DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

# Lithotectonic terrane maps of the North American Cordillera



Edited by

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Open-File Report 84-523



Prepared in cooperation with the
Geological Survey of Canada and Petroleos Mexicanos

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

1984

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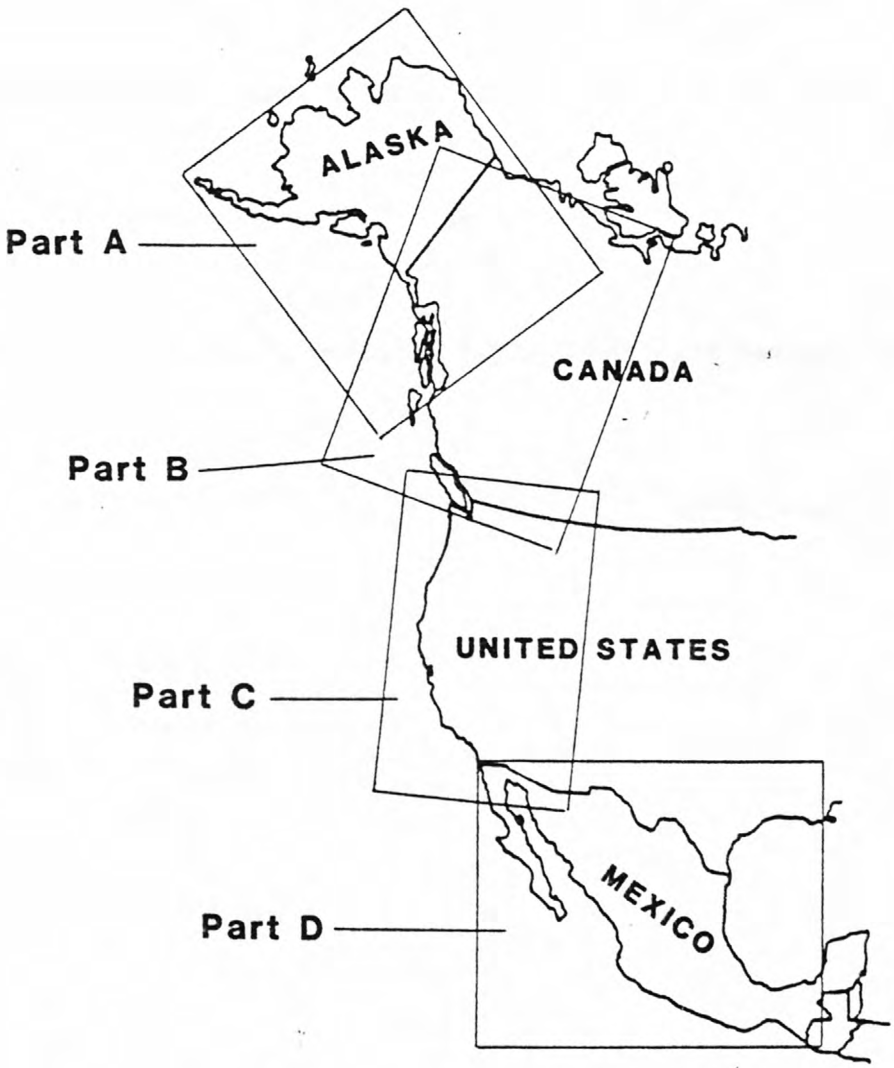


FIGURE 1.--Index map of western North America showing locations of map sheets corresponding to Parts A through D of the present report.

PART A--Lithotectonic terrane map of Alaska (west of the 141st Meridian)

By

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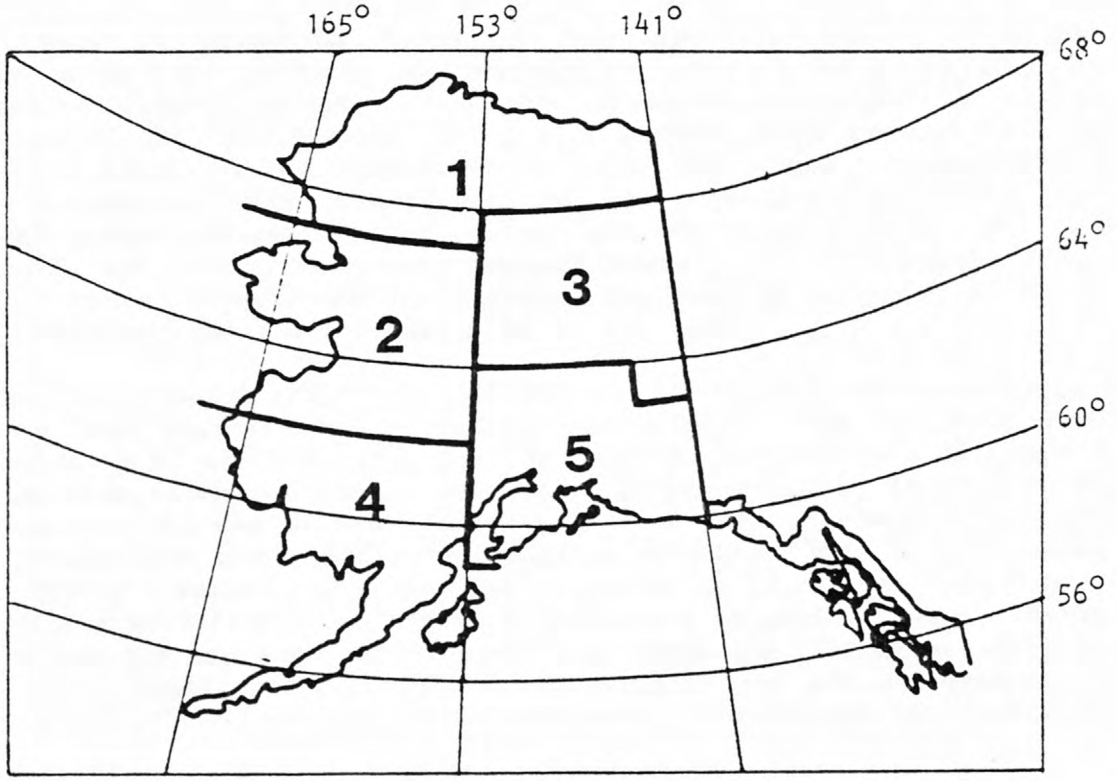


FIGURE 2.--Regions of Alaska (west of the 141st Meridian) numbered 1 through 5.

EXPLANATORY NOTE

The lithotectonic terrane map of Alaska west of the 141st Meridian is one of four such maps, covering the North American Cordillera from Alaska through Mexico, prepared at 1:2,500,000 scale as a cooperative project of the U. S. Geological Survey, Geological Survey of Canada, and Petroleos Mexicanos. Financial support for map preparation was provided by the U. S. Department of Energy through contract with the Deep Gas Project. A preliminary version of this terrane map for Alaska (Jones and other, 1981) was accompanied by descriptions of the terranes in the form of columnar sections which are not reproduced here.

Each terrane depicted on this map is fault bounded and distinguished from its neighboring terranes, as well as from Phanerozoic North America, by a distinctive geologic record which may be expresed by its stratigraphy as well as by its igneous or metamorphic history. The disparities among the various terranes and between the terranes and neighboring parts of the North American continent are sufficiently great so that paleogeographic reconstruction of the original sites of the terranes and their displacement paths through time is open to serious debate if not impossible to determine. Some terranes embody only a very fragmentary rock record, but they are nonetheless individualized in that they cannot reasonably be fitted into their neighbors. Further discussion of the definition and characterization of lithotectonic (= "suspect," = "tectonostratigraphic") accreted terranes is provided by Coney and others (1980) and Jones and others (1983).

The basic outcrop pattern and extent of post-accretion cover deposits for this map have been adapted from Beikman (1980). Cover rocks are shown only where the identity of the bed rock terranes obscured beneath them is unknown or cannot be reasonably inferred. Post-accretionary plutonic igneous rocks are not shown on this map because their separation from plutonic rocks that have been transported along with the terranes in Alaska is in most cases uncertain. The line weight and style of contacts shown on the map incorporate significant departures from those conventionally used on geologic maps. Heavy lines on the terrane map show only those faults that are terrane boundaries. Faults that only bound post-accretion cover deposits are not differentiated from the light-weight lines that also represent depositional or intrusive contacts.

## DESCRIPTION OF MAP UNITS

### POST-ACCRETION COVER DEPOSITS

Cz CENOZOIC DEPOSITS

K UPPER CRETACEOUS DEPOSITS

### POST-AMALGAMATION OVERLAP ASSEMBLAGE

GN GRAVINA-NUTZOTIN BELT--Upper Jurassic to mid-Cretaceous argillite, graywacke, and conglomerate; andesitic volcanic, tuffaceous, and volcaniclastic rocks; and mid-Cretaceous granitic rocks. Sedimentary rocks range from marine turbidites to shallow-water and nonmarine deposits. Coarse clastic rocks are derived from locally underlying WR and from (an) unknown metamorphic source terrane(s) (Richter, 1976). In southeast Alaska GN rests depositionally on both the Wrangellia and Alexander terranes.

### ACCRETED TERRANES

[Arranged alphabetically by map symbol. Numbers in parentheses following terrane names indicate locations of terranes on the map according to the region(s) enumerated on figure 2.]

AAC COLDFOOT SUBTERRANE OF ARCTIC ALASKA TERRANE (1, 3)--Metagraywacke, phyllite, and quartz mica schist, polymetamorphosed in late Mesozoic; age of protolith uncertain, but probably mid-Paleozoic.

AAD DELONG MOUNTAINS SUBTERRANE OF ARCTIC ALASKA TERRANE (1)--Complex stratigraphic assemblage characterized by thick Devonian and Mississippian carbonates, and younger sequences of chert and argillite; includes Kelly River, Ipnavik River, and Nuka Ridge thrust sequences of Mayfield and others 1978.

AAE ENDICOTT MOUNTAINS SUBTERRANE OF ARCTIC ALASKA TERRANE (1)--Stratified sequence of Devonian clastic rocks (e.g. Huntfork Shale, Kanayut Conglomerate) Mississippian shale (Kayak) and carbonate rocks (Lisburne Group), and younger Paleozoic and early Mesozoic chert, argillite and calcareous rocks (e.g. Kuna, Siksikpuk, and Otuk Formations).

AAH HAMMOND SUBTERRANE OF ARCTIC ALASKA TERRANE (1, 3)--Structurally complex and polymetamorphased assemblage of mid-Paleozoic or older carbonate rocks (= Skagit Limestone), calcschist, quartz-mica schist, quartzite, and metarhyolite; intruded by Upper Devonian gneissic granitic rocks. Sparse radiometric ages suggest local presence of Precambrian basement rocks (Dillon and others, 1980; Hitzman and others, 1982).

AAN NORTH SLOPE SUBTERRANE OF ARCTIC ALASKA TERRANE (1)--Precambian to lower Paleozoic basement rocks (Nerukpuk Group, in part) overlain by Kekiktuk conglomerate (Mississippian), Lisburne Group

(Mississippian to Pennsylvanian), Sadlerochit Group (Permian-Triassic) and younger Mesozoic strata.

AM ANGAYUCHAM TERRANE (1, 2, 3)--Structurally and stratigraphically complex assemblage of oceanic rocks, including gabbro, diabase, pillow basalt, tuff, chert, gray-wacke, argillite, and minor limestone; sedimentary rocks range in age from Mississippian to Jurassic. Major periods of basaltic volcanism appear to be late Carboniferous and Late Triassic, although many volcanic sequences are not yet well dated. Separate thrust sheets of plutonic ultramafic rocks occur throughout the terrane, but none of these can yet be genetically linked to the basaltic rocks. Terrane structurally overlies Ruby terrane on the south and the Arctic Alaska terrane on the north.

AXC CRAIG SUBTERRANE OF ALEXANDER TERRANE (5)--In Alaska, marble of Paleozoic, partly Devonian, protolith age (MacKevett, 1978).

BP BROAD PASS TERRANE (5)--Structurally complex assemblage of chert, argillite, phyllite, bedded tuff, graywacke, and limestone; chert contains Mississippian radiolarians and limestone blocks contain Silurian(?) and Devonian fossils (Jones and others, 1980).

BRY BALDRY TERRANE (3)--Structurally complex and polymetamorphased assemblage of radiolarian chert, marble, greenschist, mica-schist; protolith and metamorphic ages undetermined, but protolithic ages probably early to middle Paleozoic.

CG CHUGACH TERRANE (4, 5)--Complexly folded and weakly metamorphosed Upper Cretaceous (Maastrichtian) graywacke and slate, locally interleaved with disrupted assemblages of Jura-Cretaceous radiolarian chert, gabbro ultramafic rocks, pillow basalt, and tuff, as well as rare blocks of limestone, diorite, and other exotic lithologic types.

CH CHULITNA TERRANE (5)--Folded and thrust-faulted, but internally coherent sequence of Upper Devonian ophiolite; Mississippian chert; Permian volcanic conglomerate, limestone, chert, and argillite; Lower Triassic limestone; Upper Triassic redbeds, pillow basalt, limestone; sandstone, and shale; and Jurassic argillite, sandstone, and chert. Terrane overlies highly deformed upper Mesozoic argillite and graywacke of KH along a major thrust fault (Jones and others, 1980).

CW CLEARWATER TERRANE (5)--Poorly known, structurally complex assemblage of argillite, pillow basalt, and shallow-water limestone containing Upper Triassic (upper Norian) fossils.

CZ CRAZY MOUNTAINS TERRANE (3)--Quartzitic sandstone containing the trace fossil <u>Oldhamia</u> of probable Cambrian age, as well as younger sandstone, grit, slate, chert, and carbonate rocks, some of which are as young as late Early Devonian (Churkin and others, 1982). As suggested by Churkin and others (1982), this terrane may be related to the Wickersham Terrane to the southwest.

DL DILLINGER TERRANE (4, 5)--Complexly folded and faulted sequence of lower Paleozoic graptolitic shale, basinal carbonate rocks, and, turbiditic sandstone, shale, and grit; overlain unconformably by Lower Jurassic fossiliferous limy sandstone and siltstone.

GD GOODNEWS TERRANE (4)--Disrupted assemblage of chert, pillow basalt, tuff, minor limestone, and blocks of ultramafic rock; dated limestones range from Ordovician to Permian; dated cherts are both late Paleozoic and Mesozoic. Lawsonite-bearing metamorphic rocks locally developed (Hoare and Coonrad, 1978).

IN INNOKO TERRANE (2)--Folded and disrupted assemblage of chert, argillite, minor graywacke, limestone blocks, and volcanogenic sandstone, conglomerate, and tuff. Dated cherts range from Late Devonian to Late Triassic, dated limestones are mainly Carboniferous. Sedimentary rocks are generally similar to those of the Angagucham terrane, but the large volume of pillow basalt, gabbro, and diabase characteristic of that terrane are absent in the Innoko.

KA KANDIK RIVER TERRANE (3)--Highly deformed thick sequence of flyschoid pelitic rocks and sandstone which is mainly of Early Cretaceous age and generally fault bounded against neighboring older rocks. KA includes the upper part of the Glenn Shale and the Kandik Group which are isoclinally folded and affected by low-grade metamorphism (Churkin and others, 1982).

KG KAGVIK TERRANE (1)--Disrupted and strongly folded assemblage of chert, argillite, limestone turbidites, minor tuff, and intermediate to silicic volcanic rocks that are locally mineralized (Nokleberg and others, 1982); dated cherts range in age from Mississippian to Triassic. This assemblage has been interpreted by Churkin and others (1979) to represent a deep water, allochthonous oceanic assemblage deformed by collision of a southern Paleozoic island arc terrane and a northern continental terrane. Other workers (e.g., Mull and others, 1982) believe that the Kagvik was deposited in an intra-cratonic basin and that it forms the upper part of the Endicott Mountains subterrane of AA. Distribution of the "Kagvik sequence" of Churkin and others is shown on the terrane map so that readers may be appraised of the distribution of the rocks in question. In our opinion the conflicting interpretations remain unresolved.

KH KAHILTNA TERRANE (4, 5)--Structurally disrupted deep marine, partly volcaniclastic, flyschoid graywacke and pelitic rocks, including minor amounts of chert, limestone, and conglomerate. Mainly of Early Cretaceous age, but includes rocks ranging in known age from Late Jurassic to Cenomanian. Metamorphism ranges from zeolite to amphibolite grade.

KIL KILBUCK TERRANE (4)--Gneiss and schist exposed in the Kanektok River region, including biotite-hornblende gneiss, garnet amphibolite, quartz-mica schist, and marble. Radiometric ages indicate metamorphism during the Precambrian (Hoare and Coonrad, 1978).

KK KACHEMAK TERRANE (5)--Small sliver of pillow basalt, chert, and minor limestone structurally wedged between the Peninsular terrane and the Chugach terrane. Radiolarian cherts are Triassic in age.

KY KOYUKUK TERRANE--Andesitic flows, tuffs, breccias, agglomerates, conglomerates, tuffaceous graywacke, and mudstone; local intercalations of shelly limestone contain Lower Cretaceous (Valanginian) fossils. According to Patton (1973), a depositional base of the volcanic sequence has not been observed.

LG LIVENGOOD TERRANE (3)--Highly folded but weakly metamorphed assemblage of Paleozoic rocks, including the basal Livengood Dome Chert (Ordovician), and overlying dolomite, chert, volcanic rocks, serpentinite, and fossiliferous shale, sandstone, grit, and minor limestone of Devonian age. No basement is known, and the Livengood terrane appears to rest structurally on deformed upper Mesozoic flysch (Churkin and others, 1980).

MAN MANLEY TERRANE (3)--Complexly deformed flyschoid Mesozoic sedimentary rocks including Upper Triassic argillite and chert; Upper Jurassic quartzite containing clasts of Upper Triassic chert; graywacke-pelite flysch containing Valanginian and Albian fossils; and volcanic conglomerate of uncertain age. Intruded by mid-Cretaceous granitic rocks and by gabbro and serpentinite of unknown age.

MK McKINLEY TERRANE (5)--Thick sequence of upper Paleozoic (Permian) flysch overlain by Triassic chert and Upper Triassic (Norian) pillow basalt, gabbro, and diabase, upper part is deformed flysch and chert of Late Jurassic (?) to Cretaceous age. Terrane includes the Red Paint subterrane (Jones and others, 1982), composed of chert ranging in age from Mississippian to Late Triassic, thrust over and folded with the upper Mesozoic flysch assemblage.

ML MACLAREN TERRANE (5)--Pelitic gneiss and schist, amphibolite, and foliated granodiorite. In part, a high grade metamorphosed equivalent of upper Mesozoic KH flysch, but also contains protoliths not present in nearby flysch assemblage.

MN MINCHUMINA TERRANE (3, 5)--Complex folded assemblage of chert, argillite, and minor quartzite. Radiolarians and graptolites indicate Ordovician ages, but chert as young as Devonian may also be present.

MNK MINOOK TERRANE (3)--Upper Paleozoic (Permian?) flysch with minor beds of chert-pebble grit and conglomerate. In fault contact on northwest with Ruby and Baldry terranes, on north with Tozitna terrane, and on southeast with Wickersham terrane and Mesozoic flysch of the Manley terrane. Eastern extent of terrane poorly constrained.

MY MYSTIC TERRANE (5)--Complexly folded, but partly coherent assemblage of sedimentary and volcanic rocks, including: Ordovician graptolitic shale and associated(?) pillow basalt, massive Silurian limestone, Upper Devonian sandstone, shale, conglomerate, and reefal limestone; uppermost Devonian to Pennsylvanian radiolarian chert; Permian flysch, chert, argillite, and conglomerate (locally plant bearing); and associated pillow basalt and gabbro that may be Triassic in age.

NN NENANA TERRANE (5)--Folded and locally metamorphosed limestone, quartzite, black siltstone, and gabbro; Upper Triassic pelagic bivalves known from the Wells Creek area. Some of these rocks superficially resemble those of the structurally disjunct Triassic rocks of the Pingston terrane, but probably represent deposition in shallower water as evidenced by locally abundant calcareous bioclasts and the higher percentage of carbonate rocks.

NX NIXON FORK TERRANE (2, 3, 4)--Stratified sequence of Paleozoic reefal carbonate rocks (Ordovician to Upper Devonian) deposited on Precambrian basement, and overlain by Permian, Triassic, and Cretaceous fossiliferous sedimentary rocks. Basement rocks are mainly pelitic and calcareous schists with minor marble, quartzite, and felsic metavolcanic rocks. Permian strata contain clasts of these basement rocks (Patton and others, 1980).

NY NYACK TERRANE (4)--Andesitic, trachytic, and basaltic flows and breccias with interbedded volcaniclastic rocks; contains fossils of Middle Jurassic age (Hoare and Coonrad, 1978).

PC PORCUPINE TERRANE (1, 3)--Precambrian(?) phyllite, slate, quartzite, and carbonate rocks, overlain by a thick, structurally and stratigraphically complex assemblage of shallow-water limestone, dolomite, and shale, ranging in age from Cambrian(?) to Late Devonian: upper Paleozoic rocks include sandstone, limestone, shale, siltstone, massive quartzite, and chert pebble conglomerate (= Step Conglomerate of Permian age). No definite occurrences of Triassic rocks known; however, Jurassic ammonite-bearing strata occur in two places in the northern part of the terrane (Imlay and Detterman, 1973).

PE PENINSULAR TERRANE (4, 5)--Permian limestone; Upper Triassic (Norian) limestone, argillite, basalt, and tuff; Lower Jurassic andesitic flows, breccias, volcaniclastic siltstone and sandstone; Middle Jurassic to Cretaceous fossiliferous clastic rocks and minor bioclastic limestone; and Jurassic batholithic granitic rocks. Differs from Wrangellian sequence in presence of Lower Jurassic andesitic arc assemblage, Jurassic plutonic rocks, and Norian basalt, and in absence of upper Paleozoic andesitic basement and the Middle to Upper Triassic Nikolai Greenstone.

PN PINGSTON TERRANE (3, 5)--Strongly folded and weakly metamorphosed assemblage of upper Paleozoic (Pennsylvanian and Permian) phyllite, minor limestone, and chert; Upper Triassic thin-bedded limestone, black, sooty shale, calcareous siltstone, and minor quartzite; includes many intrusive bodies of gabbro, diabase, and diorite of unknown age.

PW PRINCE WILLIAM TERRANE (4, 5)--Strongly deformed thick assemblage of graywacke, argillite, minor conglomerate, pillow basalt, basaltic tuff, sills, and dikes; rare fossils are of Paleocene and Eocene (?) ages (Tysdal and Case, 1979).

RB RUBY TERRANE (2, 3, 4)--Structurally complex assemblage of metamorphic rocks, including phyllite, mica schist, marble, quartzite, calcschist, dolomitic marble, amphibolite, and greenschist; also includes gneissic to nonfoliated granitic rocks, as well as metachert in northeastern part of terrane. Ages of protoliths and original stratigraphic relations unknown. RB is overthrust by TZ and AM.

SD SEWARD TERRANE (2)--Regionally metamorphosed, structurally complex assemblage of mica schist, micaceous calc schist, metavolcanics (some containing glaucophane), marble, and high-grade gneissic rocks. Rocks of probable Precambrian age and known Devonian age are present but protolithic and metamorphic ages of most rocks are uncertain (Hudson, 1977).

SE SAINT ELIAS TERRANE (5)--Intermediate to high grade metamorphic equivalent of the Chuguch terrane; characterized by sillimanite-bearing quartz mica schist, amphibolite grade quartz mica schist and gneiss, and migmatitic rocks indicative of anatexis (Hudson and Plafker, 1982).

SHE SHEENJEK TERRANE (1, 3)--Sedimentary sequence composed of thin, basinal Mississippian limestone overlain by upper Paleozoic to Triassic (?) radiolarian chert and varicolored argillite; lacks pillow basalt but contains abundant sills of gabbro and diabase of probable early Mesozoic age.

ST STIKINIA TERRANE (3)--Within Alaska, granodioritic batholithic rocks of Early Jurassic age which are continuous into the Yukon Territory, Canada, where they are regarded as allochtonous and part of the Stikinia terrane. Similar granitic rocks, such as those of the Taylor Mountain batholith, farther to the northwest than those shown on the terrane map and surrounded by metamorphic rocks of YT, could be structural outliers of ST.

SU SUSITNA TERRANE (5)--Large slab of pillow basalt and intercalated volcaniclastic sedimentary rocks containing Upper Triassic (Norian) fossils (Jones and others, 1980).

SV SEVENTYMILE TERRANE (3)--Scattered remnants of a folded sheet of harzburgitic ultramafic rock, gabbro, pillow basalt, and red radiolarian chert (locally dated as Permian) (Keith and others, 1981).

TG TOGIAK TERRANE (4)--Structurally complex, thick assemblage of Jurassic and Lower Cretaceous volcanic and volcaniclastic rocks, including pillowed flows, tuffs, breccias, conglomerate, graywacke, chert, and minor shelly argillaceous limestone of Early Cretaceous age (Hoare and Coonrad, 1978).

TK TIKCHIK TERRANE (4)--Structurally complex assemblages of radiolarian chert of Paleozoic and Mesozoic ages; Permian limestone and clastic rocks; and pillow basalt and graywacke. Internal stratigraphic relations unknown (Hoare and Coonrad, 1978).

TZ TOZITNA TERRANE (1, 2, 3)--Structurally complex assemblage of gabbro, pillow basalt, massive basalt and diabase, argillite, tuff, chert, graywacke, minor conglomerate, and Permian(?) limestone composed of comminuted prismatic bivalve shells (Churkin and others, 1982). Radiolarian cherts range in age from Mississippian to Triassic; sparse radiometric ages (K/Ar) from gabbros are Late Triassic, although Paleozoic basaltic rocks are probably present. Terrane includes the Rampart Group of east-central Alaska (Brosge and others, 1969).

VEN VENETIE TERRANE (1, 3)--Sedimentary sequence composed of a basal unit of graywacke, siltstone, and shale (locally phyllitic) with very minor blocks of limestone, overlain (structurally?) by folded radiolarian chert, varicolored (red and green) argillite and minor volcaniclastic rocks. Age of the clastic rocks has not been well-established, although spores from clastic rocks and corals from limestone are both of probable Devonian age. Radiolarian cherts from the upper unit range in age from Mississippian to Triassic, and volcaniclastic rocks are also Triassic.

WC WOODCHOPPER CANYON TERRANE (3)--Pillow basalt and pillow breccia, tuff, and volcanic graywacke of the Woodchopper Volcanics, as well as minor black shale and fossiliferous limestone (Churkin and others, 1982). Corals, brachiopods, and graptolites from the shale and limestone beds are Devonian in age.

WF WEST FORK TERRANE (5)--Massively bedded volcanic mudstone and intermediate or mafic tuff structurally juxtaposed (and possibly originally in stratigraphic sequence) with a unit of disrupted argillite, radiolarian chert, and sandstone. Radiolarians in chert are Late Jurassic in age. Lenses and fault slivers of phosphatic, sandy or conglomeratic limestone occur in both the massive tuffaceous mudstone and the disrupted chert-argillite units and contain Lower Jurassic mollusks including ammonites (Jones and others, 1980).

WHM WHITE MOUNTAINS TERRANE (3)--Ordovician volcanic and volcaniclastic rocks and conglomerate overlain by Silurian and Devonian limestone and dolomite. Undated clastic rocks form upper part of this sequence (see Churkin and others, 1982).

WR WRANGELLIA TERRANE (5)--Well-known stratigraphic assemblage consisting of basal upper Paleozoic arc-related volcanic breccias, flows, and volcaniclastic rocks, overlain by non-volcanic Permian limestone, pelitic rocks, and chert. Triassic rocks commence with black cherty argillite of Ladinian age, overlain by thousands of meters of subaerial to pillowed basalt. Above this are platformal and basinal Upper Triassic limestones that grade upward into basinal, spiculitic, argillaceous and calcareous rocks. Succeeding Jura-

Cretaceous rocks are predominantly clastic (MacKevett, 1978; Jones and others, 1977; and Silberling and others, 1981).

WS WICKERSHAM TERRANE (3)--Quartz-rich sandstone and grit, shale, and maroon to green slate; fossils of probable Cambrian age known locally. Wickersham terrane lacks regionally developed penetrative metamorphic fabric and greenschist metamorphism of nearby Yukon-Tanana terrane. Referred to as the "Beaver Terrane" by Churkin and others (1982).

WY WINDY TERRANE (5)--Disrupted assemblage of serpentinite, basalt, meta-chert, and blocks of Devonian limestone shale, in a matrix of upper Mesozoic conglomeratic flysch.

YA YAKUTAT TERRANE (5)--Upper Mesozoic graywacke and shale, containing structurally interleaved lenses of disrupted chert, argillite, and volcanic rocks. Includes Eocene basalt and organic-rich shale.

YO YORK TERRANE (2)--Weakly metamorphosed, structurally complex assemblage of Precambrian(?) to lower Paleozoic fine-grained clastic rocks (e.g., the "York Slate"), argillaceous limestone, and fossiliferous limestone of Ordovician and Silurian ages. Younger strata are estimated to be as much as 3,000 m thick, and may include rocks of late Precambrian, Cambrian, and Devonian ages (Sainsbury, 1969; Hudson, 1977).

YT YUKON TANANA TERRANE (3, 5)--Enormous tract of poly-deformed and metamorphosed rock occupying much of east-central Alaska and adjoining Yukon territory of Canada. Dominant lithologies are quartz-mica schist and gneiss, quartzite, quartz-rich grit, metarhyolite, gneissic plutonic rocks, and minor marble. Internal stratigraphy is unknown; terrane is probably composite, but meaningful regional subdivisions not yet available. Ages of protoliths largely unknown, although mid Paleozoic granitoids and Devonian marble appear to be present. Terminal metamorphic event seems to be late Mesozoic based on K/Ar dates (Foster, 1976). Referred to as "Yukon Crystalline Terrane" by Churkin and others (1982).

## NON-ACCRETIONARY CONTINENTAL ROCKS AND OCEANIC PLATE

NAm NORTH AMERICA--Non-acretionary continental rocks of north America with respect to the Phanerozoic

PAC PACIFIC PLATE

— — ... Terrane-bounding fault--dashed where approximately located; dotted where shown as concealed beneath post-accretion Cenozoic deposits.

——— Post-accretion or post-amalgamation contact--includes both depositional contacts and faults that are not terrane boundaries.

REFERENCES


Beikman, H. M., 1980, Geologic map of Alaska: U. S. Geological Survey, scale 1:2,500,000.

Brosge, W. P., Lanphere, M. A., Reiser, H. N., and Chapman, R. M., 1969, Probable Permian age of the Rampart Group, central Alaska: U.S. Geological Survey Bulletin 1294-B, p. B1-B18.

Churkin, Michael, Jr., Carter, Claire, and Trexler, J. H., Jr., 1980, Collision-deformed Paleozoic continental margin of Alaska--foundation for microplate accretion: Geological Society of America, v. 91, p. 648-654.

Churkin, M., Jr., Foster, H. L, Chapman, R. M., and Weber, F. R., 1982, Terranes and suture zones in east-central Alaska: Journal Geophysical Research, v. 87, no. B5, p. 3718-3730.

Churkin, Michael, Jr., Nokleberg, W. J., and Huie, Carl, 1979, Collision-deformed Paleozoic continental margin, western Brooks Range, Alaska: Geology, v. 7, p. 379-383.

Coney, P. J., Jones, D. L., and Monger, J. W. H., 1980, Cordilleran suspect terranes: Nature, v. 288, p. 329-333.

Dillon, J. T., Pessel, G. H., Chen, J. H., and Veach, N. C., 1980, Middle Paleozoic magmatism and orogenesis in the Brooks Range, Alaska: Geology, v. 8, p. 338-343.

Foster, H. L., 1976, Geologic map of the Eagle Quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigation Series Map I-922, scale 1:250,000.

Hitzman, M. W., Smith, T. E., and Proffett, J. M., 1982, Bedrock geology of the Ambler District, southwestern Brooks Range, Alaska: Alaska Div. Geol. and Geophysical Surveys, Geologic Report 75, 2 pls.

Hoare, J. M., and Coonrad, W. L., 1978, Geologic map of Goodnews and Hagemeister Island Quadrangles region, southwestern Alaska: U. S. Geological Survey Open-File Report 78-9-B.

Hudson, Travis, 1977, Geologic map of Seward Peninsula, Alaska: U.S. Geological Survey Open-File Report 77-796A, scale 1:1,000,000.

Hudson, Travis, and Plafker, George, 1982, Paleogene metamorphism of an accretionary flysch terrane, eastern Gulf of Alaska: Geological Society of America Bulletin, v. 93, p. 1280-1290.

Imlay, R. W., and Detterman, R. L., 1973, Jurassic paleobiogeography of Alaska: U.S. Geological Survey Professional Paper 801, 34 p.

Jones, D. L., Howell, D. G., Coney, P. J., and Monger, J. W. H., 1983, Recognition, charcter, and analysis of tectonostratigraphic terranes in western North America, in Hashimoto, M., and Uyeda, S., eds., Accretion tectonics in the Circum-Pacific regions: Terra Scientific Publishing Company, Tokyo, p. 21-35.

Jones, D. L., Silberling, N. J., Berg, H. C., and Plafker, George, 1981, Tectonostratigraphic terrane map of Alaska: U. S. Geological Survey Open-File Report 81-792.

Jones, D. L., Silberling, N. J., Csejtey, Bela, Jr., Nelson, W. H., and Blome, C. D., 1980, Age and structural significance of ophiolite and adjoining rocks in the Upper Chulitna district, south-central Alaska: U.S. Geological Survey Professional Paper 1121-A, 21 p.

Jones, D. L., Silberling, N. J., Gilbert, Wyatt, and Coney, Peter, 1982, Character, distribution, and tectonic significance of accretionary terranes in the central Alaska Range: Journal Geophysical Research, v. 87, no. B5, p. 3709-3717.

Jones, D. L., Silberling, N. J., and Hillhouse, J., 1977, Wrangellia--a displaced terrane in northwestern North America: Canadian Journal Earth Sciences, v. 14, p. 2565-2577.

Keith, T. E., Foster, H. L., Foster, R. L., Post, E. V., and Lehmbeck, W. L., 1981, Geology of an alpine-type peridotite in the Mount Sorenson area, east-central Alaska: U.S. Geological Survey Professional Paper 1170-A, p. A1-A9.

