along these preexisting fracture planes in response to extensional forces imposed by the Rundle thrust stepping up-section.

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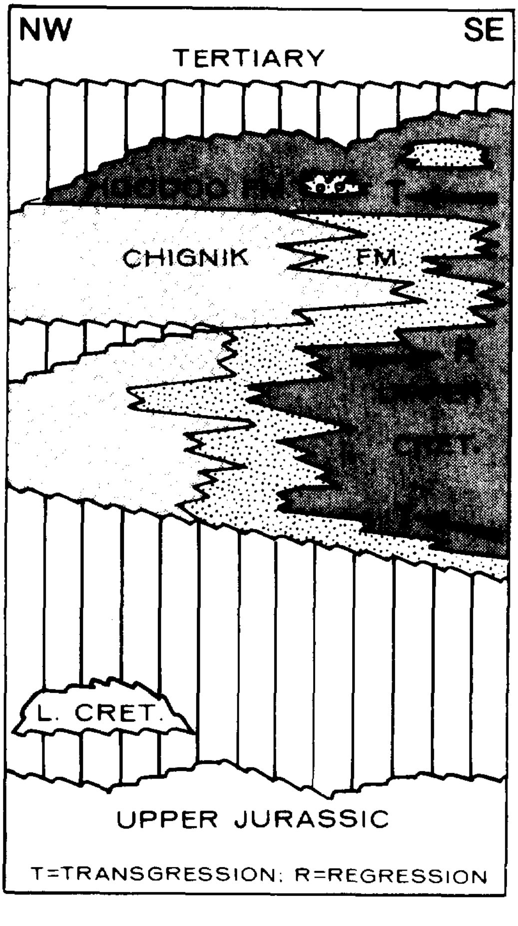
Cretaceous Stratigraphy, Chignik Area, Alaska Peninsula, Alaska

Lower and Upper Cretaceous strata in the Chignik area were deposited in a fore-arc basin along an intermittently active continental-plate margin. The Lower Cretaceous part is preserved in a limited area and consists of 98 m of shallow-marine sandstone, rich in *Inoceramus* prisms, and shale of Valanginian to Hauterivian(?) age. These rocks are correlated with the Herendeen Limestone, which crops out 160 km to the southwest.

Upper Cretaceous strata in the Chignik area comprise the Chignik Formation of Campanian age and the Hoodoo Formation of Campanian to Maestrichtian age. In the Chignik Bay area, the Chignik is composed of 550 m of predominantly deltaic shoreface sandstone overlain by about 300 m of predominantly nonmarine coastal-plain facies; at least 15 transgressive-regressive cycles are recognized. Oil staining is common in more permeable, coarser grained sandstones in the Chignik Bay area. About 14 km to the northwest, the Chignik Formation is dominantly nonmarine and is less than 400 m thick. Thick conglomerate units and at least one intraformational unconformity indicate continuing tectonic activity in the source area located to the northwest.

The Hoodoo Formation conformably overlies, and in part intertongues with, the Chignik Formation. The Hoodoo consists of 600 m of deep-water silty shale with local turbidites and slope-channel conglomerates. Lower Tertiary strata unconformably overlie the Hoodoo.



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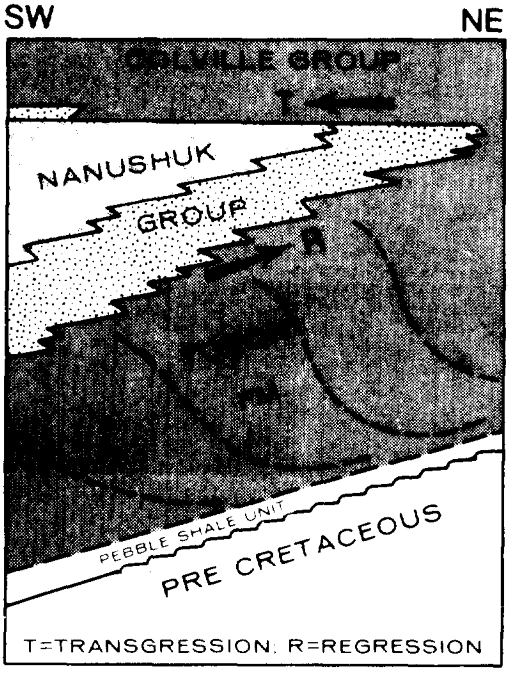
Stratigraphic Relations of Nanushuk Group (Middle Cretaceous) and Associated Strata, North Slope of Alaska

The Nanushuk Group of Albian to Cenomanian age is a passive-margin deltaic deposit 3,500 m thick that underlies much of the western and central North Slope. Correlation of about 30 test wells, integrated with seismic control, indicates that the Nanushuk delta prograded from west-southwest to east-northeast across the subsiding Colville basin. The primary source area was in the distant southwest, probably in the area of the present Chukchi Sea or beyond. The ancestral Brooks Range, which bounds the south side of the basin, was a secondary but important source area.

