major decollements are recognized. In the mountain belt, the lower one lies in the Lower Carboniferous Kayak Formation but often steps down to the base of the Upper Devonian Kanayut or Lower Carboniferous Kekiktuk Conglomerates. Near the Sadlerochit and Shublik Mountains, it steps down to its deepest level to the base of the Cambrian to Middle Devonian Katakturuk Dolomite. The upper decollement is poorly exposed in the mountains and lies in the Jurassic Kingak Shale. Locally, these are removed by Early Cretaceous erosion and the decollement steps upsequence.

The two decollements separate three tectonic sequences that deform differently. First, basement below the lower decollement deforms into a set of thrust duplexes. The core of these is well exposed in the Franklin Mountains. The Sagavanirktok sidewall ramp is a major basement structure that causes the northern swing in the mountain front between the central and northeastern Brooks Range. Second, the lower cover between the two decollements deforms more complexly than basement by both passive drape over the underlying duplexes and by active thrust stacking. Large-scale buckle folding occurs in a shear zone above the Sagavanirktok sidewall ramp. Third, the upper cover above the upper decollement is poorly preserved in the mountains as allochthonous klippe in depressions in the basement and lower cover duplexes.

Crustal shortening across the eastern Brooks Range is estimated by two-dimensional section balancing at over 400 km. This is substantially more than previous estimates and is comparable to those for the western Brooks Range. The inferred lack of relative rotation between the western and eastern Brooks Range does not substantiate a rotational opening for the Arctic Ocean.

REININK-SMITH, LINDA M., Univ. Alaska, Fairbanks, AK

Description and Mineralogy of Tertiary Volcanic Ash Partings and Their Relationship to Coal Seams, Near Homer, Alaska

Outcrops of Tertiary coal-bearing units in sea cliffs of the Kenai Peninsula provide an excellent study area for volcanic ash partings in coals. Twenty mid- to late-Miocene, 50-cm to 3-m thick coal seams exposed in the sea cliffs about 10 km west of Homer contain an average of 10 volcanic ash or lapilli tuff partings each. The bedding relationships of the coal with any one parting cannot be predicted, and the contacts of the partings with the coal range from very sharp to predominantly gradational. These bedding relationships provide clues about the surface on which the ashes fell and on which the coal was accumulating. For example, some ashes fell in standing water, others on irregular subaerial surfaces.

The partings are in various stages of alteration to kaolinite and bentonite, and vary in thickness from a few millimeters to about 10 cm. The consistency and texture of the partings depend on the degree of alteration; the less altered partings display visible pumice fragments and euhedral feldspars, commonly within a finer grained matrix. Separate pumice fragments, excluding matrix, can also occur as partings in the coal. The more altered partings may be wet and plastic, or they may be well indurated claystones; the colors range from gray-yellow to dark brown. The indurated partings are more common in the older part of the section. The coal seams may be capped by volcanic ash partings and are commonly underlain by a pencil shale of nonvolcanic origin.

RYHERD, TIMOTHY J., Univ. Alaska, Fairbanks, AK, and CHESTER E. PARIS, ARCO Alaska, Inc., Anchorage, AK

Lower Paleozoic Carbonate Slope-Sequence, Northern Seward Peninsula, Alaska

Examination of a lower Paleozoic carbonate unit exposed along the northern coast of the Seward Peninsula revealed an undeformed section at Cape Deceit, greater than 160 m (525 ft) thick, that represents part of a prograding carbonate submarine-fan sequence. The top 60 m (200 ft) of the sequence is a massive, disorganized, carbonate conglomerate interpreted to be debris flows deposited in large feeder channels of an inner-fan complex. Stratigraphically below this interval are channelized conglomerates and calcarenites, 40-50 m (131-165 ft) thick. Overall, this section thickens and coarsens upward but is composed of many thinning- and fining-upward cycles, 2-8 m (7-26 ft) thick. This section probably represents channel deposits of the midfan complex. The bottom part of the sequence consists of a coarsely crystalline, thinly bedded limestone section overlying a calcareous shale section. The beds within this section are laterally extensive and represent outer-fan, fan-fringe, and basin-plain deposits.

Although no recognizable megafossils were found in the Cape Deceit section, Silurian conodonts have been reported by other workers. Rugose coral fragments of indeterminate age were found in an undeformed section, 19 km (10 mi) to the east, which appears to be correlative with the Cape Deceit section.

