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PLUTONIC BELTS OF CENTRAL AND SOUTHERN ALASKA RANGE AND ALASKA PENINSULA

Potassium-argon mineral ages and reconnaissance mapping of approximately 30,000 sq mi of the central and southern Alaska Range and Alaska Peninsula indicate that there were 3 major plutonic episodes during the Mesozoic and Tertiary. The first began in the Early Jurassic (about 180 m.y. ago) and continued for about 25 m.y. No plutonic rocks older than Jurassic have been recognized. Plutons of Jurassic age form an arcuate belt about 600 mi long which roughly parallels the Talkeetna geanticline and Matanuska geosyncline, major tectonic elements of south-central Alaska. Jurassic plutonic rocks are largely diorite and quartz diorite with minor granodiorite. Late Cretaceous and early Tertiary plutons (83–55 m.y.) occur locally within this belt, but in the southern Alaska Range these plutons characteristically form north-trending belts transverse to the earlier tectonic elements and locally extend out into what was probably a more stable area bordering the earlier tectonic features. Composition of these plutons ranges from diorite through granite, but granodiorite and quartz monzonite predominate. Isolated granitic stocks of this age also extend eastward into the central Alaska Range. The data suggest that this period of magma generation and emplacement may be separated into Late Cretaceous (70–85 m.y.) and early Tertiary (50–65 m.y.) plutonic episodes. Middle Tertiary plutons (34–41 m.y.) form a north-trending belt about 100 mi long in the central part of the southern Alaska Range. These rocks, characteristically granites and quartz monzonites, are flanked by more mafic early Tertiary and Late Cretaceous plutons. Small plutons of middle Tertiary age also are present locally in the central part of the Alaska Peninsula. A still younger plutonic episode (25–30 m.y.), perhaps a later phase of the middle Tertiary episode, is represented by small isolated granitic stocks. The plutonic rocks of the central and southern Alaska Range and Alaska Peninsula are more silicic with decreasing age.

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STRUCTURE AND STRATIGRAPHY OF EASTERN ALASKA RANGE, ALASKA

The eastern Alaska Range, between 141°W (international boundary) and 145°W in south-central Alaska, provides clues to the tectonic development of northwest North America.

The Denali fault system, a major structural feature extending in an arcuate path from the Bering Sea to the Gulf of Alaska, transects the eastern Alaska Range and separates extremely diverse geologic terranes. North of the Denali fault lies a widespread terrane of highly deformed metamorphosed sedimentary and minor igneous rocks, Precambrian to Devonian in age. South of the Denali fault system these rocks are absent and the oldest rocks exposed are a heterogeneous series of Pennsylvanian(?) or Permian volcanics and volcaniclastics derived from a late Paleozoic volcanic island arc probably built directly on oceanic crust. These rocks are overlain by a succession of Permian marine sediments and limestones, Triassic carbonaceous shales, subaerial tholeiitic basalt flows and marine limestones and Jurassic-Cretaceous argillite, graywacke, and conglomerate with a cumulative thickness locally exceeding 10,000 ft. Sedimentation culminated in middle(?) Cretaceous time with a short-lived and restricted episode of andesitic volcanism. Relatively undeformed continental sedimentary rocks of Cretaceous age or younger and late Cenozoic terrestrial volcanic flows overlie the older rocks with marked angular unconformity.

Linear bodies of serpentinized ultramafics occur with the Permian rocks on the west in the central Alaska Range and on the east in Canada. In the eastern Alaska Range ultramafic rocks have not been observed south of the Denali fault but they are present locally along the fault zone and in the older terrane directly north of the fault.

All rocks older than Late Cretaceous south of the Denali fault system have been cut by steep normal faults and by numerous reverse and thrust faults that dip north toward the Denali fault. The Jurassic-Cretaceous marine sedimentary rocks also exhibit complex folding, locally isoclinal, with fold axes plunging at shallow angles generally northwest.

The geologic data suggest that the oceanic terrane south of the Denali fault collapsed against and was added to the continental American plate, probably in Early Triassic time. Since then this terrane has been deformed many times as later oceanic plates impinged against the continental margin. The Denali fault, which is an ancient subduction zone, has been reactivated as a ridge-arc dextral transform fault, probably during the early Pliocene in response to a change in the direction of spreading in the North Pacific oceanic plate. The Totschunda fault system, which diverges from the Denali structure near 144°W and trends southeasterly toward the Fairweather fault in the Gulf of Alaska, is another major right-lateral strike-slip structure that may have developed as recently as in the middle Pleistocene. The Denali fault system appears to be presently inactive southeast of the Denali-Totschunda junction.

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STRUCTURE, STRATIGRAPHY, AND ISOTOPIC COMPOSITION OF ROCKS OF SEWARD PENINSULA, ALASKA

The Seward Peninsula consists principally of metamorphic rocks of Precambrian age, of less metamorphosed pelitic and carbonate rocks of late Precambrian age, and of thick carbonate rocks of Paleozoic age. These rocks are intermixed in extensive thrust plates of two ages: the earlier (eastward thrusting) is probably pre-middle Cretaceous, and the later (northward thrusting) is older than 74 m.y. Stocks and batholiths of granitic rocks, containing alkalic rocks locally, and gneissic phases intruded the older thrust plates, whereas stocks of biotite granite with associated tin and beryllium deposits intruded the younger thrust sheets. Extensive andesitic volcanic rocks on the eastern Seward Peninsula are of Late Jurassic to Early Cretaceous age; they grade upward into graywackes and siltstones of Cretaceous age which are tightly folded. Tertiary rocks are coal bearing and deformed and crop out in small areas; they are most probably of late Tertiary age. Extensive volcanic fields of latest Tertiary to Holocene age cover large areas of the central and eastern Seward Peninsula. Marine terraces older than Sangamon are warped, and a range-front fault along the Kigluaik Mountains offsets moraines of Wisconsin age.

