BASALT AND OTHER HARD-ROCK TYPES IN EPA REGION 10

A Brief Introduction to the Geology and Tectonics of the Pacific Northwest with Emphasis on "Basalts"

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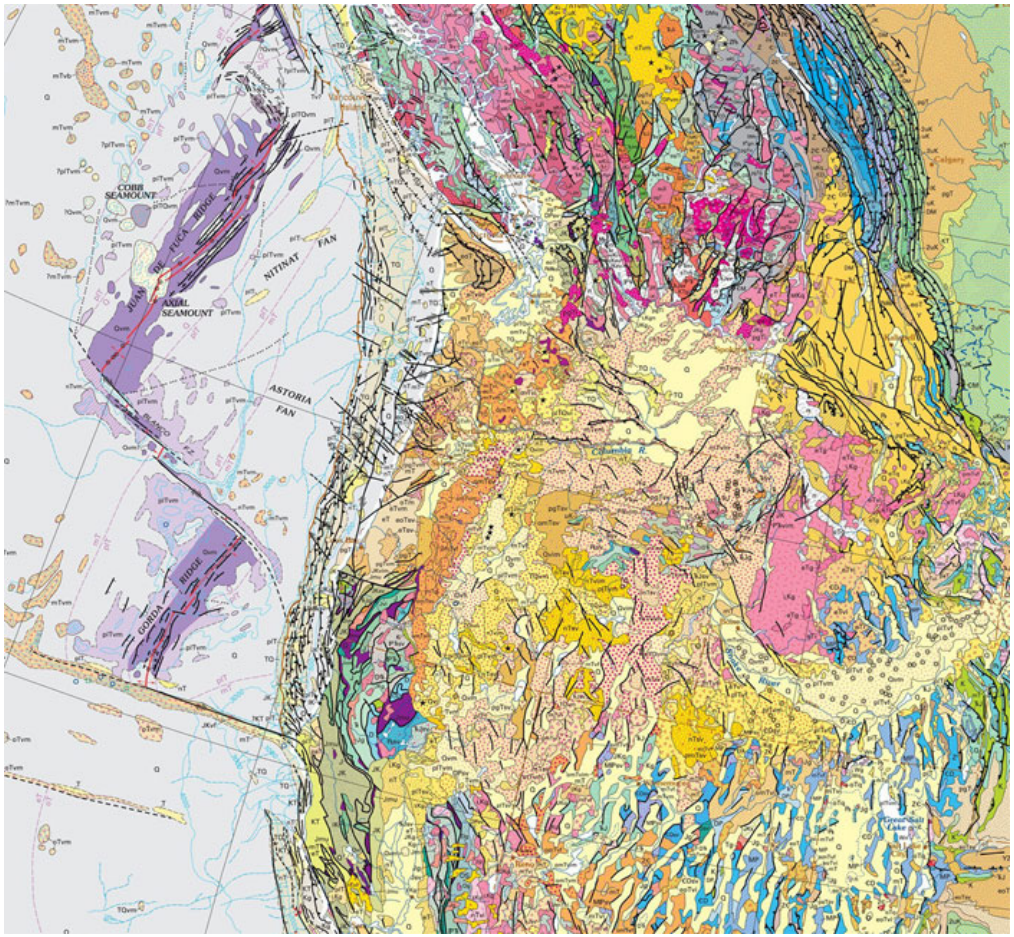
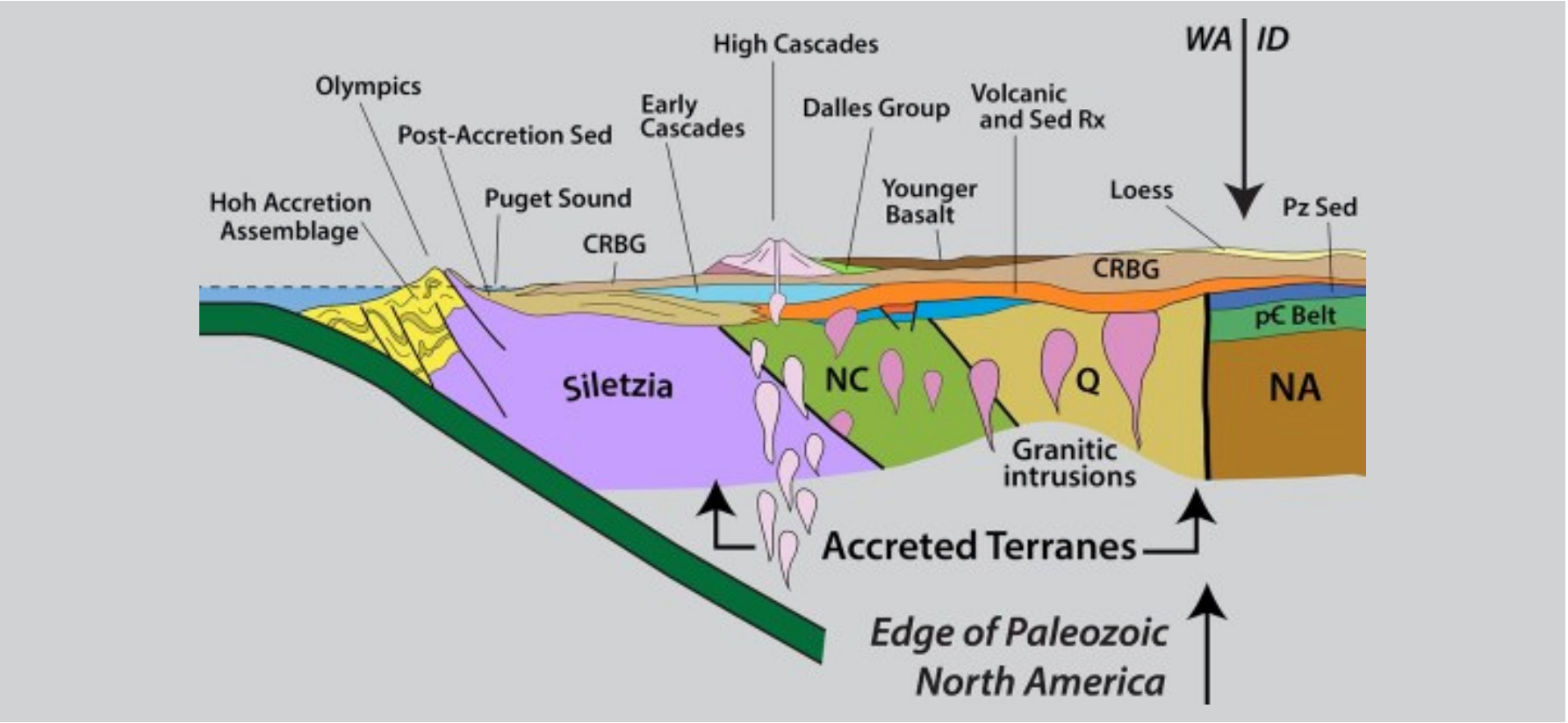
Complex Tectonic & Geologic History

