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Association Round Table

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Abstracts

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Facies Comparison of Autochthonous and Allochthonous Permian and Triassic Units, North-Central Brooks Range, Alaska

Eight stratigraphic sections of Permian and Triassic rocks have been studied over a 30 km by 150 km area in the Endicott and Philip Smith Mountains of the central Brooks Range. Six of the sections are located on the Endicott Mountains allochthon, and the remaining two are parautochthonous columns in the Mount Doonerak area. The sections record a facies transition between the autochthonous Sadlerochit Group and Shublik Formation of the northeastern Brooks Range and the characteristically siliceous rocks of the allochthonous Siksikpuk and Otuk formations of the western Brooks Range.

Laterally continuous and bioturbated beds of fine-grained sandstone, siltstone, and shale dominantly compose the Permian sequence, whereas the Triassic rocks consist of black shales, thin rhythmically bedded siliceous mudstones, and fossiliferous limestones. When the allochthonous sections are restored to a position south of the Mount Doonerak area, a general shallowing trend from southwest to northeast becomes evident within the reconstructed marine basin. To the south and west, the Permian sediments show a marked increase in silica content, with the occurrence of barite and a corresponding decrease in the thickness of the basal, coarser grained clastics. The Triassic formations also document an increase in silica and the presence of barite to the south and west, while becoming significantly sooty and phosphatic to the north and east. Ongoing petrographic and micropaleontologic studies of the field data will clarify these general paleogeographic relationships.

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Geochemistry of Coal from Cretaceous Corwin and Chandler Formations, National Petroleum Reserve in Alaska (NPRA)

The Cretaceous, coal-bearing Corwin and Chandler Formations accumulated in two river-dominated deltas on the North Slope. The larger Corwin delta (Corwin Formation), in the western portion of NPRA, prograded northeastward and eastward, and the smaller Umiat delta (Chandler Formation), in the southeastern part of NPRA, prograded northward.

Ninety coal samples from these formations within NPRA were collected and analyzed in order to evaluate coal quality and elemental distribution. Their apparent rank ranges from lignite A in the northern part of NPRA to high-volatile A bituminous coal in the southern part. Mean vitrinite reflectance values range from 0.65 to 0.74%. Some Corwin Formation coal samples west of NPRA have coking potential with free-swelling indexes between 3.0 and 5.0. Compared to other western United States Cretaceous coal, NPRA coal is significantly lower in ash, volatile matter, 0, Si, Al, Ca, Fe, Ti, Cu, F, Li, Mn, Mo, Pb, Sb, Se, Th, and Zn. Statistical comparisons of element concentrations indicate that the mean content of Si, Al, K, Li, Sc, Y, and Yb increases as the mean ash content increases (correlation coefficient at least 0.7). Sulfur values are extremely low (0.1%), and elements that normally show positive correlation with sulfur, such as Fe, As, Cd, Co, Cu, Mo, Pb, and Zn, are also low.

Therefore, coal from NPRA can be characterized by low ash and sulfur contents and low contents of elements of environmental concern, such as As, Be, Hg, Mo, Sb, and Se. The elements found to have positive correlations with ash content are probably present as aluminosilicate or stable oxide minerals. Variations in element content and quality of NPRA coal were probably influenced by the geochemical conditions that existed in the Corwin and Umiat delta systems.

*Denotes speaker other than senior author.

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Alaskan Peninsula Cenozoic Stratigraphy: Stratigraphic Sequences and Current Research

"Geology of the Alaska Peninsula-Island Arc and Continental Margin," by C. A. Burk, is the principal reference for stratigraphic studies on the Alaska Peninsula. Burk mapped the Phanerozoic stratigraphy and provided a geologic history and structural interpretation of the area between Wide Bay and Unimak Island. Cenozoic rocks were mapped as three unconformity-bounded sequences. Recognition of specific formations was difficult due to similarity of lithofacies, isolated outcrops, rapid facies changes, and alteration and burial by young volcanics. Consequently, megafossil assemblages were relied upon to facilitate correlations between study areas.

The three unconformity-bounded Cenozoic sequences are:

1. The Paleogene Beaver Bay Group consisting of three formations: the dominantly nonmarine Tolstoi Formation, the dominantly marine Stepovak Formation, and the volcanic Meshik Formation. Current work suggests these units are at least in part coeval facies of late Paleocene through Oligocene age.

2. The Neogene Bear Lake Formation consisting of the lower Unga Conglomerate Member and an unnamed upper member. Rapid facies changes and incorrect reports of fossil occurrence have resulted in confusion of stratigraphic relationships within this sequence of middle to late Miocene age.

