Ancient Bends and Reaches of the Great River

Geomorphology
of the Columbia River

The Columbia River System

Length 1,243 miles
2000 km

Drains 258,000 sq mi
668,000 sq km

Two Countries

More than a dozen Nations

One Province

Seven States

An odd river, not much like most others.

The river rises in southern British Columbia in a huge tectonic valley called the Rocky Mountain Trench.

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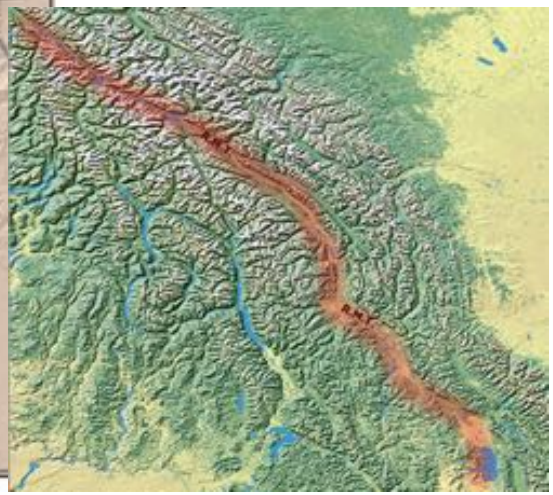
For the first 200 miles (320 km) the river flows northwest down the trend of the Rocky Mountain Trench.



…through old faulted and tectonic valleys that were deeply scoured by ice.

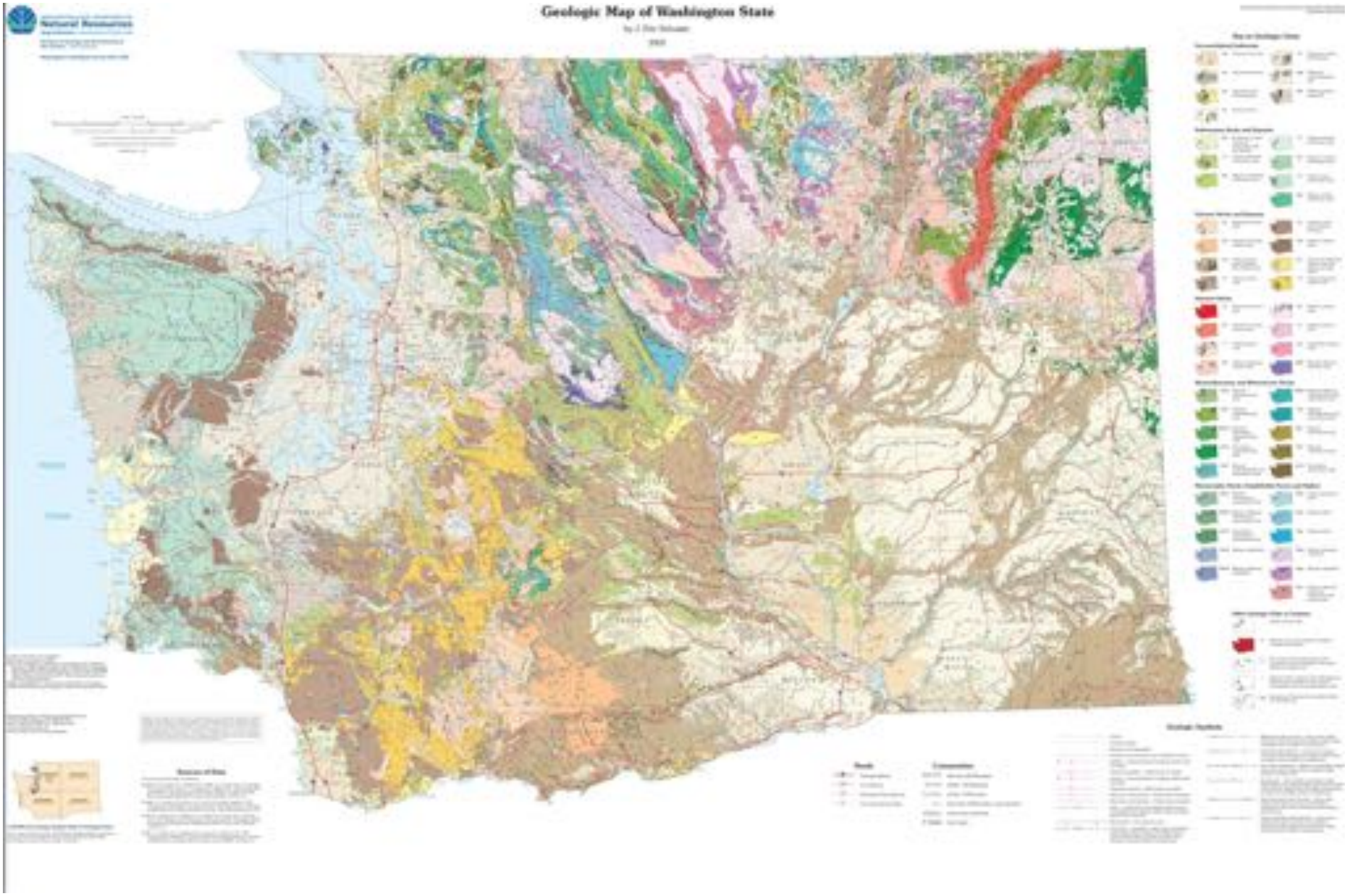
Far to the north where the junction of the Canoe River marks the northern end of the Selkirk Range, the river is defeated by high mountains and resistant rock. It turns south in the first of its *GREAT BENDS*.

The route south takes the Columbia along tectonic and glacial valleys of the Okanogan Highlands.

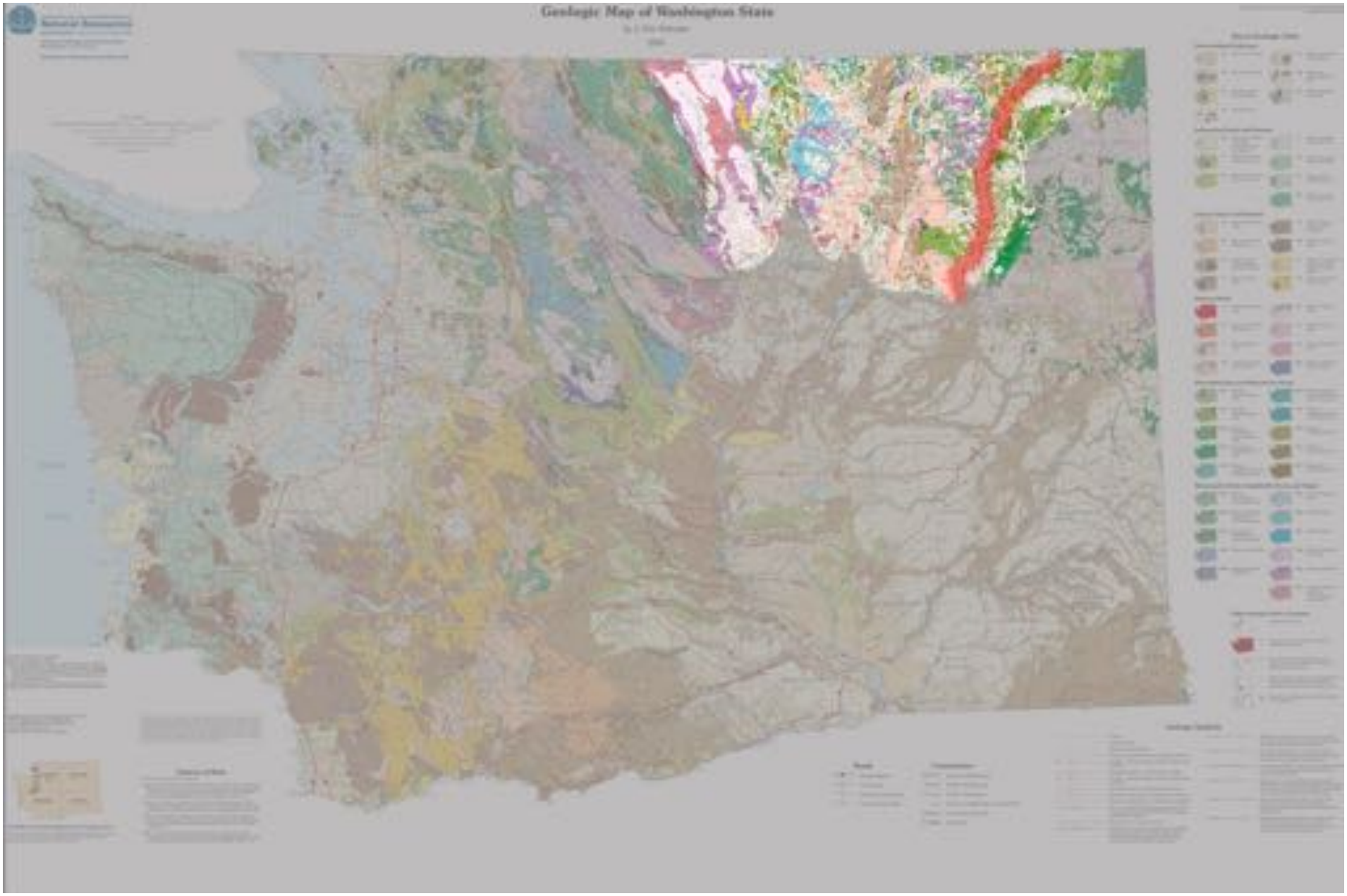
This gets the river into Washington.

Geology of Washington

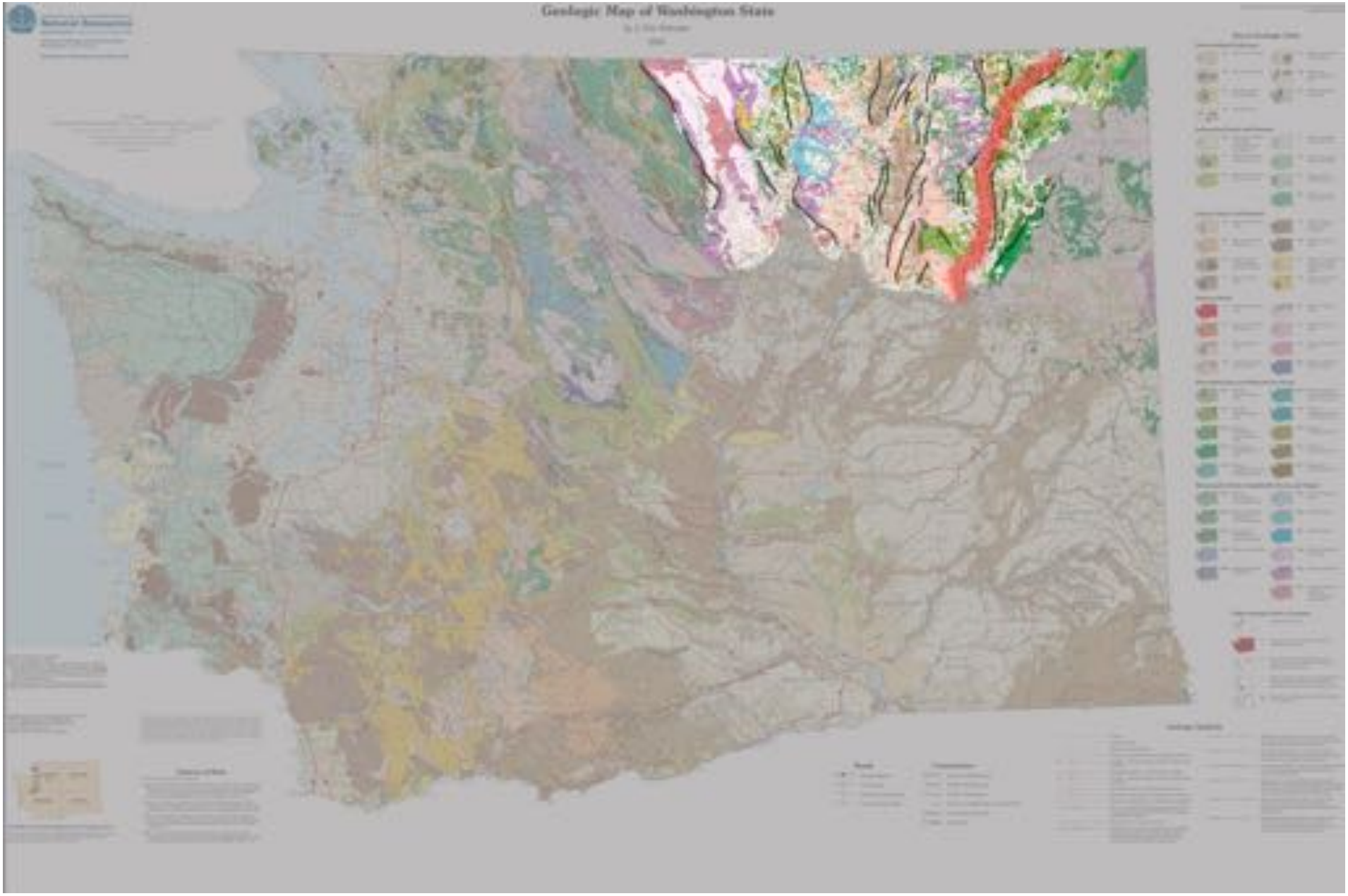
The river flows south through the Okanogan Highlands

