Mapping of the north flank of the Doonerak fenster has traced the Amawk thrust, the sole fault of the Endicott Mountains allochthon, from the North Fork of the Koyukuk River–Mount Doonerak area eastward for more than 40 km (25 mi) to the east plunge of the Doonerak anticline at Koyuktuvuk Creek near the Dietrich River. Mapping has concentrated on the structural style of the area and on the autochthonous or parautochthonous Carboniferous Lisburne Group, Kayak Shale, and Kekiktuk Conglomerate—which are present along most of the anticline—and Triassic Karen Creek Sandstone, Triassic Shublik Formation, and Permian-Triassic Sadlerochit Group—which are present only in the west. This Triassic to Mississippian section closely resembles the coeval autochthonous to parautochthonous Ellesmerian section of the subsurface to the north and in the Brooks Range to the northeast.

The north-dipping Amawk thrust is mapped between outcrops of lower Paleozoic metasedimentary rocks and this subjacent Triassic to Mississippian section. On the west, an unbroken stratigraphic sequence underlies the Amawk thrust; a complete section of Karen Creek, Shublik, Sadlerochit, Lisburne, Kayak, and Kekiktuk is exposed in the canyon of Bombardment Creek. The Kekiktuk Conglomerate unconformably overlies weathered Ordovician-Cambrian mafic volcanic rocks. Well-developed slaty cleavage in Sadlerochit and Lisburne rocks is compatible with northward-thrust transport of the overlying Endicott Mountains allochthon. East of Bombardment Creek, structural complexity increases markedly, and multiple slivers of Kekiktuk, Kayak, Lisburne, and Sadlerochit are mapped below the Amawk thrust. At Falsoola Mountain, near the east end of the fenster, the Lisburne is isoclinally folded. Near Koyuktuvuk Creek, this parautochthonous section can be described as a broken formation. Movement has occurred along incompetent horizons, particularly within the Kayak Shale, resulting in imbrication of the competent beds. This movement can be interpreted as drag resulting from emplacement of the overlying Endicott Mountains allochthon and not from a regionally significant thrust fault.

Along most of the north side of the fenster, from Mount Doonerak eastward to Falsoola Mountain, east-trending high-angle longitudinal faults uplift the core of the fenster. These vertical to steeply south-dipping faults have vertical separations of a few meters to over 500 m (1,600 ft), and postdate the Early Cretaceous (probably Neocomian) emplacement of the Endicott Mountains allochthon. This uplift was probably related to the Albian and Late Cretaceous tectonic events interpreted elsewhere in the Brookian orogen. Alternatively, the high-angle faults can be interpreted as part of the floor of a duplex. However, there is no evidence of any large amount of horizontal translation along these faults.

MULL, CHARLES G., Alaska Div. Geol. and Geoph. Surveys, Anchorage, AK, CHESTER PARIS, ARCO Alaska, Inc., Anchorage, AK, and KAREN E. ADAMS, Univ. Alaska, Fairbanks, AK

Kemik Sandstones, Arctic National Wildlife Refuge (ANWR), Alaska

In the Sadlerochit Mountains area of ANWR, the Kemik Sandstone of Hauterivian-Barremian age ranges to at least 35 m (120 ft) of very well sorted, fine-grained quartzose sandstone with minor pebble conglomerate. It is an elongate body traceable for over 160 km (100 mi) from the eastern Sadlerochit Mountains into the subsurface near the Sagavanirktok River to the west. In the northeast, it crops out in a belt about 16 km (10 mi) wide; to the southwest in the subsurface, it expands to about 65 km (40 mi) wide. It is a potential petroleum reservoir in the subsurface of ANWR, but its distribution north and east of the Sadlerochit Mountains is unknown.

The Kemik overlies a regional angular unconformity with increasing depth of truncation northward; it is overlain by and intertongues with an unnamed "pebble-shale" unit. Data suggest that the Kemik was derived from erosion of Lisburne Group carbonate rocks and a terrain of mature sedimentary rocks north and east of the outcrop belt. Conglomerate clasts consist dominantly of white leached spicular and foraminiferal chert, silicified carbonate, and quartzite. Although the sand has a nearly uniform grain size from east to west, conglomerate clasts are most abundant to the northeast and become smaller and less abundant westward; few are noted west of the Canning River. This distribution is suggestive of longshore drift from the northeast.

