
D) Pool Sizes B*y Rank
   ------------------

   Pool Rank                     Distribution

        1     MEAN   = 1048.4    S.D.   = 1097.6     P(N>=r)= .99932
              99%    = 110.68    75%    = 452.73     10%    = 2067.1
              95%    = 210.70    50%    = 749.83      5%    = 2828.6
              90%    = 283.91    25%    = 1259.3      1%    = 5280.9

        2     MEAN   = 478.39    S.D.   = 357.60     P(N>=r)= .99449
              99%    = 50.098    75%    = 244.42     10%    = 897.91
              95%    = 108.59    50%    = 391.46      5%    = 1135.1
              90%    = 151.28    25%    = 608.32      1%    = 1778.3

        3     MEAN   = 300.07    S.D.   = 209.53     P(N>=r)= .97730
              99%    = 26.910    75%    = 155.46     10%    = 560.97
              95%    = 63.025    50%    = 253.50      5%    = 692.82
              90%    = 91.763    25%    = 390.33      1%    = 1025.2

        4     MEAN   = 210.49    S.D.   = 146.35     P(N>=r)= .93669
              99%    = 17.320    75%    = 106.51     10%    = 397.67
              95%    = 40.378    50%    = 178.93      5%    = 487.12
              90%    = 60.222    25%    = 278.15      1%    = 703.63

        5     MEAN   = 157.70    S.D.   = 110.85     P(N>=r)= .86476
              99%    = 12.772    75%    = 77.518     10%    = 301.71
              95%    = 28.740    50%    = 133.56      5%    = 368.68
              90%    = 42.906    25%    = 210.52      1%    = 526.65

        6     MEAN   = 124.05    S.D.   = 88.041     P(N>=r)= .76239
              99%    = 10.294    75%    = 59.761     10%    = 239.55
              95%    = 22.343    50%    = 104.41      5%    = 292.62
              90%    = 33.025    25%    = 166.47      1%    = 415.72

        7     MEAN   = 101.44    S.D.   = 72.232     P(N>=r)= .63972
              99%    = 8.7883    75%    = 48.483     10%    = 196.77
              95%    = 18.517    50%    = 84.971      5%    = 240.38
              90%    = 27.036    25%    = 136.33      1%    = 340.42

        8     MEAN   = 85.531    S.D.   = 60.723     P(N>=r)= .51147
              99%    = 7.7909    75%    = 40.973     10%    = 165.96
              95%    = 16.036    50%    = 71.512      5%    = 202.70
              90%    = 23.146    25%    = 114.86      1%    = 286.35

E) The mean of the potential =  2353.5
```

PETRIMES MODULE PSUM

```
MONTE CARLO SUM SIMULATION
POOL SIZE DISTRIBUTION
**************************

UAI        C5440101
PLAY       South Delta-Mesozoic gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, FEB  2, 2001, 10:39 AM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE IN DATA BASE ?   >    Y
   OIL (O) OR GAS (G) ?                  >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO USE MPRO OUTPUT?       >    Y
   DO YOU ASSUME LOGNORMAL DISTRIBUTION? >    Y
   DO YOU WANT TO USE PPSD OUTPUT?       >    Y
   DO YOU COMPUTE CONDITIONAL POTENTIAL? >    N

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   -------------------------------
   Summary      mu     = 5.0415     MEAN   = 306.47
   Statistics   sig. sq= 1.3673     S.D.   = 524.12

   Upper        99.99% = 1.9993     60.00% = 115.04     15.00% = 519.78
   Percentiles  99.00% = 10.189     55.00% = 133.56     10.00% = 692.30
                95.00% = 22.604     50.00% = 154.70      8.00% = 799.87
                90.00% = 34.569     45.00% = 179.19      6.00% = 952.89
                85.00% = 46.043     40.00% = 208.04      5.00% = 1058.7
                80.00% = 57.822     35.00% = 242.75      4.00% = 1198.2
                75.00% = 70.302     30.00% = 285.62      2.00% = 1707.8
                70.00% = 83.789     25.00% = 340.42      1.00% = 2348.9
                65.00% = 98.586     20.00% = 413.89       .01% = 11970.

C) NO. OF POOLS DISTRIBUTION
   ------------------------------
   Lower Support     =    0
   Upper Support     =   27
   Expectation       =      7.92698
   Standard Deviation=      3.22706


D) Summary Statistics for 4000 Simulations
   ---------------------------------------

   Play Resource:    (  B cu m    )
   ------------------------------
     Minimum     = .0000000E+00Maximum           = 20.30180
     Expectation = 2.432530    Standard Deviation= 1.742724

   EMPERICAL DISTRIBUTION:
   ----------------------
```

Greater than Percentage	Play Potential
100.00	.00000E+00
99.00	.18142
95.00	.48941
90.00	.72355
85.00	.92550
80.00	1.0815
75.00	1.2620
70.00	1.4062
65.00	1.5508
60.00	1.7089
55.00	1.8698
50.00	2.0402
45.00	2.2209
40.00	2.4170
35.00	2.6301
30.00	2.8758
25.00	3.1710
20.00	3.5065
15.00	3.9387
10.00	4.5919
8.00	4.9254
6.00	5.3993
5.00	5.6884
4.00	6.0976
2.00	7.0300
1.00	8.2659
.01	18.688
.00	20.140-

PETRIMES MODULE PPSD

```
PROSPECT OR POOL SIZE DISTRIBUTION USING
LOGNORMAL OR MONTE CARLO SIMULATION
***************************************

UAI        C5460101
PLAY       South Delta-Paleozoic gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   TUE, JAN 23, 2001,  9:42 AM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB?           >    Y
   OIL (O) OR GAS (G) ?                  >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO HONOR A PERCENTILE?    > Y
   UPPER PERCENTILE TO BE HONORED?       > .10000E-01

A) Basic Information
   ----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Input Constant(s)
   ----------------

   No input constant.

C) Summary
   -------

   Variable                       Lognormal Approximation

   IN-PLACE     mu     = 5.5676     MEAN   = 498.85
   POOL SIZE    sig. sq= 1.2895     S.D.   = 809.13
   (DERIVED)    99.99% = 3.8362     60.00% = 196.35     15.00% = 849.37
                99.00% = 18.651     55.00% = 226.99     10.00% = 1122.0
                95.00% = 40.438     50.00% = 261.80      8.00% = 1290.9
                90.00% = 61.088     45.00% = 301.95      6.00% = 1530.1
                85.00% = 80.694     40.00% = 349.07      5.00% = 1694.9
                80.00% = 100.67     35.00% = 405.50      4.00% = 1911.3
                75.00% = 121.71     30.00% = 474.88      2.00% = 2696.5
                70.00% = 144.33     25.00% = 563.12      1.00% = 3674.8
                65.00% = 169.02     20.00% = 680.81       .01% = 17867.

D) Pool Size Equation
   ------------------

   NO. OF GEO-VARIABLES= 5

   POOL SIZE =        1.00000
               * AREA OF      * NET PAY      * POROSITY     * HYDROCARBON
                 POOL                                         SATURATION

              ------------------------------------------------------------
                 GAS FMN
                 VOLUME
                 FACTOR
```

```
GEOLOGICAL VARIABLES
--------------------
A) Variables Used
   -------------

   VARIABLE     UNIT OF      O/G VERSION TYPE NO. OF   UAI
                MEASUREMENT                  POINTS
                SYMBOL                       USED

   AREA OF          sq km    Gas    1      2      4   C5460101
   POOL

   NET PAY            m      Gas    1      2      4   C5460101

   POROSITY       dec  fr    Gas    1      2      4   C5460101

   HYDROCARBON    dec  fr    Gas    1      2      4   C5460101
   SATURATION

   GAS FMN                   Gas    1      2      4   C5460101
   VOLUME
   FACTOR

B) Summary
   -------

   Variable                       Lognormal Approximation

   AREA OF      mu     =-.35667     MEAN   = 1.1866
   POOL         sig. sq= 1.0555     S.D.   = 1.6241
                99.99% = .15336E-01 60.00% = .53958     15.00% = 2.0302
                99.00% = .64138E-01 55.00% = .61522     10.00% = 2.6116
                95.00% = .12918     50.00% = .70000      8.00% = 2.9650
                90.00% = .18762     45.00% = .79646      6.00% = 3.4579
                85.00% = .24135     40.00% = .90811      5.00% = 3.7932
                80.00% = .29483     35.00% = 1.0400      4.00% = 4.2289
                75.00% = .35007     30.00% = 1.1997      2.00% = 5.7737
                70.00% = .40843     25.00% = 1.3997      1.00% = 7.6398
                65.00% = .47117     20.00% = 1.6619       .01% = 31.950

   NET PAY      mu     = 3.0910     MEAN   = 23.793
                sig. sq= .15674     S.D.   = 9.8014
                99.99% = 5.0464     60.00% = 19.900     15.00% = 33.161
                99.00% = 8.7586     55.00% = 20.932     10.00% = 36.540
                95.00% = 11.471     50.00% = 22.000      8.00% = 38.371
                90.00% = 13.246     45.00% = 23.122      6.00% = 40.714
                85.00% = 14.596     40.00% = 24.321      5.00% = 42.193
                80.00% = 15.766     35.00% = 25.626      4.00% = 43.998
                75.00% = 16.844     30.00% = 27.076      2.00% = 49.607
                70.00% = 17.875     25.00% = 28.734      1.00% = 55.260
                65.00% = 18.887     20.00% = 30.699       .01% = 95.910

   POROSITY     mu     =-2.3026     MEAN   = .10307
                sig. sq= .60438E-01 S.D.   = .25726E-01
                99.99% = .40080E-01 60.00% = .93962E-01 15.00% = .12902
                99.00% = .56444E-01 55.00% = .96958E-01 10.00% = .13703
                95.00% = .66739E-01 50.00% = .10000      8.00% = .14126
                90.00% = .72975E-01 45.00% = .10314      6.00% = .14655
                85.00% = .77507E-01 40.00% = .10643      5.00% = .14984
                80.00% = .81310E-01 35.00% = .10994      4.00% = .15379
                75.00% = .84720E-01 30.00% = .11376      2.00% = .16568
                70.00% = .87904E-01 25.00% = .11804      1.00% = .17717
                65.00% = .90962E-01 20.00% = .12299       .01% = .24950
```