MacKevett, E. M., Jr., 1978, Geologic map of the McCarthy Quadrangle, Alaska: U.S. Geological Survey Map I-1032, scale 1:250,000.

Mayfield, C. F., Tailleur, I. L., Mull, C. G., and Sable, E. G., 1978, Bedrock geologic map of the south half of National Petroleum Reserve in Alaska: U.S. Geological Survey Open-File Report 78-70B.

Mull, C. G., Tailleur, I. L., Mayfield, C. F., Ellersieck, Inyo, and Curtis, S., 1982, New upper Paleozoic and Lower Mesozoic stratigraphic units, central and western Brooks Range, Alaska: American Association of Petroleum Geologists Bulletin, v. 66, p. 348-362.

Nokleberg, W. J., and Winkler, G. R., 1982, Stratiform zinc-lead deposits in the Drenchwater Creek area, Howard Pass Quadrangle, northwestern Brooks Range, Alaska: U.S. Geological Survey Professional Paper 1209, 22 p.

Patton, W. W., Jr., 1973, Reconnaissance geology of the northern Yukon-Koyukuk Province, Alaska: U.S. Geological Survey Professional Paper 774-A, 17 p.

Patton, W. W., Moll, E. J., Dutro, J. T., Jr., Silberman, M. L., and Chapman, R. M., 1980, Preliminary geologic map of the Medfra Quadrangle, Alaska: U.S. Geological Survey Open-File Report 80-811A.

Richter, D. H., 1976, Geologic map of the Nabesna Quadrangle, Alaska: U.S. Geological Survey Map I-932, scale 1:250,000.

Sainsbury, C. L., 1969, Geology and ore deposits of the central York Mountains, western Seward Peninsula, Alaska: U.S. Geological Survey Bulletin 1287, 101 p.

Silberling, N. J., Richter, D. H., Jones, D. L., and Coney, P. C., 1981, Geologic map of the bedrock part of the Healy A-1 Quadrangle south of the Talkeetna-Broxson Gulch fault system, Clearwater Mountains, Alaska: U.S. Geological Survey Open-File Report 81-1288, scale 1:63,360.

Tysdal, R. G., and Case, J. E., 1979, Geologic map of the Seward and Blying Sound Quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigation Series Map I-1150, scale 1:250,000.

# PART B -- Lithotectonic terrane map of western Canada and southeastern Alaska

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DESCRIPTION OF MAP UNITS

POST-ACCRETION COVER ROCKS

T TERTIARY ROCKS

UKT UPPER CRETACEOUS AND TERTIARY ROCKS

POST-AMALGAMATION OR POST-ACCRETION
BATHOLITHIC ROCKS

BATHOLITHIC ROCKS--Granitic and gneissic rocks

POST-AMALGAMATION OVERLAP ASSEMBLAGES

MUK MIDDLE AND UPPER CRETACEOUS ROCKS OF SPENCES BRIDGE AND KINGSVALE GROUPS--Depositional on both QN and southernmost part of CC

UJ-LK UPPER JURASSIC AND LOWER CRETACEOUS ROCKS OF BOWSER BASIN--Depositional only on ST but contains detritus from CC

GN GRAVINA-NUTZOTIN BELT--Upper Jurassic to mid-Cretaceous argillite and graywacke, intermediate and mafic volcanic rocks, and granitic to ultramafic intrusive rocks. Depositonal on AX and WR

ACCRETED TERRANES

[Arranged alphabetically by map symbol]

AAN NORTH SLOPE SUBTERRANE OF ARCTIC ALASKA TERRANE--Precambrian to lower Paleozoic basement rocks unconformably overlain by Mississippian to Jurassic continental-margin deposits, all of which have undergone large-scale rotation or translation so that original facies transitions with strata of the North American miogeocline are disrupted

AX ALEXANDER TERRANE UNDIFFERENTIATED--Schist and gneiss derived from feldspathic sediments, felsic to mafic volcanic rocks, minor pelitic and carbonate rocks

AXA ADMIRALTY SUBTERRANE--Devonian and Mississippian basalt, carbonate rocks, and chert

AXC CRAIG SUBTERRANE--Pre-Ordovician metamorphic complex and Ordovician to Triassic basic to acidic volcanic rocks, terriginous clastic and carbonate rocks. Paleozoic paleomagnetic data discordant with that of North America and indicative of a lower paleolatitude

AXN ANNETTE SUBTERRANE--Variably metamorphosed Ordovician to Triassic intrusive, extrusive, clastic and carbonate rocks; no known post-Middle Devonian Paleozoic strata

BR BRIDGE RIVER TERRANE--Disrupted, variably metamorphosed, Middle Triassic to Lower Jurassic chert, argillite, basalt, ultramafic rocks, and minor carbonate rocks

BV BARKERVILLE TERRANE--Variably metamorphosed, possibly upper Proterozoic and Paleozoic pelite, grit, volcaniclastic rocks, and minor carbonate rocks

CA CASSIAR TERRANE--Upper Precambrian to Devonian platformal carbonate rocks, sandstone, and graptolitic shale

CC CACHE CREEK UNDIFFERENTIATED--Disrupted Pennsylvanian and Permian chert, argillite, basalt, and carbonate and ultramafic rocks; local high-grade blueschist. Permian faunas in all parts of the Cache Creek Group resemble those in Japan, China, Indonesia, and the Himalayan region and differ from coeval North American faunas. Over 10° northerly shift with respect to North America indicated by paleomagnetic data from cross-cutting Lower Cretaceous pluton

CCB BONAPARTE SUBTERRANNE--Mélange having a matrix of Permian to Upper Triassic chert and argillite and blocks of chert, basalt, ultramafic rocks, and Middle Pennsylvanian to Lower Permian carbonate rocks

CCF FRENCH RANGE SUBTERRANE--Permian carbonate rocks overlying basic or acidic volcanic rocks; interbedded Upper Triassic chert and graywacke occurs locally

CCM MARBLE RANGE SUBTERRANE--Mid- and Upper Permian shallow-water carbonate rock and minor basalt and chert

CCN NAKINA SUBTERRANE--Coherent Mississippian to Triassic sequence of basalt overlain by Mississippian to Permian carbonate rock and Middle or Upper Triassic chert

CCP PAVILION SUBTERRANE--Lower and Upper Triassic argillite, chert, and siltstone; minor Permian and Upper Triassic limestone, volcaniclastic rocks, and basalt

CCS SENTINEL SUBTERRANE--Disrupted Pennsylvanian, Permian and possibly Mesozoic radiolarian chert and argillite, pillow basalt, diabase sills, and extensive, probably olistostromal basalt and carbonate breccia containing clasts of Mississippian to Permian ages

CG CHUGACH TERRANE--Late Cretaceous graywacke, argillite, and mélange having a matrix of Upper Jurassic to Lower Cretaceous cherty argillite matrix and blocks of basic volcanic rocks, chert, limestone, and ultramafic rocks

CK CHILLIWACK SUBTERRANE--Pennsylvanian to Permian argillite, siltstone, sandstone, conglomerate, carbonate rocks, and dacitic to basaltic volcanic rocks, overlain by Upper Triassic and Lower Jurassic argillite, siltstone and volcanic sandstone. Permian fusulinid faunas resemble those of Quesnellia and Stikinia and are not dissimilar from faunas in the southwestern United States

CR CRESCENT TERRANE--Eocene basalt flows, breccia, tuff, and volcanic sandstones; cut by gabbro and diabase intrusions

HZ HOZAMEEN TERRANE--Disrupted Permian to Middle Jurassic chert, argillite, basalt, minor carbonate and alpine-type ultramafic rocks

KA KANDIK RIVER TERRANE--Flyschoid pelitic rocks and sandstone, mainly of Early Cretaceous age; highly deformed and affected by low-grade metamorphism

KL KLUANE TERRANE--Quartz-biotite schist possibly derived from a Jurassic-Cretaceous clastic protolith

KO KOOTENAY TERRANE--Variably metamorphosed, lower Paleozoic strata comprising pelite, quartz grit, basic acidic volcanic rocks, and Devonian and(?) older intrusions that were deformed prior to deposition of late Paleozoic pelite, conglomerate, sandstone, limestone, and basic volcanic rock. In part these strata resemble coeval "North American" strata to the east, but the latter contain no record of lower to mid Paleozoic deformation and intrusion

MD MCLEOD TERRANE--Metamorphic rocks, including micaceous garnet and chlorite schist, minor metaquartzite, and granitic rocks

MO MONASHEE TERRANE--Lower Proterozoic, high-grade metamorphic rocks comprising cores of paragneiss and orthogneiss as old as 2.5 Ga, mantled by quartzitic, semi-pelitic and calc-silicate gneiss and minor marble and metaquartzite cut by 2.0 Ga orthogneiss intrusions

MT METHOW-TYAUGHTON TERRANE--Upper Triassic to Cretaceous clastic sedimentary strata containing local carbonate and volcanic rocks. By late Early Cretaceous time this terrane is a partial facies equivalent of a coeval continental arc built upon Quesnellia to the east

NK NOOKSACK TERRANE--Upper Triassic(?) Lower Jurassic to Lower Cretaceous clastic rocks, interbedded intermediate to acidic volcanic rocks, and metamorphosed equivalents of these

PC PORCUPINE TERRANE--Precambrian(?) sedimentary rocks overlain by generally shallow-marine carbonate and clastic rocks of Cambrian(?) to Late Devonian age

PR PACIFIC RIM TERRANE--Disrupted, mainly Upper Jurassic and Lower Cretaceous, graywacke, argillite, chert, and basalt

QN QUESNELLIA TERRANE UNDIFFERENTIATED--Upper Triassic and Lower Jurassic calcalkaline to alkaline volcanic rocks and comagmatic intrusive rocks, argillite, volcanic sandstone, and minor carbonate rock; upper Paleozoic carbonate rock occurs locally. Permian, Triassic and some Jurassic faunas differ from coeval faunas at same present latitude on craton

QNH HARPER RANCH SUBTERRANE--Upper Devonian to Permian argillite, sandstone and conglomerate, basic to acidic volcanic rocks, and carbonate rock. Permian faunas similar to those of CK and probably ST

QNO OKANAGAN SUBTERRANE--Disrupted and variably metamorphosed chert, argillite, and basalt; local upper Paleozoic limestone and ultramafic rocks

SE SAINT ELIAS TERRANE--Metamorphosed volcanic and sedimentary rocks of probable late Mesozoic age

SH SHUKSAN TERRANE--Metamorphosed, greenschist- and blueschist-grade, basic volcanic rocks, pelite and pelitic quartz grit of probable Jurassic protolith age; metamorphosed in Late Jurassic-Early Cretaceous time

SK SKAGIT TERRANE--Metamorphosed, locally migmatitic rocks, derived from a predominantly clastic sequence with subordinate volcanic rocks (in part possibly BR, HZ, and MT) and metamorphosed in mid- or Late Cretaceous time. Anomalously low paleomagnetic inclinations with respect to stable North America in mid-Cretaceous plutonic rocks cutting this terrane

SM SLIDE MOUNTAIN TERRANE--Upper Paleozoic chert, argillite, sandstone, conglomerate, and local mafic intrusions, stratigraphically or structurally overlain by basalt, local alpine-type ultramafic rocks, and carbonate rocks. Permian faunas in this terrane in northern British Columbia have affinities with those of southwest United States and northwest Mexico

ST STIKINIA TERRANE--Mississippian to Jurassic basic to acidic volcanic rocks and clastic rocks, and important amounts of upper Paleozoic carbonate rock. Permian, Triassic and Jurassic faunas differ from those at same present latitude on craton, but are similar to those farther south in the western and southwestern conterminous U.S.; Triassic and Jurassic magnetic inclinations indicate about 13° northward displacement with respect to paleolatitudes on craton

TA TRACY ARM TERRANE--Metamorphosed pelitic and quartzofeldspathic schist and paragneiss, marble, amphibolite, and minor serpentinite. Possible late Proterozic protolith age in northwestern British Columbia; to the south these rocks may be merely high-grade metamorphic equivalents of flanking terranes

TUS, TUN, TUC TAKU TERRANE--Variably metamorphosed upper Paleozoic and Triassic basalt and local acid volcanic rock, carbonate rock, and pelite. Includes undated metamorphosed clastics and volcanics similar to Jurassic and Cretaceous strata in Gravina-Nutzotin overlap assemblage

WM WINDY-MCKINLEY TERRANE--Devonian to Triassic ultramafic rock, limestone, chert, and pillow basalt

WR WRANGELLIA TERRANE--Upper Paleozoic to Jurassic acid to basic volcanic rocks and comagmatic intrusions, limestone, pelite, and conspicuous Middle(?) and Upper Triassic thoeliitic basalt overlain by carbonate rocks. Paleomagnetic data on Triassic and Jurassic strata indicate derivation from low latitudes

YA YAKUTAT TERRANE--Upper Mesozoic pelite, graywacke, and mélange, and Cenozoic marine and continental clastic rocks

YT YUKON-TANANA TERRANE--Heterogenous metamorphic terrane comprising sedimentary and magmatic rocks of possible late Proterozoic, Paleozoic, and Mesozoic protolith ages. Includes gneiss, clastic metasedimentary rocks, foliated granitic rocks, and ophiolite

NON-ACCRETIONARY CONTINENTAL ROCKS
AND OCEANIC PLATES

NAm NORTH AMERICA--Non-accretionary continental rocks of North America with respect to the Phanerozoic

JDF JUAN DE FUCA PLATE

PAC PACIFIC PLATE

— — ··· Terrane-bounding fault--dashed where approximately located; dotted where concealed beneath cover deposits or within batholithic rocks

———— Post-amalgamation or post-accretion contact--includes both depositional and intrusive contacts and faults that are not terrane boundaries

(1) Localities where evidence for amalgamation of terranes exists--Described in Table 1 of pamphlet

## DISCUSSION

This map shows the distribution of lithotectonic terranes in western Canada and southeastern Alaska. It is one of four such maps, covering the North American Cordillera from Alaska through Mexico, prepared at 1:2,500,000 scale as a cooperative project of the U.S. Geological Survey, Geological Survey of Canada, and Petroleos Mexicanos.

Each terrane preserves a geological record different from those of its neighbors and from rocks deposited on or adjacent to cratonic North America. The boundaries of terranes are discontinuities, generally major faults, across which the geological record changes abruptly. While some of these changes may be due to structural telescoping of different facies, there is sufficient paleontological and paleomagnetic evidence to show or suggest that many terranes were originally widely separated from one another and/or from cratonic North America by distances of up to thousands of kilometers.

There are five categories of terranes.

(1) Coherent terranes: These are the ideal type, with either "layer-cake" stratigraphy or else demonstrable internal facies changes. They are commonly little metamorphosed and some contain distinctive paleontological and paleomagnetic records. Examples are AX, CA, QN, ST, WR.

(2) Disrupted terranes: These are commonly ophiolitic terranes, whose internal homogeneity derives both from their relatively limited range of lithologies, mostly indicative of deposition in ocean basins, and from their characteristic deformational style, which includes mélange and broken formation. This category contains subterranes with internally coherent stratigraphy dispersed between other subterranes featuring extreme stratigraphic disruption. Examples are BR, CC, PR, with, for example, CCN as a subterrane that has coherent stratigraphy within CC.

(3) Metamorphic terranes: These are derived mainly from stratified sequences, but their integrity is provided by a metamorphic and structural overprint that largely or wholly conceals the stratigraphic record. Enough characteristics of the protolith of a metamorphic terrane (such as YT) may be preserved to distinguish it on stratigraphic grounds from adjacent terranes. Other metamorphic terranes (such as SK) are partly or wholly the metamorphosed equivalents of adjacent terranes; still others (such as TA) are of uncertain primary affinity.

(4) Subterranes: These are divisions of terranes, denoted by three-letter symbols, and their use commonly indicates lithotectonic affinity but not necessarily stratigraphic continuity. For example, the Cache Creek terrane (CC), with its limited range of lithologies and distinctive Permian faunas, clearly constitutes a terrane that is very different from adjacent, coeval terranes (QN, ST), yet within it are subterranes with different stratigraphies (for example CCF, CCN) whose original relations to one another are unknown. Similarly, the Alexander terrane contains two, probably three subterranes (AXA, AXN, AXC) that appear to have had independent histories prior to the Permian.

(5) Superterranes: These are composite terranes, composed of major terranes amalgamated with others prior to their accretion to the ancient continental margin. There appear to be two superterranes in this segment of the Cordillera, an eastern and a western. The eastern super terrane consists of terranes CC, QN, ST, and SM, which were amalgamated in the early Mesozoic and began its accretion in Jurassic time. It was called "Composite Terrane I" by Monger and others (1982) and "Stikinian superterrane" by Saleeby (1983). Middle and late Mesozoic overlap assemblages of the Bowser Basin (map unit UJ-LK) and of the Spences Bridge and Kingsvale Groups (map unit MUK) may have undergone substantial displacement with respect to North America along with the amalgamated terranes of this superterrane. A western superterrane is composed of terranes AX and WR, which were amalgamated in the Late Jurasic and accreted in the Cretaceous. It was designated "composite Terrane II" by Monger and others (1982) and "Wrangellian superterrane" by Saleeby (1983). The Upper Jurassic to mid-Cretaceous Gravina-Nutzotin overlap assemblage (GN) was deposited upon the amalgamated AX and WR terranes prior to their accretion. The boundary between the eastern superterrane and the ancient western margin of North America corresponds with a major metamorphic and structural welt, the Omineca Crystalline Belt. The boundary between the eastern and western superterranes coincides with a second welt, the Coast Plutonic Complex, within which deformation and metamorphism were concentrated. The process of accretion of these superterranes to the ancient western margin of North America in Jurassic and Cretaceous times may be responsible for the two major metamorphic and structural culminations. The evidence for amalgamation is enumerated in table 1, which follows the descriptions of terranes, and the location of the evidence is shown by corresponding numbers on the terrane map.

All of these terranes are suspect (Coney and others, 1981) in the sense that their original paleogeographic positions relative to the North American craton are uncertain. However, there are indications that they exhibit widely differing amounts of displacement. Some terranes as determined by paleontological or paleomagnetic data or by extreme stratigraphic dissimilarities, are probably exotic (for example AX, WR, parts of CC). Others could have formed off-shore of western North America but were later displaced northwards (for example CK, QN, SM, ST, parts of CC). Others are fragments of the continental terrace wedge, slivered off during Cretaceous and Tertiary dextral strike-slip motion (for example CA), and still others are suspect because they contain features unknown on the cratonic margin and yet exhibit possible stratigraphic similarities (for example BV, MD, MO, KO, YT). The evidence for displacement is given in the summary descriptions of terranes.

The basic outcrop pattern and extent of post-accretion or post-amalgamation cover deposits and batholithic granitic rocks shown on the terrane map is adapted from Tipper and others (1981). The line weight and style of contacts shown on the map incorporate significant departures from those conventionally used on geologic maps. Heavy lines on the terrane map show only those faults that are terrane boundaries. Faults that only bound post-accretion or post-amalgamation cover deposits or batholithic igneous rocks are not differentiated from the light-weight lines that also represent depositional and intrusive contacts.

## ACKNOWLEDGMENTS

Advice and assistance in compiling this map have been received from colleagues mainly in the Geological Surveys of Canada and the United States, notably P. J. Coney, H. Gabrielse, S. Gordey, D. L. Jones, A. V. Okulitch, G. Plafker, N. J. Silberling, L. Struik, D. J. Tempelman-Kluit, H. W. Tipper, G. J. Woodsworth and J. O. Wheeler. P. B. Read, Geotex Consultants, gave advice on aspects of the southeastern part of the Canadian Cordillera. These geologists may or may not agree with the map pattern, which is the responsibility of the authors.

## DESCRIPTION OF TERRANES AND NAMED OVERLAP ASSEMBLAGES

[Arranged alphabetically by name]

AX ALEXANDER TERRANE--The Alexander terrane comprises late Precambrian to Triassic strata. Where little metamorphosed, AX is divided into three subterranes (Admiralty, AXA; Craig, AXC; and Annette, AXN) at least two of which (AXA, AXC) appear to have had an independent history until Permian time, when they first share common rock units (Brew and others, 1966; Berg and others 1972, 1978). Rocks of Mississippian to Triassic age (AXN?) located 35 km northwest of Prince Rupert, B.C. (M. J. Orchard, oral commun., 1982; Hutchison, 1982), are provisionally correlated with Alexander terrane rocks in southeastern Alaska on the basis of stratigraphic similarities. Metamorphosed strata in the Coast Plutonic Complex south of Prince Rupert are shown on the map as undivided Alexander terrane (AX). They consist mainly of greenschist- to amphibolite-facies schist and gneiss, derived largely from feldspathic sediments and felsic to mafic volcanics and in small part from lesser shale, graywacke, and carbonate. Regional metamorphism of these rocks is of mid-Cretaceous age (Woodsworth and others, in press).

AXA ADMIRALTY SUBTERRANE--The Admiralty subterrane of the Alexander terrane is distinguished by a coherent Paleozoic sequence of Devonian marine metabasalt and carbonate (Gambier Bay Formation) overlain by Late Devonian and Mississipian basaltic tuff and radiolarian chert (Cannery Formation). Ordovician carbonaceous flysch and minor basaltic tuff (Hood Bay Formation) are in fault contact with the younger Paleozoic units. The stratigraphic basement of the subterrane is not exposed. Pebbles of Cannery chert occur as clasts in the Permian Halleck Formation of Craig subterrane, thus linking the two subterranes by Permian time (Berg and others, 1978; loc. 3, table 1).

AXN ANNETTE SUBTERRANE--The Annette subterrane comprises a heterogeneous assemblage of variably metamorphosed Ordovician or Silurian to Triassic intrusive, extrusive, clastic and carbonate rocks, and it is characterized by the absence of any known post-Middle Devonian Paleozoic strata (Berg and others, 1978). Recent investigations by Gehrels and others (1983) show that Annette subterrane contains an Ordovician-Silurian volcanoplutonic complex similar to the one in the southern part of Craig subterrane. These data suggest that the two subterranes may have been in related tectonic environments in Ordovician-Silurian time, but the marked differences in their Devonian and later Paleozoic history support retaining their classification as distinctive subdivisions of the Alexander terrane.

AXC CRAIG SUBTERRANE--The Craig subterrane is distiguished by a relatively complete and undeformed sequence of Ordovician to Permian basaltic to silicic volcanic and volcaniclastic rocks, and terrigenous clastic and carbonate rocks (Brew, 1966; Berg and others, 1972, 1978), and by a pre-Ordovician metamorphic complex (Wales Group). Recent mapping and geochronologic studies (Eberlein and others, 1983; Gehrels and others, 1983 a, b) show that the southern part of the Craig subterrane is underlain by an Ordovician-Silurian volcanoplutonic basement complex of diorite and trondhjemite, and by cogenetic volcanic and volcaniclastic rocks. This complex is in fault contact with Wales Group metabasite and metacarbonate. Paleomagnetic data indicate that the terrane has undergone about 15° of northward movement relative to cratonic North America since Pennsylvanian time (Van der Voo and others, 1980), but no apparent change in latitude since Late Triassic time (Hillhouse, and Grommé 1980), if an origin in the northern hemisphere is assumed.

AAN ARCTIC ALASKA TERRANE, NORTH SLOPE SUBTERRANE--This subterrane of the Arctic Alaska terrane consists of Precambrian to lower Paleozoic basement rocks (Neruokpuk Group, in part) overlain by the Kekiktuk Conglomerate (Mississippian), Lisburne Group (Mississippian to Pennsylvanian), Sadlerochit Group (Permian to Triassic), and younger Mesozoic strata. In general, the Carboniferous through early Mesozoic rocks are miogeoclinal shelf deposits, as are the North American strata of this general age in the Mackenzie platform and Richardson Mountains, which, however, have a very different stratigraphic section and substrate. AAN continues across northern Alaska, where it forms the structurally lowest rocks beneath successive overthrust sheets composed of other subterranes of the Arctic Alaska terrane and the rest of the terranes that characterize the major share of the Brooks Range.

BV BARKERVILLE TERRANE--The Barkerville terrane is composed of interbedded grit and pelite which locally contains volcaniclastic rocks, limestone and quartzite-clast conglomerate. It is complexly deformed and metamorphosed to greenschist to amphibolite facies and is of possible Proterozoic to late Paleozoic premetamorphic ages (Struik, 1981; oral commun., 1982). It contains a body of orthogneiss of possible Devonian age (A. V. Okulitch, oral commun., 1982). In both gross composition and regional structural setting BV is similar to the Kootenay and Yukon-Tanana terranes.

BR BRIDGE RIVER TERRANE--The Bridge River terrane is a disrupted terrane composed of bedded radiolarian chert, argillite, basalt, minor sandstone and carbonate rocks, and alpine-type ultramafics (Roddick and Hutchison, 1973). Commonly, the metamorphic grade is subgreenschist and the rocks typically are chaotic (broken formation, mèlange), or at best, have a weakly developed foliation. Structurally interleaved with these are higher grade metamorphic rocks, namely siliceous schist, amphibolite, local marble, and ultramafics, which are assumed on compositional grounds to have been derived from the low-grade Bridge River rocks ( Potter, 1983). Paleontological ages range from Middle Triassic to late Early Jurassic (Cameron and Monger, 1971; D. L. Jones, oral commun., 1978; M. J. Orchard, oral commun., 1981), and isotopic ages from associated gabbro are as old as Permian (R. L. Armstrong, oral commun., 1981).

CA CASSIAR TERRANE--The coherent Cassiar terrane comprises sedimentary rocks, ranging in age from late Precambrian to Devonian, similar in part to North American platformal strata in the Rocky Mountains but separated from them by offshelf Cambrian, Ordovician, Silurian and Devonian facies. Silurian and Devonian strata in both Rocky Mountain and Cassiar successions comprise a relatively condensed sequence of carbonate and clean sandstone. A transitional facies in the Cassiar terrane includes graptolitic Ordovician and Silurian rocks like those in the westernmost Rocky Mountains. The Cassiar terrane appears to have been displaced northward by 500 to 1000 km along the western margin of ancestral North America, in part at least by late Mesozoic and early Tertiary right-lateral strike-slip faults, so that platformal strata to the west are juxtaposed with off-shelf facies to the east (Gabrielse, 1963; in press).

CC CACHE CREEK TERRANE--The undifferentiated part of the Cache Creek terrane, located in central British Columbia, comprises structurally complex radiolarian chert, argillite and basalt, extensive bodies of shallow-water carbonate rocks, alpine-type ultramafic rocks, melange containing these components, and, near Pinchi Lake, local high-grade blueschist and eclogite (Armstrong, 1948; Paterson, 1977). Calcareous strata are of Pennsylvanian and Permian ages, and blueschist yields Late Triassic isotopic ages (Paterson and Harakal, 1974).

Mid- and Upper Permian fusulinid and coral faunas in all Cache Creek rocks are similar to coeval faunas in Japan, China, Indonesia, and the Himalayan region and are different from coeval faunas of cratonic North America and other Cordilleran terranes. The local presence of more cosmopolitan ammonoid faunas in the Cache Creek terrane allows its exotic faunas to be correlated with those of the North American (West Texas) Permian (Ross and Nassichuk, 1971). The Cache Creek fauna suggest that Permian (and presumably older) rocks in the Cache Creek Group are truly exotic with respect to North America (Ross and Ross, 1983). However, by latest Triassic time there is evidence to link CC to QN and ST, which have Permian faunas that are displaced but not obviously exotic (Monger and others, 1982; Ross and Ross, 1983). Paleomagnetic data from a discordant Lower Cretaceous anorthositic gabbro emplaced in Cache Creek suggests that the Cache Creek terrane lay more than 10° to the south relative to the North American craton as late as mid-Cretaceous time (Monger and Irving, 1980).

CCB BONAPARTE SUBTERRANE--The disrupted Bonaparte subterrane in southern British Columbia consists of mélange with Permian to Upper Triassic radiolarian chert and argillite matrix (D. L. Jones, oral commun., 1981), and blocks of chert, basalt, ultramafic rock, and Middle Pennsylvanian and Lower Permian limestone. Local blocks of volcaniclastics within the mélange are lithologically identical to rocks in the westernmost facies of the upper Triassic Nicola Group to the east within the Quesnellia terrane (Monger, 1981; Shannon, 1981; 1982). Norian strata of the Nicola Group adjacent to Cache Creek rocks include conglomerate of chert, greenstone, limestone, and ultramafic clasts (Travers, 1978; Monger 1981). Chert clasts from this conglomerate yield probable Middle Triassic conodonts (M. J. Orchard, oral commun, 1982.), older than those in any Nicola rocks. These observations suggest that the Bonaparte subterrane was associated with Quesnellia by Upper Triassic time (loc. 13, table 1).

CCF FRENCH RANGE SUBTERRANE--The coherent French Range subterrane of northern British Columbia consists of Permian shallow-water carbonate (Teslin Fm.) conformably, and locally gradationally, overlying basic flows or siliceous flows and pyroclastics (French Range Fm.). These rocks are locally conformable on, and gradational with, a sequence of cherty pelite, chert, and intercalated volcanic graywacke (Kedahda Fm.), but elsewhere lie on it with unknown (thrust?) relationships (Monger, 1969; 1974). At the northwest end of this terrrane, radiolarian chert interbedded with graywacke has yielded Upper Triassic (Norian) conodonts (M. J. Orchard, oral commun., 1982; loc. 7, table 1). Because this graywacke is lithologically identical with coeval graywacke in Stikinia, it suggests that in latest Triassic time the French Range subterrane was a facies equivalent of Stikinia. Cache Creek detritus was shed onto Stikinia in late Middle Jurassic time (for example, loc. 9, table 1) and Cache Creek strata subsequently were structurally superposed on Stikinia (for example, loc. 8, table 1) (Monger and others, 1978).

CCM MARBLE RANGE SUBTERRANE--The Marble Range subterrane of southern British Columbia comprises extensive shallow-water mid and Upper Permian carbonate rocks along with minor interbedded basalt and local chert (Trettin, 1980). Associated with these rocks are thin-bedded radiolarian limestone and calcareous tuff of Early Triassic age (M. J. Orchard, oral commun., 1982). This subterrane is in thrust(?) fault contact with the Bonaparte subterrane to the east and Pavilion subterrane to the west.

CCN NAKINA SUBTERRANE--The coherent Nakina subterrane contains the most complete stratigraphic section known in the Cache Creek terrane. Its base is Mississippian basalt (Nakina Fm.) containing pods of Upper Mississippian carbonate at the top. On one side basalt is in fault contact with the Nahlin ultramafic body, mainly tectonized harzburgite but locally cumulate ultramafic, gabbro, and trondjhemite that possibly represents the oceanic crust on which the Nakina subterrane was deposited. Conformably and gradationally overlying the basalt are thick (2000 m), shallow-water to intertidal, reefoidal Upper Mississippian to Upper Permian carbonate rocks (Horsefeed Fm.). These are overlain, with regional angular unconformity, by Middle or Upper Triassic chert (Monger, 1975, 1977a; Terry, 1977).

CCP PAVILION SUBTERRANE--The Pavilion subterrane comprises interbedded silicified argillite, siltstone, and chert of Early and Late Triassic ages, and minor Permian and Upper Triassic limestone, volcaniclastics and local metabasalt. The volcaniclastics resemble those of Late Triassic age in Quesnellia (Nicora Group). No stratigraphic order is known, although the subterrane typically is not mèlange or broken formation (Trettin, 1980; Monger, 1981).

CCS SENTINEL SUBTERRANE--The disrupted Sentinel subterrane is dominated by bedded radiolarian chert and argillite of Pennsylvanian, Permian, and "Mesozoic" ages (D. L. Jones, oral commun., 1972). In places, pillow basalt and diabase sills are conformable with enclosing red chert. Elsewhere, extensive breccias comprise blocks mainly of basalt, but locally of limestone. The limestone blocks are of Lower Mississippian, mid and latest Pennsylvanian, and Permian ages. In size, the blocks range upwards from a few centimeters in diameter to one or two kilometers. The breccias are commonly conformable with bedding in the enclosing chert and argillite and thus are believed to be olistostromes (Monger, 1975; 1976; 1977a), but in places they are tectonized and become foliated, with phacoidal blocks.

CK CHILLIWACK TERRANE--The coherent Chilliwack terrane comprises the upper Paleozoic Chilliwack Group and the disconformably overlying Upper Triassic-Lower Jurassic Cultus Formation. These rocks are recumbently folded and imbricated with the Nooksack terrane on east-dipping, mid-Cretaceous thrust faults. Devonian strata have been reported from this terrane in northwestern Washington (Danner, 1966; Misch, 1966; Monger, 1970). In Canada the stratigraphy appears to be coherent, with argillite, siltstone, Pennsylvanian limestone, and local plant-bearing conglomerate overlain by Lower Permian limestone and dacitic and basaltic volcanics. Disconformably above is Upper Triassic and Lower Jurassic argillite, siltstone and volcanic sandstone. In one place these rocks appear to be overlain disconformably by Upper Jurassic (Oxfordian) black shales that are possibly facies equivalent of the Nooksack Group. If so, Nooksack and Chilliwack terranes can be linked by Late Jurassic time (loc. 5, table 1). Chilliwack, Nooksack, and Shuksan terranes are brought together by mid- to Upper Cretaceous thrust faults.

Permian faunas in the Chilliwack Group are similar to those in Quesnellia according to W. R. Danner (oral commun., 1980) and possibly also to those of Stikinia (Monger and Ross, 1971).

CG CHUGACH TERRANE--Chugach terrane, shown on the map as a single unit, actually comprises the following two distinctive tectonostratigraphic assemblages (Plafker and others, 1977): (1)

a strongly folded but coherent flysch assemblage of graywacke, argillite, and slate containing rare fossils of Late Cretaceous (Campanian to early Maestrichtian) age; and (2) a polymictic disrupted (melange) assemblage composed of blocks of basic volcanic rocks, chert, ultramafic rocks, limestone, and plutonic rocks in a matrix of cherty, tuffaceous argillite. Greenschist-to-amphibolite facies regional metamorphism locally overprints sporadic remnants of blueschist facies metamorphism. Radiolarians in chert range in age from Late Jurassic to Early Cretaceous. These two assemblages are structurally interleaved in many places, but in general the disrupted assemblage tends to be structurally above the coherent flysch assemblage.

The Chugach terrane may have been floored by Upper Jurassic oceanic crust, because the blocks of radiolarian chert are associated with pillow basalt and minor serpentinite (Berg and others, 1978).

