

Beautiful Rocks in Washington (Aren't they all beautiful?)

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WASHINGTON STATE DEPT OF
**NATURAL
RESOURCES**
WASHINGTON
GEOLOGICAL SURVEY



Who am I to discuss rocks?

DNR Mining and Minerals Program Manager

Geology degrees and licensed engineering geologist

Previous experience:

- Owned small geologic consulting company
- Surface Mine Reclamation Program
- Taught geology and earth science at Wenatchee Valley College

“Field geologist”

DNR Mining and Minerals Program

Manages earth resources on DNR Trust lands.

- Prospecting leases and mining contracts around the state.
- Assists DNR regions with aggregate removal contracts.
- Works with DNR Clean Energy on geothermal resource leases
- Provides mineral resource assessments to DNR Assets
- Compiles geologic information for DNR trust lands related to minerals, aggregate, etc.
- SME on earth resources



Talk plan

Where are we?

- Current tectonic setting

When did this happen?

- Geologic history

How did it get here?

- Tectonic history

Under what conditions do interesting minerals and fossils form?

Who cares?

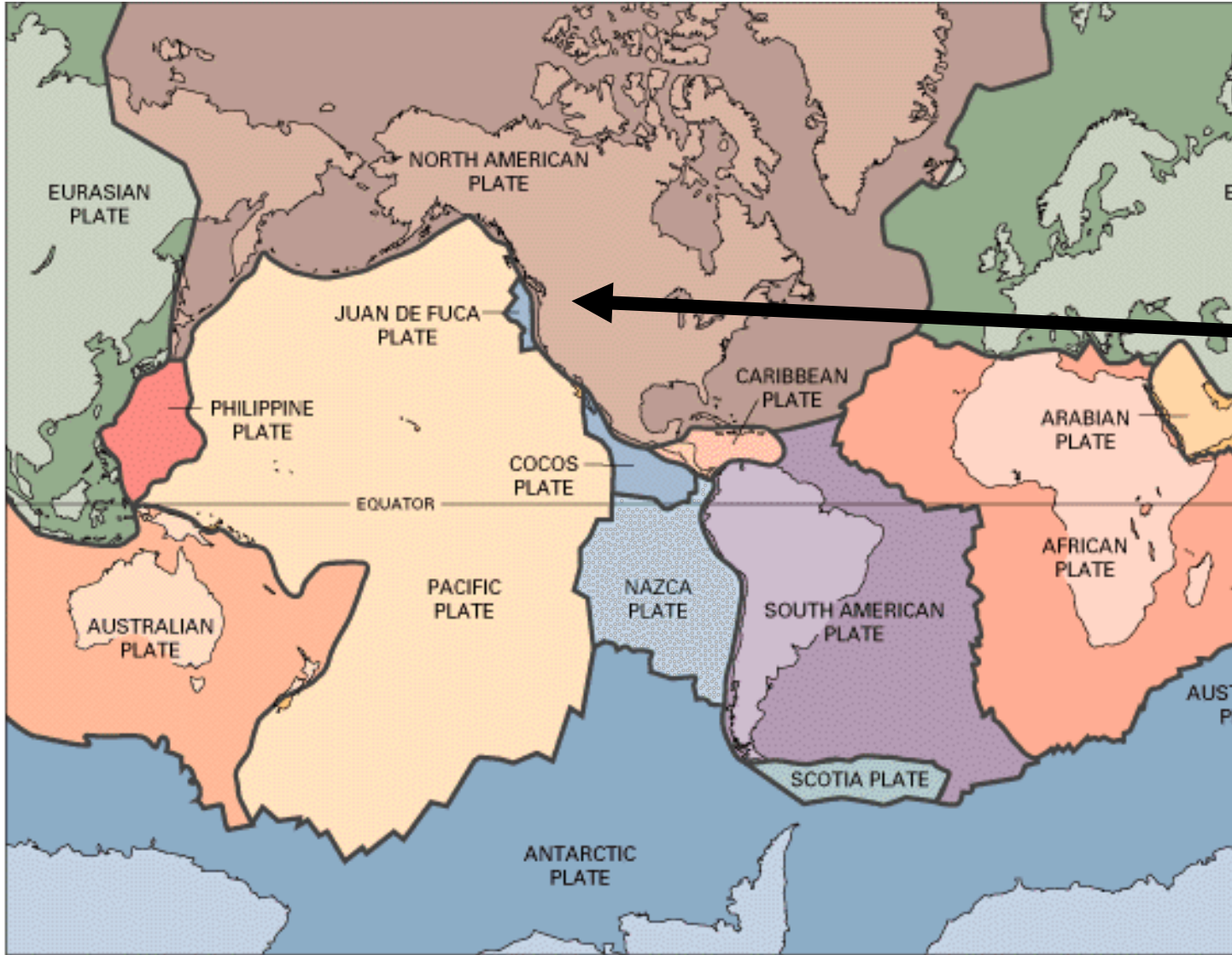
- Rockhounding in Washington



A topographic map of the Pacific Northwest and northern California, showing mountain ranges, rivers, and cities. The text "Where are we?" is overlaid in white. The map includes labels for cities like Vancouver, Seattle, Portland, and Spokane, and mountain ranges like the Coast Range, Cascade Range, and Bitterroot Range. Rivers such as the Columbia, Snake, and Willamette are also labeled.

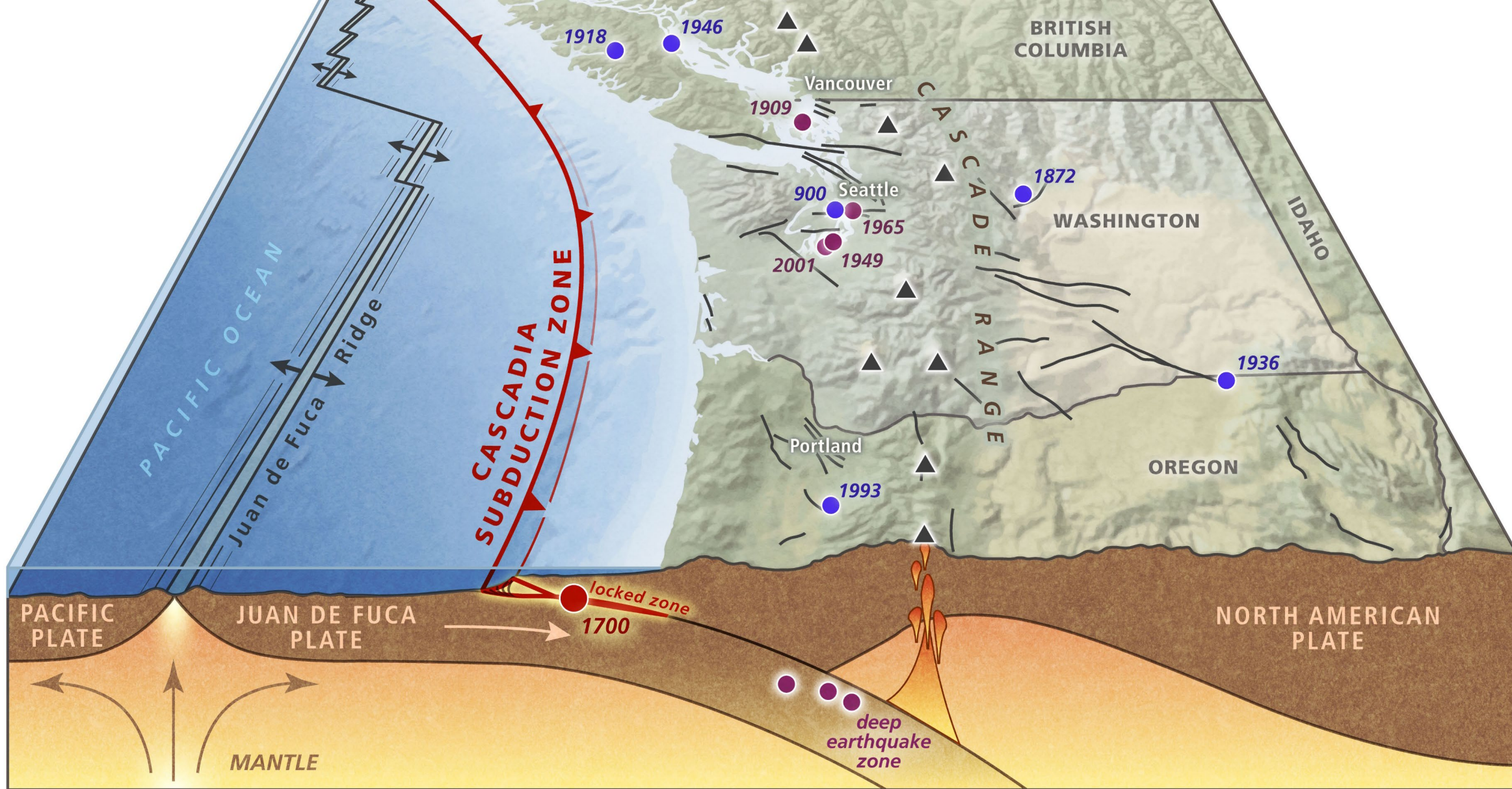
Where are we?



