2015 Bretz Club Field Trip
Columbia River Gorge
Apri 11, 2015
Multiple Parts
Multiple Authors
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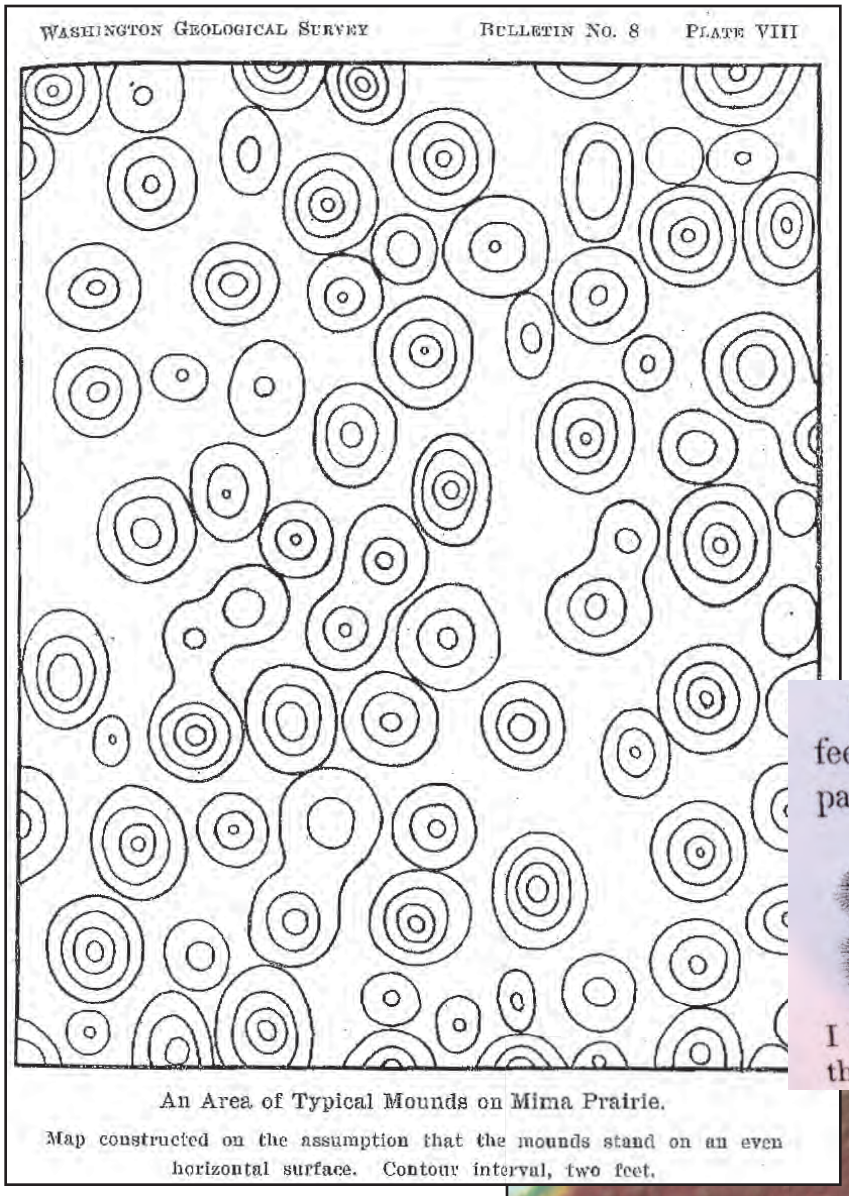
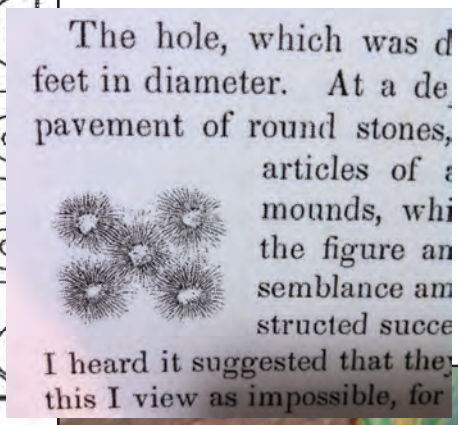
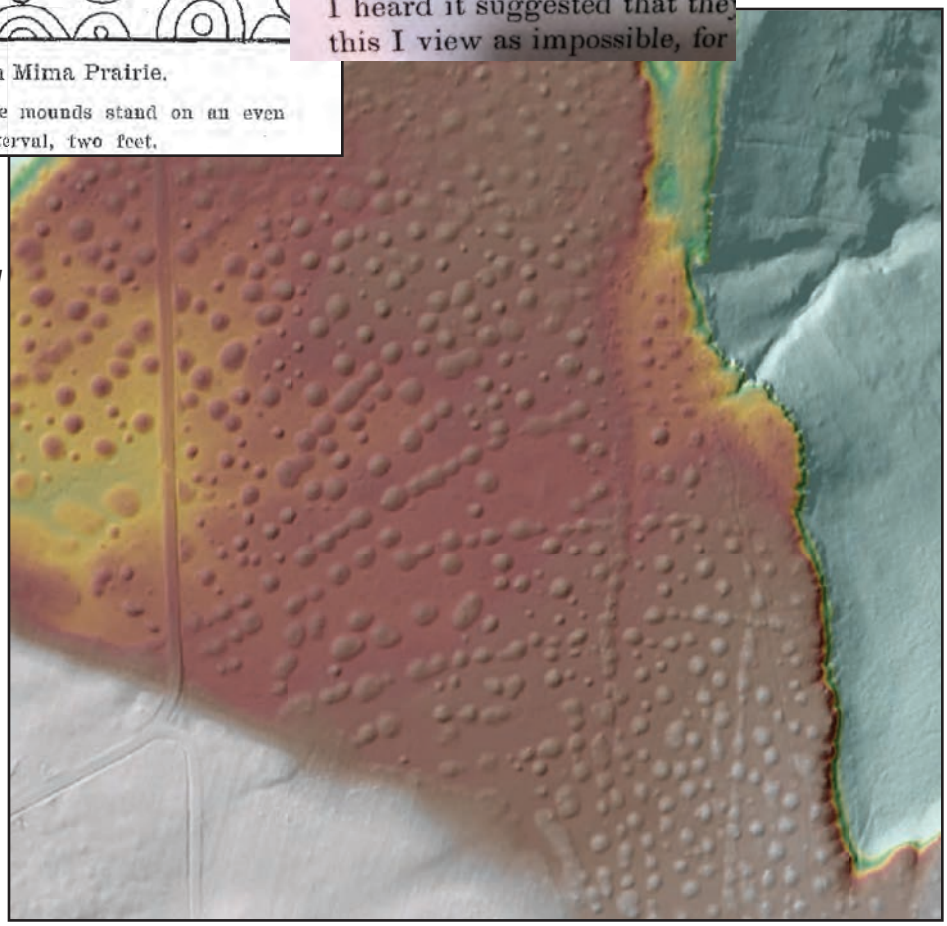


Bretz (1913)



Wilkes (1844)

"Although I have examined them with great care, I have been unable to arrive at any satisfactory conclusion in respect to their origin."
John Strong Newberry (1855)



Chenowith Tableland (image by C. Cannon; 2014 lidar love courtesy Ian Madin)

Bretz 2015 Field trip; Possible schedule

1. Depart Camp Collins at 8:30.

2. Reconvene at Lewis and Clark SP at 9:00.
    Exit 18, Interstate 84 [45.541478°; -122.379897°]
    Day campers can meet there.
    Consolidate vehicles here.
    Depart at 9:15.
    (bathrooms here)