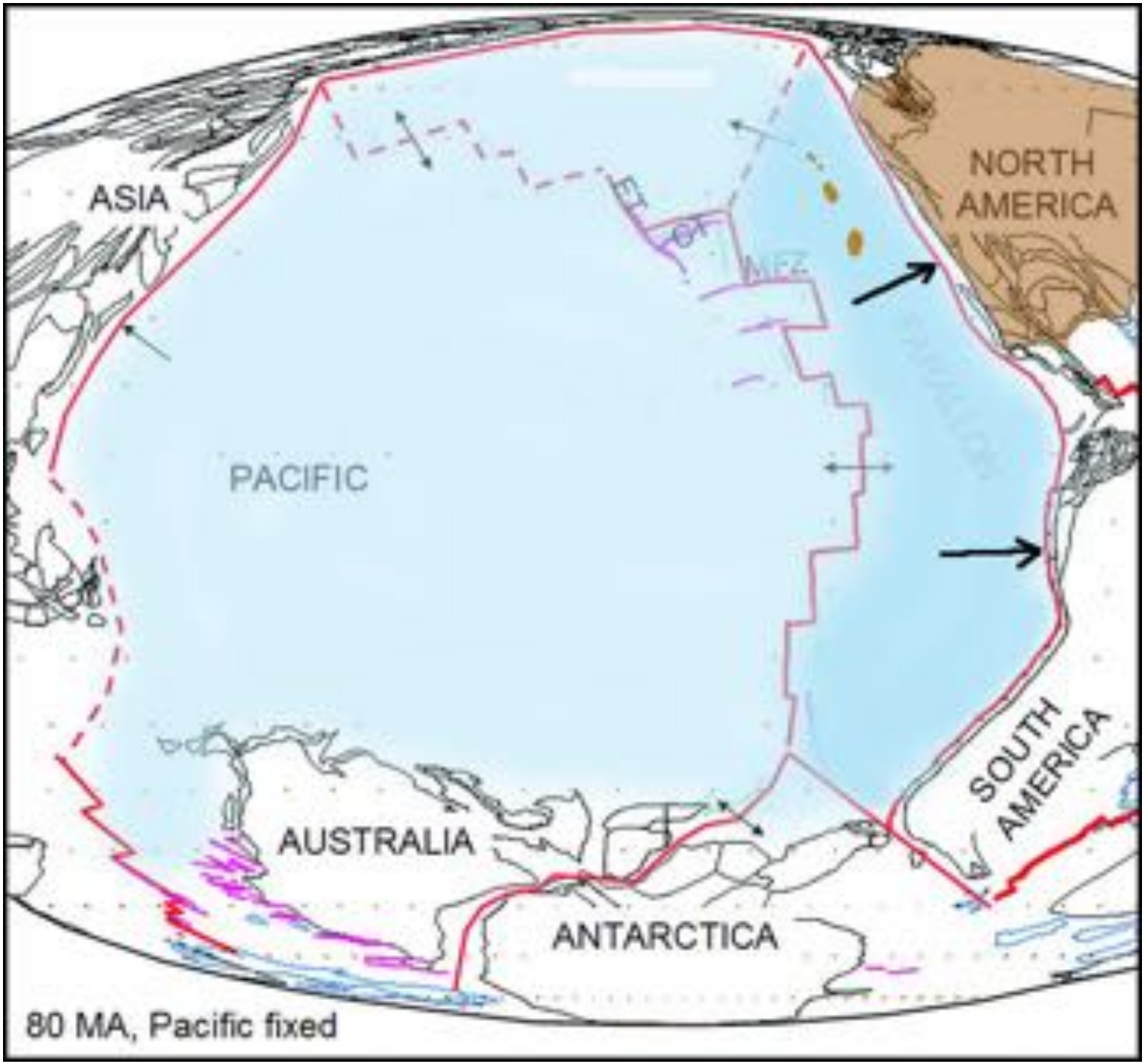


Okanogan Highlands



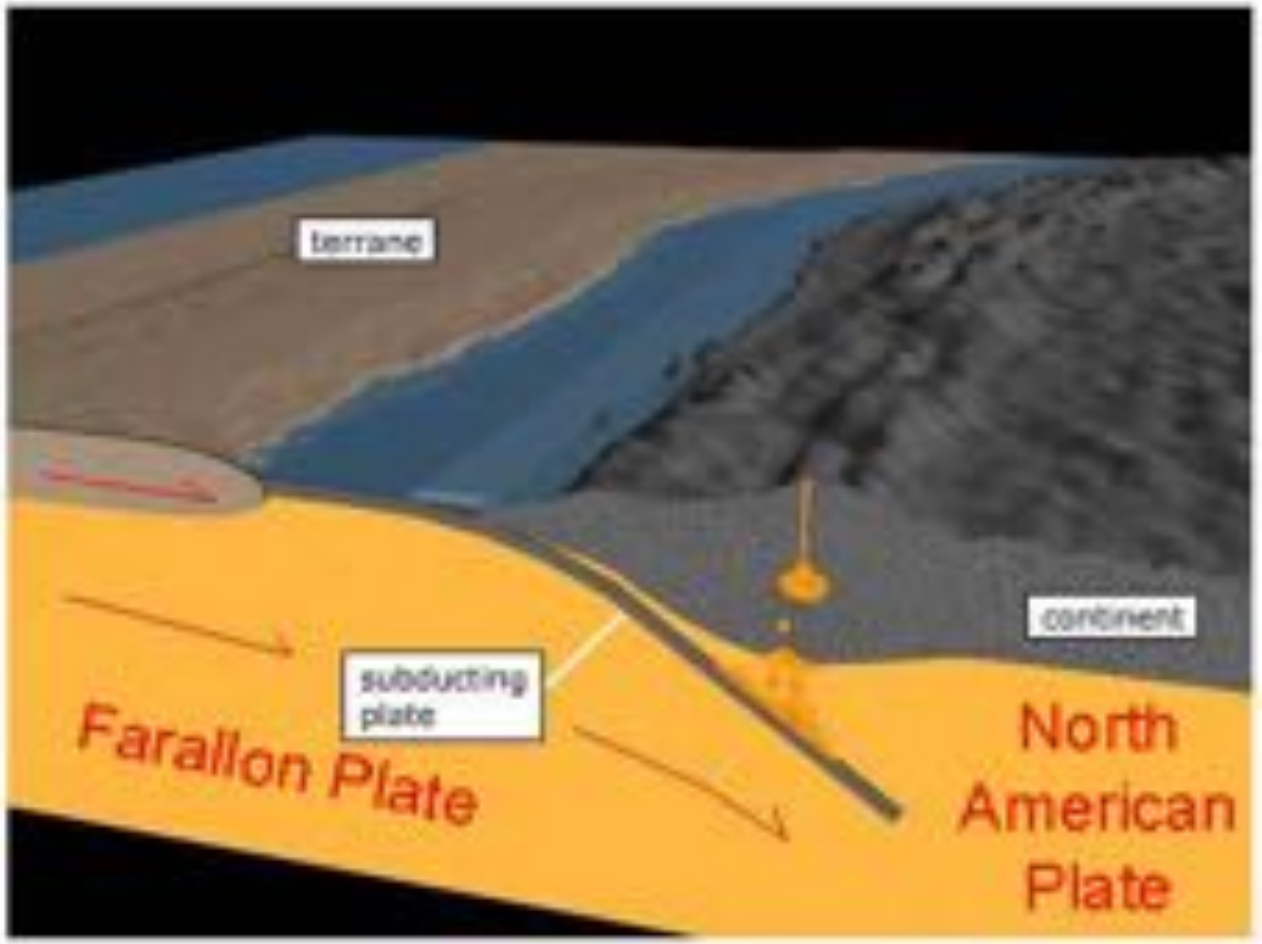
Geological structure in the Okanogan Highlands



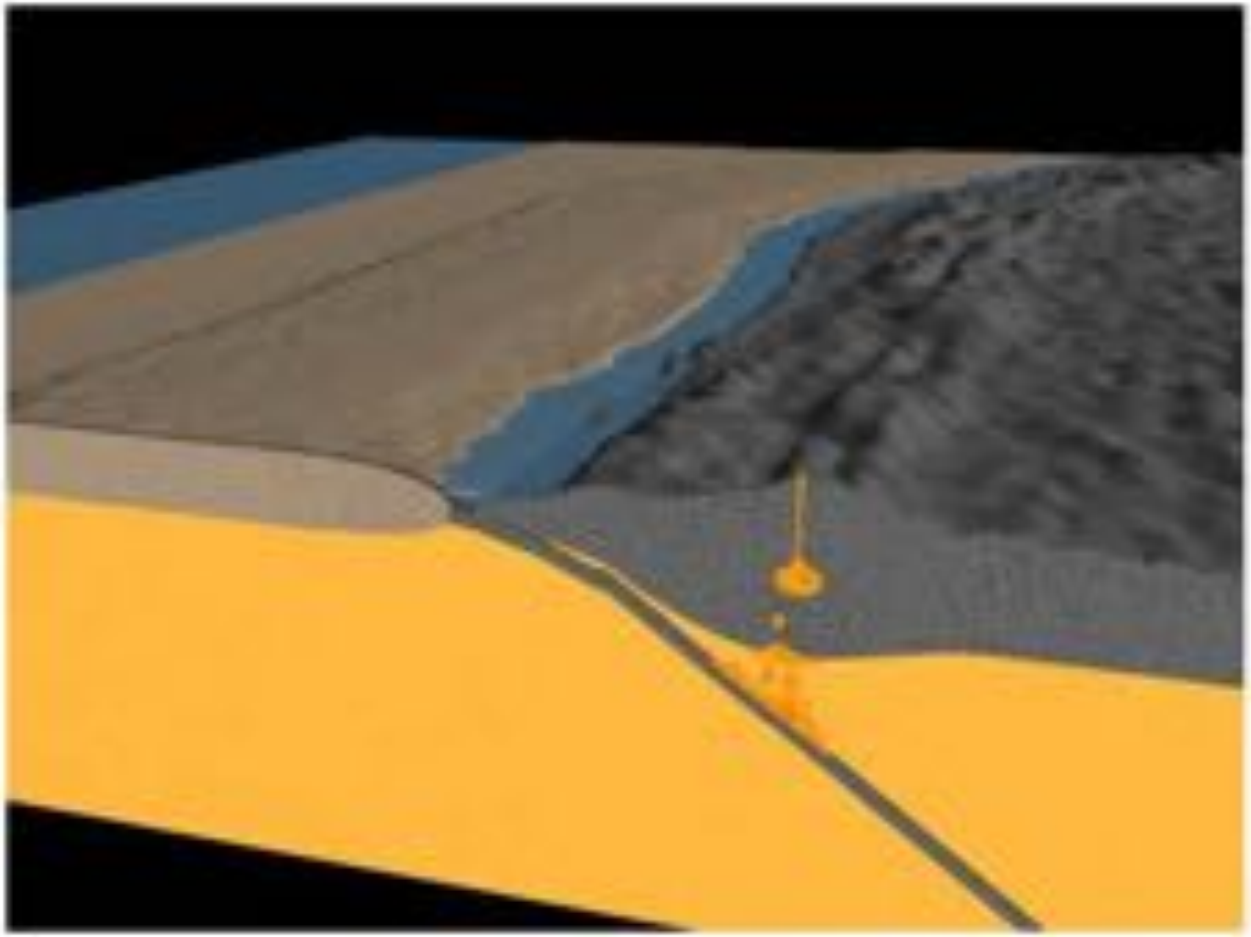


80 million years ago during Cretaceous time the Farallon Plate rafted micro-continents northeast and plastered them onto North America

