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Map showing tectonostratigraphic terranes of Alaska, columnar sections, and summary description of terranes

by

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Tectonostratigraphic terrane map of Alaska

Part 3--Summary description of terranes

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Introduction

The concept that much of the Cordillera of western North America is made up of originally separate allochthonous tectonostratigraphic terranes is based largely on stratigraphic, structural, and geophysical data obtained during the past 5 years or so (Coney, Jones, and Monger, 1980). Many of these new data have not yet been published, or are available only piecemeal in various scattered scientific journals or in open-file reports of the U.S. Geological Survey and the Geological Survey of Canada. The purpose of this map with accompanying columnar sections and brief text is to make available in preliminary form information on the distribution, character, and age of the various tectonostratigraphic terranes of Alaska. Descriptions of and columnar sections for terranes of southeastern Alaska and adjoining Canada are provided in an earlier companion report (Berg and others, 1978), and are not reproduced here.

Definition of tectonostratigraphic terrane:

A tectonostratigraphic terrane is defined as a fault-bounded geologic entity, usually of regional extent, that is characterized by a distinctive stratigraphic sequence or rock assemblage that differs markedly from those of nearby, partly or entirely coeval neighbors. In terrane definition and analysis, the entire preserved stratigraphic sequence or assemblage must be considered, and comparisons made on the basis of the total record of sedimentation and structural history up until the time of accretion. If two unlike sequences are linked by intermediate facies, then the entire assemblage is considered to form one terrane. However, if the intervening intermediate facies are lacking and direct connections cannot be proven between two unlike sequences, separate terranes are required.

Two types of terranes are recognized: 1)stratigraphic terranes that are characterized by depositional contacts between major internal stratigraphic subdivisions, and 2) disrupted terranes, in which major internal contacts are faults. The latter type are sometimes referred to as melanges, but we prefer not to use that term because of its close association with subduction zones.

The following section provides a brief description and interpretation for each terrane (with the exception of southeast Alaska, which is covered in an earlier report). The basic stratigraphic data are presented in the columnar sections shown on sheet 2.

Description of terranes

North Slope (columns 1 and 5)--Paleozoic and Mesozoic continental shelf assemblage of clastic and carbonate rocks with probable Precambrian basement. Terrane may have moved southward from original position in Arctic Ocean, either by rotation (Grantz and others, 1979) or by translation.

York (column 2)--Tectonic assemblage of lower Paleozoic shelf-type carbonate rocks thrust over presumed Precambrian slate. Trilobites of non-North American affinity occur in rocks of Middle to Late Ordovician age (Ormiston and Ross, 1979).

Seward (column 3)--Ancient deep continental crustal rocks of granulite metamorphic facies (Throckmorton and Hummel, 1979) tectonically mixed with younger metamorphosed volcanic and sedimentary rocks.

Kagvik (column 4)--Radiolarian chert, argillite, and minor volcaniclastic rocks of late Paleozoic and early Mesozoic age deposited far from sources of terrigenous clastic detritus. Basement rocks unknown. Terrane interpreted by Churkin and others (1979) as the tectonically disrupted deep-water, oceanic equivalent of North Slope terrane.

Endicott (column 6)--Complexly deformed Paleozoic (and Precambrian?) shallow-water carbonate and clastic rocks, intruded by mid-Paleozoic (Devonian) granitoid plutons (Dillon and others, 1980).

Ruby (columns 7 and 10)--Complexly deformed Precambrian and Paleozoic sedimentary and igneous rocks (Silberman and others, 1979), intruded by mid-Paleozoic granitoid plutons (Dillon and others, 1980). Large volumes of metarhyolitic rocks are present, particularly in the northern sector, that are interpreted as arc-related volcanic products of both Precambrian and mid-Paleozoic ages (Dillon and others, 1980).