```
HYDROCARBON  mu     =-.16252     MEAN   = .85038
SATURATION   sig. sq= .88600E-03 S.D.   = .25318E-01
             99.99% = .76093     60.00% = .84361     15.00% = .87663
             99.00% = .79313     55.00% = .84683     10.00% = .88305
             95.00% = .80939     50.00% = .85000      8.00% = .88630
             90.00% = .81819     45.00% = .85319      6.00% = .89026
             85.00% = .82418     40.00% = .85643      5.00% = .89265
             80.00% = .82897     35.00% = .85981      4.00% = .89547
             75.00% = .83311     30.00% = .86337      2.00% = .90358
             70.00% = .83684     25.00% = .86724      1.00% = .91094
             65.00% = .84031     20.00% = .87156       .01% = .94950

GAS FMN      mu     =-5.2983     MEAN   = .50399E-02
VOLUME       sig. sq= .15887E-01 S.D.   = .63777E-03
FACTOR       99.99% = .31289E-02 60.00% = .48429E-02 15.00% = .56978E-02
             99.00% = .37293E-02 55.00% = .49214E-02 10.00% = .58765E-02
             95.00% = .40638E-02 50.00% = .50000E-02  8.00% = .59687E-02
             90.00% = .42542E-02 45.00% = .50798E-02  6.00% = .60824E-02
             85.00% = .43877E-02 40.00% = .51622E-02  5.00% = .61519E-02
             80.00% = .44968E-02 35.00% = .52488E-02  4.00% = .62345E-02
             75.00% = .45925E-02 30.00% = .53416E-02  2.00% = .64773E-02
             70.00% = .46802E-02 25.00% = .54437E-02  1.00% = .67037E-02
             65.00% = .47630E-02 20.00% = .55596E-02   .01% = .79900E-02
```

C) Covariance Matrix

```
-----------------

VARIABLE

AREA OF         1.05551
POOL

NET PAY          .00000     .15674

POROSITY         .00000     .00000     .06044

HYDROCARBON      .00000     .00000     .00000     .00089
SATURATION

GAS FMN          .00000     .00000     .00000     .00000     .01589
VOLUME
FACTOR
```

D) Correlation Matrix

```
------------------

VARIABLE

AREA OF       1.00000
POOL

NET PAY        .00000    1.00000

POROSITY       .00000     .00000    1.00000

HYDROCARBON    .00000     .00000     .00000    1.00000
SATURATION

GAS FMN        .00000     .00000     .00000     .00000    1.00000
VOLUME
FACTOR
```

PETRIMES MODULE MPRO

```
NO. OF POOLS DISTRIBUTION AND RISKS
***********************************

UAI        C5460101
PLAY       South Delta-Paleozoic gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   TUE, JAN 23, 2001,  9:47 AM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB?           >    Y
   OIL (O) OR GAS (G) ?                  >    G


A) Risks
   -----

                  GEOLOGICAL FACTOR               MARGINAL PROBABILITY
                  -----------------               --------------------

   PLAY LEVEL     Overall Play Level Risk        =       1.00

   PROSPECT LEVEL Presence of Closure          ( 1)       .60
                  Presence of Porosity         ( 3)       .50
                  Adequate Seal                ( 4)       .90
                  Adequate Timing              ( 5)       .80
                  Adequate Source              ( 6)       .80
                  Adequate Preservation        ( 8)       .80
                  ---------------------------------------------------
                  Overall Prospect Level Risk    =        .14

   EXPLORATION RISK:                             =        .14
```

```
B) No. of Prospects Distribution
   ----------------------------

   Minimum       =    46
   Maximum       =   200
   Mean          =  109.25
   S.D.          =   45.44

   Frequency   No. of Prospects
   ---------   ----------------

     99.00          46
        95          51
        90          56
        80          66
        75          71
        60          86
        50          95
        40         116
        25         148
        20         158
        10         179
         5         190
         1         198
         0         200
```

```
C) No. of Pools Distribution
   ------------------------

   Minimum       =     0
   Maximum       =    49
   Mean          =   15.10
   S.D.          =    7.24

   Frequency   No. of Pools
   ---------   ------------

     99.99          0
      99            3
      95            5
      90            7
      80            9
      75            9
      60           12
      50           14
      40           16
      25           20
      20           22
      10           26
       5           28
       1           33
       0           49
```

Note: The no. of pools distribution is saved in the database with UDI= 6201GB4

PETRIMES MODULE PSRK

```
INDIVIDUAL POOL SIZES BY RANK
WHERE N IS A RANDOM VARIABLE
*****************************

UAI        C5460101
PLAY       South Delta-Paleozoic gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   TUE, JAN 23, 2001, 10:37 AM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB ?          > Y
   DO YOU WANT TO USE MPRO OUTPUT?       > Y
   MIN. AND MAX. POOL RANKS?             >      1    15
   DO YOU USE LOGNORNAL ASSUMPTION?      > Y
   DO YOU WANT TO USE PPSD OUTPUT?       > Y

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   --------------------------------
   Summary      mu     = 5.5676     MEAN   = 498.85
   Statistics   sig. sq= 1.2895     S.D.   = 809.13

   Upper        99.99% = 3.8362     60.00% = 196.35     15.00% = 849.37
   Percentiles  99.00% = 18.651     55.00% = 226.99     10.00% = 1122.0
                95.00% = 40.438     50.00% = 261.80      8.00% = 1290.9
                90.00% = 61.088     45.00% = 301.95      6.00% = 1530.1
                85.00% = 80.694     40.00% = 349.07      5.00% = 1694.9
                80.00% = 100.67     35.00% = 405.50      4.00% = 1911.3
                75.00% = 121.71     30.00% = 474.88      2.00% = 2696.5
                70.00% = 144.33     25.00% = 563.12      1.00% = 3674.8
                65.00% = 169.02     20.00% = 680.81       .01% = 17867.

C) No. of Pools Distribution
   ------------------------
   Lower Support     =   0
   Upper Support     =  49
   Expectation       =  15.10
   Standard Deviation=   7.24

D) Pool Sizes By Rank
   ------------------

   Pool Rank                      Distribution

        1     MEAN   = 2253.7     S.D.   = 2029.1     P(N>=r)= .99992
              99%    = 322.85     75%    = 1097.2     10%    = 4254.7
              95%    = 555.12     50%    = 1720.0      5%    = 5652.0
              90%    = 722.72     25%    = 2728.0      1%    = 10012.

        2     MEAN   = 1170.3     S.D.   = 752.62     P(N>=r)= .99928
              99%    = 177.76     75%    = 662.55     10%    = 2081.9
              95%    = 328.80     50%    = 1006.2      5%    = 2557.3
              90%    = 434.86     25%    = 1481.3      1%    = 3805.1

        3     MEAN   = 807.22     S.D.   = 482.81     P(N>=r)= .99658
```

```
          99%    = 105.19     75%    = 465.17     10%    = 1422.8
          95%    = 216.05     50%    = 716.43      5%    = 1704.7
          90%    = 295.23     25%    = 1042.6      1%    = 2389.8

    4     MEAN   = 612.90     S.D.   = 364.58     P(N>=r)= .98907
          99%    = 66.299     75%    = 347.15     10%    = 1088.8
          95%    = 148.54     50%    = 550.16      5%    = 1290.3
          90%    = 210.80     25%    = 805.76      1%    = 1757.9

    5     MEAN   = 490.12     S.D.   = 296.26     P(N>=r)= .97327
          99%    = 45.850     75%    = 269.28     10%    = 882.61
          95%    = 106.76     50%    = 441.23      5%    = 1040.2
          90%    = 156.41     25%    = 654.76      1%    = 1394.3

    6     MEAN   = 406.18     S.D.   = 250.43     P(N>=r)= .94640
          99%    = 34.789     75%    = 215.98     10%    = 741.58
          95%    = 81.022     50%    = 365.31      5%    = 871.17
          90%    = 120.99     25%    = 549.95      1%    = 1155.8

    7     MEAN   = 346.13     S.D.   = 216.79     P(N>=r)= .90759
          99%    = 28.411     75%    = 179.02     10%    = 638.82
          95%    = 65.097     50%    = 310.70      5%    = 748.83
          90%    = 97.891     25%    = 473.42      1%    = 986.26

    8     MEAN   = 301.73     S.D.   = 190.66     P(N>=r)= .85828
          99%    = 24.483     75%    = 153.19     10%    = 560.55
          95%    = 55.003     50%    = 270.59      5%    = 655.90
          90%    = 82.687     25%    = 415.46      1%    = 859.09

    9     MEAN   = 267.91     S.D.   = 169.54     P(N>=r)= .80152
          99%    = 21.926     75%    = 134.91     10%    = 498.79
          95%    = 48.382     50%    = 240.46      5%    = 582.66
          90%    = 72.471     25%    = 370.17      1%    = 759.73

   10     MEAN   = 241.32     S.D.   = 151.98     P(N>=r)= .74096
          99%    = 20.183     75%    = 121.69     10%    = 448.56
          95%    = 43.877     50%    = 217.17      5%    = 523.15
          90%    = 65.414     25%    = 333.65      1%    = 679.58

   11     MEAN   = 219.72     S.D.   = 137.05     P(N>=r)= .67987
          99%    = 18.949     75%    = 111.81     10%    = 406.60
          95%    = 40.693     50%    = 198.46      5%    = 473.52
          90%    = 60.370     25%    = 303.31      1%    = 613.23

   12     MEAN   = 201.57     S.D.   = 124.16     P(N>=r)= .62071
          99%    = 18.036     75%    = 104.03     10%    = 370.75
          95%    = 38.341     50%    = 182.78      5%    = 431.22
          90%    = 56.598     25%    = 277.36      1%    = 557.10

   13     MEAN   = 185.82     S.D.   = 112.90     P(N>=r)= .56500
          99%    = 17.323     75%    = 97.503     10%    = 339.50
          95%    = 36.495     50%    = 169.06      5%    = 394.50
          90%    = 53.590     25%    = 254.64      1%    = 508.78

   14     MEAN   = 171.78     S.D.   = 102.99     P(N>=r)= .51340
          99%    = 16.718     75%    = 91.630     10%    = 311.85
          95%    = 34.919     50%    = 156.64      5%    = 362.16
          90%    = 50.982     25%    = 234.35      1%    = 466.56

   15     MEAN   = 159.01     S.D.   = 94.235     P(N>=r)= .46594
          99%    = 16.153     75%    = 86.056     10%    = 287.10
          95%    = 33.443     50%    = 145.15      5%    = 333.36
          90%    = 48.521     25%    = 215.98      1%    = 429.28
```

E) The mean of the potential = 7203.4

PETRIMES MODULE PSUM

```
MONTE CARLO SUM SIMULATION
POOL SIZE DISTRIBUTION
**************************

UAI        C5460101
PLAY       South Delta-Paleozoic gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   TUE, JAN 23, 2001, 10:39 AM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE IN DATA BASE ?   >    Y
   OIL (O) OR GAS (G) ?                  >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO USE MPRO OUTPUT?       >    Y
   DO YOU ASSUME LOGNORMAL DISTRIBUTION? >    Y
   DO YOU WANT TO USE PPSD OUTPUT?       >    Y
   DO YOU COMPUTE CONDITIONAL POTENTIAL? >    N

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   -------------------------------
   Summary      mu     = 5.5676     MEAN   = 498.85
   Statistics   sig. sq= 1.2895     S.D.   = 809.13

   Upper        99.99% = 3.8362     60.00% = 196.35     15.00% = 849.37
   Percentiles  99.00% = 18.651     55.00% = 226.99     10.00% = 1122.0
                95.00% = 40.438     50.00% = 261.80      8.00% = 1290.9
                90.00% = 61.088     45.00% = 301.95      6.00% = 1530.1
                85.00% = 80.694     40.00% = 349.07      5.00% = 1694.9
                80.00% = 100.67     35.00% = 405.50      4.00% = 1911.3
                75.00% = 121.71     30.00% = 474.88      2.00% = 2696.5
                70.00% = 144.33     25.00% = 563.12      1.00% = 3674.8
                65.00% = 169.02     20.00% = 680.81       .01% = 17867.