CR CRESCENT TERRANE--The Crescent terrane comprises tholeiitic pillow basalt, amygdaloidal flows, aquagene tuff, and breccia with intercalated volcanic sandstones containing early Eocene fossils. Dike complexes of basalt, diabase and gabbro intrude the volcanic rocks (Muller, 1980a).

GN GRAVINA-NUTZOTIN OVERLAP ASSEMBLAGE--Gravina-Nutzotin "belt" (Berg and others, 1972) comprises Upper Jurassic to mid-Cretaceous marine argillite and graywacke, minor nonmarine strata, interbedded andesitic to basaltic volcanic and volcaniclastic rocks, and subvolcanic plutons ranging from quartz diorite to dunite and peridotite (Berg and others, 1972, 1978). Preliminary paleomagnetic studies show anomalously shallow inclinations with respect to stable North America (Panuska and Decker, 1982). The Gravina-Nutzotin belt lies depositionally on both Alexander terrane (on Gravina, Kupreanof, and Admiralty Islands in the Alexander Archipelago) and Wrangellia (near the Alaska-Yukon boundary) and is thus an overlap assemblage, linking AX and WR into a superterrane (locs. 1 and 2; table 1). The eastern boundary of the belt with Taku terrane is inferred to be a zone of northeast-dipping thrust faults (Berg and others, 1972, 1978). In places, however, Taku terrane contains undated metagraywacke, argillite, and andesitic metatuff that may in part correlate with Jurassic or Cretaceous strata in the Gravina-Nutzotin belt (Berg, 1982, p. 13). If so, the belt may locally overlap Taku terrane, thus linking at least part of it to the AX + WR superterrane. The Dezadeash Formation, an Upper Jurassic-Lower Cretaceous sequence of flysch and subordinate volcaniclastic rocks northeast of the Denali fault in Yukon Territory (Eisbacher, 1976; Eisbacher and Hopkins, 1977), is included in the Gravina-Nutzotin belt on the basis of similarities in lithology and stratigraphic position. The eastern side of the Dezadeash appears to be involved in latest Cretaceous and early Tertiary structures and metamorphism associated with the Coast Plutonic Complex, and may be the protolith of the Kluane terrane (loc. 4, table 1).

HZ HOZAMEEN TERRANE--The Hozameen terrane comprises bedded chert, argillite, basalt, minor carbonate and alpine-type ultramafic rocks, and it has undergone metamorphism that ranges from subgreenschist to greenschist facies. The lowest grade rocks typically are disrupted. Radiolarian faunas ranging in age from Permian to Middle Jurassic have been recovered from this assemblage (Tennyson and others, 1982; R. A. Haugerud, written commun., 1983). The Hozameen terrane is thus similar in most respects to the Bridge River terrane but is separated from it by the Fraser-Straight Creek dextral fault system of Tertiary age.

KA KANDIK RIVER TERRANE--Exposures of this terrane along the international border in Canada are continuous into Alaska where KA is described by Churkin and others (1982) as a thick sequence of flyschoid pelitic rocks and sandstone which is mainly of Early Cretaceous age and generally fault bounded against neighboring older rocks. It includes the upper part of the Glenn Shale and higher parts of the Kandik Group which are isoclinally folded and affected by low-grade metamorphism.

KL KLUANE TERRANE--The Kluane metamorphic terrane is composed of quartz-biotite schist (Kluane schist) (Kindle, 1953; Muller, 1967; Tempelman-Kluit, 1974, Eisbacher, 1976), that apparently formed in Late Cretaceous time. Its premetamorphic age and correlation are uncertain and it is distinguished herein as a separate terrane. Eisbacher (1976) suggests that it is the metamorphosed equivalent of Jurassic-Cretaceous clastic sedimentary rocks (Gravina-Nutzotin belt), whereas Jones and others (1981) include it within the Taku terrane, which is known to contain older strata.

KO KOOTENAY TERRANE--The highly deformed, locally strongly metamorphosed but stratigraphically coherent Kootenay terrane mainly lies east of the Monashee terrane (MO), but rocks tentatively correlated with KO lie to the west of MO as well. In the Kootenay Arc to the east and south, lower Paleozoic shale, quartz grit, basic volcanics, and limestone of the Lardeau Group overlie limestone of the lower Cambrian Badshot Formation (Read and Wheeler, 1978). The relationship between the Lardeau Group and the Badshot is one of apparent stratigraphic conformity, but regional relationships may reflect a structual discordance (J. O. Wheeler, oral commun., 1982). In the interval Early Ordovician to Early Mississippian (probably in Late Devonian) time, plutonism, intense deformation, and low grade metamorphism of the Lardeau Group preceded deposition of basal conglomerate, limestone, shale, impure quartz sandstone, and local volcanics of the Milford Group of Early Mississippian to Permian age. Rocks of the Kootenay terrane are folded with rocks representative of cratonic North America. The age of the fold in question (loc. 20, table 1) is uncertain. It appears to belong to the earliest phase of deformation and thus may be mid-Paleozoic, which implies that the Kootenay terrane was juxtaposed with North American rocks by that time. Alternatively, it could be a Jurassic structure formed during the major deformation in this area (for example, see Brown and Read, 1983). Because there appears to be no record of mid-Paleozoic deformational events in coeval rocks to the east, which were deposited on or contiguous to cratonic North America, the Kootenay terrane is distinguished, but it may well be a highly telescoped facies equivalent of North American strata. According to Klepacki (1983), volcanic rocks in the Milford Group may be facies equivalents of rocks in the Slide Mountain terrane to the west, linking the two in late Paleozoic time (loc. 19, table 1). To the west of the Monashee terrane, shale, limestone, acid and basic volcanics, grit and impure quartzite compose the Eagle Bay Formation, which is of uncertain stratigraphic order and facing (Preto, 1981). Zircons from acid volcanics yield a 387 Ma age (Preto and Schiarizza, 1982) and suggest that this intensely deformed and weakly metamorphosed formation includes Lower Devonian rocks. Weakly deformed Lower and Upper Mississippian shale, sandstone, and limestone, possibly correlative with the Milford Group, lie in uncertain relationship to the Eagle Bay Formation.

MD MCLEOD TERRANE--The McLeod metamorphic terrane comprises poorly-exposed heterogenous metamorphic rocks including micaceous, garnet and chlorite schists, minor quartzite and granitoid rocks (Muller and Tipper, 1968). These rocks are of uncertain premetamorphic age and correlation, but from their general composition and structural position they may be equivalents of the Barkerville, Kootenay and Yukon-Tanana terranes.

MT METHOW-TYAUGHTON TERRANE--The Methow-Tyaughton coherent terrane comprises Upper Triassic to Cretaceous, mainly marine, clastic sedimentary strata, containing local carbonate and volcanic rocks (Tozer, 1967: Jeletzky and Tipper, 1968; Coates, 1974; Tennyson and Coles, 1978). The oldest rocks are commonly fine-grained distal turbidites that locally contain intercalated volcanic, carbonate and coarse clastic rocks. Younger rocks are mainly volcanic sandstones. By latest Early Cretaceous time these are a western sedimentary facies equivalent of continental volcanic rocks on Quesnellia (loc. 14, table 1). A chert and metamorphic source terrane to the west is reflected in lower Upper Cretaceous strata. No base to the terrane is known; speculatively it could be the partly coeval oceanic Bridge River and Hozameen terranes. Possibly the Methow-Tyaughton terrane, structurally imbricated with Bridge River and Hozameen terranes and then metamorphosed, forms part of the Skagit metamorphic terrane.

MO MONASHEE TERRANE--The Monashee metamorphic terrane (Monashee Complex of Read and Brown, 1981) is a sequence of high-grade metamorphosed rocks older than 2.0 Ga. The stratigraphy and age of this terrane is apparently unique in the Canadian Cordillera. Core gneiss composed of hornblende or hornblende-biotite paragneiss and intermediate orthogneiss up to 2.5 Ga old underlies a mantling gneiss sequence of basal quartzite, semipelitic, psammitic and calc-silicate gneisses and higher thin marble and quartzites which are of known stratigraphic facing and are cut by orthogneiss intrusions of at least 2.0 Ga age. The highest gneisses are semi-pelitic and psammitic and are intruded by abundant pegmatite. Intense Jurassic deformation and metamorphism formed complex nappes, which may have been preceded by phases of deformation and metamorphism so far unrecognized. The fault between this terrane and the Kootenay terrane apparently is cut by a mid-Jurassic pluton (loc. 21, table 1, Read and Brown, 1981). Because of differences in age between these rocks and Hudsonian continental basement (about 1.7 Ga old) to the east, and the presence in MO of a lower Proterozoic sedimentary sequence which is unknown to the east, the Monashee terrane is suspect.

NK NOOKSACK TERRANE--The Nooksack coherent terrane, in part imbricated with the Chilliwack terrane on eastward-dipping mid-Cretaceous thrusts, comprises an orderly succession of Triassic(?) conglomerate, sandstone, and argillite overlain by Middle Jurassic volcanics (keratophyres and quartz-keratophyres; Harrison Lake, Wells Creek Formations), then Upper Jurassic and Lower Cretaceous marine, mainly green volcanic sandstone, conglomerate and argillite of the Nooksack Formation and equivalent units (Misch, 1966; Monger, 1970). It is possible, but not certain, that these rocks stratigraphically overlie the Chilliwack terrane (loc. 5, table 1).

PR PACIFIC RIM TERRANE--The disrupted Pacific Rim terrane comprises greywacke, argillite, chert and metabasalt of mainly Late Jurassic (late Kimmeridgian to early Tithonian) to Early Cretaceous (mid-Valanginian ) ages (Muller, 1977). It includes the Leech River complex. Ammonites and conodonts of Late Triassic age have been found in this terrane (M. Brandon, H. W. Tipper, M. J. Orchard, oral commun., 1983). The terrane appears to be tectonically analogous to and stratigraphically correlative with parts of the Franciscan terrane of California and the Chugach terrane of southern Alaska (Muller, 1973; Cowan 1982).

PC PORCUPINE TERRANE--Within Canada this terrane comprises Precambrian(?) phyllite, slate, quartzite, and carbonate rocks, overlain by a structurally and stratigraphically complex assemblage of shallow-water marine carbonate, and fine-grained clastic rocks ranging from Cambrian(?) to Late Devonian in age. It is continuous into a larger outcrop area in Alaska where PC also includes upper Paleozoic and Jurassic strata.

QN QUESNELLIA TERRANE--The undifferentiated part of Quesnellia consists predominantly of coherent Upper Triassic and Lower Jurassic (Upper Karnian to Sinemurian) strata. These are mainly marine, calc-alkaline to alkaline volcanic rocks (Nicola and Rossland Groups, part of the Takla and Quesnel River Groups; and Nazcha and Shonektaw Formations), comagmatic intrusions, and intercalated argillite, volcanic sandstone and local limestone. Locally upper Paleozoic carbonates are present. The volcanic strata interdigitate eastward with sedimentary rocks (Slocan, "black phyllite"). Disconformably and locally unconformably above these strata are lower and Middle Jurassic shale, sandstone and conglomerate (Ashcroft, Hall Formations). Below undifferentiated Quesnellia strata are two subterranes, Okanagan (QNO) and Harper Ranch (QNH) (Okulitch and Penatfield, 1977).

Probable stratigraphic linkages can be made between Quesnellia and terranes to the east and west. Quesnellia overlaps QNO and QNH, and it lies stratigraphically on Slide Mountain terrane on the east (loc. 15, 16, 17, table 1). To the west, blocks of volcanic rocks identical in lithology to those of the Nicola Group occur in Cache Creek melange (CCB), and clasts of Middle Triassic chert, and basalt and ultramafic rocks, presumably derived from the Cache Creek terrane, are in Upper Triassic (Norian) Nicola rocks, suggesting that QN was amalgamated with CC by Late Triassic time (loc. 13, table 1). Earliest Jurassic plutons appear to stitch QN, CC, and ST together (loc. 11, table 1). Lower Jurassic (Pliensbachian) sandstone and conglomerate, apparently similar to that in QN (Ashcroft Formation), lie on CC, (Tipper, 1978, Tipper and others, 1981) suggesting that by Early Jurassic time QN, CC, ST, SM were amalgamated (loc. 12, table 1). Triassic and some Early Jurassic (Pliensbachian) faunas have similarities with those in the western conterminous U.S., but are dissimilar from coeval faunas at the same latitude on the craton (Tipper, 1981; Tozer, 1982).

QNH HARPER RANCH SUBTERRANE--The predominantly upper Paleozoic Harper Ranch subterrane includes the Harper Ranch Group and Mount Roberts Formation in British Columbia and the Anarchist Group and Mission Argillite in Washington. It comprises argillite, volcanic and chert-detritus sandstone and conglomerate, basalt, andesite and dacite and pyroclastic equivalents, and limestone bodies up to a few kilometers long, at least some of which are olistoliths. The matrix is "late Paleozoic" and Triassic, and the limestones range from latest Devonian to Permian in age (Cockfield, 1948; Mills and Davis, 1962; Rinehart and Fox, 1972; Sada and Danner, 1974; Monger, 1977; W.R. Danner, oral commun., 1981; M.J. Orchard, oral commun., 1982). Although olistostromal and structurally complex, it does not appear to contain "broken formation" or tectonic mélange. This succession is unconformably overlain by Nicola Group rocks east of Kamloops (Read and Okulitch, 1977; loc. 15, table 1). Permian faunas in this subterrane have similiarities with faunas in the Chilliwack terrane (W. R. Danner, oral commun., 1977; Ross and Ross, 1983 amd those on the craton in southwestern U.S., but are dissimilar from coeval faunas in CC and on the craton at the same latitude.

QNO OKANAGAN SUBTERRANE--The disrupted Okanagan subterrane includes the Chapperon, Anarchist, and Kobau Groups and Blind Creek, Independence, Showmaker, and Old Tom Formations in British Columbia and Kobau Formation in Washington. These rocks consist of low-grade metamorphosed and disrupted radiolarian chert, argillite, basalt, local limestone blocks and ultramafic rocks associated with "broken formation" and mélange, and higher grade metamorphosed siliceous schist, chlorite schist, amphibolite and marble. Ages appear to be mainly Carboniferous (P. B. Read, oral commun., 1979; D. L. Jones, oral commun.,1981). These rocks are unconformably overlain by Upper Triassic strata of QN (Read and Okulitch, 1977; loc. 16, table 1).

SE SAINT ELIAS TERRANE--The Saint Elias terrane is a fault-bounded block of metamorphosed upper Mesozoic volcanic and sedimentary rocks of amphibolite facies. The terrane may be a higher grade, but structurally disconnected, equivalent of the Chugach terrane (Jones and others, 1981).

SH SHUKSAN TERRANE--The Shuskan terrane comprises actinolitic greenschist, glaucophane schist, phyllite and phyllitic quartz grit (Misch, 1966). Recent isotopic studies (Armstrong, 1980) indicate Late Jurassic-Early Cretaceous blueschist metamorphism of a possible Jurassic protolith.

SK SKAGIT TERRANE--The Skagit terrane comprises greenschist to amphibolite-facies rocks, including migmatites, that were derived from a predominantly clastic sequence containing subordinate volcanics and from a variety of metamorphosed intrusives including ultramatic rocks (Misch, 1966). In part the protolith may be imbricated equivalents of HZ, BR, and MT (for example, McTaggart and Thompson 1967), but older Paleozoic rocks appear to be present as well. The main metamorphism appears to be of middle or Late Cretaceous age.

SM SLIDE MOUNTAIN TERRANE--The Slide Mountain terrane (generally equivalent to the "Eastern assemblage" of Monger, 1977) consists of a number of isolated outcrop areas containing similar rocks that have common structural settings in the Canadian Cordillera. Each outcrop area has received a different stratigraphic name. From north to south, these are: Anvil Range (lat 62°), Sylvester (lat 59°), Nina Creek (lat 55°), Slide Mountain (lat 53°) and Fennell (lat 51°), Kaslo/Milford (lat 50°). Rocks in all these areas appear to have a similar gross stratigraphy, and to emphasize this we have not separated them into subterranes. A lower sedimentary sequence, comprising chert, argillite, sandstone, conglomerate, minor carbonate rocks, local mafic sills, dikes, and flows, is overlain by basalt, local alpine-type ultramafics, chert, argillite and conglomerate. Commonly, the upper and lower sequences are in stratigraphic continuity, with major breaks either within the upper, volcanic sequence and typically delineated by serpentinite, or else at the base of the lower, sedimentary sequence. However, in southeastern British Columbia, rocks probably correlative with the lower sequence elsewhere, known as the Milford Group, lie unconformably on the Lardeau group (loc. 19, table 1.) Milford and Lardeau Groups comprise the Kootenay terrane. Although rocks of the Slide Mountain terrane are commonly highly deformed, internally imbricated and locally metamorphosed to high grades, they rarely display the type of tectonic mélange or "broken formation" characteristic of BR, CC, CG or PR. Age of the terrane ranges from Early Mississippian to Late Permian. (Gabrielse, 1963; Monger, 1977; Tempelman-Kluit, 1979; Struik, 1980; Gordey and others, 1982). In places SM is overlain with apparent disconformity by Upper Triassic strata belonging to QN. In places, SM lies with known or assumed thrust contact on older rocks, as shown by superposed Permian on Upper Triassic strata in the Yukon and by Mississippian on Permian strata in central B.C. Evidence for considerable latitudinal displacement comes from northern B.C., where SM contains Upper Permian fusulinids similar to forms in the southwestern U.S. and Mexico; no Permian fusulinids are known from coeval rocks at the same latitude on the craton. According to Klepacki (1983) volcanic rocks in the Milford Group of the Kootenay terrane may be facies equivalents of the Slide Mountain.

ST STIKINIA TERRANE--Stikinia is a coherent terrane comprising stratigraphically stacked Mississippian, Permian, Triassic and Jurassic marine and nonmarine volcanic and sedimentary strata and coeval intrusions (Souther, 1971, 1972; Tipper and Richards, 1976; Monger, 1977a, 1977b). Named units include the Asitka Group of Permian age, Takla and Stuhini Groups and Sinwa Formation of Triassic age, and Hazelton Group of Jurassic age. Dated Pennsylvanian rocks are rare; deformation, metamorphism and intrusion occurred in Early or Middle Triassic time and there appears to be a terrane-wide earliest Jurassic hiatus. To the north and east the terrane is limited by mid to upper Mesozoic thrust faults, on which Cache Creek terrane is emplaced on Stikinia, and detritus from CC is in late Middle Jurassic strata of the Bowser Basin, which lies entirely on ST (loc. 8, 9; table 1). Amalgamation of Stikinia and Cache Creek in latest Triassic time is suggested by interbedded chert and graywacke of Norian age in CC (loc. 7, table 1). The graywacke is lithogically identical with Norian graywacke in Stikinia. Evidence for displacement of Stikinia comes from Permian, Triassic and Jurassic faunas that are dissimilar from coeval faunas at the same present latitude on the craton (Monger and Ross, 1971; Tipper, 1981; Tozer, 1982) and from anomalous Triassic and Jurassic paleolatitudes derived from magnetic inclinations (Monger and Irving, 1980), although the Permian faunas appear to be similar to those of Quesnellia and Chilliwack terranes.

TUS, TUN, TUC TAKU TERRANE--Taku terrane is an enigmatic, possibly polygenetic assemblage of multiply deformed and metamorphosed strata containing sparse fossils of Permian and Middle and Late Triassic ages (Silberling and others, 1982). Key lithologies include Permian crinoidal marble intercalated with pelitic phyllite and felsic metatuff; together with upper Paleozoic basaltic metatuff and agglomerate; Middle and Upper Triassic carbonaceous and concretionary limestone, slate, phyllite, and basaltic pillow breccia; undated metaflysch and metatuff lithologically similar to Jurassic or Cretaceous strata in the Gravina-Nutzotin belt; and undated quartzite and subordinate felsic metatuff. Near the south end of the Taku terrane locally conspicuous lenses of metaconglomerate contain prominent relict roundstone clasts of trondhjemite (leucocratic quartz diorite) and quartzite, and less-conspicuous clasts of fine-grain detrital rocks (Berg, 1982). Matrix of the metaconglomerate is pelitic schist. The premetamorphic age of the metaconglomerate is unkown. In places it appears to grade into upper Paleozoic crinoidal marble; in other places it is intercalated with pelitic and tuffaceous rocks lithically similar to those in the

Gravina-Nutzotin belt, suggesting that metaconglomerate occurs at least at two stratigraphic levels.

The stratigraphic base of Taku terrane is not known. The clasts of trondhjemite in the metaconglomerate are lithologically similar to trondhjemite in the Ordovician-Silurian volcanoplutonic complex in Annette and Craig subterranes, which may have been their source, but there is no stratigraphic evidence of pre-upper Paleozoic crystalline basement beneath the presently mapped extent of Taku terrane. If the premetamorphic age of the trondhjemite-clast-bearing metaconglomerate that appears to grade into upper Paleozoic marble also is upper Paleozoic, and if the source of clasts is Annette or Craig subterrane, then the metaconglomerate may record structural juxtaposition (amalgamation) at least of southern Alexander and Taku terranes by late Paleozoic time (Berg, 1982, p. 14).

The western boundary of Taku terrane is a zone of mapped and inferred northeast-dipping thrust faults. The northeastern boundary is the western contact of a persistent northwest- to north-trending zone of foliated tonalite sills that also marks the southwestern boundary of the Coast Plutonic Complex (Brew and Ford, 1981), and which probably was emplaced along a now-obliterated Mesozoic suture that bounded Taku and Tracy Arm terranes.

In a preliminary interpretation Taku terrane appears to comprise at least three distinctive stratigraphic assemblages whose northwest-trending boundaries and internal lithologic trends obliquely intersect the western and eastern boundaries of the terrane. The northern part of the terrane (TUN) is distinguished by upper Paleozoic basaltic volcanic and volcaniclastic rocks (Berg and others, 1978), and the southern part (TUS) by coeval prevailingly pelitic clastic rocks, carbonate, and felsic volcaniclastic rocks (Berg and others, 1978; Silberling and others, 1982 p.). The third assemblage, in the central part of Taku terrane (TUC), is distinguished by undated quartzite or quartzitic gneiss and subordinate felsic metatuff (Berg, Jones, and Coney, unpub. field data, 1981). The stratigraphic differences suggest that Taku terrane comprises structurally juxtaposed and originally disjunct crustal blocks, and the truncation of their trends supports the interpretation that the terrane is bounded by partly obliterated regional faults.

TA TRACY ARM TERRANE--Tracy Arm metamorphic terrane consists of pelitic and quartzofeldspathic schist and paragneiss, amphibolite, marble, minor serpentinite, and other metamorphosed sedimentary and igneous rocks that form roof pendants, screens, and xenoliths in the Coast Plutonic Complex east of the zone of tonalite sills that forms the northeastern boundary of Taku terrane. The premetamorphic stratigraphy of Tracy Arm terrane is unknown; some of the rocks may be of Mesozoic age, others much older. For example, quartz-muscovite and quartz-biotite schist, marble and minor amphibolite in northwestern B.C. predate Upper Triassic intrusions and have a possible protolith age of later Precambrian (ca. 900 m.y.), based on strontium isotope studies (loc. 10, table 1; Werner, 1978; L. C. Werner, oral commun., 1979). These rocks are overlain with unknown relations by Upper Triassic strata similar to those of Stikinia terrane and are cut by dikes of porphyry similar to feeders of adjacent Upper Triassic volcanic rocks on Stikinia terrane, suggesting that at least this part of Tracy Arm terrane is basement to Stikinia terrane, or that the two terranes were amalgamated by Late Triassic time (loc. 10; table 1). The southern part of Tracy Arm terrane may merely be higher grade metamorphic equivalents of flanking terranes. Northeast of Ketchikan in southeastern Alaska, Tracy Arm terrane rocks are separated from Stikine terrane rocks by a northeast-dipping thrust zone that is intruded by Eocene plutons (Berg, 1982, p. 15).

WM WINDY-MCKINLEY TERRANE--The Windy-McKinley terrane is a composite, heterogenous assemblage that includes notable amounts of ultramafic rocks, blocks of Devonian limestone, Pennsylvanian and Permian chert, and locally, Triassic pillow basalt. Poorly exposed in Canada, this terrane continues well to the west in Alaska near The Denali fault (Jones and Silberling, 1979; Jones and others, 1981).

WR WRANGELLIA TERRANE--Wrangellia is a coherent terrane, with remarkably uniform Triassic stratigraphy. Commonly the oldest rocks are basic to acidic volcanic rocks, limestones, pelites and graywackes of late Paleozoic (Pennsylvanian) age belonging to the Sicker and Skolai Groups. Devonian U/Pb ages from the Sicker Group have been reported on southern Vancouver Island (Muller, 1980). Overlying the Paleozoic rocks are Middle(?) and Late Triassic strata that include thick (over 6000 m on Vancouver Island) submarine to subaerial tholeiitic basalt (Karmutsen and Nicolai Formations), overlain in turn by shallow to deep water carbonate and pelite (Quatsino, Parson Bay, Kunga, Chitistone, Nizina, and McCarthy Formations). Black argillite locally underlies the Karmutsen and Nicolai Formations. In southern Alaska this sequence is overlain by Jurassic deepwater sedimentary rocks, but on Vancouver Island and Queen Charlotte Islands it is overlain by Lower Jurassic calc-alkaline volcanic and volcaniclastic rocks (Bonanza Group; Maude and Yakoun Formations) associated with comagmatic intrusions. Paleomagnetic data from Triassic (Symons, 1971; Irving and Yole, 1972; Hillhouse, 1977; Yole and Irving, 1979) and Jurassic (Irving and Yole, 1983) rocks of Wrangellia are anomalous with respect to stable North America and indicate derivation from low paleolatitudes. Young, in part Neogene, rifting has fragmented this once continuous terrane (Yorath and Chase, 1981).

YA YAKUTAT TERRANE--The Yakutat terrane, originally called the Yakutat block by Plafker and others (1980), contains upper Mesozoic marine slate, graywacke, and mélange similar to that of Chugach terrane from which it differs by also including a sequence of marine and continental Cenozoic rocks.

YT YUKON-TANANA TERRANE--Yukon-Tanana terrane is a heterogenous metamorphic terrane. It contains three suites of ductile-deformed metamorphic rocks that rest on a basement of older gneiss. The older gneiss may be Precambrian basement, locally mobilized in the Devonian. Above it is a sheared slice of Mesozoic sedimentary and intermediate-volcanic rocks. Next is a slice of Paleozoic greenstone and ultramafic rocks, possibly a dismembered ophiolite. The highest slice comprises Devonian sheared granodiorite. The three allochthonous slices are internally disrupted, have well-developed flaser fabrics, and their depositional relations to other rocks are unknown. The strain fabric, imposed early in the Jurassic, is subhorizontal over large areas (Tempelman-Kluit, 1979; personal commun., 1982).

Table 1.--Evidence for amalgamation between terranes

[AL=Alaska, BC=British Columbia, WA=Washington, YU=Yukon, NE=northeast, NW=northwest, SW=southwest, SE=southeast, SC=southcentral, C=Central, bdy=boundary]

| Locality number on map | General Location | Nature of linkage |
|---|---|---|
| 1 | AL-YU bdy | Upper Jurassic Gravina-Nutzotin strata on Wrangellia. |
| 2 | SE AL | Upper Jurassic Gravina-Nutzotin strata on Alexander terrane. |
| 3 | SE AL | Permian Craig (AXC) strata contain clasts from Admiralty subterrane (AXA). |
| 4 | SW YU | Jura-Cretaceous Gravina-Nutzotin strata possibly metamorphosed in latest Cretaceous-Early Tertiary time to form Kluane terrane. |
| 5 | SW BC-WA bdy | Upper Jurassic strata (Nooksack equivalent?) on Chilliwack terrane. |
| 6 | SW BC-WA bdy | Nooksack, Shuksan, Chilliwack, Skagit terranes juxtaposed on Upper Cretaceous thrust faults. |
| 7 | S YU | Graywacke, interbedded with Norian chert of Cache Creek terrane, lithologically identical with Norian graywacke of Stikinia. |
| 8 | NW BC | Cache Creek terrane thrust on Stikinia in mid to Late Jurassic time. |
| 9 | N BC | Cache Creek detritus in upper Middle Jurassic clastic rocks of the Jurassic-Cretaceous Bowser Basin which lies on Stikinia. |
| 10 | NW BC | Metamorphic rocks of Tracy Arm terrane cut by dikes lithologically similar to adjacent Triassic volcanics of Stikinia. |
| 11 | C CS BC | Early Jurassic plutons cut Quesnellia, Cache Creek, Stikinia terranes. |

Table 1.--Evidence for amalgamation between terranes (Cont)

| Locality number on map | General Location | Nature of linkage |
|---|---|---|
| 12 | C BC | Similar Lower Jurassic (Pliensbachian) strata lie on Cache Creek and Quesnellia terranes. |
| 13 | SC BC | Upper Triassic volcanic rocks from Quesnellia(?) in Cache Creek mélange; Cache Creek detritus in Upper Triassic clastic rocks of Quesnellia. |
| 14 | SW BC | Upper Lower Cretaceous Quesnellia volcanic rocks interfinger with Methow-Tyaughton clastic strata. |
| 15 | SC BC | Upper Triassic Quesnellia volcanic rocks overlie Harper Ranch (QNH) subterrane. |
| 16 | SC BC | Upper Triassic Quesnellia sedimentary rocks overlie Okanagan (QNO) subterrane. |
| 17 | C BC | Middle and Upper Triassic Quesnellia sedimentary rocks overlie Slide Mountain Terrane. |
| 18 | C BC | Slide Mountain terrane structurally overlies Barkerville on post-Permian, pre-late Early Jurassic thrusts. |
| 19 | SE BC | Slide Mountain terrane may be facies equivalent of volcanic rocks in upper part of Kootenay terrane; Slide Mountaine lies structurally on Kootenay terrane. |
| 20 | SE BC | North America-Kootenay terrane boundary deformed by fold that may be either mid-Paleozoic or Jurassic. |
| 21 | SE BC | Fault separating Monashee from Kootenay terrane cut by mid-Jurassic pluton. |

# REFERENCES


Armstrong, J. E., 1949, Fort St. James map-area, Cassiar and Coast districts, British Columbia: Geological Survey of Canada, Memoir 252, 210 p.

______ 1980, Geochronometry of the Shuksan metamorphic suite, North Cascades, Washington: Geological Society of America, Abstracts with Programs, v. 12, no. 3, p. 94.

Berg, H. C., 1982, The Alaska Mineral Resource Assessment Program: Guide to information about the geology and mineral resources of the Ketchikan and Prince Rupert quadrangles, southeastern Alaska: U.S. Geological Survey Circular 855, 24 p.

Berg, H. C., Jones, D. L., and Coney, P. J., 1978, Pre-Cenozoic tectonostratigraphic terranes of southeastern Alaska and adjacent areas: U.S. Geological Survey Open-File Report 78-1085, 2 sheets, scale 1:1,000,000.

Berg, H.C., Jones, D.L. and Richter, D.H., 1972, Gravina-Nutzotin belt-tectonic significance of an upper Mesozoic sedimentary and volcanic sequence in southeastern Alaska; United States Geological Survey Profession Paper 800D, p. D1-D24.

Brew, D. A., and Ford, A. B., 1981, The Coast Plutonic Complex sill, southeastern Alaska, in Albert, N. R. D., and Hudson, T. L., eds., The United States Geological Survey in Alaska: Accomplishments during 1979: U.S. Geological Survey Circular 823-B p. B 96-B 98.

Brew, D. A., Loney, R. A., and Muffler, L. J. P., 1966, Tectonic history of southeastern Alaska: Canadian Institute of Mining and Metallurgy, Special volume 8, p. 149-170.

Brown, R.C., and Read, P.B., 1983, Shuswap terrane of British Columbia: a Mesozoic "core complex": Geology v. 11, p. 164-168.

Cameron, B. E. B., and Monger, J. W. H., 1971, Middle Triassic conodonts from the Fergusson Group, northeastern Pemberton map-area (92J), British Columbia: Geological Survey of Canada, Paper 71-1, Part 1B, p. 94-96.

Campbell, R. B., and Tipper, H. W., 1971, Bonaparte River map-area, British Columbia: Geological Survey of Canada, Memoir 363, 100 p.

Churkin, M., Jr., Foster, H. L., and Chapman, R. M., 1982, Terranes and suture zones in east central Alaska: Journal of Geophysical Research, v. 87, no. B5, p. 3718-3730.

Coates, J. A., 1974, Geology of the Manning Park area, British Columbia: Geological Survey of Canada Bulletin 238, 177 p.

Coney, P., Jones, D. L., and Monger, J. W. H., 1980, Cordilleran suspect terranes: Nature, v. 288, p. 329-333.

Cowan, D. S., 1982, Geological evidence for post-40 m.y. B.P. large-scale northwestward displacement of part of southeastern Alaska: Geology, v. 10, p 309-313.

Danner, W. R., 1965, Limestone of the western Cordilleran eugeosyncline of southwestern British Columbia, western Washington and northern Oregon: Mining and Metallurgical Institute of India, D. N. Wadia Commemorative volume, p. 114-125.

Eberlein, G. D., Churkin, M., Carter, C., Berg, H. C., and Ovenshine, A. T., 1983, Geology of the Craig quadrangle, Alaska: U.S. Geological Survey Open-File Report 83-91, scale 1:250,000, 53 p.

Eisbacher, G. H., 1976, Sedimentology of the Dezadeash flysch and its implications for strike-slip faulting along the Denali Fault, Yukon Territory and Alaska: Canadian Journal of Earth Sciences, v. 13, p. 1495-1513.

Eisbacher, G. H., and Hopkins, S. L., 1977, Mid-Cenozoic paleogeomorphology and tectonic setting of the Saint Elias Mountains, Yukon Territory: Geological Survey of Canada Paper 77-1B, p. 319-335.

Gabrielse, H., 1963, McDame map-area, Cassiar district, British Columbia: Geological Survey of Canada Memoir 319, 138 p.

______ in press, Major dextral transcurrent displacements along the Northern Rocky Mountain Trench and related lineaments in northcentral British Columbia: Geological Society of America Bulletin.

Gehrels, G. E., Saleeby, J. B., Berg, H. C., and Eberlein, G. D., 1983a, Basement continuity and variations in superjacent strata in the southern Alexander terrane, southeastern Alaska Abstracts with Programs, v. 15, no. 5, p. 385.