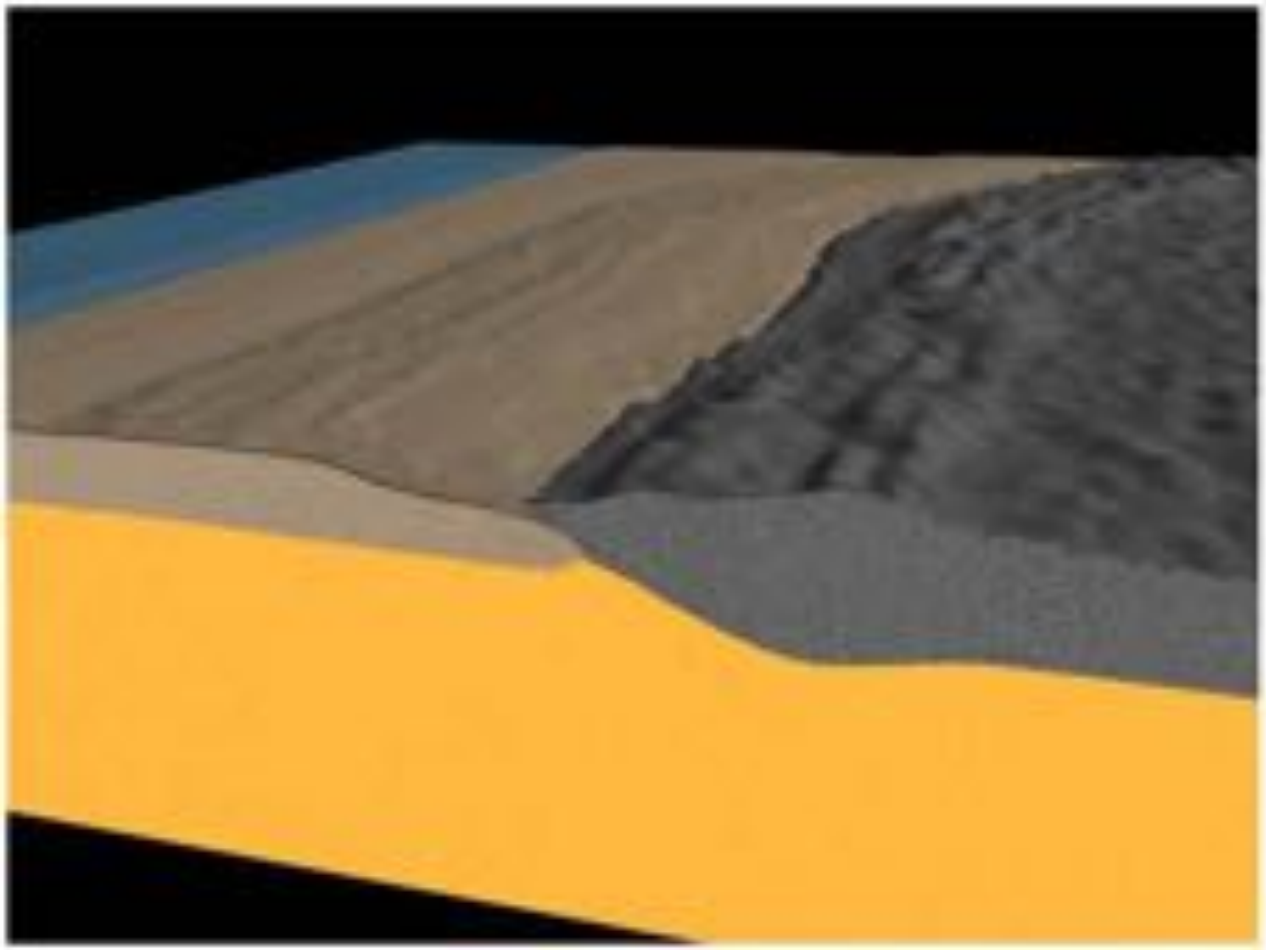
Micro-continents (terranes) raft along on the moving plate.



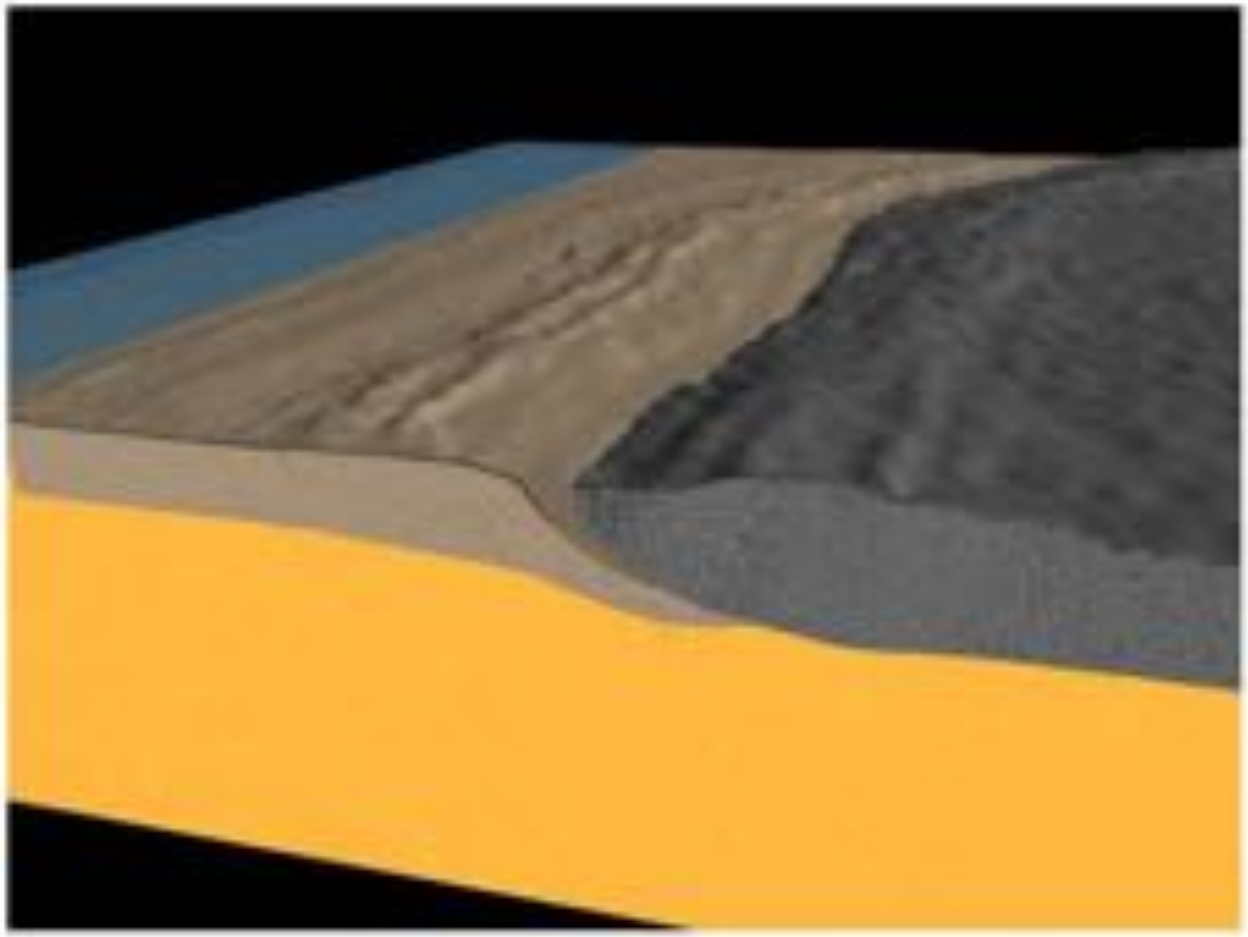
The moving terrane arrives offshore.



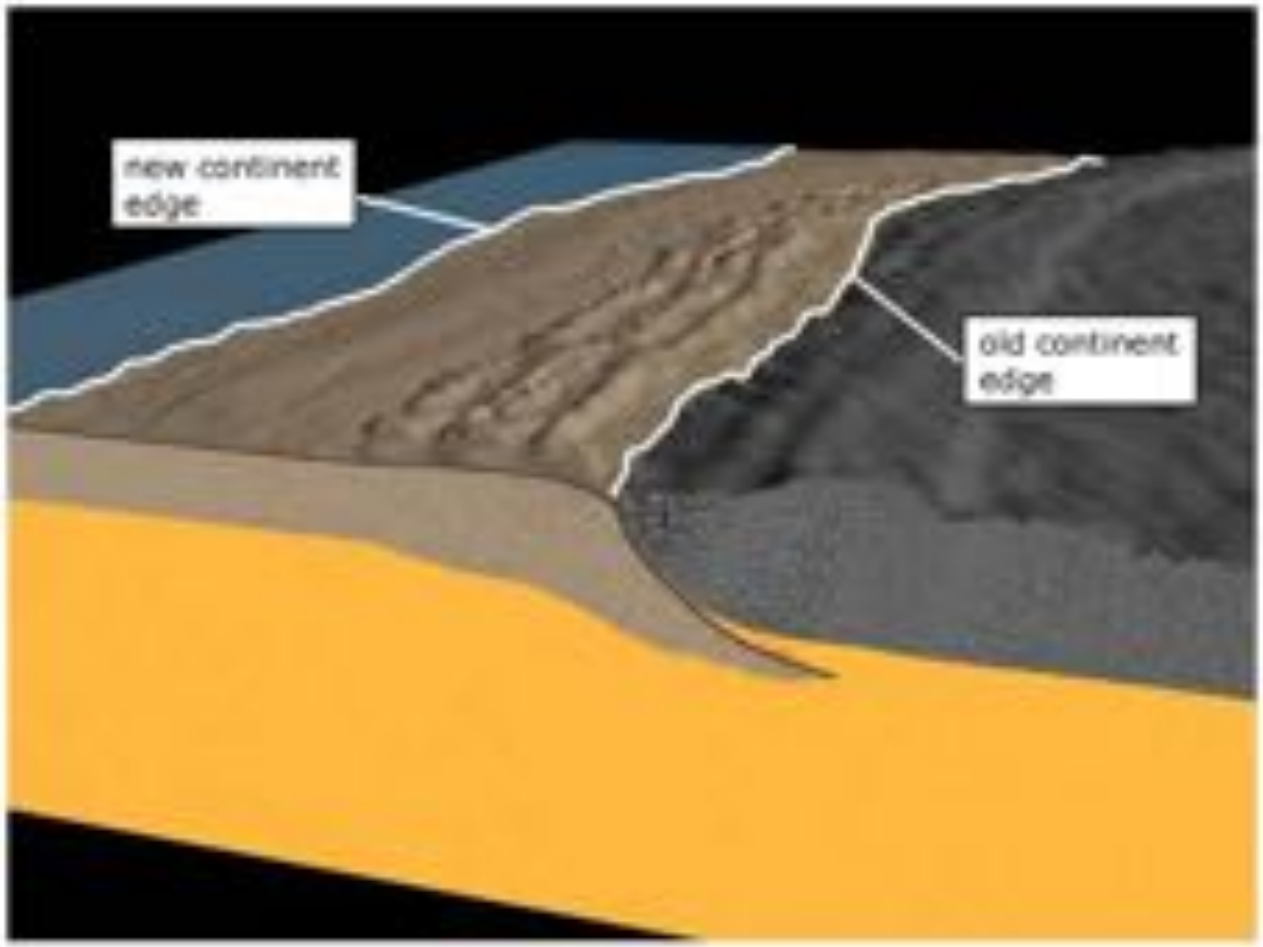
The moving terrane is smashed into the North American Plate and both are crushed and thickened as mountains rise.