Angayucham (column 8)--Tectonically complex assemblage of pillow basalt with intercalated radiolarian chert of Triassic age (Plafker and others, 1978) and underlying chert of Mississippian age (unpublished data of Jones). Includes blocks of shallow-water Paleozoic limestone (some with associated tuff and basalt) and large slabs of mafic and ultramafic rocks, interpreted as fragments of ophiolite (Patton, Tailleur, and others, 1977; Zimmerman and Frank, 1980). No ophiolite sequence is known, however, that includes the pillow lava portion.

Innoko (columns 9 and 11)--Structurally complex deep-water assemblage of chert, basic to intermediate volcanic rocks, gabbro, and blocks of Paleozoic limestone; basement unknown, but may have been ophiolitic.

Nixon Fork (column 12)--Paleozoic carbonate platform deposits and overlying shallow-water clastic rocks resting on metamorphosed Precambrian basement (Patton and Dutro, 1979).

Minchumina (column 13)--Structurally complex assemblage of Lower Paleozoic radiolarian chert, argillite, minor quartzite, and graptolitic shale. Interpreted by Churkin and others (1980) as deep-water equivalent of Nixon Fork terrane.

Livengood (column 14)--Tectonically complex assemblage of lower Paleozoic chert, graptolitic shale, basalt, limestone, clastic rocks, and serpentinite, overlain by upper Mesozoic flysch. Correlated in part with the Road River Formation of Canada by Chapman and others (1979).

White Mountains (column 15)--Tectonically complex assemblage of lower Paleozoic mafic volcanic rocks, quartzite, argillite, and blocks of limestone.

Wickersham (column 16)--Tectonically complex and metamorphosed assemblage of continentally derived Precambrian to lower Paleozoic sedimentary rocks.

Porcupine (column 17)--Continental shelf assemblage of platform carbonate and clastic rocks resting on Precambrian basement.

Yukon (column 18)--Continental slope and shelf deposits resting on Precambrian basement.

Woodchopper (no column)--Tectonically complex assemblage of mid-Paleozoic graptolitic shale, pillow basalt, tuff, shale, chert, and sandstone, with blocks(?) and beds of limestone and dolomite. Middle Devonian brachiopods and corals are known from one locality in limestone (Brabb and Churkin, 1969), and Lower Devonian graptolites are known from one locality in shale (Michael Churkin, Jr., oral commun., 1980).

70-Mile (column 19)--Disrupted ophiolite composed of ultramafic rocks, gabbro, pillow basalt, and red radiolarian chert of Permian age. This oceanic assemblage tectonically overlies metamorphosed quartzose sedimentary rocks of the Yukon-Tanana terrane.

Yukon-Tanana (columns 20 and 21)--Tectonically complex metamorphosed assemblage of continentally derived sedimentary, volcanic, and granitic rocks of Precambrian and Paleozoic age. Terminal metamorphic event as determined by radiometric (^{40}K-^{40}Ar) dating (Bundtzen and Turner, 1979) is mid-Cretaceous (108 to 85 m.y.b.p.).

Nyac --Arc-related assemblage of andesite, basalt, and dacitic volcanic and volcaniclastic rocks with interbedded graywacke, siltstone, impure limestone, and conglomerate. Fossils of Middle Jurassic age present.

Pingston terrane (column 22)--Tectonically juxtaposed and intermixed deep-water upper Paleozoic phyllite, chert, and minor limestone, and Triassic black argillite, gray limestone, and calcareous siltstone and sandstone. Extensively intruded by gabbro and diabase prior to pervasive isoclinal folding.

McKinley terrane (column 23)--Tectonically disrupted upper Paleozoic flysch and Triassic chert, argillite, minor limestone, sandstone, pillow basalt, and gabbro. Pillow basalt is overlain by Upper Jurassic or Lower Cretaceous flysch, including graded fine-grained conglomerate and radiolarian chert. This flysch generally lies along the north and north-west side of the McKinley terrane outcrop belt. Structurally emplaced within it southwest of Mount McKinley is a separate subterrane (Red Paint) composed of narrow tectonic septa of highly deformed black, gray, green, and red, bedded radiolarian chert which ranges in age from Mississippian to Late Triassic, with Pennsylvanian and Permian ages particularly well represented. Thus, the McKinley terrane includes two different basinal marine upper Paleozoic sequences whose original relations are unknown.