C) NO. OF POOLS DISTRIBUTION
   ------------------------------
   Lower Support     =    0
   Upper Support     =   49
   Expectation       =     15.10272
   Standard Deviation=      7.24418


D) Summary Statistics for 4000 Simulations
   --------------------------------------

   Play Resource:    (  B cu m    )
   ------------------------------
     Minimum     = .1544554    Maximum           = 33.45845
     Expectation = 7.523363    Standard Deviation= 4.663376

   EMPERICAL DISTRIBUTION:
   ----------------------
```

Greater than Percentage	Play Potential
100.00	.15446
99.00	.87468
95.00	1.6994
90.00	2.3555
85.00	2.9483
80.00	3.4788
75.00	3.9972
70.00	4.5850
65.00	5.0365
60.00	5.5197
55.00	6.0653
50.00	6.6614
45.00	7.2674
40.00	7.8857
35.00	8.5103
30.00	9.2216
25.00	10.064
20.00	11.098
15.00	12.215
10.00	13.715
8.00	14.470
6.00	15.512
5.00	16.536
4.00	17.344
2.00	19.535
1.00	21.752
.01	33.164
.00	33.429

PETRIMES MODULE PPPS

PLAY POTENTIAL CONDITION ON
TOTAL SUM OF DISCOVERED RESERVE
```
******************************

UAI        C5460101
PLAY       South Delta-Paleozoic gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   TUE, JAN 23, 2001, 10:41 AM
```

USER SUPPLIED PARAMETERS
```
------------------------
   DO YOU WANT TO STORE IN DATA BASE?  >    Y
   OIL (O) OR GAS (G)?                 >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT?>   SI
   RECOVERABLE RESOURCES?              >    N
   CONDITION VALUE AND ITS UNIT?       >    311.00     19
```

A) Basic Information
```
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)
```

B) PLAY RESOURCE DISTRIBUTION
```
   -----------------------------

   Summary      MEAN   = 7.5234     S.D.   = 4.6634
   Statistics   B cu m

   Upper       100.00% = .15446     55.00% = 6.0653      8.00% = 14.470
   Percentiles  99.00% = .87468     50.00% = 6.6614      6.00% = 15.512
                95.00% = 1.6994     45.00% = 7.2674      5.00% = 16.536
                90.00% = 2.3555     40.00% = 7.8857      4.00% = 17.344
                85.00% = 2.9483     35.00% = 8.5103      2.00% = 19.535
                80.00% = 3.4788     30.00% = 9.2216      1.00% = 21.752
                75.00% = 3.9972     25.00% = 10.064       .01% = 33.164
                70.00% = 4.5850     20.00% = 11.098       .00% = 33.429
                65.00% = 5.0365     15.00% = 12.215
                60.00% = 5.5197     10.00% = 13.715
```

C) Summary Statistics for 5000 Simulations

-------**-------------------------------

Play Potential: (B cu m)

Minimum = .1047840E-01Maximum = 32.41308
Expectation = 7.279167 Standard Deviation= 4.818757

EMPERICAL DISTRIBUTION:

Greater than Percentage	Play Potential
100.00	.10478E-01
99.00	.60054
95.00	1.3824
90.00	2.0107
85.00	2.5747
80.00	3.1288
75.00	3.6557
70.00	4.2706
65.00	4.7228
60.00	5.1871
55.00	5.8006
50.00	6.3701
45.00	7.0142
40.00	7.6513
35.00	8.2200
30.00	8.9133
25.00	9.8504
20.00	10.863
15.00	12.036
10.00	13.482
8.00	14.405
6.00	15.598
5.00	16.573
4.00	17.544
2.00	19.687
1.00	21.719
.01	32.318
.00	32.404

PETRIMES MODULE PPSD

PROSPECT OR POOL SIZE DISTRIBUTION USING LOGNORMAL OR MONTE CARLO SIMULATION
****

UAI C54E0101
PLAY Herschel oil play
Assessor Peter Hannigan
Geologist Peter Hannigan
Remarks Yukon North Slope Hydrocarbon Assessment Project
Run date FRI, JAN 26, 2001, 12:08 PM

USER SUPPLIED PARAMETERS

DO YOU WANT TO STORE ON DB? > Y
OIL (O) OR GAS (G) ? > O
BRITISH OR S.I. UNIT OF MEASUREMENT? > SI
RECOVERABLE RESOURCES? > N
DO YOU WANT TO HONOR A PERCENTILE? > Y
UPPER PERCENTILE TO BE HONORED? > .10000E-01

A) Basic Information

TYPE OF RESOURCE =Oil In-place
SYSTEM OF MEASUREMENT =S.I.
UNIT OF MEASUREMENT =M cu m (19)

B) Input Constant(s)

No input constant.

C) Summary

Variable	Lognormal Approximation		
IN-PLACE	mu = 1.7330	MEAN = 9.0178	
POOL SIZE	sig. sq= .93241	S.D. = 11.193	
(DERIVED)	99.99% = .15596	60.00% = 4.4298	15.00% = 15.391
	99.00% = .59848	55.00% = 5.0111	10.00% = 19.501
	95.00% = 1.1557	50.00% = 5.6576	8.00% = 21.972
	90.00% = 1.6413	45.00% = 6.3875	6.00% = 25.389
	85.00% = 2.0797	40.00% = 7.2256	5.00% = 27.696
	80.00% = 2.5101	35.00% = 8.2077	4.00% = 30.676
	75.00% = 2.9497	30.00% = 9.3874	2.00% = 41.105
	70.00% = 3.4097	25.00% = 10.851	1.00% = 53.482
	65.00% = 3.8998	20.00% = 12.752	.01% = 205.23

D) Pool Size Equation

NO. OF GEO-VARIABLES= 6

POOL SIZE = 1.00000
* AREA OF POOL * NET PAY * POROSITY * HYDROCARBON SATURATION
* OIL FRACTION OIL FMN VOLUME FACTOR

```
GEOLOGICAL VARIABLES
--------------------
A) Variables Used
   --------------

   VARIABLE     UNIT OF      O/G VERSION TYPE NO. OF   UAI
                MEASUREMENT                 POINTS
                SYMBOL                      USED

   AREA OF          sq km    Oil    1      2      4   C54E0101
   POOL

   NET PAY            m      Oil    1      2      4   C54E0101

   POROSITY       dec  fr    Oil    1      2      4   C54E0101

   HYDROCARBON    dec  fr    Oil    1      2      4   C54E0101
   SATURATION

   OIL FRACTION   dec  fr    Oil    1      2      4   C54E0101

   OIL FMN                   Oil    1      2      4   C54E0101
   VOLUME
   FACTOR

B) Summary
   -------

   Variable                      Lognormal Approximation

   AREA OF      mu     = 1.6094     MEAN   = 6.0505
   POOL         sig. sq= .38140     S.D.   = 4.1229
                99.99% = .50292     60.00% = 4.2758     15.00% = 9.4831
                99.00% = 1.1886     55.00% = 4.6266     10.00% = 11.033
                95.00% = 1.8105     50.00% = 5.0000      8.00% = 11.908
                90.00% = 2.2659     45.00% = 5.4035      6.00% = 13.061
                85.00% = 2.6363     40.00% = 5.8468      5.00% = 13.808
                80.00% = 2.9733     35.00% = 6.3433      4.00% = 14.741
                75.00% = 3.2966     30.00% = 6.9122      2.00% = 17.775
                70.00% = 3.6168     25.00% = 7.5836      1.00% = 21.034
                65.00% = 3.9412     20.00% = 8.4081       .01% = 49.710

   NET PAY      mu     = 3.6889     MEAN   = 50.320
                sig. sq= .45903     S.D.   = 38.406
                99.99% = 3.2193     60.00% = 33.691     15.00% = 80.728
                99.00% = 8.2708     55.00% = 36.735     10.00% = 95.312
                95.00% = 13.124     50.00% = 40.000      8.00% = 103.63
                90.00% = 16.787     45.00% = 43.555      6.00% = 114.69
                85.00% = 19.820     40.00% = 47.490      5.00% = 121.91
                80.00% = 22.616     35.00% = 51.932      4.00% = 130.97
                75.00% = 25.328     30.00% = 57.064      2.00% = 160.83
                70.00% = 28.039     25.00% = 63.172      1.00% = 193.45
                65.00% = 30.809     20.00% = 70.746       .01% = 497.00

   POROSITY     mu     =-1.7720     MEAN   = .17247
                sig. sq= .28812E-01 S.D.   = .29487E-01
                99.99% = .90426E-01 60.00% = .16284     15.00% = .20270
                99.00% = .11454     55.00% = .16641     10.00% = .21131
                95.00% = .12859     50.00% = .17000      8.00% = .21579
                90.00% = .13677     45.00% = .17367      6.00% = .22134
                85.00% = .14258     40.00% = .17747      5.00% = .22475
                80.00% = .14737     35.00% = .18149      4.00% = .22883
                75.00% = .15161     30.00% = .18583      2.00% = .24091
                70.00% = .15552     25.00% = .19062      1.00% = .25231
                65.00% = .15924     20.00% = .19611       .01% = .31960

