A Field Trip into The Olympic Mountains

Led by James Aldrich Ph.D.

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Photos:

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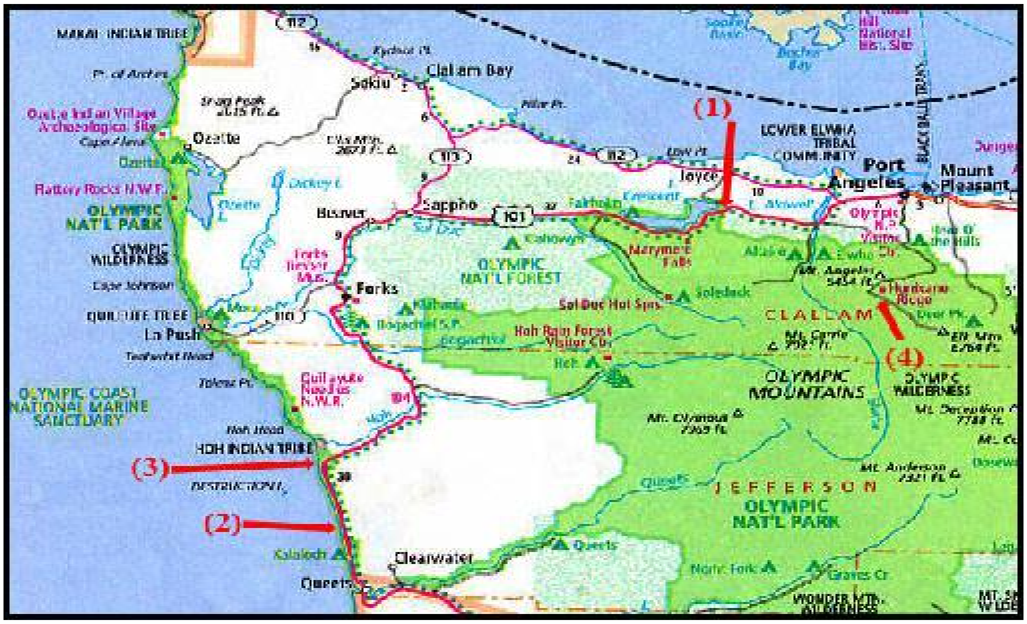


Four Field Trip Locations:

(1) East end of Crescent Lake

(2) Beach 4 on the Coast

(3) Ruby Beach on the Coast

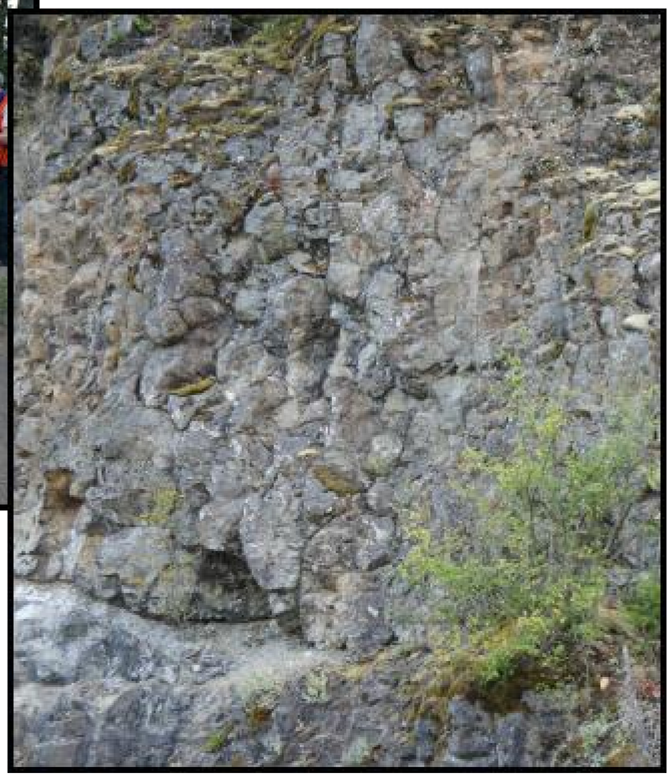
(4) Hurricane Ridge Road and Hill Trail

Stop 1: Crescent Lake - Crescent Basalt flows

Fundamental to the geology of the Olympic mountains is the basalt which makes up so much of them. This is rock created at mid ocean ridges which sea floor spreading brings to continental margins where subduction is occurring, part of the conveyor belt of earth surface crust with formation in the ocean and

consumption beneath continents. Basalt is also made in oceanic islands where hot spots are burning through the ocean floor to feed volcanoes like Hawaii. Subduction wedges basalt and deep ocean sediments into the continental margin and builds out the land mass over time using slices of the oceanic material as construction material.