Gehrels, G. E., Saleeby, J. B., and Berg, H. C., 1983b, Preliminary description of the Late Silurian-Early Devonian Klakas orogeny in the southern Alexander terrane, southeastern Alaska, in Stevens, C. H., ed., Pre-Jurassic rocks in western North American suspect terranes: Los Angeles, Calif., Pacific Section, Society of Economic Paleontologists and Mineralogists, p. 131-141.

Gordy, S. P., Gabrielse, H. and Orchard, M. J., 1982, Stratigraphy and structure of Sylvester allochthon, southwest McDame map-area, northern British Columbia: Geological Survey of Canada Paper 82-1B, p. 101-106.

Hillhouse, J. W., 1977, Paleomagnetism of the Triassic Nikolai Greenstone, McCarthy Quadrangle, Alaska: Canadian Journal of Earth Sciences v. 12, p. 1953-1955.

Hillhouse, J. W., and Grommé, C. S., 1980, Paleomagnetism of the Triassic Hound Island Volcanics, Alexander Terrane, southeastern Alaska: Journal of Geophysical Research, v. 85, no. B5, p. 2594-2602.

Hutchison, W. W., 1982, Geology of the Prince Rupert-Skeena map-area, British Columbia: Geological Survey of Canada Memoir 394, 116 p.

Irving, E. and Yole, R. W., 1972, Paleomagnetism and the kinematic history of mafic and ultramafic rocks in fold mountain belts, in Irving, E., ed., The ancient oceanic lithosphere: Canada Department of Energy, Mines, and Resources, Earth Physics Branch, v. 42, p 87-95.

______ 1983, Paleolatitudes, apparent displacements and internal rotations of the Bonanza volcanics (Early Jurassic) of Vancouver Island, B.C.: Geological Association of Canada, Program with Abstracts, v. 8, p. A35.

Jeletzky, J. A., and Tipper, H. W., 1967, Upper Jurassic and Cretaceous rocks of Taseko Lakes map-area and their bearing on the geological history of southwestern British Columbia: Geological Survey of Canada Paper 67-54, 218 p.

Jones, D. L. and Silberling, N. J. 1979, Mesozoic stratigraphy--The key to tectonic analysis of southern and central Alaska: U.S. Geological Survey Open-File Report 79-1200, 37 p.

Jones, D. L., Silberling, N. J., and Hillhouse, J., 1977, Wrangellia; a displaced terrane in northwestern North America: Canadian Journal of Earth Sciences, v. 14, p. 2565-2577.

Jones, D. L., Silberling, N. J., Berg, H. C., and Plafker, G., 1981, Tectonostratigraphic terrane map of Alaska: United States Geological Survey Open-File Report 81-792, 2 sheets, scale 1:2,500,000.

Klepacki, D. W., 1983, Stratigraphic and structural relationships of the Milford, Kaslo, and Slocan Groups, Roseberry Quadrangle, Lardeau map-area, British Columbia: Geological Survey of Canada Paper 83-1a, p. 229-233.

Kindle, E. D., 1953, Dezadeash map-area, Yukon Territory: Geological Survey of Canada Memoir 268, 68 p.

Mattinson, J. M., 1972, Age of zircons from the Northern Cascade Mountains, Washington: Geological Society of America Bulletin, v. 83, p. 3769-3784.

McTaggart, K. C., and Thompson, R. M., 1967, Geology of part of the Northern Cascades in southern British Columbia: Canadian Journal of Earth Sciences, v. 4, p. 1199-1228.

Misch, P., 1966, Tectonic evolution of the Northern Cascades of Washington State: Canadian Institute of Mining and Metallurgy, Special volume 8, p. 101-145.

Monger, J. W. H., 1968, Stratigraphy and structure of upper Paleozoic rocks, northeast Dease Lake map-area, British Columbia (104J); Geological Survey of Canada Paper 68-48, 41 p.

______1970, Hope map-area, west half, British Columbia: Geological Survey of Canada Paper 69-47, 75 p.

______1975, Upper Paleozoic rocks of the Atlin Terrane, northwestern British Columbia and south-central Yukon: Geological Survey of Canada Paper 74-47, 63 p.

______1977a, Upper Paleozoic rocks of the western Canadian Cordillera and their bearing on Cordilleran evolution: Canadian Journal of Earth sciences, v. 14, p. 1832-1859.

______1977b, Upper Paleozoic rocks of northwestern British Columbia: Geological Survey of Canada Paper 77-1A, p. 255-272.

______1981, Geology of parts of western Ashcroft map-area, southwestern British Columbia: Geological Survey of Canada Paper 81-1A, p. 185-189.

Monger, J. W. H., Richards T. A., and Paterson, I. A., 1978, The Hinterland Belt of the Canadian Cordillera: Canadian Journal of Earth Sciences, v. 15, p. 823-830.

Monger, J. W. H., and Ross, C. A., 1971, Distribution of fusulinacean in the Canadian Cordillera: Canadian Journal of Earth Sciences, v. 16, p. 770-791.

Monger, J. W. H., Price, R. A., and Tempelman-Kluit, D. J., 1982, Tectonic accretion and the origin of the two major metamorphic and plutonic welts in the Canadian Cordillera: Geology, v. 10, p. 70-75.

Muller, J. E., 1967, Kluane Lake map-area, Yukon Territory: Geological Survey of Canada Memoir 340, 137 p.

______1971, Lower Cretaceous flysch sequence of the west coast of Vancouver Island: Geological Society of America, Abstracts with Programs, v. 5, p. 84.

______1973, Lower Cretaceous flysch sequence of the west coast of Vancouver Island, Geological Society of America, Abstracts with Programs, v. 15 p. 84.

______1977, Evolution of the Pacific margin, Vancouver Island and adjacent regions, Canadian Journal of Earth Sciences v. 14, p. 2062-2085.

______1980, The Paleozoic Sicker Group of Vancouver Island, British Columbia: Geological Survey of Canada Paper 79-30, 23 p.

______1980a, Chemistry and origin of the Eocene Mechosin volcanics, Vancouver Island, British Columbia: Canadian Journal of Earth Sciences, v. 17, p. 199-209.

Muller, J. E., and Carson, D. J. T., 1969, Geology and mineral deposits of Alberni map-area, British Columbia (92F): Geological Survey of Canada Paper 68-50, 52 p.

Okulitch, A. V., and Peatfield, G. R., 1977, Geologic history of the late Paleozoic-early Mesozoic eugeocline in southern British Columbia and eastern Washington: Geological Association of Canada, Program with Abstracts, 1977 Annual Meeting, p. 40.

Panuska, B. C., and Decker, J., 1982, Paleomagnetic pilot study of the Gravina-Nutzotin belt, Alaska: Geological Society of America, Abstracts with Programs, v. 14, no. 4, p. 223.

Paterson, T. A., 1977, The geological and evolution of the Pinchi fault zone at Pinchi Lake, central British Columbia: Canadian Journal of Earth Sciences, v. 14, p. 1324-1342.

Paterson, T. A., and Harakal, J., 1974, Potassium-argon dating of blueschist from Pinchi Lake central British Columbia: Canadian Journal of Earth Sciences, v. 11, p. 1007-1011.

Plafker, G., Jones, D. L, and Pessagno, E. A., Jr., 1977, A Cretaceous accretionary flysch and mélange terrane along the Gulf of Alaska margin: U.S. Geological Survey Circular 751-B, p. B41-B43.

Plafker, G., Winkler, G. R., Coonrad, W. L., and Claypool, G., 1980, Preliminary report on the geology of the continental slope adjacent to OCS Lease Sale 55 eastern Gulf of Alaska: Petroleum resource implications: U.S. Geological Survey Open-File Report 80-1089, 70 p.

Potter, C.J., 1983, Geology of the Bridge River Complex, southern Shulaps Range, British Columbia: a record of Mesozoic convergent tectonics: University of Washington, Ph.D. thesis, 192 p.

Preto, V. A., in Brown, R. L., Fyles, J. T., Glover, J. E., Hoy, T., Okulitch, A. V. and Read, P. B., 1981, Southern Cordilleran cross-section - Cranbrook to Kamloops: in Thompson, R. F. and Cook, D. G. eds., Field Guides to geology and mineral deposits: Geological Association of Canada, p. 335-372.

Preto, V. A. G., and Schiarizza, P., 1982, Geology and Mineral Deposits of Eagle Bay and Fernell Formations from Adams Plateau to Clearwater south-central B.C.: Geological Association of Canada, Cordilleran Section, Program and Abstracts, p. 22-24.

Read, P. B., and Okulitch, A. V., 1977, The Triassic unconformity of south-central British Columbia: Canadian Journal of Earth Sciences, v. 14, p. 606-638.

Read, P. B., and Wheeler, J. O., 1976, Geology of Lardeau west-half map area: Geological Survey of Canada Open-File Map 288.

Read, P. B. and Brown, R. L., 1981, Columbia River Fault zone: south-eastern margin of the Shuswap and Monashee complexes, southern British Columbia: Canadian Journal of Earth Sciences, v. 18, p. 1127-1145.

Rinehart, C. D., and Fox, K. F., 1972, Geology and mineral deposits of the Loomis quadrangle, Okanagan County, Washington: Washington Division of Mines and Gelogy, Bulletin 64, 124 p.

Roddick, J. A., and Hutchison, W. W., 1973, Pemberton (east half) map-area, British Columbia: Geological Survey of Canada Paper 73-17, 21 p.

Ross, C. A., and Nassichuk, W. W., 1971, Yabeina and Waagenoceras from the Atlin Horst area, northwestern British Columbia: Journal of Paleontology, v. 44 p. 779-781.

Ross, C. A., and Ross, J. R. P., 1983, Late Paleozoic accreted terranes of western North America, in Stevens, C. H., ed., Pre-Jurassic rocks in western North American suspect terranes: Pacific Section, Society of Economic Paleontologists and Mineralogists, p. 7-22.

Sada, K. and Danner, W. R., 1974, Early and Middle Pennsylvanian fusulinids from southern British Columbia, Canada, and northwestern Washington: Transactions and proceedings of the Geological Society of Japan, new series v. 93, p. 249-265.

Saleeby, J. B., (1983), Accretionary tectonics of the North American Cordillera: Annual Review of Earth and Planetary Sciences, v. 11, p. 45-73.

Shannon, K. R., 1981, The Cache Creek Group and contiguous rocks, near Cache Creek, British Columbia: Geological Survey of Canada Paper 81-1A, p. 217-221.

_____ 1982, Cache Creek Group and contigous rocks near Cache Creek, B.C. University of British Columbia, M.Sc. Thesis, 72 p.

Silberling, N. J., Wardlaw, B. R., and Berg, H. C., 1982, New paleontologic age determinations from the Taku terrane, Ketchikan area, southeastern Alaska, in Coonrad, W. L., ed., United States Geological Survey of Alaska: Accomplishments during 1980: U.S. Geological Survey Circular 844, p. 117-119.

Souther, J. E., 1971, Geology and mineral deposits of Tulsequah map-area, British Columbia: Geological Survey of Canada Memoir 362, 84 p.

_____ 1972, Telegraph Creek map-area, British Columbia: Geological Survey of Canada Paper 71-44, 38 p.

Struik, L. C., 1981, A re-examination of the type-area of the Devono-Mississippian Cariboo Orogeny, central British Columbia: Canadian Journal of Earth Sciences, v. 18, p. 1767-1775.

Symons, D. T. A., 1971, Paleomagnetic notes on the karmutsen basalt, Vancouver Island: Geological Survey of Canada Paper 71-24, p. 11-24.

Tempelman-Kluit, D. J., 1974, Reconnaissance geology of Aishihik Lake, Snag and part of Stewart River map-areas, west central Yukon: Geological Survey of Canada Paper 73-41, 97 p.

_____ 1979, Transported cataclastic ophiolite and granodiorite in Yukon; evidence of arc-continent collision: Geological Survey of Canada Paper 79-14, 27 p.

Tennyson, M. E. and Coles, M. R., 1978, Tectonic significance of Upper Mesozoic Methow-Pasayten sequence, northeastern Cascade Range, Washington and British Columbia: in Howell, D. G., and McDougall, K. A., eds., Mesozoic paleogeography of the western United States, Pacific Coast Paleogeography Symposium 2, Pacific Section, Society of Economic Paleontologists and Mineralogists, p. 494-508

Tennyson, M. E., Jones, D. L., and Murchey, B. L., 1982, Age and nature of chert and mafic rocks of the Hozameen Group, North Cascade Range, Washington: Geological Society of America, Abstracts with Programs, v. 14, p. 239.

Terry, J., 1977, Geology of the Nahlin ultramafic body, Atlin-Tulsequah map-area (104N, 104E), north-western British Columbia: Geological Survey of Canada Paper 77-1A, p. 263-266.

Tipper, H. W., 1978, Northeastern part of Quesnel (93B) map-area, British Columbia: Geological Survey of Canada Paper 78-1A, p. 67-68.

_____ 1982, Offset of an upper Pliensbachian geographic zonation in the North American Cordillera by transcurrent movement: Canadian Journal of Earth Sciences, v. 18, p. 1788-1792.

Tipper, H. W., and Richards, T., 1976, Jurassic stratigraphy and history of north-central British Columbia: Geological Survey of Canada Bulletin 270, 73 p.

Tipper, H. W., Woodsworth, G. J., and Gabrielse, H., 1981, Tectonic assemblage map of the Canadian Cordillera, Map 1505A, scale 1:2,000,000.

Tozer, E. T., 1967, A standard for Triassic time: Geological Survey of Canada Bulletin 156, 103 p.

_____1982, Marine Triassic faunas of North America: their significance for assessing plate and terrane movements: Geologische Rundschau, v. 71, p. 1077-1104.

Travers, W. B., 1978, Overturned Nicola and Ashcroft strata and their relation to the Cache Creek Group, southwestern Intermontane Belt, British Columbia: Canadian Journal of Earth Sciences, v. 15, p. 99-116.

Trettin, H., 1980, Permian rocks of the Cache Creek Group in the Marble Range, Clinton area, British Columbia: Geological Survey of Canada Paper 79-17, p. 17.

Van der Voo, R., Jones, M., Grommé, C. S., Eberlein, G. D., and Churkin, M., 1980, Paleozoic paleomagnetism and northward drift of the Alexander terrane, southeastern Alaska: Journal of Geophysical Research, v. 85, p. 5281-5296.

Werner, L., 1978, Metamorphic terrane, northern Coast Mountains west of Atlin Lake, British Columbia: Geological Survey of Canada Paper 78-1A, p. 69-70.

Woodsworth, G. J., Loveridge, W. D., Armstrong, R. L., and Sillivan, R. W., (in press) Uranium-lead dates from the Central Gneiss Complex and Ecstall pluton, Prince Rupert map-area, British Columbia: Canadian Journal of Earth Sciences.

Yancey, T. E., 1975, Permian marine biotic provinces in North America: Journal of Paleontology, v. 40, p. 758-766.

Yorath, C. J., and Chase, R. L., 1981, Tectonic history of the Queen Charlotte Islands and adjacent areas--a model: Canadian Journal of Earth Sciences, v. 18, p. 1717-1739.

PART C -- Lithotectonic terrane map of the western conterminous United States

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# DESCRIPTION OF MAP UNITS

## POST-ACCRETION COVER DEPOSITS

| | |
|---|---|
| Q | QUATERNARY DEPOSITS |
| Cz | CENOZOIC DEPOSITS |
| $K_2$ | CRETACEOUS DEPOSITS--Albian in age at base |
| $K_1$ | CRETACEOUS DEPOSITS--Neocomian in age at base |

## POST-ACCRETION BATHOLITHIC ROCKS

BATHOLITHIC ROCKS--granitic and gneissic rocks

## ACCRETED TERRANES

[Arranged alphabetically by map symbol. Numbers in parentheses following terrane names indicate locations of terranes on map according to the region(s) where they occur, enumerated as follows:

1. Northern Washington and southern Vancouver Island, Canada
2. Coastal and offshore Washington and Oregon
3. Northeast Oregon, west-central Idaho, and southeast Washington
4. Southern Idaho and Nevada
5. Klamath Mountains and Coast Ranges of southwestern Oregon and northern California
6. Coast Ranges and offshore continental borderlands of southern California
7. Sierra Nevada and east-central California
8. Peninsular Ranges and Mojave region of southern California and southwest Arizona]

| | |
|---|---|
| AG | APPLEGATE TERRANE (5) |
| AZ | ALCATRAZ TERRANE (5) |
| BA | BAKER TERRANE (3) |
| BH | BURNT HILLS TERRANE (5) |
| BL | BUCKS LAKE TERRANE (7) |
| BRK | BLACK ROCK TERRANE (4) |
| BY | BALDY TERRANE (5, 8) |
| CAB | CABORCA TERRANE (8) |
| CD | CONDREY MOUNTAIN TERRANE (5) |
| CE | CENTRAL TERRANE (5, 6) |
| CK | CHILLIWACK TERRANE (1) |
| CM | CENTRAL METAMORPHIC TERRANE (5) |
| CO | COASTAL TERRANE (5) |
| CR | CRESCENT TERRANE (1, 2) |
| CT | CATALINA TERRANE (6) |
| CTS | CORTES TERRANE (8) |
| DO | DON PEDRO TERRANE (7) |
| DP | DEL PUERTO TERRANE (6) |
| EC | ELDER CREEK TERRANE (5) |
| EK | EASTERN KLAMATH TERRANE (5) |
| EP | EL PASO TERRANE (8) |

| | | |
|---|---|---|
| FH | FOOTHILLS TERRANE | (7) |
| FJ | FORT JONES TERRANE | (5) |
| FR | FEATHER RIVER TERRANE | (7) |
| FU | FULMAR TERRANE | (2) |
| GB | GOLD BEACH TERRANE | (5) |
| GC | GOLCONDA TERRANE | (4) |
| GS | GRINDSTONE TERRANE | (3) |
| HB | HEALDSBURG TERRANE | (5) |
| HF | HAYFORK TERRANE | (5) |
| HG | HIGH SIERRA-GODDARD TERRANE | (7) |
| HO | HOH TERRANE | (2) |
| HR | HARO-SPIEDEN TERRANE | (1) |
| HZ | HOZAMEEN TERRANE | (1) |
| IZ | IZEE TERRANE | (3) |
| JN | JACKSON TERRANE | (4) |
| JO | JUNGO TERRANE | (4) |
| KI | KING RANGE TERRANE | (5) |
| KN | KINGS TERRANE | (7) |
| KO | KOOTENAY TERRANE | (1) |
| KR | KETTLE ROCK TERRANE | (7) |
| KW | KAWEAH TERRANE | (7) |
| LZ | LOPEZ TERRANE | (1) |
| MB | MARBLE MOUNTAIN TERRANE | (5) |
| MC | MAY CREEK TERRANE | (5) |
| MH | MARIN HEADLANDS TERRANE | (5, 6) |
| MI | MOUNT INGALLS TERRANE | (1) |
| MM | MCCOY MOUNTAINS TERRANE | (8) |
| MR | MERCED RIVER TERRANE | (7) |
| MT | METHOW TERRANE | (1) |
| MU | MALIBU TERRANE | (6) |
| NA | NASON TERRANE | (1) |
| NF | NORTH FORK TERRANE | (5) |
| NK | NOOKSACK TERRANE | (1) |
| NQ | NOVATO QUARRY TERRANE | (5) |
| NR | NICASIO TERRANE | (5) |
| NSI | NORTHERN SIERRA TERRANE | (7) |
| OC | OLYMPIC CORE TERRANE | (2) |
| OF | OLDS FERRY TERRANE | (3) |
| OP | OLNEY PASS TERRANE | (1) |
| OW | OWYHEE TERRANE | (4) |
| OWN | OWENS TERRANE | (7) |
| OZ | OZETTE TERRANE | (2) |
| PA | POINT ARENA TERRANE | (5) |
| PAR | PATTON RIDGE TERRANE | (6) |
| PM | PERMANENTE TERRANE | (6) |
| PP | PICKETT PEAK TERRANE | (5) |
| PR | PACIFIC RIM TERRANE | (1) |
| QN | QUESNELLIA TERRANE--Undifferentiated | (1) |
| QNH | QUESNELLIA TERRANE, HARPER RANCH SUBTERRANE | (1) |
| QNO | QUESNELLIA TERRANE, OKANAGAN SUBTERRANE | (1) |
| RC | ROARING CREEK TERRANE | (1) |
| RD | RODRIQUEZ TERRANE | (6) |
| RM | ROBERTS TERRANE | (4) |
| RS | RATTLESNAKE CREEK TERRANE | (5) |

SA SANTA ANA TERRANE (8)
SB SAN BRUNO MOUNTAIN TERRANE (6)
SCM SNOW CAMP MOUNTAIN TERRANE (5)
SH SHUKSAN TERRANE (1)
SHM SHADOW MOUNTAIN TERRANE (8)
SJ SAN JUAN TERRANE (1)
SK SKAGIT TERRANE (1)
SL SALINIA TERRANE (5, 6)
SN SAN NICOLAS TERRANE (6)
SR SALMON RIVER TERRANE (5)
SS SAN SIMEON TERRANE (6)
STM STANLEY MOUNTAIN TERRANE (6)
SW SNOW MOUNTAIN TERRANE (5)
SZ SILETZ TERRANE (2)
TJ TUJUNGA TERRANE (6, 8)
TR TRINITY TERRANE (5)
TS TWIN SISTERS TERRANE (1)
VA VAN ARSDALE TERRANE (5)
WA WALLOWA TERRANE (3)
WKB WESTERN KLAMATH TERRANE, BRIGGS CREEK SUBTERRANE (5)
WKD WESTERN KLAMATH TERRANE, DRY BUTTE SUBTERRANE (5)
WKR WESTERN KLAMATH TERRANE, ROGUE VALLEY SUBTERRANE (5)
WKS WESTERN KLAMATH TERRANE, SMITH RIVER SUBTERRANE (5)
WMP WHITE MOUNTAIN PEAK TERRANE (7)
WPD WALKER LAKE TERRANE, PARADISE SUBTERRANE (4)
WPN WALKER LAKE TERRANE, PINE NUT SUBTERRANE (4)
WR WRANGELLIA TERRANE (1)
YB YOLLA BOLLY TERRANE (5, 6)
YR YREKA TERRANE (5)

## NON-ACCRETIONARY CONTINENTAL ROCKS AND OCEANIC PLATES

NAm NORTH AMERICA--Non-accretionary continental rocks of North America with respect to the Phanerozoic
JDF JUAN DE FUCA PLATE
PAC PACIFIC PLATE

## AGES OF OVERLAP RELATIONSHIPS

[Post-accretion overlap relationships shown locally by line of dots following depositional overlap contacts. Numbers in parenthesis following ages of overlap indicate locations of overlap relationships according to the numerical scheme enumerated under "Accreted Terranes" heading.]

$T_5$ LATE MIOCENE OVERLAP (6)
$T_4$ MIDDLE OR EARLY MIOCENE OVERLAP (6)
$T_3$ LATE EOCENE OVERLAP (2, 5)
$T_2$ EARLY EOCENE OVERLAP (6)
$K_3$ LATE CRETACEOUS (CAMPANIAN) OVERLAP (6)
$K_2$ EARLY CRETACEOUS (ALBIAN) OVERLAP (5)
$K_1$ EARLY CRETACEOUS (NEOCOMIAN) OVERLAP (5)
Jl EARLY JURASSIC OVERLAP (3)
$T_Ru$ LATE TRIASSIC OVERLAP (4)

— — ... Terrane-bounding fault--dashed where approximately located.

——— Post-accretion or post-amalgamation contact--includes both depositional and intrusive contacts and faults that are not terrane boundaries.

▲— —— Approximate east limit of belt of low-angle Cordilleran thrust faults.

## DISCUSSION

The lithotectonic terrane map of the western conterminous United States is one of four such maps, covering the North American Cordillera from Alaska through Mexico, prepared at 1:2,500,000 scale as a cooperative project of the U.S. Geological Survey, Geological Survey of Canada, and Petroleos Mexicanos.

Each terrane depicted on this map is fault bounded and distinguished from its neighboring terranes, as well as from Phanerozoic North America, by a distinctive geologic record, which is expressed by its stratigraphy as well as its igneous and metamorphic history. The disparities among the various terranes and between the terranes and neighboring parts of the North America continent are sufficiently great so that paleogeographic reconstruction of the original sites of the terranes and their displacement paths through time is open to serious debate if not impossible to determine. Some terranes embody only a very fragmentary rock record, but they are nonetheless individualized in that they cannot resonably be fitted into their neighbors. Further discussion of the definition and characterization of lithotectonic (= "suspect," = "tectono-stratigraphic") accreted terranes is provided by Coney and others (1980) and Jones and others (1983).

The concept of accreted terranes must not be confused with that of exotic terranes, for although some terranes of the western conterminous United States may have been displaced for great distances--more than 1,000 km in some instances--prior to their accretion to the North American continent, and are thus truly exotic, many others represent original continental-margin features, such as island arcs that were never far offshore, or even displaced pieces of the continental margin itself. The role of strike-slip faulting in the net displacement histories of the terranes in this part of the Cordillera is especially important. In many cases the major displacement of terranes took place by strike-slip faulting along or within the continental margin, and original accretionary relationships have commonly been totally obliterated by subsequent strike-slip fault displacements.

The basic outcrop pattern and extent of post-accretion cover deposits and granitic rocks shown on the terrane map is adapted from King and Beikman (1974). Within California the selection and distribution of terranes is taken with only minor modification from the preliminary terrane map of California prepared by Blake and others (1982). The line weight and style of contacts shown on the map incorporate significant departures from that conventionally used on geologic maps. Heavy lines on the terrane map show only those faults that are terrane boundaries. These heavy lines are dashed where approximately located and dotted where regionally concealed beneath post-accretion cover deposits and yet fairly well located by geophysical or other means. Faults that simply bound post-accretion cover deposits or plutonic rocks are not differentiated from the light-weight lines that also represent depositional or intrusive contacts.

Descriptions of the terranes in this pamphlet vary in length according to the complexity and variability of the terranes, and are most detailed in those cases where published descriptions are either inadequate or lacking. The terranes of California have for the most part been characterized previously in columnar-section form by Blake and others (1982).

DESCRIPTIONS OF TERRANES

[Arranged alphabetically by name]

AZ ALCATRAZ TERRANE--Sandstone, mudstone, and conglomerate containing abundant detrital potassium feldspar. Fossils from Alcatraz Island are of Early Cretaceous (Valanginian) age and indicate shallow-water deposition. AZ is part of the original Franciscan Formation as defined by Lawson (1914) and is restricted to that part of San Francisco northeast of the Hunters Pt.-Ft. Point shear zone as well as Alcatraz and Yerba Buena Islands.

AG APPLEGATE TERRANE--Basaltic, andesitic, and dacitic flows, breccias, and tuffs plus minor marble and metasedimentary rocks. Limited paleontological evidence suggests an early Mesozoic age for these rocks (Irwin and Galanis, 1976).

BA BAKER TERRANE--Disrupted Upper Paleozoic oceanic crust (e.g., Canyon Mountain complex), associated deep-marine sedimentary rocks of Late Paleozoic and Triassic age (e.g., Elkhorn Ridge Argillite), and tectonically admixed blocks representing a wide variety of rock types. Termed the "Central melange terrane" by Dickinson (1979).

Tectonic blocks, commonly in serpentine matrix, of all sizes include: plutonic ophiolitic fragments and mafic igneous rocks of both oceanic and island-arc affinities (Mullen, 1982); radiolarian cherts whose known ages are partly Permian but mostly Triassic and as young as Norian (C. D. Blome and D. L. Jones, unpublished data); extensive bodies of highly deformed but lithologically coherent metamorphic and sedimentary rocks such as the Burnt River Schist and Nelson Marble; and shallow marine upper Paleozoic limestones, some which are fusulinid bearing and represent either Tethyan or North American faunal provinces.

Lawsonite-bearing blueschist, associated with strongly sheared chert, quartzite, marble, and mafic metavolcanic rocks, is represented among the more western outliers of the Baker terrane in central Oregon. These rocks, near Mitchell, Oregon, have yielded a $^{40}Ar$-$^{39}Ar$ age of about 223 m.y. (Hotz and others, 1977).

BY BALDY TERRANE--A metamorphic terrane composed of the Pelona, Orocopia, and Rand Schists. These lower green-schist to lower amphibolite facies metamorphic rocks have a protolith of graywacke with minor pelite, chert, basalt, marble and serpentinite.

The Pelona schist including the mylonitic rocks within the Vincent thrust zone, yield K-Ar and Rb-Sr ages ranging from 47-59 m.y. This is interpreted as the age of metamorphism; the age of the protolith is unknown. The oldest post-metamorphic intrusion into the schist is the lower Tertiary (?) Marcus Wash Granite (Haxel, 1977).

BRK BLACK ROCK TERRANE--Upper Paleozoic to mid-Triassic oceanic-basin and island-arc rocks in isolated, areally limited, locally metamorphosed exposures in northwestermost Nevada. Includes all of the pre-Tertiary strata in the southwest Bilk Creek Mountains near Quinn River Crossing (area 2, fig. 3) (Kettner and Wardlaw, 1981),

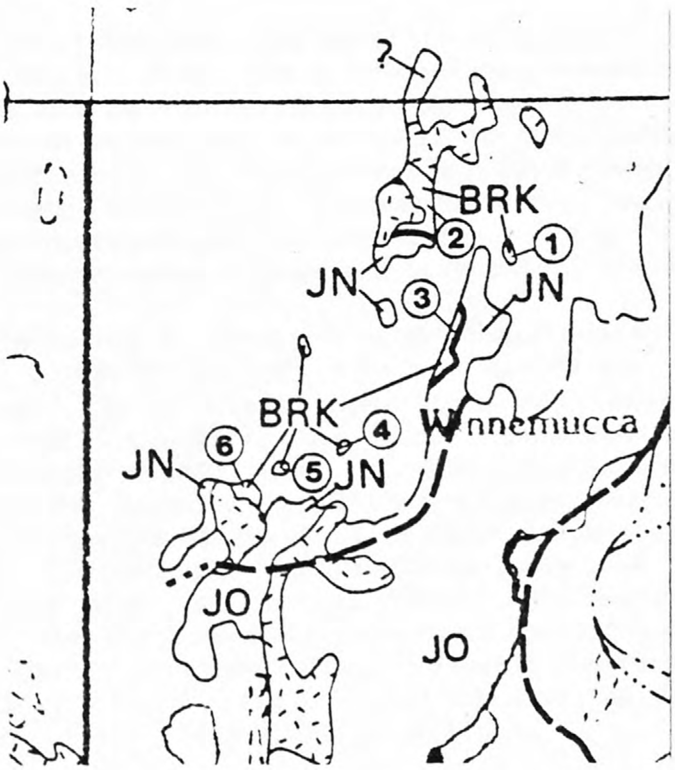


FIGURE 3.--Portion of the terrane map of the western conterminous United States showing the location in northwesternmost Nevada of the numbered outcrop areas of the Black Rock terrane discussed in the text.

the "McGill Canyon unit" of Russell (1984) in the west central Jackson Mountains (area 3, fig. 3), and units $T_R ls$, $T_R c$, and $T_R l$ (in stratigraphically descending order as listed), unit $T_R p$ (faulted under $T_R l$ and undated), and possibly the higher grade metamorphic rocks of $T_R q$ and $T_R am$ mapped by Smith (1973) in the Pine Forest Range (area 1, fig. 3). These rocks and the others included in the Black Rock terrane could represent either a single original terrane of stratigraphically interrelated, but laterally variable, rocks that has been tectonically telescoped or a composite of different terranes.

Sparsely distributed fossils show that correlative strata differ among all six of the isolated outcrop areas enumerated on figure 3. Nonetheless, some general stratigraphic characteristics seem to prevail throughout, as follows:

(1) Structurally low, and possibly the oldest, strata in the Pine Forest Range, Bilk Creek Mountains, Jackson Mountains, and southwest Calico Mountains (area 5, fig. 3) all include pelitic or cherty rocks associated with sandy or conglomeratic turbidites of both siliceous and volcanogenic provenance. Mississippian radiolarians have been recovered from hemipelagic siliceous argillite interlayered with turbidites of the "McGill Canyon unit" in the Jackson Range (Jones and Silberling, unpublished data).

(2) Lower Permian strata include conspicuous limestone units as well as andesitic volcanogenic deposits. Limestones are platformal (Bilk Creek Mountains and Pine Forest Range), olistostromal (Jackson Mountains), and basinal (northeastern Granite Range; area 6, fig. 3). Fusulinid limestone of Bilk Creek Mountains is regarded as lithologically and faunally like the McCloud Formation of the East Klamath terrane (Skinner and Wilde, 1965, p. 15) and the Coyote Butte Formation of the Grindstone terrane (Wardlaw and others, 1982). Volcanogenic Lower Permian rocks of the Black Rock terrane also include both shallow-marine, shelly, partly coarse-grained, volcanic sedimentary rocks (Black Rock Point; area 4, fig. 3) and deep-marine felspathic-volcanic turbidites (e.g., Bilk Creek Mountains).

(3) Middle Triassic strata, known only in two places within the terrane, are basinal in character and rest with disconformity on Permian strata. In the Pine Forest Range basinal Triassic limestones are separated by a thin unit of radiolarian chert and argillite from impure limestone and terrigenous clastic rocks of mid-Permian (Wordian) age (Silberling and B. R. Wardlaw, unpublished data); in the Bilk Creek Mountains phosphatic siliceous mudstone, siliceous tuff, and minor limestone of the Lower (?) and Middle Triassic Quinn River Formation rest on radiolarian chert of Wordian or younger Permian age (Jones and Silberling, unpublished data).

The Black Rock terrane, or at least parts of it, can be interpreted as the base of the Jackson terrane, but stratigraphic continuity between the two terranes has not been demonstrated. In places, as in the Jackson Mountains (Russell, 1984) rocks of the Black Rock terrane have the same deformational fabric as those of the contiguous, structurally lower, Jackson terrane. Elsewhere, in the Pine Forest Range (R. C. Speed and Silberling, unpublished data), rocks of the two terranes, although in apparent stratigraphic order are separated by a fault and have different structural styles.