   HYDROCARBON  mu     =-.65393     MEAN   = .52058
   SATURATION   sig. sq= .22286E-02 S.D.   = .24589E-01
                99.99% = .43627     60.00% = .51382     15.00% = .54608
                99.00% = .46592     55.00% = .51692     10.00% = .55243
                95.00% = .48115     50.00% = .52000      8.00% = .55566
                90.00% = .48947     45.00% = .52309      6.00% = .55960
                85.00% = .49517     40.00% = .52626      5.00% = .56199
                80.00% = .49974     35.00% = .52955      4.00% = .56480
                75.00% = .50370     30.00% = .53303      2.00% = .57294
                70.00% = .50728     25.00% = .53682      1.00% = .58036
                65.00% = .51063     20.00% = .54108       .01% = .61980

   OIL FRACTION mu     =-.91629     MEAN   = .41225
                sig. sq= .60332E-01 S.D.   = .10281
                99.99% = .16045     60.00% = .37587     15.00% = .51597
                99.00% = .22589     55.00% = .38784     10.00% = .54798
                95.00% = .26705     50.00% = .40000      8.00% = .56486
                90.00% = .29198     45.00% = .41254      6.00% = .58602
                85.00% = .31010     40.00% = .42568      5.00% = .59913
                80.00% = .32530     35.00% = .43971      4.00% = .61491
                75.00% = .33893     30.00% = .45499      2.00% = .66243
                70.00% = .35166     25.00% = .47207      1.00% = .70831
                65.00% = .36388     20.00% = .49186       .01% = .99720

   OIL FMN      mu     = .22314     MEAN   = 1.2504
   VOLUME       sig. sq= .60560E-03 S.D.   = .30775E-01
   FACTOR       99.99% = 1.1407     60.00% = 1.2422     15.00% = 1.2823
                99.00% = 1.1804     55.00% = 1.2461     10.00% = 1.2901
                95.00% = 1.2004     50.00% = 1.2500      8.00% = 1.2940
                90.00% = 1.2112     45.00% = 1.2539      6.00% = 1.2988
                85.00% = 1.2185     40.00% = 1.2578      5.00% = 1.3016
                80.00% = 1.2244     35.00% = 1.2619      4.00% = 1.3050
                75.00% = 1.2294     30.00% = 1.2662      2.00% = 1.3148
                70.00% = 1.2340     25.00% = 1.2709      1.00% = 1.3236
                65.00% = 1.2382     20.00% = 1.2762       .01% = 1.3698

C) Covariance Matrix
   -----------------

   VARIABLE

   AREA OF           .38140
   POOL

   NET PAY           .00000     .45903

   POROSITY          .00000     .00000     .02881

   HYDROCARBON       .00000     .00000     .00000     .00223
   SATURATION

   OIL FRACTION      .00000     .00000     .00000     .00000     .06033

   OIL FMN           .00000     .00000     .00000     .00000     .00000
   VOLUME
   FACTOR


   VARIABLE

   OIL FMN           .00061
   VOLUME
   FACTOR
```

D) Correlation Matrix

VARIABLE					
AREA OF POOL	1.00000				
NET PAY	.00000	1.00000			
POROSITY	.00000	.00000	1.00000		
HYDROCARBON SATURATION	.00000	.00000	.00000	1.00000	
OIL FRACTION	.00000	.00000	.00000	.00000	1.00000
OIL FMN VOLUME FACTOR	.00000	.00000	.00000	.00000	.00000

VARIABLE	
OIL FMN VOLUME FACTOR	1.00000

PETRIMES MODULE MPRO

NO. OF POOLS DISTRIBUTION AND RISKS
****

UAI C54E0101
PLAY Herschel oil play
Assessor Peter Hannigan
Geologist Peter Hannigan
Remarks Yukon North Slope Hydrocarbon Assessment Project
Run date FRI, JAN 26, 2001, 12:09 PM

USER SUPPLIED PARAMETERS

DO YOU WANT TO STORE ON DB? > Y
OIL (O) OR GAS (G) ? > O

A) Risks

	GEOLOGICAL FACTOR		MARGINAL PROBABILITY
PLAY LEVEL	Overall Play Level Risk	=	1.00
PROSPECT LEVEL	Presence of Closure	(1)	.70
	Presence of Porosity	(3)	.90
	Adequate Seal	(4)	.60
	Adequate Timing	(5)	.80
	Adequate Source	(6)	.70
	Adequate Preservation	(8)	.80
	Overall Prospect Level Risk	=	.17
EXPLORATION RISK:		=	.17

B) No. of Prospects Distribution

Minimum = 10
Maximum = 50
Mean = 27.92
S.D. = 11.72

Frequency	No. of Prospects
99.00	10
95	12
90	13
80	16
75	18
60	22
50	25
40	30
25	38
20	40
10	45
5	48
1	50
0	50

C) No. of Pools Distribution

Minimum = 0
Maximum = 21
Mean = 4.73
S.D. = 2.80

Frequency	No. of Pools
97.40	0
95	1
90	1
80	2
75	3
60	4
50	4
40	5
25	6
20	7
10	9
5	10
1	12
0	21

Note: The no. of pools distribution is saved in the database with UDI= 6201OB4

PETRIMES MODULE PSRK

```
INDIVIDUAL POOL SIZES BY RANK
WHERE N IS A RANDOM VARIABLE
*****************************

UAI        C54E0101
PLAY       Herschel oil play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, JAN 26, 2001, 12:10 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB ?          > Y
   DO YOU WANT TO USE MPRO OUTPUT?       > Y
   MIN. AND MAX. POOL RANKS?             >      1     5
   DO YOU USE LOGNORNAL ASSUMPTION?      > Y
   DO YOU WANT TO USE PPSD OUTPUT?       > Y

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Oil In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   --------------------------------
   Summary      mu     = 1.7330     MEAN   = 9.0178
   Statistics   sig. sq= .93241     S.D.   = 11.193

   Upper        99.99% = .15596     60.00% = 4.4298     15.00% = 15.391
   Percentiles  99.00% = .59848     55.00% = 5.0111     10.00% = 19.501
                95.00% = 1.1557     50.00% = 5.6576      8.00% = 21.972
                90.00% = 1.6413     45.00% = 6.3875      6.00% = 25.389
                85.00% = 2.0797     40.00% = 7.2256      5.00% = 27.696
                80.00% = 2.5101     35.00% = 8.2077      4.00% = 30.676
                75.00% = 2.9497     30.00% = 9.3874      2.00% = 41.105
                70.00% = 3.4097     25.00% = 10.851      1.00% = 53.482
                65.00% = 3.8998     20.00% = 12.752       .01% = 205.23

C) No. of Pools Distribution
   -------------------------
   Lower Support     =   0
   Upper Support     =  21
   Expectation       =   4.73
   Standard Deviation=   2.80

D) Pool Sizes By Rank
   ------------------

   Pool Rank                      Distribution

        1     MEAN   = 20.290     S.D.   = 18.379     P(N>=r)= .97399
              99%    = 1.6600     75%    = 9.2188     10%    = 39.684
              95%    = 3.7164     50%    = 15.499      5%    = 52.367
              90%    = 5.3906     25%    = 25.345      1%    = 90.150

        2     MEAN   = 10.240     S.D.   = 7.3619     P(N>=r)= .89343
              99%    = .96181     75%    = 5.1390     10%    = 19.342
              95%    = 2.0305     50%    = 8.5941      5%    = 23.977
              90%    = 2.9513     25%    = 13.382      1%    = 35.835

        3     MEAN   = 6.9831     S.D.   = 4.7122     P(N>=r)= .76446
              99%    = .72994     75%    = 3.5827     10%    = 13.058
              95%    = 1.4571     50%    = 5.9920      5%    = 15.878
              90%    = 2.0780     25%    = 9.2387      1%    = 22.637

        4     MEAN   = 5.3403     S.D.   = 3.4743     P(N>=r)= .61665
              99%    = .61565     75%    = 2.7948     10%    = 9.8998
              95%    = 1.1827     50%    = 4.6277      5%    = 11.927
              90%    = 1.6555     25%    = 7.0817      1%    = 16.619

        5     MEAN   = 4.3322     S.D.   = 2.7386     P(N>=r)= .47506
              99%    = .54402     75%    = 2.3146     10%    = 7.9583
              95%    = 1.0163     50%    = 3.7785      5%    = 9.5351
              90%    = 1.4008     25%    = 5.7350      1%    = 13.111

E) The mean of the potential =  39.601
```

PETRIMES MODULE PSUM

```
MONTE CARLO SUM SIMULATION
POOL SIZE DISTRIBUTION
*************************

UAI        C54E0101
PLAY       Herschel oil play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, JAN 26, 2001, 12:13 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE IN DATA BASE ?   >    Y
   OIL (O) OR GAS (G) ?                  >    O
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO USE MPRO OUTPUT?       >    Y
   DO YOU ASSUME LOGNORMAL DISTRIBUTION? >    Y
   DO YOU WANT TO USE PPSD OUTPUT?       >    Y
   DO YOU COMPUTE CONDITIONAL POTENTIAL? >    N

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Oil In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   --------------------------------
   Summary      mu     = 1.7330     MEAN   = 9.0178
   Statistics   sig. sq= .93241     S.D.   = 11.193

   Upper        99.99% = .15596     60.00% = 4.4298     15.00% = 15.391
   Percentiles  99.00% = .59848     55.00% = 5.0111     10.00% = 19.501
                95.00% = 1.1557     50.00% = 5.6576      8.00% = 21.972
                90.00% = 1.6413     45.00% = 6.3875      6.00% = 25.389
                85.00% = 2.0797     40.00% = 7.2256      5.00% = 27.696
                80.00% = 2.5101     35.00% = 8.2077      4.00% = 30.676
                75.00% = 2.9497     30.00% = 9.3874      2.00% = 41.105
                70.00% = 3.4097     25.00% = 10.851      1.00% = 53.482
                65.00% = 3.8998     20.00% = 12.752       .01% = 205.23
```

```
C) NO. OF POOLS DISTRIBUTION
   ------------------------------
   Lower Support     =    0
   Upper Support     =   21
   Expectation       =      4.72808
   Standard Deviation=      2.80484


D) Summary Statistics for 4000 Simulations
   ---------------------------------------

   Play Resource:    (    M cu m  )
   ------------------------------
     Minimum     = .0000000E+00Maximum           = 349.0305
     Expectation = 42.40630    Standard Deviation= 34.55067

