U.S. DEPARTMENT OF THE INTERIOR
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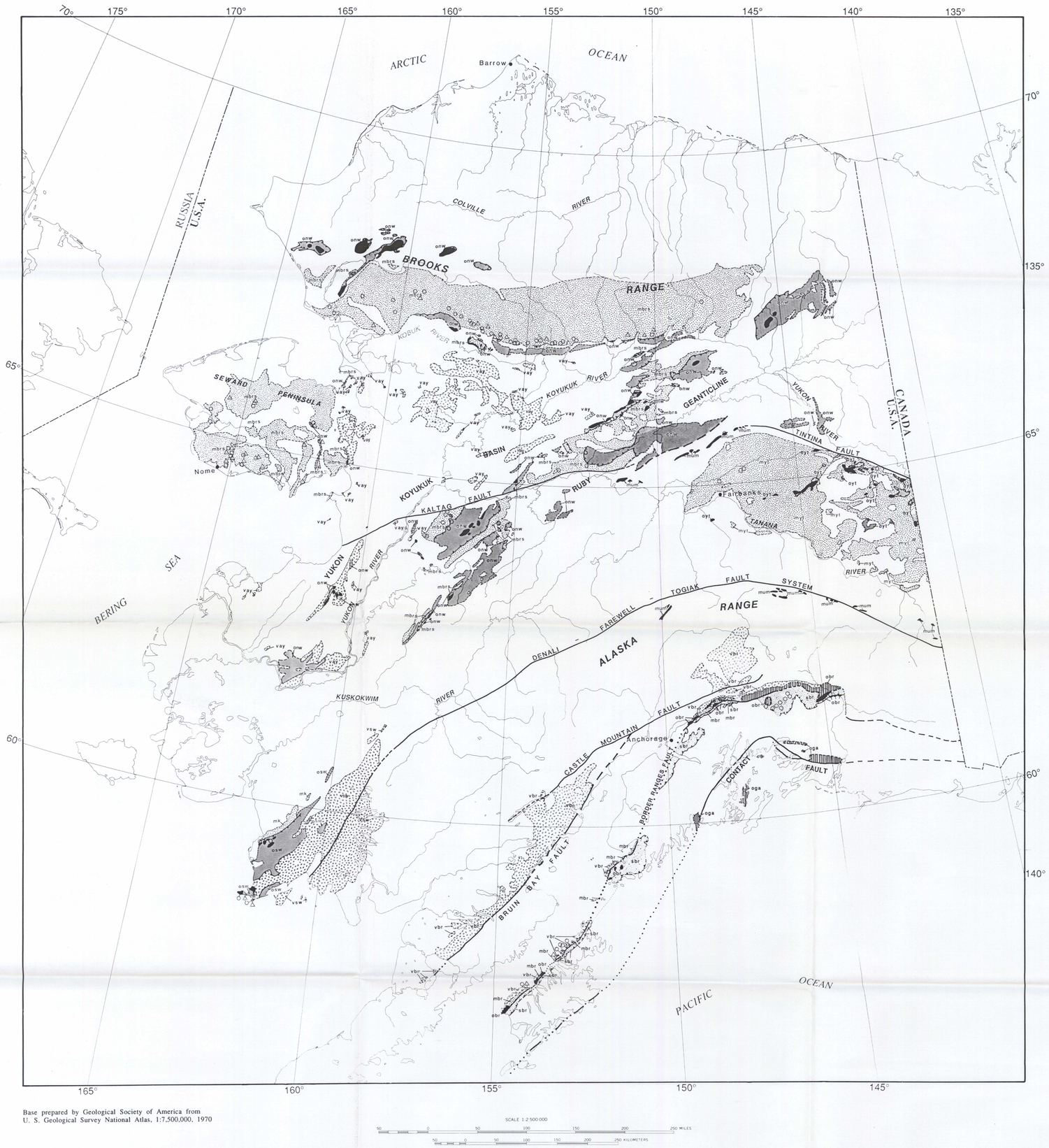

Base prepared by Geological Society of America from
U. S. Geological Survey National Atlas, 1:7,500,000, 1970