3. Cascade Locks Marine Park (arrive at 10:15)
    Location: Cascade Locks, I-84 exit 44 [45.668213°; -121.896078°]
    Walk out to Thunder Island and discuss Bridge of the Gods landslide.
    Depart at 11:15 (maybe a bit earlier).
    (bathrooms here)

4. Chenowith Tableland Mima mounds (arrive about noon)
    Location: The Dalles, I-84 exit 83; end of Sandlin Rd (3225 Sandlin Rd)
    [45.613427°; -121.242806°]
    Walk out over spectacular Mima mound field to rim; nice lunch vista of The Dalles basin.
    Somebody (anybody?) futilely explains genesis of Mima mounds.
    Depart at 1:30.
    (no bathrooms)

5. Dalles roadcut site on 197 (arrive 1:45)
    Location: Highway 197 roadcut, I-84 exit 87 [45.585310°; -121.120502°]
    Loess OR ancient flood stratigraphy; recent paleomag; Missoula flood rhythmites.
    Depart 2:30.
    (no bathrooms)

6. Mouth of Deschutes River (Deschutes River Recreation Area; arrive 3:00)
    Location: Deschutes River Recreation Area, I-84 exit 97 [45.629302°; -120.913706°]
    Lake of the Gods; Deschutes River geomorphology.
    Depart at 4.
    (bathrooms at Heritage Landing)

7. Thunder Island Brewing Co., Cascade Locks Marine Park
    Arrive at 5.
    (bathrooms)

THUMBNAIL GEOLOGIC HISTORY OF THE COLUMBIA RIVER

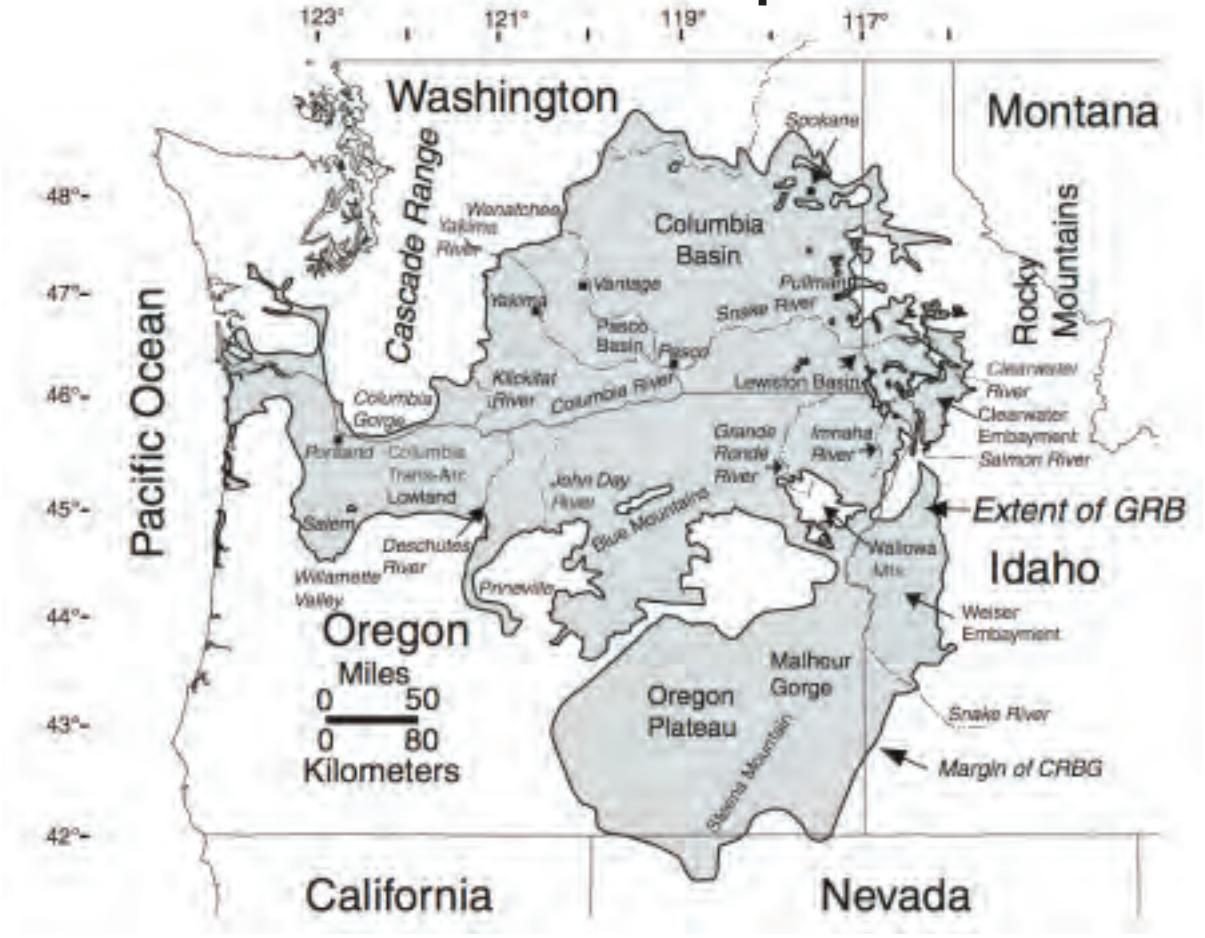
(prepared by Jim O'Connor and Richard Waitt, U.S. Geological Survey; revised April, 2015)

70-40 m.y.	Birth of the Cascade Range volcanic arc
17-12 m.y.	Voluminous Columbia River Basalt Group lava flows vent from eastern Oregon, eastern Washington, and western Idaho. 175,000 cubic kilometers of basalt bury the landscape; dozens of flows passed through ancestral Columbia River valleys to the Pacific
12-2 m.y.	Cascade Range volcanism produces broad aprons of sediment (Dalles/Rhododendron Formation). Local vents pour lava flows into Columbia River valley and build up 100s of small cones (Boring Lavas); Portland Basin forms
4-3 m.y.	Regional volcanism diverts river north into present gorge through Cascade Range
3-2 m.y.	Beginning of glacial ages, capture of the Snake River, cutting of Hells Canyon
2-1 m.y.	Modern Cascade Range warps up; present stratovolcanoes (Hood, Adams, Saint Helens) form; Columbia River cuts present gorge; landslides push river against south gorge wall, forming south-wall waterfalls
1-0.1 m.y.	At least two extensive glaciations encroach into northern Portland Basin from southern Washington Cascade Range; episodes of Columbia River deposition of sand and gravel in Portland Basin
600,000 yr ago	Prune Hill lavas solidify, future source of Columbia River jetty rock
200,000 yr ago	Mount Tabor pokes through Portland basin; one of several during last 1 m.y.
100,000 yr ago	Mount Hood volcano collapses; resulting debris flow buries present site of Hood River, dams Columbia
95,000 yr ago	Lava flows descend Wind River into Columbia River, damming deep lake
55,000 yr ago	Beacon Rock volcano pushes through Columbia valley
45,000 yr ago	Mount St. Helens erupts cataclysmically (Ape Canyon eruptive period), sending voluminous lahars down Lewis River valley, and blanketing Oregon and southern Washington with tephra
30-15,000 yr ago	Last glacial age; sea level drops 120 m globally, lowering Columbia River ~100 m in Portland basin; 30 m at Cascade Locks. Portland basin coated with windblown silt from Pleistocene mega-east winds
20-15,000 yr ago	Dozens of great floods from Glacial Lake Missoula sweep down Columbia River with volumes as great as 2500 km^3, and with discharges as great as 10 million m^3/s. Maximum flood stage 120-150 m above sea level in Portland, 300 m above sea level at The Dalles. Sculpts landscape; deposits immense gravel bars along main current threads; layered sand, silt, and clay in slackwater areas
12-5,000 yr ago	Sea level rises rapidly to present level; Columbia River keeps up by depositing 120 m of sand and silt
7,500 yr ago	Mount Mazama (Crater Lake) erupts 50 km^3 of magma; Columbia River channel filled with up to 5 m of pumice and ash
5,000-60 yr ago	Large sand dunes grow along Columbia River valley bottom
2,000 yr ago	Sea level stabilizes near present elevation
1,500 yr ago	Eruptions of Mt. Hood send multiple lahars down the Sandy River to the Columbia, forms Sandy River delta
1420-1460 AD	Bonneville Landslide blocks Columbia River at "Bridge of the Gods;" Lake of the Gods up to 85 m ASL; similar to combined Bonneville, The Dalles, and John Day dams; lake breaches landslide dam sometime before 1480, sending ~200,000 m^3/s down the Columbia River. Cascade Rapids is the remnant landslide dam, impounding Columbia River 15 m above pre-landslide level
Jan. 26, 1700	Giant Cascadia earthquake shakes entire Pacific Northwest, sends tsunami across Pacific
1781 AD	Mount Hood erupts, sending "Old Maid" lahars down Sandy River
Dec. 1861	Regional rain-on-snow flooding in the Pacific Northwest, largest floods of last several thousand years on many Columbia River tributaries (Willamette, Deschutes, John Day)
June 7, 1894	Largest historic flood on the Columbia River, 34,000 m^3/s from snowmelt
June 1, 1948	Vanport flood on the Columbia River, 28,600 m^3/s
May 18, 1980	Mount St. Helens erupts, sending ~34 million m^3 of sediment into the Columbia River near Longview
Feb. 6-10, 1996	Massive debris flows during regional rain-on-snow event bury houses, Interstate 84, and railway in Dodson/Warrendale area; Columbia River and tributaries achieve maximum stages since 1964