   EMPERICAL DISTRIBUTION:
   ----------------------
     Greater than    Play
     Percentage      Potential
     ------------    -----------
        100.00          .00000E+00
         95.00         2.7805
         90.00         6.8992
         85.00         10.490
         80.00         13.667
         75.00         16.913
         70.00         20.214
         65.00         23.473
         60.00         27.095
         55.00         30.753
         50.00         34.605
         45.00         38.698
         40.00         43.242
         35.00         48.156
         30.00         52.590
         25.00         59.358
         20.00         65.791
         15.00         75.218
         10.00         88.821
          8.00         95.161
          6.00         101.91
          5.00         107.90
          4.00         114.67
          2.00         132.80
          1.00         156.25
           .01         324.33
           .00         346.56
```

PETRIMES MODULE PPSD

PROSPECT OR POOL SIZE DISTRIBUTION USING
LOGNORMAL OR MONTE CARLO SIMULATION
```
****************************************
```

```
UAI        C54D0101
PLAY       Herschel gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, JAN 26, 2001, 11:13 AM
```

USER SUPPLIED PARAMETERS

```
-----------------------
   DO YOU WANT TO STORE ON DB?           >    Y
   OIL (O) OR GAS (G) ?                  >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO HONOR A PERCENTILE?    > Y
   UPPER PERCENTILE TO BE HONORED?       > .10000E-01
```

A) Basic Information

```
   ----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)
```

B) Input Constant(s)

```
   ----------------

   No input constant.
```

C) Summary

```
   -------

   Variable                       Lognormal Approximation

   IN-PLACE     mu     = 7.8831     MEAN   = 4163.4
   POOL SIZE    sig. sq= .90202     S.D.   = 5038.5
   (DERIVED)    99.99% = 77.552     60.00% = 2084.9      15.00% = 7096.9
                99.00% = 291.09     55.00% = 2353.7      10.00% = 8957.2
                95.00% = 556.06     50.00% = 2652.0       8.00% = 10072.
                90.00% = 785.19     45.00% = 2988.2       6.00% = 11611.
                85.00% = 991.01     40.00% = 3373.4       5.00% = 12648.
                80.00% = 1192.4     35.00% = 3823.9       4.00% = 13985.
                75.00% = 1397.5     30.00% = 4363.9       2.00% = 18650.
                70.00% = 1611.7     25.00% = 5032.5       1.00% = 24161.
                65.00% = 1839.2     20.00% = 5898.2        .01% = 90689.
```

D) Pool Size Equation

```
   ------------------

   NO. OF GEO-VARIABLES= 6

   POOL SIZE =        1.00000
               * AREA OF      * NET PAY      * POROSITY     * HYDROCARBON
                 POOL                                         SATURATION

               * GAS FRACTION


             -----------------------------------------------------------
                 GAS FMN
                 VOLUME
                 FACTOR
```

GEOLOGICAL VARIABLES
```
--------------------
```
A) Variables Used

```
   --------------

   VARIABLE     UNIT OF      O/G VERSION TYPE NO. OF   UAI
                MEASUREMENT                   POINTS
                SYMBOL                        USED

   AREA OF         sq km    Gas    1      2      4   C54D0101
   POOL

   NET PAY           m      Gas    1      2      4   C54D0101

   POROSITY       dec  fr   Gas    1      2      4   C54D0101

   HYDROCARBON    dec  fr   Gas    1      2      4   C54D0101
   SATURATION

   GAS FRACTION   dec  fr   Gas    1      2      4   C54D0101

   GAS FMN                  Gas    1      2      4   C54D0101
   VOLUME
   FACTOR
```

B) Summary

```
   -------

   Variable                       Lognormal Approximation

   AREA OF      mu     = 1.6094     MEAN   = 6.0505
   POOL         sig. sq= .38140     S.D.   = 4.1229
                99.99% = .50292     60.00% = 4.2758      15.00% = 9.4831
                99.00% = 1.1886     55.00% = 4.6266      10.00% = 11.033
                95.00% = 1.8105     50.00% = 5.0000       8.00% = 11.908
                90.00% = 2.2659     45.00% = 5.4035       6.00% = 13.061
                85.00% = 2.6363     40.00% = 5.8468       5.00% = 13.808
                80.00% = 2.9733     35.00% = 6.3433       4.00% = 14.741
                75.00% = 3.2966     30.00% = 6.9122       2.00% = 17.775
                70.00% = 3.6168     25.00% = 7.5836       1.00% = 21.034
                65.00% = 3.9412     20.00% = 8.4081        .01% = 49.710

   NET PAY      mu     = 3.6889     MEAN   = 50.320
                sig. sq= .45903     S.D.   = 38.406
                99.99% = 3.2193     60.00% = 33.691      15.00% = 80.728
                99.00% = 8.2708     55.00% = 36.735      10.00% = 95.312
                95.00% = 13.124     50.00% = 40.000       8.00% = 103.63
                90.00% = 16.787     45.00% = 43.555       6.00% = 114.69
```

```
              85.00% = 19.820     40.00% = 47.490      5.00% = 121.91
              80.00% = 22.616     35.00% = 51.932      4.00% = 130.97
              75.00% = 25.328     30.00% = 57.064      2.00% = 160.83
              70.00% = 28.039     25.00% = 63.172      1.00% = 193.45
              65.00% = 30.809     20.00% = 70.746       .01% = 497.00

POROSITY      mu     =-1.7720     MEAN   = .17247
              sig. sq= .28812E-01 S.D.   = .29487E-01
              99.99% = .90426E-01 60.00% = .16284     15.00% = .20270
              99.00% = .11454     55.00% = .16641     10.00% = .21131
              95.00% = .12859     50.00% = .17000      8.00% = .21579
              90.00% = .13677     45.00% = .17367      6.00% = .22134
              85.00% = .14258     40.00% = .17747      5.00% = .22475
              80.00% = .14737     35.00% = .18149      4.00% = .22883
              75.00% = .15161     30.00% = .18583      2.00% = .24091
              70.00% = .15552     25.00% = .19062      1.00% = .25231
              65.00% = .15924     20.00% = .19611       .01% = .31960

HYDROCARBON   mu     =-.65393     MEAN   = .52058
SATURATION    sig. sq= .22286E-02 S.D.   = .24589E-01
              99.99% = .43627     60.00% = .51382     15.00% = .54608
              99.00% = .46592     55.00% = .51692     10.00% = .55243
              95.00% = .48115     50.00% = .52000      8.00% = .55566
              90.00% = .48947     45.00% = .52309      6.00% = .55960
              85.00% = .49517     40.00% = .52626      5.00% = .56199
              80.00% = .49974     35.00% = .52955      4.00% = .56480
              75.00% = .50370     30.00% = .53303      2.00% = .57294
              70.00% = .50728     25.00% = .53682      1.00% = .58036
              65.00% = .51063     20.00% = .54108       .01% = .61980

GAS FRACTION  mu     =-.51083     MEAN   = .60565
              sig. sq= .18756E-01 S.D.   = .83335E-01
              99.99% = .36054     60.00% = .57954     15.00% = .69151
              99.00% = .43630     55.00% = .58976     10.00% = .71511
              95.00% = .47898     50.00% = .60000      8.00% = .72731
              90.00% = .50342     45.00% = .61042      6.00% = .74238
              85.00% = .52060     40.00% = .62118      5.00% = .75159
              80.00% = .53468     35.00% = .63251      4.00% = .76257
              75.00% = .54706     30.00% = .64468      2.00% = .79488
              70.00% = .55842     25.00% = .65806      1.00% = .82512
              65.00% = .56916     20.00% = .67330       .01% = .99850

GAS FMN       mu     =-5.5215     MEAN   = .40236E-02
VOLUME        sig. sq= .11789E-01 S.D.   = .43816E-03
FACTOR        99.99% = .26711E-02 60.00% = .38915E-02 15.00% = .44764E-02
              99.00% = .31072E-02 55.00% = .39458E-02 10.00% = .45972E-02
              95.00% = .33458E-02 50.00% = .40000E-02  8.00% = .46592E-02
              90.00% = .34804E-02 45.00% = .40549E-02  6.00% = .47356E-02
              85.00% = .35743E-02 40.00% = .41116E-02  5.00% = .47821E-02
              80.00% = .36507E-02 35.00% = .41709E-02  4.00% = .48374E-02
              75.00% = .37175E-02 30.00% = .42344E-02  2.00% = .49992E-02
              70.00% = .37786E-02 25.00% = .43039E-02  1.00% = .51494E-02
              65.00% = .38361E-02 20.00% = .43827E-02   .01% = .59900E-02
```

C) Covar*iance Matrix

```
   -----------------

   VARIABLE

   AREA OF          .38140
   POOL

   NET PAY          .00000     .45903

   POROSITY         .00000     .00000     .02881

   HYDROCARBON      .00000     .00000     .00000     .00223
   SATURATION

   GAS FRACTION     .00000     .00000     .00000     .00000     .01876

   GAS FMN          .00000     .00000     .00000     .00000     .00000
   VOLUME
   FACTOR



   VARIABLE

   GAS FMN          .01179
   VOLUME
   FACTOR
```

D) Correlation Matrix

```
   ------------------

   VARIABLE

   AREA OF       1.00000
   POOL

   NET PAY        .00000    1.00000

   POROSITY       .00000     .00000    1.00000

   HYDROCARBON    .00000     .00000     .00000    1.00000
   SATURATION

   GAS FRACTION   .00000     .00000     .00000     .00000    1.00000

   GAS FMN        .00000     .00000     .00000     .00000     .00000
   VOLUME
   FACTOR



   VARIABLE

   GAS FMN       1.00000
   VOLUME
   FACTOR
```

PETRIMES MODULE MPRO

```
NO. OF POOLS DISTRIBUTION AND RISKS
**********************************

UAI        C54D0101
PLAY       Herschel gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, JAN 26, 2001, 12:26 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB?           >    Y
   OIL (O) OR GAS (G) ?                  >    G


A) Risks
   -----

                  GEOLOGICAL FACTOR               MARGINAL PROBABILITY
                  -----------------               --------------------

   PLAY LEVEL     Overall Play Level Risk        =       1.00

   PROSPECT LEVEL Presence of Closure          ( 1)       .70
                  Adequate Seal                ( 4)       .90
                  Adequate Timing              ( 5)       .60
                  Adequate Source              ( 6)       .80
                  Adequate Maturation          ( 7)       .70
                  Adequacy of Recovery         ( 9)       .80
                  ----------------------------------------------------
                  Overall Prospect Level Risk    =        .17

   EXPLORATION RISK:                             =        .17
```

```
B) No. of Prospects Distribution
   ----------------------------

   Minimum       =    10
   Maximum       =    50
   Mean          =   27.92
   S.D.          =   11.72

   Frequency   No. of Prospects
   ---------   ----------------

     99.00          10
       95           12
       90           13
       80           16
       75           18
       60           22
       50           25
       40           30
       25           38
       20           40
       10           45
        5           48
        1           50
        0           50
```