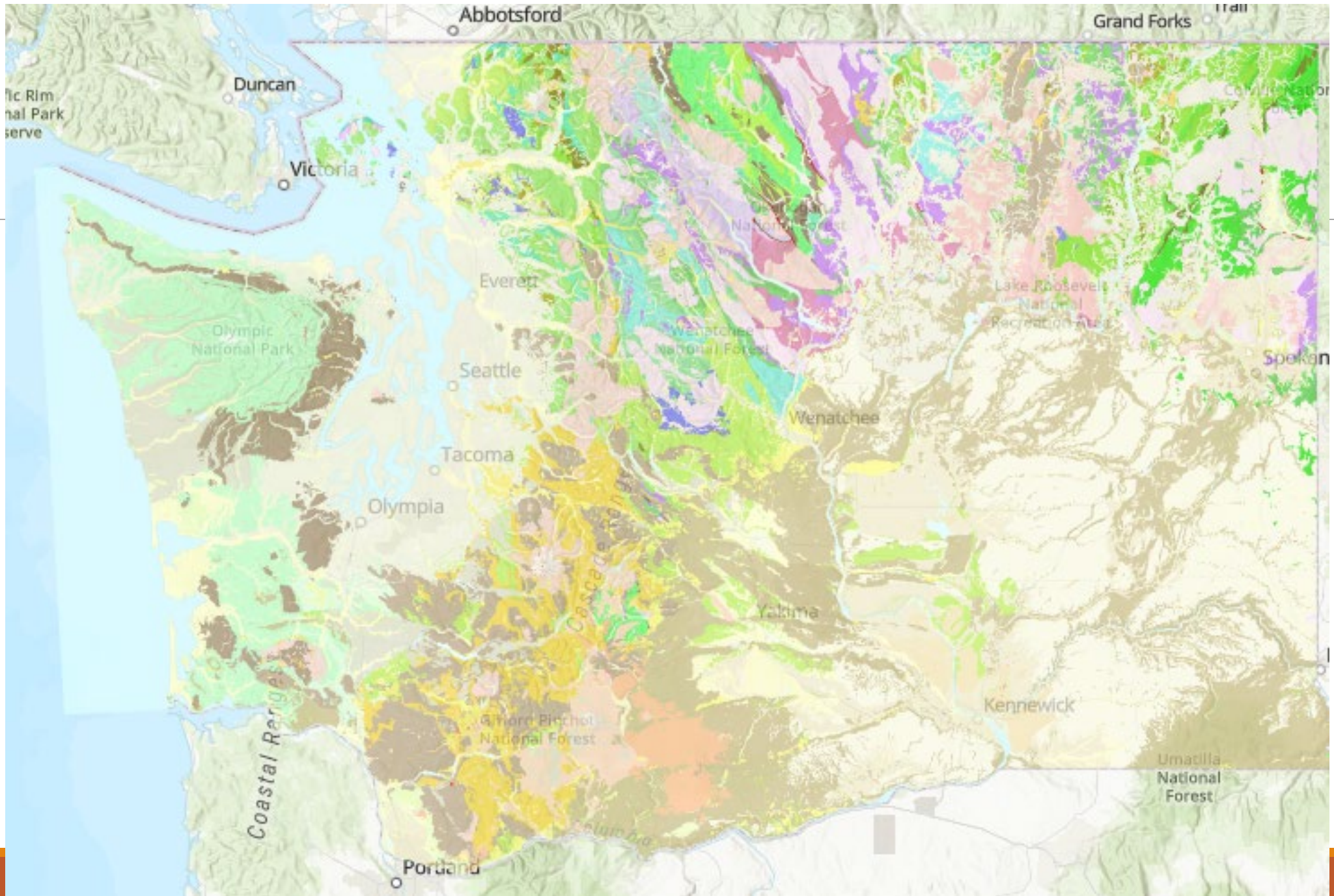


Tectonic setting

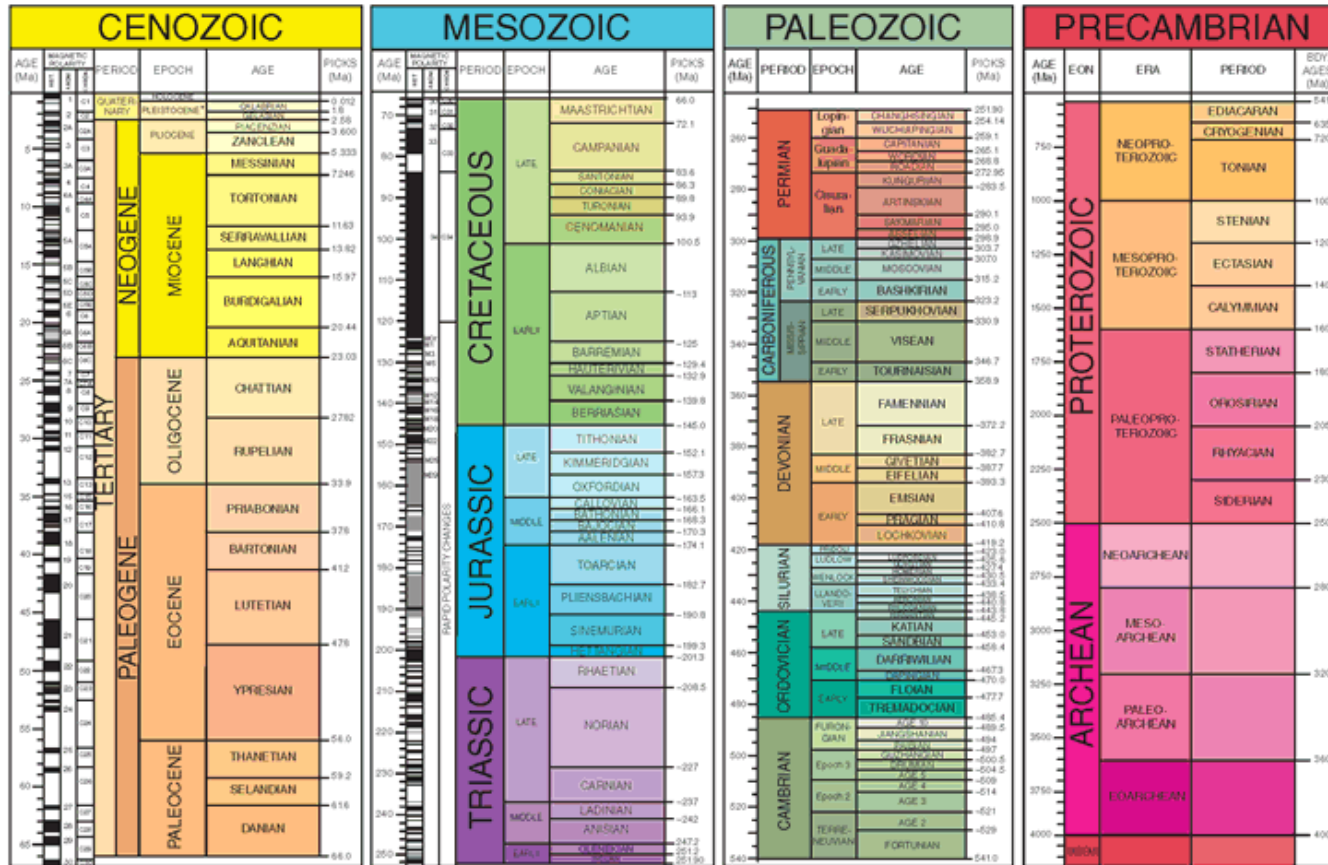
Pacific and Inland Northwest are on North American plate but affected by the Cascadia subduction zone (Cascadia)



- year → 1918 ● crustal earthquake
- deep earthquake
- subduction zone earthquake
- crustal fault
- ▲ major volcano