- Accreted terranes
- Subduction related volcanism
- Yellowstone hot spot related volcanism
- Basin and range related volcanism
- Faulting and folding
- Ancestral Columbia River system
- Plio-Pleistocene cataclysmic floods



A General Example of the "Geologic Complexity"



An excellent video animation explaining current models of the Cenozoic volcanic and tectonic evolution of the Pacific Northwest, produced by Oregon State University and IRIS, is available at:

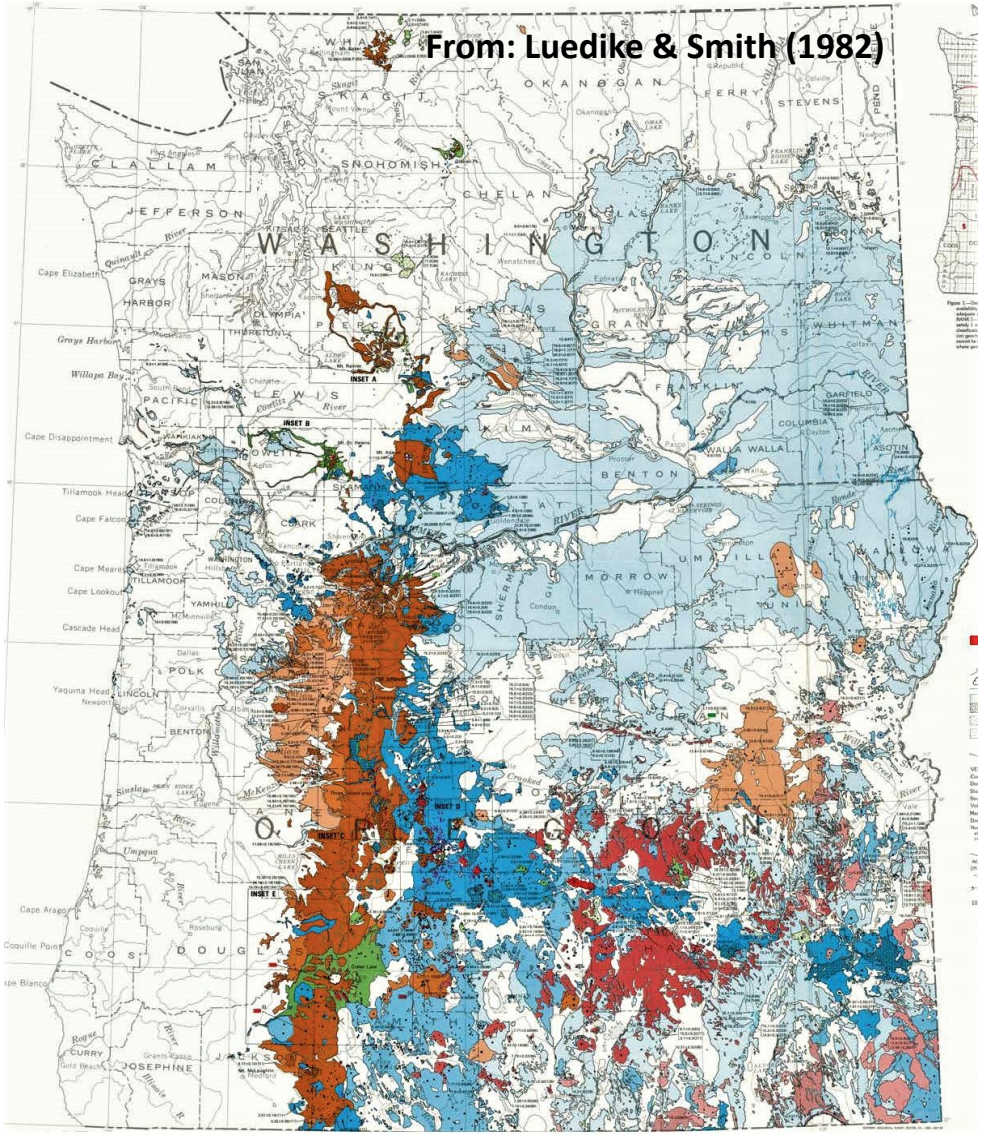
https://www.iris.edu/hq/inclass/animation/pacific_northwest_55_million_years_of_volcanism