```
C) No. of Pools Distribution
   -------------------------

   Minimum       =     0
   Maximum       =    21
   Mean          =    4.73
   S.D.          =    2.80

Frequency   No. of Pools
---------   ------------
    97.40           0
      95            1
      90            1
      80            2
      75            3
      60            4
      50            4
      40            5
      25            6
      20            7
      10            9
       5           10
       1           12
       0           21
```

Note: The no. of pools distribution is saved in the database with UDI= 6201GB4

PETRIMES MODULE PSRK

```
INDIVIDUAL POOL SIZES BY RANK
WHERE N IS A RANDOM VARIABLE
*****************************

UAI        C54D0101
PLAY       Herschel gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, JAN 26, 2001, 12:27 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB ?          > Y
   DO YOU WANT TO USE MPRO OUTPUT?       > Y
   MIN. AND MAX. POOL RANKS?             >      1     5
   DO YOU USE LOGNORNAL ASSUMPTION?      > Y
   DO YOU WANT TO USE PPSD OUTPUT?       > Y

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   --------------------------------
   Summary      mu      = 7.8831     MEAN   = 4163.4
   Statistics   sig. sq= .90202      S.D.   = 5038.5

   Upper        99.99% = 77.552      60.00% = 2084.9     15.00% = 7096.9
   Percentiles  99.00% = 291.09      55.00% = 2353.7     10.00% = 8957.2
                95.00% = 556.06      50.00% = 2652.0      8.00% = 10072.
                90.00% = 785.19      45.00% = 2988.2      6.00% = 11611.
                85.00% = 991.01      40.00% = 3373.4      5.00% = 12648.
                80.00% = 1192.4      35.00% = 3823.9      4.00% = 13985.
                75.00% = 1397.5      30.00% = 4363.9      2.00% = 18650.
                70.00% = 1611.7      25.00% = 5032.5      1.00% = 24161.
                65.00% = 1839.2      20.00% = 5898.2       .01% = 90689.

C) No. of Pools Distribution
   -------------------------
   Lower Support     =   0
   Upper Support     =  21
   Expectation       =   4.73
   Standard Deviation=   2.80
```

D) Pool Sizes By Rank

```
   ------------------

   Pool Rank                    Distribution

        1     MEAN   = 9269.1     S.D.   = 8208.5     P(N>=r)= .97399
              99%    = 793.97     75%    = 4286.8     10%    = 18016.
              95%    = 1754.1     50%    = 7145.8      5%    = 23666.
              90%    = 2528.8     25%    = 11591.      1%    = 40378.

        2     MEAN   = 4736.3     S.D.   = 3343.4     P(N>=r)= .89343
              99%    = 464.17     75%    = 2412.7     10%    = 8885.1
              95%    = 967.94     50%    = 4000.9      5%    = 10976.
              90%    = 1398.3     25%    = 6184.8      1%    = 16296.

        3     MEAN   = 3251.1     S.D.   = 2156.4     P(N>=r)= .76446
              99%    = 353.87     75%    = 1692.0     10%    = 6037.4
              95%    = 698.41     50%    = 2806.1      5%    = 7317.5
              90%    = 990.25     25%    = 4295.9      1%    = 10372.

        4     MEAN   = 2497.8     S.D.   = 1597.8     P(N>=r)= .61665
              99%    = 299.30     75%    = 1325.3     10%    = 4598.1
              95%    = 568.84     50%    = 2176.4      5%    = 5522.6
              90%    = 791.83     25%    = 3307.3      1%    = 7653.6

        5     MEAN   = 2033.5     S.D.   = 1264.1     P(N>=r)= .47506
              99%    = 265.01     75%    = 1101.0     10%    = 3709.6
              95%    = 490.02     50%    = 1783.0      5%    = 4431.4
              90%    = 671.85     25%    = 2687.7      1%    = 6061.7
```

E) The mean of the potential = 18251.

PETRIMES MODULE PSUM

```
MONTE CARLO SUM SIMULATION
POOL SIZE DISTRIBUTION
**************************

UAI        C54D0101
PLAY       Herschel gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, JAN 26, 2001, 12:28 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE IN DATA BASE ?   >    Y
   OIL (O) OR GAS (G) ?                  >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO USE MPRO OUTPUT?       >    Y
   DO YOU ASSUME LOGNORMAL DISTRIBUTION? >    Y
   DO YOU WANT TO USE PPSD OUTPUT?       >    Y
   DO YOU COMPUTE CONDITIONAL POTENTIAL? >    N

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   -------------------------------
   Summary      mu     = 7.8831     MEAN   = 4163.4
   Statistics   sig. sq= .90202     S.D.   = 5038.5

   Upper        99.99% = 77.552     60.00% = 2084.9     15.00% = 7096.9
   Percentiles  99.00% = 291.09     55.00% = 2353.7     10.00% = 8957.2
                95.00% = 556.06     50.00% = 2652.0      8.00% = 10072.
                90.00% = 785.19     45.00% = 2988.2      6.00% = 11611.
                85.00% = 991.01     40.00% = 3373.4      5.00% = 12648.
                80.00% = 1192.4     35.00% = 3823.9      4.00% = 13985.
                75.00% = 1397.5     30.00% = 4363.9      2.00% = 18650.
                70.00% = 1611.7     25.00% = 5032.5      1.00% = 24161.
                65.00% = 1839.2     20.00% = 5898.2       .01% = 90689.

C) NO. OF POOLS DISTRIBUTION
   -----------------------------
   Lower Support     =    0
   Upper Support     =   21
   Expectation       =      4.72808
   Standard Deviation=      2.80484
```

```
D) Summary Statistics for 4000 Simulations
   --------------------------------------

   Play Resource:    (  B cu m    )
   ------------------------------
     Minimum     = .0000000E+00Maximum           = 154.6978
     Expectation = 19.58015    Standard Deviation= 15.77324

   EMPERICAL DISTRIBUTION:
   ----------------------
     Greater than    Play
     Percentage      Potential
     ------------    -----------
        100.00         .00000E+00
         95.00         1.3186
         90.00         3.2235
         85.00         4.9252
         80.00         6.3871
         75.00         7.9166
         70.00         9.4051
         65.00         10.943
         60.00         12.589
         55.00         14.314
         50.00         16.095
         45.00         17.924
         40.00         20.023
         35.00         22.259
         30.00         24.335
         25.00         27.416
         20.00         30.370
         15.00         34.706
         10.00         40.845
          8.00         43.780
          6.00         46.897
          5.00         49.528
          4.00         52.672
          2.00         60.664
          1.00         71.442
           .01         144.59

           .00         153.69
```

PETRIMES MODULE PPSD

```
PROSPECT OR POOL SIZE DISTRIBUTION USING
LOGNORMAL OR MONTE CARLO SIMULATION
****************************************

UAI        C54K0101
PLAY       Yukon coastal plain gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Operator   Y
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, FEB  2, 2001, 12:00 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB?          >    Y
   OIL (O) OR GAS (G) ?                 >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT? >   SI
   RECOVERABLE RESOURCES?               >    N
   DO YOU WANT TO HONOR A PERCENTILE?   > Y
   UPPER PERCENTILE TO BE HONORED?      > .10000E-01

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Input Constant(s)
   -----------------

   No input constant.

C) Summary
   -------

   Variable                      Lognormal Approximation

   IN-PLACE     mu     = 7.9616     MEAN   = 4871.3
   POOL SIZE    sig. sq= 1.0590     S.D.   = 6685.3
   (DERIVED)    99.99% = 62.459     60.00% = 2210.4     15.00% = 8334.8
                99.00% = 261.82     55.00% = 2520.8     10.00% = 10726.
                95.00% = 527.93     50.00% = 2868.8      8.00% = 12180.
                90.00% = 767.26     45.00% = 3264.8      6.00% = 14209.
                85.00% = 987.40     40.00% = 3723.2      5.00% = 15589.
                80.00% = 1206.6     35.00% = 4264.8      4.00% = 17382.
                75.00% = 1433.0     30.00% = 4921.0      2.00% = 23744.
                70.00% = 1672.4     25.00% = 5742.9      1.00% = 31433.
                65.00% = 1929.7     20.00% = 6820.7       .01% = .13176E+06
```

D) Pool Size Equation

```
------------------

NO. OF GEO-VARIABLES= 6

POOL SIZE =        1.00000
            * AREA OF      * FORMATION    * POROSITY     * TRAP FILL
              CLOSURE        THICKNESS

            * HYDROCARBON
              SATURATION

           ------------------------------------------------------------
              GAS FMN
              VOLUME
              FACTOR
```

GEOLOGICAL VARIABLES

```
--------------------
```

A) Variables Used

```
-------------

VARIABLE     UNIT OF      O/G VERSION TYPE NO. OF   UAI
             MEASUREMENT                   POINTS
             SYMBOL                        USED

AREA OF         sq km    Gas    1      2      4   C54K0101
CLOSURE

FORMATION         m      Gas    1      2      4   C54K0101
THICKNESS

POROSITY       dec  fr   Gas    1      2      4   C54K0101

TRAP FILL      dec  fr   Gas    1      2      4   C54K0101

HYDROCARBON    dec  fr   Gas    1      2      4   C54K0101
SATURATION

GAS FMN                  Gas    1      2      4   C54K0101
VOLUME
FACTOR
```

B) Summary

```
-------

Variable                      Lognormal Approximation

AREA OF      mu     = 2.1972     MEAN   = 12.505
CLOSURE      sig. sq= .65782     S.D.   = 12.063
             99.99% = .44082     60.00% = 7.3283     15.00% = 20.860
             99.00% = 1.3640     55.00% = 8.1279     10.00% = 25.448
             95.00% = 2.3706     50.00% = 9.0000      8.00% = 28.130
             90.00% = 3.1829     45.00% = 9.9656      6.00% = 31.761
             85.00% = 3.8830     40.00% = 11.053      5.00% = 34.168
             80.00% = 4.5477     35.00% = 12.302      4.00% = 37.231
             75.00% = 5.2079     30.00% = 13.771      2.00% = 47.605
             70.00% = 5.8820     25.00% = 15.553      1.00% = 59.385
             65.00% = 6.5844     20.00% = 17.811       .01% = 183.75

