The potential occurrence of middle Cretaceous source beds beneath a steadily thickening pile of Cenozoic basin-plain and rise-prism deposits can be viewed as increasing the chances that deep-water reservoirs in the Aleutian basin have been charged by migrating hydrocarbons.

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Investigation of Source Rock-Crude Oil Relationships in North Slope Hydrocarbon Habitat

Carbon isotopic studies of kerogen assemblages and petroleums from the North Slope-Colville trough area of Alaska have permitted firmer source-oil correlation assignments. As a section, the Mesozoic contains a suite of potential source beds including the Shublik Formation, Kingak Shale formation, and Lower Cretaceous units and, most notably, a post-Neocomian, highly radioactive zone (HRZ). The maturation and generation history of these sediments has been broadly controlled by the Brookian orogeny.

Using well data, trends in generalized source richness, hydrocarbon proneness, and organofacies have been recognized. In projecting these data into the deeper Colville trough, a considerable variation in hydrocarbon generating potential was noted over the Mesozoic section. Several particularly attractive oil-prone units were recognized.

The generic relationship of a wide range of North Slope petroleums—including early, normal, and post-mature or biodegraded examples—was established. A majority of the principal accumulations could be assigned to the previously defined Barrow-Prudhoe oil family. This widespread generic series included petroleums from Upper Cretaceous, Kuparuk River, Ivishak, and Lisburne reservoirs. Lesser, but distinct, Simpson/Seabee-type oil groupings were also recognized.

Effective source-to-oil correlation was achieved by a comparison of the carbon isotopic compositions of the kerogen pyrolyzates and the crude oils. The possible contributions of the various source units were assessed in terms of isotopic match, source potential, and volumetrics. Assuming continuity of source characteristics into the deeper Colville trough, a Triassic/Jurassic combination constituted the closest source match to the major oil accumulations.

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Lateral Continuity of the Blarney Creek Thrust, Doonerak Window, Central Brooks Range, Alaska

The contact between Carboniferous and lower Paleozoic rocks, exposed along the northern margin of the Doonerak window in the central Brooks Range, is a major thrust fault called the Blarney Creek thrust (BCT). The BCT has been traced over a distance of 25 km, from Falsoola Mountain to Wien Mountain. The tectonic nature of this contact is demonstrated by: (1) omission of stratigraphic units above and below the BCT; (2) large angular discordance in orientation of first-generation cleavage at the BCT; (3) numerous thrust imbricates developed in the upper-plate Carboniferous section that sole into the BCT; and (4) truncation of an upper-plate graben structure at the BCT. Lack of evidence for pre-Carboniferous deformation in the lower plate casts doubt on the interpretation of the contact as an angular unconformity. However, the localized presence below the BCT of Mississippian Kekiktuk Conglomerate and Kayak Shale, in apparent depositional contact with lower Paleozoic rocks, suggests that the BCT follows an originally disconformable contact between the Carboniferous and lower Paleozoic rocks. The juxtaposition of younger over older rocks at the BCT is explained by calling upon the BCT to act as the upper detachment surface of a duplex structure. Duplex development involves initial imbrication of the Carboniferous section using the BCT as a basal decollement, followed by formation of deeper thrusts in the lower Paleozoic section, which ramp up and merge into the BCT.

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Tectonic Evolution of the Transverse Ranges of Southern California

The Transverse Ranges of southern California trend anomalously east-west in a tectonic regime otherwise dominated by the northwest-southeast trending San Andreas fault system. Plate tectonics theory offers an explanation for the origin of the Transverse Ranges. Convergence of the North American Plate (NAP) with the East Pacific Rise (EPR) and the overriding of the EPR by the NAP south of the Mendocino Fracture Zone led to development of northwest-trending, right-lateral faults on the leading edge of the NAP in southern California. Subsequent deflection of the NAP to the southwest by the still active Gorda-Juan de Fuca Ridge segment of the EPR resulted in southwesterly deflection of the San Andreas fault (SAF) forming the big bend in that fault.

These plate movements are responsible for the east-west trend and juxtaposition of major components of the Transverse Ranges. The east-west-trending Santa Ynez Range represents northward-moving rocks on the south side of the SAF, which were deflected westerly and did not negotiate the big bend in that fault. The elevated central part of the Transverse Ranges from the big bend southeasterly to Cajon Pass is under compression as northwesterly moving blocks on the south side of the SAF converge on southwesterly moving blocks on the north side of that fault. The easternmost range in the Transverse Ranges, the San Bernardino Mountains, is under similar compression on the north side of the bent portion of the SAF.