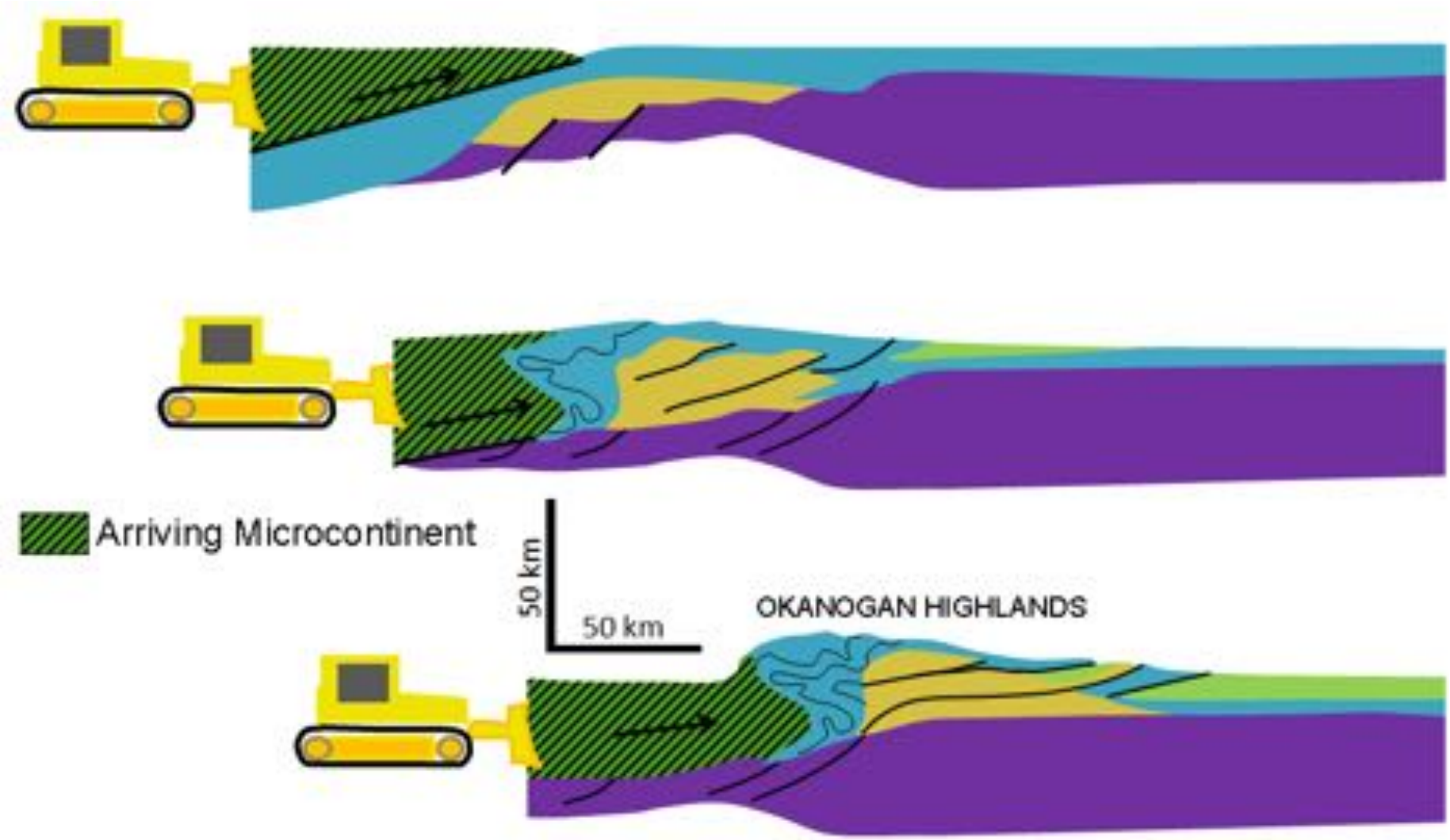
Crushing causes folded and faulted structures that run parallel to the impact margin.



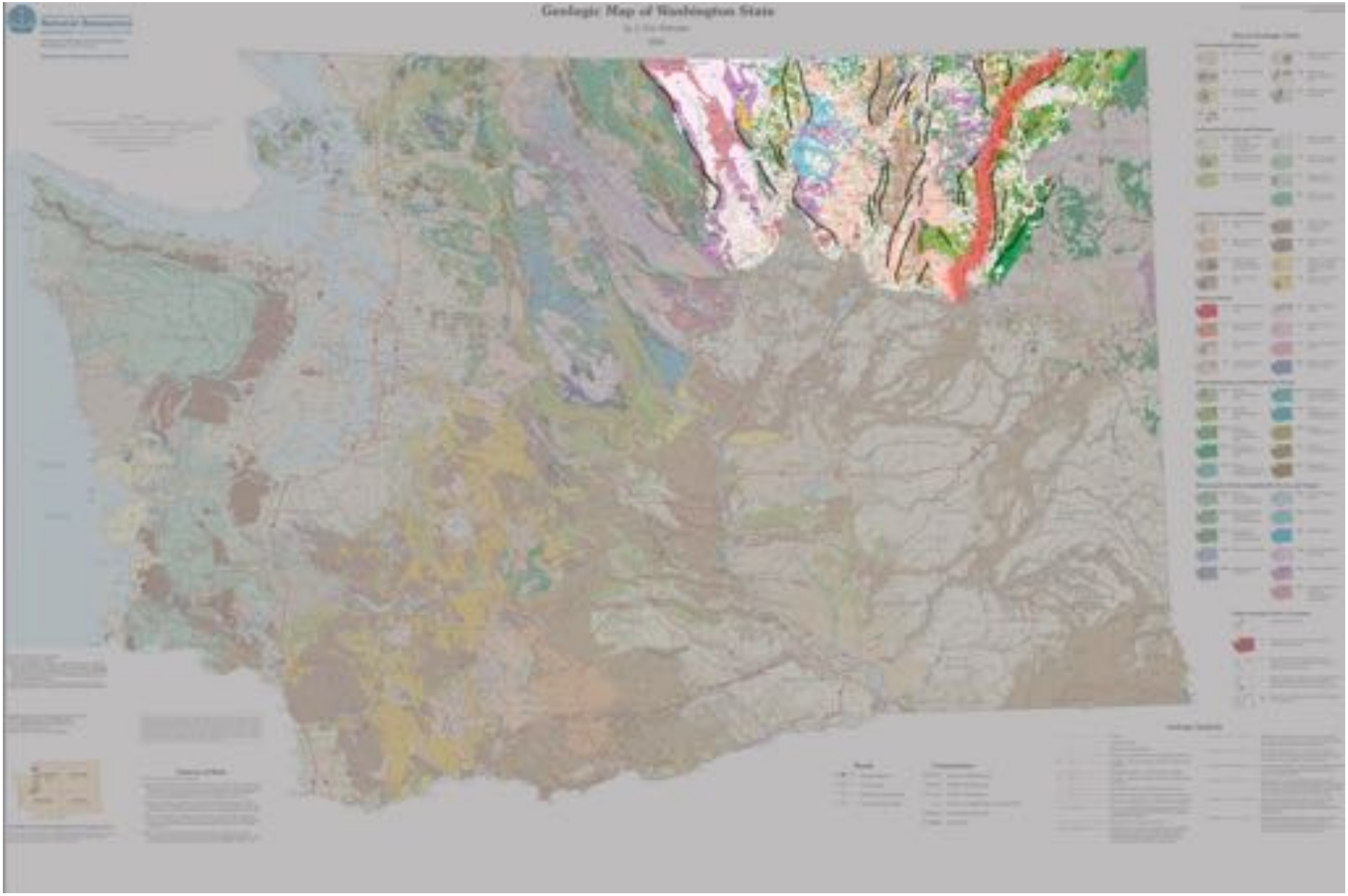
The continent grows and new mountains are formed.

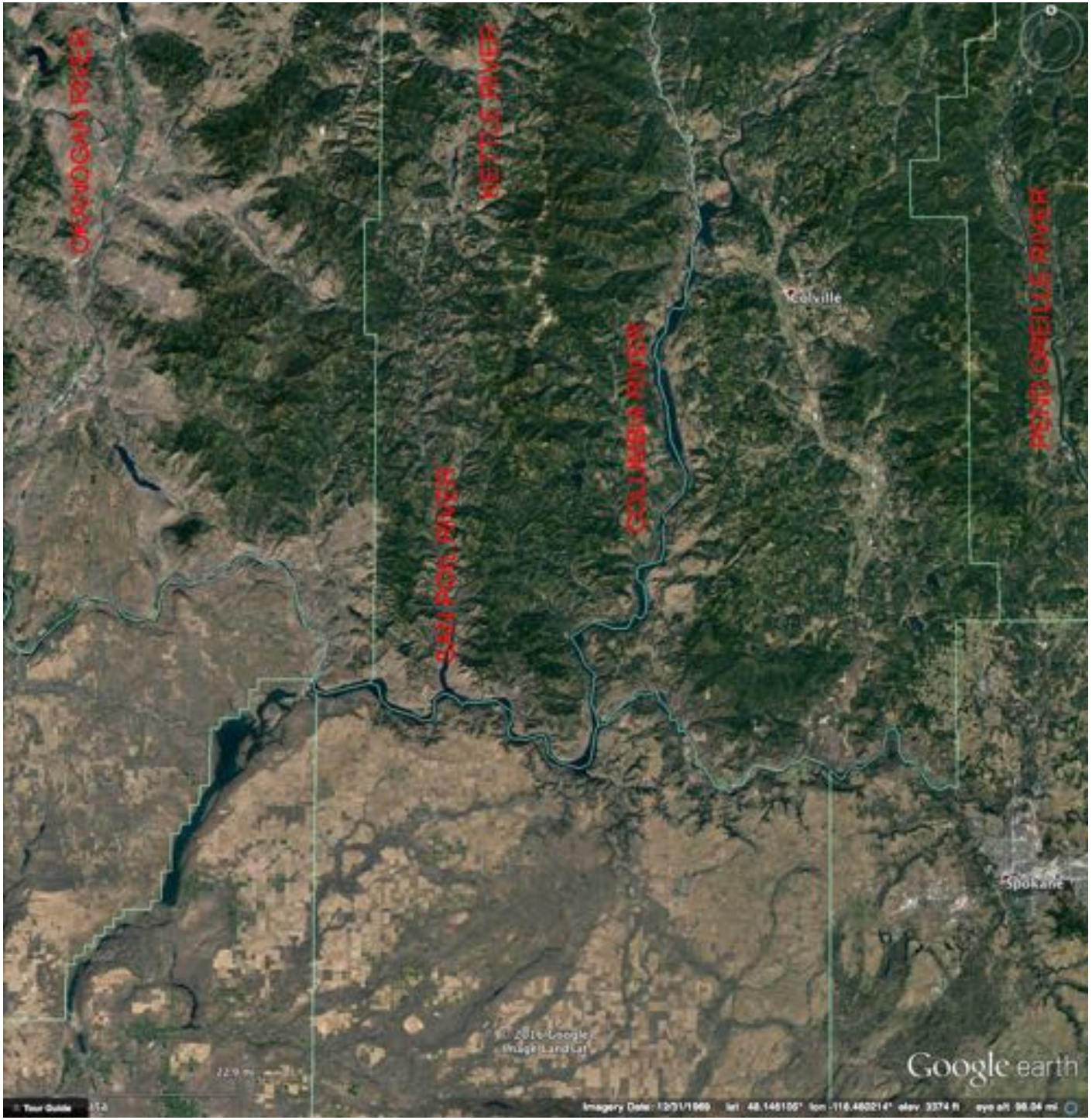


This process takes millions of years and is repeated as new micro-continent terranes are rafted in.



There are many north-south faults and valleys in the Okanogan.
The Columbia simply takes a path of least resistance.