Early attempts to date the Precambrian rocks by K-Ar and Rb-Sr dating of micas failed because of their mal effects of the large Cretaceous intrusives. The rocks are currently being dated by Rb-Sr analyses of whole rocks. Thirteen dated samples indicate an age of 700 m.y. for the regional high-grade metamorphism of Precambrian rocks. A younger (Cretaceous?) thermal metamorphism was so severe, however, that even some whole-rock ages of Precambrian(?) granitic sills and dikes were lowered. These "reset" ages generally fall near the range of the Devonian; thus they may reflect the widespread Devonian orogeny of the Circum-Arctic basin rather than resetting by younger intrusives. Uranium-thorium ratios correlate well for Cretaceous intrusives, but not so well for Precambrian intrusives.

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JURASSIC AND NEOCOMIAN PALEOZOOGEOGRAPHY OF ARCTIC

During the Jurassic and Early Cretaceous, Arctic seas were linked with the Atlantic and Pacific Oceans. Warm ocean currents penetrated from the Atlantic Ocean, resulting in greater abundance and diffusion of the marine fauna in the Atlantic part of the Arctic; this was especially pronounced during the Late Jurassic. The North Pole, as confirmed by paleomagnetic and paleobiogeographic data, was north of the Bering Strait during the whole Jurassic and Neocomian (earliest Cretaceous).

The marine fauna was only weakly differentiated during the Hettangian, Sinemurian, and early Pliensbachian (Early Jurassic). The Tethyan and Boreal provinces developed; the latter, situated around the pole, was characterized by sparser cephalopod associations and by the appearance of endemic forms (up to the family level) in the benthos. During the late Pliensbachian, faunal differentiation reached the province level. The Boreal region was differentiated into West European and Arctic provinces, which continued to exist during the Toarcian and early Aalenian. During the Middle Jurassic (from late Aalenian time), faunal diversity in the Boreal region increased sharply, with Arctic and North American provinces differentiated within this region. The West European province appears to have extended beyond the limits of the Boreal region. During the Callovian, Oxfordian, and Kimeridgean (Late Jurassic), the Boreal region again tended to form two subregions: the Arctic region which included the North Siberian, Chukotsk-Canadian, and North American provinces; and the Boreal Atlantic region which included the West European and Urals-Greenland provinces.

During the Volgian (Volzhian) and early Berriasian (latest Jurassic, earliest Cretaceous), the Boreal fauna was more isolated from the Tethyan fauna and constituted a Boreal realm with Arctic and Boreal Atlantic regions. The Arctic region included the North-Siberian, Chukotsk-Canadian (around the Pole), and Boreal Pacific provinces, and the Boreal-Atlantic region consisted of the West European, East-European, and Urals-Greenland provinces. During the late Berriasian, Valanginian, and early Hauterivian (Early Cretaceous) the Arctic region extended westward and included the Trans-Uralian region.

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STRUCTURAL EVOLUTION OF BERING CONTINENTAL MARGIN: CRETACEOUS TO HOLOCENE

Spreading in a broad arc from Kamchatka to the tip of the Alaska Peninsula, the Bering continental margin separates the deep Bering Sea from its fringing shelf.

Rock dredgings and geophysical data indicate that beneath a veneer of Cenozoic deposits the central sector of the margin (between Alaska and Siberia) is in part underlain by folded sedimentary strata of Late Cretaceous (Campanian) age. These rocks can be traced seaward beneath the deep basin of the Bering Sea, as well as landward to coastal exposures of Mesozoic rocks in Siberia and western Alaska. The deeply submerged Cretaceous rocks appear to be the eroded remnants of a continental margin that was uplifted and deformed in latest Cretaceous or earliest Tertiary time. We speculate that tectonism of the continental margin may be linked with the convergence of a North Pacific lithospheric plate and an American-Eurasian plate in the late Mesozoic; normal or direct convergence off southern Alaska and the Kamchatka-Koryak region where coastal mountain building was intense, and oblique convergence along the less deformed central sector of the Bering margin.

By Oligocene time the seaward fringes of the coastal mountains were beveled to low relief and submerged to form the foundation of the Neogene shelf and continental margin. Submergence was very extensive along its central sector. There narrow grabens parallel with the margin formed in response to extensional rifting and filled with as much as 2,600 m of neritic and upper bathyal deposits. Faults bordering outer-shelf basins and flanking structural highs in the central sector may connect on the west with major fractures offsetting Cretaceous rocks underlying the Koryak Mountains (Cape Navarin area). Eastward from the central sector outer-shelf structural trends appear to turn inside or north of the Alaska Peninsula rather than merge with Pacific marginal structures.

During the Neogene, 500 m or more of pelagic and terrigenous sediment accumulated over the collapsing margin. These deposits were deformed by slumping and basement faulting and, in the late Cenozoic, largely stripped from some areas by an episode of intense canyon cutting.

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RECENT SEDIMENTATION ON SOUTHERN BERING SHELF

A veneer of contemporary sediments covers the entire continental shelf in the Bristol Bay region of the southeast Bering Sea. This broad shelf, covering an area of 1.5×10^5 sq km has a relatively smooth bottom and gentle slope of about 1:4,000. Nearshore sediment is gravelly, coarse sand which grades to fine sand offshore. In general, the mean size of the sediment is related to the depth. The nearshore and offshore heterogenous sediments are very poorly sorted whereas homogeneous sand in the center is well sorted. The mineralogy of sand is diverse, reflecting the complex sources: sedimentary, metamorphic, and igneous terrane of the hinterland in the north and east, and typically volcanics from the Aleutian Islands in the