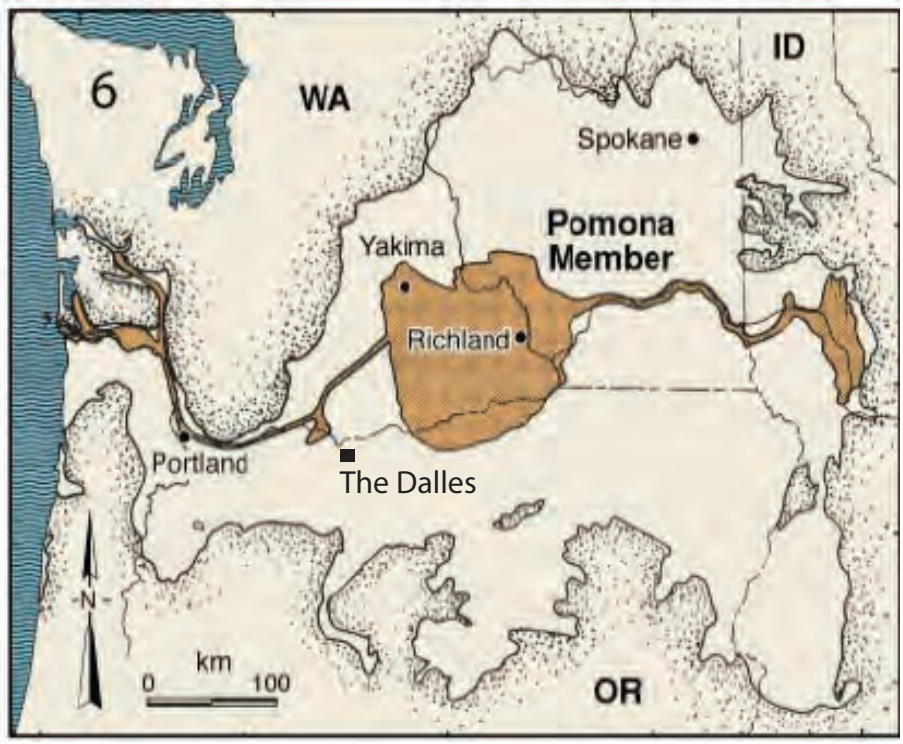
THUMBNAIL HUMAN HISTORY OF THE COLUMBIA RIVER

14,500 yr ago	First documented humans in Pacific Northwest, DNA in Paisley Caves coprolites
10,000 yr ago	Evidence of salmon fishery at the head of Five Mile Rapids near The Dalles
8,000 yr ago	Earliest dated cultural features in the Portland basin
3,000 to 150 yr ago	Dozens of Native American villages along Columbia River, notable population centers in the Celilo/Five Mile Rapids area near The Dalles, the Portland Basin, and, after about 500 yr ago, Cascade Rapids
~300-150 yr ago	First European contact, development of equestrian culture, vast reductions of Native American populations by smallpox and other communicable diseases
August 1775	Bruno de Hezeta discovers mouth of Columbia River (and names it Rio de San Roque)
May 11, 1792	Captain Robert Gray enters river and gives it the name “Columbia River”
October 1792	Lieutenant William Broughton (of Vancouver expedition) sails upstream to near Sandy River confluence
Oct.-Nov. 1805	Lewis and Clark travel through the Columbia River Gorge on the way to Pacific, running Five Mile Rapids, but portaging around Cascade Rapids; measure first tide at Beacon Rock; return through Gorge April 1806
March 1811	Contingent sent by John Jacob Astor establishes Astoria as fur trading post, becomes Fort George in 1812
July 1811	David Thompson explores entire route of Columbia River
1825	Hudson’s Bay Company established at Fort Vancouver
1841	Wilkes Expedition maps Columbia River channel; James Dwight Dana first geologist in PNW
1842	First Oregon Trail emigrants reach end of the trail at The Dalles, forced to take to the river for final 100 km
1851	“the clearing” on west bank of Willamette incorporated as ‘Portland’ (instead of as ‘Boston’)
1855	Abbot Railroad surveys, includes doctor/geologist John Strong Newberry
1853-1910	First Coast and Geodetic Surveys of Columbia River channel and floodplain
1856	First portage railway constructed around Cascade Rapids
1860s	Oregon Navigation Company runs sternwheelers between Portland and Lewiston, Idaho
1870s	First wagon road from Sandy to The Dalles
1870s	Beginning of continuous stage measurements of the Columbia River (at Cascade Locks and Umatilla)
1870s	First dredging and pile dike construction by U.S. Army Corps of Engineers
1882-1883	Union Pacific railroad completed on Oregon side by E.H. Harriman
1880-1900	Fish wheels, gill nets, and hooks annually extract up to 3 million pounds of salmon from the Columbia
1896	Cascade Locks completed, allowing ship travel past Cascade Rapids
1905	First USGS topographic quadrangles of Columbia River Gorge area
1912	James J. Hill completes Spokane, Portland & Seattle Railway on north bank of the Columbia
1915	Columbia River Scenic Highway opens between Troutdale and The Dalles
1915	Completion of Celilo Canal, allowing ship traffic past Five Mile Rapids and Celilo Falls
1938	Completion of Bonneville Dam; drowning of Cascade Rapids
1957	Completion of The Dalles Dam, drowning of Five Mile Rapids and Celilo Falls
1950-1980	Construction of Interstate 84, destruction of parts of the Columbia River Scenic Highway
1984	Rajneeshee’s salt salad bars in The Dalles with salmonella in attempt to steal Wasco County election
1986	Columbia River Gorge National Scenic Area Act
March 2009	Omnibus Public Land Management Act authorizes Ice Age Floods National Geologic Trail

