Cathy Connor University Alaska Southeast
Introductory Physical Geology Lab
Roadside Engineering Geology Around Auke Bay -Student Consultant Scenario
FINAL LAB Due 04/21-22/06 (40 points)

In this Lab we will explore shoreline and glacial features, the structural geology of Gravina Belt rocks, and the structural integrity of the early Holocene Gastineau Formation at each of six sites around Auke Bay, in the City and Borough of Juneau, Alaska.

Background

It is the 100th Anniversary of the San Francisco April 18, 1906 Earthquake. At that time San Francisco, with a population of 400,000 people, was the 8th largest city in the U.S. The quake struck without warning at 5:12 am, its epicenter on the San Andreas fault offshore of western SF and southwest of the future site of the Golden Gate Bridge (not yet erected). Three thousand people were killed and 225,000 made homeless.

The earthquake was recorded on 6 local seismometers and 90 stations around the world, the beginnings of the global seismic network. Modern analyses suggest that the Moment Magnitude M_w of this earthquake was 7.7-7.9 although the Richter scale magnitude, developed for local earthquakes on high frequency seismometers, was 8.3 A seismogram recorded in the State Museum in Albany, New York was featured on the front page of the New York Times. Fires broke out within minutes of the ground shaking. A firestorm lasting for 3 days destroyed 28,000 buildings damaging up to 85% of the city. (from Zoback, 2006, *GSA Today*, handed out in class)

Purpose of this Lab

Your have been hired as a geologist for the City and Borough of Juneau to produce a report on the suitability of 6 housing sites, located on both bedrock and unconsolidated sediment in several locations around the Auke Bay area. With Juneau's ever-expanding population, city planners are looking for new locations to build houses. At each of the sites we visit, you will be asked to evaluate the "ground" in terms of its mass-wasting potential, slope and seismic stability, drainage, bedrock type, bedrock structure, soil type and stability, and any other geologic, hydrologic, or climatic hazards you can envision for each site.

Grading

For this lab you will be evaluated on the basis of
1) Your field notes (turn 04/21-22/06 with your report) 50%
2) Your completed, typed, and professionally written report to the CBJ, "your employer" 50%

Be certain to take good field notes that include information such as:

1. Description of location of each site, (mark location on the 1:25,000 scale map), identify geologic age of and type. of bedrock, make neat tables of data you collect, include sketches of sites and geomorphology of the landscape of the sites, note important landmarks or points of interest. Observe existing structures located on these sites and note any evidence of ongoing problems such as creep, mass wasting, etc.

2. Carefully answer all of the questions below for each site **in your field notebook**. The CBJ is interested in a general geologic report. Their engineers will want to know rock type, slope steepness, aspect (direction site facing), soil conditions, geologic hazards, active geologic processes, and general landscape description for each site you visit.

3. Collect structural data from outcrops. Plot the strike and dip data directly onto your map at each stop where such data is collected and make a data table in your notebook of the information you collect so that you can include it in your final report.

Trip Log

Stop 1 Smuggler's Cove

South end of Fritz Cove Road at Smuggler's Cove. Park at turn around and walk down to beach (trail is on left side of guard-rail as you face the water).

We will be measuring the attitude (strike and dip) of the Late Jurassic and Cretaceous sedimentary marine rocks on the beach. These rocks were shed off a Baja California-sized landmass that was tectonically added to the southeastern Alaskan coastline. At that time, between about 90 and 50 million years ago, our coastline featured an active convergent plate margin with a subduction zone. See ancillary materials at the end for information about taking strike and dips, apparent dip measurements, Gravina Belt geology, turbidite deposits, and other useful information.

Step 1.

Locate yourself on the topographic map provided. Describe the types of rock you see exposed here.

Step 2. Use your compass to measure the strike and dip of the **bedding planes** at three different points along the outcrop and record your answers below.

1. Strike=_____ Dip=_____

2. Strike=_____ Dip=_____

3. Strike=_____ Dip=_____

Plot one of your strike and dip readings on the topo map at your location for this stop. Note that **joint planes** also occur in the rocks at this outcrop.
Measure the strike and dip of one of the **joint** planes.

4. Strike=_____ Dip=_____

5. Do you see any **fossils** in this rock? What is evidence in the rocks that reveals the environment of deposition?

6. What is the stratigraphic thickness of this outcrop? Use hand level to measure vertical elevation above sea level, tape to measure sea level to outcrop top distance.