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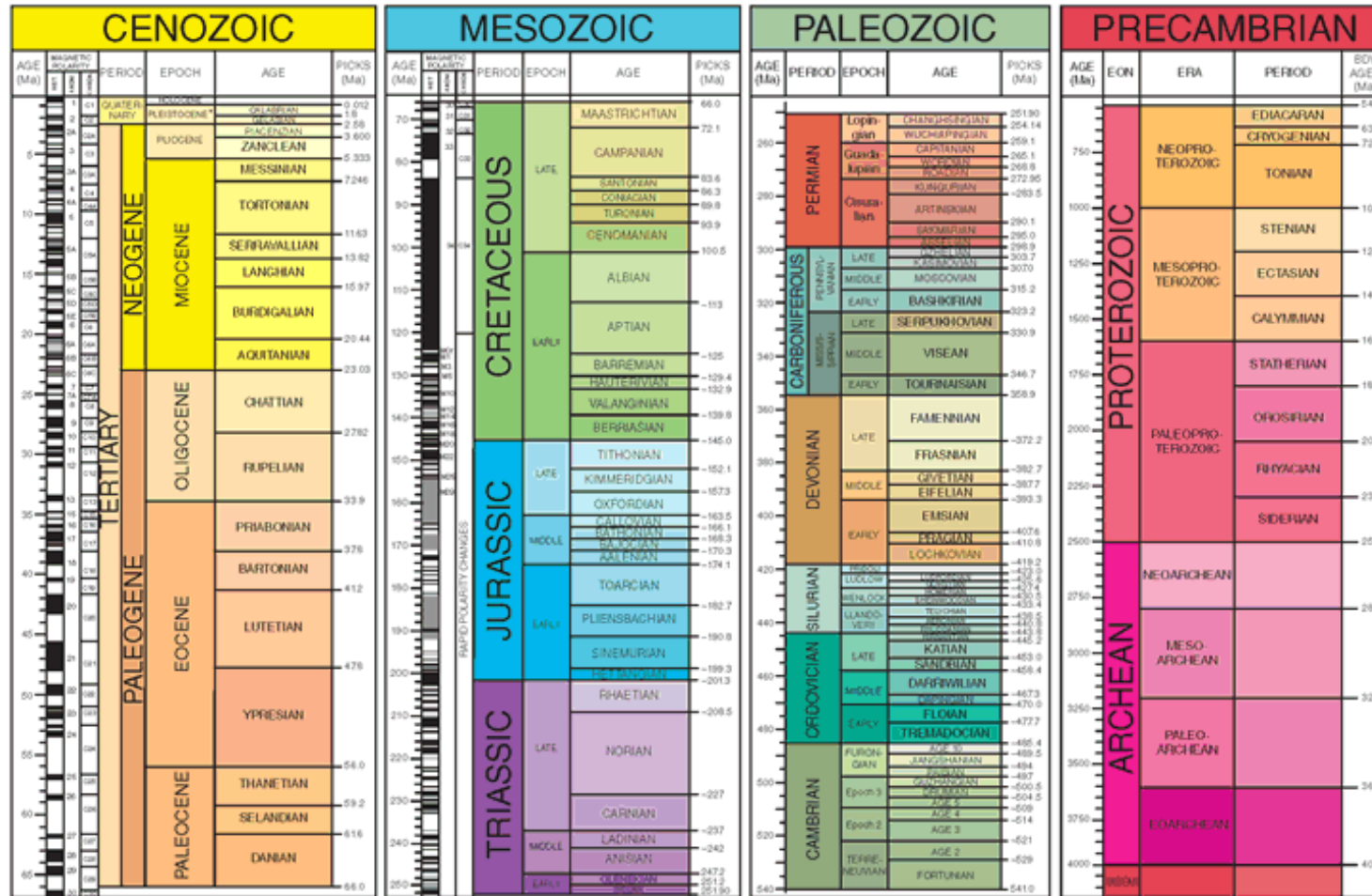


When did this happen?
How did it get here?



Walker, J.D., Gassman, J.W., Bowring, S.A., and Babcock, L.E., compilers, 2018, Geologic Time Scale v. 5.0: Geological Society of America, <https://doi.org/10.1130/2018.CS305RDC>. ©2018 The Geological Society of America
 *The Proterozoic is divided into four ages, but only two are shown here. What is shown as Cambrian is actually three ages—Cambrian from 1.80 to 0.781 Ma, Middle from 0.781 to 0.126 Ma, and Late from 0.126 to 0.0117 Ma.
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Belt Basin



Whoa!



Basement



Walker, J.D., Geissman, J.W., Bowering, S.A., and Babcock, L.E., compilers, 2018, Geologic Time Scale v. 5.0. Geological Society of America, <https://doi.org/10.1130/2018.CT500593C>. ©2018 The Geological Society of America.
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Belt Basin and splitting of Rodinia



~1.4 Ga sediments deposited in Belt Basin

- Maybe an inland sea or large lake
- Minerals in the sediments suggest a nearby igneous source (volcanoes?)
- Similar minerals in Australia and Siberia suggest those areas may have been “next door”

~720 Ma Rodinia split up

- Supercontinent
- Belt Basin and western North America now part of “Laurentia”

What are these rocks now?

- “Basement” rocks are gneiss and schists
- “Belt Supergroup” rocks are metasedimentary

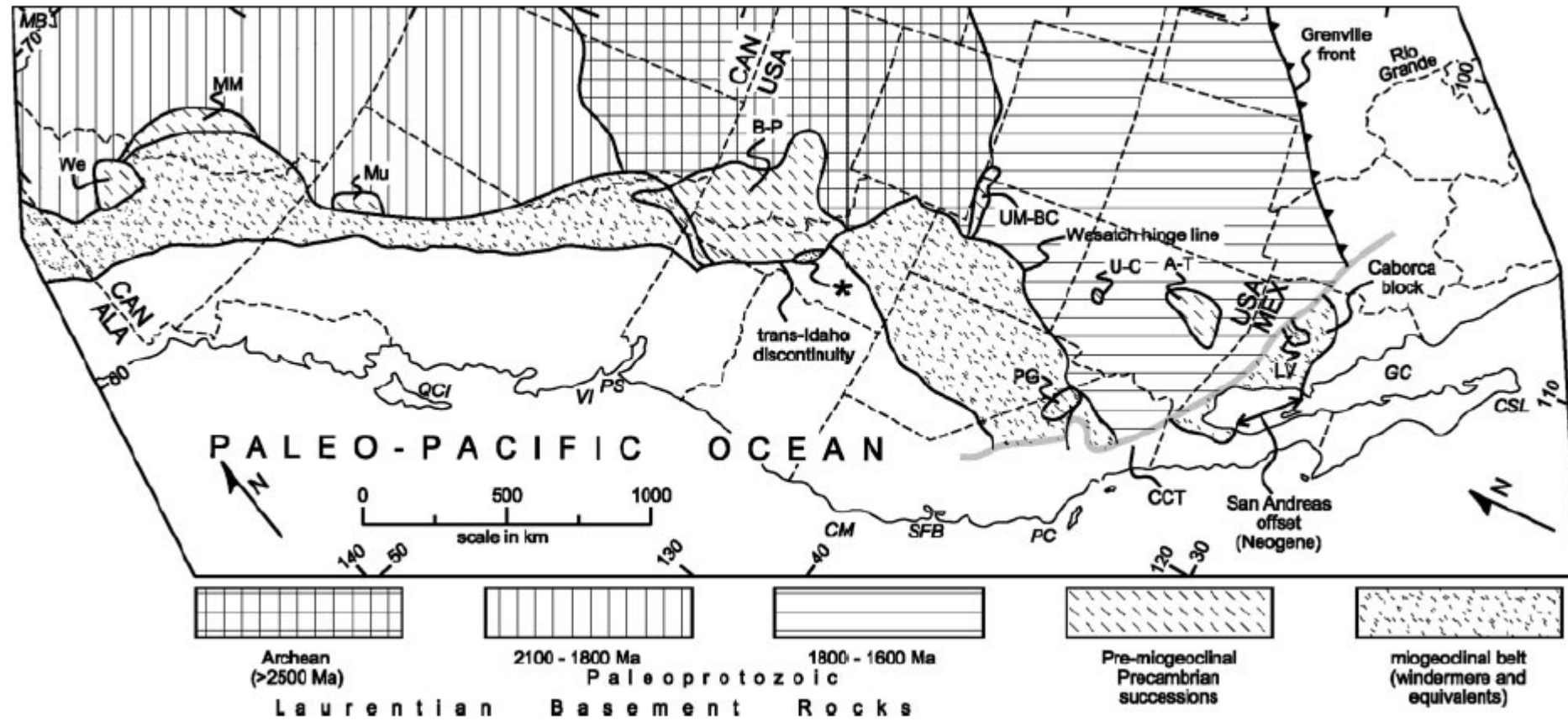
Passive margin

Splitting of Rodinia left “new” continent Laurentia with a passive western margin.