Columbia River Basalt Group

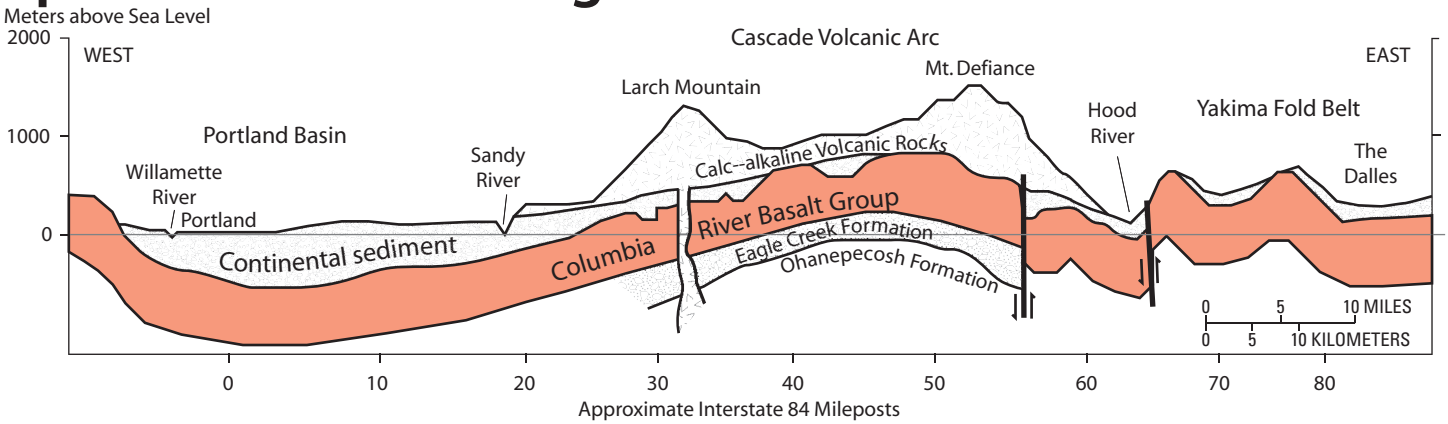


Extent of Columbia River Basalt Group; 16.7 Ma - 5.5 Ma, 210,000 km^2; 210,000 km^3
http://volcanoes.usgs.gov/observatories/cvo/cvo_columbia_river_basalt.html

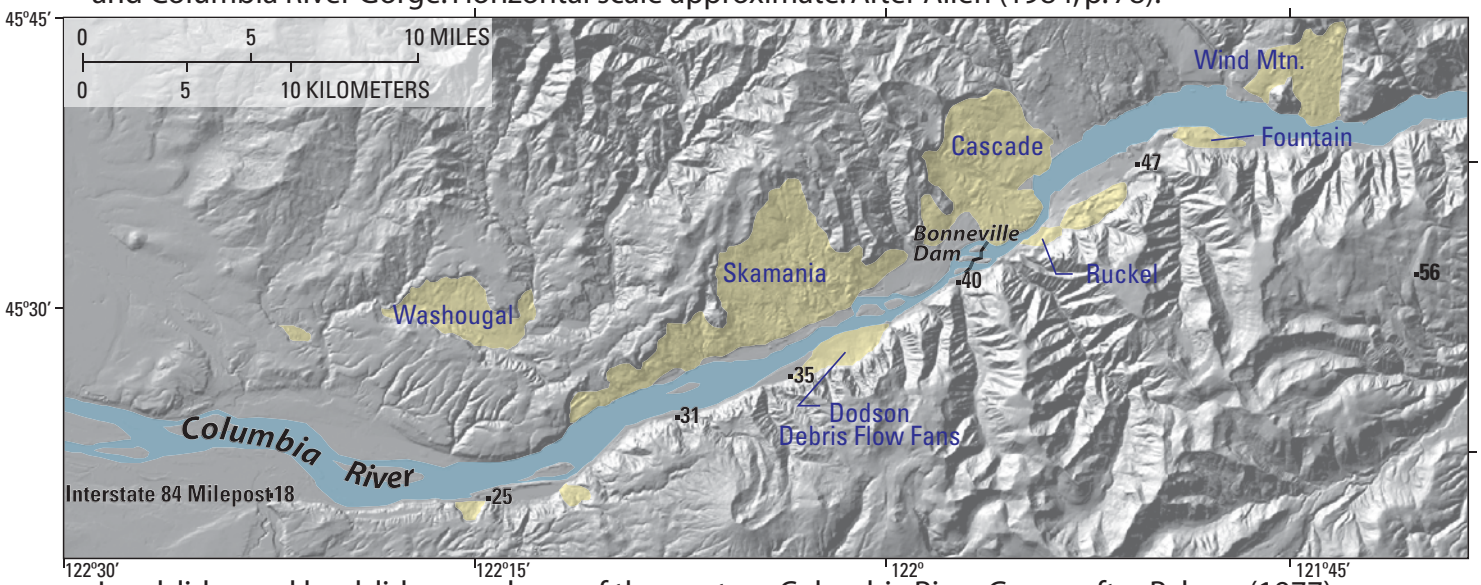


11.8 Ma Pomona flow, last one down the Columbia (modified from Tolan et al., 2009)

Uplift and Landsliding



Schematic geologic cross section for south of the Columbia River corridor through the Portland Basin and Columbia River Gorge. Horizontal scale approximate. After Allen (1984, p. 78).



Landslides and landslide complexes of the western Columbia River Gorge, after Palmer (1977).

