DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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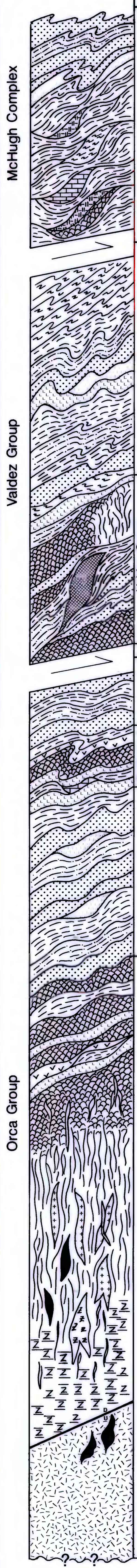
OPHIOLITIC COMPLEXES OF THE GULF OF ALASKA

by Steven W. Nelson



A LITHOLOGY	B THICKNESS	C AGE	D MINERAL DEPOSITS ASSOCIATED WITH OPHIOLITIC TERRANES
Disrupted and metamorphosed broken formation (melange) consisting of blocks (up to several kilometers in size) of chert, pillow basalt, marble, and schist in an argillaceous matrix, and a more coherent clastic section of graywacke, siltstone, and conglomerate. Prehnite-pumpellyite to greenschist-grade metamorphism. Structurally overlain by Border Ranges ultramafic and mafic complex locally. Clark, 1973; Connelly, 1978; Cowan and Boss, 1978; Burns, 1985.	Structural thickness up to 20km	Mesozoic Argillaceous matrix and chert blocks--Late Triassic (Carnian) to Late Cretaceous (Cenomanian) radiolarian ages. Marble blocks-Late Mississippian conodonts and Late Pennsylvanian fusulinids. K-Ar age of granitic clast from conglomerate of 150 Ma, and 161 Ma to 192 Ma ages from metamorphic rocks. Accretionary age early Late Cretaceous. Karl and others, 1979; Nelson and others, 1986, 1987; Winkler and others, 1981; Plafker and others, 1989.	No deposits known
Predominantly interbedded sandstone, siltstone, and minor mudstone and conglomerate. This sequence of flysch consists of fan, slope, and basin-plain deposits and has a dominantly magmatic-arc provenance. Mafic volcanic rocks, consist of massive greenstone, pillow basalt, gabbro, tuffaceous units, minor sheeted dikes. Rare serpentinized dunite and peridotite. The entire sequence is extensively folded and faulted. Metamorphosed to grades ranging from zeolite to lower greenschist facies commonly and to amphibolite facies locally. Schrader, 1900; Budnik, 1974; Plafker and others, 1977; Zuffa and others, 1980; Nilsen and Zuffa, 1982; Dumoulin, 1987.	2 to 5km	Late Cretaceous Campanian (?) and Maestrichtian pelecypods. Jones and Clark, 1973; Tysdal and Plafker, 1978.	Au-Gold-bearing quartz veins in flysch with associated placers. Cu-Massive sulfide deposit associated with mafic volcanic rocks. One major mine. Jansons and others, 1984; Nelson and others, 1984.
Complexly deformed flysch and mafic igneous rocks. Sedimentary sequence composed of sandstone, siltstone, mudstone, and conglomerate with structures indicative of deposition by turbidity currents. Facies study indicates deposition in inner and middle parts of a complex system of submarine fans. Source area of sediments was plutonic-metamorphic roots of eroded arc. Mafic igneous rocks divided into Ophiolite sequence and an Outboard (non-ophiolite) sequence. Metamorphic grade ranges from laumontite to upper greenschist facies and local areas of hornblende hornfels. Grant and Higgins, 1910; Winkler, 1976; Winkler and Plafker, 1981; Nelson and others, 1985; Goldfarb and others, 1986; Dumoulin, 1987; Nelson, unpub.	2-3km	Paleocene to middle Eocene Age based on microfossil and megafossil assemblages and intrusion by 53-50 Ma granitic plutons. Plafker and Lanphere, 1974; Plafker and others, 1985; Nelson and others, 1985.	Cu, Au, and Ag-Produced in Prince William Sound area from volcanogenic massive sulfide deposits hosted in turbidites associated with ophiolite.
Pillow Basalt--Includes hyaloclastite, massive basalt flows, breccia, and minor interbedded turbidite. Tholeiitic to basaltic andesite, porphyritic, vesicular, and amygdaloidal. Metamorphosed to prehnite-pumpellyite facies.	1-5km (6-10km)	K-Ar whole rock dates Glacier Is. -42.5 ±6.9 Ma Ellamar -44.7 ±5.0 Ma Miller, 1984.	Knight Island -43 mines and prospects developed for copper. Resurrection Peninsula-8 prospects; known occurrences of Cu, Pb, Zn. Jansons and others, 1984; Nelson and others, 1984.
Sheeted Dike--Pyroxene gabbro to rare hornblende diorite; aphanitic to porphyritic and diabasic textures. Width of dikes varies from 10cm-2m, most vertical, although low angle cross cutting dikes locally present. Includes peridotite xenoliths. Dike orientation on Resurrection Peninsula-NS, W, and NW; on Knight Island NE, W, and NW.	1-5km		
Plagiogranite--On Knight Island, occurs as "lenses" within the sheeted dike unit; at Resurrection Peninsula intrudes gabbro and sheeted dikes, occurs as "lenses" in sheeted dikes, and is intruded by basalt dikes. Medium grained equigranular and porphyritic.	up to 30m	U-Pb zircon date from plagiogranite Resurrection Peninsula -57 ±1.0 Ma Nelson and others, 1989.	
Gabbro--On Resurrection Peninsula, layered gabbro with alternating plagioclase-rich and clinopyroxene-rich layers and fault bounded block of coarse-grained gabbro with ophitic and pegmatitic phases; includes xenoliths of partially serpentinized ultramafic rock. On Knight Island, gabbro occurs as small (<1km²) bodies in sheeted dikes.	0-2km ?		
Ultramafic Rocks--On Knight Island, occur as xenoliths in sheeted dikes and larger (up to 200m x 400m) tectonic inclusions in Port Audrey shear zone (other inclusions include amphibolite, greenschist, siliceous mylonites, pillow basalt and metasediments). Olivine altered to serpentine, chlorite, and talc; clinopyroxene altered to actinolite, hornblende, and chlorite. Dunite, wehrlite, and olivine clinopyroxenite found in float. On Resurrection Peninsula occur as xenoliths in gabbro (dunite and pyroxenite), float (harzburgite), and serpentinized periodite bodies in turbidites. Richter, 1965; Winkler, 1973; Tysdal and others, 1977; Nelson and others, 1985, 1989.	?		