BL BUCKS LAKE TERRANE--Structurally complex, partly upper Paleozoic and lower Mesozoic argillite and metachert, assigned mainly to the "Calaveras Formation," undated meta-andesite and meta-tuff of the Franklin Canyon Formation, and a complex structural mix of serpentinite and ultramafic rocks, chert-pelite metasedimentary rocks, and mainly mafic metavolcanic rocks termed the Horseshoe Bend Formation (Hietanen, 1981a, 1981b). Fossils from argillite-metachert assemblages contain Pennsylvanian-Permian conodonts and late Triassic to Early Jurassic radiolarians. Much of BL is deformed and metamorphosed by closely spaced Jura-Cretaceous granitic plutons.

As described by Hietanen, (1981a), from east to west, "Calaveras," Franklin Canyon, and Horseshoe Bend formations form three subparallel, fault-bounded belts within BL which resemble respectively MR, DO, and the eastern part of FH farther south. BL is shown by Saleeby (1982, fig. 1) as a mixture of chert-argillite "melange" belonging to his "central belt" within FH and Mesozoic volcaniclastic rocks and slate of FH, and it is regarded by him as part of the Sierra Nevada ophiolite belt.

BH BURNT HILLS TERRANE--Arkosic graywacke, mudstone, and conglomerate plus interbedded radiolarian chert. Fossils from the graywacke and mudstone are of Late Cretaceous (Coniacian) age, radiolarians from the chert are mid-Cretaceous (Aptian-Albian). Within the terrane there is a metamorphic gradation from little deformed graywacke containing pumpellyite to metagraywacke containing jadeitic pyroxene. The rocks appear to represent a submarine fan sequence consisting of thick, lenticular channel sands and conglomerates plus associated thin-bedded, finer-grained overbank deposits.

CAB CABORCA TERRANE--Metamorphic rocks in southwest Arizona that represent the northwestern projection into the United States of CAB from Sonora, Mexico, where it consists of Precambrian basement rocks overlain by upper Precambrian through Paleozoic miogeoclinal strata believed to have been offset several hundres of kilometers south-eastward from their original position along the North American margin by the Mojave-Sonora megashear of Silver and Anderson (1974) (Coney and Campa, 1984). Precambrian basement ages of CAB would presumably be older than those of adjacent North American rocks across the megashear. The northwest limit of CAB against BY and TJ in southwest Arizona is essentially arbitrary.

CT CATALINA TERRANE--Metamorphic rocks, partly of high P/T kind, in three thrust-bounded units (Platt, 1975). The structurally highest unit consists of metasedimentary and metavolcanic rocks metamorphosed to amphibolite grade. The middle unit is similar lithologically but metamorphosed to glaucophanitic greenschist. The lowest unit consists of metagraywacke, metachert, and metavolcanic rocks metamorphosed to blueschists. Protolith ages are unknown.

CE CENTRAL TERRANE--Tectonic melange (disrupted terrane) consisting of resistant blocks in a highly sheared argillaceous matrix. Some of the blocks are big enough and contain enough stratigraphy to qualify as separate terranes (e.g., Marin Headlands, Nicasio, Permanente). Others such as the well-known Laytonville limestone blocks (Alvarez and others, 1980) are undifferentiated from the Central terrane.

The matrix, where well-exposed and less sheared, usually is made up of interbedded fine-grain mudstone, lithic sandstone, and radiolarian tuff. Pillow lava is probably also part of the matrix but is usually detached by shearing. Fossils from the matrix and interbedded chert range from Late Jurassic (Tithonian) to Early Cretaceous (Valanginian) age.

CM CENTRAL METAMORPHIC TERRANE--Amphibolite-grade Salmon Hornblende Schist and overlying Abrams Mica Schist (Irwin, 1977b). No fossils have been found in either of these units. Isotopic ages indicate a Carboniferous age of metamorphism. Recent work in the Weaver Bally area (Blake, 1983) suggests that the lower Salmon Hornblende Schist is a metagabbro and that the overlying metavolcanic (?) and metasedimentary rocks may represent the upper portion of an island arc.

CK CHILLIWACK TERRANE--Recumbantly folded and imbricated, but stratigraphically coherent, upper Paleozoic rocks of the Chilliwack Group disconformably overlain by Upper Triassic and Lower Jurassic argillite, siltstone, and volcanic sandstone of the Cultus Formation. The Chilliwack Group includes argillite, siltstone, Pennsylvanian limestone and local plant-bearing coarse terrigenous clastic rocks, all of which are overlain by Lower Permian limestone and dacitic to basaltic volcanic rocks (Misch, 1966; Monger, 1970). Mississippian strata have not been recognized, but Devonian reefoid limestones in uncertain stratigraphic relationship within the Chilliwack Group have been described by Danner (1977) along with upper Paleozoic rocks of the group.

CO COASTAL TERRANE--Broken formation consisting largely of arkosic sandstone. Fossils range from Late Cretaceous to Eocene. Characterized by abundant laumontite veins. Locally isoclinally folded and/or stratally disrupted. Believed by some (e.g., Bachman, 1978) to have been accreted in a trench. Recent work indicates that some of these rocks may contain fossils with Tethyan affinities suggesting large-scale translation from equatorial regions (oral commun., R. J. McLaughlin, 1983).

CD CONDREY MOUNTAIN TERRANE--Quartz-mica schist, metachert, metatuff, and scarce metaserpentinite; contains metamorphic minerals transitional between blueschist and greenschist facies (R. G. Coleman, oral commun., 1983).

CTS CORTES TERRANE--A continental fragment composed of Precambrian basement and metamorphosed Paleozoic continental margin strata. Prebathholithic rocks of the Cortes terrane include various clastic strata that reflect amphibolite grade metamorphism and minor amounts of marble. Plutons 125-90 m.y.-old of the Peninsular Ranges batholith stitch CTS, MU, and SA. Initial Sr 87/86 isotopic ratios of approximately 0.707 imply Precambrian crust was involved as the source for the plutons. Tertiary sedimentary rocks unconformably overlie the Cortes terrane.

CR CRESCENT TERRANE--Basalt flows, pillow lava, comagmatic mafic dikes, tuff, and breccia. Flyschoid argillite and volcanic sandstone intercalated with marine basalt contains early and middle Eocene fossils. Younger Eocene and Oligocene basaltic volcanic rocks and associated sedimentary rocks are subaerial to deep marine. Stratigraphically similar to SZ, but paleomagnetic studies (Beck and Plumley, 1980; Beck and Engebretson, 1982) of pre-Miocene rocks indicate that tectonic rotation of CR was not as a single block and was of lesser magnitude than that of SZ, indicating that CR is a distinct tectonic block from SZ. Submarine projection of CR to form the Prometheus anomaly offshore from southern Vancouver Island follows the interpretation of MacLeod and others (1977).

DP DEL PUERTO TERRANE--Island-arc ophiolite sequence overlain by Lotta Creek Tuff and fine-grained sedimentary rocks of Upper Jurassic and Cretaceous age. Differs from other terranes of the Great Valley sequence by its siliceous volcanic (quartz keratophyre) member and the Lotta Creek Tuff (Evarts, 1977).

DO DON PEDRO TERRANE--Structurally complex assemblage of metamorphosed mafic and intermediate volcanic rocks, argillite, and marble. These rocks are generally equivalent to the "metavolcanic unit of the Calaveras complex" (Sharp and Wright, 1981). They are older than Nevadan deformation and 163-166 m.y. plutons of the Jawbone granitoid sequence of Stern and others (1981) but otherwise are undated.

DO forms the western part of the "Merced River terrane" of Nokleberg (1983). In contrast, following Sharp and Wright (1981), Saleeby (1982) regards the metavolcanic rocks of DO as Jura-Trias in age and similar to the Penon Blanco Volcanics of FH. He treats DO as the "eastern belt of the Jurassic volcaniclastic rocks and slate" which forms much of FH. For the time being, however, the metavolcanic rocks of DO are retained as a separate terrane, because they are not interpreted as being tied depositionally to ophiolitic rocks of the Sierra Nevada ophiolite belt as are, according to Saleeby (1982), the Penon Blanco and other strata included here in FH.

EK EASTERN KLAMATH TERRANE--Island arc volcanic rocks plus intercalated sedimentary rocks of Devonian through Middle Jurassic age. Forms a younging-eastward, homoclinal but internally deformed, sequence that to the west is faulted against the Trinity terrane. Overlain to the south and east, with great angular unconformity, by sedimentary rocks of Cretaceous age (Irwin, 1966).

EC ELDER CREEK TERRANE--Disrupted ophiolite overlain by mafic breccia and Jurassic to Cretaceous sedimentary rocks. Differentiated from other terranes of the Great Valley sequence by the oceanic crustal nature of the ophiolite, the strongly unconformable mafic breccia, probably marking a former transform fault deposit, and the somewhat older age of the basal clastic sedimentary rocks (Kimmeridgian).

EP EL PASO TERRANE--Tectonically complicated and stratigraphically diverse Paleozoic rocks believed to record the mid-Paleozoic Antler orogeny and subsequent late Paleozoic deposition and igneous activity. As interpreted by Carr and others (1982) and Poole and others (1982), rocks having affinity with RM of central Nevada, including Cambrian(?) to Devonian fine-grained terrigenous clastic rocks, bedded chert, and greenstone, unconformably overlain by lowermost Mississippian coarse and fine-grained siliciclastic rocks, were thrust over lower and middle Paleozoic deep marine miogeoclinal strata in Early Mississippian time. Overlapping this Antler-like deformation are Mississippian to Pennsylvanian terrigenous clastic flysch and local carbonate rocks; Lower Permian carbonate debris flows, chert conglomerate, and volcaniclastic rocks; and Upper Permian shallow marine to subaerial andesitic volcanic rocks. Deformed Paleozoic rocks are cut by unfoliated plutonic rocks having Early Triassic or Late Permian K/Ar ages (M. D. Carr, oral commun., 1982).

FR FEATHER RIVER TERRANE--Serpentinite, meta-peridotite, and other metamorphosed ultramafic and mafic plutonic rocks of the Feather River ultramafic body which is bounded and internally slivered by faults so that origination as either an ophiolitic slab or a high-level, high-temperature intrusive is uncertain (see Irwin, 1977a, and references therein).

K/Ar age of hornblende from gabbro associated with ultramafic rocks of FR is about 285 m.y. (Hietanen, 1981a), and the U-Pb zircon age of FR meta-plagiogranite is interpreted to lie within 275 to 313 m.y. (Saleeby and Moores, 1979), suggesting correlation of FR with the oldest ophiolitic rocks of FH and KW.

FH FOOTHILLS TERRANE--Flyschoid slate, metagraywacke, and metavolcanic tuff and breccia of Middle to Late Jurassic age (Callovian-Oxfordian); metabasalt flows, pillow lavas, and breccia of Jura-Trias and Middle to Late Jurassic ages; serpentinite and chert-argillite melange; and ophiolitic igneous rocks both as tectonic blocks in melange and as coherent bodies stratigraphically related to mid-Jurassic mafic metavolcanic rocks of island-arc affinity. (see Nokleberg, 1983; Saleeby, 1982; and references cited therein).

According to Saleeby (1982) ophiolitic rocks having U-Pb zircon ages clustered around 300 m.y. and 200 m.y. occur as tectonic blocks in melange, and, in addition, ophiolitic rocks dated at about 160 m.y. include those of the "Smartville terrane" (Xenophontas and Bond, 1978) and are associated stratigraphically with island-arc metavolcanic and volcaniclastic rocks.

Limestone blocks in the "Central Belt" (Saleeby, 1982) chert-argillite melange contain Lower Permian fusulinids of Tethyan kind (Douglass, 1967).

A complex history is envisaged by Saleeby (1982) that unifies FH and, in his interpretation, also KW, DO, and BL, all of which form the "Sierra Nevada ophiolite belt." In this multistage process, early Mesozoic accretion of upper Paleozoic seafloor is interpreted to have resulted in regional metamorphism and production of ophiolitic melange which became the basement of Jurassic volcanic arcs. These arcs, in turn, underwent episodes of rifting and ophiolite production at about 200 m.y. and 160 m.y., and the rift basins so formed were the depositional sites of the Jurassic volcanic-sedimentary sequences.

A U-Pb zircon age of 140 m.y is reported by Stern and others (1981) for mafic intrusive rocks of the Guadalupe complex that postdates "Nevadan" deformation of Jurassic strata of FH.

FJ FORT JONES TERRANE--Metachert, metabasalt, and metatuff containing blueschist minerals overprinted by a younger Nevadan greenschist event. Includes Stuart Fork Formation (Davis and others, 1965). No fossils are known but radiometric age of metamorphism is approximately 220 m.y. (Upper Triassic) on blueschist (Hotz, 1977).

FU FULMAR TERRANE--Distinguished by thick lower Eocene zeolitized, micaceous, arkosic wacke and interbedded siltstone which are penetrated by offshore wells and interpreted by Snavely and others (1980) to be bounded by a dextral transform fault from the correlative basaltic rocks of the Siletz River Volcanics which characterize SZ. Fault boundary between FU and SZ interpreted to be overlapped by upper Eocene and Oligocene marine tuffaceous siltstone and sandstone (Snavely and others, 1980; 1981).

GC GOLCONDA TERRANE--Deformed and imbricated slices of upper Paleozoic deep-marine pelagic and turbiditic sedimentary rocks and pillow lavas of the Golconda allochthon and the unconformably overlying Triassic strata, part or all of which are interpreted to be post-accretionary deposits laid down after emplacement of the allochthon on the Golconda thrust during Triassic time.

The eastern boundary of the Golconda terrane on the terrane map delimits the eastern extent of isolated exposures of the Golconda allochthon, questioned where assignment to the allochthon is uncertain. The actual map pattern of these exposures among those of both the Roberts Mountains terrane and North American Paleozoic rocks is too complicated to show at map scale. Similarly, the lower Mesozoic cover rocks (T u) of the Golconda terrane have a complex outcrop pattern; their eastern extent, as shown on the terrane map in north-central Nevada is considerably farther east than the west limit of outcrops of the Golconda allochthon.

Rocks of the Golconda allochthon include the Schoonover complex in northeast Nevada (Miller and others, 1983), the Havallah sequence in north-central Nevada (Silberling and Roberts, 1962), and the Pablo Formation in central Nevada (Speed, 1977a). In all of these areas, rocks of the Golconda allochthon are thrust over upper Paleozoic shelf strata that overlap the Roberts Mountains allochthon and that are included here in the Roberts Mountains terrane.

Radiolarian dating of cherts within the Golconda allochthon in north-central Nevada (Murchey, 1983) provide insight on the depositional history of the allochthon prior to its tectonic disruption either during its development as an accretionary prism (Speed, 1979) or during subsequent thrust emplacement of the allochthon. The oldest radiolarian cherts are Mississippian in age and were deposited in association with pillow basalt; Pennsylvanian strata, in addition to chert and argillite, include important units of coarse siliciclastic turbidites, possibly derived from the North American margin; widespread turbidites of impure limestone and calcareous sandstone are Early Permian in age; and the youngest deposits, some of which are dense silicified micritic limestone (commonly described as laminated chert), are mid Permian in age.

Lower Mesozoic rocks resting unconformably upon the Golconda allochthon include, in ascending order, the Koipato Group of largely subaerial and siliceous Lower Triassic volcanic rocks (Silberling, 1973); the carbonate-platform complex of the Star Peak Group which ranges from Early to Late Triassic in age (Nichols and Silberling, 1977), and the fine-grained terrigenous clastic, deltaic to basinal marine deposits of the Upper Triassic and Lower Jurassic Auld Lang Syne Group (Burke and Silberling, 1973). Sedimentation of the Auld Lang Syne is interpreted by Lupe and Silberling (in press) to be genetically related to that of the fluviatile parts of the Chinle Group on cratonic North America, and if so, it would overlap the accretionary overthrusting of the Golconda allochthon. Nevertheless, none of the lower Mesozoic strata actually overlap the terrane boundary onto North America, and the age and nature of this boundary is thus interpretational. Tectonic emplacement of the upper Paleozoic rocks of the Golconda allochthon is generally regarded as an Early Triassic, pre-Koipato event. However, emplacement of these rocks, predeformed as a subduction-related accretionary prism, could have taken place following deposition of the Koipato Group (Dickinson, 1977, p. 149) or even during deposition of the Star Peak Group in Middle or Late Triassic time.

GB GOLD BEACH TERRANE--Island-arc volcanic rocks overlain by quartz-poor volcaniclastic sedimentary rocks and scarce radiolarian chert (Otter Point Formation). Contains fossils of Upper Jurassic (Tithonian) age. Sandstones and conglomerates contain structures formed by turbidity currents, and are characterized by abundant laumonitite veins. Locally deformed and unconformably overlain by Late Cretaceous sandstone, mudstone and conglomerate (Cape Sebastian, Hunter Cove, and Houstenaden Creek Formations of Bourgeois, 1980). Paleomagnetic data suggest that GB formed far to the south of its present position relative to the craton and was also subjected to a clockwise rotation of more than 90$^{o}$ (D. C. Engebretson, unpublished data).

GS GRINDSTONE TERRANE--Tectonically disrupted assemblage of (1) mid Devonian limestone interstratified between chert sandstone and chert and argillite; (2) Lower Mississippian argillite, sandy limestone, and calcareous or conglomeratic sandstone (Coffee Creek

Formation); (3) Lower Pennsylvanian(?) mudstone, sandstone, and conglomerate containing plant remains (Spotted Ridge Formation); and (4) Lower Permian (Leonardian; Wardlaw and others, 1982), partly fusulinid-bearing, partly feldspathic-sandy, limestone (Coyote Butte Formation). Original descriptions of these units are by Kleweno and Jeffords (1961) and by Merriam and Berthiaume (1943). Associated radiolarian cherts are of Permian and Early Triassic age (C. D. Blome and D. L. Jones, unpublished data; Wardlaw and Jones, 1980).

According to Wardlaw and others (1982) the Coyote Butte Formation is faunally and lithogically similar to correlative rocks of the Bilk Creek terrane.

Although the Devonian to Lower Triassic rocks of GD are structurally chaotic, GD lacks the pervasive serpentine of BK. GD was characterized as the "Melange terrane of the Grindstone-Twelvemile area" by Dickinson and Thayer (1978, p. 152).

HR HARO-SPIEDEN TERRANE--Andesitic sandstone, conglomerate, and minor fossiliferous marine Upper Triassic calcareous rocks of the Haro Formation and andesitic conglomerate, sandstone, and mudstone of the Spieden Group in which both Upper Jurassic and Lower Cretaceous fossils occur. The dip and facing direction of these formations in the San Juan Islands requires unexposed faults between them and separating them from SJ; neither formation is as deformed and disrupted as are nearby, partly coeval rocks of SJ (Whetten and others, 1978). Closer similarity may exist between Triassic rocks of HR and those of PR on Vancouver Island.

HF HAYFORK TERRANE--Basal meta-andesite plus overlying volcaniclastic sedimentary rocks, chert, argillite, and minor limestone; melange near structural top (Irwin, 1977b). Wright (1982) has subdivided the Hayfork terrane into two subterranes, the structurally lower, western Hayfork terrane, representing a middle Jurassic ( 170 m.y.) volcanic arc unit plus overlying volcaniclastic sedimentary rocks, and an upper, eastern Hayfork terrane, made up largely of chert and argillite, quartzose sandstone, and polymictic conglomerate. Also present are various blocks and slabs of chert, limestone, and rare glaucophane schist. Fossils from the limestone blocks range in age from Pennsylvanian to Permian and include exotic Tethyan forms. Radiolarians from the chert are largely Late Triassic, and probably date the eastern Hayfork terrane.

HB HEALDSBURG TERRANE--Middle Jurassic ophiolite overlain by Upper Jurassic to Lower Cretaceous conglomerate, sandstone, and mudstone. Includes scarce andesitic(?) flows and breccias in lower part of sedimentary sequence. Conglomerates are up to 3000 m thick, contain well-rounded pebbles and cobbles of porphyritic rhyolite, and probably represent deltaic to shallow marine deposition (D. C. Howell, written commun., 1982).

HG HIGH SIERRA - GODDARD TERRANE--Upper Paleozoic (Pennsylvanian and possibly Mississippian and Permian) fine-grained terrigenous clastic and calcareous marine metasedimentary rocks, including metachert, unconformably overlain by Permo-Triassic and Lower to Middle Jurassic felsic to intermediate metavolcanic and volcanogenic metasedimentary rocks. Combines the High Sierra and Goddard terranes of Nokleberg (1983).

Carboniferous (and Permian?) strata of HG were sutured with lower Paleozoic rocks of OWN prior to the intrusion of granitic rocks of the latest Triassic to Early Jurassic Lee Vining series which cut both terranes and the fault that separates them. Lower Mesozoic metavolcanic rocks of HG are nowhere known to depositionally overlie rocks of the Owens terrane, but they are linked with OWN by mutually intruding Upper Cretaceous plutonic rocks and with KI by unconformably overlying mid-Cretaceous siliceous volcanic flows, tuffs, and shallow-level intrusive rocks (see Nokleberg, 1983, and references cited therein).

HO HOH TERRANE--Middle Miocene to upper Oligocene melange and broken formation which is largely offshore, forming the upper continental slope. Off Washington HO is interpreted to underlie the entire continental shelf, and is equated with onshore exposures of sandstone and siltstone in sheared siltstone matrix on the Olympic Peninsula (Snavely and others, 1980). Interpreted to structurally overlie subducting late Miocene oceanic crust of the Juan de Fuca plate (JDF) (Snavely and Wagner, 1981).

HZ HOZAMEEN TERRANE--Structurally disrupted and metamorphosed bedded chert, argillite, and basalt associated with minor amounts of carbonate rock and alpine-type ultramafic rocks. Ages of radiolarian cherts range from Permian to Middle Jurassic (Tennyson and other, 1982).

IZ IZEE TERRANE--Thick, mainly flyschoid, clastic sedimentary rocks and subordinate volcaniclastic and volcanic rocks of Late Triassic (Karnian?, Norian) through Middle Jurassic (Callovian) age. Termed the "Mesozoic clastic terrane" by Dickinson (1979).

Complex stratigraphic relationships and local unconformities manifest tectonic instability during deposition. On the northwest, overstepping parts of the clastic succession are interpreted to depositionally overlie, and to have received sediment from, "melange"-like rocks included here in the Baker terrane (Dickinson, 1979).

JN JACKSON TERRANE--Upper Triassic to mid Jurassic volcanogenic and volcanic rocks, including the oceanic magmatic arc rocks of the Happy Creek igneous complex (Russell, 1984).

As described by Russell (1984) in the Jackson Mountains the lower part ("Boulder Creek beds") of this lower Mesozoic terrane, of which partial stratigraphic sections are preserved in several different nappes, includes both pelagic and volcanogenic turbidites as well as redeposited carbonate rocks. These grade upward into the Happy Creek igneous complex which is composed of basaltic andesite, andesite, diorite, and quartz diorite as flows, volcanic breccias, and intrusives, and which is dated by a Rb/Sr isochron having a central value of about 160 m.y.

Part of the Boulder Creek beds is a distinctive turbiditic unit of uppermost Triassic (upper Norian) age composed of volcanic breccia and conglomerate containing fossiliferous limestone clasts of late Karnian-early Norian (middle Late Triassic) age. This unit occurs in the Jackson Mountains, Pine Forest Range, and northwestern Granite Range (Jones and Silberling, unpublished data), and it is the basis for lumping intervening isolated exposures of andesitic breccias and turbiditic volcanogenic sedimentary rocks into the Jackson terrane. In the Pine Forest Range this distinctive unit forms map units Phv and Phl of Smith (1973) and is conformably overlain by his map unit Phg. It is conformably underlain, in descending order, by Smith's map units Phl, Pha, and $T_R$lg which represent older parts of the Norian Stage and are also included in the Jackson terrane (Silberling, unpublished data; R. C. Speed and B. R. Wardlaw, written communications, 1981).

In the Jackson Mountains the lower Mesozoic rocks of the Jackson terrane are unconformably overlain by Lower Cretaceous non-marine conglomeratic and lacustrine deposits which could have been deposited prior to final accretion of the Jackson terrane.

JO JUNGO TERRANE--Extremely thick succession of basinal, turbiditic, exclusively fine-grained terrigenous clastic rocks which are mainly of Norian (late Late Triassic) age but are in places as young as Pliensbachian (Early Jurassic). Except for the upper Lower or Middle Jurassic quartzitic sandstones of the Boyer Ranch Formation which is areally associated with the Humboldt Lopolith of Speed (1976) near the Fencemaker thrust, these are the only pre-Tertiary strata exposed west of the Fencemaker and Winnemucca thrust system, that bounds the Golconda terrane, all of the way west to the eastern boundary of the Jackson terrane.

Strata of the Jungo subterrane are interpreted to be the basinal facies of the Auld Lang Syne Group (Lupe and Silberling, in press) the more shelfal facies of which is part of the Golconda terrane. For the most part they form the "basinal terrane of the early Mesozoic" of Speed (1978). They are regarded as a distinct terrane because they differ significantly in thickness and depositional environment from their presumed shelfal facies, from which they are structurally detached, and they also differ from the correlative strata of the Golconda terrane in that their basement is a matter of conjecture. Speed (1979) has suggested that the basin they occupy developed by thermal contraction of a hypothetical upper Paleozoic magmatic arc ("Sonomia") whose collision with North America caused thrust emplacement of the Golconda allochthon. Among other alternatives, these lower Mesozoic strata might even rest directly on oceanic crust newly formed during Triassic rifting following such a collisional event.

KW KAWEAH TERRANE--Disrupted ophiolite of the "Kings-Kaweah ophiolite belt" (Saleeby, 1978), tectonically accumulated in latest Paleozoic to Jurassic time, and associated deep-marine and olistrostromal sedimentary and volcanic rocks, all of which were metamorphosed during emplacement of the Sierra Nevada batholith.

Ophiolitic rocks, forming tectonic slabs such as those collectively included in the "Kings River ophiolite," are embedded in the "Kaweah serpentine melange" of Saleeby (1978). Palgiogranites among these ophiolitic rocks yield U-Pb zircon ages of about 200 m.y. and about 300 m.y. like those of ophiolitic associations in FH (Saleeby, 1982).

According to Saleeby and others (1978) metasedimentary and metavolcanic rocks are associated with the ophiolitic rocks west of the "Foothills Suture" but are not involved in the intense tectonic mixing that produced the serpentine melange. These metamorphosed strata are interpreted to unconformably overlie the ophiolite and melange and include metamorphosed pillow lavas, radiolarian chert, flyshoid pelitic and sandy rocks, and olistrostromal deposits. Original rocks types represented in olistrostromes are ophiolitic and deep-marine sedimentary rocks as well as quartzitic terrigenous clastic rocks and limestone, some of which contains Late Permian fusulinids of Tethyan affinity.

KW is regarded as an integral part of the "Sierra Nevada ophiolite belt" by Saleeby (1982) and would thus be the southern continuation of FH and possibly DO. By Nokleberg (1983) KW is treated instead as the southern extension of that part of his "Merced River terrane" included here in MR and DO. KW was interpreted by Saleeby and others (1978) as being tied to KI by early Mesozoic strata that hypothecially overlapped the "Foothills Suture," the boundary between KW and KI. However, the Foothills Suture is also believed to be a much younger, at least in part Nevadan age, structure (Nokleberg, 1983).

KR KETTLE ROCK TERRANE--Lower and Middle Jurassic, mainly andesitic and dacitic, volcanic flows, tuffs, and breccia and volcaniclastic and terrigenous(?) clastic sedimentary rocks, most or all of which are submarine deposits. Volcanic tuff and breccia predominate in the heterogeneous lower part of succession, whereas younger strata of Callovian (late Middle Jurassic) and possibly younger age contain more pelitic rocks and quartozose sandstone along with pyroclastic and volcaniclastic rocks (McMath, 1966; Imlay, 1980).

KR corresponds to the "Kettle River block" of D'Allura and others (1977), incorporating the "Mount Jura" and "Kettle Rock" blocks of McMath (1966). Original stratigraphic continuity of KR with Upper Triassic rocks of NSI is commonly assumed, but the two terranes are everywhere separated by the Taylorsville thrust. Partly correlative Jurassic strata of NSI farther south in the Sierra Nevada could be lateral equivalents of KR but are lithologically distinct.

KN KINGS TERRANE--Early Mesozoic miogeoclinal metasedimentary rocks, including thick units of quartzitic or arkosic metasandstone, slate, and marble, and subordinate amounts of metadacitic tuff and breccia. Fossils from different roof-pendant exposures date these rocks as Late Triassic and Early Jurassic.

KN is linked with HG by unconformably overlying mid-Cretaceous siliceous volcanic flows and tuffs (see Nokleberg, 1983, and references cited therein).

KI KINGS RANGE TERRANE--Upper Cretaceous pillow lava overlain by thin-bedded turbidites thought to range in age from Early Cenozoic to Middle Miocene by McLaughlin and others (1982). Turbidites are characterized by closely-spaced folds of three generations. Represents youngest known terrane within the Franciscan Complex in California.

KO KOOTENAY TERRANE--Highly deformed lower and middle Paleozoic pelitic rocks, turbiditic quartzose sandstone, mafic volcanic rocks, minor limestone, and their metamorphic equivalents that may generally correspond to the Lardeau and Millford Groups in the more extensive exposures of the Kootenay terrane in southeast British Columbia. In the Kootenay Arc of northeast Washington, KO includes the Covada Group (in part of Early Ordovician age) and Devonian rocks of the "western asemblage" of Snook and others (1982).

LZ LOPEZ TERRANE--Deformed and in part highly disrupted and foliated graywacke-argillite flysch of Late Jurassic to mid-Cretaceous age. Associated rocks are Middle and Upper Jurassic radiolarian chert, pillow lava, mafic intrusive rocks yielding Middle or Late Jurassic radiometric ages, ultramafic rocks, and serpentine which are interpreted to be the dismembered ophiolitic basement of the flysch sequence (Whetten and others, 1977). As used here, LZ includes besides the "Lopez terrane" the "Decatur and Sinclair terranes" of Whetten and others (1977).

MU MALIBU TERRANE--The oldest units in the Malibu terrane are the Upper Jurassic Santa Monica Slate and Santa Cruz Schist composed of both metasedimentary and metavolcaniclastic strata. The Santa Monica Slate is intruded by Upper Cretaceous quartz diorite and granodiorite while the Santa Cruz Island Schist is intruded by an Upper Jurassic tonalitic pluton. Unconformably above these rocks are Upper Cretaceous and Tertiary sedimentary rocks having intercalated Miocene volcanic rocks.

MB MARBLE MOUNTAIN TERRANE--Siliceous metasedimentary rocks including metachert, quartz-biotite schist, and amphibolite plus marble, calcschist, and minor metaserpentinite. Metamorphosed to amphibolite facies. Believed to represent a metamorphosed tectonic melange (Mary Donato, oral commun., 1983).

MH MARIN HEADLANDS TERRANE--Pillow lava overlain by thick section of radiolarian chert (Lower Jurassic to Middle Cretaceous) capped unconformably by Middle Cretaceous (Cenomanian) sandstone (Murchey, 1980). Probably formed in open ocean, far removed from continental detritus until Middle Cretaceous time (Karl, 1982).

MC MAY CREEK TERRANE--Garnet-bearing schist, quartzite, and amphibolite forming a displaced fragment of a high-grade metamorphic terrane of unknown provenance and age.

MM MCCOY MOUNTAINS TERRANE--Metavolcanic rocks of Jurassic age disconformably overlain by fluviatile sandstone, conglomerate, siltstone, and mudstone of both plutonic-volcanic and cratonic provenance and metamorphosed to greenschist facies during or prior to Callovian time (Harding and others, 1982).

MR MERCED RIVER TERRANE--Structurally complex, partly chaotic, assemblage of argillite and chert, metamorphosed conglomerate and quartzose sandstone, and marble. Stratigraphic ages unknown except for the occurrence of a coral of possible Permian age (R. A. Schweickert, personal commun., 1982). MR strata are cut by 163-166 m.y. plutons of the Jawbone granitoid sequence of Stern and others (1981).

On the advice of R. A. Schweickert, (personal commun., 1981), MR is restricted by Blake and others (1982) to only the central belt of rocks included in the typical Calaveras Formation which is entirely included in the "Merced River terrane" of Nokleberg (1983). MR is equivalent to the "pre-Jurassic Calaveras complex" of Saleeby (1982, fig. 1, p. 1805).

Chert-argillite melange of MR is constrained in age to pre-Jurassic by U-Pb and K-Ar dating of its main metamorphic deformation fabric (Sharp and others, 1982, cited in Saleeby, 1982).

MT METHOW TERRANE--Thick, terrigenous-clastic sequence which within Washington State includes rocks of Late Jurassic and Cretaceous ages (Barksdale, 1975). Predominant rock types are volcanic-lithic sandstones or arkosic sandstones and associated pelitic rocks which were deposited in sedimentary environments ranging from deep marine to nonmarine. Complexly interstratified and intertongued with these rocks are conglomerate, and volcanic and volcaniclastic rocks. Jurassic through Lower Cretaceous strata record an eastern provenance, but beginning in early Late Cretaceous time, sediment was received from both eastern and western sources (Tennyson and Cole, 1978). The substrate of these Jura-Cretaceous clastic rocks is unknown.

MI MOUNT INGALLS TERRANE--Mostly highly tectonized serpentinite and serpentinized peridodite with large and small inclusions of metasediments (flyschoid sandstone and argillite, and radiolarian chert), mafic and intermediate volcanic rocks, and diabase and gabbro, imbricated on all scales. Comprises "Ingalls tectonic complex" of Tabor and others (1982c). Gabbro and chert yield Late Jurassic U-Pb ages (Southwick, 1974, p. 391) and radiolarian ages (E. A. Pessagno, Jr., oral commun., 1977), and the terrane was assembled and thrust onto the Nason Terrane prior to the Late Cretaceous (R. B. Miller, 1980; Robert Miller, 1980).

NA NASON TERRANE--Mostly metapelite of the Chiwaukum Schist having interbeds of gneissic amphibolite (metabasite) and of rare marble in its lower part (Tabor and others, 1980, 1984). NA was overthrust by MI after early regional metamorphism but prior to the Late Cretaceous instrusion of the Mount Stuart batholith and concomitant metamorphism (R. B. Miller, 1980).

NR NICASIO TERRANE--Pillow lava intercalated with and overlain by radiolarian chert of Lower Cretaceous (Valanginian) age. Pillow lava is chemically similar to ocean-island basalt, and terrane probably represents a sea-mount.

