Regional dispersal patterns indicate these beds accumulated within the midfan environment of a northward-prograding submarine fan complex. The upper 20-30% of the Fortress Mountain rests above a conspicuous angular discordance and is composed of upward-fining channel sequences of conglomerate, sandstone, and shale. This phase of deposition records progradation of fan-delta and fluvial environments. The regional depositional architecture of the Fortress Mountain records the buildup and sedimentologic evolution of the Cretaceous shelf, which ultimately allowed progradation of overlying deltaic and interdeltaic complexes of the Nanushuk Group and related strata.

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Crude Oil Chemistry and Classification, North Slope, Alaska

Detailed chemical analyses of crude oil from the North Slope of Alaska began with United States Bureau of Mines efforts about 35 years ago. The discovery of major commercial accumulations within the past 15 years has resulted in routine application of modern analytical techniques, with the resulting classification of North Slope oils into two chemically distinct, and presumably separately sourced, families. This report will review published analytical results obtained for North Slope oils to date, in light of data for nine specific North Slope oils analyzed by Union Oil.

The nine oils analyzed are from the National Petroleum Reserve in Alaska and Prudhoe Bay field, and include a condensate and at least four biodegraded oils. Gravity and sulfur content variations are 65-54.1° API and 0.01-1.85%, respectively. Carbon isotope ratios of total (untopped) oils vary between −29.4 and −25.3 ‰, and are a discriminating parameter for grouping these oils into two chemical families. Other distinguishing chemical attributes include vanadium, nickel, and sulfur concentrations, V/(V + Ni) ratios, carbon number distribution of the major 5(α), 14(α), 17(α), 20R-steranes, and $i\text{-}C_{19}/i\text{-}C_{20}$ isoprenoid ratios. Using these distinctions, the oils are successfully grouped into two types. Type A oils, typified by the Prudhoe crude, are relatively high in vanadium, nickel, and sulfur content, isotopically light, and high in tricycle terpane content. Type B oils, typified by the Umiat and Simpson crudes, are low in sulfur and metals and contain relatively high concentrations of 5(α), 14(α), 17(α), 20R-ethylcholestane. Although little definitive published work on potential source rocks of maturities less than peak generation is available, the oil typing demonstrated here and elsewhere strongly suggests at least two distinct source sequences. Based on the biological marker geochemistry of the oil types, the nature of these sequences may be predictable.

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Geotectonics of the Bering Sea Area, Alaska

Plate tectonic interactions in the Bering Sea area have played a major role in its structural and geological history since Paleozoic time. The geotectonic style of different areas is similar due to the widespread influence of plate motions. Three major structural and depositional belts have been identified linking the Siberian area to Alaska across the Bering Sea. The northern belt, the Verkhoyansk-Chukotsk-Seward-Brooks, consists of early Mesozoic miogeosynclinal sediments. The middle belt, the Okhotsk-Chukotsk-Yukon-Koyukuk, consists of a Mesozoic magmatic arc and numerous accreted allochthonous terranes. These features were formed as a result of convergence/subduction of a southern oceanic plate. The southern belt, the Koryak-Anadyr-Peninsular, consists of terranes accreted during Cretaceous time and forms the southern limit of Mesozoic subduction.

During Late Cretaceous to early Tertiary time, rifting in the Atlantic caused these belts to be oroclinally bent southward and resulted in a shift of the Mesozoic subduction zone to a more southerly location. During formation of the oroclinal fold, subduction along the Bering Shelf margin changed from direct to oblique subduction, then to transform motion. Major movement along this margin ceased as the current Aleutian Island arc system began to form.

Late Cretaceous to early Tertiary structures within the Koryak-Anadyr-Peninsular area are potentially important for petroleum exploration because they could have formed concurrently with source and reservoir facies.

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The Paleogene Sequence on the Alaska Peninsula

Paleogene strata are exposed nearly the entire length of the Alaska Peninsula. They include continental and marine volcaniclastic rocks and a thick volcanic sequence. The strata are divided into the Tolstoi, Stepovak, Meshik, and Belkofski (in part) Formations in the southern part of the peninsula, and into the nonmarine clastic West Foreland Formation and the Hemlock Conglomerate in the northern part.

The Tolstoi Formation (Paleocene and Eocene), 670-1,380 m thick, consists mainly of continental quartz- and chert-rich sandstone and conglomerate, siltstone, and coal. Volcanic clasts and tuffaceous detritus increase in abundance upward. Neritic strata are present as interbeds in the type area. The formation overlies, with a major unconformity, strata ranging in age from Late Jurassic to Late Cretaceous. Partly coeval strata at the north end of the peninsula (West Foreland Formation) are mainly volcanic sandstone and conglomerate.