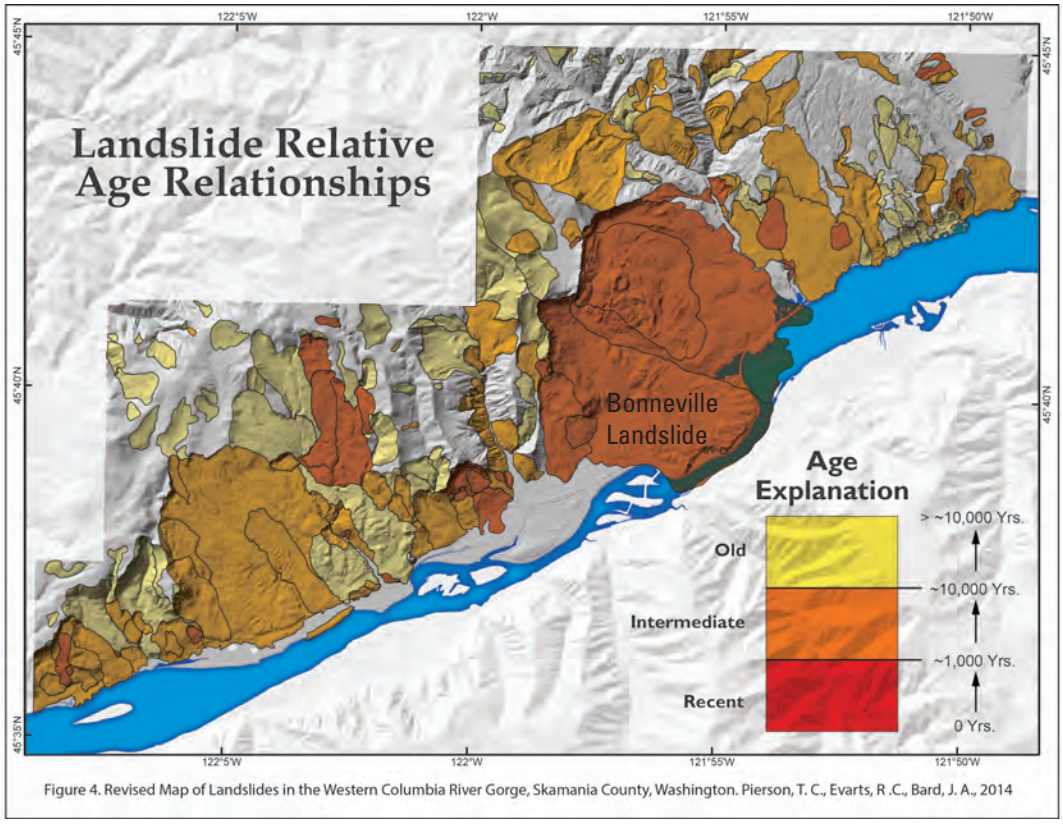
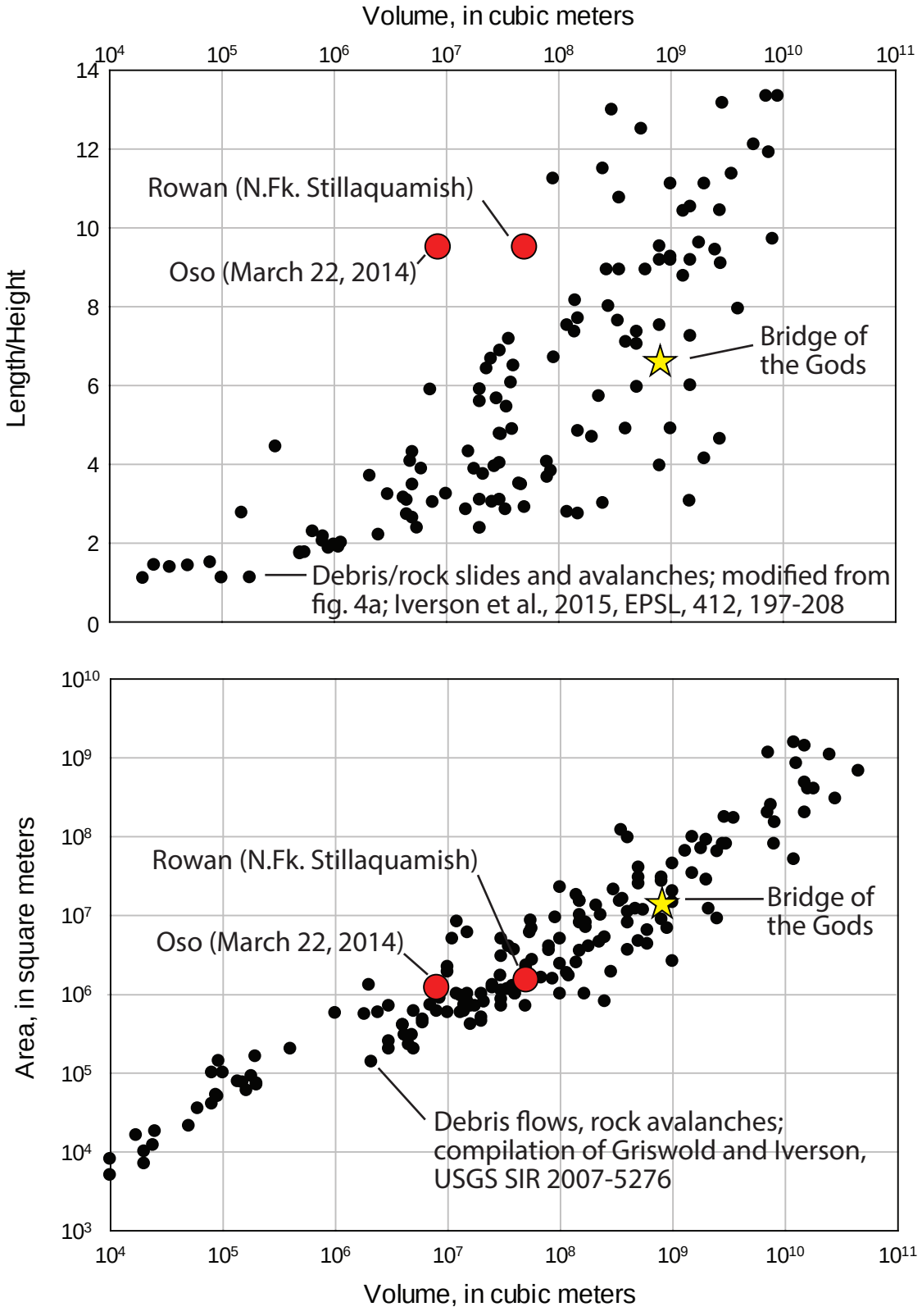


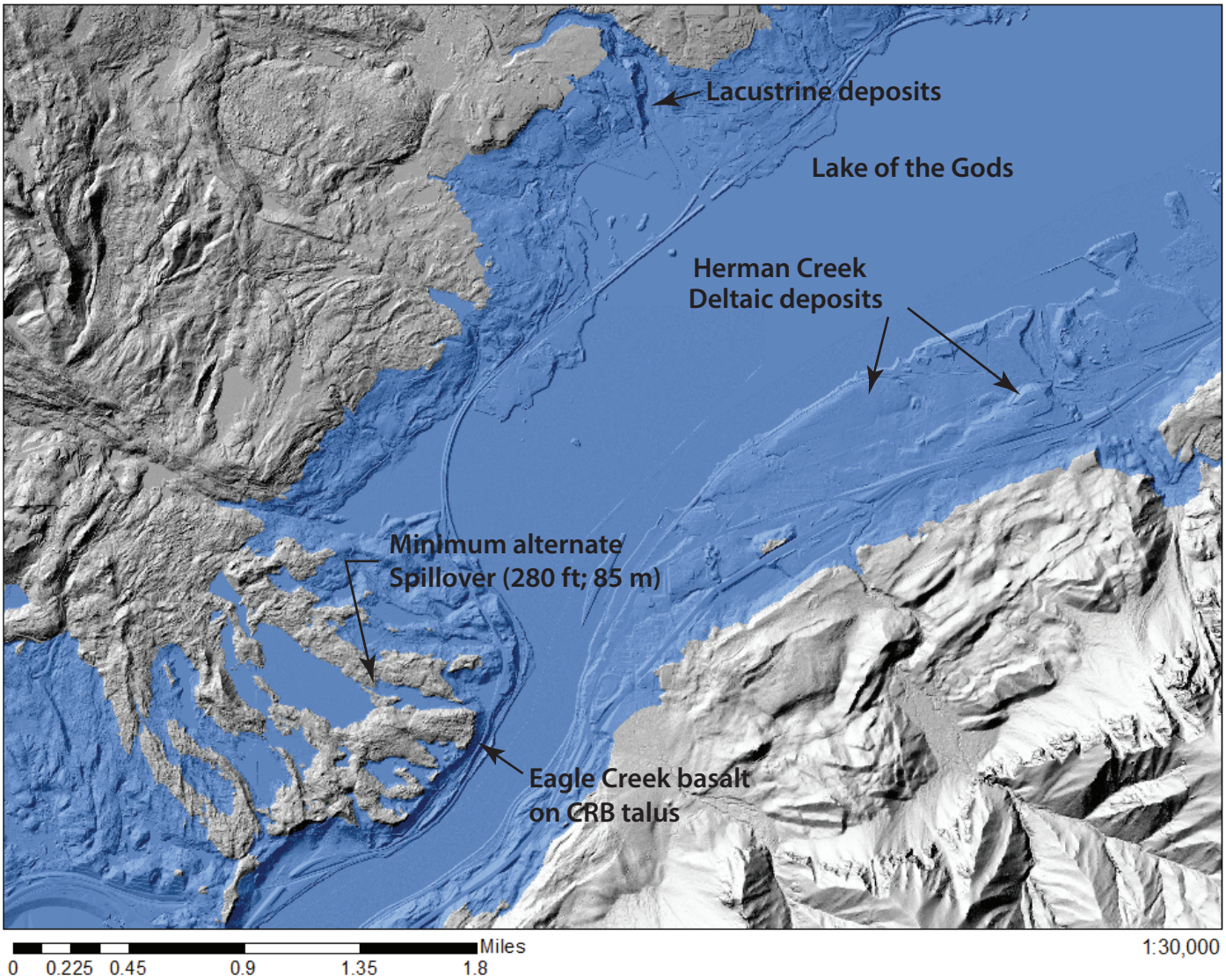
Figure 4. Revised Map of Landslides in the Western Columbia River Gorge, Skamania County, Washington. Pierson, T. C., Evarts, R .C., Bard, J. A., 2014