A shoreface depositional environment, possibly a barrier island along a coast with low tidal flux, seems to be represented in the Kemik. Beds up to 2 m (6 ft) thick with sweeping low-angle cross stratification are interbedded with parallel laminated units and scattered, thin, maroon siltstone-mudstone beds. Vertical burrows up to 0.5 m (20 in.) long and truncated by overlying beds are conspicuous in some areas. A sparse pelecypod fauna is present, usually in the maroon silty horizons.

The Kemik and other coeval sandstone and conglomerate horizons in the subsurface, such as the Put River sands and the Point Thomson sands, are probably separate bodies of sediment derived from uplifted blocks along the rifted Arctic Alaska plate margin.

MURPHY, J. M., Univ. Alaska, Fairbanks, AK, and JOHN DECKER, Alaska Div. Geol. and Geoph. Surveys, Fairbanks, AK

Goodnews Terrane and Kuskokwim Group, Eek Mountains, Southwest Alaska: Open Marine to Trench-Slope Transition

In the Eek Mountains, southwest Alaska, four depositional settings record Permian to mid-Cretaceous marine sedimentation and post-Valanginian crustal shortening. Sequence 1: pillowed basalt flows (SiO_2 = 44%) and volcaniclastic sediments intercalated with Permian Atomodesma-bearing sandy limestones grade upward through volcanic debris flow deposits and tuffaceous argillites into sequence 2: thin-bedded chert with argillite partings. Sequence 3 rests conformably(?) on sequence 2 and consists of undated argillite grading upward into Early Cretaceous (Valanginian) thin-bedded Tcde/Tde turbidites and thick-bedded conglomeratic grain flow deposits. Sequence 4 consists of late Early Cretaceous (Albian) thick-bedded conglomeratic grain flow deposits and minor Tcde/Tde and Ta/Tab turbidites. Sequence 4 (Kuskokwim Group) overlies sequences 1, 2, and 3 (Goodnews terrane) with an angular unconformity preserving submarine canyon cut-and-fill.

Sequence 1 requires an ocean island(?), and sequence 2 an open marine origin. Sequences 3 and 4 are inner-fan turbidite deposits; conglomerate and sandstone compositions indicate recycled orogen, arc orogen, and collision orogen provenances. This suggests preaccretion Valanginian clastic input from the now-adjacent Kilbuck terrane.

All four sequences record southeast over northwest imbrication along southeast-dipping thrusts. Deformation and metamorphic intensity increases with age/depth; a maximum is recorded in pervasively foliated Permian greenstone crosscut by prehnite and pumpellyite veins. Sequences 1 and 2 are highly disrupted, with local blocks-in-matrix fabric. Sequence 3 shows a similar, less pervasive style. Sequence 4 is locally disrupted and overturned along faults but lacks penetrative deformation. Deformation began between Valanginian and Albian times, and either progressively penetrated upsection with time or was multiphased with consistent recurring structural style.

NEWBERRY, R. J., Univ. Alaska, Fairbanks, AK

Overview of Gold-Bearing Skarns of Southern Alaska

Although skarn deposits occur throughout Alaska, skarns with appreciable gold production/reserves are largely limited to an arcuate belt that stretches through southeastern and southern Alaska to the Alaska Peninsula. Within this belt are nearly 100 known gold-bearing skarn prospects and deposits. They occur in a variety of tectono-stratigraphic terranes, with no consistent age or character of the host carbonate unit. These skarns are, however, characterized by specific geologic associations, including intrusives, alteration, ore and gangue mineralogy, and trace metals.

Intrusions associated with gold skarns are typically medium-grained, equigranular to slightly porphyritic members of gabbro-diorite-tonalite or diorite-quartz monzodiorite suites. Intrusive alteration, if present, consists predominantly of secondary albite, actinolite, and epidote, with little secondary quartz and sulfide and very rare secondary K-feldspar and muscovite. Typical "identifying" mineralogies include an abundance of epidote, chalcopyrite, and chlorite; the presence of pyrrhotite, "specular magnetite," idocrase, scapolite, hornblende, and albite; and the general absence of bornite, sphalerite, and galena. Generally, only minor amounts of sulfides and magnetite in gold skarns are present in the skarns per se or the associated plutons; most of the (gold-bearing) sulfide and magnetite is present at the marble front. Trace elements found at anomalous levels in gold skarns include Ni, Co, As, V, Mo, Sb, and Bi. Elements that are inevitably low in gold skarns include Zn, Pb, F, Sn, Be, W, and Ba. These elemental characteristics contrast strongly with those of gold-poor skarns and with metamorphosed volcanogenic massive sulfide deposits.