Mafic and Felsic Extrusive Rocks

Same "rock types" can have drastically different physical and hydraulic properties

Major Factors Include:

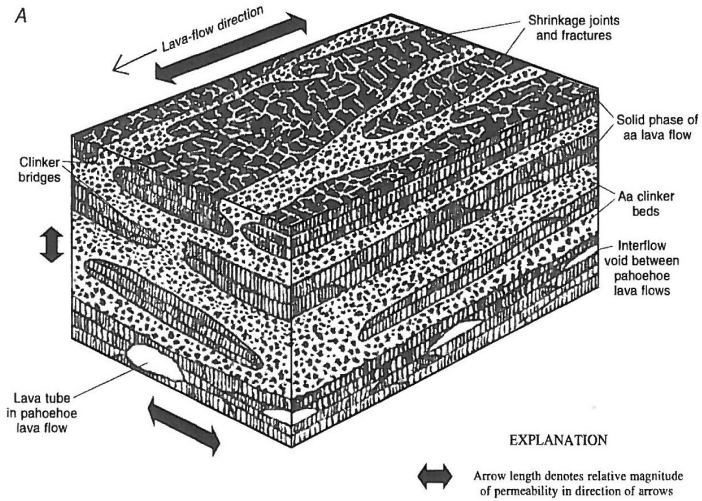
- **Mode of eruption/emplacement**
  - composition & temperature
  - rate & volume of eruption
  - vent geometry
- **Paleo-environmental conditions at time of eruption/emplacement**
- **Post-eruption/emplacement "secondary processes"**
  - alteration/weathering
  - mineralization
  - tectonic deformation
  - erosion
  - sediment deposition



Basalt Flows 101

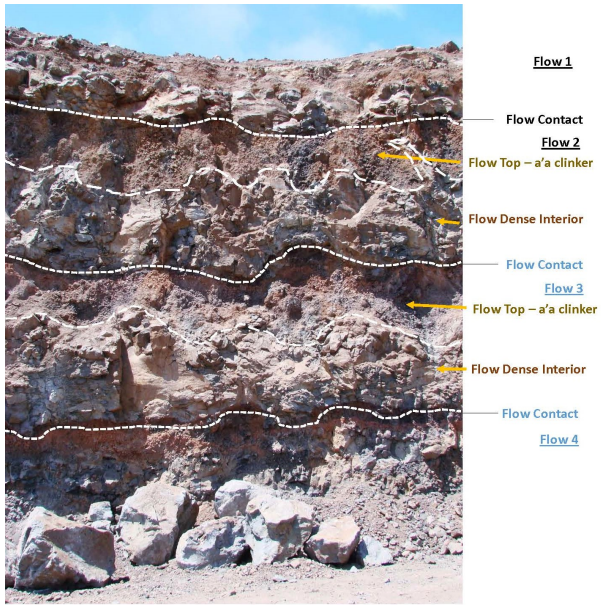
"Hawaiian Basalt Model"