Sketch a profile of the geomorphic features on the prominent point forming the western edge of Smuggler's Cove. Does it have any distinctive features? Suggest some of the dynamic earth processes you have learned about in GEOLOGY 104 that may have caused such features. Are such processes still active today?

Stop 2. Fox Farm Road Outcrop
Leave cars parked and walk up Fritz Cove road to Fox Farm Road. Wander down to outcrop on north side of road. Look over the rocks exposed in this relatively new subdivision.

7. Locate position on the map.

8. Measure the strike and dip of the rocks at this location and record them below. Plot them on your map.
Strike=_____ Dip=_____
Is the dip direction parallel with the road or are you measuring an apparent dip?

9. Which is older the graywacke sandstone or the quartz veins? Why?
What is the orange mineral around the quartz veins?
What other mineral can be found with the quartz veins?
Note Eagle's Nest in big tree behind house. What regulations does the U.S. Fish and Wildlife Service have regarding building near active bald eagle nests?
What additional costs might be created for homeowners building on bedrock?
What long term savings might they benefit from?

Stop 3. Climber's Cliff
Drive about a quarter of a mile northward along Fritz Cove Road and park just south of prominent cliffs along eastside of roadway.

10. What rock type is this at the climber's cliff? How did it form?
What type of mass movement occurs along this stretch of road?
Could this rock have been deposited in the same environment as the rock at Site #1? Explain.
Can you measure the strike and dip of the bedding in this rock? Explain.
What precautions did the road engineers take when building Fritz Cove Road along this stretch?

Stop 4. Beach Exposure along Fritz Cove Road, **NOTE** THIS IS PRIVATE PROPERTY AND WE HAVE PERMISSION TO VISIT TODAY ONLY**. DO NOT RETURN** WITH ALL OF YOUR FRIENDS AND RELATIONS TO VISIT THIS SITE. FUTURE GEOLOGY 104 STUDENTS ARE DEPENDING ON YOU!

Park alongside the road and avoid blocking driveway or garage.
Walk down to beach, slowly and carefully. The beach trail is on right hand side of driveway. The trail is very steep and often covered with spruce needles, descend carefully. Rocks along trail are quite capable of cutting your hand open if you fall on them...ask my brother!
11. Locate site on the map.
12. What rock type occurs as bedrock in the bank underneath the trees?
13. Measure the strike and dip of the foliation or cleavage planes of this rock.
Strike=_____ Dip=_____. Plot your measurement on your map.
Is this house sited directly atop bedrock?
What impacts did Typhoon Tom have on this site during the Fall of 1996?
14. Note the wavecut terrace at north end of cove. How did this form?

15. Scrutinize the petroglyph created by Aukwan people. Study the photo below thought to have been taken by S. R. Capps, USGS unknown date. Are all of these carvings still present? By what methods could you determine the age of these carvings made in Cretaceous rock?

16. Visit the unusual outcrop past petroglyph. Describe the geologic events that occurred here? Name the two rock types _____ and_____.
Which is older? ___Explain.
What mineral occurs as large phenocrysts in the upper rock type? _____
Is this mineral commonly found in this rock?
How could you determine the age of these rocks?

Stop 5 Auke Bay Elementary School
Park in school parking lot and walk up the hill on right hand side, by new kindergarten room with large bay window. Follow the creek upstream to waterfall area

17. How old are the sediments, through which the creek is eroding its channel?
18. In what depositional environment did these sediments form? What evidence suggests this?
19. What is our present elevation above sea level? Explain the presence of marine sediments in the creek at this elevation.
20. What future economic resource might form in these area?
21. Visit grassy slope behind covered playground and experiment with human-induced shock waves. What form of mass movement could be induced by seismic waves at this site?
22. Look at stratigraphic sections created from engineering studies of the Auke Bay School site. Why did this turn out to be a very expensive school site for the CBJ?

Stop 6 UAS Recreation Center Road
Follow the Back Loop Road to the Back Entrance to UAS Campus. Turn left into the new UAS Recreation Center and park by uphill outcrop.

22. Locate site on the map. .
23. Measure strike and dip of rocks at this location and plot on map.
Strike=_____ Dip=_____
24. What types of rock do you see at this exposure?
Do these rocks appear to be the same as those we saw along Fritz Cove Road?

25. Are the uppermost glacial erratics, glaciomarine sediments, and modern soil sitting on a wave cut platform? Explain.
What information can you learn from this outcrop to help you answer the question?
What other data might be helpful?

26. Have your strike and dip measurements remained consistent from the end of the Mendenhall Peninsula to the UAS Campus? Explain.

