

# Erratic Behavior on Rattlesnake Mountain

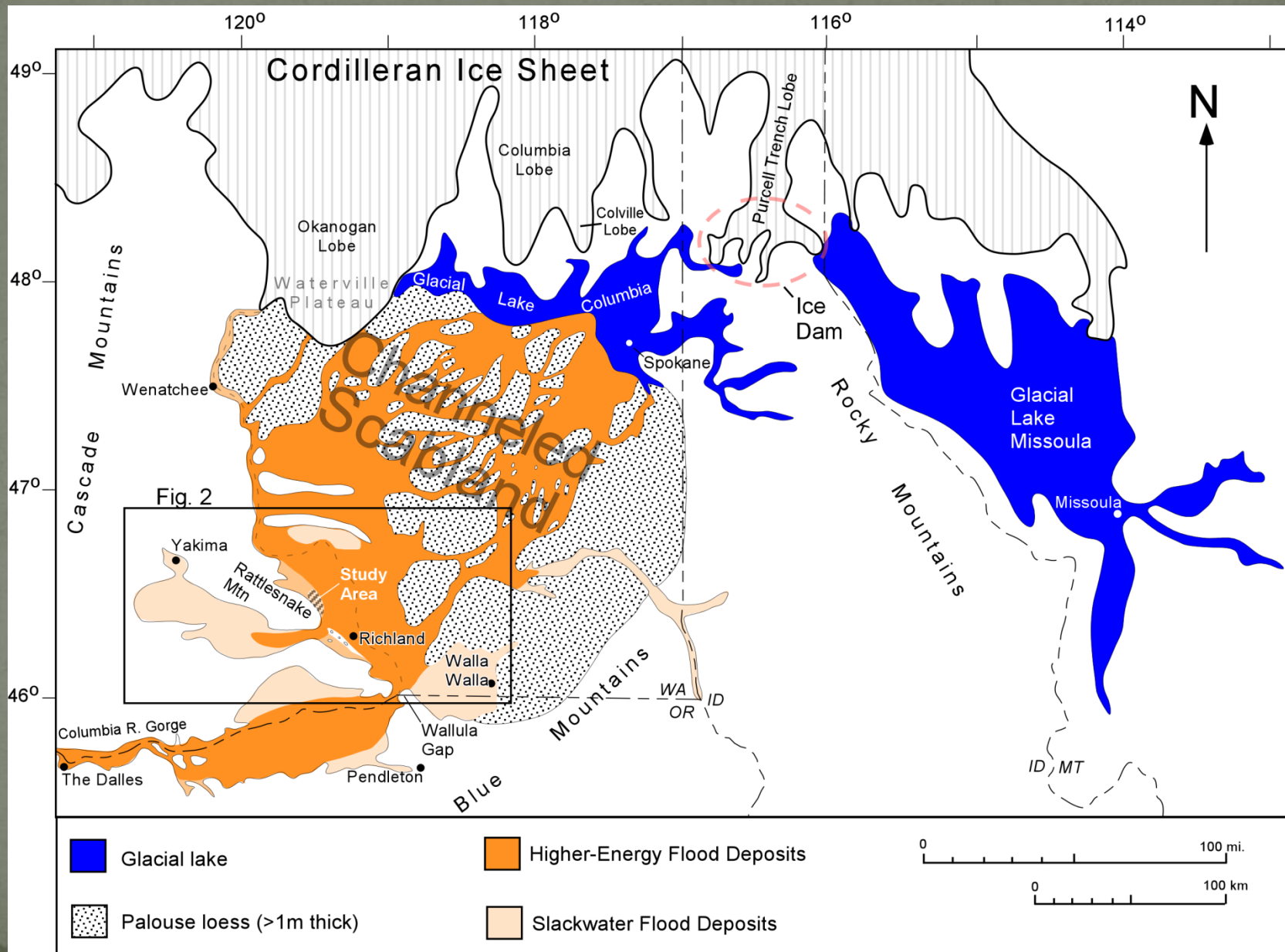


Bruce Bjornstad



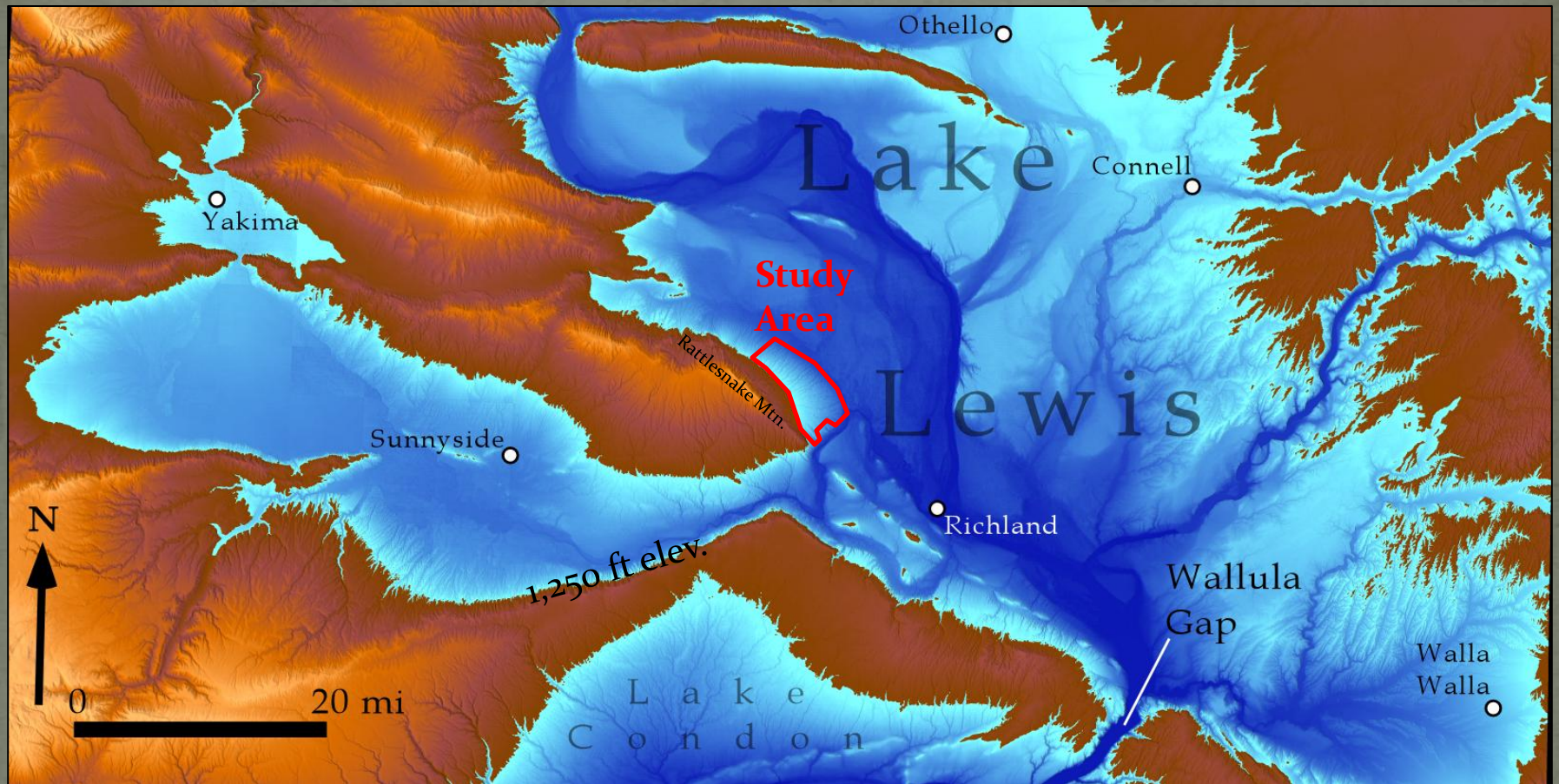
# Abstract

Ice-rafted debris is common in slackwater areas along the 1,100-km route for cataclysmic outburst floods from glacial lakes Missoula and Columbia in the northwestern United States. A detailed analysis was performed at Rattlesnake Mountain where an exceptionally high concentration of ice-rafted debris exists midway along the floods' path. Here floodwaters temporarily rose to near 380 m elevation (forming short-lived Lake Lewis) behind the first substantial hydraulic constriction for outburst floods at nearby Wallula Gap. Within the 60 km<sup>2</sup> study area more than 2,100 erratic isolates and clusters, as well as bergmounds were recorded. Three quarters of erratic boulders are of granitic composition, which stand in stark contrast to indigenous, dark Columbia River basalt. Exposure ages on