Generalized conceptual model for basalt flow emplacement geometry



Basalt pahoehoe flows

Basalt a'a flows



Pacific Northwest Examples Where “Hawaiian Basalt Model” Applies

Columbia River Flood Basalt Province

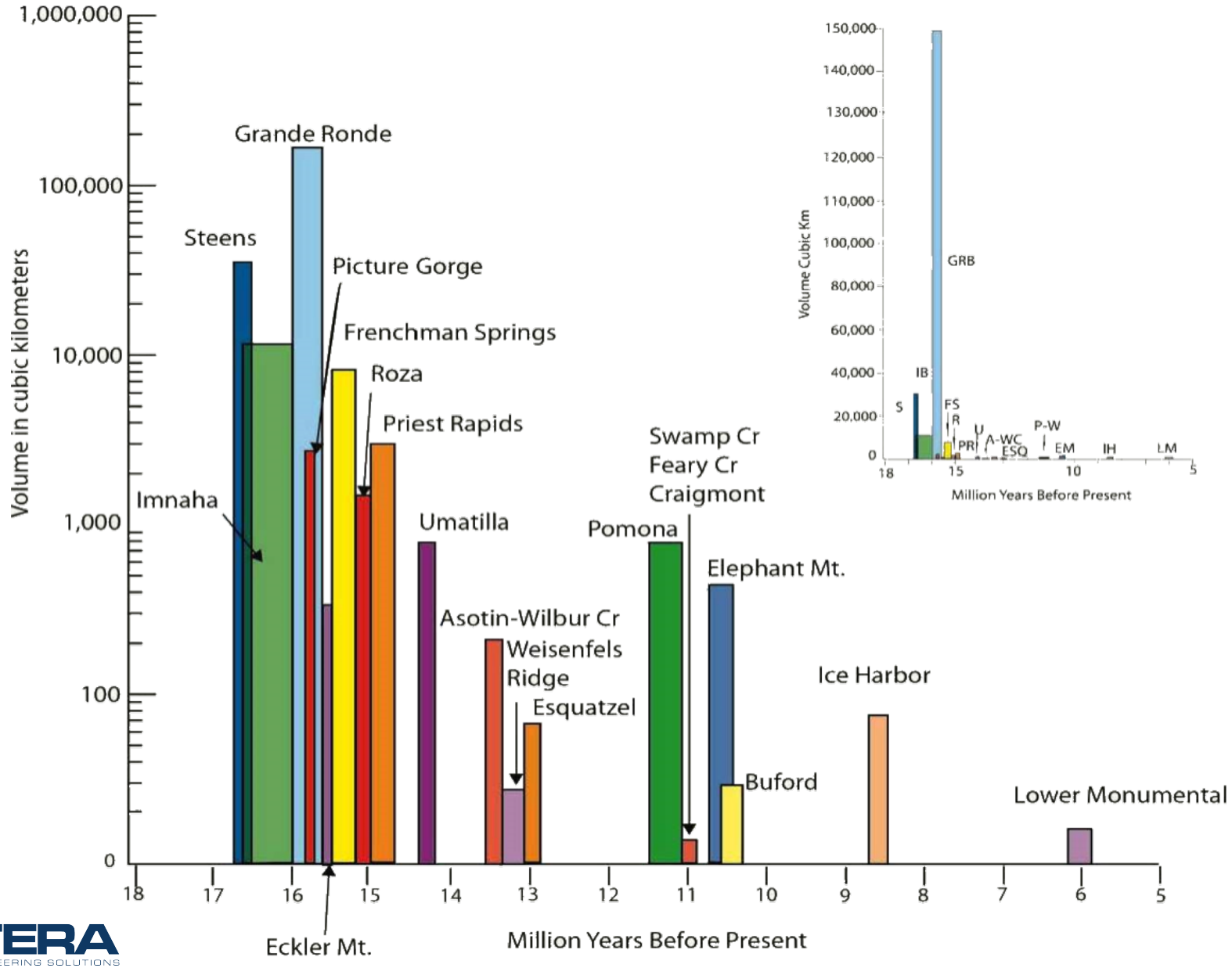
"Hawaiian Basalt Model" does not apply

Why?