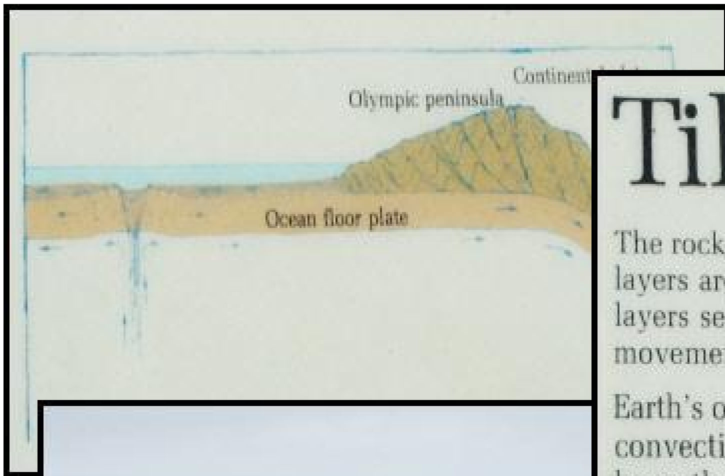
Crescent Basalt: Flows of black pillow basalt striking approximately east-west and dipping steeply (~85^{0}) north. Pillows show that the lava was extruded onto the seafloor where it chilled rapidly into a solidified mass. This basalt dates from 53 to 45 million years ago when it rose at a sea floor spreading center. Spreading carried it continentward, and subduction jammed it into the margin of N. America.

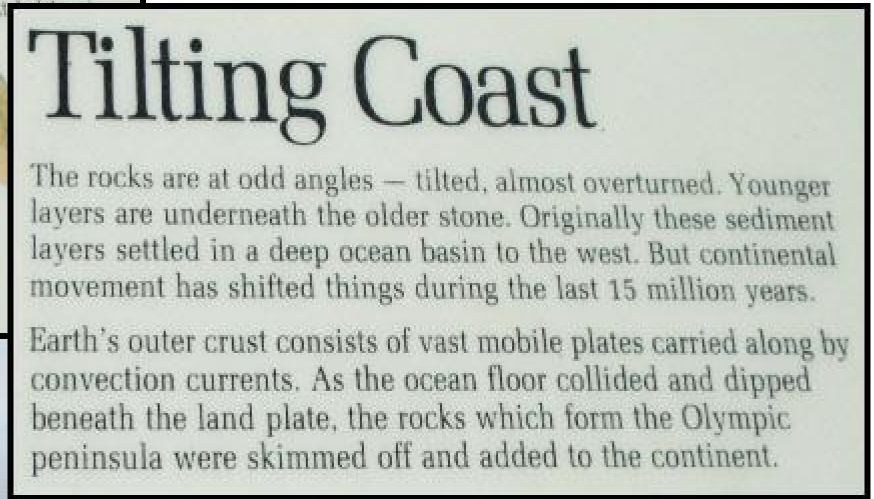


Beach 4: Turbidites - submarine mass flows of sediment on the edge of the continent

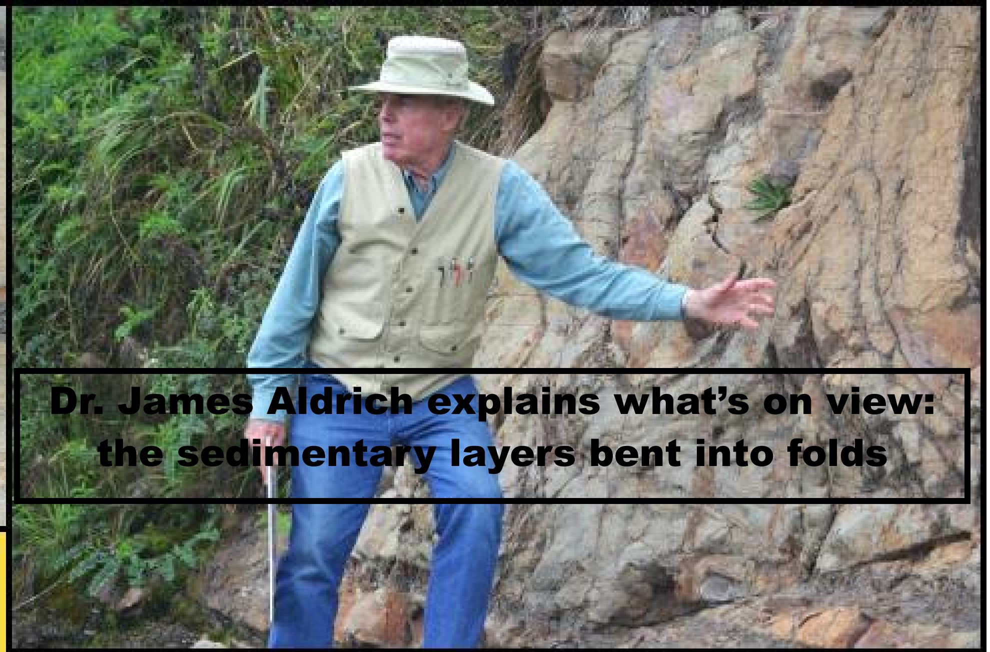
The Coastal OCS outcrops at this stop consist primarily of thick- to thin-bedded turbidite sandstone (graywacke) and siltstone. At the end of the trail are steep, east-dipping sandstones. Their orientation (right-side up or overturned) can be determined from primary sedimentary structures.