three dispersed erratics are constrained to the late-Wisconsin Glaciation (16-17ka). Most ice-rafted debris is concentrated between 200 and 300 m elevation. Far fewer erratics and bergmounds lie above 300 m elevation because of the preponderance of less-than-maximum floods. Plus, larger deep-rooted icebergs were forced to ground farther away from the ancient shorelines of transient Lake Lewis. As floodwaters moved across the uneven surface of Rattlesnake Mountain, many erratic-bearing icebergs congregated into pre-existing gullies that trend crosswise to the flood-flow direction.





# Location of Study Area

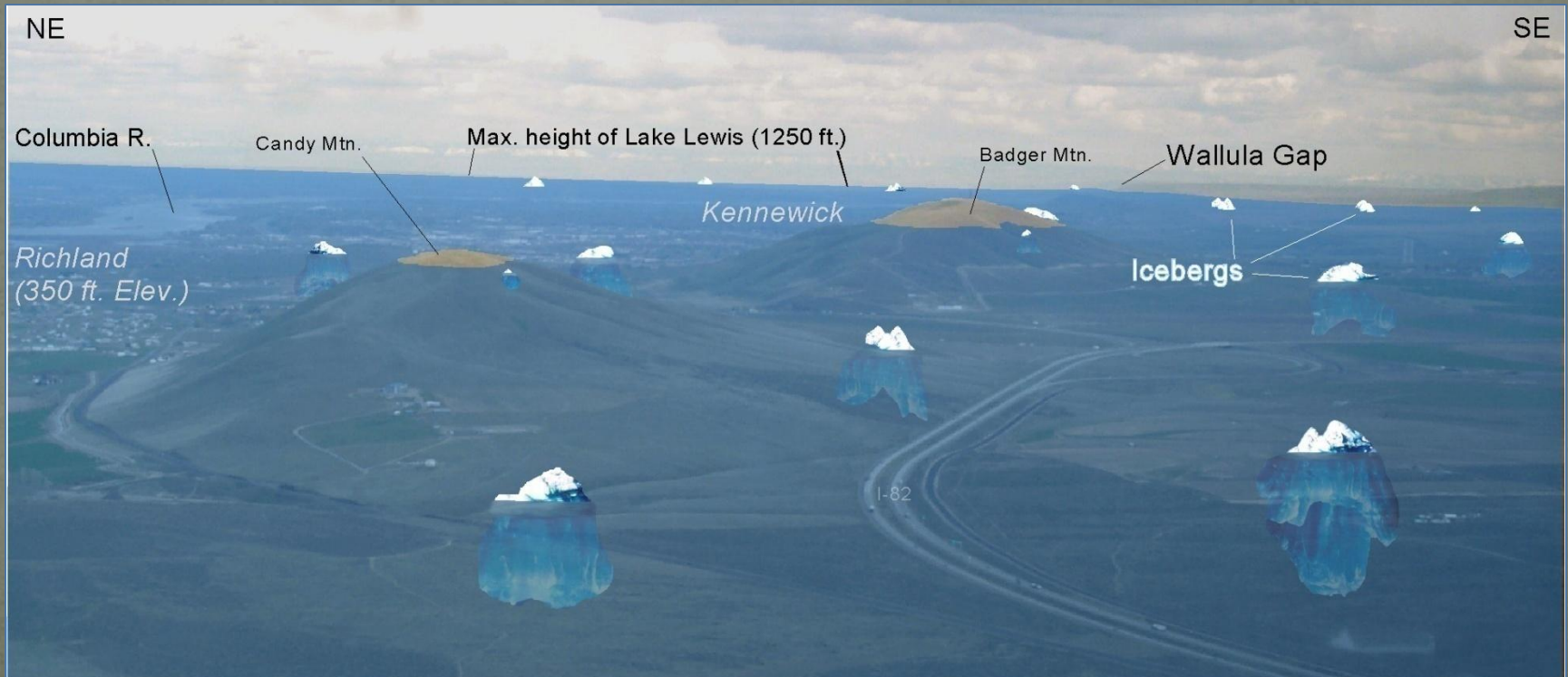


"A widespread submergence of the lower Columbia Valley is known to have occurred during the Wisconsin glaciation. It is recorded by berg-floated erratic boulders, some of great size, scattered widely in the Columbia Valley below the present altitude of about 1,250 feet above tide."

J Harlen Bretz (1923)