Seismic data indicate the Nanushuk to be part of a sequence of topset beds that are laterally equivalent to and underlain by outer shelf topsets, slope foresets, and basinal bottomsets of the Torok Formation. Distal bottomset beds, which consist of shales and minor sandstones, were deposited in water depths of 450 to 900 m. The original continental slope angle generally steepened



from west to east to as much as 6°.

The total incremental stratigraphic rise of the base of the Nanushuk is about 2,100 m from the westernmost well to the pinch-out on the east, a distance of 370 km. However, subsidence was not uniform throughout the basin, as indicated by less subsidence of the passive Barrow arch on the north side of the Colville basin.

Subcommercial amounts of oil and gas occur in shallow anticlinal and truncation traps in the Nanushuk Group, one of many objectives being evaluated by the current National Petroleum Reserve in Alaska (NPRA) drilling program.

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Depositional Environment of Clay Minerals from Northeast Gulf of Alaska

Analyses of more than 100 recent bottom samples from the northeastern Gulf of Alaska continental shelf between Icy Point and Prince William Sound show an average clay mineral assemblage of 61% kaolinite and chlorite, 37% illite, and 2% smectite. Organic content generally is less than 2%.

The clays being deposited today are predominantly glacially eroded, fluvially transported, and rapidly deposited. The present depositional environment is characterized by rapid mechanical erosion at the outcrop with little or no chemical weathering, rapid fluvial transport, and continental shelf sedimentation rates as high as 30 m/1,000 years. Of the 50 largest streams draining into the Gulf of Alaska, all are either glacially fed or drain a recently deglaciated area.

The Yakataga Formation of Miocene through Holocene age which underlies much of the continental shelf in this area, has many mud-rich units similar to the modern shelf sediment in clay mineralogy and mode of origin. The Yakataga Formation averages 60% kaolinite and chlorite, 27% illite, and 13% smectite. Differences in the smectite and illite content of the Yakataga Formation and the modern shelf samples may represent post-depositional diagenesis of the Yakataga Formation.

In climate, geography, and sedimentary regime, the northeastern Gulf of Alaska depositional environment has remained relatively constant since middle Miocene time. One question yet to be answered is whether the presently accumulating continental shelf sediment will prove to be a hydrocarbon source bed of the future. Drilling in the Yakataga Formation has failed to confirm its status as a major source unit.

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Generation of Abnormal Pressures Through Organic Matter Transformations

In argillaceous and carbonate-evaporite source beds, much of the oil-generating organic matter is concentrated along bedding surfaces (varves and laminae). During the principal phase of oil generation, when adequate thermal energy is available, 25 to 30 wt. % of the original organic matter commonly is converted to liquids, mainly bitumen, with a relatively small percentage of water. Part of the bitumen is then thermally cracked to crude oil before oil expulsion occurs. Substantial amounts of gas, principally hydrocarbons with some CO_2 and N_2, are also generated. Much of the water and CO_2 is generated before oil is formed.

The release of fluids from the organic matter causes a reduction in the volume of the residual solid organic matter; however, this volume decrease is offset by the considerably greater volume of the generated fluids. Thus, the volumes of generated products plus residual organic matter represent a substantial net volume increase relative to the volume of the organic matter at the start of significant oil generation. Consequently, very high pressures result locally along the bedding surfaces if the laminae are adequately sealed. Eventually, these localized, transitory, high fluid pressures will develop along the bedding in most parts of the source-rock sequence if the entire source-rock system is sealed and confined. This generated fluid pressure supplements aquathermal pressure caused by thermal expansion of water but is more focused in time and space and is, therefore, a more important factor in internal migration and expulsion than aquathermal pressure.

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Post-Compaction, Subsurface Secondary Porosity Generation, and Occlusion in Upper Jurassic Smackover in Southern Arkansas

The upper Smackover (Oxfordian) in southern Arkansas consists of a high energy, blanket sequence of ooid grainstones. It is a prolific gas and oil producer. Regional and field petrographic studies of reservoirs lead to the conclusion that porosity distribution is primarily controlled by post-compactional diagenetic processes. The most significant processes are calcspar cementation, occluding or reducing intergranular porosity, and dissolution, leading to evolution of vugs and enlargement of primary intergranular pores.

The calcspar cement occurs as large poikilitic crystals, cementing several grains, or as blocky crystals with straight "compromise" boundaries. The cement binds crushed grains and particles of spalled-off oolitic laminae. Pressure solution microstylolites between adjacent grains do not extend into the cement crystals; cement generally pre-dates hydrocarbon emplacement, although some cements do contain hydrocarbon inclusions indicating that the timing of migration and cementation was nearly coincidental.

The secondary pores consist of equidimensional or elongate vugs, from a few to several hundred microns in size. The dissolution post-dates all other diagenetic phases, excluding stylolitization.

Both the calcite precipitation and dissolution are related to hydrocarbon migration, as well as to the updip movement of deep-seated brines, originating from the Louann Salt basins, evolving finally to calcium chloride brines, commonly found in the Smackover reservoir.

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Powder River Basin "High" and its Implications for Future Exploration

A large basement "high," or structurally positive element, defined by isopach maps and Bouguer gravity