FORMATION    mu     = 4.3175     MEAN   = 82.950
THICKNESS    sig. sq= .20151     S.D.   = 39.194
             99.99% = 14.126     60.00% = 66.938     15.00% = 119.43
             99.00% = 26.395     55.00% = 70.886     10.00% = 133.32
             95.00% = 35.842     50.00% = 75.000      8.00% = 140.92
             90.00% = 42.191     45.00% = 79.352      6.00% = 150.72
             85.00% = 47.098     40.00% = 84.034      5.00% = 156.94
             80.00% = 51.402     35.00% = 89.162      4.00% = 164.58
             75.00% = 55.407     30.00% = 94.906      2.00% = 188.56
             70.00% = 59.269     25.00% = 101.52      1.00% = 213.11
             65.00% = 63.087     20.00% = 109.43       .01% = 398.20

POROSITY     mu     =-2.3026     MEAN   = .10226
             sig. sq= .44688E-01 S.D.   = .21861E-01
             99.99% = .45558E-01 60.00% = .94785E-01 15.00% = .12450
             99.00% = .61154E-01 55.00% = .97379E-01 10.00% = .13112
             95.00% = .70630E-01 50.00% = .10000      8.00% = .13458
             90.00% = .76268E-01 45.00% = .10269      6.00% = .13891
             85.00% = .80324E-01 40.00% = .10550      5.00% = .14158
             80.00% = .83701E-01 35.00% = .10849      4.00% = .14479
             75.00% = .86711E-01 30.00% = .11172      2.00% = .15437
             70.00% = .89507E-01 25.00% = .11532      1.00% = .16352
             65.00% = .92177E-01 20.00% = .11947       .01% = .21950

TRAP FILL    mu     =-1.3863     MEAN   = .26788
             sig. sq= .13819     S.D.   = .10312
             99.99% = .62738E-01 60.00% = .22753     15.00% = .36751
             99.00% = .10529     55.00% = .23859     10.00% = .40257
             95.00% = .13564     50.00% = .25000      8.00% = .42148
             90.00% = .15525     45.00% = .26196      6.00% = .44560
             85.00% = .17007     40.00% = .27469      5.00% = .46078
             80.00% = .18284     35.00% = .28850      4.00% = .47926
             75.00% = .19456     30.00% = .30381      2.00% = .53642
             70.00% = .20572     25.00% = .32124      1.00% = .59362
             65.00% = .21664     20.00% = .34183       .01% = .99620

HYDROCARBON  mu     =-.16252     MEAN   = .85038
SATURATION   sig. sq= .88600E-03 S.D.   = .25318E-01
             99.99% = .76093     60.00% = .84361     15.00% = .87663
             99.00% = .79313     55.00% = .84683     10.00% = .88305
             95.00% = .80939     50.00% = .85000      8.00% = .88630
             90.00% = .81819     45.00% = .85319      6.00% = .89026
             85.00% = .82418     40.00% = .85643      5.00% = .89265
             80.00% = .82897     35.00% = .85981      4.00% = .89547
             75.00% = .83311     30.00% = .86337      2.00% = .90358
             70.00% = .83684     25.00% = .86724      1.00% = .91094
             65.00% = .84031     20.00% = .87156       .01% = .94950

GAS FMN      mu     =-5.2983     MEAN   = .50399E-02
VOLUME       sig. sq= .15887E-01 S.D.   = .63777E-03
FACTOR       99.99% = .31289E-02 60.00% = .48429E-02 15.00% = .56978E-02
             99.00% = .37293E-02 55.00% = .49214E-02 10.00% = .58765E-02
             95.00% = .40638E-02 50.00% = .50000E-02  8.00% = .59687E-02
             90.00% = .42542E-02 45.00% = .50798E-02  6.00% = .60824E-02
             85.00% = .43877E-02 40.00% = .51622E-02  5.00% = .61519E-02
             80.00% = .44968E-02 35.00% = .52488E-02  4.00% = .62345E-02
             75.00% = .45925E-02 30.00% = .53416E-02  2.00% = .64773E-02
             70.00% = .46802E-02 25.00% = .54437E-02  1.00% = .67037E-02
             65.00% = .47630E-02 20.00% = .55596E-02   .01% = .79900E-02
```

```
C) Covariance Matrix
   -----------------

   VARIABLE

   AREA OF          .65782
   CLOSURE

   FORMATION        .00000     .20151
   THICKNESS

   POROSITY         .00000     .00000     .04469

   TRAP FILL        .00000     .00000     .00000     .13819

   HYDROCARBON      .00000     .00000     .00000     .00000     .00089
   SATURATION

   GAS FMN          .00000     .00000     .00000     .00000     .00000
   VOLUME
   FACTOR


   VARIABLE

   GAS FMN          .01589
   VOLUME
   FACTOR

D) Correlation Matrix
   ------------------

   VARIABLE

   AREA OF       1.00000
   CLOSURE

   FORMATION      .00000    1.00000
   THICKNESS

   POROSITY       .00000     .00000    1.00000

   TRAP FILL      .00000     .00000     .00000    1.00000

   HYDROCARBON    .00000     .00000     .00000     .00000    1.00000
   SATURATION

   GAS FMN        .00000     .00000     .00000     .00000     .00000
   VOLUME
   FACTOR


   VARIABLE

   GAS FMN       1.00000
   VOLUME

   FACTOR
```

PETRIMES MODULE MPRO

```
NO. OF POOLS DISTRIBUTION AND RISKS
***********************************

UAI        C54K0101
PLAY       Yukon coastal plain gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, FEB  2, 2001, 11:47 AM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB?          >    Y
   OIL (O) OR GAS (G) ?                 >    G


A) Risks
   -----

               GEOLOGICAL FACTOR              MARGINAL PROBABILITY
               -----------------              --------------------

   PLAY LEVEL     Overall Play Level Risk       =       1.00

   PROSPECT LEVEL Presence of Closure         ( 1)       .70
                  Presence of Porosity        ( 3)       .65
                  Adequate Seal               ( 4)       .80
                  Adequate Timing             ( 5)       .60
                  Adequate Source             ( 6)       .80
                  Adequate Preservation       ( 8)       .60
                  ----------------------------------------------------
                  Overall Prospect Level Risk    =       .10

   EXPLORATION RISK:                             =       .10


B) No. of Prospects Distribution
   -----------------------------

   Minimum      =     5
   Maximum      =    40
   Mean         =   24.15
   S.D.         =   10.25

   Frequency    No. of Prospects
   ---------    ----------------
     99.00            5
       95             7
       90             9
       80            13
       75            15
       60            21
       50            25
       40            28
       25            33
       20            34
       10            37
        5            39
        1            40
        0            40


C) No. of Pools Distribution
   -------------------------

   Minimum      =     0
   Maximum      =    14
   Mean         =    2.53
   S.D.         =    1.85

   Frequency    No. of Pools
   ---------    ------------
     87.27            0
       80             1
       75             1
       60             2
       50             2
       40             3
       25             4
       20             4
       10             5
        5             6
        1             8
        0            14

Note: The
no. of pools
distribution is
saved in the
database with
UDI= 6201GB4
```

PETRIMES MODULE PSRK

```
INDIVIDUAL POOL SIZES BY RANK
WHERE N IS A RANDOM VARIABLE
*****************************
UAI        C54K0101
PLAY       Yukon coastal plain gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, FEB  2, 2001, 12:02 PM

USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE ON DB ?         > Y
   DO YOU WANT TO USE MPRO OUTPUT?      > Y
   MIN. AND MAX. POOL RANKS?            >      1     3
   DO YOU USE LOGNORNAL ASSUMPTION?     > Y
   DO YOU WANT TO USE PPSD OUTPUT?      > Y

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   --------------------------------
   Summary      mu     = 7.9616     MEAN   = 4871.3
   Statistics   sig. sq= 1.0590     S.D.   = 6685.3
   Upper        99.99% = 62.459     60.00% = 2210.4     15.00% = 8334.8
   Percentiles  99.00% = 261.82     55.00% = 2520.8     10.00% = 10726.
                95.00% = 527.93     50.00% = 2868.8      8.00% = 12180.
                90.00% = 767.26     45.00% = 3264.8      6.00% = 14209.
                85.00% = 987.40     40.00% = 3723.2      5.00% = 15589.
                80.00% = 1206.6     35.00% = 4264.8      4.00% = 17382.
                75.00% = 1433.0     30.00% = 4921.0      2.00% = 23744.
                70.00% = 1672.4     25.00% = 5742.9      1.00% = 31433.
                65.00% = 1929.7     20.00% = 6820.7       .01% = .13176E+06

C) No. of Pools Distribution
   -------------------------
   Lower Support     =   0
   Upper Support     =  14
   Expectation       =   2.53
   Standard Deviation=   1.85

D) Pool Sizes By Rank
   ------------------
   Pool Rank                      Distribution
        1     MEAN   = 8704.3     S.D.   = 9663.2     P(N>=r)= .87266
              99%    = 475.24     75%    = 3186.3     10%    = 18198.
              95%    = 1092.3     50%    = 5998.4      5%    = 25009.
              90%    = 1670.0     25%    = 10790.      1%    = 46181.
        2     MEAN   = 3994.3     S.D.   = 3404.2     P(N>=r)= .66507
              99%    = 311.26     75%    = 1717.3     10%    = 8047.4
              95%    = 647.01     50%    = 3093.3      5%    = 10348.
              90%    = 946.04     25%    = 5211.9      1%    = 16478.
        3     MEAN   = 2601.7     S.D.   = 2023.4     P(N>=r)= .45238
              99%    = 245.65     75%    = 1194.3     10%    = 5132.0
              95%    = 483.20     50%    = 2085.8      5%    = 6457.0
              90%    = 685.68     25%    = 3422.8      1%    = 9775.8


E) The mean of the potential =  11429.
```

PETRIMES MODULE PSUM

```
MONTE CARLO SUM SIMULATION
POOL SIZE DISTRIBUTION
**************************

UAI        C54K0101
PLAY       Yukon coastal plain gas play
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, FEB  2, 2001, 12:03 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE IN DATA BASE ?   >    Y
   OIL (O) OR GAS (G) ?                  >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU WANT TO USE MPRO OUTPUT?       >    Y
   DO YOU ASSUME LOGNORMAL DISTRIBUTION? >    Y
   DO YOU WANT TO USE PPSD OUTPUT?       >    Y
   DO YOU COMPUTE CONDITIONAL POTENTIAL? >    N

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) Lognormal Pool Size Distribution
   --------------------------------
   Summary      mu     = 7.9616     MEAN   = 4871.3
   Statistics   sig. sq= 1.0590     S.D.   = 6685.3