E GEOCHEMISTRY OF MAFIC, ULTRAMAFIC, AND ASSOCIATED ROCKS

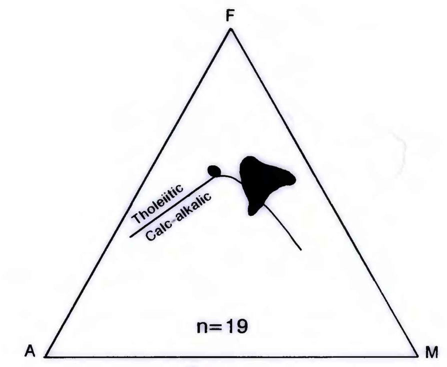


Figure 1.

AMF diagram of mafic volcanic blocks from the McHugh Complex and correlative units in Alaska. Hill, 1979; Nelson and Blome, 1991; Plafker and others, 1989. Boundary line after Irvine and Baragar (1971)

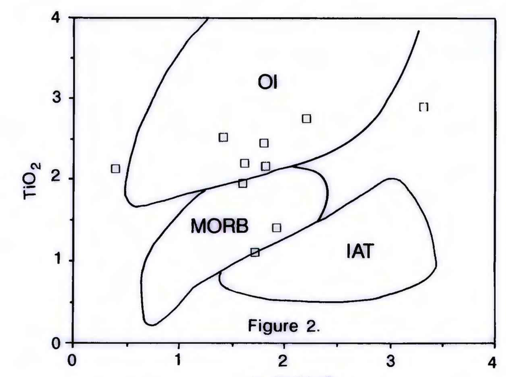


Figure 2.