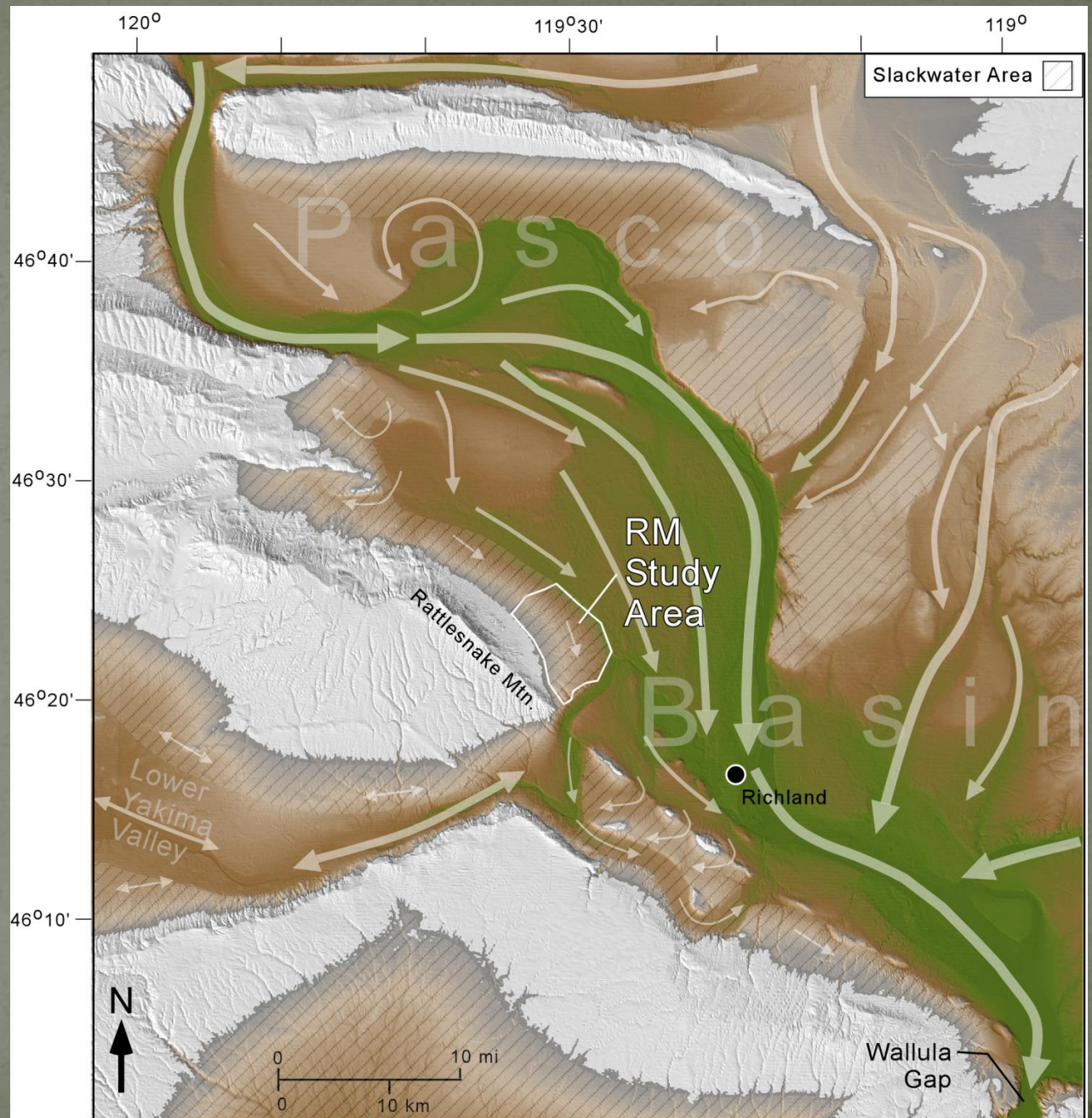


# Erratics Rafted in on Icebergs During Ice Age Floods





# Flood Flow Through the Pasco Basin





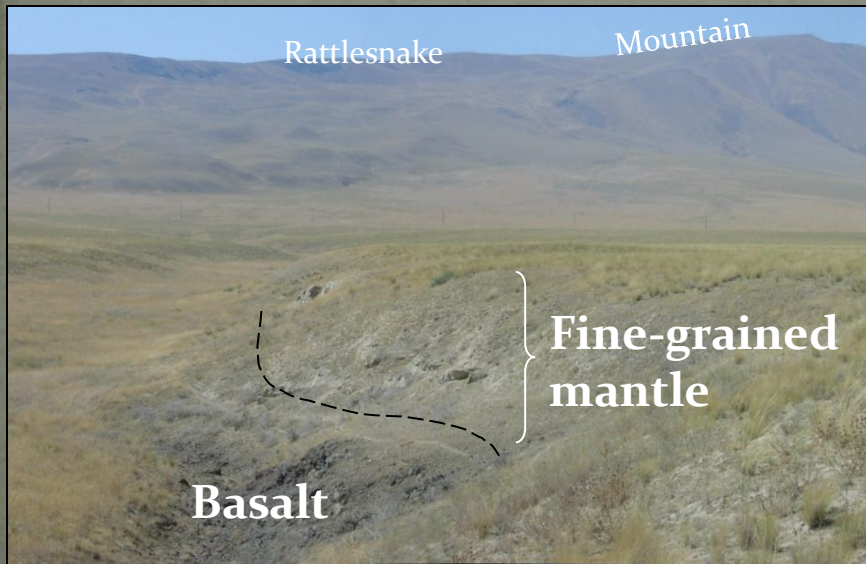
# Environmental Setting



- Pristine, undisturbed, and protected area for last 60 years, now part of the HRNM

- Sparsely vegetated. Totally burnt off in 2000 wildfire, and partially burnt in 2003.

- Gently sloping, low-relief slope of Rattlesnake Mtn.



- Only indigenous rock = dark Columbia River Basalt (exposed at base of arroyos)

- Thin ( $\leq 20$  ft), fine-grained mantle of Holocene loess, slopewash, and/or slack-water flood deposits above basalt

- **Ice-rafted debris is undisturbed and easily recognized in this environment**



# Data Collection

- Type of debris
- GPS location
- Elevation
- Size
- Rock type
- Roundness
- Surface characteristics



- ❖ *Erratic size limit  $\geq 1 \text{ ft}^2$   
(Max. observed cross-sectional area)*
- ❖ *Data points  $\sim 2,250$*
- ❖ *Study area  $\sim 23 \text{ mi}^2$*