NK NOOKSACK TERRANE--Thrust faulted, but stratigraphically coherent succession of (1) Triassic(?) conglomerate, sandstone, and argillite, (2) Middle Jurassic keratophyric volcanic rocks (Harrison Lake and Wells Creek Formations), and (3) Upper Jurassic and Lower Cretaceous marine, volcanic sandstone, conglomerate, and argillite of the Nooksack Formation and equivalent units (Misch, 1966; Monger, 1970). The younger of these rocks might also rest stratigraphically on older rocks of CK with which NK is in part imbricated on east-dipping, mid-Cretaceous thrust faults, but this has not been demonstrated.

NSI NORTHERN SIERRA TERRANE--Highly deformed and thrust-disrupted Ordovician-Silurian rise and slope deposits of the Shoo Fly complex, consisting mainly of phyllite, quartzose turbiditic sandstone, and radiolarian chert, unconformably overlain by a deformed, but stratigraphically coherent succession of arc-related marine volcanic, volcaniclastic and largely turbiditic sedimentary rocks ranging from Late Devonian to Middle Jurassic age (D'Allura and others, 1977; Bond and DeVay, 1980; Schweickert, 1981; Harwood, 1983).

In addition to the angular unconformity beneath Frasnian? or Fammenian (Late Devonian) arc-related strata (Varga and Moores, 1981), a regionally significant disconformity represents much of Pennsylvanian and possibly earliest Permian time, and Upper Triassic strata rest with angular unconformity on mid-Permian and older strata (Harwood, 1983).

Compared with Lower Jurassic strata of KR, which are pyroclastic and first-cycle volcaniclastic rocks, the correlative Sailor Canyon Formation of NSI is a much thicker succession formed mainly of well organized slate-volcanic graywacke turbidite.

NF NORTH FORK TERRANE--Tectonically dismembered ophiolite plus overlying limestone, chert, siliceous tuff, and sandstone. Locally a chaotic melange containing blocks and slabs of Permian limestone having Tethyan faunal affinities and blueschist knockers. Radiolarians from chert range from Late Triassic to Middle(?) Jurassic (Irwin and others, 1982).

NQ NOVATO QUARRY TERRANE--Graywacke, mudstone, and conglomerate of Late Cretaceous (Campanian) age. Contains sedimentary structures indicative of a submarine fan environment of deposition. Locally tightly folded but in general less deformed than other Franciscan terranes. Contain prehnite and pumpellyite. Possibly depositional on Franciscan melange in a trench-slope setting.

OF OLDS FERRY TERRANE--Upper Triassic mafic and intermediate volcanic and volcaniclastic rocks of the Huntington Formation of Brooks, (1979) termed the "Huntington arc terrane" by Dickinson (1979), Lower Jurassic (and possibly uppermost Triassic) limestone and coarse-grained volcaniclastic rocks, and Lower and Middle Jurassic sandy and pelitic sedimentary rocks.

As described by Brooks (1979), the Upper Triassic volcanic rocks are variably metamorphosed, submarine in origin, and mainly andesitic in composition, but range from basalt to rhyolite. Interlayered sedimentary rocks are entirely volcaniclastic or tuffaceous except for rare pods of limestone. Ammonite and Halobia faunas of late Karnian and early and middle Norian age are known from widely scattered, stratigraphically unrelated localities. Upper Triassic strata are cut by small bodies of quartz diorite or granodiorite having K/Ar ages of 190-220 m.y. Generally faulted over these Upper Triassic rocks, but originally overlying them unconformably and hence included here in Olds Ferry terrane, is the Jet Creek Member of the Weatherby Formation of Brooks (1979) consisting of shallow-marine limestone and gypsum intercalated with volcaniclastic conglomerate and sandstone of Early Jurassic (Sinemurian to late Pliensbachian) age. The rest of the Weatherby Formation, consisting mainly of Lower and Middle Jurassic immature sandstone and argillite, is also included in OF although these rocks partly overlap in age with the Jet Creek Member and are tectonically telescoped against it.

Paleomagnetic data from Upper Triassic basalts of OF agree with those of Triassic rocks of WA and indicate a paleolatitude of about 18$^{\circ}$ north or south. A large clockwise rotation (Hillhouse and others, 1982) in post-Early Cretaceous time is indicated by paleomagnetic data from plutons and remagnetized Triassic rocks within OF and WA.

OP OLNEY PASS TERRANE--A melange belt having Mesozoic and some Paleozoic components consisting of a pervasively sheared, scaley, mostly argillacous, matrix containing steep-sided, outcrop- to mountain-size phacoids of sandstone, along with less common phacoids of greenstone, metagabbro, meta-andesite, chert, limestone, and metatonalite (Frizzell and others, 1982, 1984; Tabor and others, 1982a, p. 14-15). OP contains Late Jurassic and Early Cretaceous megafossils (Danner, 1957), Middle Jurassic through Early Cretaceous radiolarians (C. D. Blome, written commun., 1982), and limestone containing Permian fusulinids. Meta-igneous rocks have yielded Late Jurassic U-Pb ages. Rocks included in OP have a complicated nomenclatorial history summarized well by Dungan (1974, p. 8-21).

OC OLYMPIC CORE--Disrupted and low-grade metamorphosed subduction-accretion prism of flyschoid marine sedimentary rocks and oceanic basalt ranging from Eocene to Miocene in age (Tabor and Cady, 1978).

OWN OWENS TERRANE--Thermally metamorphosed lower Paleozoic (Lower Cambrian to Silurian) shelf, slope and rise deposits of calcareous quartzose sandstone, siltstone, pelitic rocks, biogenic chert, and carbonate rocks (see Nokleberg, 1983, and references cited therein). Intruded by latest Triassic to Early Jurassic rocks of the Sheelite granitoid sequence (including the Lee Vining intrusive series) as well as by Jurassic and Cretaceous plutons. U-Pb zircon ages and Rb-Sr isochron ages for older granitic rocks of the Sheelite sequence range from about 214 to 201 m.y. (Stern and others, 1981).

Interpreted as part of the North American miogeocline displaced from an uncertain original location on the continental margin probably along with at least the older (upper Paleozoic to Early Triassic) strata of HG that were amalgamated with OWN prior to intrusion of the early Mesozoic plutonic rocks.

OW OWYHEE TERRANE--A metamorphic terrane of interlayered mica schist, quartzite, and marble representing protoliths of pelitic, sandy, and orthoquartzitic terrigeneous-clastic rocks and limestone of unknown age (Silberling, unpublished data; Ekren and others, 1981). Intruded by granitic rocks of the Idaho batholith having a K/Ar age on biotite of 87±3 m.y. (Armstrong and others, 1977).

OZ OZETTE TERRANE--Accretionary prism of middle and lower(?) Eocene melange and broken formation unconformably overlain by less deformed upper Eocene and Oligocene strata (Snavely and others, 1980). Includes the "Ozette melange" of Snavely and Wagner (1981) which is interpreted as being thrust beneath the offshore extension of CR and is overlapped by upper Miocene marine sedimentary rocks. Onshore on the Olympic Peninsula, OZ includes gneissic diorite which has a K/Ar hornblende age of 144 m.y. and is overlain by pillow lava, graywacke, and argillite (MacLeod and others, 1977).

PR PACIFIC RIM TERRANE--Tectonically disrupted, deep-marine sedimentary and volcanic rocks of Late Jurassic to Early Cretaceous age associated with andesitic volcanic rocks and limestone, some of which has yielded Upper Triassic fossils (Brandon, 1983; M. T. Brandon, H. W. Tipper, and M. J. Orchard, oral commun., 1983). PR is restricted to Vancouver Island where it includes the Leech River complex.

PAR PATTON RIDGE TERRANE--Zeolite-cemented graywacke is the principal rock of the Patton terrane. Other lithologies include basalt, greenchert, serpentinite, and ultramafic rocks. This assemblage of strata resembles the Coastal terrane of northern California.

Oligocene and younger siltstone depositionally overlies these strata, and Miocene and Pliocene volcanic rocks are locally abundant.

PM PERMANENTE TERRANE--Structurally complex, partly chaotic basalt, pelagic limestone, radiolarian chert, and volcanogenic sandstone. Probably an Early Cretaceous (Valanginian?) seamount province, capped by Upper Cretaceous (Cenomanian) foraminiferal limestone. May include a slab of dismembered ophiolite (Miller-Hoare, 1980). Shown by Blake and others (1974) to contain fossils having warm-water (Tethyan) affinities.

PP PICKETT PEAK TERRANE--Strongly deformed quartz-mica schist, metagraywacke, metabasalt, and metachert. Contains high-pressure blueschist-facies minerals. Includes South Fork Mountain Schist, Colebrooke Schist, and Valentine Spring Formation. No fossil are known; radiometric ages on metamorphic minerals suggest an Early Cretaceous ( 125 m.y.) metamorphic age.

PA POINT ARENA TERRANE--Little-deformed turbidite sandstone, shale, and conglomerate, of Late Cretaceous to Eocene age. Includes two distinctive units: strata (1) of Stewart's Point and (2) of German Rancho, the former being derived from a granitic source area and the latter from a basalt-gabbro source (Wentworth, 1968).

QN QUESNELLIA TERRANE--South of the U.S.-Canadian border undifferentiated QN consists predominantly of stratigraphically coherent Upper Triassic (to Lower Jurassic?) greenstones and volcanogenic or terrigenous-clastic metasedimentary rocks, such as the Ellemehan Formation, regarded here as equivalent to the Nicola Group in British Columbia (Monger and Berg, 1984). Also included in QN are minor marine limestone and granitic intrusive rocks, such as the Loomis pluton, that are probably comagmatic with the lower Mesozoic greenstones. Mainly from relations in British Columbia, undifferentiated Quesnellia is believed to overlap two subterranes, Okanagan (QNO) and Harper Ranch (QNH), composed mainly of upper Paleozoic rocks (Okulitch and Peatfield, 1977).

QNH HARPER RANCH SUBTERRANE--Pelitic rocks, volcanic-chert-lithic sandstone and conglomerate, limestone, and minor volcanic flows and pyroclastic rocks; all more or less metamorphosed and assigned to units such as the Anarchist Group (of Rinehart and Fox, 1972) and Mission Argillite. Most dated limestone bodies are Permian in age; in British Columbia limestones of QNH are recognized partly as olistoliths and range from latest Devonian to Permian age, whereas both late Paleozoic and Triassic ages are reported from olistolithic matrix rocks (Monger and Berg, 1984).

QNO OKANAGAN SUBTERRANE--Mainly oceanic rocks including argillite, radiolarian chert, limestone blocks, basalt, basaltic hypabyssal intrusive rocks, and ultramafic rocks, all structurally disrupted and metamorphosed to varying degrees. In Washington mainly represented by the Kobau Formation and Palmer Mountain Greenstone. Depositional unconformity between the Kobau Formation of QNO and the Anarchist Group of QNH reported by Rinehart and Fox (1972) reinterpreted here as a fault on the basis of regional considerations. In British Columbia known ages are late Paleozoic, and rocks equivalent to QNO are unconformably overlain by Upper Triassic strata of QN (Read and Okulitch, 1977; Monger and Berg, 1984).

RS RATTLESNAKE CREEK TERRANE--Structurally complex, largely chaotic, mixture of sedimentary and igneous rocks. Includes some large, relatively coherent slabs of ophiolite, arc volcanics, graywacke and shale. Triassic fossils have been found in limestone blocks; cherts have yielded both Triassic and Jurassic radiolarians (Irwin and others, 1982). Wright (1982) has dated the ophiolitic rocks at 193-207 m.y. and interprets this terrane as a dismembered, oceanic island arc complex.

RC ROARING CREEK TERRANE--A composite metamorphic terrane consisting of the "Mad River terrane" and "Swakane terrane" of Tabor and others (1984) and the "Chelan Mountain terrane" of Tabor and others

(1980), each of which has a mostly supracrustal protolith (Tabor and others, 1980, 1982d). The "Mad River terrane" probably overlies the "Swakane terrane" along a low-angle fault and consists of complexly and isoclinally folded hornblende schist, schistose amphibolite, micareous quartz schist, micaceous quartzite, biotite gneiss, and rare calc-silicate schist, marble, and ultramafic rocks, all of which are intruded (?) by orthogneiss containing zircons of probable paleozoic or older age (Mattinson, 1972). The "Swakane terrane," consisting of the Swakane Biotite Gneiss, is mostly a uniform granoblastic gneiss having planar foliation and rare, thin layers of hornblende schist, amphibolite, and marble. U-Th-Pb zircon dates for these rocks are subject to various interpretations but probably indicate a Precambrian protolith age (Mattinson, 1972). The "Chelan Mountain terrane" is dominated by the Chelan Complex, a migmatite derived primarily from Triassic tonalite (Hopson and Mattinson, 1971) and to a lesser extent from Permian or older metasedimentary and metavolcanic rocks (Tabor and others, 1984). Also included are the Late Cretaceous anatectic Entiat and Chelan plutons which are derived from the migmatite.

RC was metamorphosed during Late Cretaceous time.

RM ROBERTS TERRANE--Devonian and older, deep marine to continental slope rocks of the Roberts Mountains allochthon proper, as well as the upper Paleozoic, nonmarine to shallow-marine strata of the so-called overlap assemblage which are known or inferred to have been deposited unconformably upon the allochthon prior to emplacement of the structurally higher Golconda allochthon.

Lower Paleozoic rocks of the Roberts Mountains allochthon are partly of oceanic character, including important amounts of rhythmically bedded radiolarian chert, graptolitic pelitic rocks, and pillow basalt, and partly representative of terrigenous clastic continental rise and slope deposits. They characteristically occur in complexly interleaved thrust plates. Among the formational units of the Roberts Mountains allochthon in northcentral Nevada are the Vinini and Valmy Formations (Ordovician), Elder Sandstone (Silurian), and Slaven Chert (Devonian). Also included in the allochthon are Upper Cambrian arkosic turbidites of the Harmony Formation which are among the more western exposures of the Roberts Mountains allochthon in northern Nevada (see discussion by Stewart, 1980, p. 21-24).

Thrust emplacement of the Roberts Mountains allochthon over the North American continental shelf originally in latest Devonian to Early Mississippian time is widely accepted. Nevertheless, major eastward thrusting involving both these rocks and the depositionally overlying upper Paleozoic overlap-assemblage rocks is also recognized locally (Dover, 1980; Ketner and Smith, 1982). Consequently, the eastern limit of the Roberts terrane, as shown on the terrane map, delimits all of the isolated exposures of these rocks that are believed to be allochthonous, regardless of their inferred thrust history or the time of their final emplacement. The actual outcrop pattern of these rocks is far too complicated to show at map scale.

In southwestern Nevada, adjacent to the California border, the Palmetto Formation of Ordovician age, along with structurally interleaved Devonian calcareous and sandy rocks, is only questionably treated as part of the Roberts Mountains allochthon--and hence the Roberts terrane--because structural detachment of the Palmetto from older rocks, and ultimately from the pre-Cambrian continental basement, is not certain (see Stewart, 1980, p. 39-40).

In keeping with the definition of the terrane farther north, shelfal Mississippian and Permian (Diablo Formation) strata along with the lowermost Triassic Candelaria Formation, all of which rest unconformably on the Palmetto Formation and pre-date the inferred time of thrusting of the Golconda allochthon, are also questionably regarded as part of the Roberts terrane.

In central Idaho rocks included in the Roberts terrane belong to the complexly imbricated Sun Valley allochthon (Dover, 1980) of Devonian and older strata and to the structurally higher allochthon made up of the Wood River Formation of late Paleozoic age. Although the bulk of the Sun Valley allochthon in formed of Devonian siliceous argillite and chert of the Milligan Formation, thrust slices of Silurian and Ordovician argillite, siltstone, graptolitic shale, and quartzite, which resemble correlative strata in the typical Roberts Mountains allochthon of central Nevada, are included in the Sun Valley allochthon. The Wood River Formation is inferred to have been deposited originally on rocks of the Sun Valley allochthon (Sandberg, et al., 1975). Major eastward thrust displacement of both the Wood River and Sun Valley allochthons in Mesozoic time is convincingly argued by Dover (1980).

RD RODRIQUEZ TERRANE--The Rodriquez terrane is composed of Miocene seamount volcanic rocks and upper Cenozoic pelagic strata.

SL SALINIA TERRANE--Salinia consists of mid-Cretaceous plutonic rocks that intrude a heterogeneous assemblage of metasedimentary strata. The main body of prebatholithic rocks is composed of amphibolite to locally granulite facies, quartzo-feldspathic gneiss and granofels in the Santa Lucia and Gabilan Ranges. Subordinate amounts of micaceous and feldspathic quartzite, schist, and marble are also found. A second prebatholith subterrane includes the metagraywacke of the Sierra de Salinas Range (Ross, 1977).

Four granitic "blocks" have been defined by Ross (1977) based on petrographic similarities and structural coherence. Initial Sr values for these granitic rocks are greater than 0.706. K/Ar radiometric ages of crystallization from granitic rocks found in Salinia range from 78 to 104 m.y. (Evernden and Kistler, 1970).

Unconformably overlying the intrusive and metasedimentary basement of Salinia are Upper Cretaceous and conformable Paleocene clastic strata. A regional middle Paleocene to early Eocene unconformity separates these strata from overlying Eocene and younger strata.

SR SALMON RIVER TERRANE--Volcaniclastic rocks (metandesite?) overlain by disrupted sedimentary sequence containing chert, clastic rocks, volcanic rocks, minor limestone, and scarce serpentinite;

tholeiitic pillow basalt and diabase; and high-Ti basalt (massive and pillowed) associated with limestone, chert, and argillite. The latter rocks contain Permian fusulinids having Tethyan affinities and radiolarians of Permian, Late Triassic, Early and Middle Jurassic age. According to Nicholas Mortimer (oral commun., 1983) these three units could be the Hayfork terrane (metandesite) plus overlying oceanic basement and cover of the North Fork terrane.

SB SAN BRUNO MOUNTAIN TERRANE--Moderately deformed sandstone, mudstone and scarce conglomerate. No fossils are known from these rocks, but they contain abundant detrital potassium feldspar and are therefore believed to be late Mesozoic or early Cenozoic age. Although unmetamorphosed, the sandstone is locally cut by epidote and adularia veins similar to those occurring in other terranes of the type Franciscan.

SJ SAN JUAN TERRANE--A sporadically exposed belt of melange containing both Mesozoic and Paleozoic components (Frizzell and others, 1982; Tabor and others, 1982a, 1982b). SJ is penetratively deformed, and for the most part intensely folded, chert and metachert alternating with tectonically formed stringers of calcareous argillite. Also included in the terrane are greenstone, metagraywacke, metaconglomerate, meta-intrusive rocks, marble, and ultramafic rocks. Marbles yield Permian fusulinids which have Tethyan affinities (Danner, 1977, p. 500), and tonolite gneiss yields 190 m.y. U-Pb ages from zircon (Wetten and others, 1980, table 2). Available dating indicates that SJ of the Cascade Range had a different and more variable protolith than that of OP.

In the San Juan Islands, SJ includes the "Roche Harbor, Constitution, and Eagle Cove terranes" and the "Turtleback intrusive igneous complex" of Whetten and others (1978).

SN SAN NICOLAS TERRANE--Jurassic plutonic basement complex overlain by Upper Cretaceous flysch and Cenozoic strata. Basement rocks consist of the Willows Plutonic Complex of Santa Cruz Island, composed of dioritic, some gabbroic, and minor tonalitic and ultramafic rocks. These rocks are dated radiometrically by zircons as 162+/-3 m.y. old and are correlated with the Coast Range ophiolite.

Upper Cretaceous flysch occurs throughout this terrane. Paleocene and younger strata unconformably overlie the flysch, and Miocene volcanic rocks are locally abundant.

SS SAN SIMEON TERRANE--Franciscan assemblage rocks consisting chiefly of melange composed of mixed oceanic and continentally-derived rocks of differing Mesozoic ages, lithologies, and metamorphic grade. Coherent slabs of Cretaceous flysch occur within the melange. These strata may represent trench slope deposition in basins floored by the melange. Eocene and younger strata unconformably overlie this terrane (Howell and others, 1977).

SA SANTA ANA TERRANE--Stratigraphically coherent, but structurally complex and partly metamorphosed Mesozoic turbiditic sedimentary rocks and volcanic rocks. The stratigraphically lowest exposed part of the terrane in the Santa Ana Mountains is the Bedford Canyon Formation consisting of blocks of Triassic chert included in Middle Jurassic shale and turbiditic sandstone units which themselves are in fault contact with olistoliths(?) of limestone. The Bedford Canyon Formation is overlain, in part unconformably, by the Upper Jurassic-Lower Cretaceous Santiago Peak Volcanics.

Gabbroic to tonalitic plutons 120-90 m.y. old intrude the pre-batholithic strata and are depositionally overlain by Upper Cretaceous and Tertiary sedimentary strata. Miocene volcanic rocks occur locally.

SHM SHADOW MOUNTAIN TERRANE--Isolated outcrop area of metamorphosed calcareous and fine-grained clastic sedimentary rocks regarded as early and middle Paleozoic in protolith age by Blake and others (1982). Characterized as "Eugeoclinal" by Jones and others (1983) but seemingly more miogeoclinal in character; in either case not definitely distinquishable from rocks included in EP.

SH SHUKSAN TERRANE--Mainly black sericite-quartz phyllite with quartz segregation veinlets and lenses, mica schist, and lesser amounts of greenschist, actinolite schist, and interclated blueschist. Armstrong (1980) suggests that the "Shuksan Metamorphic Suite" of Misch (1966), which forms part of SH, embraces several accretionary wedges of different ages, but that all of them had Mesozoic protoliths and all were metamorphosed during the Late Jurassic and early Cretaceous. Also included in SH is the Easton Schist, regarded as an equivalent of the "Shuksan Metamorphic Suite," and the Tonga Formation of Yeats (1958) (Tabor and others, 1984).

SZ SILETZ TERRANE--Distinguished by lower to middle Eocene basaltic flows, pillow lava, and breccia of the Siletz River Volcanics which in their upper part are locally interbedded and interfingered with micaceous siltstone and basaltic sandstone (Snavely and others, 1968). Overlying middle Eocene strata are widespread, thick, arkosic- and lithic-sandstone turbidites such as the Tyee Formation. Upper Eocene rocks include partly tuffaceous marine sandstone and siltstone and both submarine and subaerial basaltic and andesitic volcanic rocks. Younger Tertiary strata are shared with adjacent terranes. Paleo-magnetic studies indicate consistent post-Eocene clockwise rotation of 50-70° throughout SZ block (Simpson and Cox, 1977; Beck and Plumley, 1980).

SK SKAGIT TERRANE--Greenschist- to amphibolite-grade metamorphic rocks, including migmatites, that were derived from a predominantly clastic sequence having subordinate volcanic rocks and a variety of metamorphosed intrusive rocks (Misch, 1966). The main metamorphism is evidently Late Cretaceous in age, but there are indications of a mid-Paleozoic metamorphic event as well (Mattinson, 1972).

SCM SNOW CAMP MOUNTAIN TERRANE--Middle Jurassic ophiolite overlain by Late Jurassic-Early Cretaceous sedimentary rocks of the Riddle and Days

Creek Formations. Formerly thought to be typical Coast Range ophiolite but shown by Smith and others (1982) to contain abundant porphyritic andesite and dacite flows, tuffs, and agglomerates along the Rogue River.

SW SNOW MOUNTAIN TERRANE--Sea-mount province consisting of Ti-rich basalt, alkalic rhyolite, and intercalated sedimentary rocks (Macpherson, 1983). Originally thought to have been developed on top of the Coast Range ophiolite (Elder Creek terrane) but now considered as an enormous slab within the Central terrane of the Franciscan assemblage.

STM STANLEY MOUNTAIN TERRANE--Middle Jurassic (153-165 m.y. old) Coast Range Ophiolite overlain by Upper Jurassic and Cretaceous tuffaceous chert and flysch. These lithologies are similar to strata of the Great Valley sequence of central California. Eocene and younger strata unconformably overlie the older strata of this terrane.

TR TRINITY TERRANE--Strongly deformed and recrystallized peridotite, minor layered and intrusive gabbro, diabase dike-and-sill complex, plus rare volcanic rocks. Has yielded early Paleozoic radiometric ages. Believed by Lindsley-Griffin (1977) to represent an Ordovician ophiolite. Quick (1981), however, has interpreted the Trinity ultramafic mass as a mantle diapir, intrusive into an island arc or back-arc basin environment.

TJ TUJUNGA TERRANE--A composite of Precambrian metamorphic terranes that are intruded by Jurassic, Cretaceous, and Tertiary plutons and depositionaly overlain by Cretaceous and Tertiary graywacke. The pre-Jurassic rocks of the Tujunga terrane compose two thrust bounded nappes, the structurally lower Joshua Tree nappe of upper-crustal affinities and the structurally higher San Gabriel nappe of mid-crustal lithologies (Powell, 1981).

TS TWIN SISTERS TERRANE--Enstatite-bearing dunite and subordinate saxonite, altered to serpentinite at margins of the terrane (Ragan, 1963; Christiansen, 1971). TS appears to be a rootless, fault-bounded lense (Thompson and Robinson, 1975) of mantle origin and was emplaced by thrusting and strike-slip faulting (Levine, 1981).

VA VAN ARSDALE TERRANE--Pillow lava, minor radiolarian chert (Upper Jurassic?), and mudstone, all unconformably overlain by Upper Cretaceous (Maestrictian) sandstone and shale (Pomo Formation of Berkland, 1972). Probably represents the youngest-known sea-mount rafted into the Central terrane of the Franciscan assemblage.

WPD, WPN WALKER LAKE TERRANE--The two subdivisions of this terrane, the Paradise and Pine Nut subterranes, have depositional histories that are only partly similar and deformational styles that differ.

WPD PARADISE SUBTERRANE--Lower Mesozoic carbonate, siliciclastic, and volcaniclastic rocks of the so-called Luning sequence (Silberling and Roberts, 1962) and associated, in part depositionally subjacent, upper Paleozoic andesitic volcanic and volcanogenic sedimentary rocks. These rocks occur in numerous nappes representing several major allochthons such as the "Luning allochthon" and "Pamlico allochthon" of Oldow (1978; 1981).

Andesitic volcanic breccia and volcanogenic sedimentary rocks of uncertain age depositionally underlie upper Middle Triassic strata disconformably in the Shoshone Mountains in the northeasternmost exposure of the subterrane. Other andesitic upper Paleozoic rocks, such as the Black Dyke Formation (Speed, 1977b), are structurally emplaced amidst nappes of the lower Mesozoic strata characteristic of the subterrane.

The principal lower Mesozoic lithologic entities are: (1) the disrupted carbonate platform complex and intercalated clastic rocks of the Luning Formation which is mainly Norian (late Late Triassic) in age, (2) calcareous fine-grained terrigenous clastic rocks of the Gabbs and Sunrise Formations of latest Triassic to Early Jurassic age, and (3) the lithologically diverse, partly volcaniclastic, synorogenic Dunlap Formation of late Early Jurassic and possibly younger age. In the more eastern and southern of the pre-Dunlap early Mesozoic strata, volcaniclastic and tuffaceous contituents are inconspicuous, but they increase in importance to the north and west in the structurally higher parts of the subterrane.

Below the Luning thrust, the sole of the Luning allochthon, the Dunlap Formation rests unconformalby on volcanogenic, turbiditic, subsea fan deposits of the Mina Formation which is at least partly of Permian age (Speed, 1977b). Other Mesozoic strata of uncertain formational assignment are in complex fault relationships with the Mina Formation and include a heterogeneous, largely subaerial assortment of coarse- and fine-grained clastic and volcanic rocks, to parts of which the name Gold Range Formation has been variously applied (Speed, 1977b). Volcanic rocks of this complex, which has participated in regional deformation, have yielded Rb-Sr isochron ages of about 102 and 142 m.y. (Speed and Kistler, 1980). The history recorded by the Mina Formation and the Mesozoic rocks depositionally and structually associated with it, all of which are the southern-most exposures included in the Paradise subterrane, differs from that of the rest of the subterrane enough so that these rocks could be regarded as a distinct tectonostratigraphic element.

WPN PINE NUT SUBTERRANE--Upper Triassic (mainly Norian) basinal marine volcanic and carbonate rocks (Oreana Peak Formation of Noble), overlain in turn by Lower Jurassic fine-grained terrigenous clastic and tuffaceous sedimentary rocks (main part of Gardnerville Formation of Noble) and a thick late Early Jurassic (late Toarcian) and younger succession of conglomerate, sandstone, and volcanic rocks (uppermost Gardnerville and the Preachers, Veta Grande, Gold Bug, and Double Springs Formations, all of Noble) (Moore, 1969, p. 6-7, after Noble, 1962). Associated plutonic rocks of Jurassic age would necessarily have been displaced as part of the Pine Nut subterrane.

Like that of the Paradise subterrane, the section of the Pine Nut subterrane records an abrupt change near the end of Triassic time from deposition of significant amounts of carbonate rock to prolonged deposition of exclusively fine-grained siliclastic (and tuffaceous) marine rocks which are then surmounted by partly subaerial synorogenic volcanic and sedimentary rocks. Gross correlation of major lithologic entities between the two subterranes is thus evident (Stewart, 1980). However, in the Pine Nut subterrane no pre-Triassic rocks are known, the early Mesozoic marine rocks are more volcanic and generally deeper marine deposits, initiation of coarse clastic and volcanic deposition began later in Jurassic time, and these rocks appear not to have participated in the nappe-like, overthrust style of deformation characteristic of the Paradise subterrane (J. S. Oldow, oral commun., 1982).

WA WALLOWA TERRANE--Stratified terrane of Permian to Lower Jurassic oceanic plateau and island-arc volcanic and sedimentary rocks having affinity with Wrangellia.

Lower part of stratigraphic sequence formed of intermediate and mafic, mainly submarine, volcanic and volcaniclastic rocks of Early Permian and mid-Triassic (Ladinian to Karnian) ages (Seven Devils Group of Vallier, 1977, and the partially equivalent Clover Creek Greenstone and "Lower Sedimentary Series" of Smith and Allen, 1941). These are successively overlain by non-volcanic platform carbonate rocks (Martin Bridge Limestone) of late Karnian to early Norian (mid-Late Triassic) age and a thick sequence of more or less calcareous, basinal marine, fine-grained clastic metasedimentary rocks (Hurwal Formation) ranging from Late Triassic to late Early Jurassic age. Volcanogenic sediment reappears in the upper part of the Hurwal Formation as feldspathic siltstone and sandstone. Locally resting with angular unconformity on Triassic rocks of the Wallowa terrane is dark mudstone with minor siltstone and sandstone (Coon Hollow Formation) that has yielded ammonites of Callovian (late Middle Jurassic) and Oxfordian (early Late Jurassic) ages. The Bald Mountain batholith, having a probable maximum age of 155-160 m.y. (Armstrong and others, 1977), cuts the boundary of WA and BA.

Paleomagnetic studies of the Seven Devils Group indicate a mid-Triassic paleolatitude for WA of about 18$^{o}$ north or south (Hillhouse and others, 1982). A magnetic direction overprinting the evidently Triassic magnetization is attributed to metamorphism during intrusion of 130-160 m.y. old plutons and is statistically the same as that determined by Wilson and Cox (1980) for these plutons. This magnetic direction, as recalculated by Hillhouse and others (1982), indicates a clockwise rotation of about 66$^{o}$ since Early Cretaceous time.

WA has been referred to as the "Wallowa Mountains--Seven Devils Mountains volcanic arc terrane" by Brooks and Vallier (1978) and the "Seven Devils terrane" by Dickinson (1979) and by others, and it is regarded by Jones and others (1977) as a possible part of Wrangellia.

WKB, WKD, WKR, WKS WESTERN KLAMATH TERRANE

WKB BRIGGS CREEK SUBTERRANE--Garnet-bearing amphibolite, micaceous quartzite, quartz schist, and meta-chert. WKB forms a tectonic slice between the Dry Butte and Rogue Valley subterranes, and it possibly represents a deep-seated portion of the latter (Garcia, 1982).

WKD DRY BUTTE SUBTERRANE--Metaperiodotite, metagabbro, metaquartz diorite and metavolcanic rocks intruded by plutons of Late Jurassic age. Metamorphosed sequence believed to represent roots of Western Klamath arc but could possibly contain some older (Triassic?) meta-igneous rocks (N. J. Page, oral commun., 1982).

WKR ROGUE VALLEY SUBTERRANE--Ophiolite, overlain by an island arc sequence of basaltic to andesitic flows, tuffs, breccias (Rogue Formation) plus mudstone and minor sandstone (Galice Formation) of Upper Jurassic (Oxfordian-Kimmeridgian) age (Garcia, 1982).

WKS SMITH RIVER SUBTERRANE--Josephine ophiolite plus overlying sedimentary rocks of Galice Formation of Upper Jurassic (Oxfordian-Kimmeridgian) age. Believed to have formed in a marginal basin, behind the Western Klamath arc, and subsequently thrust onto it (Harper, 1980).

WMP WHITE MOUNTAIN PEAK TERRANE--Undated, probably late Paleozoic and/or early Mesozoic, metavolcanic and metasedimentary rocks in the northern White Mountains of eastern California. Metavolcanic rocks represent original felsic flows and pyroclastic tuffs as well as andesitic flows. Metasedimentary rocks include phyllite and slate, as well as volcaniclastic sandstone and conglomerate (see McKee, and others, 1982, and references cited therein).

Separated from lower Paleozoic and upper Precambrian strata of the North American miogeocline by intrusive plutonic rocks of the Granodiorite of Mount Barcroft, U-Pb zircon ages from which are 160-161 m.y. (Stern, and others, 1981).

WR WRANGELLIA TERRANE--The southernmost exposures of Wrangellia crop out south of the 49th Parallel on Vancouver Island; stratigraphically similar and probably genetically related rocks in northeast Oregon and vicinity are assigned to the Wallowa terrane.

Paraphasing Muller and others (1974), the oldest exposed part of WR on Vancouver Island is the Sicker Group composed of intermediate volcanic, volcaniclastic, pelitic, and carbonate rocks of Pennsylvanian and probably Permian ages. Overlying the Sicker is the Vancouver Group composed of (1) Middle Triassic argillite much intruded by diabasic sills, (2) Middle to Upper Triassic tholeitic, mainly submarine, basalt of the Karmutsen Formation, (3) Upper Triassic limestone and basinal impure calcareous rocks of the Quatsino and Parson Bay Formations, and (4) Lower Jurassic calc-alkaline volcanic and volcaniclastic rocks of the Bonanza Volcanics. Middle to Upper Jurassic granitic rocks of the Island Intrusions invade both the Sicker and Vancouver Groups.