Although gold skarns are generally small deposits (< 1 mmt), their consistent geologic characteristics make them relatively predictable ore-deposit targets in Alaska.

NIGH, ERIC L., ALUN H. WHITTAKER, and JOHN D. MACPHERSON, Exploration Logging Inc., Sacramento, CA

Statistical Analysis of Correlation of Porosity and Permeability Determinations from Well Cuttings Using a Portable pNMR Apparatus with Conventional Core Analysis and Wireline Log Readings

The porosity-permeability (P-K) analyzer is a field-portable device that uses the principle of pulsed nuclear magnetic resonance to determine the content of hydrogen nuclei present in the free and bound water in rock samples. Using a simple dual-water model, these values may be used to calculate total porosity, free fluid index, and permeability index. The principle of measurement is such as to require relatively small sample volumes and reliable results can be obtained from well-cuttings samples or 3-mm diameter core plugs.

Results from the P-K analyzer are responsive to total fluid-filled pore space in the rock, although it is possible to distinguish free, i.e., movable, fluid from bound fluid, i.e., at grain boundaries or within restricted pores and in argillaceous rocks. The P-K response is entirely independent of formation lithology, mineralogy, or salinity of pore waters and is not appreciably affected by the presence of light oils. The presence of free or dissolved gases in the sample will have a significant effect on response. However, samples are brine flushed and aspirated in preparation for analysis in order to remove this effect.

We see, from these differences, that results from the P-K method cannot be expected to show a direct one-to-one correlation with those from conventional core analysis or the wireline density or neutron logging tools. A statistical analysis is presented using data from each of the analytical methods and types and conditions of sample. A strong correlation is demonstrated both visually and statistically, thereby providing verification of the P-K method and facilitating its use alongside data previously obtained by more conventional methods.

NILSEN, TOR H., U.S. Geol. Survey, Menlo Park, CA

Sedimentology of Tidally Deposited Miocene Bear Lake Formation, Alaskan Peninsula

The Miocene Bear Lake Formation—chiefly sandstone, shale, and conglomerate—crops out on the Alaskan Peninsula between Port Heiden and Pavlof Bay. As thick as 1,600 m in outcrop and 2,368 m in subsurface, the Bear Lake Formation appears to have been deposited mostly by tidal processes in a semi-enclosed back-arc basin that was bordered to the southeast by volcanic uplands of the Aleutian arc. To the northeast, the basin originally extended beneath Bristol Bay as part of the North Aleutian basin. The Bear Lake Formation, which rests unconformably on Oligocene volcanogenic sedimentary rocks and is unconformably overlain by Pliocene volcanic rocks, contains few, if any, interbedded volcanic rocks. Sandstone of the Bear Lake Formation contains more quartz, locally as much as 65%, than most Tertiary strata of the Alaska Peninsula. Rounded clasts of granitic rocks as large as 25 cm were probably derived from large batholithic complexes to the southeast.

Sandstone beds are characterized by large-scale trough and tangential-tabular cross-strata, herringbone cross-strata, shale drapes on cross-strata, reactivation surfaces, channeling, superposition of small-scale cross-strata or current ripple markings on large-scale cross-strata with reversal of flow directions, scattered megafossils, local coquinas, and local burrows that include *Ophiomorpha*. Shaly sequences are characterized by flaser bedding, current and oscillation ripple markings, starved ripple markings, abundant small-scale bioturbation, load casts, abundant mica and plant fragments, and synsedimentary slumps. Coarse-grained fluvial deposits at the base and fine-grained marine shelf deposits at the top of many sections suggest deposition during a major transgression, possibly as a result of subsidence of the Aleutian arc during an interval of relative volcanic quiescence.

