Knowledge of the relative motion of the North American and Eurasian plates during the late Mesozoic and Cenozoic provide insight into the observed timing and style of deformational events in the Bering Sea region. Periods of strong convergence between the North American and Eurasian plates (approximately 70-50 Ma, Maestrichtian to Paleocene) are correlated with compressional deformation between the Chukotsk Peninsula and northern Alaska and the initiation of development and movement along the Denali fault. The convergence also may be the cause of a previously proposed counterclockwise rotation of the Alaska Peninsula. Transform motion between these plates (approximately 50-37 Ma, middle to upper Eocene) correlates with subsidence of the Bering shelf and creation of a series of pull-apart basins (Anadyr, Amak, Bristol Bay, Navarin, Pribilof, and St. George) along the Bering margin. Slight compressive convergence from 37 Ma to present may be responsible for the anticlinal deformation of basin-filling sediments in the Anadyr and Khatyrka basins reported by McLean. A correlation between the velocities with which the two plates moved away from each other in the North Atlantic and the geometry of interaction in the Bering Sea region can be seen for most of the Tertiary.

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Conodont Thermal Maturation Patterns in Paleozoic and Triassic Rocks, Northern Alaska—Geologic and Exploration Implications

The Paleozoic through Jurassic stratigraphic sequence in the Brooks Range consists of platform to intraplatform basin deposits 1-5 km thick. This comparatively thin sequence of heterogeneous lithologies was tectonically disrupted and shortened at least 600 km to form a stack of allochthons that were transported relatively northward and emplaced during the earliest Cretaceous. Thermal patterns in Paleozoic and Triassic rocks, based on conodont color alteration indices (CAI) from about 600 localities, show: (1) a gradual increase in thermal level from the northern margin to about 3/4 of the distance southward across the range (from CAI 1 to 5.5 and higher); (2) a belt of mixed high values (CAI 4.5 to 7) along the south border of the range; (3) thermal levels in surface and subsurface samples in the range related to tectonic burial and not to pre-thrust burial metamorphism; (4) the same CAI values in rocks above and below the Ellesmerian unconformity in the northeast Brooks Range; (5) an association of anomalously high CAI values with mineralized areas and plutonic rocks; (6) a few anomalously high CAI areas of unknown origin that deserve further study; (7) thermal potential of hydrocarbons (CAI = 4.5) only in the westernmost and northern margins of the Brooks Range; and (9) mineralization potential related to anomalously high CAI values in the southern Brooks Range.

Triassic through Mississippian rocks in wells on the north flank of the Colville basin show conventional burial metamorphism patterns within each well and from well to well. All rocks indexed have thermal potential for hydrocarbons (CAI = 1-4.5).

The geology of the Seward Peninsula appears to be a southwestern continuation of that in the Brooks Range. Most of the western one-fifth of the Seward Peninsula contains 4-5 km of unmetamorphosed platformal, dominantly shallow-water carbonate rocks of Early Ordovician through Devonian age having CAI values of 3-4. Eastward, these rocks are thrust onto a blueschist terrane of mafic volcanogenic and clastic deposits and mixed carbonate and clastic rocks of probable Ordovician through Silurian age. Adjacent to, and possibly infolded with, these rocks are metamorphosed shallow-water carbonates of Early Ordovician through Devonian age similar to the rocks of the westernmost Seward Peninsula. Conodonts from the metacarbonate rocks have CAI values of 5.5-7, indicating temperatures of 350-450°C that are consistent with blueschist metamorphism.

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Thermal Windows of Yukon-Koyukuk Basin, Alaska

Vitrinite reflectance values from two mid-Late Cretaceous sedimentary sections in the Yukon-Koyukuk basin are within the oil window when plotted on a time-temperature-reflectance nomogram. However, preliminary paleomagnetic studies in other areas indicate a higher temperature overprint. To establish a more consistent record of paleothermometry in the basin, over 500 paleomagnetic samples from 35 localities and 25 K-Ar dating samples were analyzed. The samples include cobbles from conglomerates to test for remagnetization and argon loss.

Our analysis indicates that (1) some sample localities fail the conglomerate test (cobbles show consistent magnetic directions) and have experienced temperatures of 300°-500°C, (2) other localities, along the lower Yukon River, display primary paleomagnetic signals that pass both conglomerate and regional fold tests and have reversals, and (3) K-Ar ages of detrital components (volcanic pebbles and muscovite) from the lower Yukon River localities are older than their age of deposition, suggesting that temperatures have not exceeded the K-Ar blocking temperatures of these components (~ 300°C for muscovite and lower for whole rocks).

The complex thermal history of the Yukon-Koyukuk basin is a result of at least three magmatic episodes. The overprinted areas are closest to igneous occurrences; other areas were thermally unaffected by these widespread magmatic pulses.

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Brooks Range and Eastern Alps: A Tectonic Comparison

A comparison of the tectonic evolution of the Brooks Range (BR) and the Eastern Alps (EA) reveals a remarkable parallelism. Both of these Mesozoic-Cenozoic orogenic belts are underlain by sialic crust formed in an earlier Paleozoic orogenic cycle. The old basement is revealed in major tectonic windows: the Tauern Fenster (EA) and the Doonerak Window-Schwatka Mountains (BR)—which are unconformably overlapped by transgressive, neritic marine clastic to carbonate successions—the Permo-Triassic through Hochstegenkalk sequence (EA), and the Kekiktuk-Kayak-Lisburne sequence (BR). These successions are passive-margin sequences that pass southward, in palinspastically restored cross sections, to synchronous deep-water facies deposited on ophiolitic basement—Bunderschiefer on Triassic-Jurassic ophiolites (EA) and Kuna facies or Etivluk sequence on upper Paleozoic ophiolites (BR). Onset of subduction-collision is marked by olistostromal facies—Cretaceous wildflysch (EA) and Jura-Cretaceous Okpikruak Formation (BR)—and the development of major flysch-molasse successions in the foreland basins of the collisional fold and thrust belts.

Important major contrasts between these two mountain ranges reside in their colliding blocks and their post-orogenic histories. Alpine orogenesis was driven by continent-continent collision, closing out a young, narrow ocean, whereas Brooks Range deformation appears to have originated by arc-continent collision, closing out an older, broad (?)ocean. Younger Cenozoic deformation is extensional and strike-slip in the Eastern Alps, producing disjunctive basins, but Cenozoic deformation in the Brooks Range is diverse and includes compression in the east and extension in the far west.

By means of numerous stratigraphic and structural analogs in the better known Eastern Alps, the comparison of these two mountain belts provides interpretive insight into the Brooks Range.

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Early Electromagnetic Soundings in Permafrost Sections on North Slope, Alaska

During 1970-71, electromagnetic methods were used to determine permafrost thickness on the North Slope of Alaska between Barrow and Prudhoe Bay. In the measurements, the electromagnetic coupling between two loops of wire lying on the ground was measured over a frequency range from 20 to 8,000 Hz. An initial interpretation was done using graphical curve matching, but the data have been subsequently reinterpreted using a computer-based inversion approach. The results indicate that permafrost thickness, as indicated by high electrical resistivity in near surface rocks, is highly variable, ranging from 0 to 2,200 ft (0-660 m). The frozen rock has the least thickness and lowest resistivity in the deltaic areas beneath northward-flowing rivers. The effect may possibly be explained by the warming effect of the water flow in the rivers or by a change to finer grain size in the sediments in the deltaic areas.