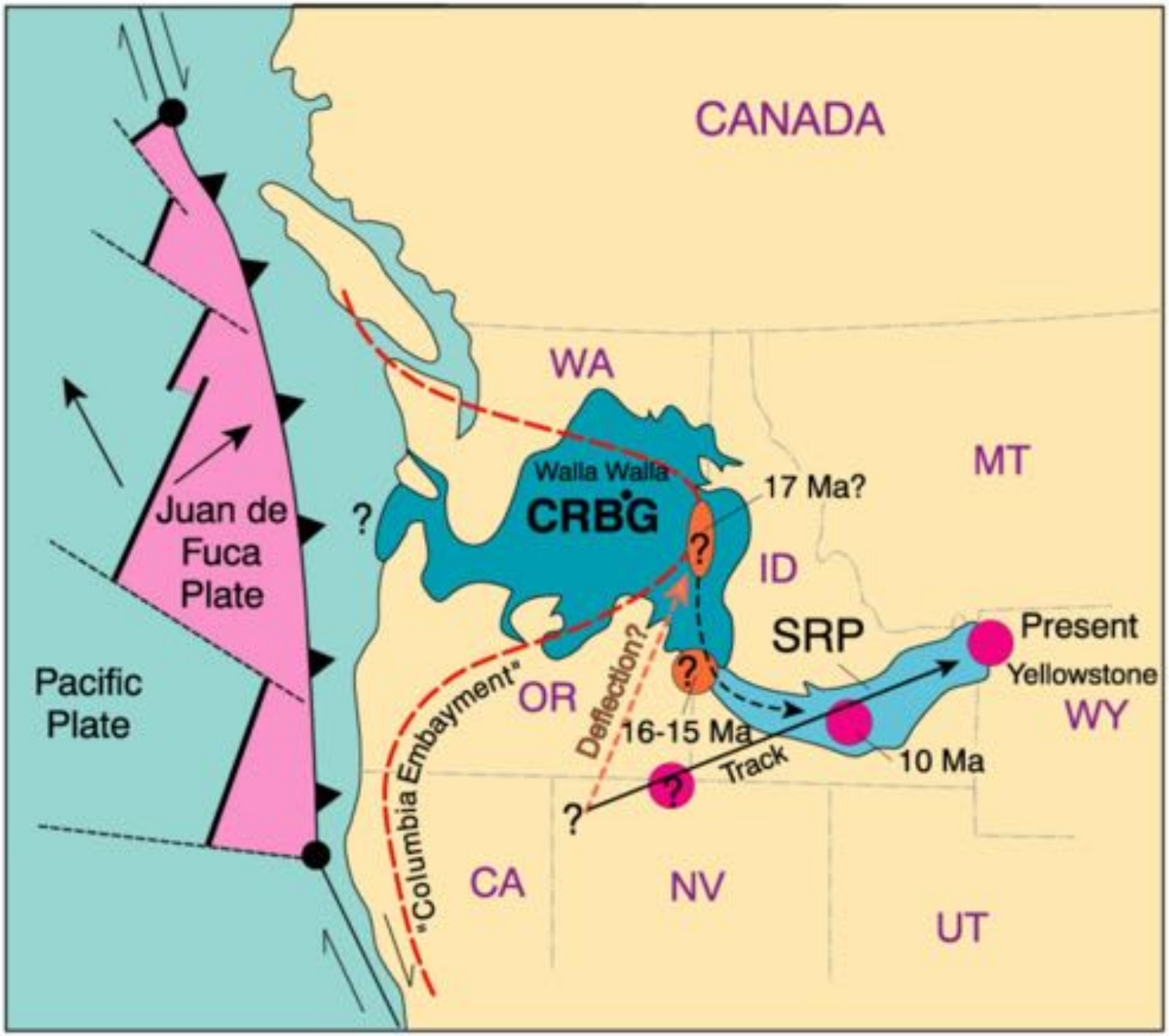


North-south rivers and ridges of the Okanogan Highland terrane structure.

Where it exits the Okanogan Highlands, near its confluence with the Spokane River, the Columbia makes a radical right turn to the west.

The radical right turn is forced where the river encounters the basalt lavas of the Columbia River Plateau.

The basalt lava flows of the Columbia Plateau are no older than Miocene; about 17 million years.
What was there before? We do not know.



The Columbia Embayment

- broad lowland?
- arm of the ocean?

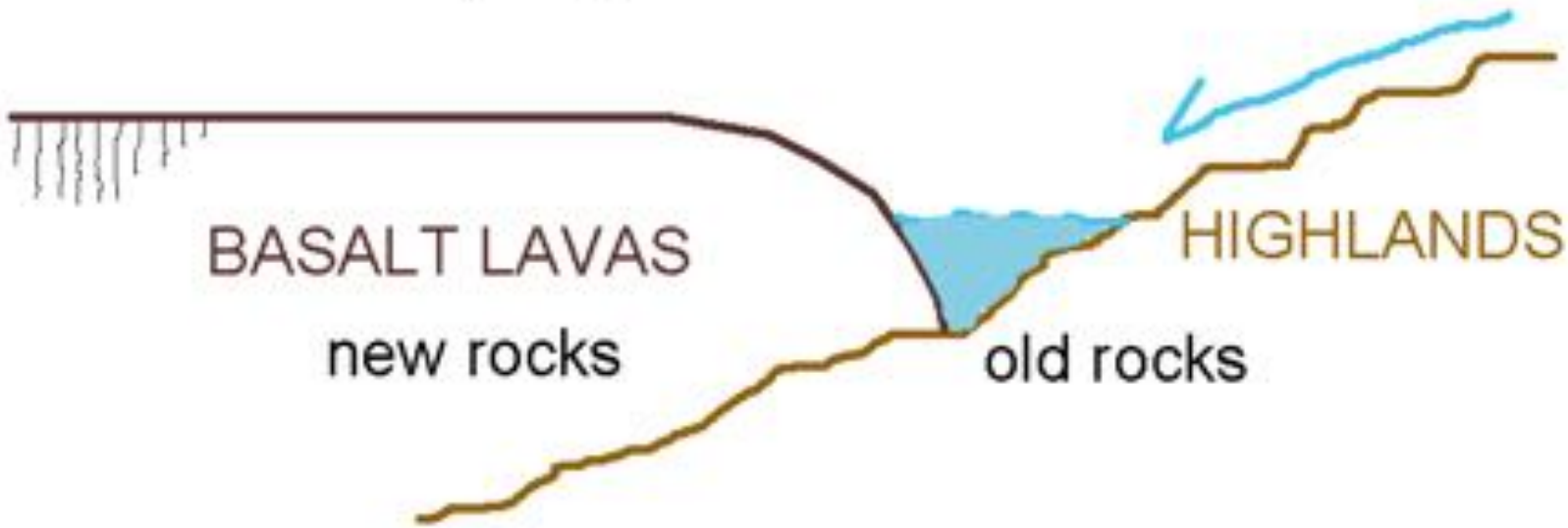
Filled with basalt lavas after 17 million years ago.

The area where basalt lavas flooded the Columbia Plateau:16.7 million years ago.

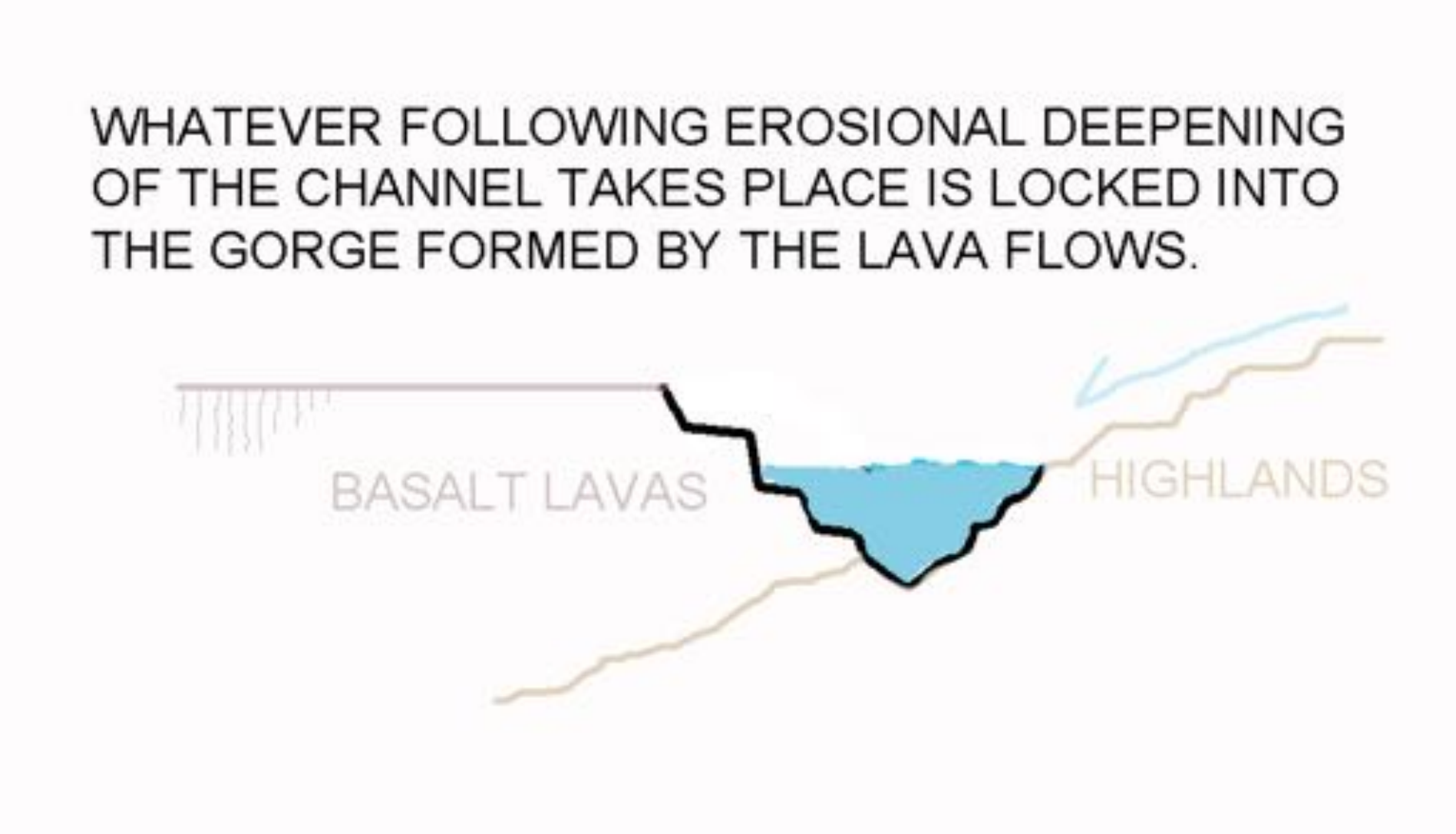
In places more than 10,000 feet thick.