# Three Types of Ice-Rafted Debris



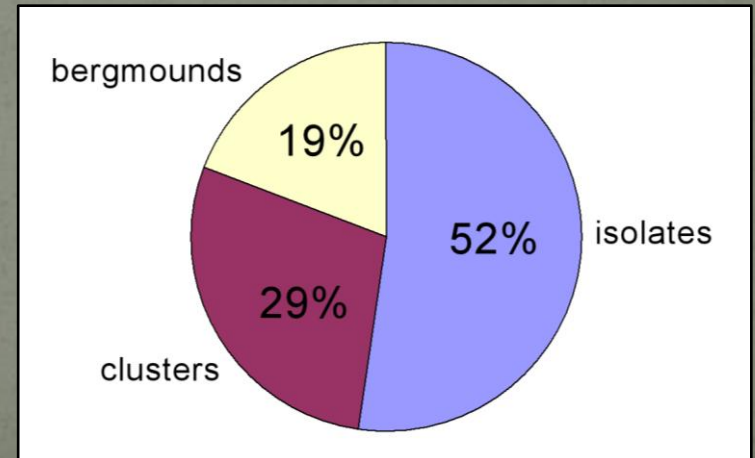
1. Isolated erratics



2. Erratic clusters



3. Bergmounds





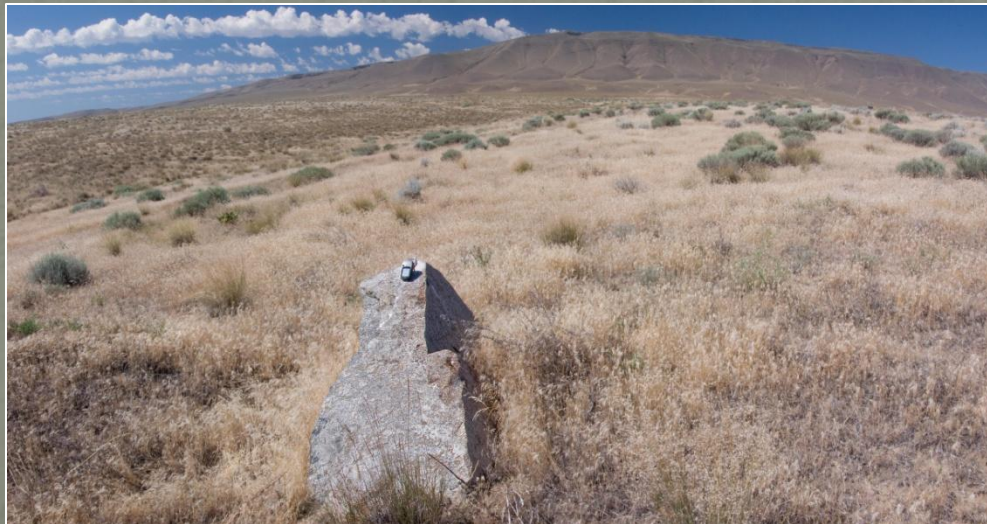
# Isolated Erratics



Granodiorite  
18 ft<sup>2</sup>  
530 ft elev.



Argillite (Belt Rock)  
36 ft<sup>2</sup>  
820 ft elev.



Diorite  
12 ft<sup>2</sup>  
880 ft elev.



# Erratic Clusters



Granodiorite  
9 ft<sup>2</sup> (largest)  
1,000 ft elev.



Argillite  
120 ft<sup>2</sup> (largest)  
800 ft elev.



Diorite  
11 ft<sup>2</sup> (largest)  
930 ft elev.

