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Arctic Reconstruction from an Alaskan Viewpoint

Field, seismic, structural, and stratigraphic data were used to reconstruct the geologic history of the Arctic in 10-m.y. time slices from the present to mid-Jurassic—the initial opening of the Arctic Ocean. A basic assumption is that Lomonosov Ridge, Alpha Ridge, Mendeleyev Ridge, and Chukchi Plateau are all foundered continental plates.

Opening of the Arctic occurs in two stages: Late Jurassic-Cretaceous for the Canada basin and Neogene for the Eurasian basin. Opening is facilitated by two subparallel transform shears—the Arctic (Kaltag-Porcupine) on the east and the Chukchi on the west. Deformation is essentially tensional on the Barents side of the Arctic and shear-compressional on the Alaska side.

The development of Chutkoya, North Slope, Brooks Range, northwest Canada, Seward Peninsula, and central Alaska can be sequentially related to Arctic opening, modified by impingement on the northern terrane of allochthonous terranes arriving from the south—the Pacific plates of Tintina, Denali, Orca (Prince William-Chugach-Yakutat), Anadyr, Khatyrka, Kolyman, and other minor terranes.

The North Slope of Alaska, a passive, rifted, subsided margin, is restored to line up with a similar margin on Alpha Ridge. Northeastern Alaska (the Romanzof Mountain area) lines up opposite the north end of the Sverdrup Rim, near Prince Patrick and Borden Islands.

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Cretaceous Olistostrome Model, Brooks Range, Alaska

The foothills area of the Brooks Range thrust belt in the area between the Itkillik River and the Etivluk River is composed dominantly of shallow, thrusted olistostrome sheets. Three olistostrome units can be recognized based on the dominant lithology of contained olistoliths and age of the matrix shales. The lower unit is Tithonian to mid-Valanginian in age and is characterized by abundant graywacke and turbidite, mafic rocks, black cherts, olistoliths of Norian-Rhaetic shales, Nuka sands, and glide sheets of Upper Devonian to Lower Mississippian rocks. Olistolights were derived from the Misheguk, Ipnavik, and Nuka Ridge allochthonous sequences.

The middle unit is of late Valanginian age and has olistoliths of Norian shales; more abundant Upper Triassic chert; Otuk Formation; variegated, radiolarian, black and white cherts; Siksikpuk facies red, green and black shales; Upper Jurassic graywacke; and minor occurrences of mafic rocks. The unit is characterized by glide sheets of Triassic white and multicolor cherts. Olistoliths are derived from Nuka Ridge and Brooks Range sequences.

The upper unit is Hauterivian in age and olistoliths include reworked material from all older units. Olistoliths are few and widely scattered. Isolated outcrops of white chert and conglomerate boulders are characteristic.

The oldest unit was originally deposited in a now-destroyed "southern" basin, south of the Brooks Range. The middle unit was originally deposited in a basin near the present mountain front and the upper unit in the Colville trough. Each unit developed in front of and was sourced from advancing thrust sheets.

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Structural Style—Brooks Range Mountain Front, Alaska

The Brooks Range mountain front between the Sagavanirktok River and Kurupa Lake is characterized by thrust sheets of Lisburne rocks, which dominantly have stratigraphic tops to the north and either dip northward or are overturned to the south.

The early (Jurassic-Neocomian) thrust belt strikes obliquely (N70°W) into the mountain front and can be traced on seismic sections into the foothills. Individual thrust structures die out westward into overturned folds and ultimately into plunging noses as the thrust belt plunges to the west and successively higher structural levels are exposed. The total thrust displacement remains essentially constant because of transfer of motion to higher thrusts. Most of the west plunge occurs along narrow zones of "instant plunge" with essentially zero plunge occurring along trend.

The present east-west mountain front is oblique to the original thrust vergence (N20°E) of Jurassic-Neocomian age and is due to later (Albian and younger) Brooks Range core uplift, folding, and comparatively minor thrusting.

The Lisburne folds at the mountain front respond almost plastically to the late core uplift and gravitationally slide downward on rotated north-dipping thrust faults to form cascading folds with easiest relief upward and northward.

Core uplift has rotated original thrust sheets 90° in some instances so that geologic map patterns are plunge-projection cross sections of thrust plates. The pattern at Eskimo Creek (Table Mountain quadrangle, eastern Brooks Range) illustrates how a plunge view can reveal the true structure of the thrust belt.

Examples of mountain-front structures are given at Killik River, Kurupa Lake, Kaikshak Hill, Akmagolik Creek, Atigun River, and Ivishak River.

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Provenance of Conglomerate Clasts from Upper Cretaceous Kuskokwim Group, Southwest Alaska

The predominantly Upper Cretaceous (Albian to Coniacian) Kuskokwim Group consists of marine turbidites and subordinate fluvial and shallow marine strata, deposited in an elongate southwest-trending basin covering over 70,000 km^2 in southwestern Alaska. In the Sparrevohn and Cairn Mountain areas of the Lime Hills A-7 and A-8 quadrangles, fluvial, inner fan, middle fan, and outer fan facies are stacked with distal facies over proximal facies by northwest vergent thrust faults. Inner fan pebble-to-cobble conglomerate and pebbly sandstone were deposited as submarine grain flows up to 10 m thick containing reversely graded bases and normally graded tops. Clasts from these conglomeratic deposits are predominantly sedimentary rock fragments—particularly sandstone, siltstone, and argillite—originally thought to have been derived from the nearby Jurassic and Lower Cretaceous flysch (Kihiltna terrane). Detailed examination of these clasts, however, indicate that they contain as minor constituents Paleozoic coral, oolitic limestone, algal boundstone, radiolarian chert, and mafic, intermediate, and felsic volcanic rocks, most likely derived from the adjacent Nixon Fork, Dillinger, and Mystic terranes. Sandstone clasts are arkosic (Q25-F37-L38, $n = 7$) and contain subequal amounts of K-feldspar and plagioclase. Sand grains within these clasts are moderately sorted, subrounded, and have presolved contacts. Similar arkosic rocks have been described from the Dillinger terrane of the McGrath quadrangle and are the most likely source for the pebbles and cobbles within the Kuskokwim Group.

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Cretaceous Basin-to-Shelf Transition in Northern Alaska: Deposition of the Fortress Mountain Formation

The Fortress Mountain Formation (Albian) is a sequence of shale, sandstone, and conglomerate exposed as isolated synclinal outcrops in the southern foothills province of the Brooks Range. The formation overlies a variety of severely deformed older rocks, particularly the Okpikruak Formation of Neocomian age. The unit records a significant change in the depositional architecture of the North Slope Cretaceous and is closely tied to the evolution of the Brooks Range orogenic belt.

Detailed stratigraphic and sedimentologic studies of the Fortress Mountain Formation within the type region and at easternmost exposures have demonstrated a systematic change in lithology and bedding style. The lower 40% of the Fortress Mountain is transitional with the Torok Formation and is composed of thick (up to 2,000-m) intervals of gray to black shale with thin, rhythmically interbedded, fine-grained sandstone beds. This succession is interrupted periodically by allochthonous blocks of conglomerate and conglomeratic sandstone. The sequences record a transition from basin plain to slope sedimentation. The middle 30-40% of the formation is composed of thick conglomerate and conglomeratic sandstone lenses that thin toward the north and are arranged in multiple upward-coarsening sequences and megasequences.