FIELD TRIP TO CYPRESS ISLAND
SAN JUAN ISLANDS, NORTHWEST WASHINGTON

LEAD BY BERNIE DOUGAN
WHATCOM COMMUNITY COLLEGE

FOR

NORTHWEST GEOLOGIC SOCIETY

FALL 2008 FIELD TRIP
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Recommended reading on the current status of San Juan Island geology:

Tectonic evolution of the San Juan Island thrust system, Washington
E.H. Brown, B.A. Housen, and E.R. Schermer

from: Flood, Faults, and Fire: Geologic Field Trips in Washington State and Southwest British Columbia
edited by Pete Stelling and David S. Tucker
The Geologic Society of America, Field Guide 9

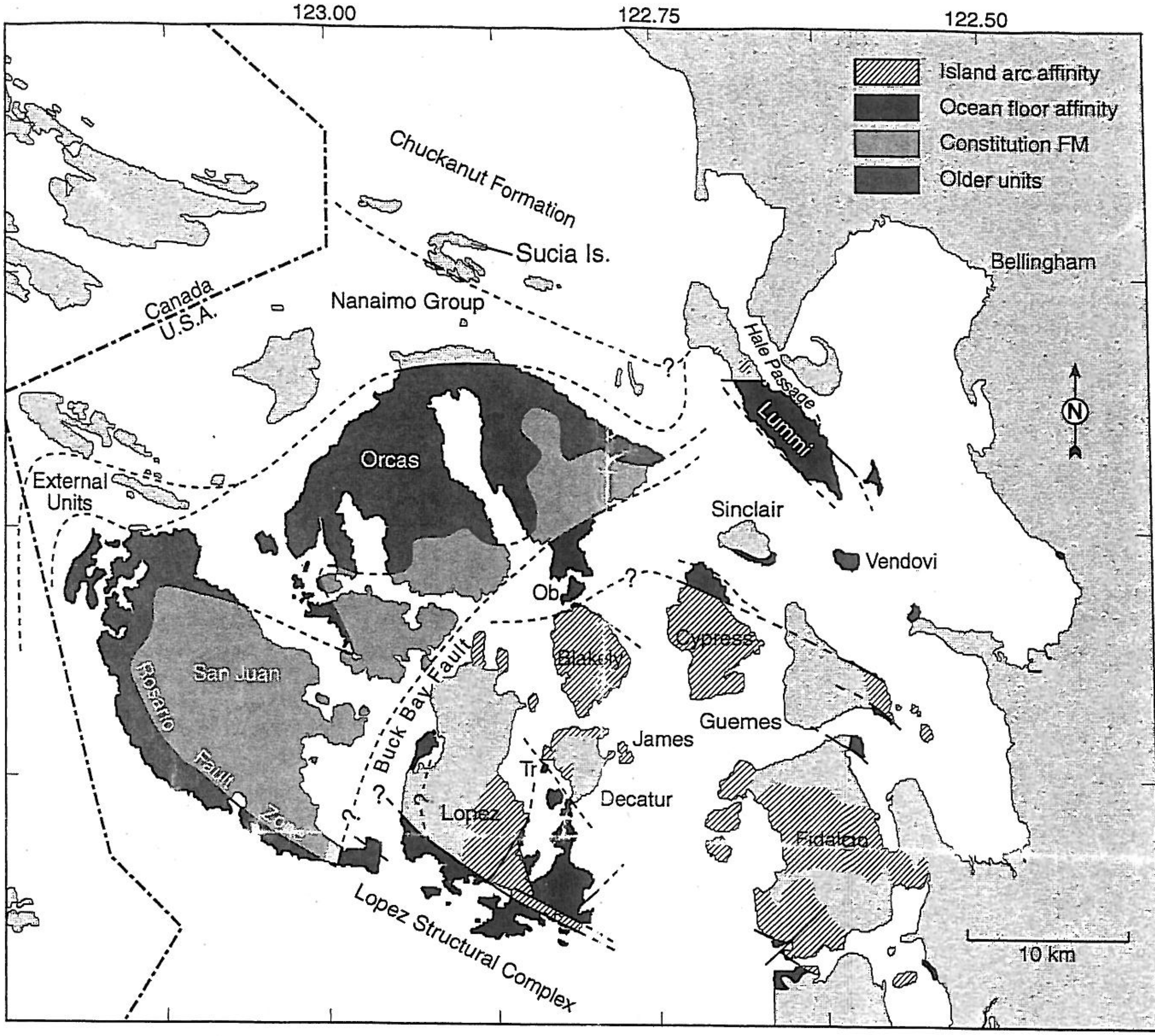
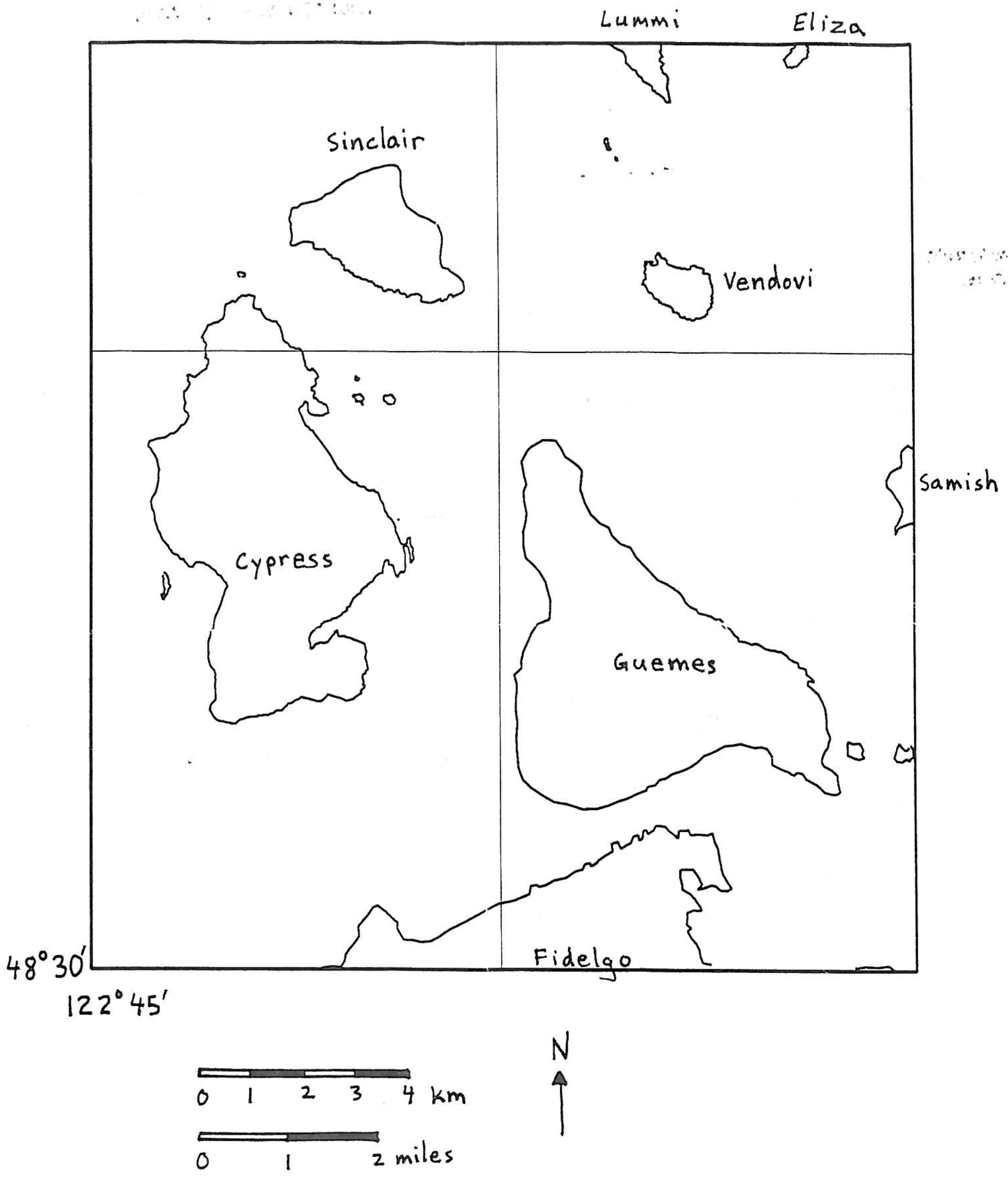