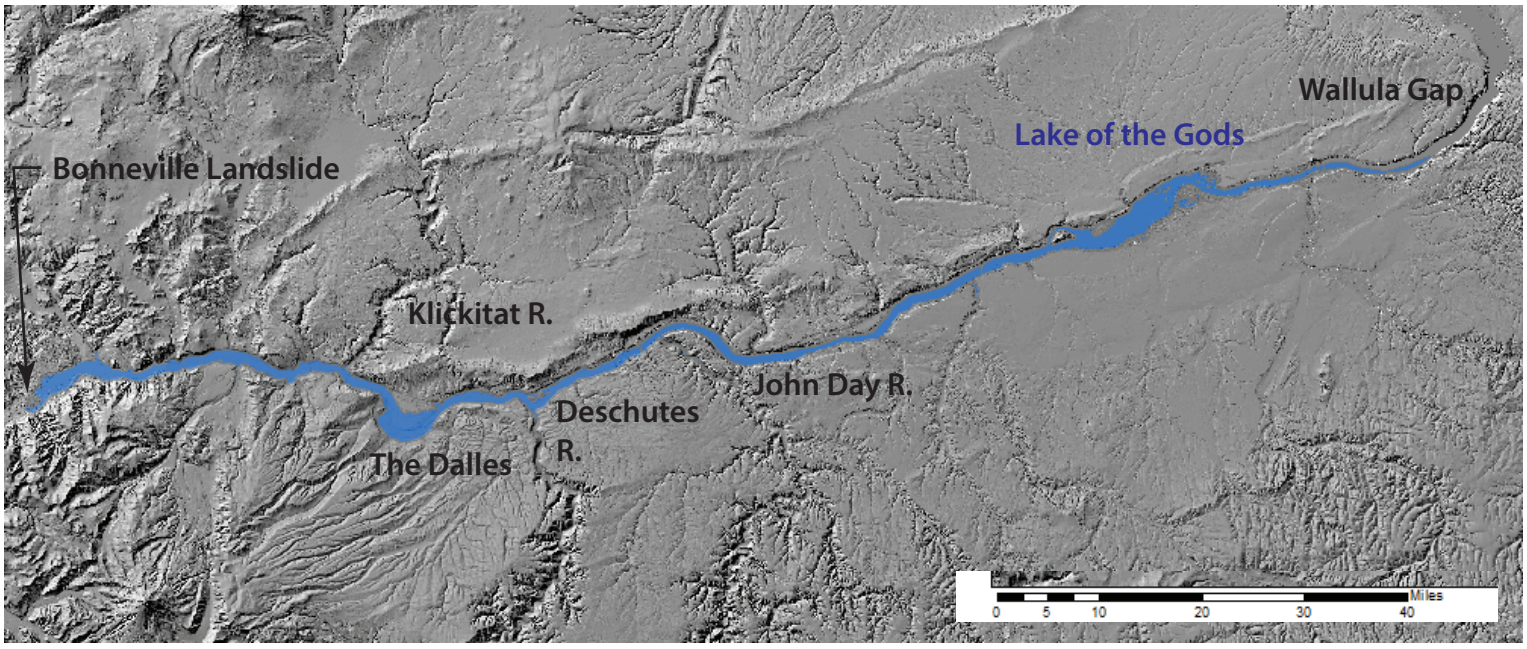
Relative landslide activity, from Tom Pierson and Russ Evarts, in progress

100 times more massive than Oso (but not quite as mobile)



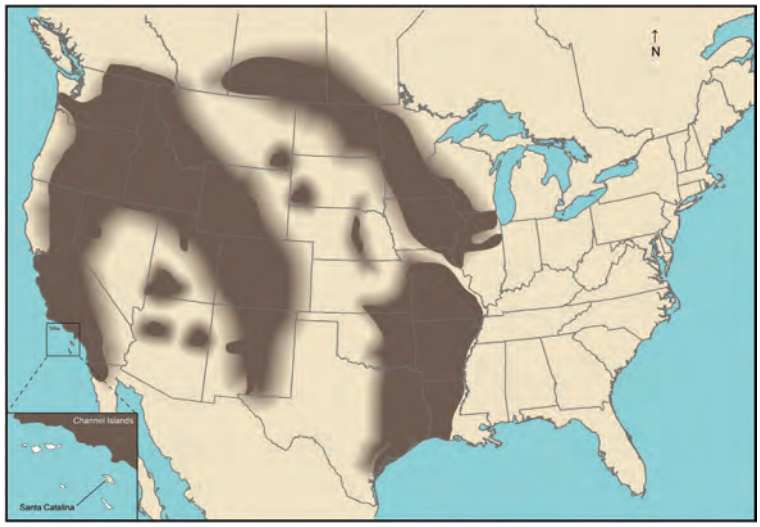
Lake of the Gods (at 280 ft [85 m] above sea level)





Lake of the Gods at 85 m above sea level, extends 250 km upstream; maps by Heather Bervid

Mima Mounds
Prairie Mounds
Biscuit Scabland
Pimple Mounds
Soil Mounds
Hog Wallows



Generalized map of Mima mound distributions in North America (from Johnson and Burnham, 2009)

Charles Wilkes (1844): "they certainly are not places of burial… and are such an undertaking as would have required the united efforts of a whole tribe."

George Gibbs (1855): "Below the Des Chutes the hills are freckled over with mounds"

Louis Agassiz (in Gibbs, 1873): "Pronounced 'unhesitatingly' to be nests of a species of sucker"

John Strong Newberry (1857): "Although I have examined them with great care, I have been unable to arrive at any satisfactory conclusion in respect to their origin."

Joseph LeConte (1874) "Surface-erosion under peculiar conditions"

G.K. Gilbert (1875) "There is little question that they are the vestiges of hummocks thrown up by prairie dogs, or other burrowing animals."

J Harlen Bretz (1913) The Mima type mounds are so striking in appearance, and so different from topographic forms ordinarily seen, that even the car-window observer is at once interested, and the range of hypotheses for their origin has been considerable." And "The explanation....is believed to lie in some combination of water and ice action..., such effective combination being unique so far as the writer is aware."

Aaron Waters (1929) "Probably no landform of similar size has occupied such a conspicuous place in geological controversy."

Rube Newcomb (1952) "[T]he enigmatic origin of these mounds [Mima Prairie] constitutes a continuous embarrassment and a challenge to geological science.

Hal Malde (1964) "I believe the patterned ground on the Snake River Plain developed under a former periglacial climate." And "The struggle of ideas concerning pimpled plains leans either to physical processes or to biological activity and is tempered by an observer's experience and prejudice."

Johnson (2009) "… evidence has gradually accumulated which confirms that burrowing animals are involved."