*Clusters often  
contain mixtures of  
different rock types*



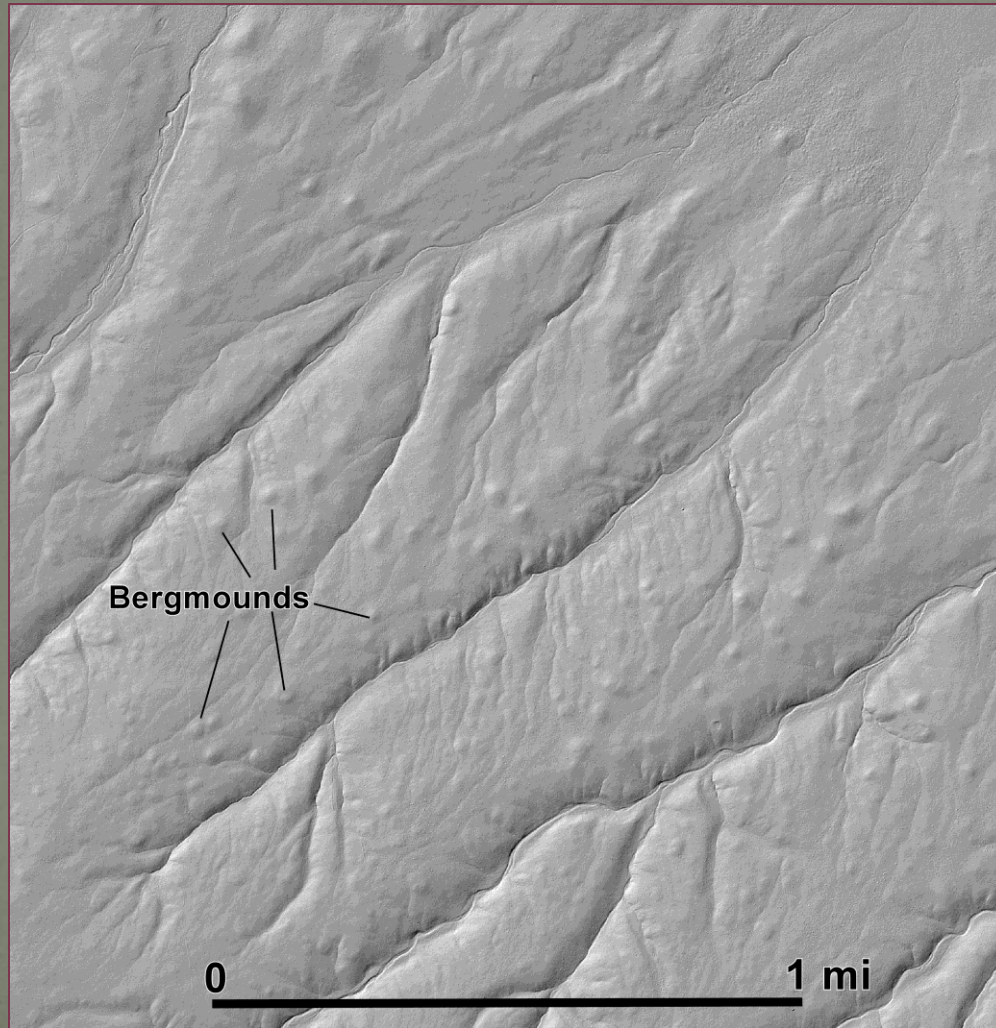
# Bergmounds



Conical-shaped, low hills of ice-rafted debris



# LiDAR Image Showing Bergmounds



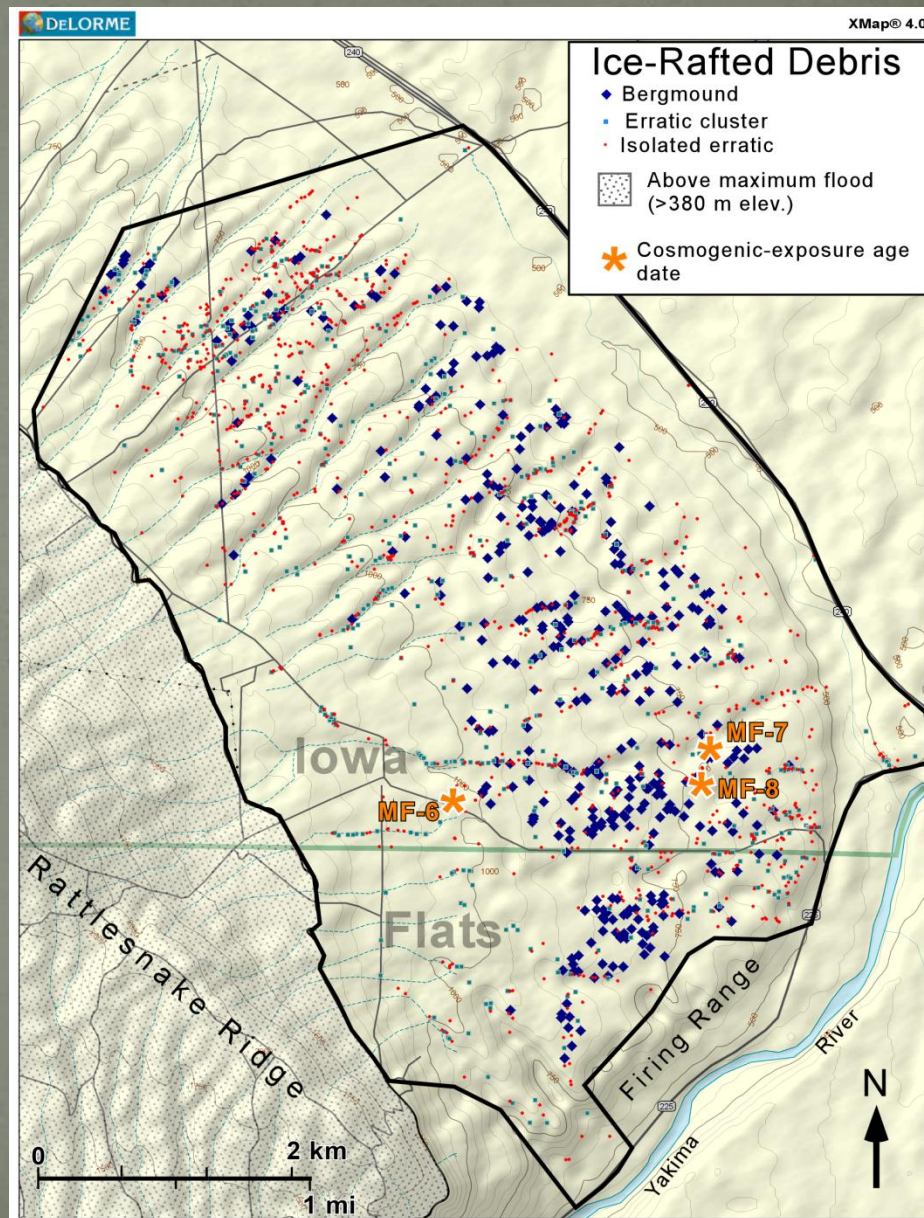
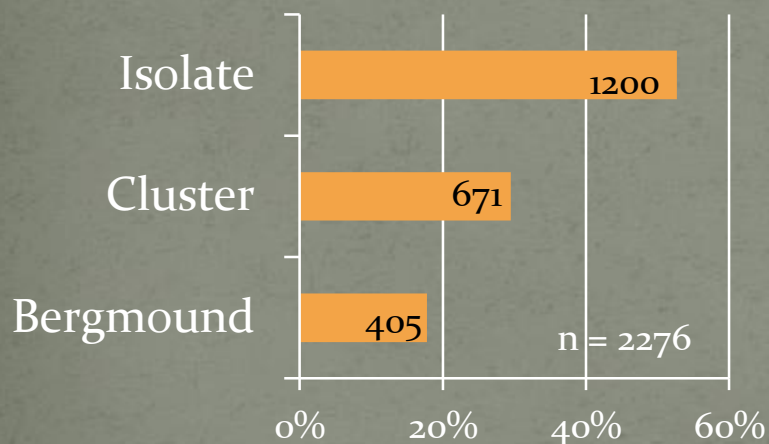
Dozens of various-sized bergmounds are visible in this LiDAR (light detection and ranging) image of a portion of Rattlesnake Mountain.

The bergmounds were left behind as large, debris-laden icebergs became grounded during the waning stages of Ice Age flooding.



# Spatial Distribution of Ice-Rafted Debris

- Amount of ice-rafted debris increases downslope
- Highest erratic 1,189 ft elev.
- Bergmounds restricted to 600 to 1,000 ft elev.



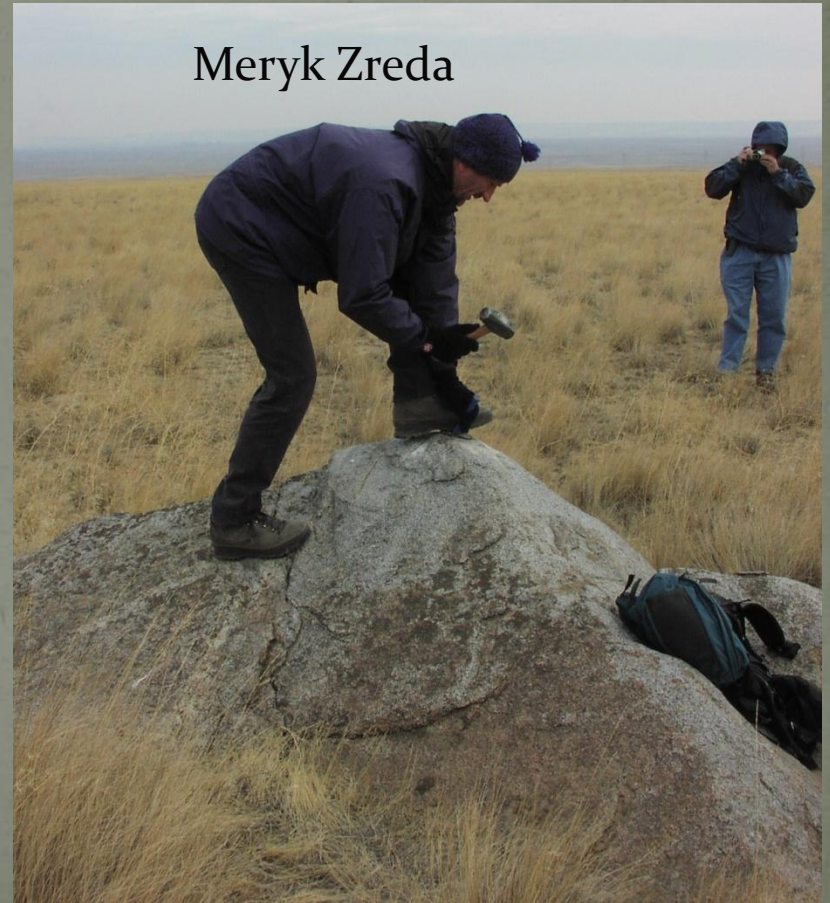


Vic Baker



Three cosmogenic-exposure age dates all between 16,000 to 17,000 years B.P.