Figure 1. Generalized geologic map showing geographic names and faults in the San Juan Islands. Patterns in legend show distribution of island arc (ophiolite) and ocean floor rocks. Areas shown in light gray are largely covered by glacial deposits but include outcrops of Nanaimo Group and Chuckanut Formation. Modified from Burmester et al. (2000).

Map reprinted from:
Murrelets and molassa in the eastern San Juan Islands
Clark Blake and David Engebretson
from: Flood, Faults, and Fire: Geologic Field Trips in Washington State and Southwest British Columbia
edited by Pete Stelling and David S. Tucker
The Geologic Society of America, Field Guide 9

Reference on map:

Burmester, R.F., Blake, M.C., Jr., and Engebretson, D.C., 2000, Remagnetization during Cretaceous Normal Superchron in eastern San Juan Islands, WA: implication for tectonic history: Tectonophysics, V. 326, p. 73-92.



Lummi
Eliza
Sinclair
Vendovi
Samish
Cypress
Guemes
Fidelgo
48°30′
122°45′
0 1 2 3 4 km
0 1 2 miles
N

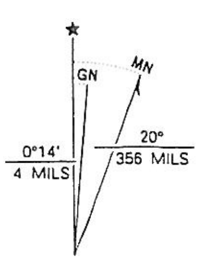
Figure 2

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER



UTM GRID AND 1994 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 5 FEET

CYPRESS ISLAND, WA

48122-E6-TF-024

GEOLOGY OF CYPRESS ISLAND

AN INTERACTIVE OVERVIEW

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ADVENTURES ABOARD THE SNOW GOOSE

CYPRESS ISLAND

Eagle Harbor- Cypress Island

Eagle Harbor is an example of a pocket beach where sedimentary, volcanic and plutonic rocks were scooped out by glacial action, down-slope movements and wave action. Through the middle of the harbor and continuing west through the lower-lying topography on the island is a geologic fault, probably active about 90 million years ago. The fault brought together ~170 m.y. old ultramafic plutonic rocks found on the southern shore with shallow-water sediments and pillow basalts seen on the beach at the head of the bay and on the steep cliffs on the northern shore.

At the small boat ramp near the abandoned dock, the beach is mainly comprised of loose ultramafic boulders (dark brown) and sparse glacial erratics (light gray to whitish crystalline rocks transported by glaciers). Many of the erratics are of granitic composition; since no granites are found in-place on the island, most likely they were carried southward by glaciers from either Vancouver Island or the North Cascades and deposited here. Note the steepness of the slope along this southern shore. The loose debris (ultramafic rocks) have tumbled down this slope. Those ultramafic boulders that have spent some time on the beach are noticeably rounded by wave action.

Walking west along this shore one can see what looks like the normal beach but upon closer examination notice that these beach particles have been glued (cemented) together. This "beach rock" was probably formed by the percolation of mineral-rich spring water through the beach deposits, forming chemical agents capable of cementing fragments together. At low tide, these springs are seen to enter the beach at several localities.

Continuing westward to the sandy beach of Eagle Harbor, notice that the boulders so common on the southern shore have all but disappeared. The western-shore of the harbor is comprised mainly of smaller pebbles, sand, and at low tide, mud. Waves entering the harbor have concentrated some of their energy to the inside of the bay and are probably responsible for the shape of this area. Stronger waves that hit at the opening of the bay near the dilapidated pier have efficiently removed the finer-grained particles while leaving behind larger ones. The existence of the bay, in a more regional context, was caused by the presence of a fault; rocks along faults tend to be weaker and more easily removed. This process is called differential erosion.

As you stand at this western shore, glance eastward out the harbor. Rocks to your left (north) are shallow-water pillow basalts, those on your right (south) are ultramafic rocks formed deep within the Earth. These ultramafic rocks were pushed northward and over the volcanic rocks forming what is called a thrust fault. A small exposure of rocks at the upper portion of the sandy beach are sedimentary rocks known as sandstones (lighter gray) and shales (darker gray). These sedimentary rocks were once deposited in horizontal planes but are now tipped to the west at about 50 degrees. Look carefully at the color and grain size of these layers and note that where the darker, fine-grained shales are in contact with the lighter, coarse grained sandstones you can see a vague planar structure. This planar feature was once horizontal and is called a bedding plane. During the deposition of these layers (strata), the shales were laid down in quiet, slow-moving water. The sandstones were probably deposited as water-saturated sands that flowed down a slope and settled out after some time. Flows of sediments of this kind are known as turbidites (from the word "turbid"). We will talk more of these at other stops.

A reasonable question now would be--what is the relationship between these sedimentary and volcanic rocks? Although somewhat controversial, a likely explanation would be that the sedimentary and volcanic rocks were laid down at different places and shuffled (faulted) together at a later time through tectonic activity. It is also possible that the source for the volcanic rocks was near to the site of deposition of the sediments and there were alternating periods of deposition of sediments and basalts. As with many observations in geology, insufficient exposure of rocks prohibits determining important relationships among the rocks with certainty.