3. A late Neogene informally defined upper sequence consisting of interbedded marginal marine, coastal-plain, and volcanic facies. Current work suggests this sequence is Pliocene through Pleistocene in age.

The ongoing research presented in this symposium focuses on the refinement of Burk's work using an interdisciplinary approach involving revised biostratigraphic frameworks, sedimentologic models, radiometric dating, and paleomagnetic studies. While much progress has been made, many problems remain unresolved.

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Depositional Environment and Geologic Age of Neogene Rocks at Cape Aliaksin, Beaver Bay, Alaska Peninsula

Neogene sandstone and conglomerate cropping out along the eastern end of Beaver Bay at Cape Aliaksin have been assigned to the Unga Conglomerate Member of the Bear Lake Formation. New data suggest that this correlation may be incorrect.

The rocks at Cape Aliaksin consist of more than 250 m of interbedded sandstone and subordinate conglomerate overlain by volcanics. Sandstones are dominately cross-stratified tabular and sigmoidal beds. Paleocurrents are bimodal with a dominant north to south transport direction. Marine fossils are dispersed through the sandstones. Conglomerates are thin beds of cobble to boulder clasts. Some show southward imbrication; others are inversely graded. Fossils are rare in the conglomerates. The sandstones are interpreted as tidal sand waves and tidal bundles; conglomerates are interpreted as storm lag and debris flow deposits.

The fossil assemblage includes gastropods, pelecypods, barnacles, and echinoids indicative of a shallow marine, cold-water biofacies. Taxa indicate a strong similarity to the fossil assemblage of the Tachilni Formation and the upper Bear Lake Formation, both assigned to the late Miocene Graysian Molluscan stage, approximately 12 Ma to 3 Ma.

Teeth of the desmostylian (sea cow) *Desmostylus* sp. cf. *D. hesperus* have been collected from the Cape Aliaksin beds. *D. hesperus* is known from North Pacific rocks assigned to the late early to early late Miocene, approximately 18 Ma to 10 Ma.

The Unga Conglomerate is in part typified by the middle Miocene pelecypod *Mytilus gratacapi* and an associated fauna unlike that of the Cape Aliaksin beds. It is suggested that the Cape Aliaksin beds are younger than the Unga Conglomerate, and are correlative to the upper Bear Lake Formation and Tachilni Formation rocks of early late Miocene age.

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Do Oil and Gold Mix in Alaska?

Excellent potential for sea-floor-placer heavy mineral deposits exists locally along the coast of Alaska within lands owned by the state. Aspen Exploration first applied for precious metal offshore prospecting permits (OPPs) from the state in 1980 for certain lands in Cook Inlet, including lands that are prospective for oil and gas production. Exploration to date has included geologic mapping, beach sampling at many locations, and a 6,400-mi low-level aeromagnetic survey. More than 20,000 ft of sediments underlie areas that appear most prospective for placer gold deposits, thereby facilitating geophysical interpretation of sea-floor magnetic anomalies. Work to date, now suspended, suggests large, linear, offshore heavy mineral concentrations, which likely include gold.

Obtaining permits in Alaska is difficult, frustrating, and expensive. After 5 years of effort, no permits have been issued to Aspen. Primary opposition has come from the Alaska Department of Fish and Game, which has taken the position that insufficient biological resource information is available in the prospect areas. These same offshore areas, however, are held under oil and gas leases from the state by various companies.

The difficulties encountered by smaller oil companies in attempting to carry out exploration in Alaska, which have forced virtually all of them to abandon their efforts in this state, are compared with difficulties hard-mineral companies are encountering. It is important to recognize that income to the state of Alaska from oil royalties and taxes is of such magnitude that needed support for hard-mineral exploration and mining is being suppressed by a hostile bureaucracy and by preservationists.

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Sag River Formation, Prudhoe Bay, Alaska: Depositional Environment and Diagenesis

The Sag River Formation is a minor hydrocarbon reservoir in the Prudhoe Bay field, Alaska. It comprises bioturbated, glauconitic, argillaceous, quartzose fine to very fine-grained sandstone and siltstone and varies from 55 ft (17 m) to 20 ft (6 m) in thickness in the field. The formation is the upper part of a very fine-grained, upward coarsening, terrigenous, clastic-dominated sequence deposited in Late Triassic time. This sequence includes the upper part of the subjacent Shublik Formation. Lithofacies variation within the Sag River is minimal with stratigraphic thinning from the north-northeast to a south-southwest shaleout. The formation was deposited in a low-energy, offshore, marine-shelf environment basinward of a low-relief source area. Upward coarsening, as well as slightly older Sag River facies in more proximal areas, suggests regionally significant marine regression during deposition.

