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

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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.

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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.

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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.

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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.

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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 disseminations in skarn deposits hosted in late Paleozoic marble and in hydrothermally altered volcanic rock adjacent to Permian dacite porphyries; (3) local Cu-, Pb-, Zn-, and Ag-sulfides, as disseminations in hypabyssal Permian dacite porphyries, often propylitically altered; (4) disseminated grains and lenses of Ni-bearing chromite hosted in extensive sills of Late Triassic(?) cumulate mafic and ultramafic rocks; (5) Au- and Ag-sulfide skarn deposits hosted in late Paleozoic and Upper Triassic marble adjacent to granitic plutons of Late Jurassic through Late Cretaceous age; (6) disseminated Cu-, Ag-, and Au-sulfides hosted in a few hydrothermally altered granitic plutons of the same age; and (7) Cu-, Ag-, and Au-sulfides in quartz veins and in associated altered Nikolai greenstone and older metavolcanic rocks.

The following tectonic model is postulated. Deposit types 1-3 formed during building of a late Paleozoic island-arc. Type 4 formed during subsequent Late Triassic rifting and extrusion of mafic magma that formed the Nikolai greenstone and coeval emplacement of mafic and ultramafic sills. Types 5 and 6 formed during subsequent subduction and formation of a Late Jurassic through Late Cretaceous island arc along the leading edge of Wrangellia during migration toward North America, and type 7 formed during accretion of Wrangellia to the North American continent during Middle or Late Cretaceous time, resulting in regional greenschist facies metamorphism and in formation of quartz sweat veins.

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Post-Ellesmerian Depositional Sequences of Central North Slope Subsurface

Detailed electrical-log correlations of bedding in the Mesozoic to recent intervals define nearly time-equivalent stratigraphic units. Basinal depositional minima separate them into depositional cycles of 15 to 40-m.y. duration, and sequences of similar cycles correspond to the major episodes of Arctic tectonism. The close of the Sag River cycle in Pleinsbachian time ended the Ellesmerian sequence of accretionary tectonics and northerly continental provenance. Long, oscillating uplift to the northwest during the Jurassic Kingak cycle, and five or more subcycles of emergence along an ancestral Barrow arch rift shoulder during the Lower Cretaceous Kup River cycle show that the Barrovian sequence accompanied Arctic rifting. The Brookian sequence records a time of Arctic seafloor spreading coincident with underthrusting of the North Slope block toward a convergent Pacific margin. A series of major overthrusts onto the block from this margin were sources for Lower Torok, Nanushuk, Schrader Bluff, Prince Creek, and Franklin Bluffs cycles. The lower Torok source was in a distant westerly direction, and those of the following cycles became progressively closer and more southerly, ending near the present position of the central and western Brooks Range. A collision between Alaska and Siberia in mid-Tertiary time initiated the Eurekan sequence of circum-Arctic compressional tectonics. The North Slope block was tilted northeast, and the Nuwok cycle was derived from the resulting regional erosion. Similar tilting and erosion beginning in the Pleistocene started the Gubik cycle that is still being deposited.

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Strength and Durability Properties of Core Lithologies from Coal-Bearing Tyonek Formation, Cook Inlet Region, Alaska

The Tyonek Formation (late Oligocene to middle Miocene) is a nonmarine unit of sandstone, siltstone, and claystone that contains large quantities of strippable subbituminous coal and lignite. The geotechnical properties, determined by field and laboratory tests on core from the Capps and Chuitna coalfields, dictate the equipment needs for excavation, determination of pit slope angle for mine planning, and durability of excavated spoil to weathering degradation.

Point-load strength index tests are rapid and inexpensive field tests approximating the tensile and unconfined compressive strength of rock types. These tests, combined with laboratory uniaxial compression tests, were used to rank the formation lithologies in order of decreasing strength: coal (2,670 psi), carbonaceous claystone (825 psi), siltstone (435 psi), claystone (375 psi), and sandstone (145 psi). Except for coal, the lithologies range in hardness from soft soil to soft rock.

Laboratory slake durability index tests, which measure the deterioration potential of rock masses as a result of cyclic wetting and drying, were used to rank lithologies in order of decreasing durability: claystone (49%), carbonaceous claystone (46%), siltstone (40%), and sandstone (20%). The cored Tyonek lithologies are noncarbonate, and their strength and durability increase with decreasing grain size and increasing clay-particle content. Compressional wave velocity, combined with point-load data, indicates that most of the rocks could be removed by bulldozers with ripping blades or by scrapers and shovels. However, coal (with rare exceptions, the strongest lithology tested) would require blasting before removal.

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Facies Analysis and Correlation in Lisburne Development Area, Prudhoe Bay, Alaska

The Lisburne is a widespread group of predominantly shallow marine carbonate rocks, largely Mississippian and Pennsylvanian in age, underlying much of Alaska's North Slope. Near Prudhoe Bay, it is divided into two formations, with the Wahoo overlying the Alapah.

Oil was discovered in the Lisburne with the drilling of the Prudhoe Bay State 1 well in 1968. An active delineation program during 1983-84 and detailed geological/geophysical studies have demonstrated the viability of the Lisburne reservoir.

Log interpretation for lithology is difficult in the Lisburne, and good core control is essential. A computerized data base has been established containing foot-by-foot descriptions for more than 5,000 ft of core. We have developed a lithofacies classification based on sediment texture, grain size and type, and dolomite content.

The upper portion of the Wahoo has received the most attention and is best understood at this time. The most distinctive features of logs in the Lisburne interval are the so-called shale marker beds. These are readily correlatable across the reservoir area and have been used as time lines to divide the Wahoo into a set of detailed subzones. The major marker beds represent distinct breaks in sedimentation. Between these breaks, lithology varies both laterally and vertically. Detailed subzones have allowed us to map individual "slices" of the reservoir and to have confidence in overall reservoir continuity. Whereas matrix porosity appears to contain most of the hydrocarbons, fracture porosity is important for the interconnection of porous intervals and for productivity of the reservoir.

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Depositional Setting and Reservoir Geology of Kuparuk River Oil Field, North Slope, Alaska

The Kuparuk River field is located approximately 20 mi (32 km) west of the Prudhoe Bay field and produces from the Lower Cretaceous Kuparuk River formation. The lower member of the Kuparuk is a sequence of interbedded sandstone, siltstone, and mudstone. Individual sandstone beds in the lower member are up to 5 ft (1.5 m) thick and consist of fine-grained, well-sorted quartzarenite. The basal part of the lower member contains five sandstone-rich cycles that prograde to the southeast. Each individual cycle strikes northeast-southwest and is up to 80 ft (254 m) thick, 40 mi (64 km) long, and 15 mi (25 km) wide. The lower member sandstones are interpreted to be storm deposits derived from a northerly source and deposited on a broad marine shelf.

The upper member was deposited on an erosional unconformity and contains two sandstone intervals. These sandstone intervals are quartzose, glauconitic, very fine to coarse grained, poorly to moderately sorted, and intensely bioturbated. Both upper member sandstones are interpreted to have been deposited as subtidal sand bodies.

The upper and lower member sandstones have similar average porosities (23%), but the average permeability of upper member sandstone is considerably higher than the average permeability of the lower member. Natural fractures in siderite-cemented zones enhance the permeability of the upper member sandstone. Reservoir performance indicates that permeability is greatest in a north-south direction in upper member sandstones, and that a north-south directional permeability may also exist in lower member sandstones. North-south-oriented line-drive waterflood patterns will be utilized in areas where a north-south directional permeability is suspected.