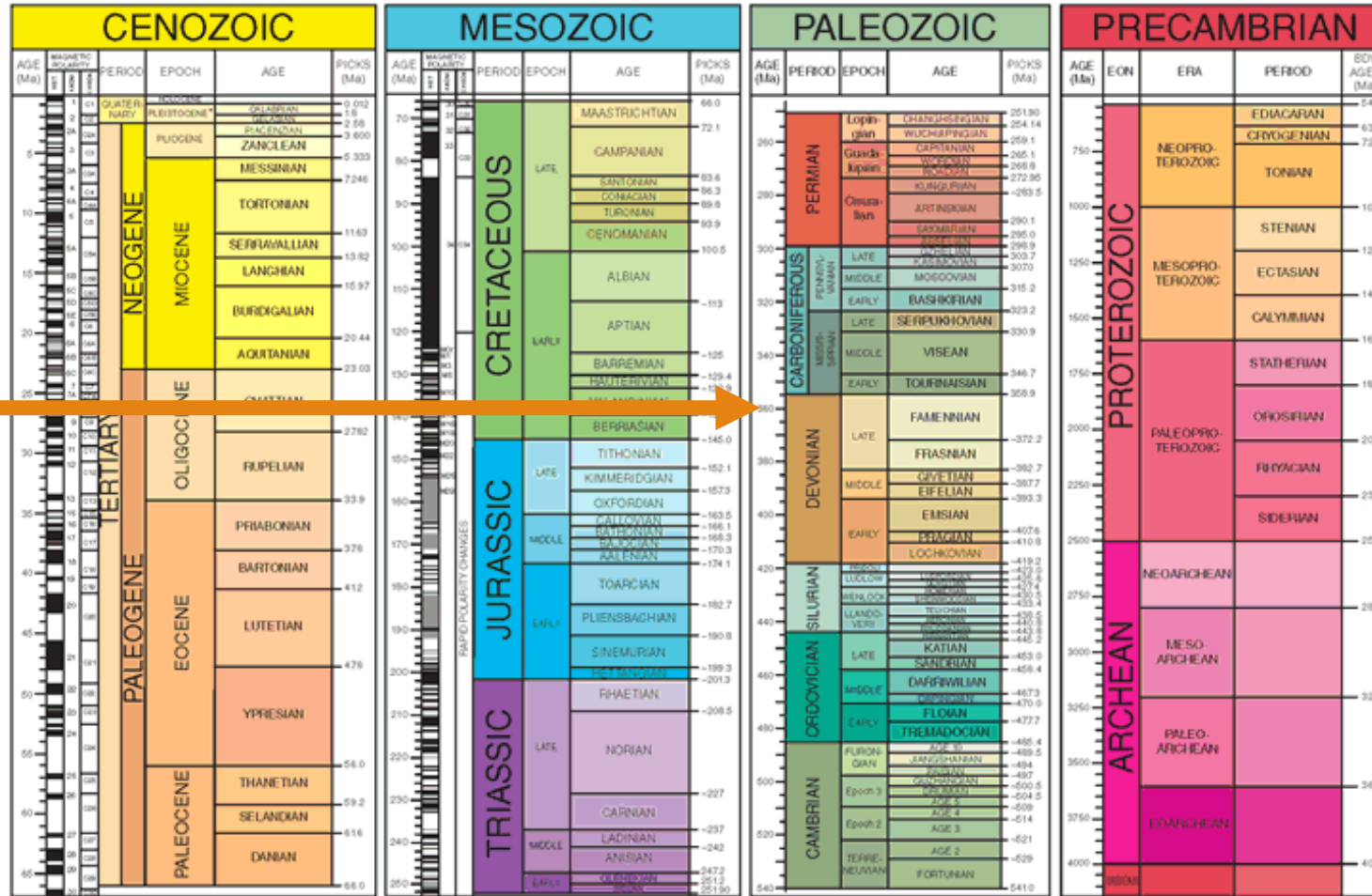
Carbonate sediments deposited over the sandstones related to rifting.

What are these rocks now?

- Sedimentary (some fossil bearing!)



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Many, many years of quiet sedimentation



Walker, J.D., Geissman, J.W., Bowering, S.A., and Babcock, L.E., compilers, 2018, Geologic Time Scale v. 5.0. Geological Society of America, <https://doi.org/10.1130/2018.CT500593C>. ©2018 The Geological Society of America
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Subduction!

Mid-Paleozoic, subduction started on western North America.

Passive margin sedimentary rocks crumpled onto edge of the continent.

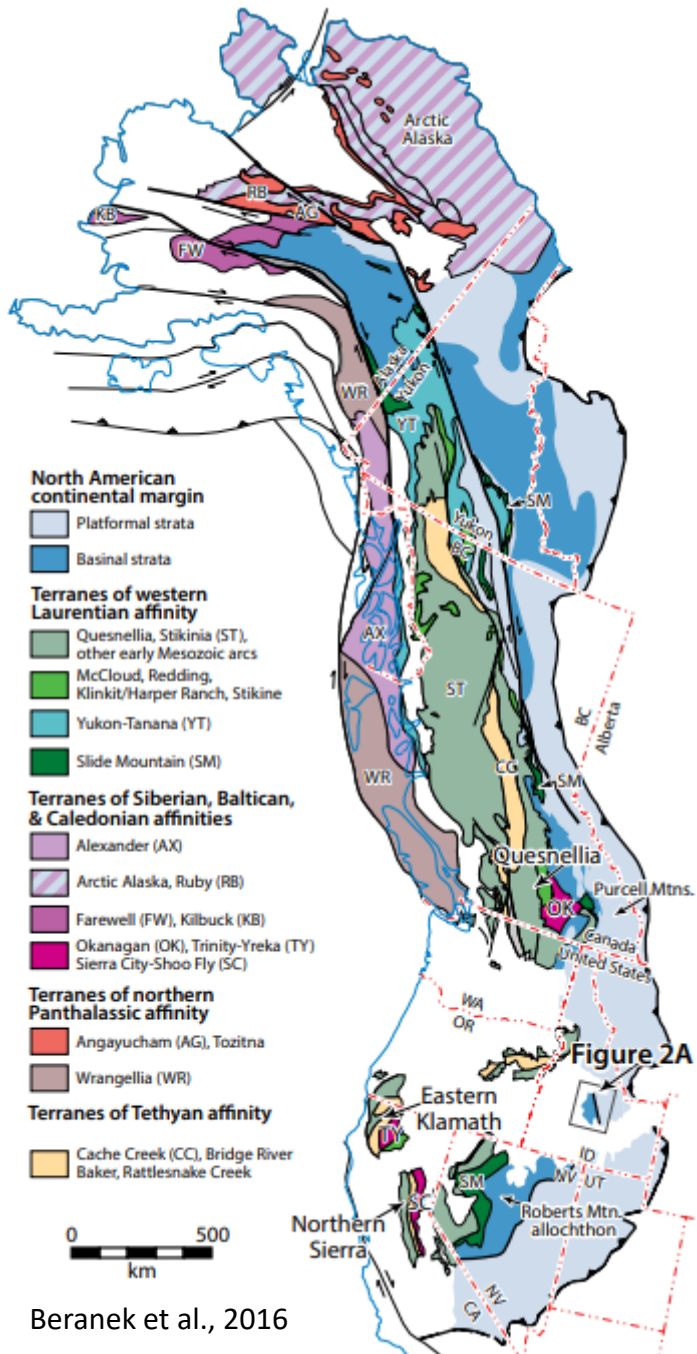
Numerous terranes “tacked” on to western margin of North America, pulled eastward by subducting plate.

