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

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

NORTHERN AND WESTERN ALASKA

**TERRANE CONTAINING OPHIOLITIC COMPLEXES OF NORTHERN AND WESTERN ALASKA**  
Late Jurassic to Devonian oceanic rocks of the Angayuchuk, Tuvotua, and Inuvik lithotectonic terranes of Jones and others (1987).  
**Black pattern** represents allochthonous alpine-type mafic-ultramafic complexes composed of a lower mantle suite of serpentized harzburgite and dunite and an upper plagioclase suite of layered ultramafic rocks and layered and resolidated gabbro. **K-Ar and Ar-Ar** ages range mostly from Late to Middle Jurassic.  
**Gray pattern** represents an intracrustal oceanic assemblage of pillow basalt, radiolarian chert, gabbro, argillite, and graywacke. Pelitic-pumpellyite metamorphic facies. Presence of glaucofane near base indicates local high-pressure metamorphism. Fossil ages range from Early Jurassic to Devonian.

**Volcanic Arc Terrane of Yukon-Tanana Uplands**  
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 intracrustal volcanic arc that was active during emplacement of the ophiolite 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 ophiolite terrane (onw) formed in this volcanic arc setting (Patton, 1991).

**Metamorphic Terranes of the Brooks Range, Ruby Mountains, 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 the Complex of Miller and others (1991). Overprinted in Cretaceous and Jurassic by transverse blueschist-green schist 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 ophiolite terranes (Patton and Box, 1989).

**Terrane Containing Ophiolitic Complexes in the Yukon-Tanana Uplands**  
Oceanic rocks of probable Triassic and Late Permian age belonging to the Severnville lithotectonic terrane of Jones and others (1987). Small area in the east-central part of Yukon-Tanana Uplands includes Early Jurassic to Late Triassic gabbro intrusions and associated metamorphic wallrocks of the Sitikina lithotectonic terrane. Metamorphism to transition blueschist-green schist 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 ophiolite terrane is unclear.

**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.

**Metamorphic Terrane of Yukon-Tanana Uplands**  
Chiefly Paleozoic and Proterozoic continental sedimentary and 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 gabbro intrusions and associated metamorphic wallrocks of the Sitikina lithotectonic terrane. Metamorphism to transition blueschist-green schist 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 ophiolite terrane is unclear.

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SOUTHWESTERN ALASKA

**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 serpentized harzburgite 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 carbonaceous rocks. Pelitic-pumpellyite and locally transitional blueschist-green schist metamorphic facies. Fossil ages range from Early Cretaceous to Early Carboniferous or Late Devonian.

**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. Pelitic-pumpellyite metamorphic facies. Mafic-ultramafic complexes of spatially associated ophiolite terrane (onw) interpreted by Box (1985) to have formed in this volcanic arc setting.

**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 metagabbroic rocks of probable continental 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 crustal terrane beneath the Goodnews and Togiak oceanic and volcanic arc terranes that lie to the southeast.

**South-Central Alaska**  
**Ophiolite 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 to the Peninsular terrane by Burns (1985).  
**Black pattern** represents ultramafic rocks including dunite, websterite, clinopyroxenite, and lesser amounts of harzburgite and websterite.  
**Gray pattern** represents gabbro complexes including gabbro, harzburgite, clinopyroxenite, ferrogabbro, 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.

**Volcanic Arc Terrane of Border Ranges Fault Zone**  
Early Jurassic and Late Triassic andesitic volcanic and volcaniclastic rocks. Minor basalt. Plutons of quartz diorite, tonalite, and granodiorite of Middle to Early Jurassic age. 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).

**Metamorphic Complexes of Border Ranges Fault Zone**  
Amphibolite, lower greenschist and quartzite 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 (1-P) ages. Transitional blueschist-green schist 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.

**Subduction Complex of Border Ranges Fault Zone**  
Melange consisting of blocks of gneiss, chert, graywacke, marble, and schist in an argillaceous matrix and more coherent sections of graywacke, schist, and conglomerate. Fossil ages from chert and marble range from Late Cretaceous to Late Triassic. Pelitic-pumpellyite to transition blueschist-green schist 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 dike and containing lesser amounts of layered gabbro, serpentized peridotite, and plagiogranite. Pelitic-pumpellyite to lower greenschist metamorphic facies. Included in Chugach and Prince William terranes of Jones and others (1987).

**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 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 a basement to island arc. Note 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 completely preserved. 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 labeled as possible ophiolite complexes, but are of uncertain affinity owing to poor exposure or lack of critical field data.

**Introduction**  
This map is the first in a series of open-file reports that present the results of a comprehensive study of the ophiolite terranes of Alaska and contiguous 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 ophiolite terranes.  
The study of the ophiolite 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 ophiolite 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 ophiolite 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 (Conry and others, 1980; Zosenko and others, 1990).  
In addition to their significance in global plate tectonics, ophiolites provide an important worldwide source of chromium, nickel, copper, manganese, asbestos, talc, and other commodities.  
On this map the ophiolite 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 these Alaskan islands on this map because no complexes of ophiolite affinities are reported in this part of Alaska.

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**Worldwide source of chromium, nickel, copper, manganese, asbestos, talc, and other commodities.**  
On this map the ophiolite 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 these Alaskan islands on this map because no complexes of ophiolite affinities are reported in this part of Alaska.

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**References**  
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