- **Largest known lava flows on earth**
  - **typical flow extent: 10,000 – 50,000 km^2**
  - **typical flow volume: +1,000 km^3**
  - **typical flow length: 100 – 200 km**
  - **typical flow thickness: 30 to 60 meters**
- **Erupted from long, linear fissure systems with lengths from 40 to over 130 km**
- **Very rapid flow emplacement ranging from weeks to months**

Age: ~17 to 5.5 Ma
Area: 210,000 km^2
Volume: 210,000 km^3
Max Thickness: 3.6 km

Columbia River Flood Basalt Province Eruptive History



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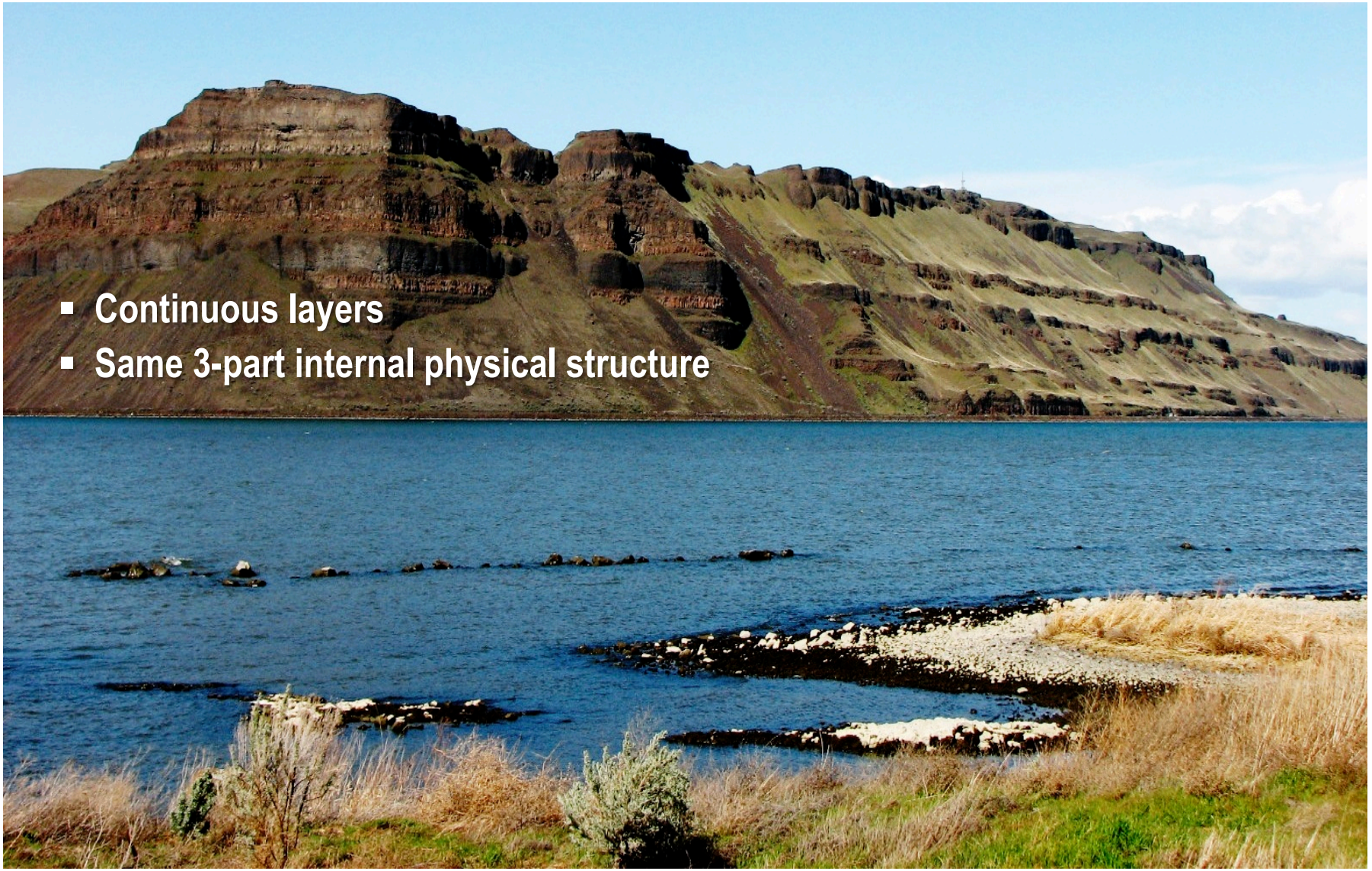
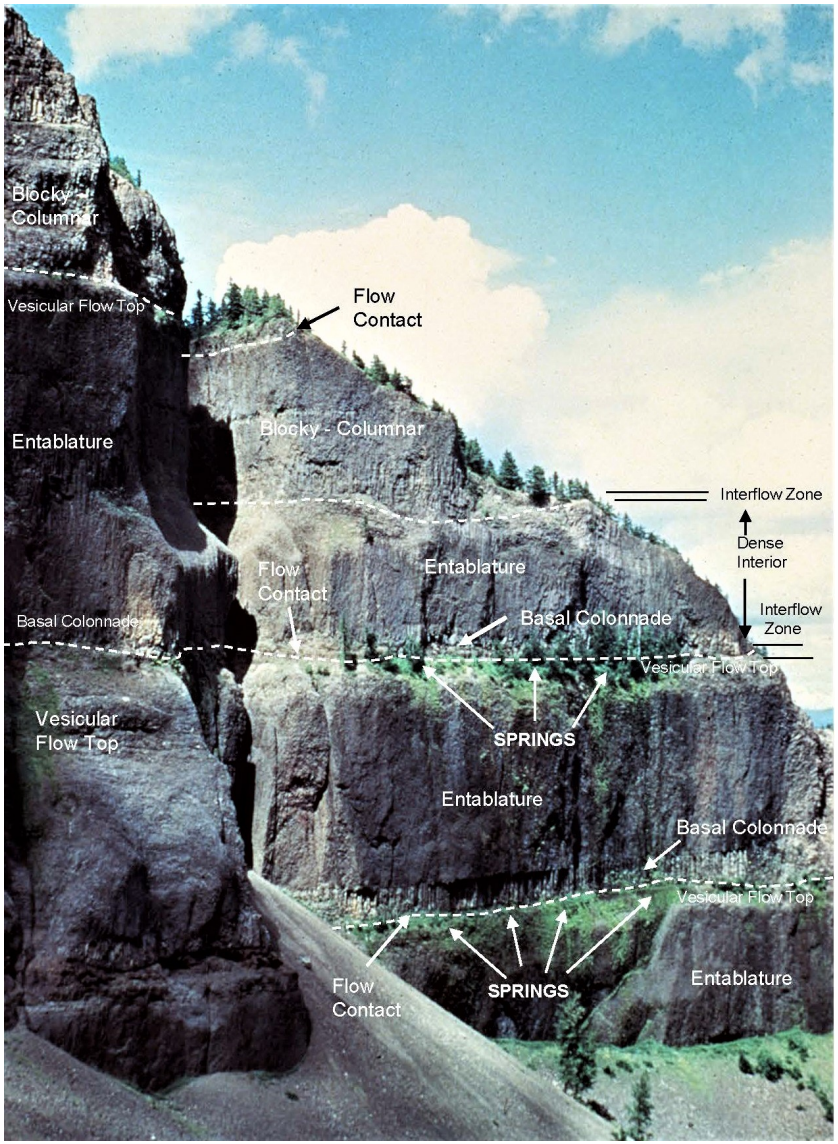
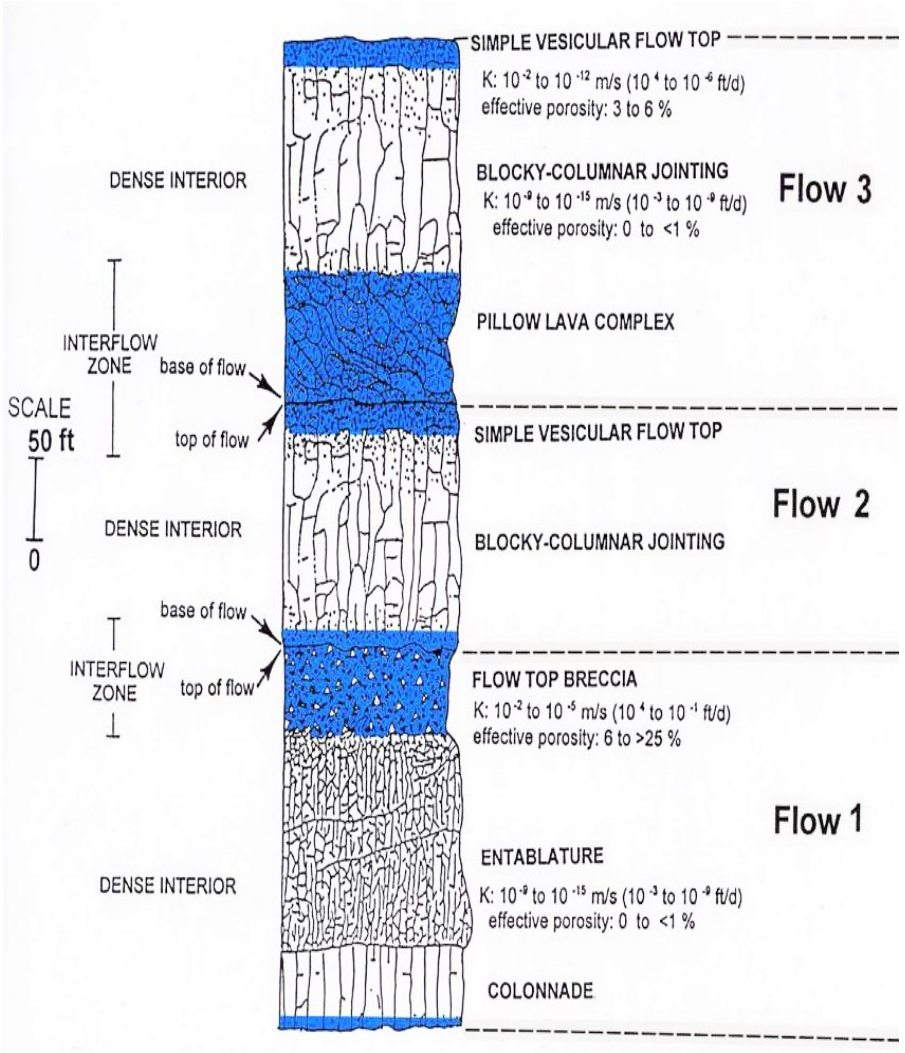
Lateral Continuity of Columbia River Basalt Flows (CRB)