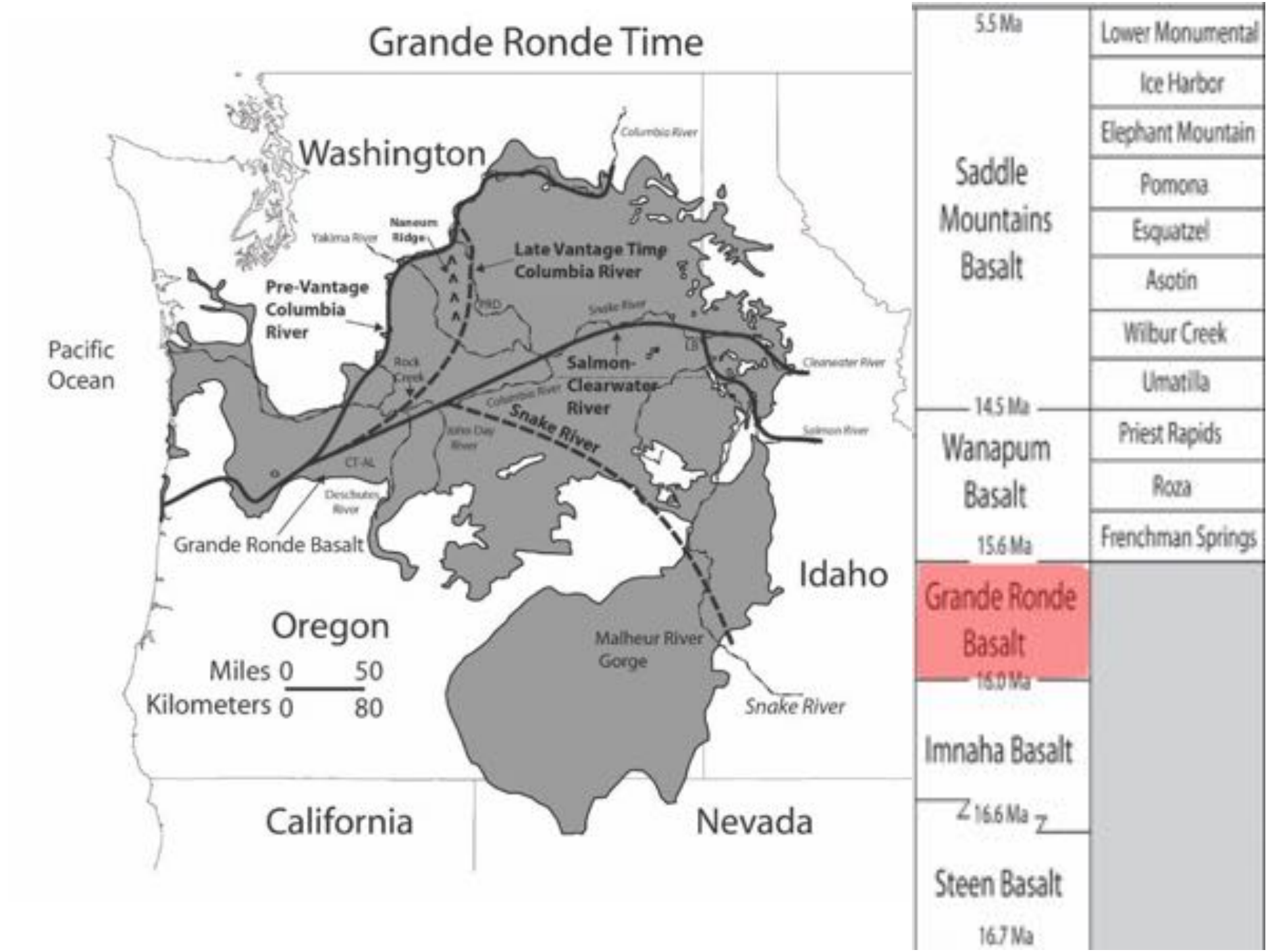
Rivers were blocked and diverted by the giant lava flows.

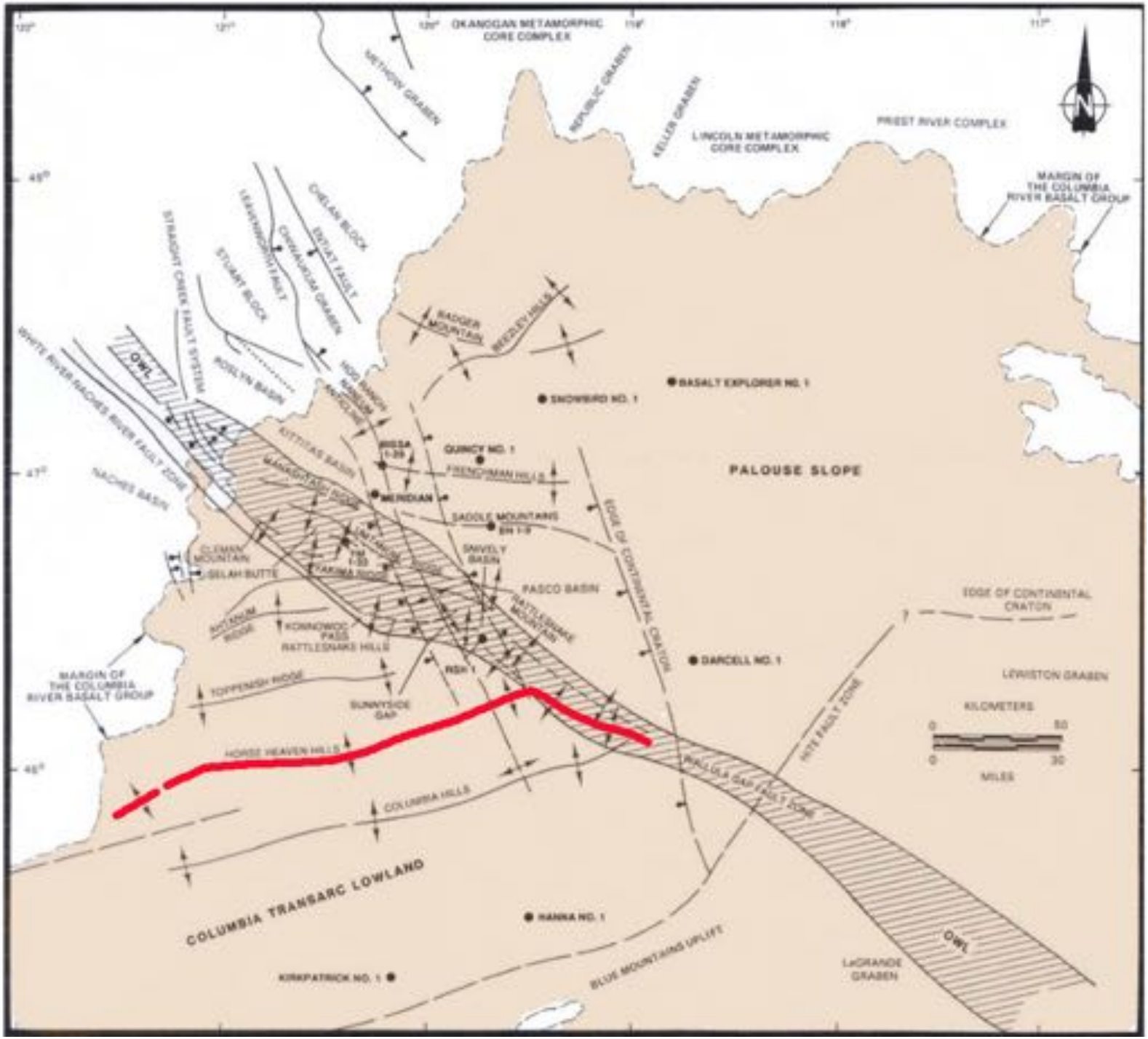
Deep lava flows dam the rivers.
Lakes form around the edge, overflow
and form a new, larger Columbia River.



The river inherits is channel from geology.




Grande Ronde Time
Washington
Pacific Ocean
Pre-Vantage Columbia River
Late Vantage Time Columbia River
Salmon-Clearwater River
Snake River
Grande Ronde Basalt
Idaho
Oregon
Miles 0 50
Kilometers 0 80
Malheur River Gorge
Snake River
California
Nevada
5.5 Ma
Saddle Mountains Basalt
14.5 Ma
Wanapum Basalt
15.6 Ma
Grande Ronde Basalt
16.0 Ma
Imnaha Basalt
16.6 Ma
Steen Basalt
16.7 Ma
Lower Monumental
Ice Harbor
Elephant Mountain
Pomona
Esquatzel
Asotin
Wilbur Creek
Umatilla
Priest Rapids
Roza
Frenchman Springs

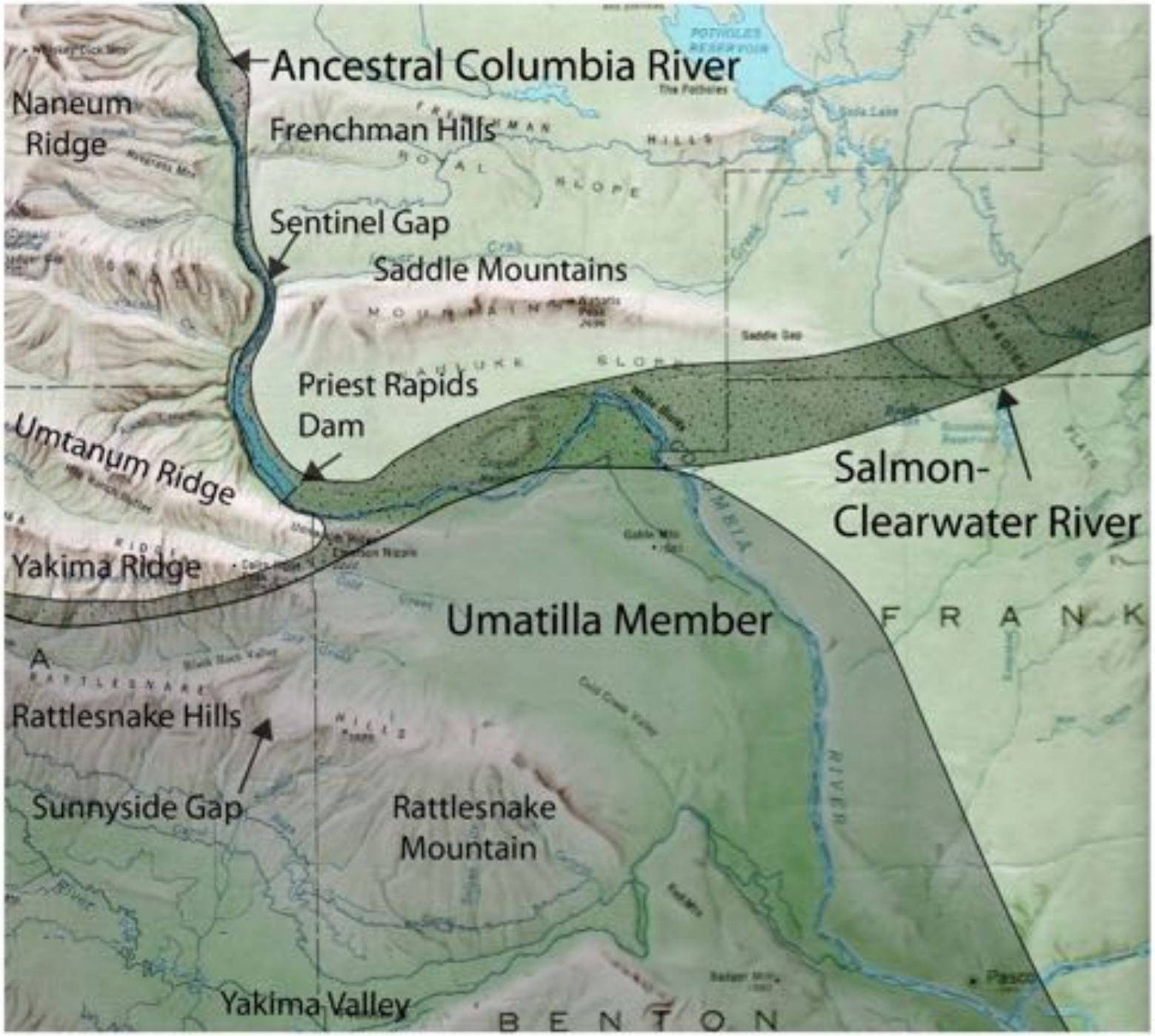


Yakima Folds

Raised the basalt into steep ridges that diverted some of the rivers.