Others:

"decay of basalt"

Chemical precipitation

Ants

Clay volcanoes

Ice-wedge polygons

Tree throw

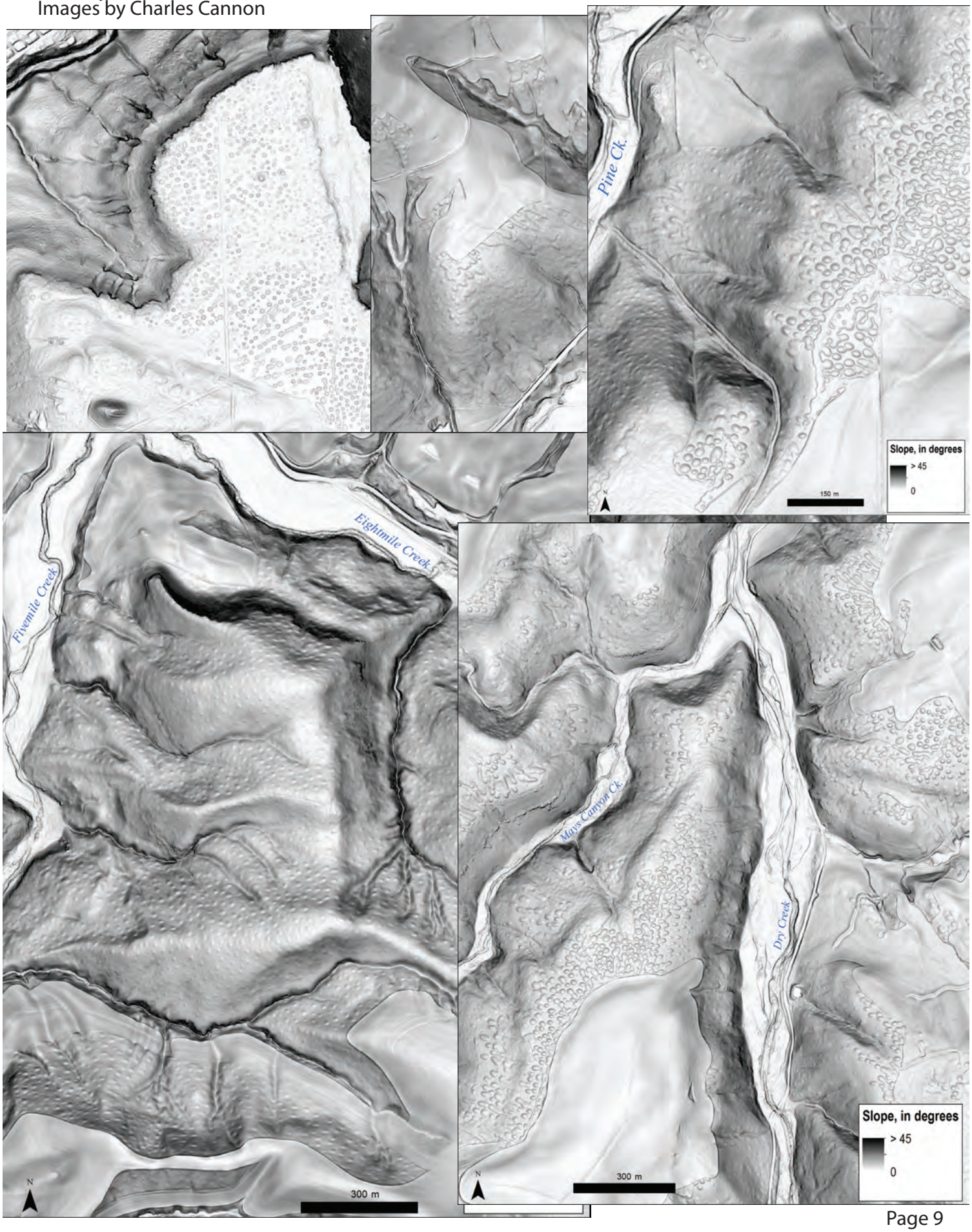
Seismic shaking

Ice-rafted debris

The Dalles pocket gopher (from Moore and Reid, 1951)

Fifty shades of....Mima Mounds

Images by Charles Cannon



Missoula Floods

Bretz (1925)
"Beyond the Channeled Scabland"