- Sometimes called suspect, exotic, or more commonly, accreted terranes

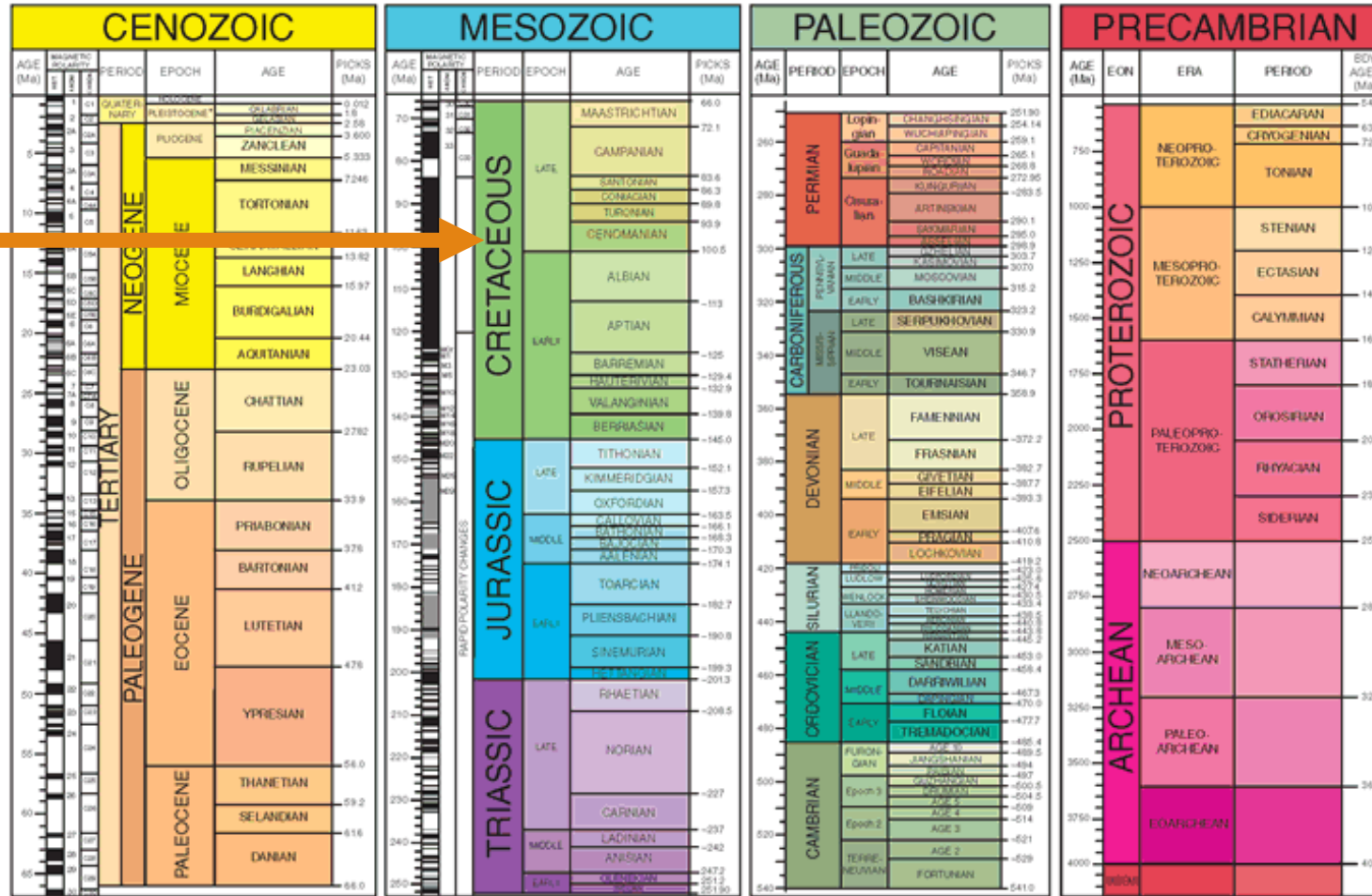
Several “orogenies”, or mountain building events caused deformation and magmatism.

What are these rocks now?

- Many terranes are metamorphic rocks
- Igneous rocks intruded terranes



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Cretaceous mountain building after many accreted terranes



Walker, J.D., Geissman, J.W., Bowering, S.A., and Babcock, L.E., compilers, 2018, Geologic Time Scale v. 5.0. Geological Society of America, <https://doi.org/10.1130/2018.CT500593C>. ©2018 The Geological Society of America
 *The Pleistocene is divided into four ages, but only two are shown here. What is shown as Calabrian is actually three ages—Calabrian from 1.80 to 0.781 Ma, Middle from 0.781 to 0.126 Ma, and Late from 0.126 to 0.0117 Ma.
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Crowded Cenozoic

Terranes continued to roll in

- Siletzia, a large igneous province which underlies much of western WA and OR, “docked” in the Eocene, ~52 Ma

Eocene extension

- Basins filled with sediments (coal!)
- Metamorphic rocks brought to the surface

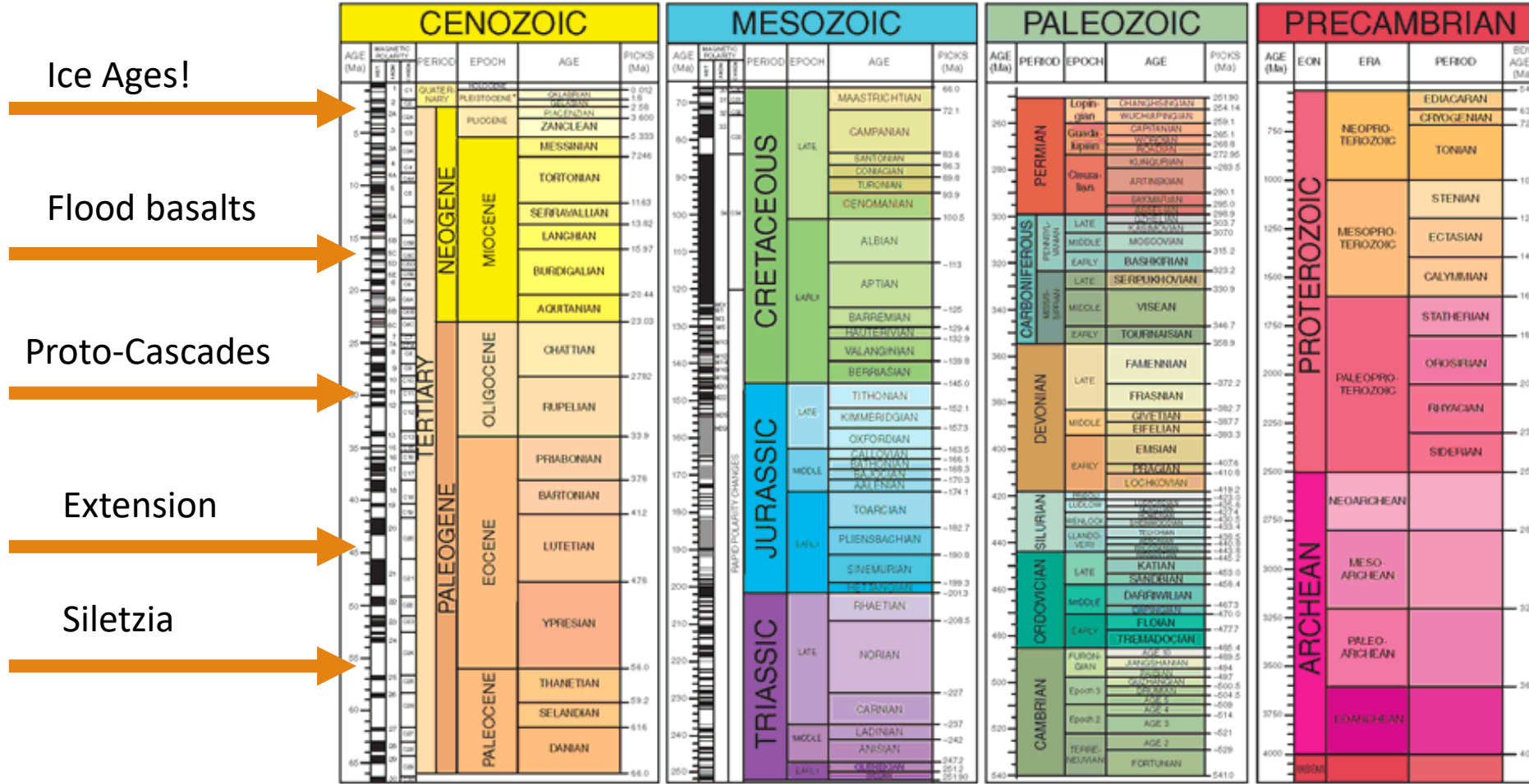
The “proto-Cascades” began building in the Oligocene.

- Igneous rocks, lots of volcaniclastic rocks
- Hydrothermal alteration of many existing rocks

Miocene flood basalts (now called the Columbia River Basalt Group) covered eastern WA and, even making it to the Pacific!