Turbidites are sediment accumulations at the base of the continental submarine margin where the seabed flattens out to the deep sea floor. As these spread out onto ocean crust, they are like material on a conveyor belt, carried into the continental margin by subduction, so they wind up piled into the growing continental edge (Olympic Mountains).

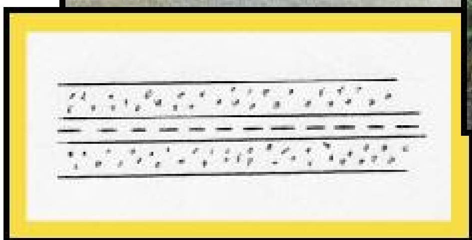

Olympic peninsula
Ocean floor plate

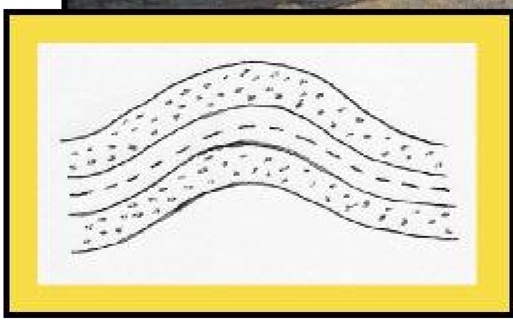

Tilting Coast
The rocks are at odd angles — tilted, almost overturned. Younger layers are underneath the older stone. Originally these sediment layers settled in a deep ocean basin to the west. But continental movement has shifted things during the last 15 million years.
Earth's outer crust consists of vast mobile plates carried along by convection currents. As the ocean floor collided and dipped beneath the land plate, the rocks which form the Olympic peninsula were skimmed off and added to the continent.