Umatilla Time

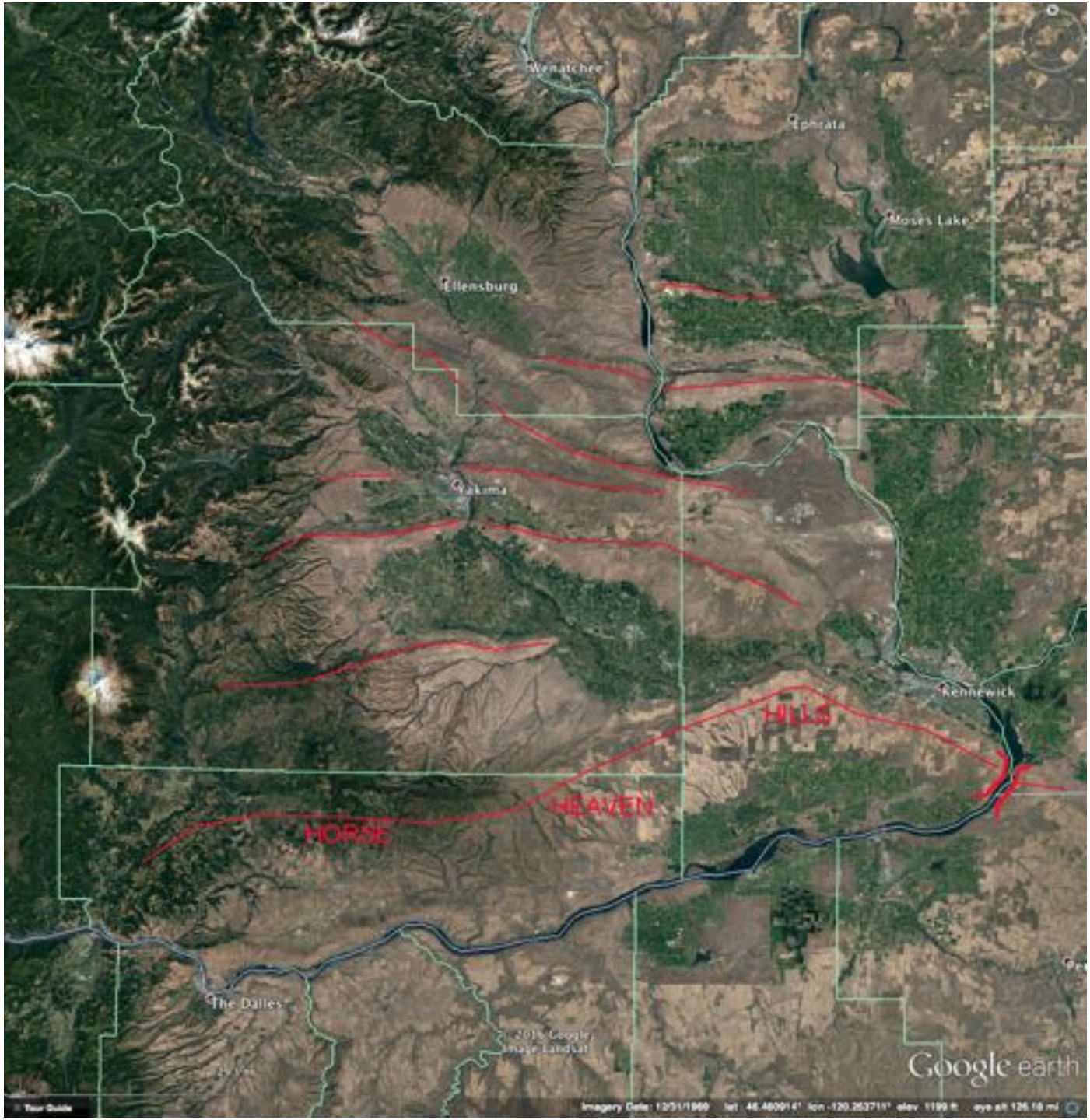
5.5 Ma	Lower Monumental
	Ice Harbor
	Elephant Mountain
Saddle Mountains Basalt	Pomona
	Esquatzel
	Asotin
	Wilbur Creek
	Umatilla
14.5 Ma	
Wanapum Basalt	Priest Rapids
	Roza
15.6 Ma	Frenchman Springs
Grande Ronde Basalt	
16.0 Ma	
Imnaha Basalt	
16.6 Ma	
Steen Basalt	
16.7 Ma	



The ancestral Columbia River cut a canyon across the rising Yakima Folds: Frenchman Hills and Saddle Mountain.

It turned sharply west around Umtanum Ridge.

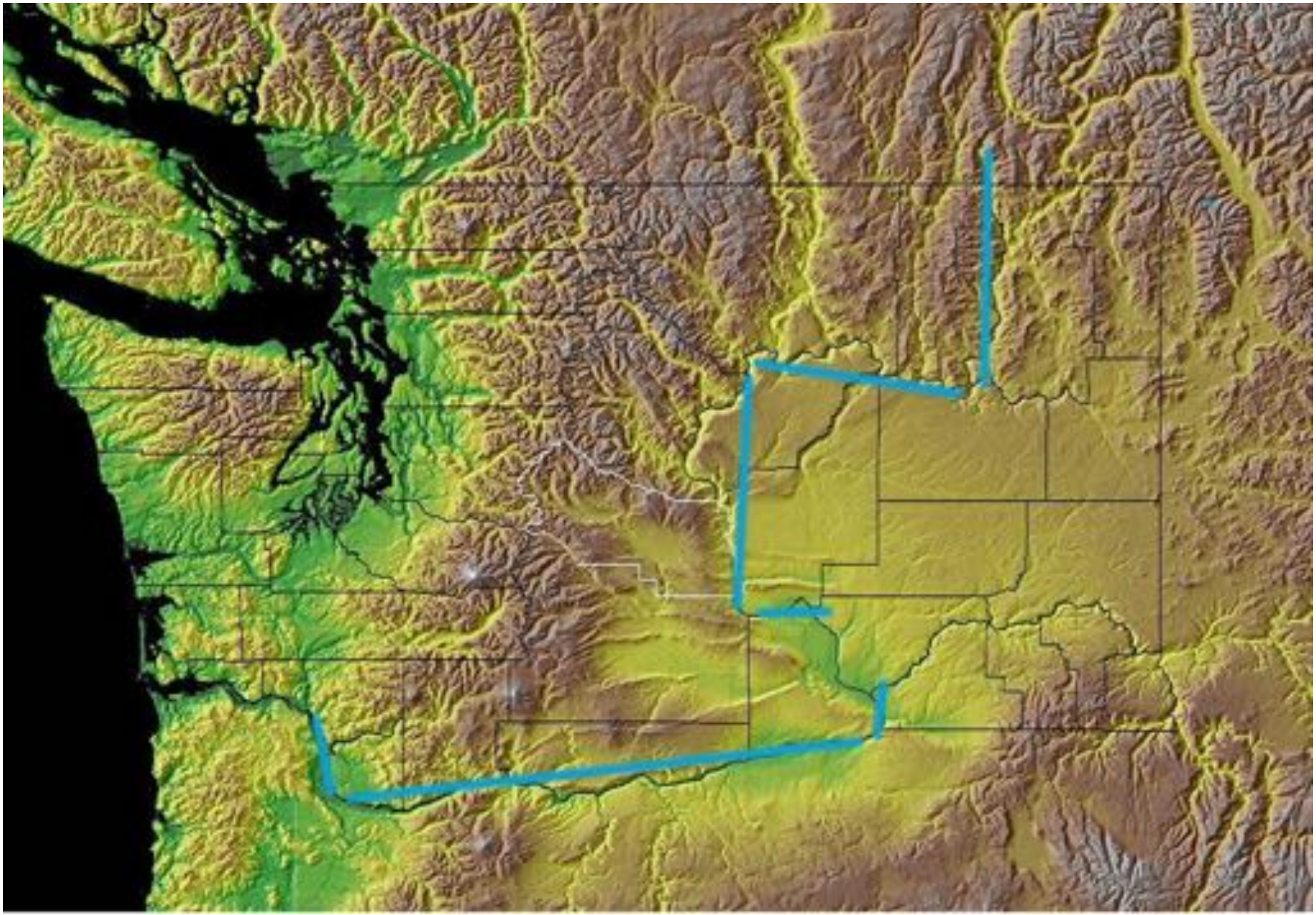
The Yakima Folds continue to rise, particularly the Horse Heaven Hills. This defeats the Columbia River at Satus Pass and forces it far to the east and through the Wallula Gap before it can flow west again.



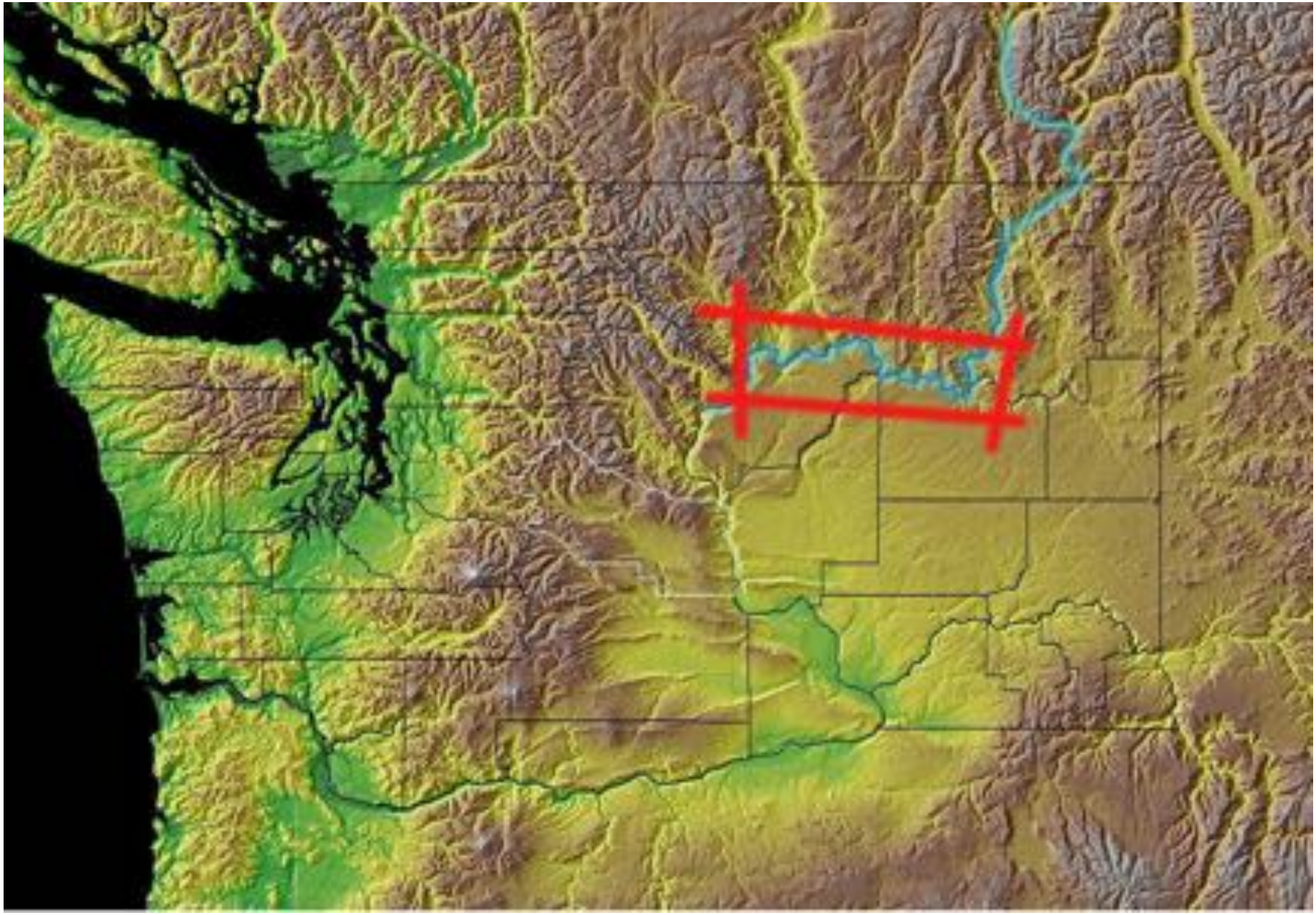
The river was diverted east: first by Yakima Ridge and later by the larger Horse Heaven Hills.

Wallula Gap lies to the east.

A: Major Landforms: the Great Bends of the Columbia.



B: Lesser Landforms: smaller bends and reaches.



Route of the Columbia River along the contact between the old rafted rocks of the Okanogan Highlands and the younger basalt lavas of the Columbia Plateau.

Straight *reaches* and sharp *bends*, all controlled by features of the bedrock.

Canyon of the Columbia River at Lake Roosevelt between Whitestone Rock and the community of Lincoln, WA.

Basalt lavas to the south.