Trail to Pelican Beach- Cypress Island

As you walk the trail northward out of Eagle Harbor towards Pelican Beach, you will see (in about 1/4 mile) a deposit of pillow basalts on your left. These can be recognized because they are more resistant to weathering and protrude out of the weathered soils and glacial deposits. If you see those whitish crystalline rocks (granites) in the soils, they were deposited by glaciers. Often the glacial deposits (glacial till) are not well-cemented together (lithified) and turn to soil quickly (geologically-speaking). Returning to the pillow basalts, look for blobs of volcanic rock within the outcrop. Often these blobs (pillows) are easily seen because the materials that once surrounded the pillows was highly fractured and more easily removed through weathering and erosion.

You may have noticed some reddish-colored rocks intermingled in the pillows. During times of little volcanism silica can precipitate out of the water to form cherts, which are often reddish because of oxidation of iron. Also, small siliceous critters known as radiolaria die and fall into the deposit. Radiolaria are often used to determine the age of deposition, a key to unravelling the geologic story.

Along much of this trail to Pelican Beach you will see additional remnants of basalts, chert, and other sediments. Weathering and glacial deposition has obscured most of the original story but as you can see from the lush vegetation, this is a worthwhile fate for the rocks.

Pelican Beach- Cypress Island

As you walked from Eagle Harbor to Pelican Beach, you were mainly walking through a large pile of volcanic and sedimentary rocks. Most of Pelican Beach south of the picnic area has these rock types exposed near the upper part of the shoreline. As we saw in Eagle Harbor, ultramafic rocks were thrust-faulted to the north over these volcanic and sedimentary rocks. A similar style of faulting can be seen near the south end of the picnic/camping area where the volcanic rocks were displaced northward and over turbidites. To see this fault you have to walk as close to the bank as possible and recognize that sandstones and shales lie below a greenish, fractured rock (basalt). It may be more evident after you have looked at the deformed turbidites at the north end of the beach at the first prominent point.

Walk north along the beach past the picnic tables to the first rock outcrop to see highly-deformed sandstones and shales (turbidites). Also note that there are many fractures filled with a whitish material (veins). Veins like these are common in metamorphic rocks that have been subjected to great pressures and temperatures. It is appropriate to call these exposures meta-sedimentary rocks due to their disrupted nature and overall sheared appearance. Shearing (rocks sliding by one another) often produces an additional layered look to rocks (called a "fabric" or "foliation"). These meta-sedimentary rocks are found on many of the islands near Pelican Beach and beyond such as the Cone Islands to the south and Towhead Island at the northern tip of Cypress. Some investigators believe that these meta-sedimentary rocks were first deposited, brought to great depths in the Earth where they were metamorphosed, and somehow returned to near the surface and later involved in the thrust faulting. For fun, try to determine where there are bedding planes in the meta-sedimentary rocks by looking for contacts between sandstones and shales. You will also see many other planar features (foliation) that are commonly confused with bedding. At this location, foliation planes are often found to be nearly parallel to bedding planes so working out the story held by the rocks is anything but straight-forward.

Summary- Cypress Island

In general there are three distinct geologic entities located on the island--ultramafic rocks south of Eagle Harbor, pillow basalts and subordinate sandstones, shale and chert between Eagle Harbor and Pelican Beach, and metamorphosed turbidites (sandstones and shales) north of Pelican Beach. Most likely these rock bodies were brought together through thrust faulting from south to north. Deep-seated ultramafic plutonic rocks were brought over the pillow basalts along a fault in Eagle Harbor and both of these units, in mass, were moved over the meta-sedimentary rocks along a fault found on Pelican Beach.

But what about the timing of these events and ages of the rocks? Well, the ultramafic rocks are probably about 170 m.y. old., the pillow basalts about 155 m.y. old, and the meta-sedimentary rocks also about 155 m.y. old. Let's try a scenario: form the ultramafic rocks first (deep within the Earth), shortly thereafter (near the surface of the Earth) deposit the pillow basalts and subordinate sediments, at about this time and probably at some distance away, deposit the (now) meta-sedimentary rocks found at the north end of the island. At about 120 m.y., bring the meta-sedimentary rocks (and maybe the pillow basalts) down to great depths so you can produce the known metamorphism. At about 90 m.y. bring all of the rocks together along thrust faults with ultramafics moving over the pillow basalts and the pillow basalts moving over the sedimentary rocks. To complete the recipe for Cypress Island, allow time for a great deal of erosion and raise all of the rocks to near sea level. Let surficial processes erode away the weakest rocks, carve some beautiful bays and leave some spectacular slopes. Next bring in several advances and retreats of mile-thick glaciers to round off edges and carve deeper grooves. Leave some of the glacial deposits behind so rich soil can develop, wait for the glacier to retreat, add some additional erosion and weathering, raise sea level. Allow some time for wave action to round off large boulders and break big rocks into sand, grow some plants and trees, add your favorite critters and there you have it--Cypress Island.