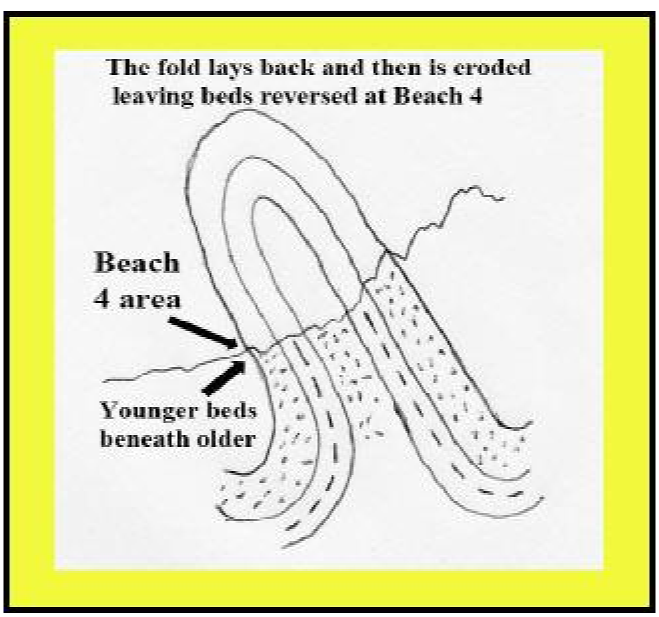
Turbidites And Folds

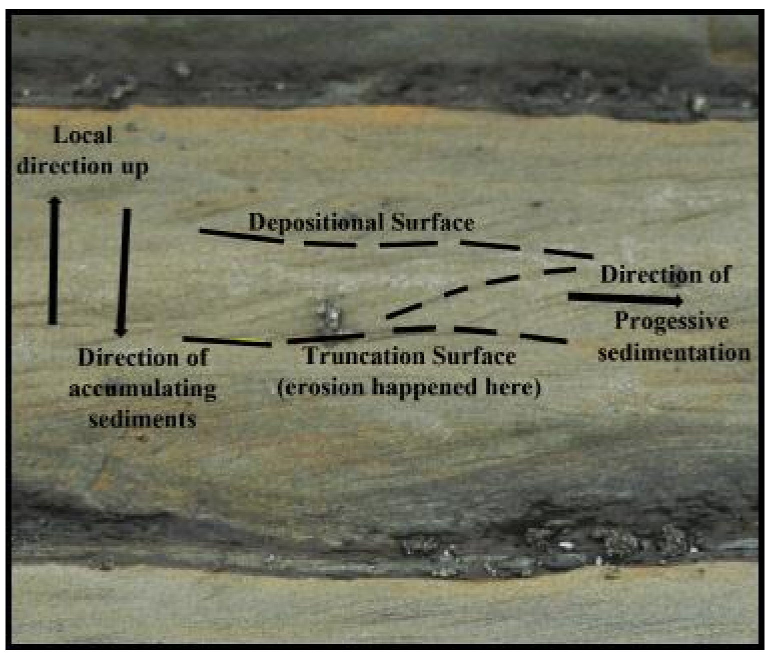


Dr. James Aldrich explains what's on view: the sedimentary layers bent into folds









Squeezing of the sediments as they are rafted into the continental margin warps the initially flat layers into folds which in the

How can you tell if sediment layers (beds) are upside down? Since they are deposited progressively, look for features that indicate direction of deposition.

extreme bend back on themselves, making some layers lie upside-down (think of a rug being shoved against a wall).

Erosion surfaces are good because something has to be deposited first before it can be eroded. An erosion surface below the deposit it is truncating means reversed bedding.

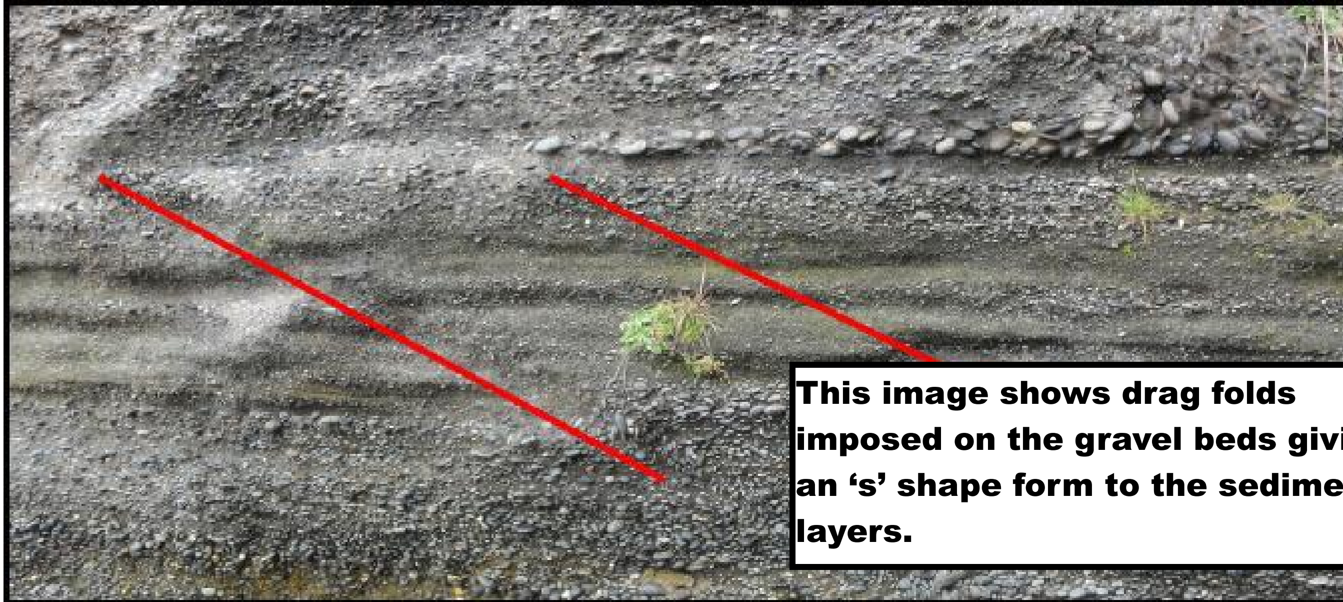
Faults: Rock layers under stress can break along planes and then slide along those faults. This happened on large and small scales.