YB YOLLA BOLLY TERRANE--Intercalated graywacke, shale, conglomerate, and radiolarian chert, all intruded by diabase-gabbro and quartz keratophyre and subsequently metamorphosed to the blueschist facies. Cherts contain radiolarians of Middle(?) Jurassic to Middle Cretaceous age (Blake and others, 1981).

YR YREKA TERRANE--Imbricate thrust sheets consisting from bottom to top of 1) Ordovician(?) keratophyre plus overlying Ordovician to Silurian limestone, siltstone, and conglomerate, 2) highly disrupted Ordovician(?) and Silurian calcareous siltstone overlain depositionally by fine to coarse clastic sedimentary rocks of the Silurian and Devonian Gazelle Formation which laterally grades into Early Devonian arc volcanic rocks, and 3) phyllitic siltstone, wacke, quartz sandstone, and radiolarian chert of Ordovician(?) age (Potter and others, 1977).

# REFERENCES


varez, Walter, Kent, D. V., Premoli-Silva, Isabella, Schweickert, R. A., and Larson, R. A., 1980, Franciscan Complex limestone deposited at 17° south paleolatitude: Geological Society of America Bulletin, v. 91, p. 476-484.

mstrong, R. L., 1980, Geochronology of the Shuksan metamorphic suite, North Cascades, Washington: Geological Society of America Abstracts with Programs, v. 12, no. 3, p. 94.

mstrong, R. L., Taubeneck, W. H., and Hales, P. O., 1977, Rb-Sr and K-Ar geochronometry of Mesozoic granitic rocks and their Sr isotopic composition, Oregon, Washington, and Idaho: Geological Society of America Bulletin, v. 88, p. 397-411.

ichman, S. B., 1978, A Cretaceous and early Tertiary subduction complex, Mendocino Coast, northern California, in Howell, D. G., and McDougall, K. A., eds., Mesozoic Paleogeography of the Western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 397-400.

irksdale, J. D., 1975, Geology of the Methow Valley, Okanogan County, Washington: Washington Department of Natural Resources, Division of Geology and Earth Resources Bulletin 68, 67 p.

eck, M. E., and Engebretson, D. C., 1982, Paleomagnetism of small basalt exposures in the west Puget Sound area, Washington, and speculations on the accretionary origin of the Olympic Mountains: Journal of Geophysical Research, v. 87, no. B5, p. 3755-3760.

eck, M. E., and Plumley, P. W., 1980, Paleomagnetism of intrusive rocks in the Coast Range of Oregon: microplate rotations in middle Tertiary time: Geology, v. 8, p. 573-577.

erkland, J. O., 1972, Paleogene "frozen" subduction zone in the Coast Ranges of northern California: 24th International Geologic Congress, Montreal, Sec. 3, p. 99-105.

lake, M. C., Jr., 1983, Geologic map and geochemical data for the Weaver Bally Roadless Area, Trinity County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1657, scale 1:48,000.

lake, M. C., Jr., Howell, D. G., and Jones, D. L., 1982, Preliminary tectonostratigraphic terrane map of California: U.S. Geological Survey Open-File Report 82-593, scale 1:700,000.

lake, M. C., Jr., Jayko, A. S., and Howell, D. G., 1981, Geology of a subduction complex in the Franciscan assemblage of northern California: Oceanologica Acta, Coll., C-3, p. 267-272.

lake, M. C., Jr., Jones, D. L., and Landis, C. A., 1974, Active continental margins: contrasts between California and New Zealand, in C. A. Burk and C. L. Drake, eds., The geology of continental margins: Springer-Verlag, p. 853-872.

ond, G. C., and DeVay, J. C., 1980, Pre-Upper Devonian quartzose sandstones in the Shoo Fly Formation northern California -- petrology, provenance and implications for regional tectonics: Journal of Geology, v. 89, p. 285-308.

ourgeois, Joanne, 1980, Sedimentology and tectonics of Upper Cretaceous rocks, southwest Oregon: University of Wisconsin, Ph.D. dissertation, 298 p.

randon, M. T., 1983, Pacific Rim Complex of western Vancouver Island; tectonic evolution of a late Mesozoic active margin west of Wrangellia: Geological Society of America Abstracts with Programs, v. 15, p. 384.

Brooks, H. C., 1979, Geologic map of Huntington and part of Olds Ferry quadrangles, Oregon: Oregon Department of Geology and Mineral Industries, Geologic Map Series GMS-13, scale 1:62,500.

Brooks, H. C., and Vallier, T. L., 1978, Mesozoic rocks and tectonic evolution of eastern Oregon and western Idaho, in Howell, D. G., and McDougall, K. A., eds., Mesozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 133-145.

Burke, D. B., and Silberling, N. J., (1973), The Auld Lang Syne Group, of Late Triassic and Jurassic (?) age, north-central Nevada: U.S. Geological Survey Bulletin 1394-E, p. E1-E14.

Carr, M. D., Poole, F. G., and Christiansen, R. L., 1982, Geologic framework of Paleozoic eugeosynclinal and transitional assemblage rocks in the north-central Mojave Desert, southern California: Geological Society of America Abstracts with Programs, v. 14, p. 154.

Coney, P. J., and Campa, M. F., 1984, Part D--Lithotectonic terrane map of Mexico, in Silberling, N. J., and Jones, D. L., eds., Lithotectonic terrane maps of the North American Cordillera: this report.

Coney, P. J., Jones, D. L., and Monger, J. W. H., 1980, Cordilleran suspect terranes. Nature, v. 288, p. 329-333.

Christensen, N. I., 1971, Fabric, seismic anisotropy and tectonic history of the Twin Sisters dunite, Washington: Geological Society of America Bulletin, v. 82, p. 1681-1694.

D'Allura, J. A., Moores, E. M., and Robinson, L., 1977, Paleozoic rocks of the northern Sierra Nevada: their structural and paleogeographic significance, in Stewart, J. H., Stevens, C. H., and Fritsche, A. E., eds., Paleozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 1, p. 394-408.

Danner, W. R., 1957, A stratigraphic reconnaissance in the northwestern Cascade Mountains and San Juan Islands of Washington State: University of Washington, Ph.D. thesis, 561 p.

Danner, W. R., 1977, Paleozoic rocks of northwestern Washington and adjacent parts of British Columbia, in Stewart, J. H., Stevens, C. H., and Fritsche, A. E., eds., Paleozoic paleogeography of the Western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 1, p. 481-502.

Davis, G. A., Holdaway, M. J., Lipman, P. W., and Romey, W. D., 1965, Structure, metamorphism, and plutonism in the south-central Klamath Mountains, California: Geological Society of America Bulletin, v. 76, p. 933-966.

Dickinson, W. R., 1977, Paleozoic plate tectonics and the evolution of the Cordilleran continental margin, in Stewart, J. H., Stevens, C. H., and Fritsche, A. E., eds., Paleozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 1, p. 137-155.

Dickinson, W. R., 1979, Mesozoic forearc basin in central Oregon: Geology, v. 7, p. 166-170.

Dickinson, W. R., and Thayer, T. P., 1978, Paleogeographic and paleotectonic implications of Mesozoic stratigraphy and structure in the John Day inlier of central Oregon in Howell, D. G., and McDougall, K. A., eds. Mesozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 147-161.

Douglass, R. C., 1967, Permian tethyan fusulinids from California: U.S. Geological Survey Professional Paper 583-A, p. 7-43.

Dover, J. H., 1980, Status of the Antler orogeny in central Idaho--clarifications and constraints from the Pioneer Mountains, in Fouch, T. D., and Magathan, E. R., eds., Paleozoic paleogeography of west-central United States: Society of Economic Paleontologists and Mineralogists, Rocky Mountain Section, West-central United States Paleogeography Symposium 1, p. 371-386.

Dungan, M. A., 1974, The origin, emplacement, and metamorphism of the Sultan mafic-ultramafic complex, North Cascades, Snohomish County, Washington; University of Washington, Ph.D. thesis, 227 p.

Ekren, E. B., McIntyre, D. H., Bennett, E. H., and Malde, H. E., 1981, Geologic map of Owyhee County, Idaho, west of longitude 116°W: U.S. Geological Survey MI Map I-1256, scale 1:125,000.

Evarts, R. C., 1977, The geology and petrology of the Del Puerto ophiolite, Diablo Range, central California Coast Ranges, in Coleman, R. G., and Irwin, W. P., eds., North American ophiolites: Oregon Department of Geology and Mineral Industries Bulletin 95, p. 121-140.

Frizzell, V. A., Jr., Tabor, R. W., and Zartman, R. B, 1984, Late Mesozoic or Early Tertiary melanges in the western Cascades of Washington: in Schuster, E., ed., Geology of Washington Symposium Volume: Washington State Department of Natural Resources.

Frizzell, V. A., Jr., Tabor, R. W., Zartman, R. E., and Jones, D. L., 1982, Mesozoic melanges in the western Cascades of Washington: Geological Society of America Abstracts with Programs, v. 14, p. 164.

Garcia, M. O., 1982, Petrology of the Rogue River island arc complex, southwest Oregon: American Journal of Science, v. 282, p. 783-807.

Harding, L. E., Coney, P. J., and Butler, R. F., 1982, Stratigraphy, sedimentary petrology, structure, and paleomagnetism of the McCoy Mtns.-Livingstone Hills Fm., SE California and SW Arizona: Geological Society of America Abstracts with Programs, v. 14, p. 170.

Harper, G. D., 1980, The Josephine ophiolite--remains of a late Jurassic marginal basin in northwestern California: Geology, v. 8, p. 333-337.

Harwood, D. S., 1983, Stratigraphy of upper Paleozoic volcanic rocks and regional unconformities in part of the northern Sierra terrane, California: Geological Society of America Bulletin, v. 94, p. 913-422.

Haxel, G. B., 1977, The Orocopia Schist and the Chocolate Mountain thrust, Picacho-Peter Kane Mountain area, southeasternmost California: California University, Santa Barbara, Ph.D. thesis, 277 p.

Hietanen, Anna, 1981a, Geology west of the Melones fault between the Feather and North Yuba Rivers, California: U.S. Geological Survey Professional Paper 1226-A, 35 p.

Hietanen, Anna, 1981b, The Feather River area as a part of the Sierra Nevada suture system in California: U.S. Geological Survey Professional Paper 1226-B, 13 p.

Hillhouse, J. W., Gromme, C. S., and Vallier, T. L., 1982, Paleomagnetism and Mesozoic tectonics of the Seven Devils Volcanic arc in northeastern Oregon: Journal of Geophysical Research, v. 87, no. B5, p. 3777-3794.

Hopson, C. A., and Mattinson, J. M., 1971, Metamorphism and plutonism, Lake Chelan Region, northern Cascades, Washington, in Metamorphism in the Canadian cordillera: Geological Association of Canada, Cordilleran Section, Programs and Abstracts, p. 13.

Hotz, P. E., Lanphere, M. A., and Swanson, D. A., 1977, Triassic blueschist from northern California and north-central Oregon: Geology, v. 5, p. 659-663.

Hotz, P. E., 1977, Blueschist facies rocks in the Yreka-Ft. Jones area, Klamath Mountains, California, in Geology of the Klamath Mountains, California: Geological Society of America Guide for 73rd Annual Cordilleran Section Meeting, Sacramento, California: p. 26-33.

Howell, D. G., Vedder, J. G., McLean, H. Joyce, J. M., Clarke, S. H., Jr., and Smith, G., 1977, Review of Cretaceous geology, Salinian and Nacimiento blocks, Coast Ranges of central California, in Howell, D. G., Vedder, J. G., and McDougall, K., eds., Cretaceous geology of the California Coast Ranges, west of the San Andreas fault: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Field Guide 2, 109 p.

Imlay, R. W., 1980, Jurassic paleobiogeography of the conterminous United States in its continental setting: U.S. Geological Survey Professional Paper 1062, 134 p.

Irwin, W. P., 1966, Geology of the Klamath Mountains province, in Bailey, E. H., ed., Geology of northern California: California Division of Mines and Geology Bulletin 190, p. 19-38.

Irwin, W. P., 1977a, Ophiolitic terranes of California, Oregon, and Nevada, in Coleman, R. G., and Irwin, W. P., eds., North American ophiolites: Oregon Department of Geology and Mineral Industries Bull. 95, p. 75-92.

Irwin, W. P., 1977b, Review of Paleozoic rocks of the Klamath Mountains, in Stewart, J. H., Stevens, C. H., and Fritsche, A. E., eds., Paleozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 1, p. 441-454.

Irwin, W. P., and Galanis, S. P., Jr., 1976, Map showing limestone and selected fossil localities in the Klamath Mountains province, California and Oregon: U.S. Geological Survey Miscellaneous Field Studies Map MF-749, scale 1:500,000.

Irwin, W. P., Jones, D. L., and Blome, C. D., 1982, Map showing sampled radiolarian localities in the Western Paleozoic and Triassic belt, Klamath Mountains, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1399, scale 1:250,000.

Jones, D. L., Howell, D. G., Coney, P. J., and Monger, J. W. H., 1983, Recognition, character, and analysis of tectonostratigraphic terranes in western North America, in Hashimoto, M., and Uyeda, S., eds., Accretion tectonics in the Circum-Pacific regions: Advances in Earth and Plantary Sciences, Terra Scientific Publishing Co., p. 21-35.

Jones, D. L., Silberling, N. J., and Hillhouse, John, 1977, Wrangellia -- a displaced terrane in northwestern North America: Canadian Journal of Earth Sciences, v. 14, p. 2565-2577.

Karl, S. M., 1982, Geochemical and depositional environments of Upper Mesozoic radiolarian cherts from the northeastern Pacific rim and from Pacific DSDP cores: Stanford University, Ph.D. thesis, 245 p.

Ketner, K. B., and Wardlaw, B. R., 1981, Permian and Triassic rocks near Quinn River Crossing, Humboldt County Nevada: Geology, v. 9, p. 123-126.

Ketner, K. B., and Smith, J. F., Jr., 1982, Mid-Paleozoic age of the Roberts thrust unsettled by new data from northern Nevada: Geology, v. 10, p. 298-303.

King, P. B., and Beikman, H. M., 1974, Geologic map of the United States (exclusive of Alaska and Hawaii): U.S. Geological Survey, scale 1:2,500,000.

Kleweno, W. P., Jr., and Jeffords, R. M., 1961, Devonian rocks in the Suplee area of central Oregon: Ore Bin, v. 23, p. 50.

Lawson, A. C., 1914, Description of the San Francisco district; Tamalpais, San Francisco, Concord, San Mateo, and Hayward quadrangles: U.S. Geological Survey Atlas, Folio 193.

Levine, C. A., 1981, Internal structures of the northwestern portion of the Twin Sisters dunite, North Cascades, Washington: University of Washington, Seattle, MS thesis, 82 p.

Lindsley-Griffin, Nancy, 1977, Paleogeographic implications of ophiolites: The Ordovician Trinity complex, Klamath Mountains, California, in Stewart, J. H., Stevens, C. H., and Fritsche, eds., Paleozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 1, p. 409-420.

Lupe, Robert, and Silberling, N. J., in press, Genetic relationship between lower Mesozoic continental strata of the Colorado Plateau and marine strata of the western Great Basin: Significance for accretionary history of Cordilleran lithotectonic terranes, in Howell, D. G., ed., Circum-Pacific tectonostratigraphic terrane symposium volume: American Association of Petroleum Geologists Memoir.

MacLeod, N. S., Tiffin, D. L., Snavely, P. D., Jr., and Currie, R. G., 1977, Geologic interpretation of magnetic and gravity anomalies in the Strait of Juan de Fuca, U.S.-Canada: Canadian Journal of Earth Sciences, v. 14, p. 223-238.

Macpherson, G. J., 1983, The Snow Mountain volcanic complex: an on-land seamount in the Franciscan terrane, California: Journal of Geology, v. 91, p. 73-92.

Mattinson, J. M., 1972, Ages of zircons from the northern Cascade Mountains, Washington: Geological Society of America Bulletin, v. 83, p. 3769-3784.

McLaughlin, R. J., Kling, S. A., Poore, R. Z., McDougall, Kristin, and Beutner, E. C., 1982, Post-middle Miocene accretion of Franciscan rocks, northwestern California: Geological Society of America Bulletin, v. 93, p. 595-605.

McKee, E. H., Diggles, M. F., Donahoe, J. L., and Elliot, G. S., 1982, Geologic map of the White Mountains Wilderness and Roadless Areas, California and Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-1361-A, scale 1:62,500.

McMath, V. E., 1966, Geology of the Taylorsville area, northern Sierra Nevada, in Geology of northern California: California Division of Mines and Geology Bulletin 190, p. 173-183.

Merriam, C. W., and Berthiaume, S. A., 1943, Late Paleozoic formations of central Oregon: Geological Society of America Bulletin, v. 54, p. 145-172.

Miller, E. L., Holdsworth, B. K., Whiteford, W. B., and Rodgers, D., 1984, Stratigraphy and structure of the Schoonover complex, northeastern Nevada: Geological Society of America Bulletin (in press).

Miller, R. B., 1980, The Windy Pass thrust and the emplacement of the Ingalls Ophiolite Complex, central Washington Cascades (abs.): Geological Society of America Abstracts with Programs, v. 12, no. 3, p. 141-142.

Miller, Robert, 1980, Structure, Petrology, and Emplacement of the Ophiolitic Ingalls Complex, North-Central Cascades, Washington: Washington University, Seattle, Ph.D. thesis, 422 p.

Miller-Hoare, M. L., 1980, Gabbroic with associated cumulate mafic and ultramafic rocks--a probable ophiolitic slice--near Stevens Creek, Canyon, California: Stanford University, M.S. thesis, 108 p.

Misch, Peter, 1966, Tectonic evolution of the northern Cascade of Washington State--a west-cordilleran case history, in Symposium on the tectonic history, mineral deposits of the western Cordillera in British Columbia and in neighboring parts of the U.S.A.: Canadian Institute of Mining and Metallurgy Special Volume 8, p. 101-148.

Monger, J. W. H., 1970, Hope map-area, west half, British Columbia: Geological Survey of Canada Paper 69-47, 75 p.

Monger, J. W. H., and Berg, H. C., 1984, Part B--Lithotectonic terrane map of western Canada and southeastern Alaska, in Silberling, N. J., and Jones, D. L., eds., Lithotectonic terrane maps of the North American Cordillera: this report.

Moore, J. G., 1969, Geology and mineral deposits of Lyon, Douglas, and Ormsby Counties, Nevada: Nevada Bureau of Mines Bulletin 75, 45 p.

Mullen, E. D., 1982, Permian and Triassic fore-arc terrane of the Blue Mountains, northeast Oregon: geochemical and other evidence: Geological Society of America Abstracts with Programs, v. 14, no. 7, p. 573.

Muller, J. E., Northcote, K. E., and Carlisle, D., 1974, Geology and mineral deposits of Alert Bay-Cape Scott Map-Area, Vancouver Island, British Columbia: Geological Survey of Canada Paper 74-8, 77 p.

Murchey, Benita, 1982, Chert facies in the Havallah sequence near Battle Mountain, Nevada: Geological Society of America Abstracts with Programs, v. 14, p. 219.

Murchey, B. L., 1980, Significance of chert age determinations in the Marin Headlands, California: Geological Society of America Abstracts with Programs, v. 12, no. 3, p. 144.

Nichols, K. M., and Silberling, N. J., 1977, Stratigraphy and depositional history of the Star Peak Group (Triassic), northwestern Nevada: Geological Society of America Special Paper 178, 73 p.

Noble, D. C., 1962, Mesozoic geology of the southern Pine Nut Range, Douglas County, Nevada: Stanford University, Ph.D. thesis, 200 p.

Nokleberg, W. J., 1983, Wall rocks of the central Sierra Nevada batholith: a collage of accretionary tectono-stratigraphic terranes: U.S. Geological Survey Professional Paper 1255, 28 p.

Okulitch, A. V., and Peatfield, G. R., 1977, Geologic history of the late Paleozoic-early Mesozoic eugeocline in southern British Columbia and eastern Washington: Geological Association of Canada, Program with Abstracts, 1977 Annual Meeting, p. 40.

Oldow, J. S., 1978, Triassic Pamlico Formation: an allochthonous sequence of volcanogenic-carbonate rocks in west-central Nevada, in Howell, D. G., and McDougall, K. A., eds., Mesozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 223-235.

-----, 1981, Structure and stratigraphy of the Luning allochthon and the kinematics of allochthon emplacement, Pilot Mountains, west-central Nevada: Geological Society of America Bulletin, Part I, v. 92, p. 888-911, Part II, v. 92, p. 1647-1669.

Poole, F. G., Carr, M. D., and Christiansen, R. L., 1982, Paleozoic geology of the El Paso Mountains, Kern County, California: Geological Society of America Abstracts with Programs, v. 14, p. 225.

Platt, J. P., 1975, Metamorphic and deformational processes in the Franciscan Complex, California: some insights from the Catalina Schist terrane: Geological Society of America Bulletin, v. 86, p. 1337-1347

Potter, A. W., Hotz, P. E., and Rohr, D. M., 1977, Stratigraphy and inferred tectonic framework of Lower Paleozoic rocks in the eastern Klamath Mountains, northern California, in Stewart, J. H., Stevens, C. H., and Fritsche, A. E., eds., Paleozoic Paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 1, p. 421-440.

Powell, R. E., 1981, Geology of the crystalline basement complex, eastern Transverse Ranges, southern California: constraints on regional tectonic interpretation: California Institute of Technology, Ph.D. Dissertation, 504 p.

Quick, J. E., 1981, Petrology and petrogenesis of the Trinity peridotite, an upper mantle diapir in the eastern Klamath Mountains, northern California: Journal of Geophysical Research, v. 86, p. 11,837-11,863.

Ragan, D. M., 1963, Emplacement of the Twin Sisters dunite, Washington: American Journal of Science, v. 261, p. 549-565.

Read, P. B., and Okulitch, A. V., 1977, The Triassic unconformity of south-central British Columbia: Canadian Journal of Earth Sciences, v. 14, p. 606-638.

Rinehart, C. D., and Fox, K. F., Jr., 1972, Geology and mineral deposits of the Loomis quadrangle, Okanogan County, Washington: Washington Division of Mines and Geology Bulletin 64, 124 p.

Ross, D. C., 1977, Pre-intrusive metasedimentary rocks of the Salinian block, California--A paleotectonic dilemma, in Stewart, J. H., Stevens, C. H., and Fritsche, A. E., eds., Paleozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 1, p. 371-380.

Russell, B. J., 1984, Mesozoic geology of the Jackson Mountains, northwestern Nevada: Geological Society of America Bulletin, v. 95, p. 313-323.

Saleeby, Jason, 1978, Kings River ophiolite, southwest Sierra Nevada foothills, California: Geological Society of America Bulletin, v. 89, p. 617-639.

Saleeby, J. B., 1982, Polygenetic ophiolite belt of the California Sierra Nevada: geochronological and tectonostratigraphic development: Journal of Geophysical Research, v. 87, no. B3, p. 1803-1824.

Saleeby, J. B., Goodin, S. E., Sharp, W. D., and Busby, C. J., 1978, Early Mesozoic paleotectonic-paleogeographic reconstruction of the southern Sierra Nevada region, in Howell, D. G., and McDougall, K. A., eds., Mesozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 311-336.

Saleeby, Jason, and Moores, E. M., 1979, Zircon ages on northern Sierra Nevada ophiolite remnants and some possible regional correlations: Geological Society of America Abstracts with Programs, v. 11, p. 125.

Sandberg, C. A., Hall, W. E., Batchelder, J. N., and Axelsen, Claus, 1975, Stratigraphy, conodont dating, and paleotectonic interpretation of the type Milligen Formation (Devonian), Wood River area, Idaho: U.S. Geological Survey Journal of Research, v. 3, no. 6, p. 707-720.

Schweickert, R. A., 1981, Tectonic evolution of the Sierra Nevada range, in Ernst, W. G., ed., The geotectonic development of California: Prentice-Hall, p. 87-131.

Sharp, W. D., and Wright, J. E., 1981, Jurassic metavolcanic sequences in the western Sierra-Klamath provinces: charcter and tectonic significance: Geological Society of America Abstracts with Programs, v. 13, p. 105.

Silberling, N. J., (1973), Geologic events during Permian-Triassic time along the Pacific margin of the United States, in Logan, A., and Hills, L. V., eds., The Permian and Triassic Systems and their mutual boundary: Alberta Society of Petroleum Geologists, Calgary, Alberta, Canada, p. 345-362.

Silberling, N. J., and Roberts, R. J., (1962), Pre-Tertiary stratigraphy and structure of northwestern Nevada: Geological Society of America Special Paper 72, 58 p.

Silver, L. T., and Anderson, T. H., 1974, Possible left-lateral early to middle Mesozoic disruption of the southwestern North American craton margin: Geological Society of America Abstracts with Programs, v. 6, p. 955-956.

Simpson, R. W., and Cox, Allan, 1977, Paleomagnetic evidence for tectonic rotation of the Oregon Coast Range: Geology, v. 5, p. 585-589.

Skinner, J. W., and Wilde, G. L., 1965, Permian biostratigraphy and fusulinid faunas of the Shasta Lake area, northern California: University of Kansas Paleontological Contributions, Protozoa, Art. 6, 98 p.

Smith, J. G., 1973, Geologic map of the Duffer Peak quadrangle, Humboldt County, Nevada: U.S. Geological Survey Miscellaneous Geologic Investigations, Map I-606.

Smith, J. G., Page, N. J., Johnson, M. G., Moring, B. C., and Gray, Floyd, 1982, Preliminary geologic map of the Medford $1^{o}$ x $2^{o}$ quadrangle, Oregon and California: U.S. Geological Survey Open-File Report 82-955, scale 1:250,000.

Smith, W. D., and Allen, J. E., 1941, Geology and physiography of the northern Wallowa Mountains, Oregon: Oregon Department of Geology and Mineral Industries, Bulletin 12, 65 p.

Snavely, P. D., Jr., MacLeod, N. S., and Wagner, H. C., 1968, Tholeiitic and alkalic basalts of the Eocene Siletz River Volcanics, Oregon Coast Range: American Journal of Science, v. 266, p. 454-481.

Snavely, P. D., Jr., and Wagner, H. C., 1981, Geologic cross section across the continental margin off Cape Flattery, Washington, and Vancouver Island, British Columbia: U.S. Geological Survey Open-File Report 81-978.

Snavely, P. D., Jr., Wagner, H. C., and Lander, D. L., 1980, Geologic cross section of the central Oregon continental margin: Geological Society of America Map and Chart Series MC-28J.

Snavely, P. D., Jr., Wagner, H. C., Rau, W. W., and Bukry, David, 1981, Geologic cross section of the southern Oregon Coast Range and adjacent continental shelf: U. S. Geological Survey Open-File Report 81-957.

Snook, J. R., Ellis, M. A., Mills, J. W., and Watkinson, A. J., 1982, The Kootenay Arc in N.E. Washington: Geological Society of America Abstracts with Programs, v. 14, p. 235.

Southwick, D. L., 1974, Geology of the alpine-type ultramafic complex near Mount Stuart, Washington: Geological Society of America Bulletin, v. 85, p. 391-402.

Speed, R. C., (1976) Geologic map of the Humboldt lopolith and surrounding terrane, Nevada: Geological Society of America Map and Chart Series MC-14.

------, (1977a) An appraisal of the Pablo Formation of presumed late Paleozoic age, central Nevada, in Stewart, J. H., Stevens, C. H., and Fritsche, A. E., eds., Paleozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 1, p. 315-336.

------, (1977b) Excelsior Formation, west-central Nevada: Stratigraphic appraisal, new divisions, and paleogeographic interpretations, in Stewart J. H., Stevern, C. H., and Fritsche, A. E., eds., Paleozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 1, p. 325-336.

------, (1978) Basinal terrane of the early Mesozoic marine province of the western Great Basin, in Howell, D. G., and McDougall, K. A., eds., Mesozoic Paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 237-252.

------, (1979) Collided Paleozoic microplate in the Western United States: Journal of Geology, v. 87, p. 279-292.

Speed, R. C., Elison, M. W., Engeln, J. F., Stahl, S. D., Vaverka, E. A., and Wiens, D. A., 1982, Mesozoic fold and thrust belt: Geological Society of America Abstracts with Programs, v. 14, p. 236.

Speed, R. C., and Kistler, R. W., 1980, Cretaceous volcanism, Excelsior Mountains, Nevada: Geological Society of America Bulletin, Part I, v. 91, p. 392-398.

Stern, T. W., Bateman, P. C., Morgan, B. A., Newell, M. F., and Peck, D. L., 1981, Isotopic U-Pb ages of zircon from the granitoids of the central Sierra Nevada, California: U.S. Geological Survey Professional Paper 1185, 17 p.

Stewart, J. H., 1980, Geology of Nevada: Nevada Bureau of Mines and Geology Special Publication 4, 136 p.

Tabor, R. W., and Cady, W. M., 1978, The structure of the Olympic Mountains, Washington--Analysis of a subduction zone: U.S. Geological Survey Professional Paper 1033, 38 p.

Tabor, R. W., Frizzell, V. A., Jr., Booth, D. B., Whetten, J. T., Waitt, R. B., Jr., and Zartman, R. E., 1982a, Preliminary geologic map of the Skykomish 1:100,000 quadrangle, Washington: U.S. Geological Survey Open-Map OF-82-747, 31 p.

Tabor, R. W., Frizzell, V. A., Jr., Whetten, J. T., Swanson, D. A., Byerly, G. R., Booth, D. B., Hetherington, M. J., Waitt, R. B., Jr., 1980, Preliminary geologic map of the Chelan 1:100,000 quadrangle, Washington: U.S. Geological Survey Open-File Map 80-841, 43 p.

Tabor, R. W., Frizzell, V. A., Yeats, R. S., and Whetten, J. T., 1982b, Geologic map of the Eagle Rock-Glacier Peak Roadless Areas (U.S.F.S. RARE II nos. 6054 and 6031) U.S. Geological Survey Miscellaneous Field Studies Map 1380-A.

Tabor, R. W., Waitt, R. B., Jr., Frizzell, V. A., Jr., Swanson, D. A., and Byerly, G. R., 1982c, Geologic map of the Wenatchee 1:100,000 quadrangle, Washington: U.S. Geological Survey Miscellaneous Investigation Series Map I-1311.

Tabor, R. W., Zartman, R. E. and Frizzell, V. A., Jr., 1982d, Possible accreted terranes in the North Cascades crystalline core, Washington: Geological Society of America Abstract with Programs, v. 14, no. 4, p. 239.

Tabor, R. W., Zartman, R. E., and Frizzell, V. A., Jr., 1984, Possible tectonostratigraphic terranes in the North Cascades crystalline core, Washington: in Schuster, E., ed., Geology of Washington Symposium Volume: Washington State Department of Natural Resources, in press.

Tennyson, M. E., and Cole, M. R., 1978, Tectonic significance of upper Mesozoic Methow-Pasayten sequence, northeastern Cascade Range, Washington, and British Columbia, in Howell, D. G., and McDougall, K. A., eds., Mesozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 499-508.

Tennyson, M. E., Jones, D. L., and Murchey, B. L., 1982, Age and nature of chert and mafic rocks of the Hozameen Group, North Cascade Range, Washington: Geological Society of America Abstracts with Programs, v. 14, p. 239.

Thompson, G. A., and Robinson, R., 1975, Gravity and magnetic investigation of the Twin Sisters dunite, northern Washington: Geological Society of America Bulletin, v. 86, p. 1413-1422.

Vallier, T. L., 1977, The Permian and Triassic Seven Devils Group, western Idaho and northeastern Oregon: U.S. Geological Survey Bulletin 1437, 58 p.

Varga, R. J., and Moores, E. M., 1981, Age, origin, and significance of an unconformity that predates island-arc volcanism in the northern Sierra Nevada: Geology, v. 9, p. 512-518.

Wardlaw, B. R., and Jones, D. L., 1980, Triassic conodonts from eugeoclinal rocks of western North America and their tectonic significance: Revista Italiana di Paleontologia e Stratigrafia, v. 85, p. 895-908.

Wardlaw, B. R., Nestell, M. K., and Dutro, J. T., Jr., 1982, Biostratigraphy and structural setting of the Permian Coyote Butte Formation of central Oregon: Geology, v. 10, p. 13-16.

Wentworth, C. M., 1968, Upper Cretaceous and lower Tertiary strata near Gualala, California, and inferred large right-slip on the San Andreas fault, in Proceedings of conference on geologic problems of San Andreas fault system, Stanford University Publicatins in Geological Sciences, v. II, p. 130-143.

Whetten, J. T., Jones, D. L., Cowan, D. S., and Zartman, R. E., 1978, Ages of mesozoic terranes in the San Juan Islands, Washington, in Howell, D. G., and McDougall, K. A., eds., Mesozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 117-132.

Whetten, J. T., Zartman, R. E., Blakely, R. J., and Jones, D. L., 1980, Allochthonous Jurassic ophiolite in northwest Washington: Geological Society of America Bulletin, Part 1, v. 91, p. 359-368.

Wilson, D., and Cox, A., 1980, Paleomagnetic evidence for tectonic rotation of Jurassic plutons in Blue Mountains, eastern Oregon: Journal of Geophysical Research, v. 85, p. 3681-3689.

Wright, J. E., 1982, Permo-Triassic accretionary subduction complex, southwestern Klamath Mountains, northern California: Journal of Geophysical Research, v. 87, p. 3805-3818.

Xenophontos, Costas, and Bond, G. C., 1978, Petrology, sedimentation and paleogeography of the Smartville terrane (Jurassic) -- bearing on the genesis of the Smartville ophiolite, in Howell, D. G., and McDougall, K. A., eds., Mesozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 311-336.

Yeats, R. S., 1958, Geology of the Skykomish area in the Cascade Mountains of Washington: Seattle, University of Washington, Ph.D. thesis, 249 p.

# PART D -- Lithotectonic terrane map of Mexico

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## DESCRIPTION OF MAP UNITS

### POST-ACCRETION COVER ROCKS

CV CENOZOIC VOLCANIC ROCKS--Middle Cenozoic volcanic rocks of the Sierra Madre Occidental and upper Cenozoic rocks of the Trans-Mexican volcanic axis.