27. Make a sketch map showing the direction of regional tectonic stresses that may have been applied to southeast Alaska during the last Cretaceous that would account for the strikes and dips you have measured this morning.

TO TURN IN:

As a geologic engineering contractor you will now use the notes, maps, sketches and data you have collected today to produce a **geologic report** for the City and Borough of Juneau. Photos of the outcrops will be available on the web if you would like to include them. Add any additional information you think is important and PERTINENT.

Report must be typed and must include

1. **One Page Cover Memo to CBJ** summarizing the results of your work and your recommendations. This should be the **first page** of your report.
2. Introduction/Purpose Section
3. Methods
4. Description of site visits and data collected (include maps with locations and strike and dip plots, data tables and any photos you might want to include.)
5. Discussion of site suitability/hazards
6. Summary, recommendations to CBJ, and conclusions
7. References
8. Your field notebook must also be turned in

Turn this work in by Friday or Saturday April 21-22, 2006,

The following ancillary materials should be helpful. References are at the end.

II. Method for steeply dipping beds. Where beds dip more than 60°, a level line of sight to a bedding plane can be found by a somewhat less precise method than that just described. After the observer is in a position to see a bedding surface as a line, he takes a bearing by the eye-level method (second method of Section 2–3), being careful to center the bull's eye bubble exactly and to sight on the trace of the bedding. If he prefers to take the bearing by the chest-level method, he may move to such a position that *the compass will be in the plane of the bedding surface.* By either method, the compass can be held level enough to define the strike line within a few degrees. The dip is measured in the same way as described above.

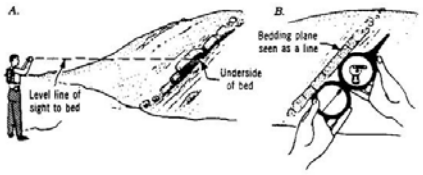


Fig. 2–7. Measuring strike and dip. (*A*) Sighting a level line in the plane of a bedding surface. (*B*) Measuring the dip of a bedding surface.

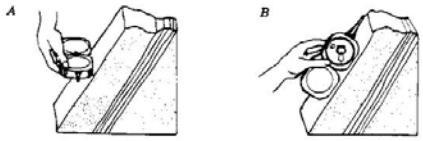
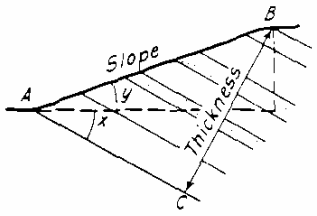


Fig. 2–8. Measuring approximate strike and dip by holding compass against a bedding surface.

IV. Method of holding compass against bedding surface. Methods I and II cannot be used where brush, rocks, or trees make it impossible to get in a position to see a bedding surface as a line. It may then be necessary to take a reading by holding the compass against a bedding surface. The surface chosen must be smooth, clean, *and representative of the outcrop.* The compass is opened and one of the lower edges of the compass box is held firmly against the bedding surface; the compass is then rotated until the bull's eye bubble is centered (Fig. 2–8A). The bearing in this position is the approximate strike.

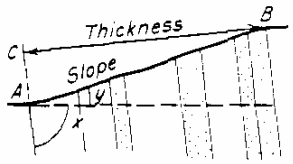
a. Slope and dip are opposed and angle of slope (y) plus angle of dip (x) is $< 90°$

$BC = AB \sin (x+y)$



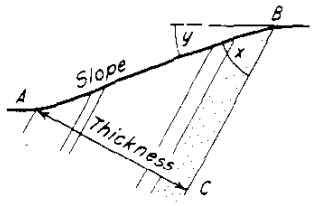
b. Slope and dip are opposed and angle of slope plus angle of dip is $> 90°$