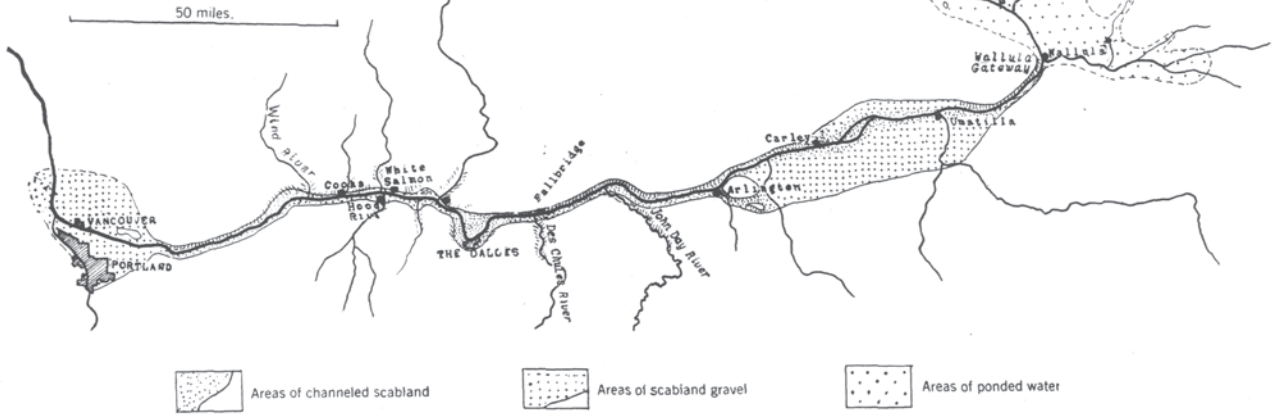
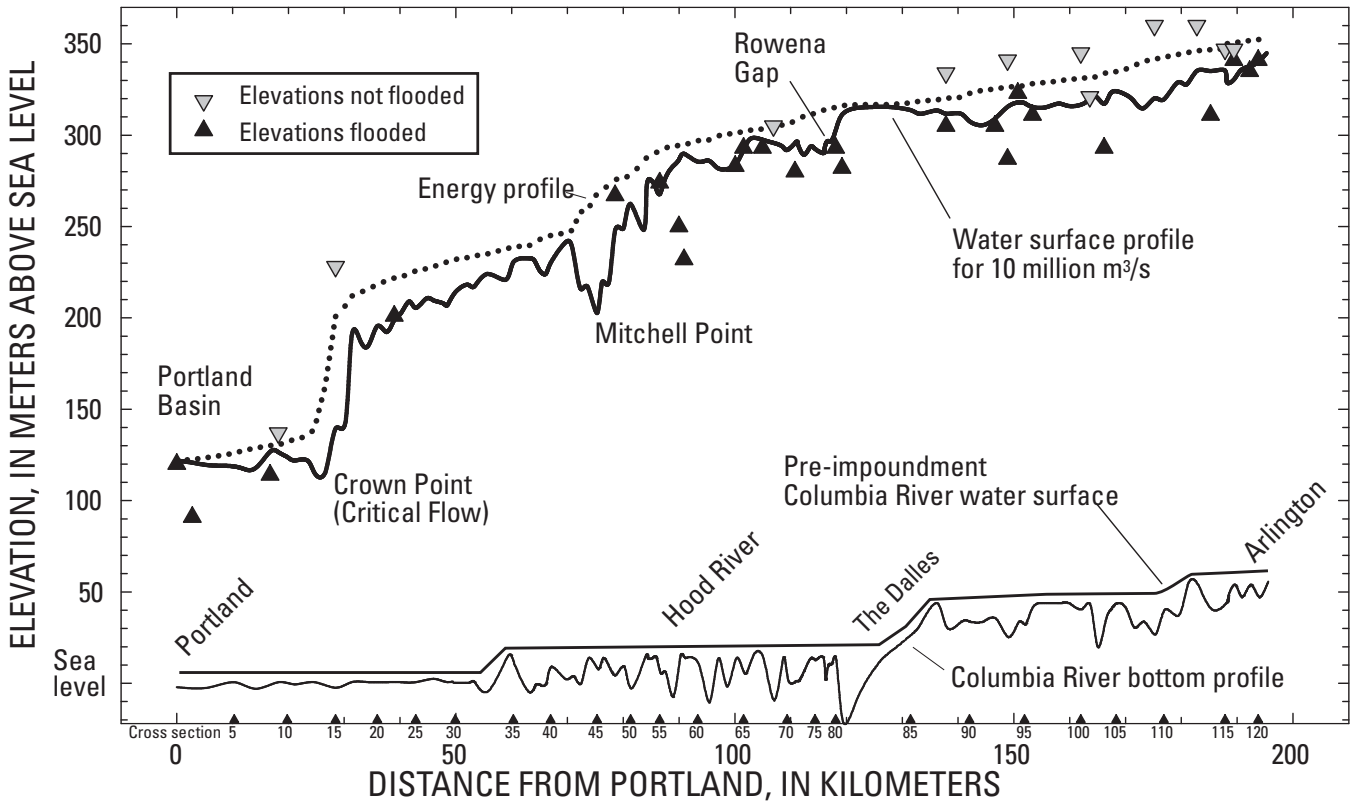
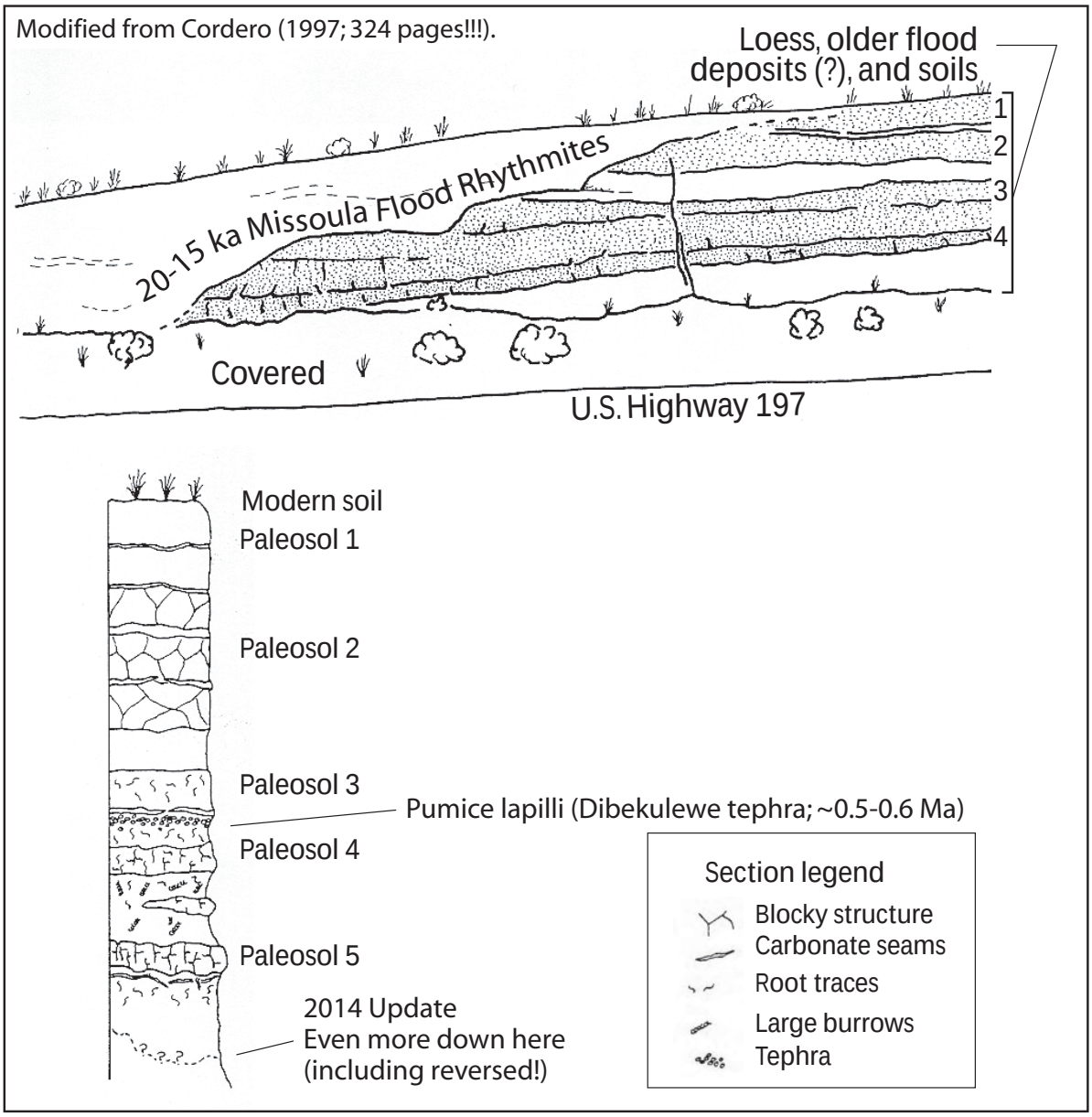


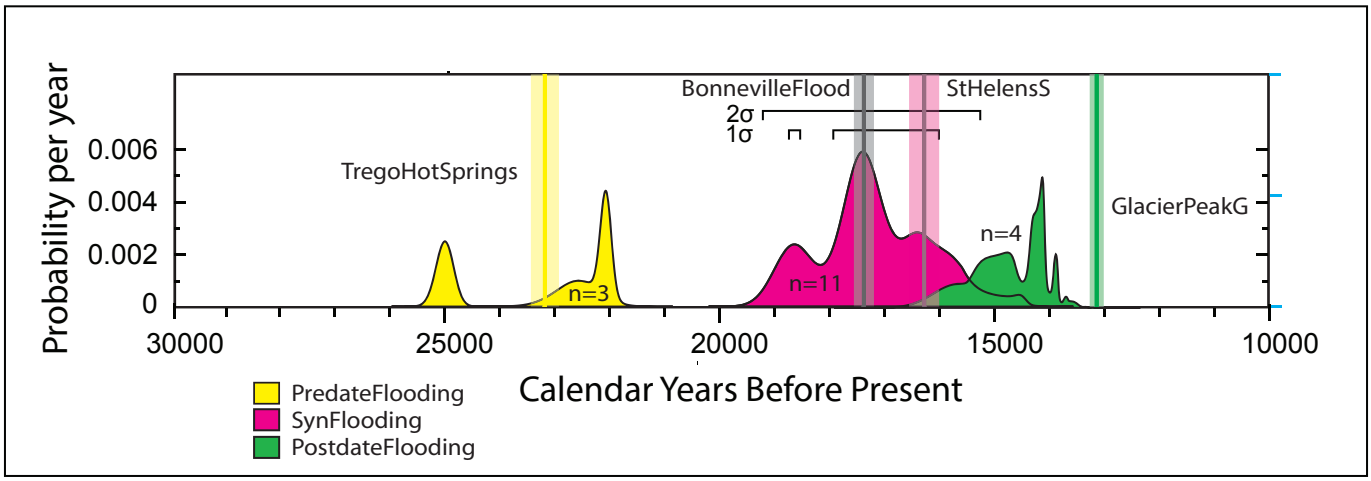
FIG. 8.—Sketch map of Columbia Valley between Wallula and Portland, showing area affected by the Spokane Flood



Evidence for maximum Missoula flood stages in lower Columbia River valley and step-backwater flow calculation results for a discharge of 10 million m3/s. Modified from Benito and O'Connor (2003).

Missoula Floods, Paleosols, Loess, and Possibly Ancient Flood deposits???





Radiocarbon controls on age of Missoula flooding (O'Connor and Benito, 2009)