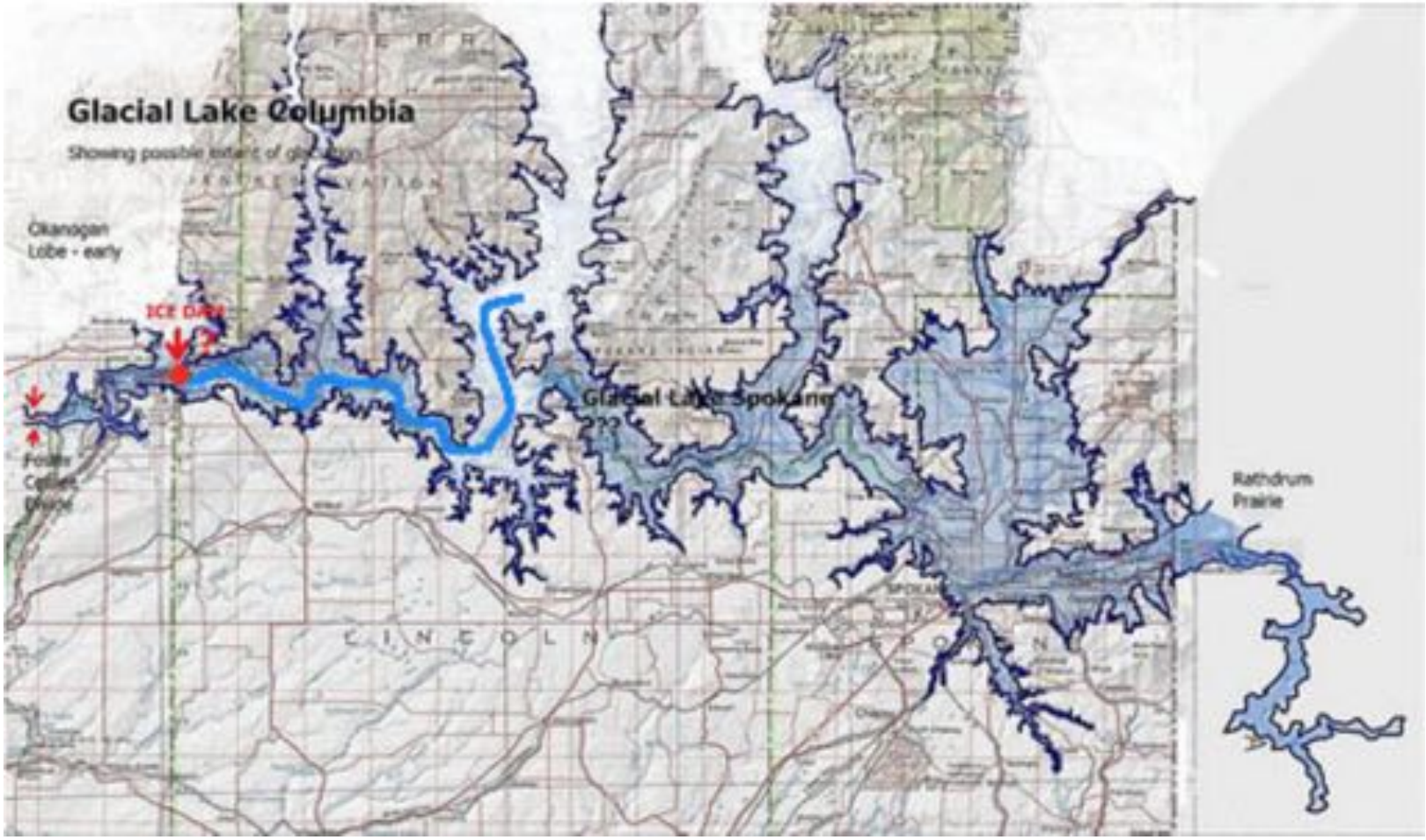
Older complex rocks of the Okanogan to the north.

Upstream view near Lincoln and Whitestone Rock.

The river near Halvorson Canyon in 1936, before Grand Coulee Dam was completed.

C: local landforms of the river.

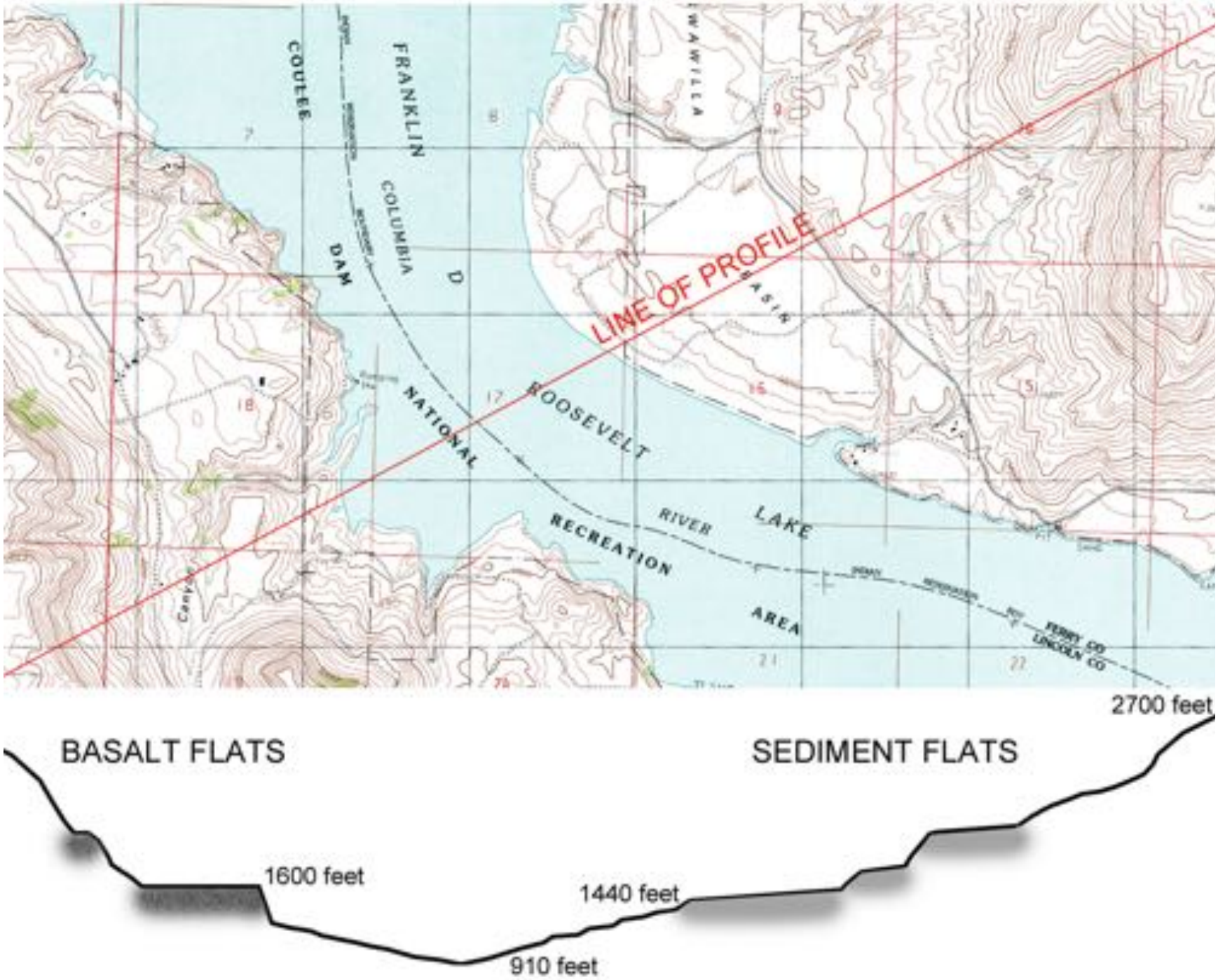
Sediments and erosion from the Spokane Floods.



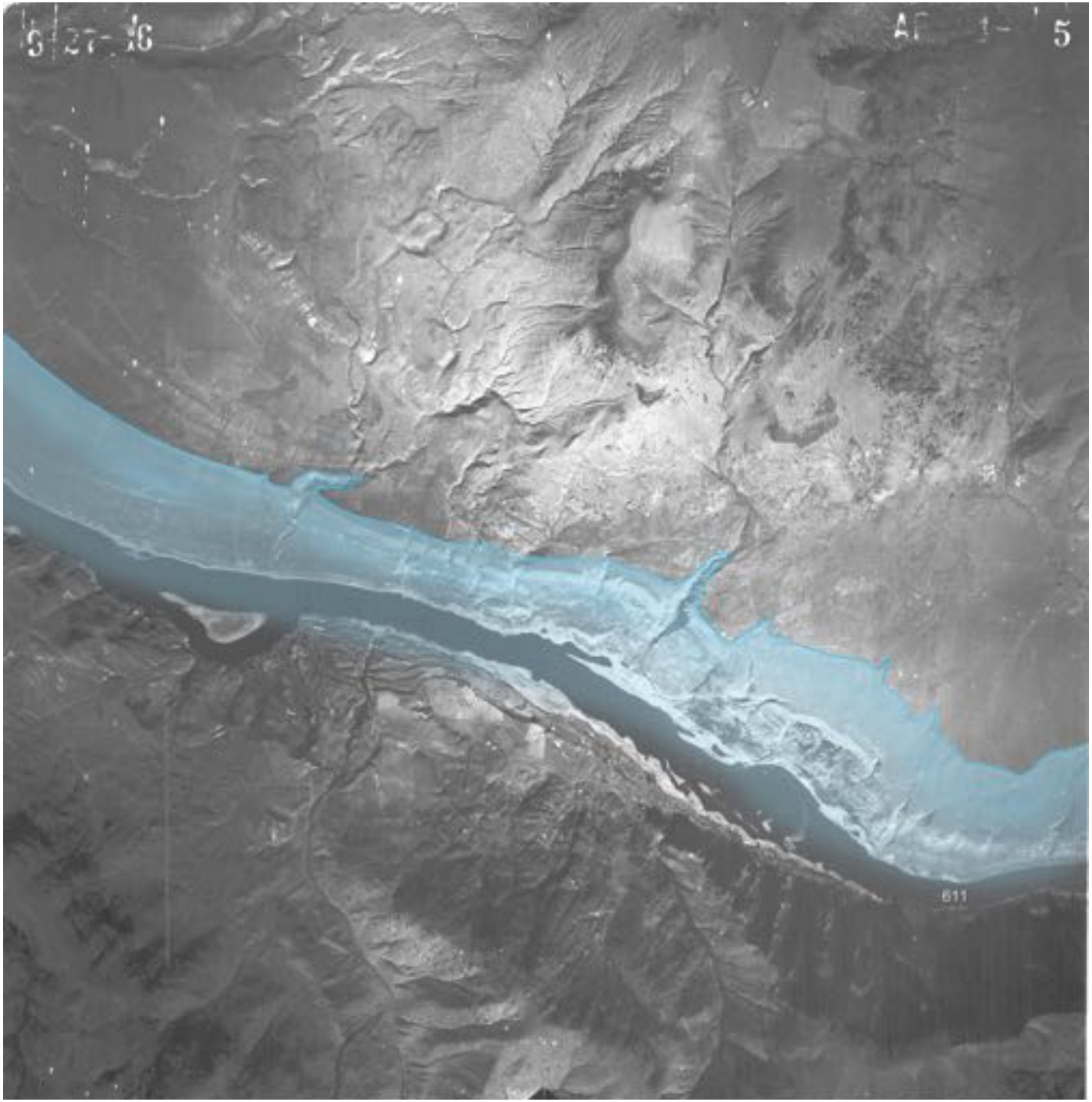
Swawilla Basin

Mica Mtn. Keller

Swawilla Basin sediments on the inside of the bend.
Strong erosion on the outside of the bend.


LINE OF PROFILE
COULEE
DAM
FRANKLIN
D
COLUMBIA
NATIONAL
ROOSEVELT
RECREATION
AREA
RIVER
LAKE
BASIN
WAWILLA
FERRY CO
LINCOLN CO
2700 feet
BASALT FLATS
SEDIMENT FLATS
1600 feet
1440 feet
910 feet

High level terraces of lake sediments.



1936 image

Present level of Lake Roosevelt shown in blue.

Landslides from large scale failure of unconsolidated terrace sediments.

Landslides show in the 1936 photographs.

2006: old landslides are downed
New landslides form on the new shoreline.

1936 before the reservoir: numerous large landslides.