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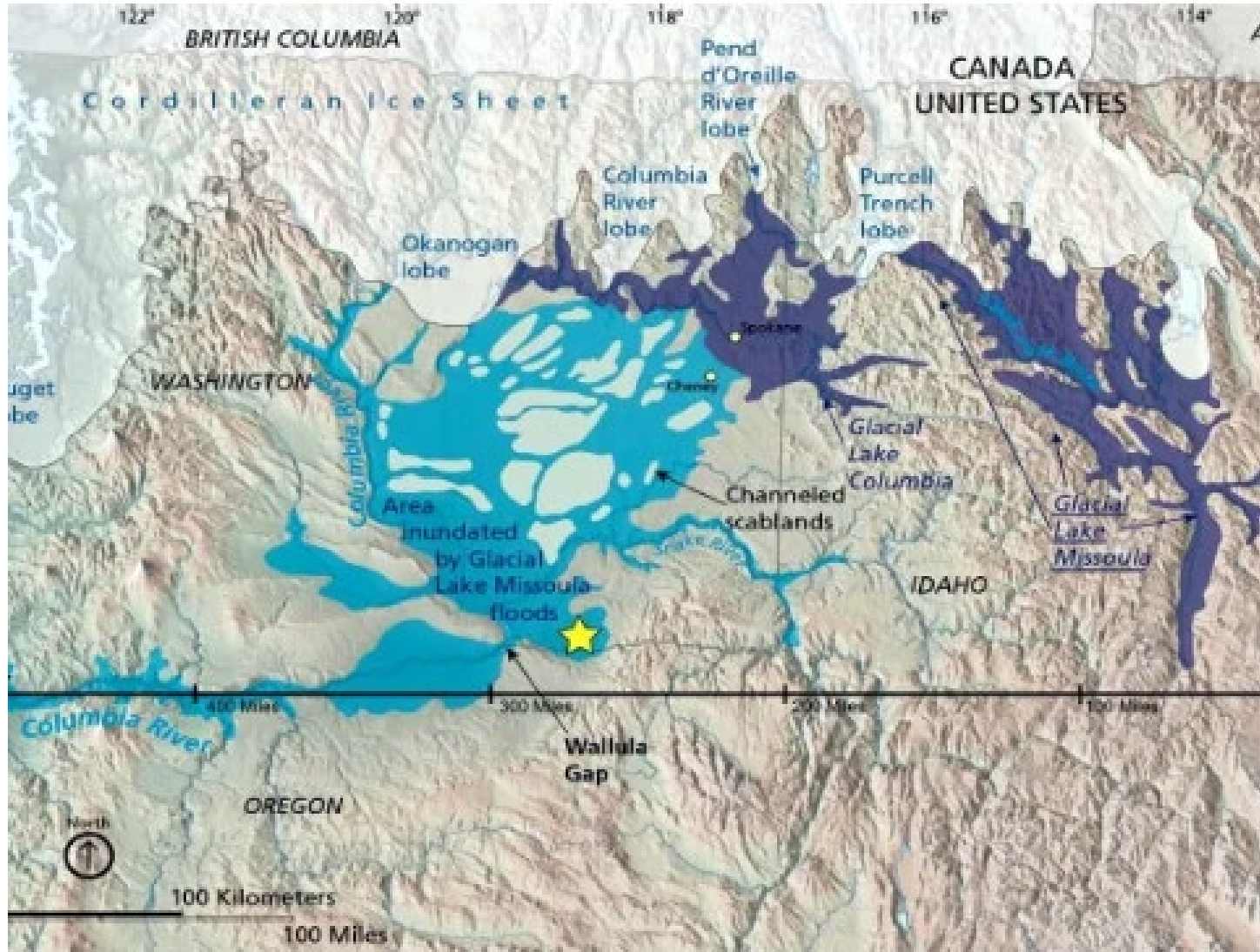
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Pleistocene Ice Ages



Cordilleran Ice Sheet covered northern WA several times.

Last glacial maximum (LGM) had Puget lowlands under ~3000 feet of ice!

Glacial outburst floods rushed across eastern and central WA, filled in the Willamette

Rocks carried from elsewhere by ice, icebergs, water....

Today – still subduction

Active volcanoes

- Mt St Helens 1980
- Lassen Peak 1921

Earthquakes

- Downgoing plate (1949, 1965, 2001)
- Megathrust (1700)
- Crustal faults (~900, 1872)

Geodetic movement

- Coastal regions moving east from downgoing plate offshore





What rocks have
minerals and fossils?



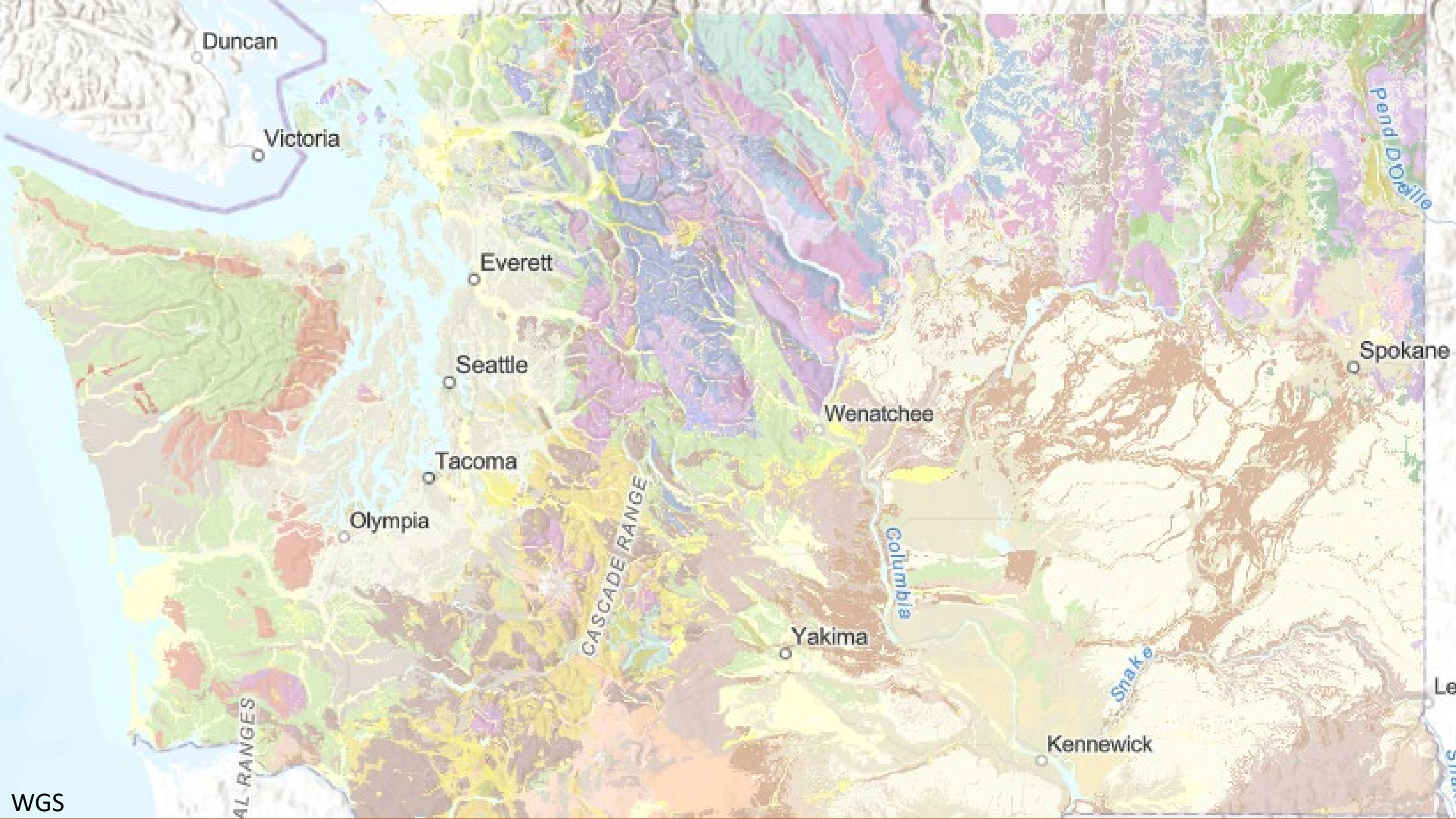
“Gemstones”

Mineral or stone that can be cut and polished for ornamentation.

Precious and semiprecious, depends on durability, rarity, etc.

Gemstone minerals are typically igneous or metamorphic minerals

- High heat and/or high pressure formation conditions
- Sometimes involves hydrothermal or magmatic fluids