Unconformity: A boundary between rock units representing the passage of time. In this case Pleistocene age sediments (up to a couple of million years old) sit on an erosion surface with sediment layers which are around 20 million years old below.

Field trip Extra: Beach Four
Deformation of Pleistocene Gravels (recent tectonics)

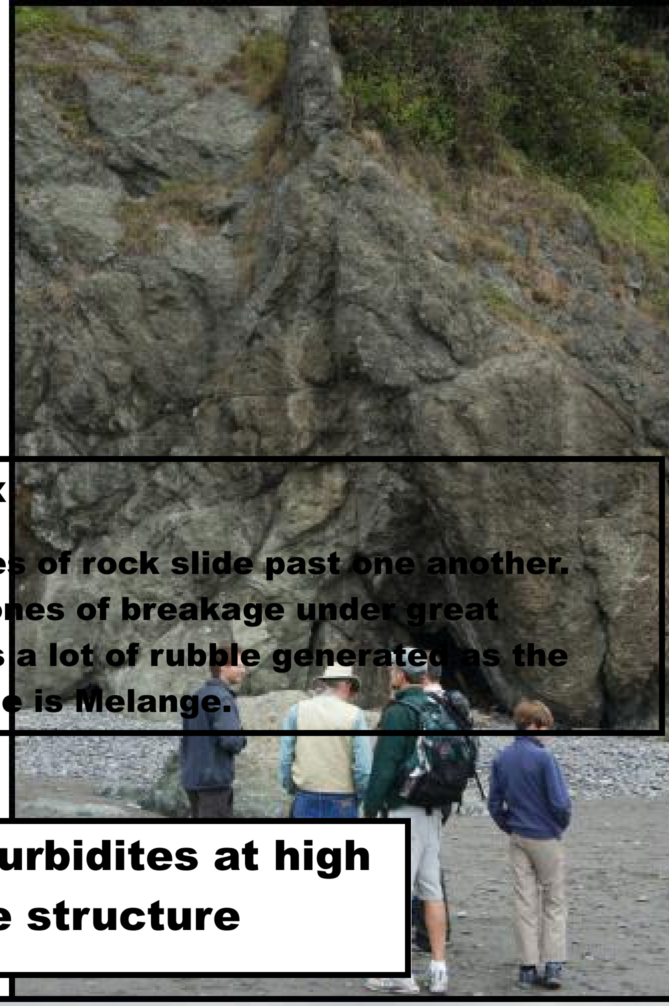
Courtesy of Carol Serdar

These younger deposits date from Ice Age times and have been deformed by faults and earthquakes. The picture below shows a cobble bed which has been folded upwards and then wrapped towards the viewer, so the cobbles go from flat and horizontal to vertical and turned towards the viewer.



This image shows drag folds imposed on the gravel beds giving an ‘s’ shape form to the sediment layers.