FeO*/MgO vs TiO_2 variation diagram for mafic volcanic rocks from the McHugh Complex. OI-ocean island; MORB-mid-ocean ridge basalt; IAT-island arc tholeiite, after Glassley, 1974. Nelson and Blome, 1991; Plafker and others, 1989.

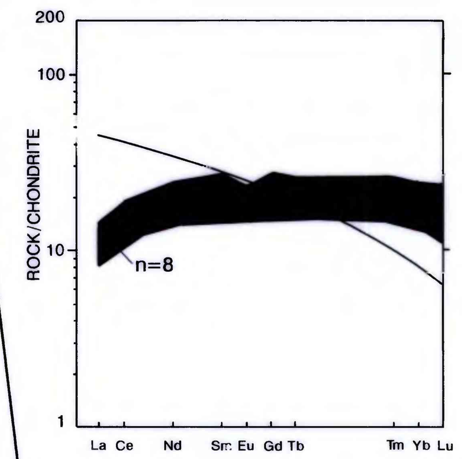


Figure 3.

Range of chondrite-normalized REE distribution for blocks of mafic volcanic rock from the McHugh Complex. Hill, 1979; Nelson and Blome, 1991; Plafker and others, 1989.

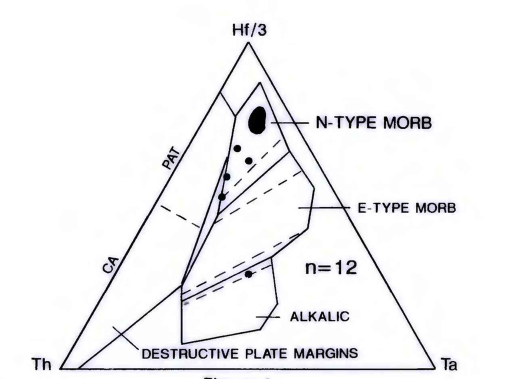


Figure 4.

Ternary diagram of (Hf/3)-Th-Ta for blocks of mafic volcanic rock from the McHugh Complex and correlative units in Alaska. Boundaries after Wood, 1980. Hill, 1979; Nelson and Blome, 1991; Plafker and others, 1989.

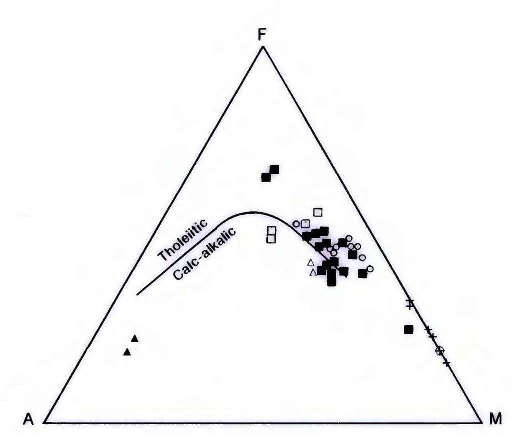


Figure 5.

AMF diagram showing variation of rocks from the three sequences from Prince William Sound region. Nelson, unpub.; Plafker and others, 1989. Boundary line after Irvine and Baragar (1971).

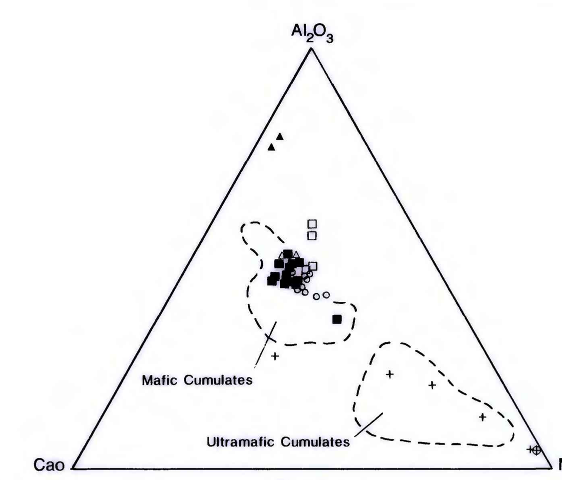


Figure 6.