SCALE 1:2,500,000

50 0 50 100 150 200 250 MILES
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NORTHERN AND WESTERN ALASKA

onw

TERRANE CONTAINING OPHIOLITIC COMPLEXES OF NORTHERN AND WESTERN ALASKA

Late Jurassic to Devonian oceanic rocks of the Angayucham, Tozitna, and Innoko lithotectonic terranes of Jones and others (1987).
Black pattern represents allochthonous alpine-type mafic-ultramafic complexes composed of a lower mantle suite of serpentinized harzburgite and dunite and an upper plutonic suite of layered ultramafic rocks and layered and nonlayered gabbro. K-Ar and Ar-Ar ages range mostly from Late to Middle Jurassic
Gray pattern represents an imbricate oceanic assemblage of pillow basalt, radiolarian chert, gabbro, argillite, and graywacke. Prehnite-pumpellyite metamorphic facies. Presence of glaucophane near base indicates local high-pressure metamorphism. Fossil ages range from Early Jurassic to Devonian

vay

VOLCANIC ARC TERRANE OF YUKON-KOYUKUK BASIN

Early Cretaceous to Middle Jurassic andesitic volcanic and volcaniclastic rocks of the Koyukuk lithotectonic terrane of Jones and others (1987). Subordinate tonalitic and trondhjemitic plutonic rocks. Interpreted to represent an intraoceanic volcanic arc that was active during emplacement of the ophiolitic terrane on the continental terranes that border the Yukon-Koyukuk basin (Patton and Box, 1989). Geologic relationships suggest that the mafic-ultramafic complexes of the spatially associated ophiolitic terrane (onw) formed in this volcanic arc setting (Patton, 1991)

mbrs

METAMORPHIC TERRANES OF SOUTHERN BROOKS RANGE, RUBY GEANTICLINE, AND SEWARD PENINSULA

Chiefly early Paleozoic and Proterozoic continental and continental-margin deposits belonging to the Arctic Alaska, Seward, and Ruby terranes of Jones and others (1987) and Idono Complex of Miller and others (1991). Overprinted in Cretaceous and Jurassic by transitional blueschist-greenschist and amphibolite metamorphic facies. These areas of metamorphic rocks believed to represent parts of the continental terranes bordering the Yukon-Koyukuk basin that were subducted during emplacement of the ophiolitic terranes (Patton and Box, 1989)

EAST-CENTRAL ALASKA

pyt

TERRANE CONTAINING OPHIOLITIC COMPLEXES IN THE YUKON-TANANA UPLANDS

Oceanic rocks of probable Triassic and Late Permian age belonging to the Seventymile lithotectonic terrane of Jones and others (1987)
Black pattern represents allochthonous alpine-type mafic-ultramafic complexes composed of serpentinized harzburgite and dunite, sparse layered gabbro, and coarse nonlayered gabbro. Age is uncertain
Gray pattern represents oceanic assemblages of pillow basalt, basaltic tuffs, radiolarian chert, argillite, graywacke, conglomerate, and limestone. Prehnite-pumpellyite metamorphic facies. Fossils of Late Triassic, Early Permian, and Mississippian ages

myt

METAMORPHIC TERRANE OF YUKON-TANANA UPLANDS

Chiefly Paleozoic and Proterozoic(?) continental sedimentary and arc volcanic rocks of the Yukon-Tanana terrane of Jones and others (1987). Small area in the east-central part of Yukon-Tanana Uplands includes Early Jurassic to Late Triassic granitic intrusives and associated metasedimentary wallrocks of the Sixkiniа lithotectonic terrane. Metamorphosed to transitional blueschist-greenschist and to amphibolite facies in Early Cretaceous, except in the east-central part of the Uplands where the regional metamorphism appears to have occurred in Early Jurassic to Late Triassic time. Relationship of regional metamorphism to emplacement of allochthonous ophiolitic terrane is unclear

mum

MAFIC AND ULTRAMAFIC COMPLEXES OF UNCERTAIN BUT POSSIBLE OPHIOLITIC AFFINITIES

Include small mafic and ultramafic bodies along Denali-Farewell-Togiak fault system in eastern and central Alaska Range and in the area between Fairbanks and Yukon River. Ages and structural setting of bodies poorly known

Contact
Approximate, concealed, or inferred contact

Fault
Dashed where approximately located or inferred, dotted where concealed

Thrust fault
Dashed where approximately located or inferred, dotted where concealed. Barbs on upper plate