Duncan

Victoria

Everett

Seattle

Tacoma

Olympia

Wenatchee

Yakima

Spokane

Kennewick

AL RANGES

CASCADE RANGE

Pend D'Oeille

Columbia

S Snake

Le

WGS

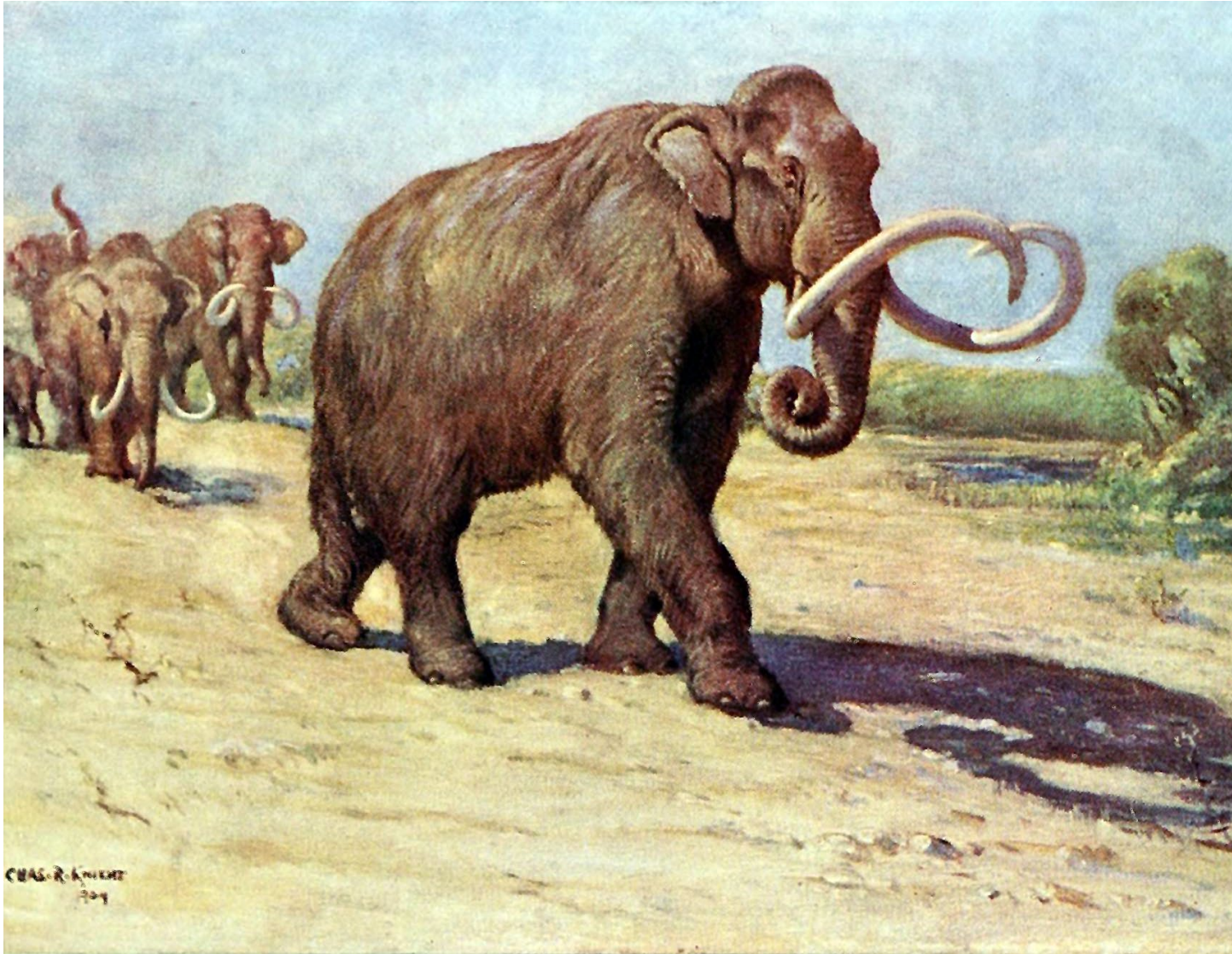
Minerals

Rocks are composed of minerals!
So if you are holding a rock, you've got a mineral in hand too!

Minerals that interest people (besides geologists) can form in many kinds of geologic environments:

- Hydrothermal/epithermal examples: quartz, fluorite, bornite and other copper minerals, pyrite.
- Metamorphic examples: galena, zeolite, epidote.
- Igneous examples: labradorite (and other feldspars), mica, garnets.
- Sedimentary examples: gypsum, barite, calcite, pyrite.





Fossils

Fossilization occurs when organic materials are replaced with minerals.

Generally requires rapid burial of the material so that the organic material is cut off from oxygen and does not rot.

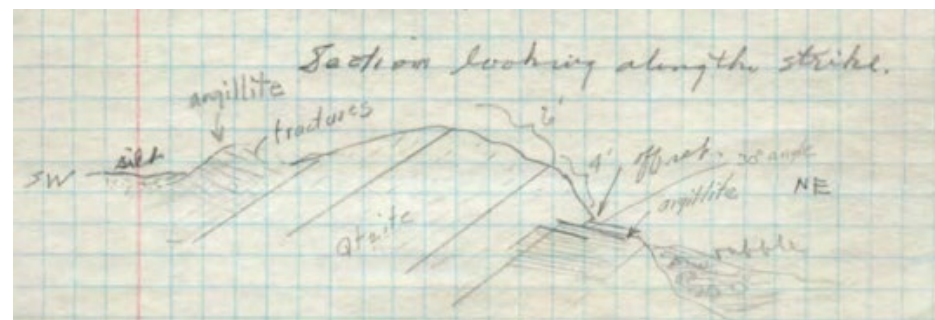
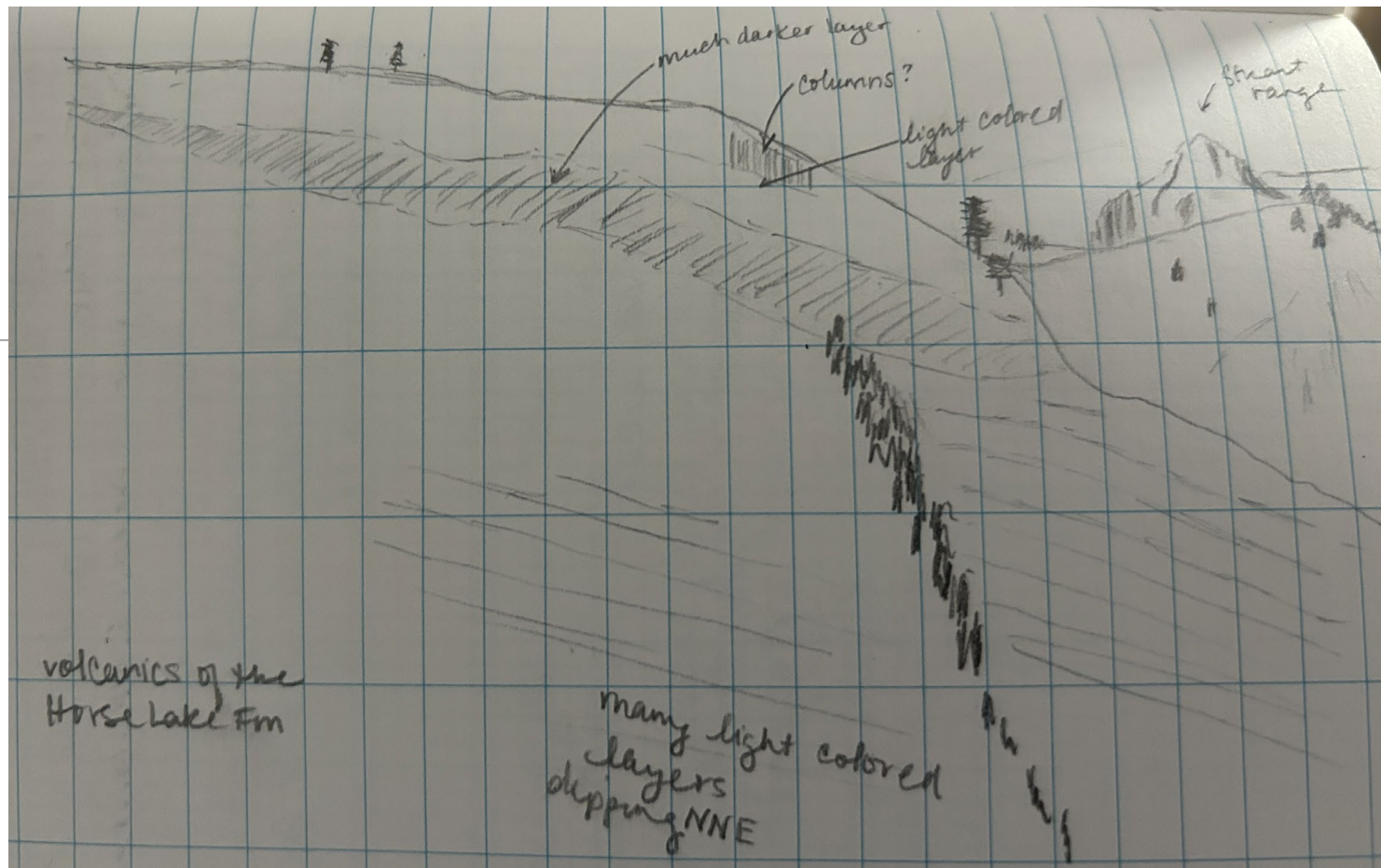
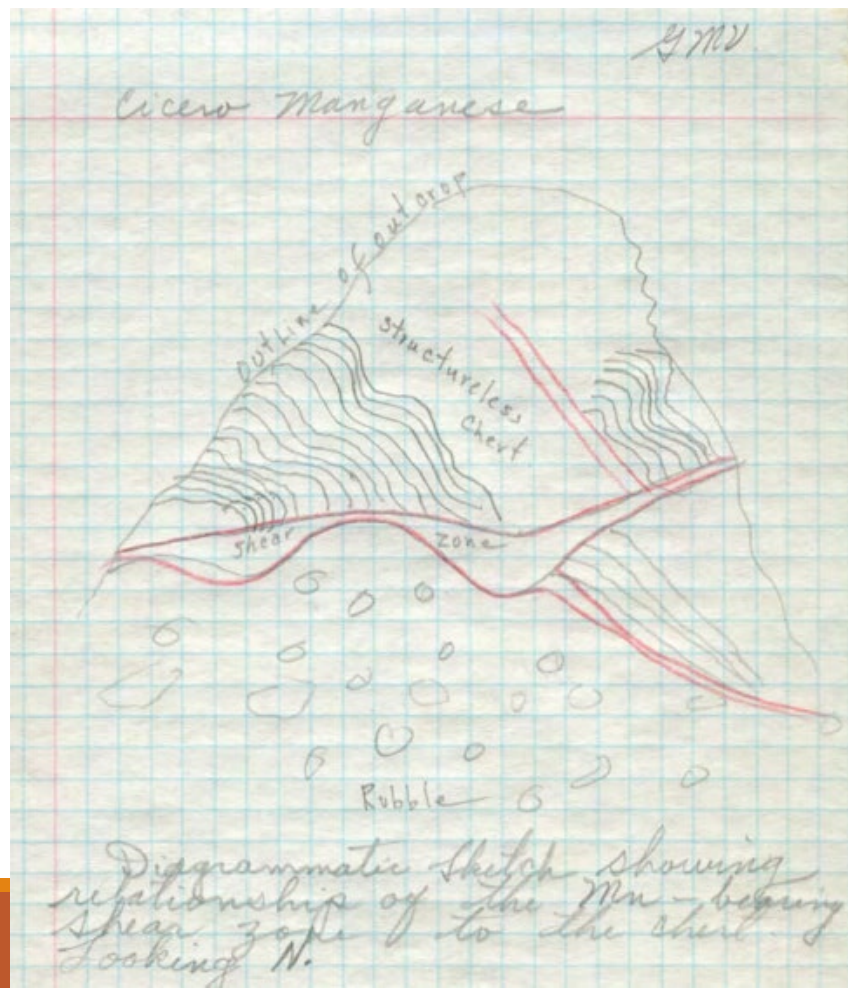
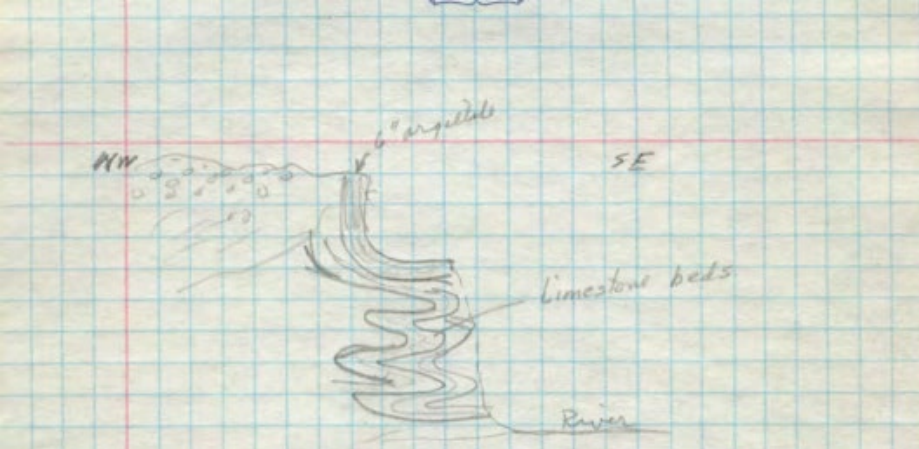
Replacement may occur from groundwater or hydrothermal fluids moving through the rock (and the buried organic specimen!).