MgO-CaO-Al_2O_3 variation diagram showing rocks from the three sequences from Prince William Sound region. Boundaries after Coleman, 1977. Nelson, unpub.; Plafker and others, 1989.

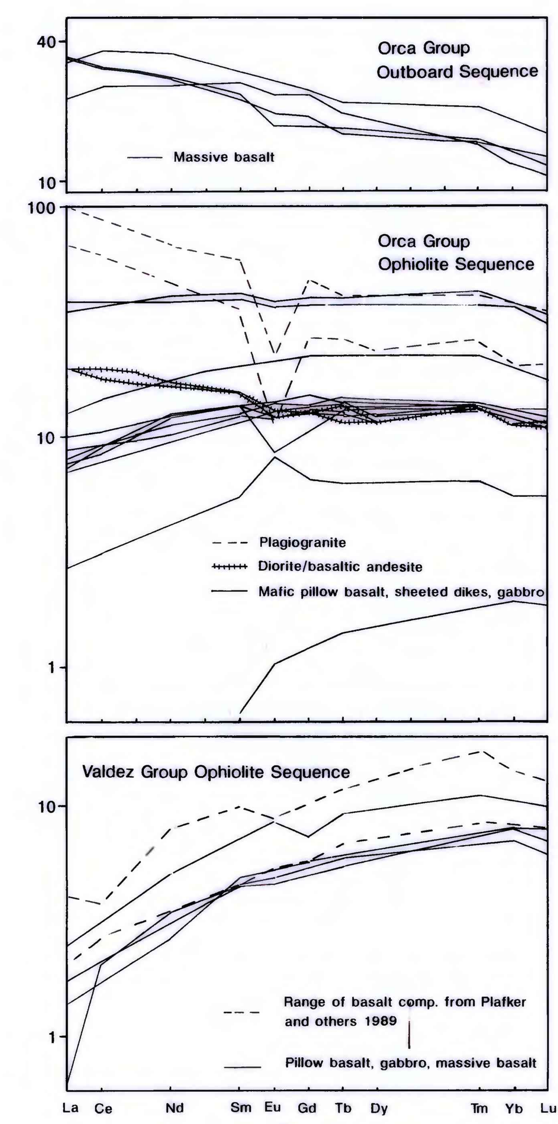


Figure 8.

Chondrite-normalized REE abundances of rocks from Prince William Sound region. Orca Group samples from Nelson, unpub. Valdez Group samples from Nelson, unpub.; Plafker and others, 1989.

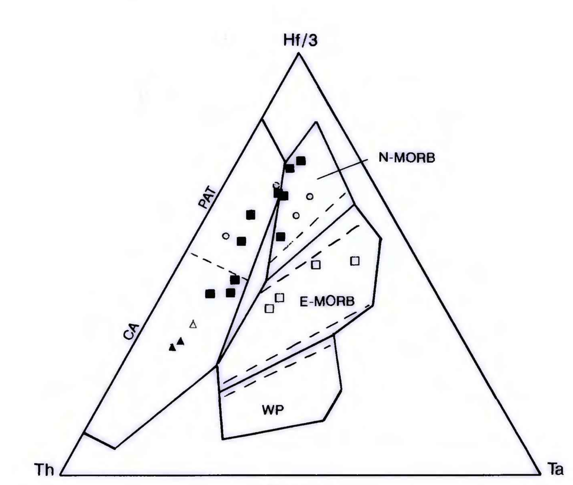


Figure 7.