$BC = AB \cos (x+y-90°)$
or $BC = AB \sin [180° - (x+y)]$



c. Slope and dip are in the same direction, with dip $>$ slope

$AC = AB \sin (x-y)$



d. Slope and dip are in the same direction, with dip $<$ slope

$BC = AB \sin (y-x)$

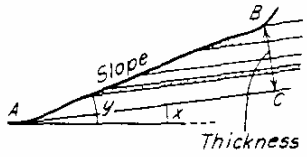
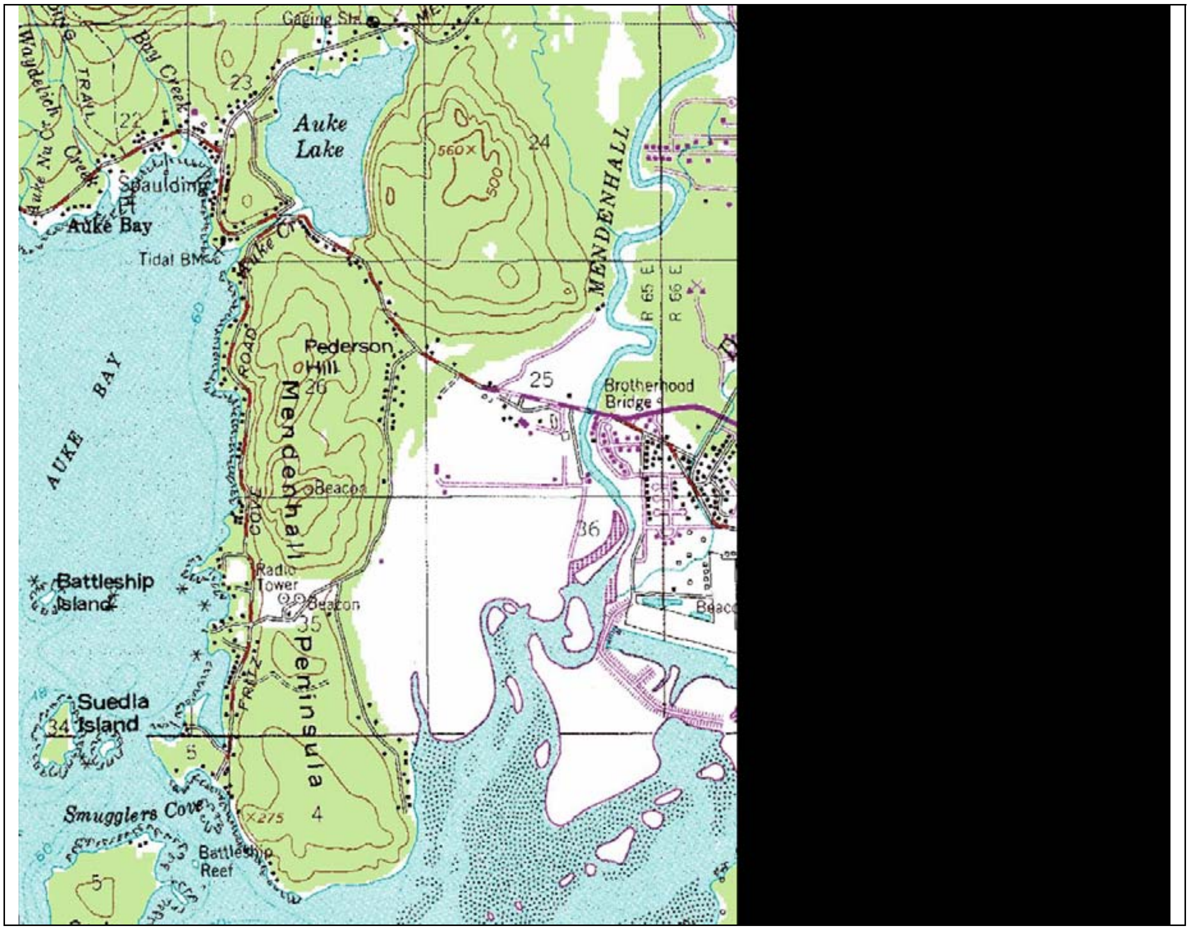


Fig. 12–22. Formulas used for the various possible combinations of direction and amount of ground slope and dip of beds.


Gaging Sta
Auke Lake
560
500
24
23
22
Bay Creek
TRAIL
Spaulding
Auke Bay
Tidal BM
Auke Cr
MENDENHALL
R 65 E
R 66 E
Pederson Hill
26
25
Brotherhood Bridge
ROAD
Mendenhall Peninsula
Beacon
AUKE BAY
36
Radio Tower
Beacon
35
Battleship Island
FRITZ
Suedla Island
34
5
Smugglers Cove
275
4
Battleship Reef
5