The Stepovak Formation, 1,800-2,000 m thick, represents two contrasting depositional environments—a lower dark siltstone and sandstone turbidite, about 975 m thick, and a shallow neritic sandstone and siltstone, rich in volcanic material, about 1,000 m thick. Locally, the upper part is deltaic sandstone, siltstone, and coal. An abundant megafauna of Eocene and Oligocene age is found in the neritic deposits. A thick coeval volcanic unit, the Meshik Formation, is present in the central part of the peninsula. Andesitic to basaltic lava, breccia, tuff, and lahars, as much as 1,500 m thick, have been K-Ar dated at 27-38 m.y. Similar rocks with interbedded sediment at the end of the peninsula are included with the Belkofski Formation.

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Lower Paleozoic and Proterozoic Rocks of Southern Brooks Range, Alaska

Lower Paleozoic or Proterozoic basement rocks occur in windows and thrust plates in several areas of the Brooks Range. Uranium-lead radiometric analyses of highly metamorphosed rocks from the Baird Mountains and Ernie Lake area have yielded Proterozoic ages. Structural, stratigraphic, petrologic, and isotopic evidence exists for Proterozoic(?) rocks in the schist belt; around the Chandalar, Arrigetch, and Igikpak plutons; and in the Cosmos Hills window. Fossiliferous, lower Paleozoic, low-grade metasedimentary rocks occur in the Romanzof Mountains, Doonerak window, and Baird Mountains, and may also surround the Chandalar plutons. Locally, the Lower Paleozoic rocks are unconformably overlain by Devonian to Mississippian metasediments and may stratigraphically overlie older, higher grade metamorphic rocks. Similarities in the stratigraphic settings and lithologies and in fossil ages and affinities allow correlation of the lower Paleozoic rocks in the southern Brooks Range.

Correlation of lower Paleozoic rocks exposed beneath the Endicott allochthon at the Doonerak fenster with coeval rocks in an overlying thrust plate to the south at Snowden Mountain is especially significant. A west-trending thrust fault, which is rooted in lower Paleozoic basement, along the north side of Snowden Mountain is postulated to account for these relationships. Apparently, the Endicott allochthon roots beneath the Snowden Mountain thrust fault. Evidence from conodont samples currently being studied by A. Harris may bear on the extent of the lower Paleozoic rocks in the upper plate of the Snowden Mountain thrust and in the Chandalar area.

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Llama-Supported Geologic Fieldwork in Brooks Range, Alaska

For the first time since their camelid ancestors migrated from Asia, across the Bering Sea land bridge, into the Brooks Range, and eventually south to the Andes during the Late Pleistocene, domestic llamas trekked through Arctic Alaska mountains. During August 1981, six llamas carrying 520 lb of gear supported a field party of eight people that traveled 80 mi over 11 days. The route followed left the Dietrich Trans-Alaska Pipeline camp on the Dalton Highway and went eastward over the 5,000-ft mountains separating the Dietrich and Mathews Rivers, then north to the headwaters of the Mathews River, and finally west to the Dietrich River drainage north of Snowden Mountain.

The geologists, who split off on traverses paralleling the pack-train route, mapped seven townships, located the bimodal Devonian Ambler volcanic belt, and traced it from near Dietrich Camp to Snowden Mountain. Farther west, this belt contains massive sulfide deposits valued in excess of $12 billion.

Although none had packing experience, all of the llamas were friendly and easy to handle. They carried 60-100 lbs each, depending on their age. Only blocky talus and very steep slopes were obstacles. The llamas easily traversed fine loose scree, making ascents and descents as steep as 1,000 ft/mi (190 m/km), bashed through alder scrub, slogged over muskeg, and forded rivers. Since they are avid foragers, minimal food was packed for the llamas. Bears were sighted during the trip, but none approached the group. Dall sheep and llamas puzzled at each other from a distance.

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Devonian Magmatism in Brooks Range, Alaska

Devonian bimodal metaplutonic and metavolcanic rocks lie in parallel, west-trending belts in the southern Brooks Range. Overlapping distribution of the plutonic and volcanic rocks occurs in volcanic centers found south of the Doonerak window in the Wiseman, Chandalar, and Colleen quadrangles, and near the Beaver Creek pluton in the Survey Pass quadrangle. The Devonian age is interpreted from isotopic analyses of U and Pb of over 55 zircon fractions from these felsic metaigneous units. Considering concordia plots and Pb-Pb ages from over 40 discordant zircon fractions and fossil ages derived from marbles intercalated in the volcanic sequences, we see an age range of 360-410 Ma. The age range is attributed to variation in crystallization ages, as well as the U-Pb systematics of the Brooks Range zircons. Their overlapping age and distribution provides evidence for cogenesis of the Devonian plutonic and volcanic rocks, and also for their correlation with Devonian magmatic rocks of the North American Cordilleran. Lower intercepts on U-Pb concordia diagrams for these zircons range from 105 to 150 Ma, bracketing the end of lead loss resulting from metamorphism. The age of this metamorphic event corresponds to the Late Jurassic and earliest Cretaceous emplacement of the Angayucham terrane.

U-Pb concordia plots of 15 zircon fractions from five samples of the Ernie Lake granitic gneiss bodies are explained as latest Proterozoic intrusion of granitic magma with entrained 2-Ga-old zircons, which subsequently lost lead during Mesozoic metamorphism.