CRB ≠ Hawaiian Basalts

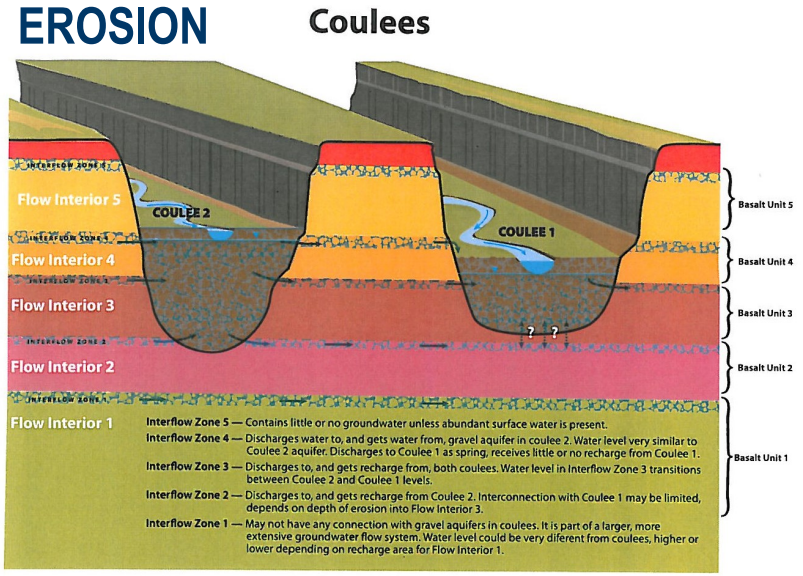


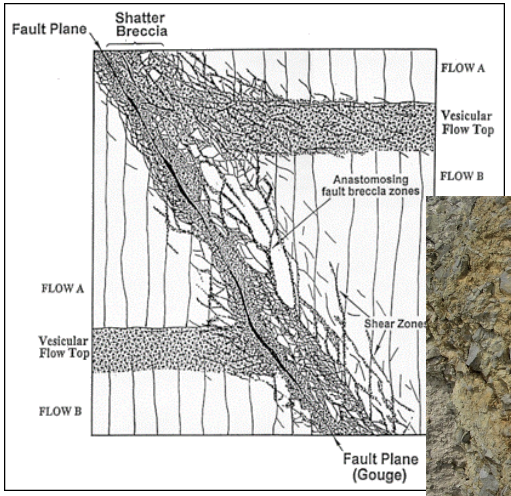
Hydrogeologic Implications



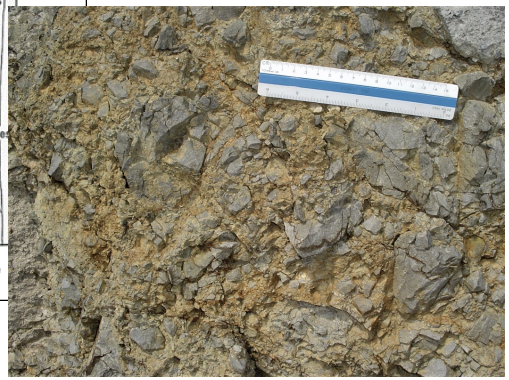
Natural Modification of CRB Aquifer Systems - A Few Examples