Stop 3: Ruby Beach: Melange - rubble on the boundary of a fault

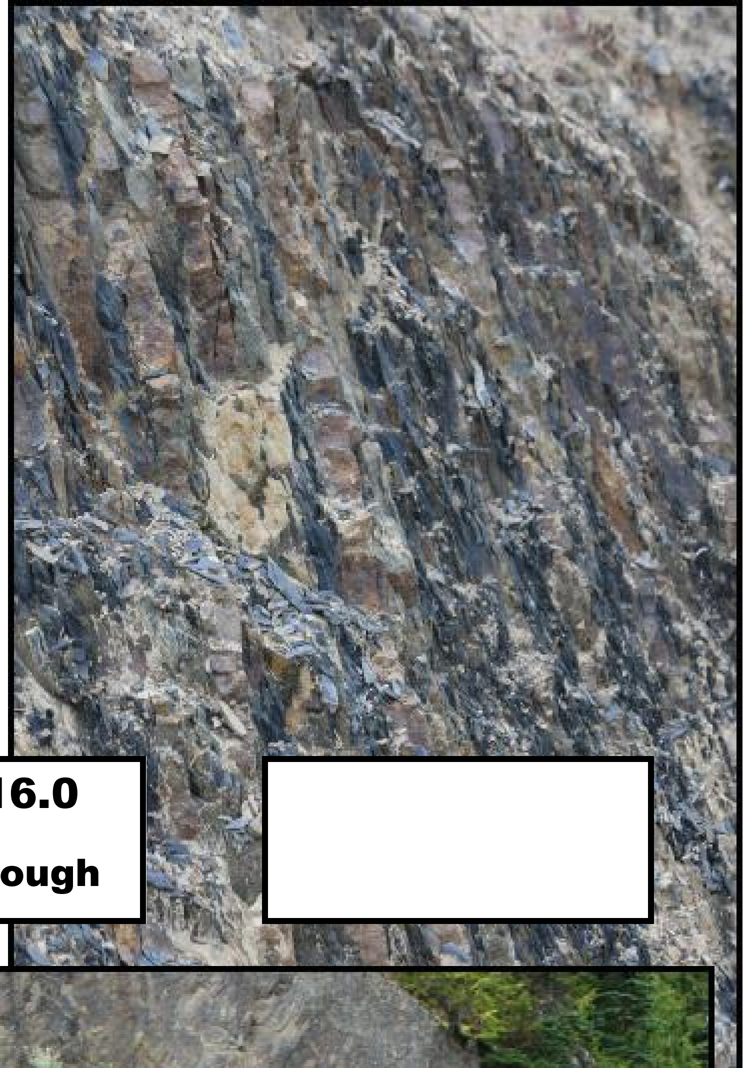


Melange: a french word for a mix

Faults are surfaces along which masses of rock slide past one another. These aren't clean, flat, planes, but zones of breakage under great pressure. As you can imagine, there is a lot of rubble generated as the rocks slip past one another. That rubble is Melange.

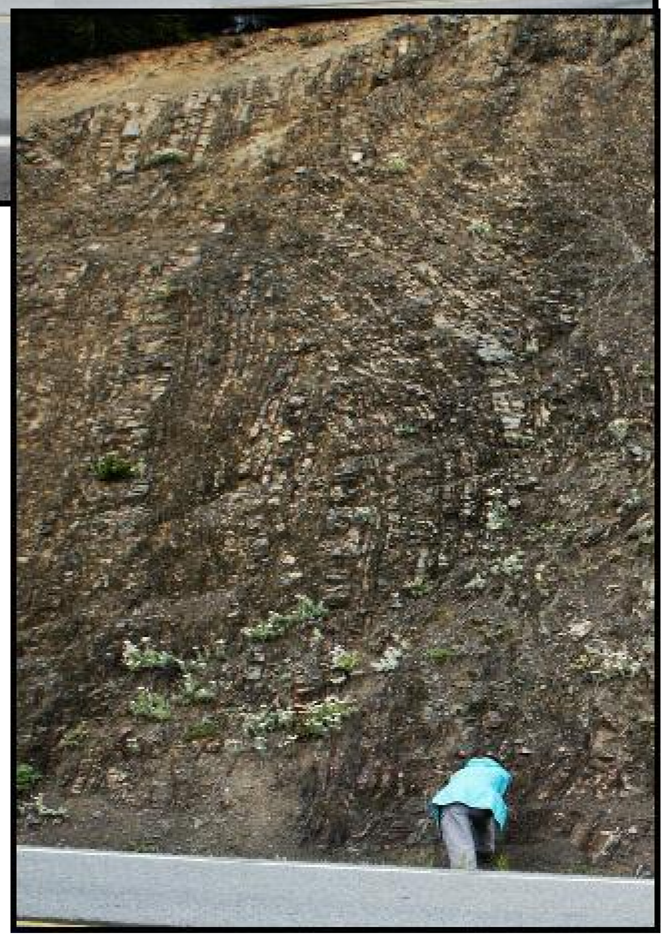
Hurricane Ridge: **Turbidites at high elevation - extreme structure**

Hurricane Hill Trail: **Needles-Grey Wolf greywacke (turbidite) sediments, standing on end.**



Hurricane Road: **Mile post 16.0**

Sediments contorted like playdough



Tortured Rocks:

Trace the layers on any of these pictures. The sedimentary beds have been deformed like playdo squeezed between two blocks. The ‘rocks and a hard place’ are the ocean crust seaward which is rafting into the continental margin, and the interior of the continent. This material was scraped off the ocean floor and jammed into the continent, building out the margin and the Olympic Mountains in the process.

Stop 6: what was seafloor underlying all the sediments,

pillow basalts carved by faults

Hard Rock Pillows: **Round balls of lava spilled out on the ocean floor. Right is a pillow which has been split by a fault.**