tions 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.