Windy terrane (column 24)--Disrupted assemblage of flyschlike terrigenous clastic rocks, including conglomerate and cobbly mudstone, of both early

Paleozoic (Silurian?) and late Mesozoic age, with isolated, conspicuous, tectonic blocks of fossiliferus Devonian limestone and of undated chert conglomerate and tuffaceous(?) fine-grained sedimentary rocks. Conodonts from shelly calcareous concretions in argillite associated with fragmental basalt and tuffaceous chert are of Late(?) Silurian age. At the west end of its outcrop belt, the Windy terrane includes an assemblage of ultramafic rocks, serpentinite, basalt, and radiolarian chert that apparently is a dismembered ophiolite, presumably of early Paleozoic age.

The fossils reported to be of Triassic age from this terrane (Moxham and others, 1959) are either unidentifiable or represent late Mesozoic Buchias.

Mystic terrane (column 25)--Highly folded and partly disrupted shallow-water marine clastic and carbonate rocks of Late Devonian age overlain by radiolarian cherts and flyschlike graywacke, argillite and conglomerate of late Paleozoic age.

Also included are pillow basalts of presumed Triassic age; blocks of Silurian platform carbonate rocks; and a large block of Ordovician graptolite shale associated with pillow basalt. The stratigraphic relations of these blocks are unknown.

The Mystic terrane may be related to the McKinley terrane, in which upper Paleozoic flysch and pillow basalt are also widespread. However, the older parts of the Mystic are not represented in the McKinley, and the stratigraphy of the upper Paleozoic insofar as is known differs substantially between the two terranes.

Dillinger terrane (columns 26, 26A, and 27)--Coherent but complexly folded assemblage of lower and middle Paleozoic graptolitic shales, sandstone turbidites, and basinal limestones of known Ordovician to Devonian age.

Partial stratigraphic sections are known in a few places, such as the Terra Cotta Mountains (Churkin and others, 1977) and the Cheeneetnuk River area (Gilbert, 1980), but most rocks of the Dilliinger terrane are poorly fossiliferous and tectonically disrupted beyond stratigraphic reconstruction. North-verging flat isoclines are conspicuous in exposures both north and south of the McKinley strand of the Denali fault. Micaceous, quartzose, calcareous sandstone and sandy limestone turbidites are diagnostic of the Dillinger terrane, and these basinal deposits serve to separate it from the correlative Ordovician to Devonian platform carbonate rocks of the Nixon Fork terrane.

Younger rocks of the Dillinger terrane are variable and of limited extent. South of the Denali fault phosphatic calcareous sandstone and shale of Early Jurassic age locally rest on more intensely deformed lower and middle Paleozoic rocks. North of the Denali fault in the Farewell and Cheeneetnuk River areas, pillow basalt of presumed Triassic age is associated with highly fossiliferous Devonian limestone, but these rocks may not belong to the Dillinger terrane.

Chulitna terrane (column 28)--Rocks of the Chulitna terrane contain a remarkably complete stratigraphic sequence that documents a unique geologic history from Late Devonian well into Mesozoic time (Jones and others, 1980). Particularly striking are an uppermost Devonian ophiolite, upper Paleozoic volcaniclastic and carbonate rocks, Lower Triassic marine limestone, and Upper Triassic nonmarine redbeds containing detritus derived from mixed oceanic and continental provenances. These redbeds are unknown elsewhere in Alaska, and they record an oceanic-continental collision in Late Triassic time which is not apparent in the stratigraphic record of nearly coeval terranes.

West Fork terrane (column 29)--Tectonically complex assemblage of poorly stratified, massive tuffaceous argillite, bedded radiolarian chert, minor clastic rocks, and blocks of phosphatic calcareous sandstone and impure limestone. Lower Jurassic fossils occur in the tuffaceous argillite unit, as well as in the blocks of calcareous sandstone; Upper Jurassic radiolarians occur in bedded chert. Lithologies and depositional environments contrast strongly with those of adjoining Chulitna terrane.