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Phosphatic Glauconitic Sandstone and Oncolite Deposition at the Upper Paleozoic Base of Etivluk Group, North-Central Brooks Range, Alaska

Carboniferous stratigraphy of the Picnic Creek allochthon in the central Brooks Range is dominated by bedded cherts and shales. In the Killik River quadrangle, bedded black cherts of the Lisburne Group are overlain by a thin diagnostic clastic unit composed of sandstone and conglomerate. The sandstone is a thin (0.35-m), laterally extensive, planar, laminated litharenite with an average Q:F:L of 40:17:43 and a Qp:Lv:Ls of 12:8:80. The provenance is interpreted to be a recycled orogen dominated by uplifted sedimentary sequences with minor plutonic, metamorphic, and volcanic sources. The presence of glauconite (7%) and authigenic phosphate (18%) indicates deposition in a shelf environment.

This phosphatic sandstone forms part of the matrix in a conglomerate at one locality. The conglomerate is lenticular (2 m × 10 m), crudely graded, and very poorly sorted, and it contains black chert ripups. Clasts are composed of oncoids (70%), chert (22%), shale (5%), and limestone (3%). Barite preferentially replaces all clasts except chert and part of the matrix. The oncolites are SS-type mode C hemispheroids, indicating formation in a continuously agitated shallow to intertidal marine environment.

Sedimentologic and petrographic observations suggest that the phosphatic glauconitic sandstone developed in a shelf environment, and the oncolitic conglomerate is a debris flow off a nearby carbonate platform that transported shallow-water material out onto the shelf. Preservation of unaltered echinoderm fragments and calcareous algal oncolites clearly indicates deposition above the CCD. Radiolarians from immediately above the clastics include spongy tetrahedral Latentifistulidea, which suggests that sandstone and conglomerate deposition probably occurred in the Morrowan (Early Pennsylvanian).

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Water Resources of the North Slope, Alaska

Lakes, streams, springs, snow, and ice are the most obvious source of fresh water on the North Slope. However, permafrost and seasonal climatic effects restrict the availability of these sources for water supply.

Shallow thaw lakes, ranging from the 315-mi^2 (815-km^2) Teshekpuk Lake to ponds less than an acre, literally blanket large parts of the coastal plain. Ice-cover formation and thickening on these lakes in winter are accompanied by an increase in dissolved-solids concentration in the remaining water, thus limiting its suitability for water supply.

Most of the precipitation occurs as snow, which is stored on the land surface until it melts in late spring and summer. Snow and ice are used to construct temporary roads and airfields, and melted snow and ice are often used as potable water. Most of the annual streamflow occurs during a brief two- to three-week breakup period in late May and early June. Streamflow virtually ceases in all streams, including the largest rivers, during the long, cold winters.

At a few locations, ground-water supplies have been obtained from shallow thawed zones adjacent to or underlying streams. Most ground water beneath the permafrost is brackish at best. Large perennial springs such as Shublik and Sadlerochit discharge from carbonate rocks in the central and eastern Brooks Range and foothills and within the southwestern Brooks Range, but are remote from areas of present development.

The most successful water-supply developments combine the use and removal of gravel with simultaneous creation of deep surface reservoirs to store abundant summer streamflow.

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Late Paleozoic to Cenozoic Reconstruction of the Arctic

The plate tectonic evolution of the Arctic is reassessed in the context of the known histories of the North Atlantic and North Pacific Oceans, and of the tectono-stratigraphic development of the lands around the Arctic Ocean. Computer map-drawing facilities were used to provide geometrical constraints on the reconstructions, which are presented in the form of eight palinspastic maps.

Stratigraphic similarities among presently dispersed continental areas identify fragments of a former "Barents plate." Collision of this plate with the Euramerican plate was the cause of the Late Devonian Ellesmerian orogeny. In later Paleozoic time, the Siberian continent also joined Pangea by collision with the combined Barents and Euramerican plates along the Urals-Taymyr suture. The Mesozoic-Cenozoic history of the Arctic is concerned with the fragmentation and dispersal of the former Barents plate, as well as the accretion of new continental fragments from the Pacific.

Of the major basins of the present-day Arctic Ocean, the Eurasia basin formed contemporaneously with the North Atlantic Ocean and is still spreading, while the earlier opening of the Canada basin was largely connected with events in the Pacific. The Canada basin formed by the separation of northern Alaska from the area now occupied by the Alpha Ridge. Initial rifting in the Late Jurassic was contemporaneous with the earliest major accretionary events in eastern Siberia and the northwestern Cordillera of North America. An Early to mid-Cretaceous age for the main phase of spreading is confirmed by the age-depth relationship for the floor of the Canada basin. After this time, the Canada basin formed part of the North Atlantic plate, and subsequent movements related to the opening of the North Atlantic and Eurasia basins were taken up within Siberia and the Bering Sea area. The history of the latter is not yet clear for times earlier than the late Eocene—the earliest time for which it is possible to make a geometrically realistic reconstruction of that area.