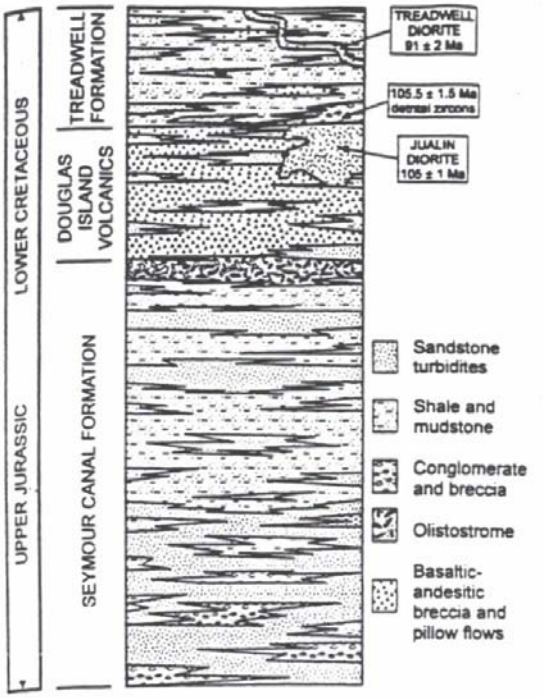


Figure 3. Schematic stratigraphic column of Gravina belt. Stratigraphy of Seymour Canal Formation is derived largely from studies near Cape Fanshaw (northwest of Petersburg in Fig. 1; Gehrels et al., 1992), whereas stratigraphy of Douglas Island Volcanics and Treadwell Formation is interpreted from relations described herein. Total stratigraphic thickness of three units is interpreted to be ~3 km.

Clastic strata east of the Douglas Island Volcanics consist predominantly of slate, argillite, and graywacke with subordinate lenses and layers of augite-porphyritic volcanics, conglomeratic horizons, thin-bedded maroon and green shale, and distinctive graywacke containing abundant calcareous concretions. These rocks were originally referred to as the Treadwell slate on Douglas Island (Martin, 1926) and the Berners Formation (Knopf, 1911, 1912) between Douglas Island and the area north of Berners Bay. Barker (1957) used the term Treadwell Formation for much of the strata originally included in the Treadwell slate and the Berners Formation. Coarse clastic strata originally included in the Berners Formation north of Berners Bay have been called the Jualin Formation (Redman, 1984). Brew and Ford (1985) assigned all of the Jurassic-Cretaceous

clastic strata between Douglas Island and Berners Bay Seymour Canal Formation.

These strata are herein referred to as the Treadwell F tion (following Barker, 1957), rather than the Seymour Formation, because they are apparently younger than the D Island Volcanics. Evidence for this relative age comes from igraphic relations with the Douglas Island Volcanics both o ern Douglas Island and in Berners Bay, and from the a detrital zircons in a sandstone of the Treadwell Formatio Berners Bay.

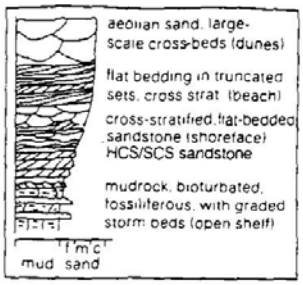


Fig. 8.10 One example of a shallow-marine siliciclastic unit: coarsening-upward marine unit resulting from progradation of a beach/barrier shoreline. Typical thickness 10 m or more.

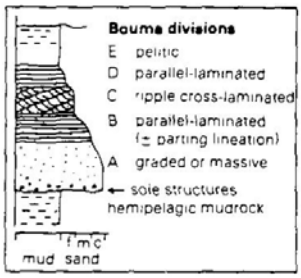


Fig. 8.11 An ideal turbidite, with Bouma divisions. In many turbidites, not all divisions are developed; AE, BCE, CDE and CE sequences are common. Turbidite beds range from a few centimetres to a metre or more in thickness.