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Late Quaternary Depositional History of Alaskan Beaufort Shelf

Diverse nonmarine and shallow marine deposits blanketing the coastal plain and continental shelf of northern Alaska are known collectively as the Gubik Formation. In the Beaufort coastal region between Barrow and Prudhoe Bay and along the Chukchi coastline southwest of Barrow, five distinct marine subunits have been recognized within the Gubik, ranging in age from middle Pliocene to late Pleistocene. A sixth pre-Holocene transgressive marine subunit, about a meter thick and bearing abundant ice-striated dropstones that originated in the Canadian Arctic Islands, is present along much of the Alaskan Beaufort coast. The aggregate thickness of the Gubik Formation on the coastal plain is no more than a few tens of meters. Offshore beneath the Beaufort shelf, however, the Gubik Formation is locally thicker than 100 m and includes not only deposits that probably correlate with those mapped onshore but also subunits of intermediate and younger ages. These have been studied mainly through the interpretation of a network of high-resolution seismic reflection profiles that covers most of the Alaskan Beaufort shelf at 18 to 35-km intervals seaward of the 25-m isobath.

In general, the Gubik Formation offshore appears to be a stack of wedge-shaped transgressive marine units that thicken toward the shelf break, beyond which they are disrupted by active slumps and landslides. This idealized geometry is altered in the area east of Canning River, where active faulting and folding have created persistent local highs and depocenters, and in the area between Smith and eastern Harrison Bays, where a complicated Quaternary drainage history has resulted in extensive local erosion of the marine wedges and in the deposition of relatively large deltaic sequences.

Accumulation of the marine wedges must have occurred during periods when depositional rates were considerably higher than at present, perhaps during deglaciations of the Canadian Arctic Islands, when great volumes of sediment-bearing ice are likely to have been debouched into the Arctic Ocean.

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Tectonic Framework of Interior Alaska—A Model of Continental Margin Extension, Collapse, and Dispersion

Preliminary results of geologic mapping and structural studies raise questions about terrane accretion models as presently applied to interior Alaska and suggest an alternative model of tectonic development. Among the regional geologic patterns and problems pertinent to any model for interior Alaska are (a) the present Z-shaped configuration of the northern Cordilleran fold-and-thrust belt (CFTB), (b) the means by which 450 km of dextral strike-slip is dispersed on splays of the Tintina fault system, (c) the original continuity of the crystalline terranes of interior Alaska and their pre-Tintina Z-shaped distribution paralleling that of CFTB, and (d) the origins of two belts of deep-water deposits with mafic-igneous and locally ophiolitic associations—one outboard and the other inboard of the crystalline belt. The proposed model features (1) a relatively straight and passive North American margin with a Proterozoic to Middle Devonian sedimentary prism that underwent intermittent extension and volcanism in its distal part, (2) a Devonian-Mississippian continental arc at the outer edge of (1) and flanked cratonward by (3), an extending and rapidly subsiding basin also developed on (1) but containing Mississippian to Triassic deep-water sediments and abundant mafic-igneous material. Collapse and structural telescoping of the margin and intense reactivation of the continental arc occurred in Jurassic through Early Cretaceous time as oceanic crust converged with North America, and exotic terranes were accreted to the outboard side of arc. Oroclinal Z-bending of Cordilleran trends probably accompanied Late Cretaceous and earliest Tertiary strike-slip movement on the Tintina and other fault systems based and rearranged.

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Lower Paleozoic Carbonate Rocks of Baird Mountains Quadrangle, Alaska

Lower Paleozoic carbonate rocks in the Baird Mountains quadrangle form a relatively thin (about 550 m), chiefly shallow-water succession that has been imbricately thrust and metamorphosed to lower greenschist facies. Middle and Upper Cambrian rocks—the first reported from the western Brooks Range—occur in the northeastern quarter of the quadrangle, south of Angayukaqsraq (formerly Hub) Mountain. They consist of marble grading upward into thin-bedded marble/dolostone couplets and contain pelagiellid mollusks, acotretid brachiopods, and agnostid trilobites. Sedimentologic features and the Pelagiellas indicate a shallow-water depositional environment. Overlying these rocks are Lower and Middle Ordovician marble and phyllite containing graptolites and conodonts of midshelf to basinal aspect. Upper Ordovician rocks in this area are bioturbated to laminated dolostone containing warm, shallow-water conodonts.

In the Omar and Squirrel Rivers areas to the west, the Lower Ordovician carbonate rocks show striking differences in lithofacies, biofacies, and thickness. Here they are mainly dolostone with locally well-developed fenestral fabric and evaporite molds, and bioturbated to laminated orange- and gray-weathering dolomitic marble.

Upper Silurian dolostone, found near Angayukaqsraq Mountain and on the central Squirrel River, contains locally abundant corals and stromatoporoids. Devonian carbonate rocks are widely distributed in the Baird Mountains quadrangle; at least two distinct sequences have been identified. In the Omar area, Lower and Middle Devonian dolostone and marble are locally cherty and rich in megafossils. In the north-central (Nakolik River) area, Middle and Upper Devonian marble is interlayered