Earliest stages of spreading in the northern North Atlantic caused the initial separation of Greenland from North America. The Eurekan orogeny in the eastern Canadian Arctic is a local result of this spreading. Palinspastic restoration of the eastern Canadian Arctic Islands is required to fill the gap otherwise left in reconstruction of that area. The Eurasia basin opened contemporaneously with the Norwegian Sea and thus entirely postdates the Canada basin. Geometrical constraints suggest that the Makarov basin, between the Alpha and Lomonosov Ridges, formed during the Eocene.

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Gravity Data from the Wiseman Quadrangle, South-Central Brooks Range

Bouger gravity in the Wiseman quadrangle is dominated by a steep north-dipping regional gradient. Within the regional gradient are several residual anomalies that correspond spatially to mapped geologic units. These residual anomalies have a persistent east-west trend, attesting to the continuity of the east-striking geology. The northern end of the gravity gradient is a broad gravity low of down to -100 Mgal and is believed to be due to a low-density root near the core of the Brooks Range. The southern termination of this gradient is a relative gravity maximum located near the "suture" of the Arctic Alaska terrane with the Angayuchum terrane. This relative high is typical of sutures found throughout the world where continental and oceanic plates once converged. In this case, the anomalies appear to be due to the juxtaposition of denser, mafic oceanic rocks to the south (Angayuchum terrane) with less dense, metamorphic continental rocks of the Arctic Alaska terrane to the north. By accounting for the relative densities of the rock units through gravity modeling, it is evident that the low-density root extends south to underlie the schist belt and possibly the mafics of the Angayuchum terrane.

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Plant Megafossil Biostratigraphy and the Late Cretaceous Environment of the North Slope, Alaska

The Early Cretaceous evolution and subsequent geographic spread of flowering plants resulted in major global floristic changes. Studies of recently collected angiosperm fossil leaf-forms using analyses of comparative leaf architecture, facies associations, migrations, and community structure have resulted in a biostratigraphic tool for Alaskan Cretaceous nonmarine deposits, and a greater understanding of the Late Cretaceous terrestrial environment of the North Slope when substantial coal resources were being laid down.

Angiosperms first arrived in northern Alaska, from the south, in latest Albian time. The Brooks Range apparently acted as a filter for some taxa and may have locally modified the climate. There is no evidence for major plant radiations at high paleolatitudes at this time.

Putative evergreens form a large component of the pre-angiosperm floras. Throughout the Late Cretaceous, progressive loss of evergreen and thermophilic elements suggest a deteriorating climate. Paleoclimatic interpretations based on gymnosperm and angiosperm taxa are that: (1) there was no seasonal dark period on the North Slope in mid-Cretaceous times; (2) a mid-Cretaceous warm, mildly seasonal climate deteriorated to being cool temperate, with pronounced seasonality, by the Paleocene; and (3) vegetation may have been light- or cold-limited by latest Cretaceous times. The paleolatitude of greater than 70°N predicted for northern Alaska by paleogeographic reconstructions would appear to conflict with the interpretation that plants experienced no seasonal dark period. An obliquity of 15° could explain this conflict and a closer relative position to the rotational pole accounts for the apparent climatic deterioration.

A detailed study of high-latitude terrestrial-plant ecosystems provides information critical to global climate models and therefore our understanding of the biosphere as a whole.

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Mississippian Alaska-Siberian Connection: Evidence from Plant Megafossils

The protolepidodendrid genera *Tomiodendron, Ursodendron, Angarophloios*, and *Meyenodendron* have been discovered on the North Slope. These taxa, with the exception of *Tomiodendron*, are known only from Mississippian (Tournaisian-Visean) units in eastern Siberia and therefore are of uniquely Angaran affinity. The absence of these genera from extensively collected European assemblages strongly suggests that eastern Siberia and northern Alaska were joined, or in very close proximity, during Mississippian time, contrary to most paleogeographic reconstructions. A disjunct relict distribution is discounted on the basis of paleogeographic reconstructions showing even greater separations between Alaska and Siberia during the Devonian.

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McArthur River Field—A Cook Inlet Giant

The eighth major discovery in Cook Inlet basin was announced on October 24, 1965, as a result of drilling the Union-operated Grayling 1-A well near the crest of a broad, low-relief anticline that had been mapped from seismic data as early as 1959. The prolific Hemlock Conglomerate was tested at rates exceeding 2,000 BOPD. As delineation wells confirmed the size of the accumulation, three separate platforms were ordered and were in place by July 1967, and within three months, production from the Hemlock had begun.

Additional oil-productive sands in the Tyonek Formation, immediately overlying the Hemlock as well as several more in the underlying West