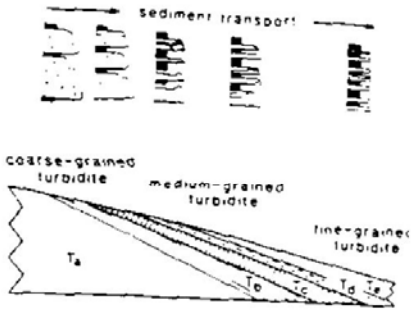
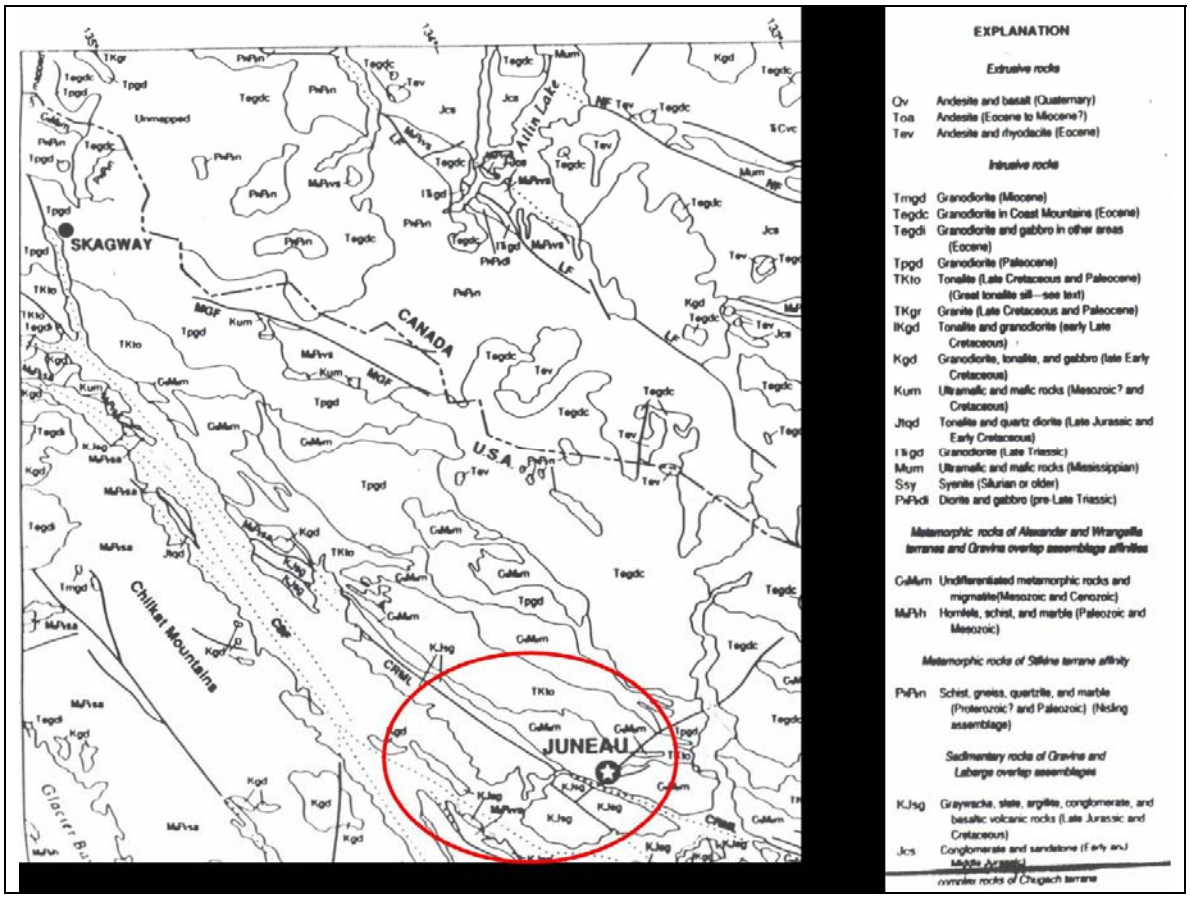


Fig. 8.12 Downcurrent changes in turbidity current deposits. T_a, T_b etc. are the Bouma divisions (see Fig. 8.11).

Fig. 8.13 A turbidite bed showing ABC divisions: a lower coarse massive division (A), overlain by a finer-grained parallel-laminated division (B), and then the upper part consisting of cross-laminae with a convolution at the top (C division). This turbidite is a bioclastic limestone. Devonian, south-west England.


SKAGWAY
JUNEAU
CANADA
U.S.A.
Chilkat Mountains
Atlin Lake
MOF
CRM
LF
EXPLANATION
Extrusive rocks
Qv Andesite and basalt (Quaternary)
Toa Andesite (Eocene to Miocene?)
Tev Andesite and rhyodacite (Eocene)
Intrusive rocks
Tmgd Granodiorite (Miocene)
Tegdc Granodiorite in Coast Mountains (Eocene)
Tegdi Granodiorite and gabbro in other areas (Eocene)
Tpgd Granodiorite (Paleocene)
TKto Tonalite (Late Cretaceous and Paleocene) (Great tonalite sill—see text)
TKgr Granite (Late Cretaceous and Paleocene)
Kgd Granodiorite, tonalite, and gabbro (late Early Cretaceous)
Kum Ultramafic and mafic rocks (Mesozoic? and Cretaceous)
Jtqd Tonalite and quartz diorite (Late Jurassic and Early Cretaceous)
Mum Ultramafic and mafic rocks (Mississippian)
Ssy Syenite (Silurian or older)
PrPvdi Diorite and gabbro (pre-Late Triassic)
Metamorphic rocks of Alexander and Wrangellia terranes and Gravina overlap assemblage affinities
GdMm Undifferentiated metamorphic rocks and migmatite(Mesozoic and Cenozoic)
MzPzh Hornfels, schist, and marble (Paleozoic and Mesozoic)
Metamorphic rocks of Stikine terrane affinity
PrPzn Schist, gneiss, quartzite, and marble (Proterozoic? and Paleozoic) (Nisling assemblage)
Sedimentary rocks of Gravina and Laberge overlap assemblages
KJsg Graywacke, slate, argillite, conglomerate, and basaltic volcanic rocks (Late Jurassic and Cretaceous)
Jcs Conglomerate and sandstone (Early and
ophiolite rocks of Chugach terrane