Hf/3-Th-Ta discrimination diagram for rocks from the three sequences from Prince William Sound region. Data from Nelson, unpub.; and Plafker and others, 1989. CA=calc-alkaline, PAT=primitive arc tholeite, WP=within plate, N-MORB=normal mid-ocean ridge basalt, E-MORB=enriched MORB (after Wood, 1980).

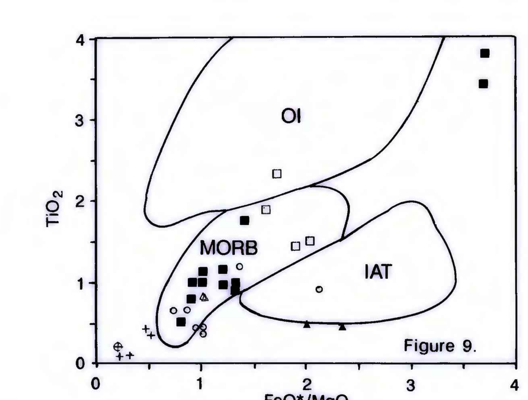


Figure 9.

Feo*/MgO vs TiO_2 variation diagram for rocks from the three sequences from Prince William Sound Region. OI-ocean island; MORB-mid-ocean ridge basalt; IAT-island arc tholeiite, after Glassley, 1974. Nelson, unpub.; Plafker and others, 1989.

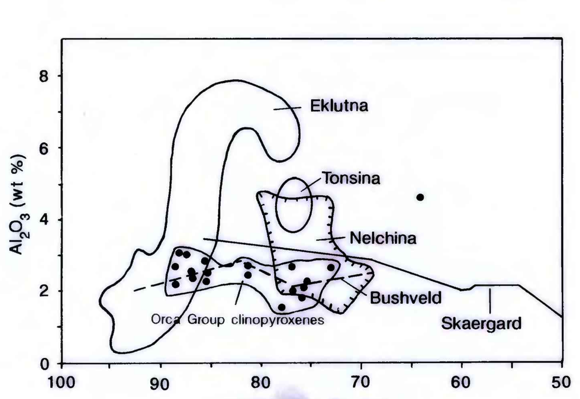


Figure 10.

Microprobe analyses of clinopyroxenes in gabbro from the Orca Group ophiolite sequence. Compositional range of clinopyroxenes from Border Ranges complex (Eklutna, Tonsina, and Nelchina) shown as well as large layered intrusions (after Burns, 1992).

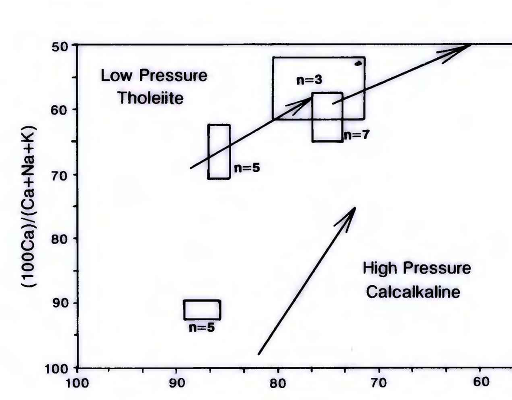


Figure 11.

Range of microprobe analyses for coexisting clinopyroxene and plagioclase in gabbro from the Orca Group ophiolite sequence. Arrows show differentiation trends for indicated compositions (Burns, 1992).

Diagram symbols

Orca Group

Ophiolite sequence

- ■ Group 1-pillow basalt, sheeted dikes, gabbro
- ▲ Group 2-plagiogranite
- △ Group 3-diorite, pillowed basaltic andesite
- \+ Group 4-ultramafic rocks