Fossilized/Petrified Wood

Cool Rocks





Who cares?





Rockhounding in Washington

1. Where do you want to rockhound?

- Figure out the land owner – county assessor webpages, OnX, Wa Geo Portal

2. Obtain permission. Don't assume permission is granted from information you hear on videos, etc.

How do you figure out where you want to go?

- Wa Geological Survey Rockhounding webpage
- Washington Geological Library
- Wa Geo Portal – mineral observations

Rockhounding on DNR Trust lands

DNR manages Trust lands for the benefit of the Trusts

- Public K-12 schools, State universities, State institutions and prisons. Some county forest lands

Rockhounding allowed on most Trust lands in small amounts for your personal collection (not selling or using within object you plan on selling, like jewelry).

No mechanized equipment.

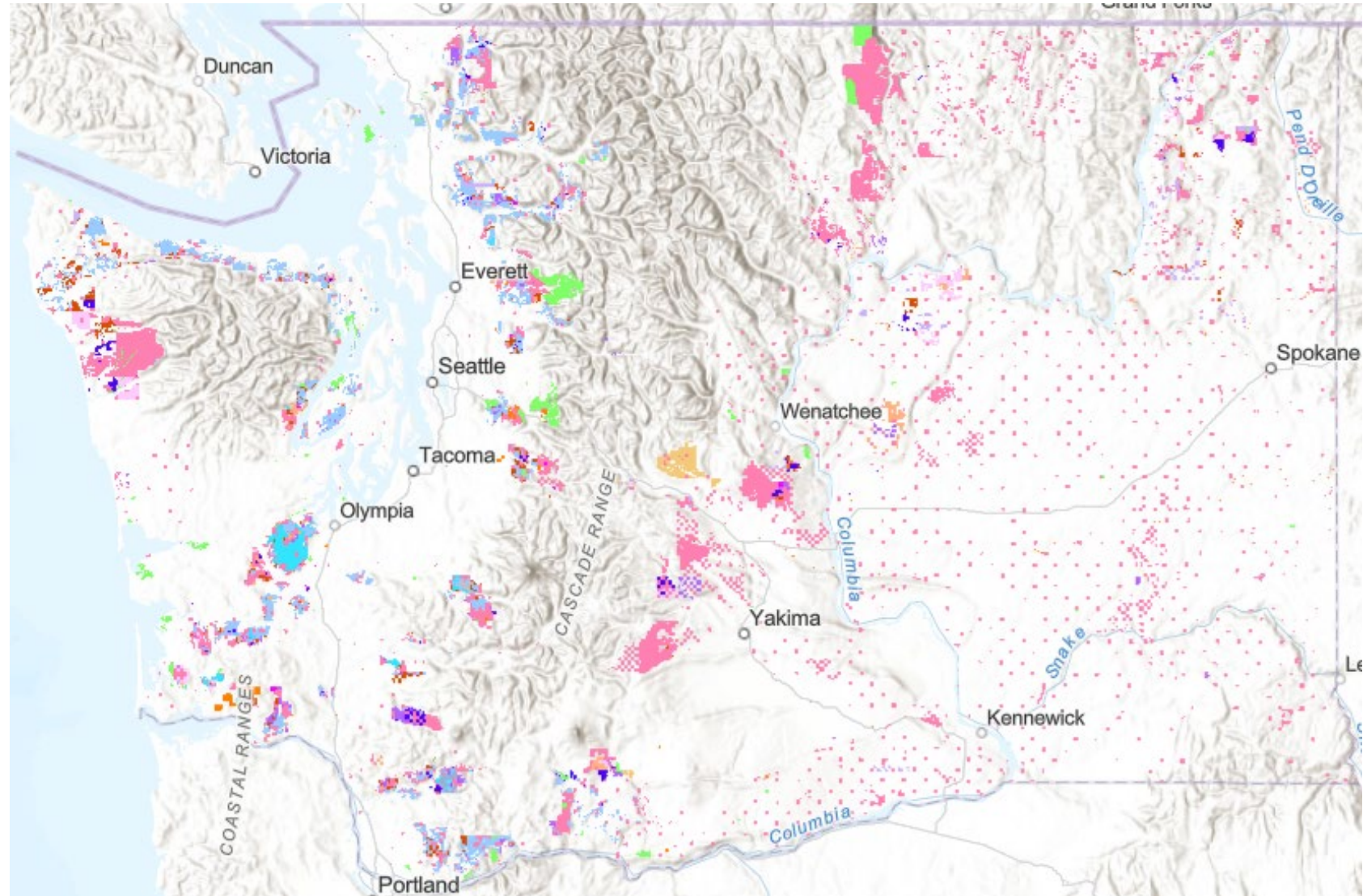
Confirm DNR access.

Enter DNR managed property at your own risk.

Currently no designated rockhounding locations.

No collection of fossils!

- DNR Aquatics may have different policies.



A couple of cool resources....

Washington Geologic Information Portal - <https://geologyportal.dnr.wa.gov>

MinDat - <https://www.mindat.org/>

Washington Geologic Library - <https://dnr.wa.gov/washington-geological-survey/washington-geology-library>

WGS Rockhounding webpage - <https://dnr.wa.gov/washington-geological-survey/explore-popular-geology/rockhounding>

Other cool geologic things

Washington 100

<https://wa100.dnr.wa.gov>

Ice Age Floods Interpretive Trail

<https://iafi.org>

kelsay.stanton@dnr.wa.gov



Click **HERE** to start exploring!

Click here to open the map shown below in full screen.