Broad Pass terrane (column 30)--Structurally complex assemblage of phyllite, siliceous tuff, and bedded chert of Mississippian age, with a few tectonic blocks of fossiliferous limestone ranging in age from Late Silurian(?) to Middle Devonian. Locally, serpentinite follows faults within the terrane.

The Middle Devonian and older shelf limestones within the Broad Pass terrane contrast with the nearby Chulitna terrane, in which the basement ophiolitic rocks were not formed until late in Devonian time. The Broad Pass terrane could be the basement for the contiguous West Fork terrane which insofar as is known is wholly younger. However, the boundary between these two terranes is an obvious throughgoing, major fault.

Susitna terrane (column 31)--Characterized by pillow basalts and associated volcanic and pelitic sedimentary rocks of latest Triassic age having exclusively pelagic or pseudoplanktonic shelly faunas. These rocks are structurally emplaced on upper Mesozoic flysch. Similar flysch also structurally overlies the Triassic basalt, suggesting the possibility of an original paraconformable depositional relationship between the two units, as indicated on column 31.

The nearest exposures of pillow basalts correlative with those of the Susitna terrane are within the McKinley terrane, north of the Denali fault. However, *Monotis* faunas from these two terranes are different and represent wholly separate biogeographical faunal provinces.

Nenana terrane (column 32)--Strongly folded and in part metamorphosed, well-bedded sandy limestone, calcareous sandstone, and argillite which at one locality has yielded poorly preserved *Halobia*? of Late Triassic age along with less diagnostic conodonts. These rocks are somewhat similar to the Upper Triassic rocks of the Pingston terrane north of the Denali fault, but differ in containing conspicuous calcareous skeletal grains and coarse detrital quartz. No part of the Nenana terrane closely resembles the distinctive and consistent lithologic character and tectonic style of the Upper Triassic rocks of the Pingston terrane.

Maclaren terrane (column 33)--Includes pelitic gneiss, green schist, and amphibole-bearing gneiss that typifies the "Maclaren metamorphic belt" of Smith and Turner (1973). These metamorphic rocks are thrust over little-metamorphosed partly volcaniclastic Jurassic and Cretaceous(?) sedimentary rocks (included in map unit KJf) to the south, but their contact with the Nenana terrane to the northwest is apparently everywhere concealed by Quaternary deposits.

Clearwater terrane (column 34)--Tectonically complex assemblage of chlorite schist, metatuff, argillite, metabasalt, and marble in a small fault-bounded sliver along the northwest boundary of Wrangellia. It is at least partly of latest Triassic age based on the occurrence of *Heterastridium* in fossiliferus marble associated with volcanic rocks. As compared with nearby rocks of this age in Wrangellia, the Clearwater terrane is volcanic, rather than nonvolcanic, more intricately deformed, and of distictly higher metamorphic grade.

Wrangellia (columns 35 to 37)--The pre-Jurassic rocks of the extensively exposed terrane are mostly structurally simple, remarkably persistent in stratigraphic character, and document a distinctive geologic history

(Jones and others, 1977). The oldest strata known are of island-arc volcanic and volcaniclastic rocks of Pennsylvanian and Early Permian age. These grade upward into younger Permian marine limestone intercalated with fine-grained nonvolcaniclastic rocks and, in some places, into paraconformably overlying Lower and/or Middle Triassic argillite and chert. Abruptly overlying these basinal deposits is the Nikolai Greenstone, a tholeiitic basalt sequence of late Middle to early Late Triassic age which is predominantly subaerial and characteristically several thousand meters thick. Upper Triassic carbonate rocks overlie the Nikolai and grade upward into progressively deep-water, nonvolcanic Upper Triassic deposits which locally are continuous with the overlying Lower Jurassic.

Major structures within the terrane juxtapose perceptibly different facies of Wrangellia (Nokleberg and others, 1981) which, while manifesting this same stratigraphic sequence, show contrasts in the relative thicknesses of particular units and in the amount and rate of subsidence that took place during their deposition.