In the Prudhoe Bay field, diagenesis along with abundant primary detrital matrix significantly diminishes reservoir quality. Ductile grain deformation, authigenic clay-grain coatings, quartz overgrowths, and carbonate cementation have resulted in microporosity and associated low permeability, which is the primary shortcoming of the Sag River reservoir. Larger, interconnected secondary pores (and associated improved reservoir quality) were produced by the dissolution of carbonate cement and possibly other mineral phases.

Reservoir quality in the Sag River Formation is strongly influenced by proximity to its subcrop with the overlying Lower Cretaceous "Highly Radioactive Zone." Mineral leaching probably resulted from aggressive fluid incursion at that truncation surface. The source of those fluids is not presently known.

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Reservoir Description of Endicott Field, Prudhoe Bay, Alaska

Located about 2 mi offshore and several miles east of Prudhoe Bay, the Endicott field contains about 1.4 billion reservoir bbl of oil and 0.5 billion reservoir bbl of gas.

Hydrocarbons occur within Mississippian fluvial sandstones of the Kekiktuk formation, which unconformably overlies the Neruokpuk Formation and grades upward into the Kayak and Itkilyariak formations. Stratigraphy is subdivided into three lithofacies that, from the base upward, reflect deposition in a swamp/lacustrine/flood plain environment (zone 1), a braided stream system (zone 2), and a meandering stream system (zone 3). Sediment dispersal was from a northerly source.

Endicott field structure defines a southwesterly plunging antiform that is bounded to the north, northeast, and southwest by major normal faults and is truncated to the northeast by the Lower Cretaceous Unconformity (LCU). Shales overlying the LCU and shales of the Kayak and Itkilyariak formations form the reservoir cap.

Reservoir properties within the hydrocarbon column vary by zone with zones 3 and 2 typified by an average net/gross-porosity-water saturation-permeability of 37%-18%-22%-500 md and 88%-22%-13%-1,100 md, respectively. In contrast, zone 1 quality is very poor. Reservoir sands are compositionally very mature and exhibit an enhanced pore network. Diagenetic minerals include quartz along with lesser kaolinite and carbonate.

Gas is present from about 9,500 ft (2,850 m) to 9,855 ft (2,958 m), oil is down to 10,180-10,200 ft (3,054-3,060 m), and tar accumulations are down to 10,400 ft (3,120 m) subsea. Average oil gravity is 23° API. Geochemical data indicate that the tar accumulations originated through a physical deasphalting process. Cenozoic imbibition resulted in water overriding tar.

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North Slope Oil and Gas: The Barrow Arch Paradox

In the 40-year history of hydrocarbon exploration on the Alaskan North Slope, about 21 accumulations with a total in-place volume of more than 60 billion bbl of oil and 35 trillion ft^3 of gas have been discovered. Although the density of exploratory drilling in this region is not uniform, enough drilling has been done to show a distinct concentration of oil and gas in the Prudhoe Bay area between the Colville and Canning Rivers. This concentration is also evident when the Prudhoe area resources are compared with the USGS estimates of undiscovered in-place oil and gas resources of the adjacent areas, the National Petroleum Reserve in Alaska and the Arctic National Wildlife Refuge. Most oil and gas in the Prudhoe area accumulated near the present coastline in reservoirs that overlie a southeasterly plunging basement ridge, the Barrow arch. The location of these accumulations, in low-relief structural-stratigraphic traps midway along the arch and downdip from its apex at Point Barrow, is the paradox.

An answer to this paradox is provided by analysis of two cross sections, one along the Barrow arch and one perpendicular, showing their original structural positions for the beginning, middle, and end of Cretaceous time. In the Early Cretaceous (mid-Neocomian), the crest of the Barrow arch was near sea level along its entire length. Because of northeasterly sediment progradation during later Cretaceous time, the Barrow area became more deeply buried than the Prudhoe area, thus making the Prudhoe area the focal point for migrating oil and gas. Beginning in the early(?) Tertiary, the Barrow area was slowly uplifted while the Prudhoe area subsided, thus beginning the process that resulted in the reversal of their relative elevations and the focus for migrating oil and gas. Studies show that the Prudhoe Bay field was tilted during the Tertiary, and some oil and gas escaped, migrated toward Barrow, and was trapped in the Kuparuk, West Sak, and Ugnu fields. This analysis suggests that most North Slope oil and gas were generated during the Cretaceous.

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K-Ar Ages of Allochthonous Mafic and Ultramafic Complexes and Their Metamorphic Aureoles, Western Brooks Range, Alaska