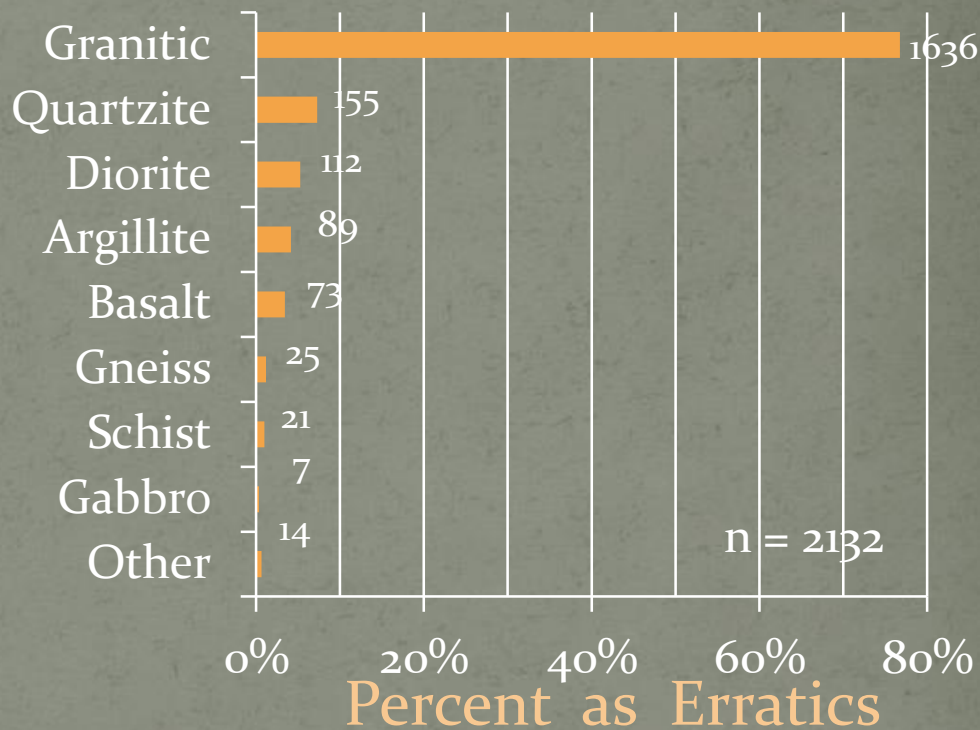
Meryk Zreda







# Rock Types Found



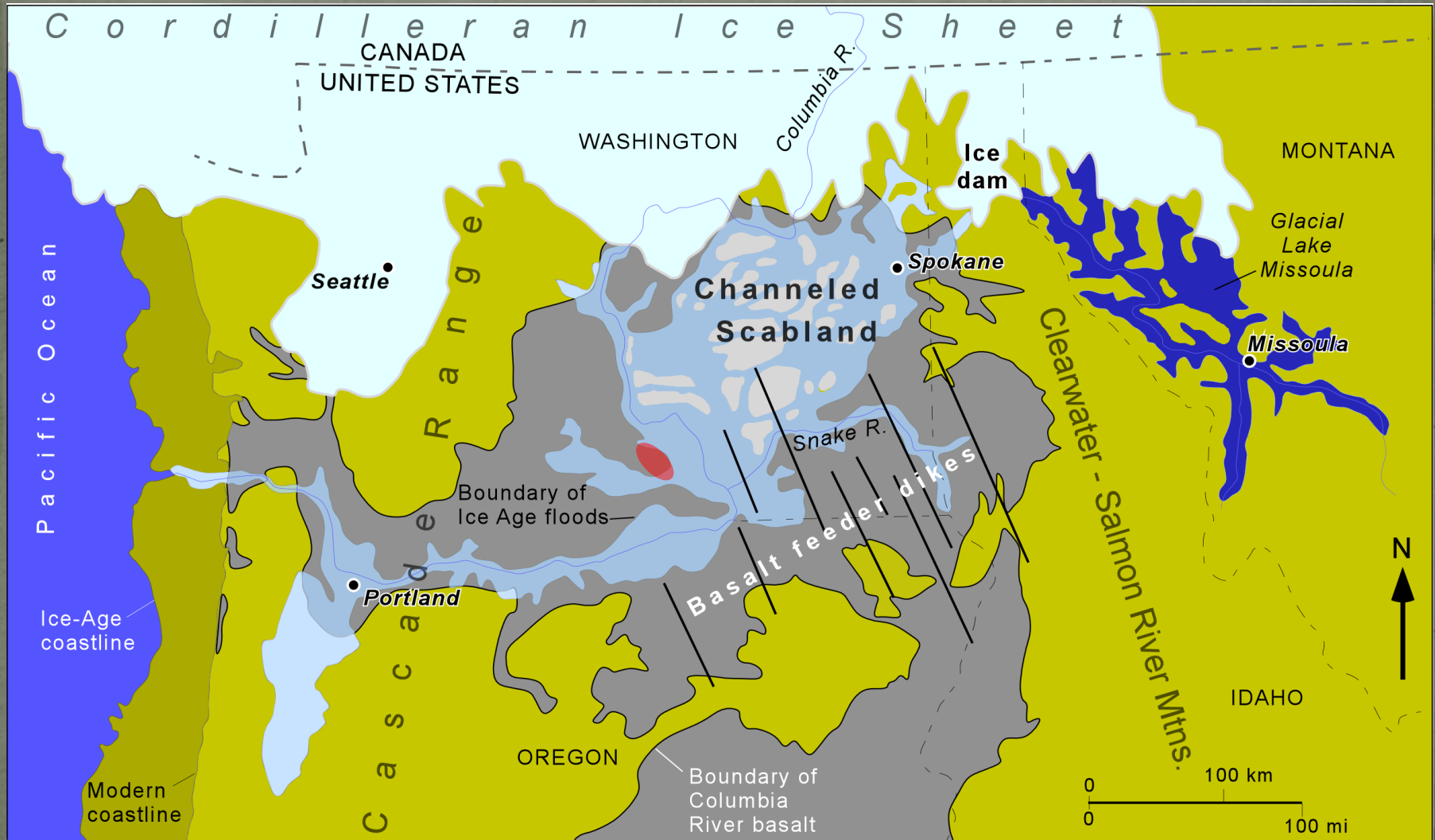