Glaucophane occurrence

Lawsonite (or pseudomorph after lawsonite) occurrence

Eclogite occurrence

SOUTHWESTERN ALASKA

osw

TERRANE CONTAINING OPHIOLITIC COMPLEXES OF SOUTHWESTERN ALASKA

Early Cretaceous to Early Carboniferous or Late Devonian oceanic rocks assigned by Jones and others (1987) to the Goodnews and Togiak lithotectonic terranes
Black pattern represents allochthonous alpine-type mafic-ultramafic complexes composed of nonlayered gabbro and lesser amounts of harzburgite and dunite. Uncertain but probable early Mesozoic age
Gray pattern represents imbricate oceanic assemblage of pillow basalt, radiolarian chert, gabbro, argillite, graywacke, and carbonate rocks. Prehnite-pumpellyite and locally transitional blueschist-greenschist metamorphic facies. Fossil ages range from Early Cretaceous to Early Carboniferous or Late Devonian

vsw

VOLCANIC ARC TERRANE OF SOUTHWESTERN ALASKA

Early Cretaceous to Late Triassic andesitic volcanic and volcaniclastic rocks assigned by Jones and others (1987) to the Togiak lithotectonic terrane. Gabbro and granodiorite of Middle Jurassic age. Prehnite-pumpellyite metamorphic facies. Mafic-ultramafic complexes of spatially associated ophiolitic terrane (osw) interpreted by Box (1985) to have formed in this volcanic arc setting

mk

METAMORPHIC TERRANE OF SOUTHWESTERN ALASKA

Early Proterozoic metamorphic assemblage assigned by Jones and others (1987) to the Kilbuck lithotectonic terrane. Composed of metasedimentary, metavolcanic, and metaplutonic rocks of probable cratonal affinities. An Early Cretaceous greenschist facies regional metamorphism, which overprints an older (Proterozoic ?) regional metamorphism, is interpreted by Box (1985) to be related to underthrusting of this cratonal terrane beneath the Goodnews and Togiak oceanic and volcanic arc terranes that lie to the southeast

SOUTH-CENTRAL ALASKA

ophiolitic north

OPHIOLITIC COMPLEXES OF BORDER RANGES FAULT ZONE

Ophiolite complexes of probable mid to early Mesozoic age. Included in the Chugach lithotectonic terrane by Jones and others (1987), but considered to belong in the Peninsular terrane by Burns (1985)
Black pattern represents ultramafic rocks including dunite, wehrlite, clinopyroxenite, and lesser amounts of harzburgite and websterite
Gray-black pattern represents gabbro complexes including gabbronorite, leucogabbronorite, ferrogabbronorite and lesser amounts of hornblende gabbro. K-Ar ages range from Middle to Early Jurassic. Intruded by quartz diorite and tonalite of Middle to Early Jurassic age

vbr

VOLCANIC ARC TERRANE OF BORDER RANGES FAULT ZONE

Early Jurassic and Late Triassic andesitic flows and volcaniclastic rocks. Minor basalt. Plutons of quartz diorite, tonalite, and granodiorite of Middle to Early Jurassic age. Included in the Peninsular lithotectonic terrane by Jones and others (1987). Border Ranges ophiolite complexes interpreted to form the base and cumulate counterpart to the volcanic arc of the Border Ranges fault zone (Burns, 1985)

mbr

METAMORPHIC COMPLEXES OF BORDER RANGES FAULT ZONE

Amphibolite, lesser greenschist and quartz-mica schist, and minor marble. Permian protolith age determined in one location (Clark, 1972). Yields Early and Middle Jurassic metamorphic mineral K-Ar ages and Early Jurassic U-Pb ages. Transitional blueschist-greenschist and amphibolite metamorphic facies. Included in the Peninsular lithotectonic terrane by Jones and others (1987). Has a close spatial relationship with Border Range ophiolite complexes, but the tectonic relationship of the two units is uncertain

abr

SUBDUCTION COMPLEX OF BORDER RANGES FAULT ZONE

Melange consisting of blocks of greenstone, chert, graywacke, marble, and schist in an argillaceous matrix and more coherent layered sections of graywacke, siltstone, and conglomerate. Fossil ages from chert and marble range from Late Cretaceous to Late Triassic. Prehnite-pumpellyite to transitional blueschist-greenschist regional metamorphism. Melange appears to have formed in Late Cretaceous during northward-directed underthrusting of the accretionary flysch prism of the Chugach terrane beneath the Border Ranges ophiolite complexes

OPHIOLITE COMPLEXES OF THE GULF OF ALASKA

Middle Eocene to Late Cretaceous ophiolite complexes composed chiefly of pillow basalt and sheeted dikes and containing lesser amounts of layered gabbro, serpentinized peridotite, and plagiogranite. Prehnite-pumpellyite to lower greenschist metamorphic facies. Included in Chugach and Prince William terranes of Jones and others (1987)

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INTRODUCTION

This map is the first in a series of open-file reports that present the results of a comprehensive study of the ophiolitic terranes of Alaska and conjugous parts of northeast Russia. Subsequent reports in this series will provide details on the lithology, mineral deposits, thickness, age, geochemistry, and geologic setting of these ophiolitic terranes.