Outboard sequence

- □ Massive basalt

Valdez Group

Valdez Group ophiolite sequence

- ○ Pillow basalt, massive basalt, gabbro
- ⊕ Ultramafic rocks

F REGIONAL SETTING AND GEOLOGY

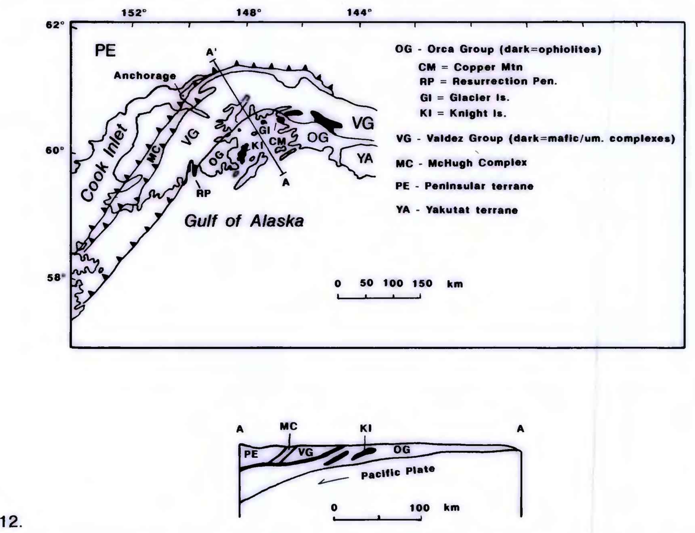


Figure 12.

Simplified map and section in southern Alaska showing geologic setting of ophiolitic terranes of Gulf of Alaska. After Plafker and others, 1989.