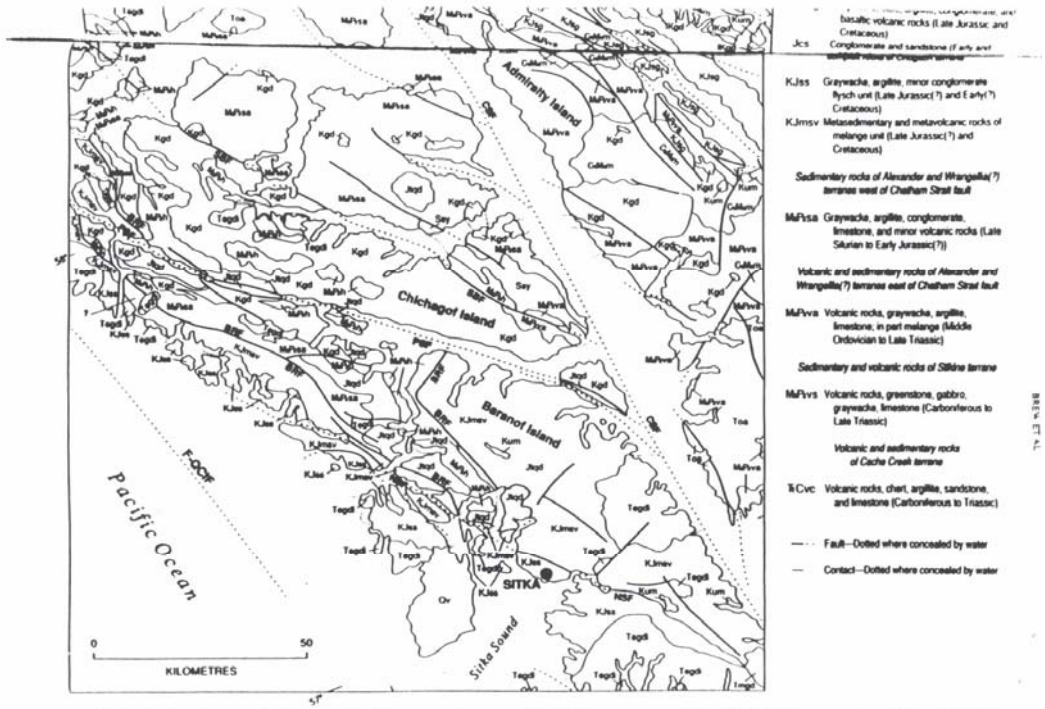


FIG. 3. Generalized geologic map of Sitka Sound to Atlin Lake ocean–continent transect. Compiled from sources given in Fig. 2. F.QCIF, Fairweather – Queen Charlotte Islands fault; NSF, Neva Strait fault; BRF, Border Ranges fault; PSF, Peril Strait fault; SBF, Sitkoh Bay fault; CSF, Chatham Strait fault; CRML, Coast Range megalineament; MGF, Meade Glacier fault; LF, Llewellyn fault; NF, Nahlin fault