The study of the ophiolitic terranes of Alaska and northeast Russia was carried out between 1989 and 1991 by the U. S. Geological Survey, the Alaska Division of Geological and Geophysical Surveys, and the Far East Branch of the Academy of Sciences of the USSR. This series of reports also includes the results of a study of the mineral deposits associated with the ophiolitic and other mafic-ultramafic terranes of Alaska carried out by the U. S. Bureau of Mines between 1981 and 1991.

Ophiolites are assemblages of mafic and ultramafic rocks that are found in orogenic belts throughout the world and often have been referred to as alpine-type mafic-ultramafic complexes. Since the recognition of plate tectonics 25 years ago, these assemblages have been of special interest because they commonly mark the boundaries of fossil lithospheric plates and provide insight into the mechanisms and timing of plate accretion and subduction. The ophiolitic terranes of Alaska are especially critical to the study of global plate tectonics because they lie at the juncture of North America and Eurasia thereby offering an unique opportunity to learn about the relative motions between these two great continental plates. They are also important to our understanding of the tectonics of Alaska and northeast Russia and its accretionary history because it is now widely accepted that this region is a collage of differing lithotectonic terranes that were accreted to the North American and Eurasian continents in Mesozoic and Cenozoic time (Coney and others, 1980; Zonenshain and others, 1990).

In addition to their significance in global plate tectonics, ophiolites provide an important worldwide source of chromite, nickel, copper, manganese, asbestos, talc, and other commodities.

On this map the ophiolitic terranes are highlighted in black and dark gray patterns. Also shown, in less bold patterns, are spatially associated metamorphic and volcanic arc terranes that may provide insight into the formation or tectonic emplacement of the ophiolites. Occurrences of blueschist facies mineral assemblages, which many workers believe are formed at convergent plate margins, are shown by symbols (circles, triangles, and squares). We have not included the Aleutian Islands on this map because no complexes of ophiolitic affinities are reported in this part of Alaska.

DEFINITION OF TERMS

The term *ophiolite*, as used in this report and in subsequent reports in this series, follows the definitions of Steinmann (1927) and the Geological Society of America Penrose Conference on ophiolites (Penrose Field Conference, 1972). It refers to an association of mafic and ultramafic rocks that in a complete sequence is characterized, from bottom to top, by tectonized ultramafic rock; a transitional zone of interlayered ultramafic and mafic cumulates, layered gabbro, massive gabbro, a mafic sheeted dike complex, and pillow basalt. Most workers now regard ophiolite assemblages as allochthonous fragments of oceanic crust and upper mantle that formed along mid-ocean ridges, in small marginal basins, or as basement to island arcs. None of the ophiolite sequences in Alaska is completely preserved; typically they are highly faulted and one or more of the characteristic components are missing. However, all of the ophiolite sequences shown on our map appear to be allochthonous with respect to the rocks that adjoin them. In the area between the Yukon River and Fairbanks, and also along the Denali-Togiak-Farewell fault system, a number of small mafic-ultramafic complexes are labelled as possible ophiolite complexes, but are of uncertain affinities owing to poor exposure or lack of critical field data.

Ophiolitic terranes are defined by us as fault-bounded belts of oceanic rocks that contain ophiolite complexes. North of the Denali-Togiak-Farewell fault system the boundaries of the ophiolitic terranes more or less coincide with the boundaries of the lithotectonic terranes defined by Jones and others (1987). In northern and western Alaska the ophiolitic terranes have been assigned by Jones and others to the Angayucham, Tozitna, and Innoko terranes, in east-central Alaska to the Seventymile terrane, and in southwest Alaska to the Goodnews terrane. South of the Denali-Togiak-Farewell fault system the ophiolitic complexes are mapped by Jones and others as parts of the Chugach and Prince William accretionary flysch terranes not as separate terranes. In this part of Alaska we limit the boundaries of the ophiolitic terrane to the ophiolite complexes themselves.

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GEOLOGIC MAP OF OPHIOLITIC AND ASSOCIATED VOLCANIC ARC AND METAMORPHIC TERRANES OF ALASKA (WEST OF THE 141st MERIDIAN)

by

W. W. Patton, Jr., J. M. Murphy, L. E. Burns, S. W. Nelson, and S. E. Box

1992