# Distribution of Columbia River Basalt



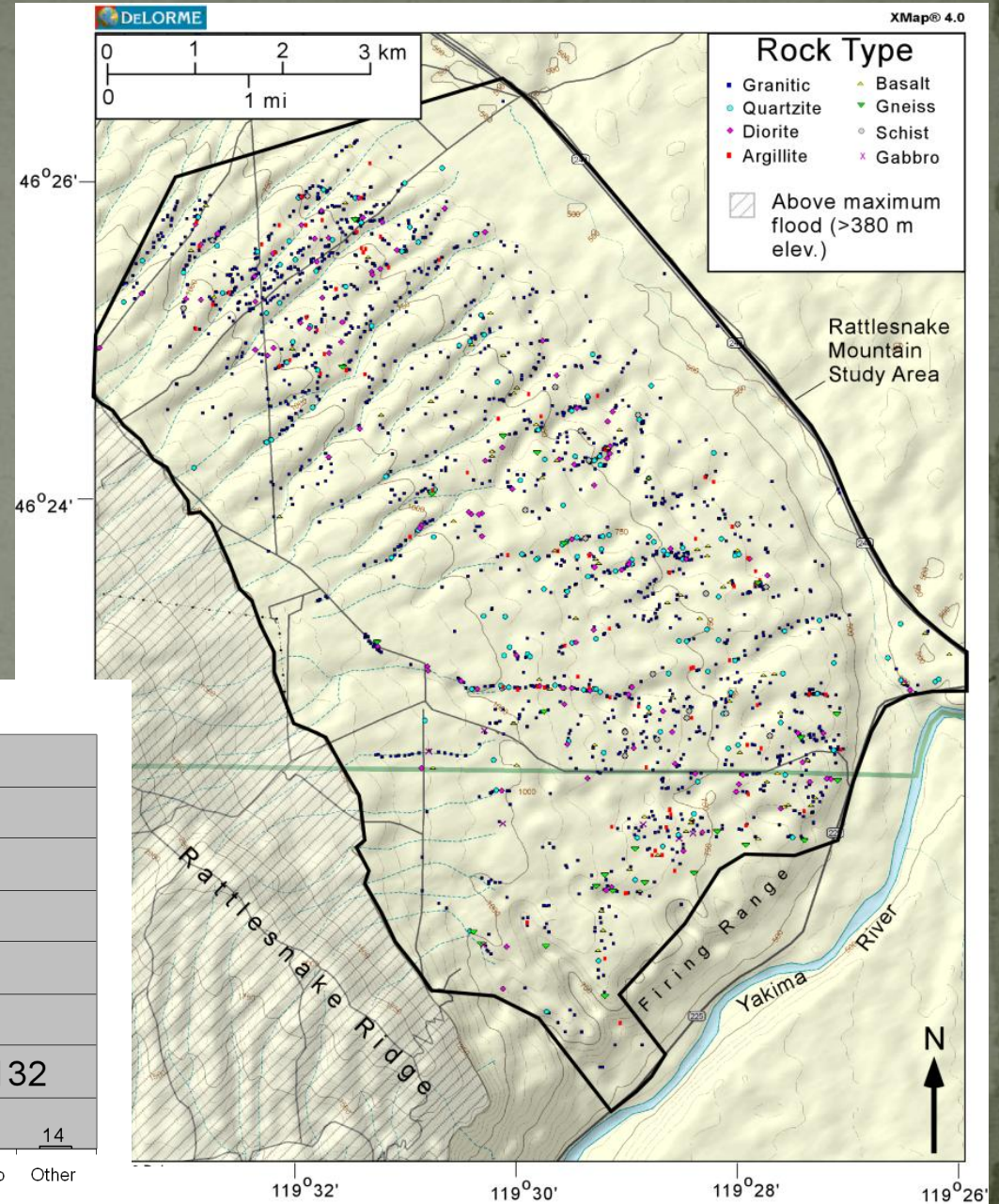
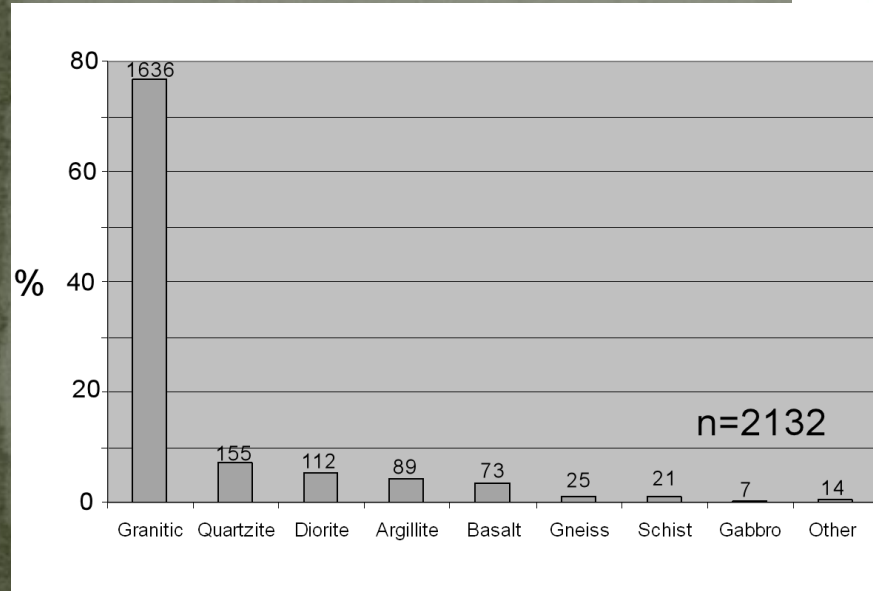