EROSION

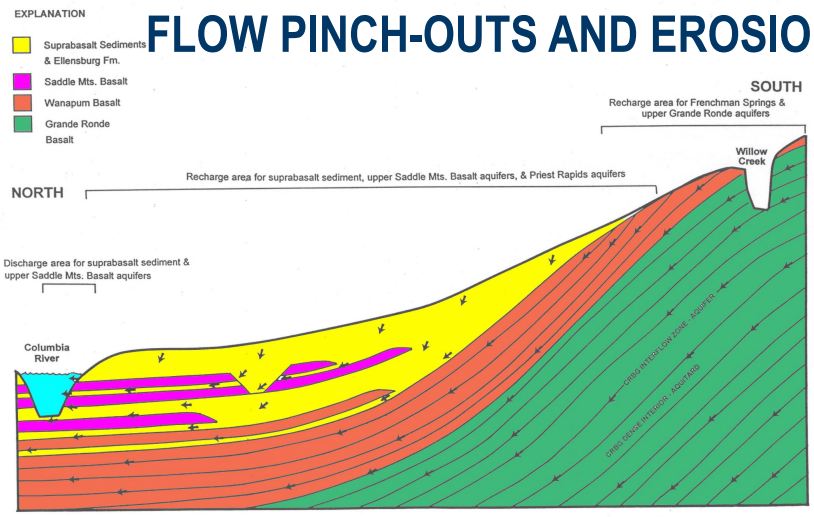




FAULTING AND FOLDING



FLOW PINCH-OUTS AND EROSION



ALTERATION

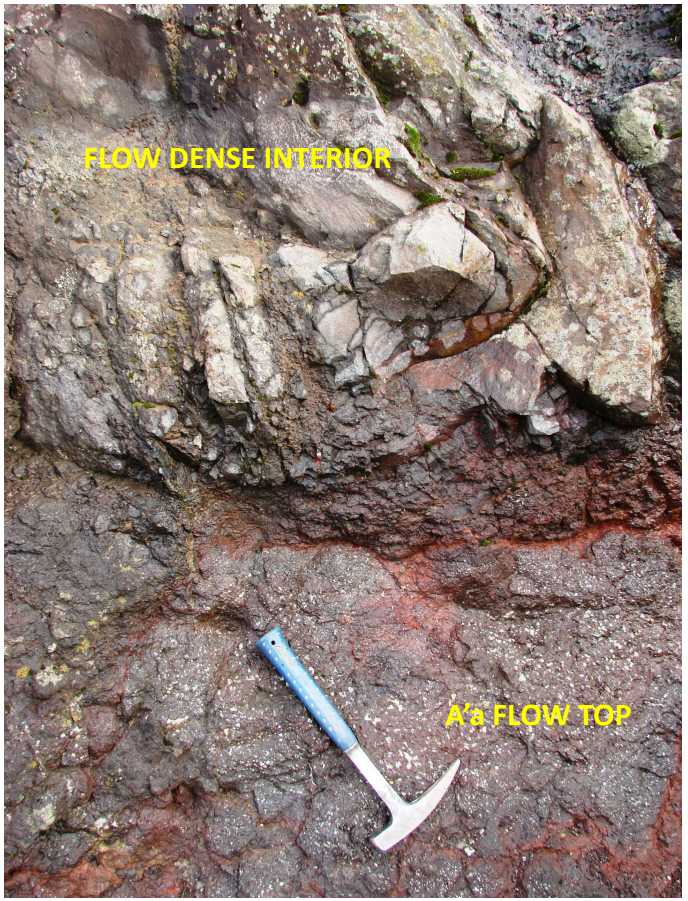
Non-Natural Modification of CRB Aquifer Systems

Eocene–Age Accreted Oceanic Crust/Oceanic Island Basalts

Another Pacific Northwest Example Where the "Hawaiian Basalt Model" Applies

"Basement" in much of western Washington and Oregon

Pervasive secondary mineralization common in interflow zones and in cooling joints



Pervasive secondary minerals infilling vesicles

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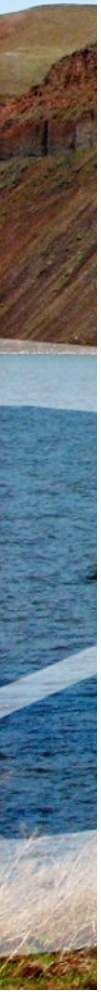

QUESTIONS