High quality paleomagnetic data have been obtained from the Nikolai Greenstone in both the Wrangell Mountains and Alaska Range that indicate anomalously low paleolatitudes as compared with the expected North American Triassic paleolatitudes (Hillhouse, 1977; Hillhouse and Gromme, 1980). Several thousand kilometers of northward movement of Wrangellia since Triassic time are required by these data.

<u>Kilbuck terrane</u> (column 39)--Regionally metamorphosed assemblage of quartz diorite, granodiorite gneiss, orthoclase gneiss, amphibolite, marble, and quartz-mica schist. Radiometric (potassium-argon) ages by D. L. Turner (reported in Hoare and Coonrad, 1979) range from 2.5 b.y. to 125

m.y.b.p. Geologic and geophysical data suggest that the terrane is rootless.

Goodnews terrane (column 40)--Structurally complex assemblage of pillow basalt, chert, limestone, blueschist, ultramafic rocks, and graywacke. Oldest rocks known are early Paleozoic, youngest are Early Cretaceous, but few stratigraphic relations have been established.

Togiak terrane (column 41)--Structurally complex assemblage of basaltic to andesitic flows, breccia, tuff, volcanic graywacke and argillite, and minor chert. Fossils range in age from Early Jurassic to Early Cretaceous.

Tikchik terrane (column 42)--Structurally complex assemblage of radiolarian chert of early Paleozoic and Mesozoic ages, mixed with mostly undated graywacke, volcanic and volcaniclastic rocks, and lenses of Permian limestone.

Peninsular terrane (columns 43 and 45)--Well-stratified sequence of Upper Triassic limestone, chert, tuff, and agglomerate (Detterman and Reed, 1980), overlain by Lower Jurassic andesitic volcanic and volcaniclastic rocks up to several thousand meters thick. Younger Jurassic and Cretaceous strata are mainly clastic and locally contain abundant marine fossils. Basement rocks are not identified, but one small exposure of Permian rocks is reported by Hanson (1957) in Puale Bay, and two small patches of middle Paleozoic (Silurian and Devonian) limestone are known north of Becharof Lake (Detterman and others, 1979). The presence of these rocks suggests that the Peninsular terrane originally formed on a continental basement.

Similarities in upper Mesozoic stratigraphy between Wrangellia and the Peninsular terrane suggest the two were amalgamated by Middle Jurassic time (Jones and Silberling, 1979).

Kachemak terrane (column 44)--Structurally complex oceanic assemblage of pillow basalt, radiolarian chert of Triassic age, minor limestone, graywacke, and grit.

Chugach terrane (columns 46, 47, 49)--Two subterranes are present (Plafker and others, 1977): 1) a strongly folded but coherent flyschlike assemblage of graywacke, argillite, and slate containing rare fossils of Late Cretaceous (Campanian to early Maestrichtian) age; 2) a polymictic disrupted assemblage composed of blocks of basic volcanic rocks, chert, ultramafics, limestone, and plutonic rocks in cherty, tuffaceous argillitic matrix. Radiolarians in chert range from Late Jurassic to Early Cretaceous. These two subterranes are structurally interleaved in many places, but, in general, the disrupted subterrane tends to be structurally above the coherent flysch subterrane. Column 49 refers to Mesozoic rocks of the Yakutat block of Plafker and others (1980) which include slate, graywacke, and melange similar to that of the Chugach terrane. The Yakutat block differs from the Chugach terrane in that it includes a lithologically distinctive sequence of marine and continental Cenozoic rocks (not shown in the columnar section on sheet 2).

Saint Elias terrane (column 48)--Metamorphosed volcanic and sedimentary rocks of amphibolite facies. May be a higher grade but structurally discontinuous equivalent of Chugach terrane.

Prince William terrane (column 50)--Structurally complex assemblage of flyschlike graywacke, siltstone, pillow basalt, diabase, and gabbro. Fossils from sedimentary rocks are rare, but all known examples are of early Cenozoic age.

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