   Upper        99.99% = 62.459     60.00% = 2210.4     15.00% = 8334.8
   Percentiles  99.00% = 261.82     55.00% = 2520.8     10.00% = 10726.
                95.00% = 527.93     50.00% = 2868.8      8.00% = 12180.
                90.00% = 767.26     45.00% = 3264.8      6.00% = 14209.
                85.00% = 987.40     40.00% = 3723.2      5.00% = 15589.
                80.00% = 1206.6     35.00% = 4264.8      4.00% = 17382.
                75.00% = 1433.0     30.00% = 4921.0      2.00% = 23744.
                70.00% = 1672.4     25.00% = 5742.9      1.00% = 31433.
                65.00% = 1929.7     20.00% = 6820.7       .01% = .13176E+06

C) NO. OF POOLS DISTRIBUTION
   ------------------------------
   Lower Support     =    0
   Upper Support     =   14
   Expectation       =      2.53117
   Standard Deviation=      1.84960
```

D) *Summary Statistics for 4000 Simulations

```
Play Resource:    (  B cu m    )
------------------------------
  Minimum     = .0000000E+00Maximum           = 157.3106
  Expectation = 12.44228    Standard Deviation= 13.61104

EMPERICAL DISTRIBUTION:
----------------------
```

Greater than Percentage	Play Potential
100.00	.00000E+00
85.00	.76783
80.00	1.7893
75.00	2.8329
70.00	3.8510
65.00	4.8850
60.00	6.0649
55.00	7.2271
50.00	8.4634
45.00	9.8860
40.00	11.438
35.00	13.128
30.00	15.289
25.00	17.542
20.00	20.512
15.00	24.260
10.00	29.722
8.00	32.826
6.00	36.776
5.00	38.204
4.00	40.867
2.00	50.116
1.00	59.716
.01	151.39
.00	156.72

PETRIMES MODULE PSUM

MONTE CARLO SUM SIMULATION
POOL SIZE DISTRIBUTION
****

```
UAI        C5410101
PLAY       All oil plays
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   MON, JAN 29, 2001,  2:16 PM
```

USER SUPPLIED PARAMETERS

```
------------------------
   DO YOU WANT TO STORE IN DATA BASE ?   >    Y
   OIL (O) OR GAS (G) ?                  >    O
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU COMPUTE CONDITIONAL POTENTIAL? >    N
```

A) Basic Information

```
-----------------
TYPE OF RESOURCE      =Oil In-place
SYSTEM OF MEASUREMENT =S.I.
UNIT OF MEASUREMENT   =M cu m  (19)
```

B) PLAY POTENTIAL DISTRIBUTION

```
------------------------------

Summary      MEAN   = 3.7985     S.D.   = 3.6877
Statistics     M cu m

Upper       100.00% = .00000E+00 55.00% = 2.5113     10.00% = 8.1451
Percentiles  95.00% = .24337     50.00% = 2.8268      8.00% = 8.8912
             90.00% = .55668     45.00% = 3.1302      6.00% = 9.7734
             85.00% = .84104     40.00% = 3.5563      5.00% = 10.497
             80.00% = 1.0941     35.00% = 3.9955      4.00% = 11.326
             75.00% = 1.3875     30.00% = 4.4510      2.00% = 14.251
             70.00% = 1.6443     25.00% = 5.1129      1.00% = 16.738
             65.00% = 1.9165     20.00% = 5.7703       .01% = 46.342
             60.00% = 2.1850     15.00% = 6.6875       .00% = 47.536

Summary      MEAN   = 42.406     S.D.   = 34.551
Statistics     M cu m

Upper       100.00% = .00000E+00 55.00% = 30.753     10.00% = 88.821
Percentiles  95.00% = 2.7805     50.00% = 34.605      8.00% = 95.161
             90.00% = 6.8992     45.00% = 38.698      6.00% = 101.91
             85.00% = 10.490     40.00% = 43.242      5.00% = 107.90
             80.00% = 13.667     35.00% = 48.156      4.00% = 114.67
             75.00% = 16.913     30.00% = 52.590      2.00% = 132.80
             70.00% = 20.214     25.00% = 59.358      1.00% = 156.25
             65.00% = 23.473     20.00% = 65.791       .01% = 324.33
             60.00% = 27.095     15.00% = 75.218       .00% = 346.56
```

C) NO. OF PLAYS DISTRIBUTION

```
------------------------------
Lower Support     =    2
Upper Support     =    2
Expectation       =      2.00000
Standard Deviation=       .00000
```

```
D) Summary Statistics for 4000 Simulations
   ---------------------------------------

   Basin Resource:   (    M cu m  )
   ------------------------------
     Minimum     = .0000000E+00Maximum           = 328.2340
     Expectation = 47.60648    Standard Deviation= 37.01921

   EMPERICAL DISTRIBUTION:
   ----------------------
     Greater than    Basin
     Percentage      Potential
     ------------    -----------
        100.00         .00000E+00
         99.00         1.3516
         95.00         6.6909
         90.00         11.123
         85.00         14.978
         80.00         18.259
         75.00         21.697
         70.00         25.456
         65.00         28.812
         60.00         32.447
         55.00         35.995
         50.00         39.767
         45.00         43.931
         40.00         48.463
         35.00         52.726
         30.00         57.466
         25.00         63.285
         20.00         71.387
         15.00         80.399
         10.00         91.935
          8.00         99.354
          6.00         105.94
          5.00         110.98
          4.00         118.50
          2.00         137.32
          1.00         160.43
           .01         326.42

           .00         328.05
```


PETRIMES MODULE PSUM

```
MONTE CARLO SUM SIMULATION
POOL SIZE DISTRIBUTION
**************************

UAI        C5400101
PLAY       All gas plays
Assessor   Peter Hannigan
Geologist  Peter Hannigan
Remarks    Yukon North Slope Hydrocarbon Assessment Project
Run date   FRI, FEB  2, 2001, 12:09 PM


USER SUPPLIED PARAMETERS
------------------------
   DO YOU WANT TO STORE IN DATA BASE ?   >    Y
   OIL (O) OR GAS (G) ?                  >    G
   BRITISH OR S.I. UNIT OF MEASUREMENT?  >   SI
   RECOVERABLE RESOURCES?                >    N
   DO YOU COMPUTE CONDITIONAL POTENTIAL? >    N

A) Basic Information
   -----------------
   TYPE OF RESOURCE      =Gas In-place
   SYSTEM OF MEASUREMENT =S.I.
   UNIT OF MEASUREMENT   =M cu m  (19)

B) PLAY POTENTIAL DISTRIBUTION
   ------------------------------


   Summary      MEAN   = 2.4325     S.D.   = 1.7427
   Statistics   B cu m

   Upper       100.00% = .00000E+00 55.00% = 1.8698      8.00% = 4.9254
   Percentiles  99.00% = .18142     50.00% = 2.0402      6.00% = 5.3993
                95.00% = .48941     45.00% = 2.2209      5.00% = 5.6884
                90.00% = .72355     40.00% = 2.4170      4.00% = 6.0976
                85.00% = .92550     35.00% = 2.6301      2.00% = 7.0300
                80.00% = 1.0815     30.00% = 2.8758      1.00% = 8.2659
                75.00% = 1.2620     25.00% = 3.1710       .01% = 18.688
                70.00% = 1.4062     20.00% = 3.5065       .00% = 20.140
                65.00% = 1.5508     15.00% = 3.9387
                60.00% = 1.7089     10.00% = 4.5919

   Summary      MEAN   = 7.5234     S.D.   = 4.6634
   Statistics   B cu m

   Upper       100.00% = .15446     55.00% = 6.0653      8.00% = 14.470
   Percentiles  99.00% = .87468     50.00% = 6.6614      6.00% = 15.512
                95.00% = 1.6994     45.00% = 7.2674      5.00% = 16.536
                90.00% = 2.3555     40.00% = 7.8857      4.00% = 17.344
                85.00% = 2.9483     35.00% = 8.5103      2.00% = 19.535
                80.00% = 3.4788     30.00% = 9.2216      1.00% = 21.752
                75.00% = 3.9972     25.00% = 10.064       .01% = 33.164
                70.00% = 4.5850     20.00% = 11.098       .00% = 33.429
                65.00% = 5.0365     15.00% = 12.215
                60.00% = 5.5197     10.00% = 13.715

   Summary      MEAN   = 19.580     S.D.   = 15.773
   Statistics   B cu m
   Upper       100.00% = .00000E+00 55.00% = 14.314     10.00% = 40.845
   Percentiles  95.00% = 1.3186     50.00% = 16.095      8.00% = 43.780
                90.00% = 3.2235     45.00% = 17.924      6.00% = 46.897
                85.00% = 4.9252     40.00% = 20.023      5.00% = 49.528
```

80.00% = 6.3871	35.00% = 22.259	4.00% = 52.672
75.00% = 7.9166	30.00% = 24.335	2.00% = 60.664
70.00% = 9.4051	25.00% = 27.416	1.00% = 71.442
65.00% = 10.943	20.00% = 30.370	.01% = 144.59
60.00% = 12.589	15.00% = 34.706	.00% = 153.69

Summary Statistics: MEAN = 12.442 S.D. = 13.611, B cu m

Upper Percentiles			
	100.00% = .00000E+00	45.00% = 9.8860	6.00% = 36.776
	85.00% = .76783	40.00% = 11.438	5.00% = 38.204
	80.00% = 1.7893	35.00% = 13.128	4.00% = 40.867
	75.00% = 2.8329	30.00% = 15.289	2.00% = 50.116
	70.00% = 3.8510	25.00% = 17.542	1.00% = 59.716
	65.00% = 4.8850	20.00% = 20.512	.01% = 151.39
	60.00% = 6.0649	15.00% = 24.260	.00% = 156.72
	55.00% = 7.2271	10.00% = 29.722	
	50.00% = 8.4634	8.00% = 32.826	

C) NO. OF PLAYS DISTRIBUTION

Lower Support = 4
Upper Support = 4
Expectation = 4.00000
Standard Deviation= .00000

D) Summary Statistics for 4000 Simulations

Basin Resource: (B cu m)

Minimum = 3.050182 Maximum = 194.6945
Expectation = 42.47473 Standard Deviation= 22.73458

EMPERICAL DISTRIBUTION:

Greater than Percentage	Basin Potential
100.00	3.0502
99.00	8.3587
95.00	14.470
90.00	18.727
85.00	21.995
80.00	24.276
75.00	26.703
70.00	29.099
65.00	31.370
60.00	33.781
55.00	36.138
50.00	38.565
45.00	41.272
40.00	44.074
35.00	46.502
30.00	49.632
25.00	53.034
20.00	57.403
15.00	62.927
10.00	69.636
8.00	73.341
6.00	77.939
5.00	81.829
4.00	85.455
2.00	102.55
1.00	123.30
.01	194.01
.00	194.63