SABLE, EDWARD G., and GARY D. STRICKER, U.S. Geol. Survey, Denver, CO

Coal in National Petroleum Reserve in Alaska (NPRA): Framework Geology and Resources

The North Slope of Alaska contains huge resources of coal, much of which lies within NPRA. The main coal-bearing units, the Corwin and Chandler Formations of the Nanushuk Group (Lower and Upper Cretaceous), underlie about 20,000 mi^2 (51,800 km^2) of NPRA. They contain low-sulfur, low-ash, and probable coking-quality coal in gently dipping beds as thick as 20 ft (6.1 m) within stratigraphic intervals as thick as 4,500 ft (1,370 m). Lesser coal potential occurs in other Upper Cretaceous units and in Lower Mississippian and Tertiary strata.

The river-dominated Corwin and Umiat deltas controlled the distribution of Nanushuk Group coal-forming environments. Most organic deposits formed on delta plains; fewer formed in alluvial plain or delta-front environments. Most NPRA coal beds are expected to be lenticular and irregular, as they probably accumulated in interdistributary basins, infilled bays, or inland flood basins, whereas some blanket beds may have formed on broad, slowly sinking, delta lobes. The major controls of coal rank and degree of deformation were depth of burial and subsequent tectonism.

Nanushuk Group coal resources in NPRA are estimated to be as much as 2.75 trillion short tons. This value is the sum of 1.42 trillion short tons of near-surface (< 500 ft or 150 m of overburden) bituminous coal, 1.25 trillion short tons of near-surface subbituminous coal, and 0.08 trillion short tons of more deeply buried subbituminous coal. These estimates indicate that the North Slope may contain as much as one-third of the United States coal potential.

SCHOLL, DAVID W., ALAN K. COOPER, and MICHAEL S. MARLOW, U.S. Geol. Survey, Menlo Park, CA

Terrane-Capture Concept for the Origin of the Aleutian–Bering Sea Region—Implications for Petroleum Resources in the Deep-Water Aleutian Basin

Regional geological and geophysical relations support the notion that the basement of the Aleutian basin of the Bering Sea is a far-traveled terrane of oceanic crust. This terrane—named Aleutia—is probably a fragment of Pacific lithosphere (Kula plate?) that formed at an equatorial spreading center in the Early Cretaceous. Aleutia arrived in the Aleutian-Bering Sea region about 55 Ma and was accreted to the Alaskan-Siberian continental margin when a long-established subduction zone located there was abandoned and shifted southward to the present offshore position of the Aleutian Arc. Formation of the arc entrapped Aleutia in the Bering Sea and thereby formed the Aleutian basin, which has since accumulated a geosynclinally massive overlap assemblage of rise-prism and basin-plain deposits as thick as 12 km.

The capture concept of Aleutia introduces two speculative circumstances relevant to assessing the resource potential of the Aleutian basin. First, the likelihood that in the middle Cretaceous its relatively shallow submerged basement resided near an equatorial spreading center implies that younger basin-plain deposits of the overlap assemblage may have accumulated above oceanic pelagic beds rich in organic matter. Elsewhere in the Pacific, middle Cretaceous beds deposited on bathymetric highs are known to be uncommonly rich in organic matter (C_o = 1-9%). Second, if deposits of the global anoxic event accumulated on Aleutia, it is likely that large amounts of organic matter were conveyed to the now-abandoned Mesozoic subduction zone at the base of the Alaskan-Siberian margin. Pelagic source beds for hydrocarbons may therefore be stored within fossil subduction complexes buried beneath the present continental rise prism.

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.

SEDIVY, R. A., I. E. PENFIELD, H. I. HALPERN, R. J. DROZD, G. A. COLE, and R. BURWOOD, Sohio Petroleum Co., Warrensville Heights, OH

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.

SEIDENSTICKER, C. M., F. E. JULIAN, J. C. PHELPS, J. S. OLDOW, and H. G. AVÉ LALLEMANT, Rice Univ., Houston, TX

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.

SHEEHAN, JACK R., MCO Resources, Inc., Los Angeles, CA

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.

SIOK, JEROME P., Univ. Alaska, Fairbanks, AK, and C. G. MULL, Alaska Div. Geol. and Geoph. Surveys, Anchorage, AK

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).

SLOAN, CHARLES E., U.S. Geol. Survey, Anchorage, AK

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