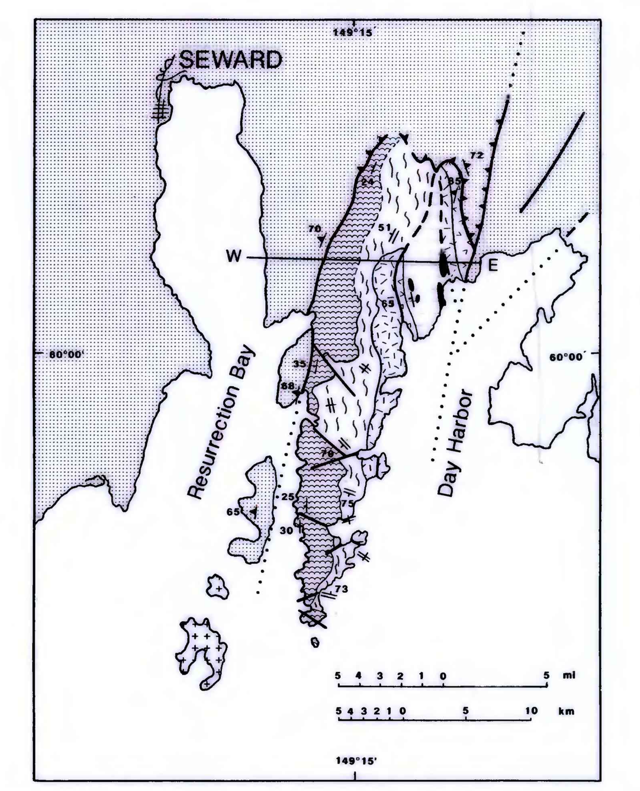


Figure 13. Geologic map of the Resurrection Peninsula ophiolite

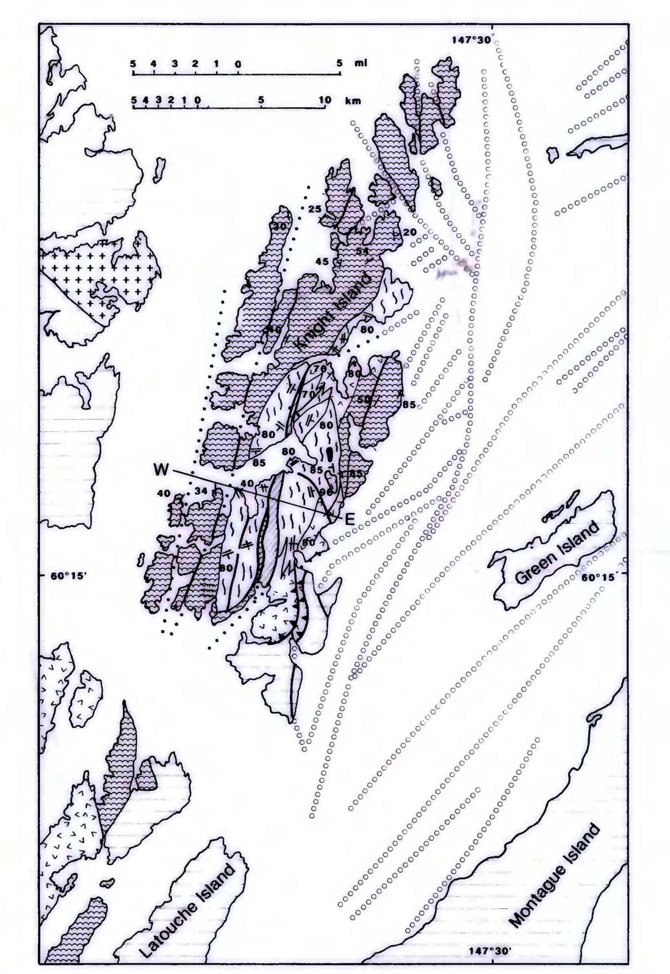


Figure 14. Geologic map of the Knight Island ophiolite

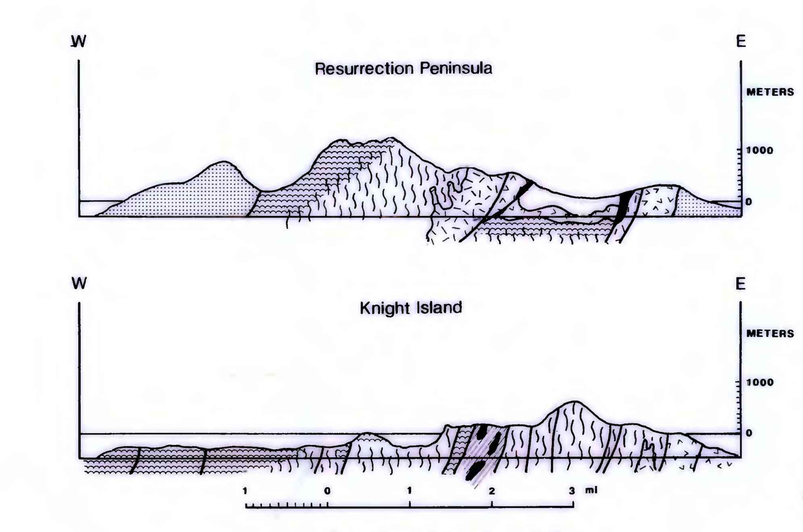


Figure 15. Cross sections through the Resurrection Peninsula and Knight Island ophiolites

EXPLANATION

Sedimentary and Metamorphic Rocks

- Mudstone, shale
- Argillite matrix in melange
- Siltstone
- Sandstone(graywacke)
- Conglomerate
- Limestone
- Bedded chert
- Greenschist, slate

Igneous Rocks

- Pillow basalt
- Massive basalt/greenstone
- Pillow breccia
- Sheeted dikes
- Plagiogranite
- Clinopyroxene gabbro stocks
- Layered gabbro
- Massive gabbro
- Serpentinized ultramafic
- Ultramafic inclusions and xenoliths

Faults

- Regional scale thrust fault (see fig. 12)
- Local normal fault

Geologic Explanation

Intrusive Rocks (Eocene and Oligocene)

- Granite and Granodiorite

Orca Group (Paleocene to middle Eocene)

- Sedimentary Rocks
- Pillow Basalt
- Sedimentary and Volcanic Rocks
- Sheeted Dikes
- Gabbro
- Ultramafic Rocks

Valdez Group (Upper Cretaceous)

- Metasedimentary Rocks

- Contact - Dashed where approximate
- Fault - Dotted where concealed; dashed where inferred
- Thrust Fault
- Lineament - Inferred from well developed bathymetric contours
- Port Audrey Shear Zone
- Dip and Strike of Bedding
- Dip and Strike of Cleavage
- Dip and Strike of Dikes
- Strike of Vertical Dikes