NILSEN, TOR H., U.S. Geol. Survey, Menlo Park, CA, and THOMAS E. MOORE, ARCO Alaska, Inc., Anchorage, AK

Tectonic Significance of Kanayut Conglomerate and Related Middle Paleozoic Deposits, Brooks Range, Alaska

The Upper Devonian and Lower Mississippian(?) Kanayut Conglomerate, which crops out for a distance of 950 km across the Brooks Range, is significant for understanding of the tectonic history of northern Alaska in relation to the geology of the circum-Arctic region. The Kanayut Conglomerate is as thick as 3,000 m and consists chiefly of conglomeratic fluvial strata that were deposited as a result of southwestward progradation of a large and coarse-grained fluvial-dominated delta. Underlying and overlying shallow marine and prodeltaic strata record the advance and retreat of the delta. The Kanayut and related deposits crop out in a series of thrust sheets in which the Paleozoic rocks were detached in the late Mesozoic from an unknown basement and transported at least several hundred kilometers northward. Detailed sedimentologic studies and measured sections in the Kanayut Conglomerate permit estimates to be made of the amount of displacement on the thrust sheets and suggest that the source area of the allochthonous middle Paleozoic deltaic deposits was the underlying autochthonous upper Precambrian and lower Paleozoic basement rocks of the North Slope.

The Kanayut Conglomerate is not palinspastically compatible with other middle Paleozoic successions in Alaska, in the cordillera of western Canada, in the conterminous western U.S., or in the Canadian Arctic Islands. The strata do, however, resemble fluvial deposits of the Old Red Sandstone in Svalbard and East Greenland. They and their associated autochthonous basement may have been displaced from an original position contiguous with the North Greenland foldbelt by post-Early Mississippian strike-slip faulting and thus indicate an early phase of circum-Arctic tectonic displacement prior to that associated with the opening of the modern Canada basin in the late Mesozoic.

NOKLEBERG, W. J., E. L. AMBOS, G. S. FUIS, W. D. MOONEY, R. A. PAGE, GEORGE PLAFKER, U.S. Geol. Survey, Menlo Park, CA, and D. L. CAMPBELL, U.S. Geol. Survey, Denver, CO

1984 Results of Trans-Alaska Crustal Transect in Chugach Mountains and Copper River Basin, Alaska

The Trans-Alaska Crustal Transect (TACT) program, a multidisciplinary investigation of the continental crust and its evolution along the Trans-Alaska pipeline corridor, was started by the USGS during 1984. Preliminary results of geologic, geophysical, and wide-angle reflection/refraction data obtained across the Chugach terrane (CGT) and the composite Wrangellia/Peninsular terrane (WRT/PET) suggest the following: (a) The CGT is composed of accretionary sequences that include, from south to north, Late Cretaceous schistose flysch, uppermost Jurassic to Early Cretaceous sheared melange, and Early(?) Jurassic blueschist/greenschist. (b) The CGT accretionary sequences have local broad, low-amplitude magnetic or gravity anomalies. (c) Seismic data show that the CGT along latitude 61°N, by alternating high- (6.9-8.0? km/sec) and low-velocity layers is suggestive of multiple thin slices of subducted oceanic crust and upper mantle. (d) Mafic and ultramafic cumulate rocks along the south margin of the WRT/PET have strong magnetic and gravity signatures and are interpreted as the uplifted root of a Jurassic magmatic arc superimposed on a late Paleozoic volcanic arc. Magnetic data suggest that comparable rocks underlie most of the PET. (e) The north-dipping Border Ranges fault (BRF) marks the suture along which the northern margin of the CGT was relatively underthrust at least 40 km beneath the WRT/PET. (f) Beneath the northern CGT and southern WRT/PET, a prominent seismic reflector (v = 7.7 km/sec), suggestive of oceanic upper mantle rocks, dips about 3°N and extends from a depth of 12 km beneath the Tasnuna River to 16 km beneath the BRF, where the dip appears to steepen to about 15° beneath the southern margin of the PET.

NOKLEBERG, W. J., and I. M. LANGE, U.S. Geol. Survey, Menlo Park, CA

Metallogenesis of Wrangellia Terrane, Eastern Alaska Range, Alaska

The Wrangellia terrane contains seven principal types of mineral deposits, each of which formed at a specific stage in the history of the terrane. They are from oldest to youngest: (1) small vein deposits of Cu-, Pb-, Zn-, Ag-, and Au-sulfides in fracture zones up to a few meters wide and as disseminations in hydrothermally altered late Paleozoic volcanic rocks; (2) Cu-, Ag-, and Au-sulfides in massive lenses and as dissemina-