The Auk People

An interview with
Lillian Petershoare

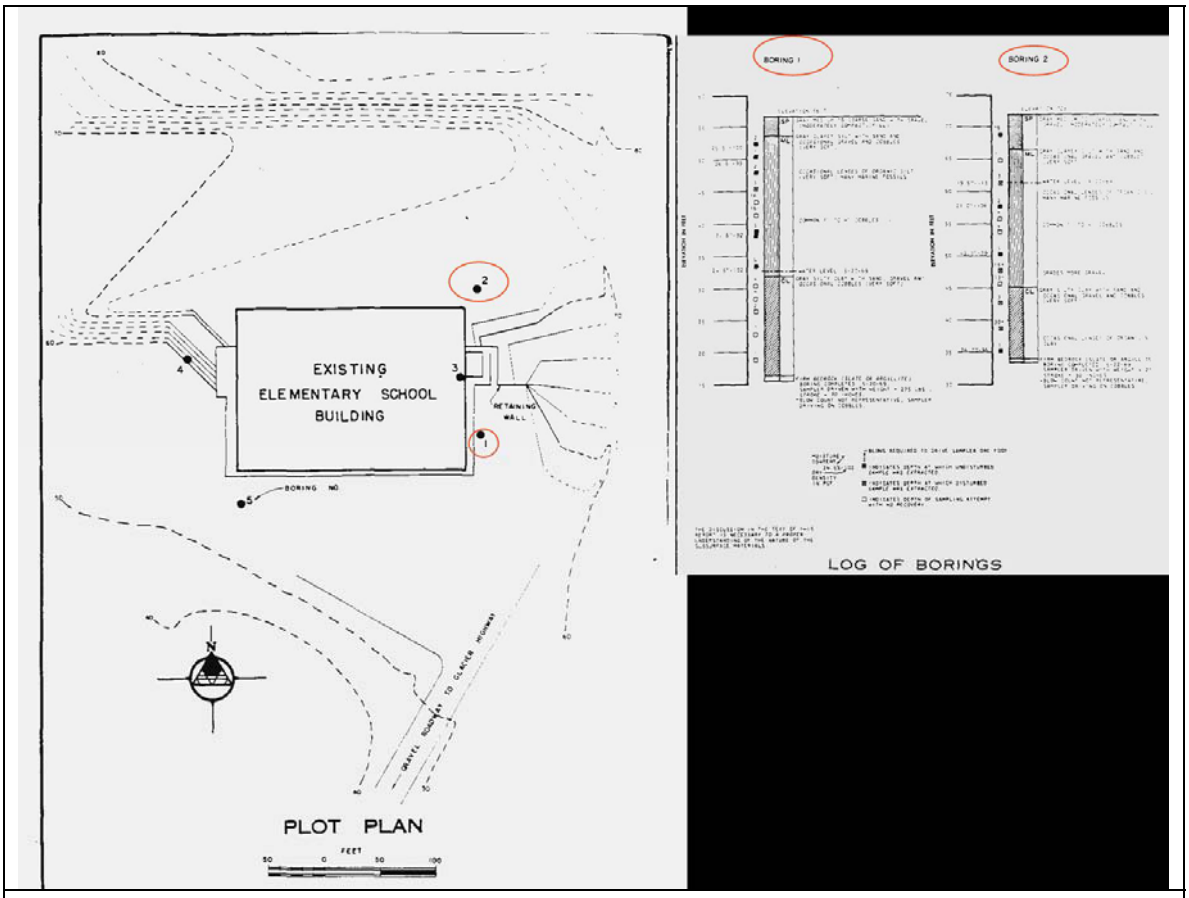
People used to think that the Tlingits had been in Auke Bay 400 to 600 years because traditional stories were told of building the Big Dipper House, Yaataa Hit, four times and each house was believed to have lasted about 100 years. However, in 1990 an ancient fish trap was found in the mud of Montana Creek. It has been carbon dated at 700 years old. So now no one knows for sure, but sometime more than 500 years ago the Stikine Indians had some kind of dispute and some of them decided to leave. They travelled down the Stikine River and then north in their big cedar canoes. Some stopped at Young Bay for the seals that were abundant while others continued north to Auke Bay.

Later the Auk people went to Klawock to make war. Because the Klawock people knew warring Auks were coming, they all fled from the village except for one old woman who was too old to escape. Before the attackers arrived the old woman painted the Dipper crest on her face. Seeing her, the Auk people were curious about the meaning of the face painting. She wouldn't tell them, but the Auks were determined to get the information. Because they had spared her life, the old woman decided to give them her most valuable gift, her family crest. Without making war, the Auks returned to their home site where they built the Big Dipper house, Yaataa Hit.

One time the creek coming out of Auke Lake got blocked so no fish could use the stream. The chief had his slaves clear the stream freeing the salmon. Then he freed the slaves. To celebrate the freedom the Tlingits made petroglyphs, carvings in rock, along the rocky beach beside what is now Fritz Cove Road.

In 1794 Captain George Vancouver sent Lieutenant Joseph Whidbey and some of his men to investigate after smoke was spotted at several sites along the shore. Sensing danger, Lieutenant Whidbey immediately returned to the ship and they left the area. Now, the name of that spot is Point Retreat.

We heard two stories about how white men got gold in the Juneau area. One story came from Lillian Petershoare's grandfather, Willie Peters, who heard it from Jimmie Rudolph. In 1880, two white



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