### ACCRETED TERRANES

[Arranged alphabetically]

AR ARTEAGA TERRANE--Metamorphosed Middle to Upper Triassic volcaniclastic rocks structurally juxtaposed with Paleozoic schists.

CAB CABORCA TERRANE--North American Precambrian basement rocks and their Paleozoic miogeoclinal cover in addition to overthrust Paleozoic allochthons and younger overlap deposits, all of which are interpreted as having been displaced southeastward with respect to North America in Middle Jurassic time.

COA COAHUILA TERRANE--Deformed and metamorphosed flysch and igneous rocks of an upper Paleozoic magmatic arc and fore-arc assemblage, and distal deep-water marine deposits spanning the Paleozoic. All of these are unconformably overlain by Triassic to Jurassic continental redbeds and evaporites.

CTS CORTES TERRANE--Metamorposed continental-margin strata mainly of Paleozoic age.

GU GUERRERO TERRANE--Upper Jurassic and Lower Cretaceous andesitic volcanic rocks and associated marine and nonmarine sedimentary rocks.

JZ JUAREZ TERRANE--Highly deformed Upper Jurassic to Lower Cretaceous marine calcareous sedimentary rocks and andesite.

LP LA PAZ TERRANE--Plutonic and metamorphic complex including metasedimentary and metagabbroic rock, in part of presumed Paleozoic age, intruded by granitic plutons.

MG MAGDALENA TERRANE--Composite of disrupted Mesozoic (?) metaophiolite and an Upper Jurassic island arc assemblage.

MYA MAYA TERRANE--Heterogeneous assemblage of metamorphosed Permo-Triassic plutonic rocks, Paleozoic flysch, and Jurassic redbeds and volcanic rocks; probably a displaced part of COA.

MX MIXTECA TERRANE--Lower Paleozoic metamorphic and ultramafic rocks deformed with their cover of Pennsylvanian terrigenous clastic rocks and unconformably overlain by Jurassic and Cretaceous marine sedimentary rocks.

MZ MOTOZINTLA TERRANE--Metamorphosed volcanic (mainly andesitic), volcaniclastic, gabbroic, and ultramafic rocks of unknown age.

OX OAXACA TERRANE--Crystalline metamorphic basement rocks of Grenville age, overlain by lower Paleozoic terrigenous clastic rocks, various upper Paleozoic sedimentary rocks, undated redbeds, and mid-Cretaceous limestone.

PAP PAPANOA TERRANE--Metamorphosed andesite, diorite, gabbro, and pyroxenite along with limestone and quartzite of presumed early Paleozoic age.

PRL PARRAL TERRANE--Highly deformed, partly calcareous, Upper Jurassic and Lower Cretaceous turbiditic sandstone.

SA SANTA ANA TERRANE--Upper Jurassic and Lower Cretaceous andestic rocks and older quartzose sandstone; intruded by granitic rocks of the Peninsular batholith.

SME SIERRA MADRE ORIENTAL TERRANE--Deformed upper Mesozoic sedimentary rocks of the Gulf of Mexico transgressive sequence and their diverse basement rocks which include, at different places, Precambrian crystalline rocks and structurally juxtaposed Paleozoic sedimentary rocks, Lower Jurassic sedimentary rocks structurally associated with Precambrian and Paleozoic rocks, and pre-Late Jurassic redbeds and volcanic rocks.

SOM SOMBRERETE TERRANE--Mid-Cretaceous calcareous flysch.

TO TOLIMAN TERRANE--Highly deformed, partly coarse-grained, Upper Jurassic(?) flysch containing exotic limestone blocks.

VZ VIZCAINO TERRANE--Triassic to Cretaceous oceanic, ophiolitic, and volcanic-arc rocks, in places structurally overlying Franciscan-like melange.

XO XOLAPA TERRANE--Migmatitic metamorphic complex yielding metamorphic ages of Jurassic to Cenozoic.

## NON-ACCRETIONARY CONTINENTAL ROCKS AND OCEANIC PLATES

NAm NORTH AMERICA--Continental North American rocks that have undergone no accretionary history during the Phanerozoic.

COC COCOS PLATE

PAC PACIFIC PLATE

--- Terrane bounding fault or boundary between oceanic plates--dashed where approximately located.

—— Post-accretion contact--includes depositional contacts and faults that are not terrane boundaries.

## DISCUSSION

This preliminary lithotectonic terrane map shows the distribution of major basement terranes in the Republic of Mexico. It is one of four such maps covering the North American Cordillera from Alaska through Mexico, prepared at 1:2,500,000 scale as a cooperative project of the U. S. Geological Survey, the Geological Survey of Canada, and Petroleos Mexicanos.

Each terrane depicted on this map is fault bounded and distinguished from its neighboring terranes, as well as from Phanerozoic North America, by a distinctive geologic record which may be expressed by its stratigraphy as well as by its igneous and metamorphic histories. The disparities between the various terranes, and between the terranes and the neighboring parts of the North American continent, are sufficiently great so that paleogeographic reconstruction of their original sites and their displacement paths through time are difficult if not impossible to determine. Some terranes embody only a very fragmentary rock record, but they are nonetheless individualized in that they cannot be readily joined to their neighbors. Further discusion of the definition and characterization of lithotectonic (="suspect" or "tectonostratigraphic") accreted terranes is provided by Coney and others (1980) and Jones and others (1983).

The line weight and style of contacts shown on the map incorporate significant departures from those conventionally used on geologic maps. Heavy lines on the terrane map show only those faults that are terrane boundaries. Faults that locally bound post Cenozoic accretionary volcanic and sedimentary rocks are not differentiated from the light-weight lines that depict the depositional contacts of these rocks.

Most of Mexico is covered at the surface by two major overlap assemblages: 1) Mesozoic continental and marine sedimentary rocks related to the Gulf of Mexico which cover most of eastern and southeastern Mexico; and 2) Cenozoic volcanic rocks, including the ignimbrite province of the Sierra Madre Occidental and the younger volcanics of the Trans-Mexican volcanic axis. Because the boundaries between basement terranes cannot be projected through the extensive post-accretion volcanic cover, these deposits (Cv) are shown on the map. The older overlap assemblage related to the Gulf of Mexico is not shown, nor are locally extensive deposits of Cenozoic alluvium.

The basement rocks of Mexico can be grouped into a three-fold zonation which subdivides the Republic into three major tectono-stratigraphic subdivisions:

1) A northern zone which is a direct continuation southward into Mexico of North American Precambrian basement and its Paleozoic and Mesozoic cover. Some of these rocks are autochthonous (NAm) whereas others (CAB) are interpreted to be composite displaced terranes.

2) An eastern zone, surrounding the Gulf of Mexico, of mainly upper Paleozoic rocks which though heterogeneous in character have a common origin as material accreted to North America during the late Paleozoic Appalachian-Quachita-Marathon orogeny. Also included is the poorly known Sierra Madre (SME) composite terrane.

3) A western and southern zone, making up Mexico's wider Pacific margin, which is characterized by an heterogeneous assemblage of mainly submarine volcanic and sedimentary rocks of Mesozoic age. Basement rocks are unknown. Also included are scattered smaller terranes that contain pre-Mesozoic rocks whose paleogeographic affinities to North America are unknown.

## DESCRIPTION OF TERRANES

### NORTH AMERICA

North America Precambrian basement and overlying cover rocks were included in the "Chihuahua terrane" by Campa and Coney (1983). Basement rocks crop out in only a few scattered localities in northern Sonora and have been penetrated in wells in the State of Chihuahua (unpublished well reports, Petroleos Mexicanos, Gerencia de Exploración; see also Lopez, 1979, fig. 4-8). The Precambrian basement is overlain depositionally by a shelfal assemblage of Paleozoic sandstone, shale, and limestone up to 3000 meters thick (Malpica and de la Torre, 1980). Faunally and lithologically these rocks are very similar to well known sequences in Arizona and New Mexico (Pierce, 1976). Toward the southeastern limit of known North American basement rocks, upper Paleozoic detrital sequences seem to reflect proximity to the southwestern extremity of the Appalachian-Quachita-Marathon orogenic belt (Bridges, 1964).

The southeastern boundary of North American basement in Mexico is an assumed deep-seated fault along the northwestern frontal zone of the accreted late Paleozoic Quachita-Marathon orogen. The southwestern boundary is a major structural discontinuity separating disparate Precambrian rocks and unlike sequences of Paleozoic and lower Mesozoic strata. This discontinuity has been termed the "Mohave-Sonora megashear" (Silver and Anderson, 1974; Anderson and Silver, 1979). This discontinuity is covered by latest Jurassic and younger strata that are part of the great transgressive sequence formed during opening of the Gulf of Mexico.

### Caborca terrane

The stratigraphic sequence for the Caborca terrane is based on isolated exposures in southwestern Sonora, where Precambrian basement rocks are overlain by a thick assemblage of upper Precambrian through Paleozoic miogeoclinal strata similar to those of southwestern Nevada and southern California (Damon and others, 1962; Anderson and Silver, 1979; Cooper and Arellano, 1946; Malpica and de la Torre, 1980; Weber and others, 1979; Anderson and others, 1979). Overlying the Paleozoic rocks are Upper Triassic marine and continental deposits of the Barranca Formation and Lower to Upper Jurassic clastic and volcaniclastic rocks (Anderson and Silver, 1979). The Caborca terrane is certainly composite because southeast of Hermosillo, Sonora, lower Paleozoic rocks of deep-marine affinity (Pfeiffer, 1979) occur in scattered exposures.

The close similarity of the pre-Upper Jurassic sequences of Caborca to those in southwestern Nevada and southern California and the marked contrast to coeval rocks in nearby Chihuahua has led to concept that the Caborca terrane is a displaced fragment of North American cratonal rocks that moved southeastward up to 800 km along the Mohave-Sonora megashear (Silver and Anderson, 1974; Anderson and Silver, 1979).

## EASTERN MEXICO

### Coahuila terrane

The Coahuila terrane, as presently known, consists of two parts: 1) a much deformed and generally mildly metamorphosed upper Paleozoic (mainly Permian) flysch and andesitic volcanic assemblage that is cut by scattered granodioritic plutons that yield late Paleozoic radiometric ages (Boese, 1921; Flawn and Diaz, 1959; Flawn and others, 1961; Denison and others, 1971); 2) the so-called "frontal zone" of the Quachita-Marathon orogen, which includes rocks of Cambrian through late Paleozoic age. These rocks are thrust northwestward over cratonic North America in the Quachita and Marathon Mountains and presumably also in Mexico. Unconformably above these two kinds of basement rocks are continental redbeds and evaporites of Late Triassic to Middle Jurassic age (Imlay, 1943; Humphry, 1956).

The upper Paleozoic flysch and volcanic rocks are here interpreted to be the "hinterland" or interior zone of the Appalachian-Quachita-Marathon orogenic belt and may represent magmatic arc and fore-arc assemblages accreted against North America during the late Paleozoic closure of the proto-Atlantic Ocean. The frontal zone may have been distal deep ocean-floor deposits that lay south of North America. The Mesozoic redbed and evaporite sequences are considered equivalent to similar facies found along the Atlantic and Gulf Coastal region to the north in the United States and are assumed to be related to early rifting which later led to the opening of the Gulf of Mexico. The southern boundary of the Coahuila terrane is the Torreón-Monterrey discontinuity.

### Maya terrane

Where exposed the composite Maya terrane is apparently more heterogeneous, but somewhat similar to, the Coahuila terrane, and may be a displaced part of the latter. Rocks of the Maya terrane include a large meta-plutonic complex, in part of Permo-Triassic age, exposed in Chiapas (Damon and others, 1981; Webber and Ojeda-Rivera, 1957) and highly deformed and metamorphosed Paleozoic flysch sequences (Hernandez, 1973). In southernmost Chiapas and neighboring Guatemala, Devonian through Permian sedimentary rocks as well as possibly older Paleozoic and Precambrian rocks of unknown affinity to North America (Clemons and others, 1974) are included in the terrane. Jurassic redbeds and volcanic rocks, and Middle Jurassic through Cretaceous transgressive marine strata cover the older rocks of the Maya terrane. The boundary between the Maya and Coahuila terranes is not known, but it is possibly the southeastern extension of the Torreón-Monterrey discontinuity where it enters the Gulf of Mexico somewhere between Matamoros and Vera Cruz.

### Sierra Madre terrane

The Sierra Madre terrane, named from the Sierra Madre Oriental, is composed mainly of folded and imbricately thrust-faulted upper Mesozoic limestone, shale, and sandstone of the Gulf of Mexico transgressive overlap sequence, deformed during the Late Cretaceous and early Tertiary Laramide orogeny (de Cserna, 1956; de Cserna and others, 1977; Tardy, 1980). In several anticlinoria, however, older basement rocks of the terrane are exposed (Carrillo, 1961, 1965; Ramirez, 1978; de Cserna and others, 1977). Near Cuidad Victoria the crytalline basement is a metamorphic complex of "Grenville" age (Fries and others,1962b). Structurally above the basement is a sedimentary sequence that ranges from Cambro-Ordovician (?) to Pennsylvanian, and which culminates in a flysch assemblage of Permian age (Carillo, 1961; Malpica and de la Torre, 1980). Farther south, near the Trans-Mexico volcanic axis, a Lower Jurassic sedimentary sequence with a fauna of "Pacific" aspect is exposed structurally above Paleozoic rocks of Mississppian and Permian ages which in turn lie above Precambrian rocks. How far and to what extent the Paleozoic and Precambrian rocks continue southward or underlie the remainder of the Sierra Madre terrane is unknown. At scattered localities between Torreón and Cuidad Victoria, along the northern margin of the terrane south of the Torreón-Monterrey discontinuity, red conglomerate, siltstone, sandstone, and silty shale is exposed below Upper Jurassic limestones of the Zuloaga Formation (Cordoba, 1963). The redbeds commonly contain abundant volcanic detritus, including rare volcanic flows. Evaporitic shale and siltstone intervene between the redbeds and the Zuloaga Formation. These rocks are usually slightly metamorphosed and may exhibit a faint cleavage. The ages of these rocks are poorly known; some may be Paleozoic, but others appear to be equivalent to the Lower and Middle Jurassic Nazas Formation (Pantoja-Alor, 1963) exposed west of Torreón. The Nazas Formation appears to be part of a Lower to Middle Jurassic volcanic arc known from southern Arizona and Sonora (Damon and others, 1981), where it lies depositionally on North American basement. If this correlation is correct, the Mexican rocks have been displaced far to the south of their equivalents to the north.

## WESTERN AND SOUTHERN MEXICO

### Vizcaino terrane

The composite Vizcaino terrane includes structurally complex assemblages of oceanic rocks found on the western coast of Baja California, particularly on the Vizcaino Peninsula (Minch and others, 1976; Rangin, 1976; 1978) and on Cedros Island. This terrane includes: Upper Triassic pillow basalt capped by a thick sequence of radiolarian-rich siliceous tuff, *Monotis*-bearing limestone, olistoliths of coralline limestone in sedimentary breccias, and fine-grained volcanogenic sandstone and shale of probable Jurassic age; Upper Jurassic pillow basalt overlain by upper Mesozoic flysch deposits; Middle Jurassic volcanic rocks, best displayed on Cedros Island; and large masses of ultramafic rock, generally strongly serpentinized. In addition to the above rocks that are not regionally metamorphosed, the terrane also includes strongly deformed "Franciscan"-like oceanic rocks metamorphosed in the blueschist facies. On Cedros Island, these blueschists lie structurally below ophiolitic rocks of Middle Jurassic age that form the basement of the overlying Jurassic volcanics and Jura-Cretaceous flysch.

## Magdalena terrane

This composite terrane is exposed on Magdalena Island, south of the Vizcaino Peninsula, and consists of a northern meta-ophiolite of presumed Mesozoic age and a southern oceanic island arc assemblage of Late Jurassic (Kimmeridgian?) age. These two subterranes are now separated by a high angle fault of probable Cenozoic age. The ophiolitic assemblage of the northern subterrane includes metamorphosed serpentinite, gabbro, basalt, and chert, all separated by thrust faults. Metamorphism is transitional between blueschist and greenschist facies. The southern subterrane is composed largely of plagioclase porphyry of probable andesitic composition with abundant tuff, breccia, turbiditic volcanogenic sandstone and siltstone, and intercalated mudflow deposits containing olistoliths of reefal limestone with abundant organic detritus. Fossils from these blocks consist of corals, echinoderms, bryozoans, and brachiopods of tropical aspect. Metamorphism within this subterrane is of prehnite-pumpellyite facies.

## Santa Ana terrane

The Santa Ana terrane consists mainly of a very thick Upper Jurassic to Lower Cretaceous (Aptian and Albian) sequence of andesitic volcanic and volcaniclastic rocks, partly of marine origin, that make up much of the western part of northern Baja California and neighboring southern California (Allison, 1955; Gastil and others, 1978). The Santa Ana terrane includes rocks as old as Early Jurassic that appear to be the basement on which the volcanic arc was constructed. Non-volcanogenic sedimentary rocks of Late Jurassic age (Bedford Canyon Formation) are well exposed in the northern part of the terrane where these strongly folded strata unconformably underlie arc-derived volcanic rocks. The Santa Ana terrane is widely intruded by Cretaceous plutonic rocks and is covered by a very Late Cretaceous shallow marine to non-marine overlap sequence.

## Cortes terrane

The poorly understood Cortes terrane lies between the Santa Ana and Caborca terranes in northwestern Mexico and southern California, and northeast of the Guerrero terrane in Sinaloa. The Cortes terrane is probably composite and contains rocks of Mesozoic and both early and late Paleozoic ages (Gastil and Miller, 1981; Malpica and de la Torre, 1980).

## Guerrero terrane

This vast terrane is best known in the Sierra Madre de Sur south of the Trans-Mexico Volcanic Axis. It is certainly composite and can be subdivided into at least three separate subterranes, the relations of which are still unclear. All three subterranes contain volcanic and sedimentary rocks that are mainly of late Mesozoic age (Late Jurassic to mid-Cretaceous), but Upper Triassic rocks are known from near Zacatecas (McGehee, 1976). The stratigraphy of each subterrane is different, as is the grade of metamorphism and the style of deformation. These three subterranes, the Teloloapån-Ixtapån, the Zihuatanejo, and the Huetamo, are described separately below.

The Teloloapån-Ixtapån subterrane (Campa and others, 1974) is a sequence of andesitic volcanic and volcanoclastic rocks interstratified with limestone, shale, and sandstone. These rocks are exposed along the easternmost edge of the Guerrero terrane in the State of Guerrero, and have yielded fossils of Late Jurassic and Early Cretaceous ages. Older basement rocks are unknown. The assemblage has been subjected to low-grade regional metamorphism and is severely deformed. Along the eastern margin in the State of Guerrero the subterrane is thrust eastward over shelf carbonates of Cretaceous age that are part of the Mixteca terrane (Campa, Ovieda, and Tardy, in press).

The Zihuatanejo subterrane is best exposed along the southern coast of Michoacán and in Colima. It is composed mainly of andesitic volcanic rocks interbedded with shale, sandstone, conglomerate, and marine limestone of Albian age. Redbeds containing dinosaur footprints are known locally. The volcanic sequences are more than 3000 meters thick, as evidenced by penetration during drilling of a recent Pemex well in the State of Colima. The rocks are deformed but not significantly metamorphosed (Campa, Ramirez, and others, in press).

The Huetamo subterrane is best known in Michoacán where a sequence of Upper Jurassic marine volcanoclastic sedimentary rocks is overlain by Neocomian flysch-like sandstone and shale. The flysch grades upward into Albian limestone interbedded with tuff and redbeds. The upper part of the sequence is entirely redbeds interstratified with ignimbritic volcanic rocks of probable Late Cretaceous age. Deformation within this subterrane consists of moderately tight upright folds; metamorphism is lacking. Basement rocks older than Late Jurassic marine sediments are unknown.

## Mixteca terrane

The Mixteca terrane is composite and consists of two different types of tectonically juxtaposed basement rocks separated by an intervening ultramafic body. These metamorphic rocks yield early Paleozoic radiometric ages (Ortega, 1978), and are overlain locally by deformed continental clastic rocks of Pennsylvanian age (Calderón-Garcia, 1956; Silva,1970), or by marine strata of Early to Middle Jurassic age. The latter are in turn overlain by Neocomian and younger shale and limestone and capped by flysch of Late Cretaceous age (Calderón-Garcia, 1956).

## Oaxaca terrane

The Oaxaca terrane consists of a granulite and anorthositic crystalline metamorphic basement overlain depositionally by latest Cambrian to Ordovician marine deposits and younger rocks of Carboniferous to Permian ages (Pantoja-Alor and Robinson, 1967). These are capped by redbeds and limestone of Early Cretaceous (Aptian and Albian) age. Basement rocks have been radiometrically dated as "Grenville" in age (Fries and others, 1962a; Ortega and others, 1977). The relationship between the Oaxaca and Mixteca terranes is not understood. It is possible that they constitute a composite terrane that amalgamated during late Paleozoic or early Mesozoic time.

## Juarez terrane

The poorly known Juarez terrane constitutes the most easterly upper Mesozoic submarine volcanic and sedimentary assemblage in Mexico. Thrust faulting in Sierra de Juarez has carried the terrane eastward over the Maya terrane and the Gulf Coastal plain, and it therefore lies east of, or inboard, of the Oaxaca terrane with its Precambrian basement rocks. Deformation within the Maya terrane is very severe and the stratigraphic sequence is strongly disrupted. A provisional stratigraphic succession consists of Upper Jurassic calcareous sandstone and shale, Neocomian thin-bedded cherty limestone, and pillowed andesitic volcanic rocks (Charleston, 1980; Carfantan, 1981). Utramafic rocks also occur, and along the western margin the base of the terrane appears to be a very thick east-dipping mylonitic gneiss of unknown age.

## Xolapa terrane

The Xolapa terrane forms a long narrow belt along the southern coast of the states of Oaxaca and Guerrero. It is defined by a complex suite of metamorphic and plutonic rocks associated with large tracts of migmatite. Radiometric ages derived from these rocks range from Jurassic to Tertiary (de Cserna, 1965; Guerrero and others, 1978; Campa, Oviedo and others, in press).

## Mini-terranes of Western and Southern Mexico

Several small terranes, including the La Paz, Parral, Sombrerete, Toliman, Arteaga, Papanoa, and Motozintla, are scattered throughout western and southern Mexico. These terranes are briefly characterized in the description of map units.

REFERENCES


Allison, E. C., 1955, Middle Cretaceous gastropods from Punta China, Baja California, Mexico: Journal of Paleontology, v. 29, no. 3, p.400-432.

Anderson, T. H., Eells, J. H., and Silver, L. T., 1979, Precambrian and Paleozoic rocks of the Caborca region, Sonora, Mexico: in Geological Society of America, 1979 Annual Meeting, Guidebook-Field Trip no. 27, p. 59-68.

Anderson, T. H., and Silver, L. T., 1979, The role of the Mohave-Sonora megashear in the tectonic evolution of northern Sonora: in Geological Society of America, 1979 Annual Meeting, Guidebook--Field Trip no. 27 p. 59-68.

Boese, E., 1921, On the Permian of Coahuila, northern Mexico: American Journal of Science, series 4, v. 1, p. 187-194.

Bridges, L. W., 1964, Stratigraphy of Mina Plumoses-Placer de Guadalupe area: West Texas Geological Society Guidebook, Pub. 64-50, p. 50-59.

Calderón-Garcia A., 1956, Bosquejo geológico de la Región de San Juan Raya, Pue: XX Congreso geológico internacional, México, Excursion A-11, p. 9-33.

Campa, M. F., Campos, M., Flores, R., and Oviedo, R., 1974, La secuencia mesozoica volcanica sedimentaria metamorfizada de Ixtapán de la Sal, Mex-Telolapán, Gro: Boletin de la Sociedad Geológica Mexicana, v. 35, p. 7-28.

Campa, M. F., and Coney, P. J., 1983, Tectono-stratigraphic terranes and mineral resource distributions in Mexico: Canadian Journal of Earth Sciences, v. 20, p. 1040-1051.

Campa, M. F., Oviedo, R. A., and Tardy, M., in press, La cabalgadura Laramidica del dominio volcanio Sedimentario (arco Alisitos Teloloapán) sobre el Miogeosinclinal Mexicano en los limites de los Estados de Guerrero y Mexico: III Congreso latino-americano de geologia, Memorias.

Campa, M. F., Ramirez, J. E., Flores, R. L., and Coney, P. J., (in press), Conjuntos estratotectonicos de la Sierra Madre del Sur: Boletin Sociedad geológica mexicana.

Carfantan, J. C., 1981, Paleogeography and tectonics of the Sierra de Juarez-Isthmus of Tehuantepec area and its relations with other terranes of southern Mexico and Central America: Geological Society of America, Abstracts with Programs, v. 13, p 48.

Carrillo, B. J., 1961, Geologia del anticlinorio Huizachal-Peregrina al N-W de Ciudad Victoria, Tamps: Boletin Asociación mexicana de geólogos petroleros, v. 13, 98 p.

Carrillo, B. J., 1965, Estudio geológico de una parte del anticlinorio de Huayacocotla: Boletin Asociación mexicana de geologos petroleros, v. 17, p. 23.

Charleston, S., 1980, Stratigraphy and tectonics of the Rio Santo Domingo area, State of Oaxaca, Mexico: 26th Congreso geológico internacional, Resumenes y Programa, p. 99.

Clemons, R. E., Anderson, T. H., Bohnenberger, O. H., and Burkart, B., 1974, Stratigraphic nomenclature of recognized Paleozoic and Mesozoic rocks of western Guatemala: American Association of Petroleum Geologists Bulletin, v. 58, p. 313-320.

Coney, P. J., Jones, D. L., and Monger, J. W. H., 1980, Cordilleran suspect terranes: Nature, v. 288, p. 329-333.

Cooper, G. A., and Arellano, A. R. V., 1946, Stratigraphy near Caborca, northwest Sonora, Mexico: American Association of Petroleum Geologists Bulletin, v. 30, p. 606-611.

Cordoba, D. A., 1963, Estudios geológicos en los Estados de Durango y San Luis Potosí (Parte 1): Universidad nacional autónoma de México, instituto de geología, Boletín, 71. p. 1-23.

de Cserna, Z., 1956, Tectónica de la Sierra Madre oriental de México entre Torreón y Monterrey: XX Congreso geológico internacional, México, p. 1-87.

de Cserna, Z., 1965, Reconocimiento geológico en la Sierra Madre del Sur de México, entre Chilpancingo y Acapulco, Estado de Guerrero. Universidad nacional autónoma de México, Instituto de Geología, Boletín 62, 76 p.

de Cserna, Z., Graf, J. L., and Ortega, F. G., 1977, Alóctono del Paleozoico inferior en la región de Ciudad Victoria, Tamaulipas: Universidad nacional autónoma de México, Instituto de Geología UNAM, Revista v. 1, p. 33-43.

Damon, P. E., Livingston, D. E., Mauger, R. L., Giletti, B. J., and Pantoja-Alor, A. J., 1962, Edad del Precámbrico "anterior" y de otras rocas del zócalo de la región de Caborca-Altar de la parte noroccidental del Estado de Sonora. Universidad nacional autónoma de México, Instituto de geología, Boletín 64, p. 11-44.

Damon, P. E., Shafiqullah, M., and Clark, K. F., 1981, Age trends of igneous activity in relation to metalogenesis in the southern Cordillera: Arizona Geological Society Digest, v. 14, p. 137-154.

Denison, R. E., Burke, W. N., Hetherington, E. A., and Otto, J. B., 1971, Basement rock framework of parts of Texas, southern New Mexico and northern Mexico, in Seewald, K., and Sundeen, D., eds., The geologic framework of the Chihuahua tectonic belt: West Texas Geological Society, Midland, Texas, p.3-14.

Drummond, K. J., chm., 1981, Plate-tectonic map of the Circum-Pacific region-northeast quadrant: American Association of Petroleum Geologists, scale 1:10,000,000.

Flawn, P. T., and Dias, T., 1959. Problems of Paleozoic tectonics in north-central and northeastern Mexico. American Association of Petroleum Geologists Bull., v. 43, p. 224-230.

Fries, C., Jr., Schmitter, V. E., Damon, P. E., and Livingston, D. E., 1962a. Rocas Precámbricas de edad grenvilliana de la parte central de Oaxaca, en el sur de México. Universidad nacional autónoma de México, Instituto de geología, Boletín, 64, p. 45-53.

Fries, C., Jr., Schmitter, V. E., Damon, P. E., Livingston, D. E., and Erickson, R., 1962b. Edad de las rocas metamorficas on los cañones de la Peregrina y de Caballeros, parte centro-occidental de Tamaulipas. Universidad nacional autónoma de México, Instituto de geología, Boletín, 64, p. 55-69.

Gastil, Gordon, and Miller, R. H., 1981, Lower Paleozoic strata on the Pacific plate of North America. Nature, v. 292, p. 828-830.

Gastil, Gordon, Morgan, G. J., and Krummenacher, D., 1978, Mesozoic history of peninsular California and related areas east of the Gulf of California, in Howell, D. G., and McDougall, K. A., eds., Mesozoic paleogeography of the western United States: Society of Economic Paleontologists and Mineralogists, Pacific Section, Pacific Coast Paleogeography Symposium 2, p. 107-116.

Guerrero, J., Silver, L. T., and Anderson, T. H., 1978, Estudios geocronológicos en el Camplejo Xolapa: IV Convención geológica nacional, México, Resumenes.

Hernandez, G. R., 1973, Paleogeografia del Paleozoico de Chiapas, México: Boletín de la Asociacion mexicana de geólogos petroleros, v. 25, p. 77-134.

Humphrey, W. E., 1956, Tectonic framework of northeastern Mexico: Transactions of the Gulf-Coast Association of Geological Societies, v. 6, p. 25-35.

Imlay, R. W., 1943, Upper Jurassic ammonites from the Placer de Guadelupa district, Chihuahua, Mexico: Journal of Paleontology, v. 17, p. 517-654.

Jones, D. L., Howell, D. G., Coney, P. J., and Monger, J. W. H., 1983, Recognition, character, and analysis of tectonstratigraphic terranes in western North America: in Hashimoto, M., and Uyeda, S., eds., Accretion tectonics in the Circum-Pacific regions: Terra Scientific Publishing Co., Tokyo, p. 21-35.

Lopez, R. E., 1979, Geologia de México: Ediciones, México, p.

Malpica, C. R., and de la Torre, L.G., 1980, La integración estratigráfica del Paleozoico de México, partes I, II, y III y anexos: Instituto mexicano del petroleo, Subdirection de technologia y exploración, Proyecto C-1079 (Inedito).

McGehee, R. V., 1976, Las rocas metamorficas del arroyo de la Pimita, Zacatecas, Zac.: Boletin de la Sociedad geológica mexicana, v. 37, p. 1-10.

Minch, J. C., Gastil, R. G., Fink, W., Robinson, J., and James, A. H., 1976, Geology of the Vizcaino Penisula, in Aspects of the geologic history of the California continental borderland: Society of Economic Paleontologists and Mineralogists, Pacific Section, Miscellaneous Publication 24, p. 136-195.

Ortega, G. F., 1978, Estratigrafia del Complejo Acatlán en la Mixteca Baja, Estados de Puebla y Oaxaca: Universidad nacional autónoma de México, Revista del Instituto de geologia, v. 2, p. 112-131.

Ortega, G. F., Anderson, T. H., and Silver, L. T., 1977, Lithologies and geochronology of the Precambrian craton of southern Mexico: Geological Society of America, Abstracts with Programs, v. 9, p. 1121-1122.

Pantoja-Alor, J., 1963, Resumen de la geologia de la Hoja San Pedro del Gallo, Estado de Durango: Universidad nacional autónoma de México, Instituto de geologia.

Pantoja-Alor, J., and Robinson, R. A., 1967, Paleozoic sedimentary rocks in Oaxaca, Mexico: Science, v. 157, p. 1033-1035.

Peiffer, R. F., 1979, Les zones isotopiques du Paleozoique inferieur du nord-ouest mexicain, temoins du relais entre les Appalaches et la Cordillera ouest americaine: Comptes rendus hebdomadaires des seances de l' Academie des sciences, Serie D: Sciences naturelles, v. 288, p. 1517-1519.

Pierce, H. W., 1976, Elements of Paleozoic tectonics in Arizona: Arizona Geological Society Digest, v. 10, p. 37-58.

Ramirez, R. C., 1978, Reinterpretación tectónica del Esquisto Granjeno de Ciudad Victoria, Tamps: Universidad nacional autónoma de México, Revista del Instituto de geologia, v. 2(1), p. 31-36.

Rangin, Claude, 1976, Le complexe ophiolitique de basse Californie: une paléocroûte océanique écaillée (péninsule de Vizcaino, Baja California, Mexique): Bulletin de la Société Géologique de France, v. 18, p. 1677-1685.

---------------, 1978, Sur un complexe volcanique andesitique du Jurassique supérieur et ses rapports avec des complexes ophiolitiques sur la marge continentale de basse Californie (Mexique): Comptes rendus hebdomadaires des seances de l'Academie des sciénces, Serie D, Sciénce naturelles, v. 286, p. 1049-1052.

Silva, P. A., 1970, Plantas del Pensilvánico de la región de Tehuacán, Puebla: Universidad nacional autónoma de México, Instituto de geología y paleontología Mexicana, no. 29, 109 p.

Silver, L. T., and Anderson, T. H., 1974, Possible left-lateral early to middle Mesozoic disruption of the southwestern North American craton margin: Geological Society of America, Abstracts with Programs, v. 6, p. 955-956.

Tardy, Marc, 1980, Contribution a l'etude geologique de la Sierra Madre oriental du Mexique: These du doctorat d'etat, Univesite de Paris, 445 p.

Webber, B. N., and Ojeda Rivera, J., 1957, Investigación sobre lateritas fósiles en las regiones sureste de Oaxaca y sur de Chiapas: Instituto nacional de recursos minerales, Boletín 37, p. 1-67.

Weber, R., Cevallos, F. S., Lopez, C. A., Olre, F. A., and Singer, S. S., 1979, Los estromatolitos del Precámbrico tárdio de la alrededores de Caborca, Estado de Sonora: Universidad nacional autónoma de México, Revista del Insituto de geología, v. 3, p. 9-23.