# Area of Flooding vs. Basalt



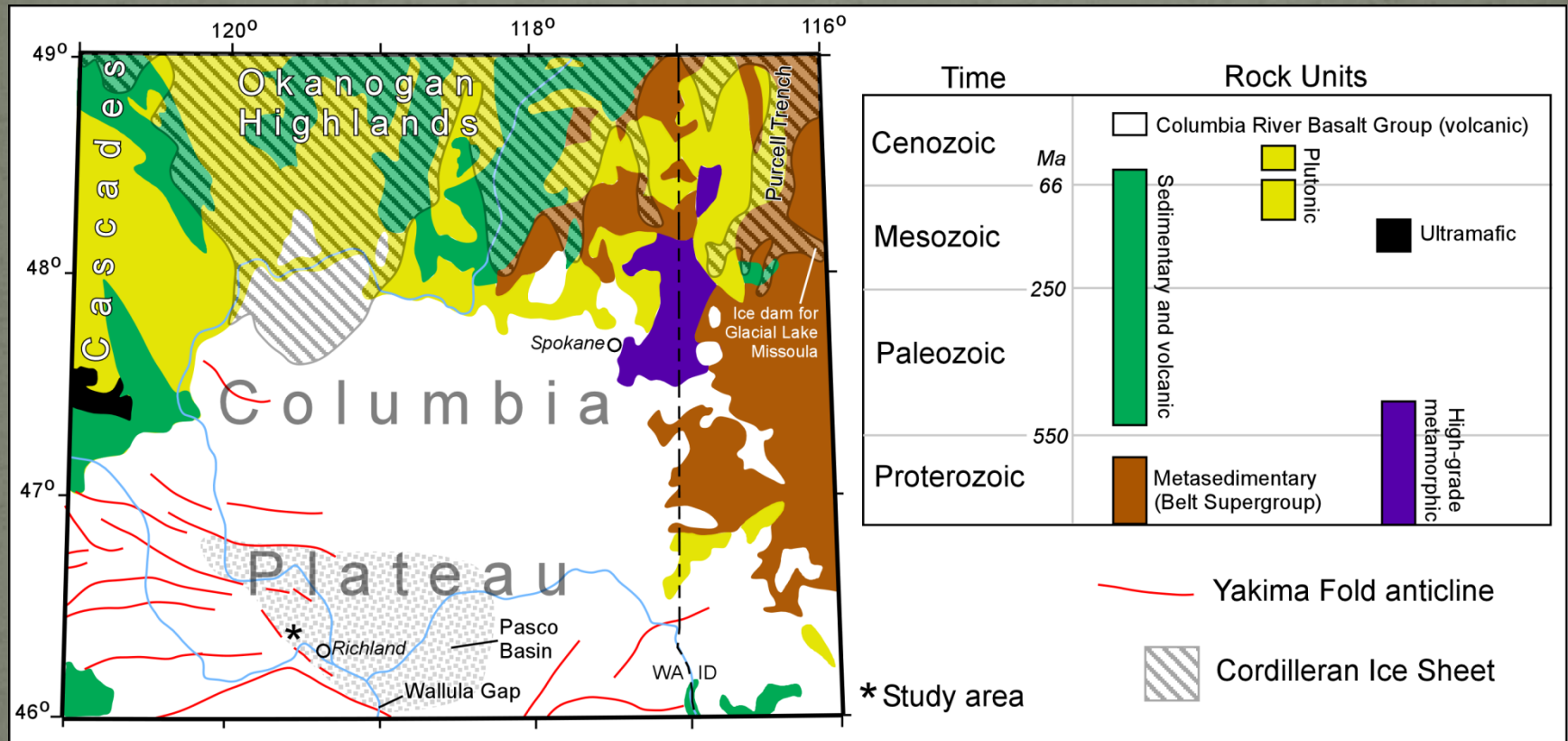


# Spatial Distribution by Rock Type





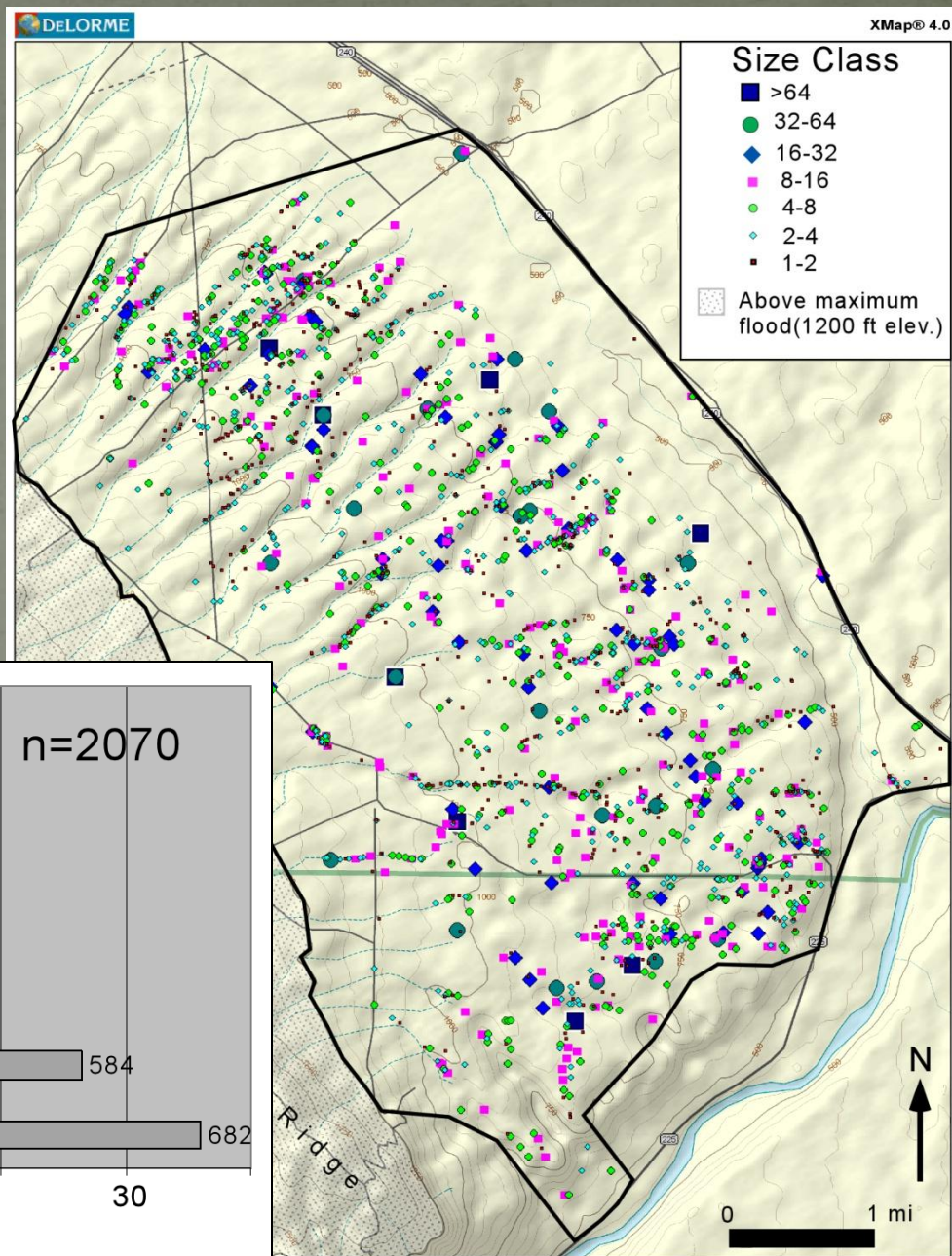
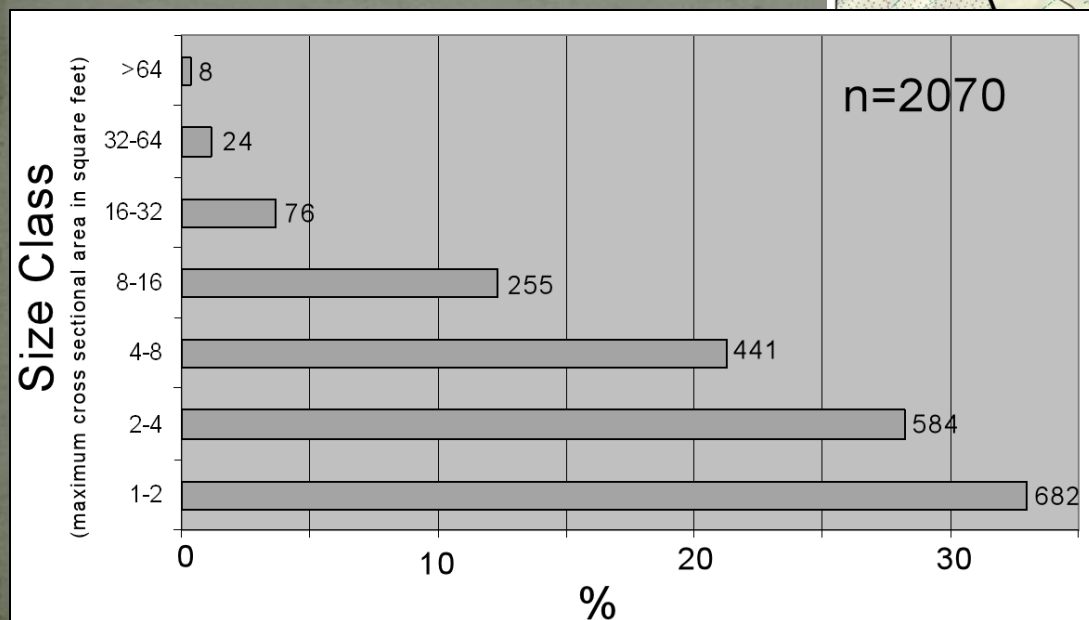
# Rock Types of the Pacific Northwest





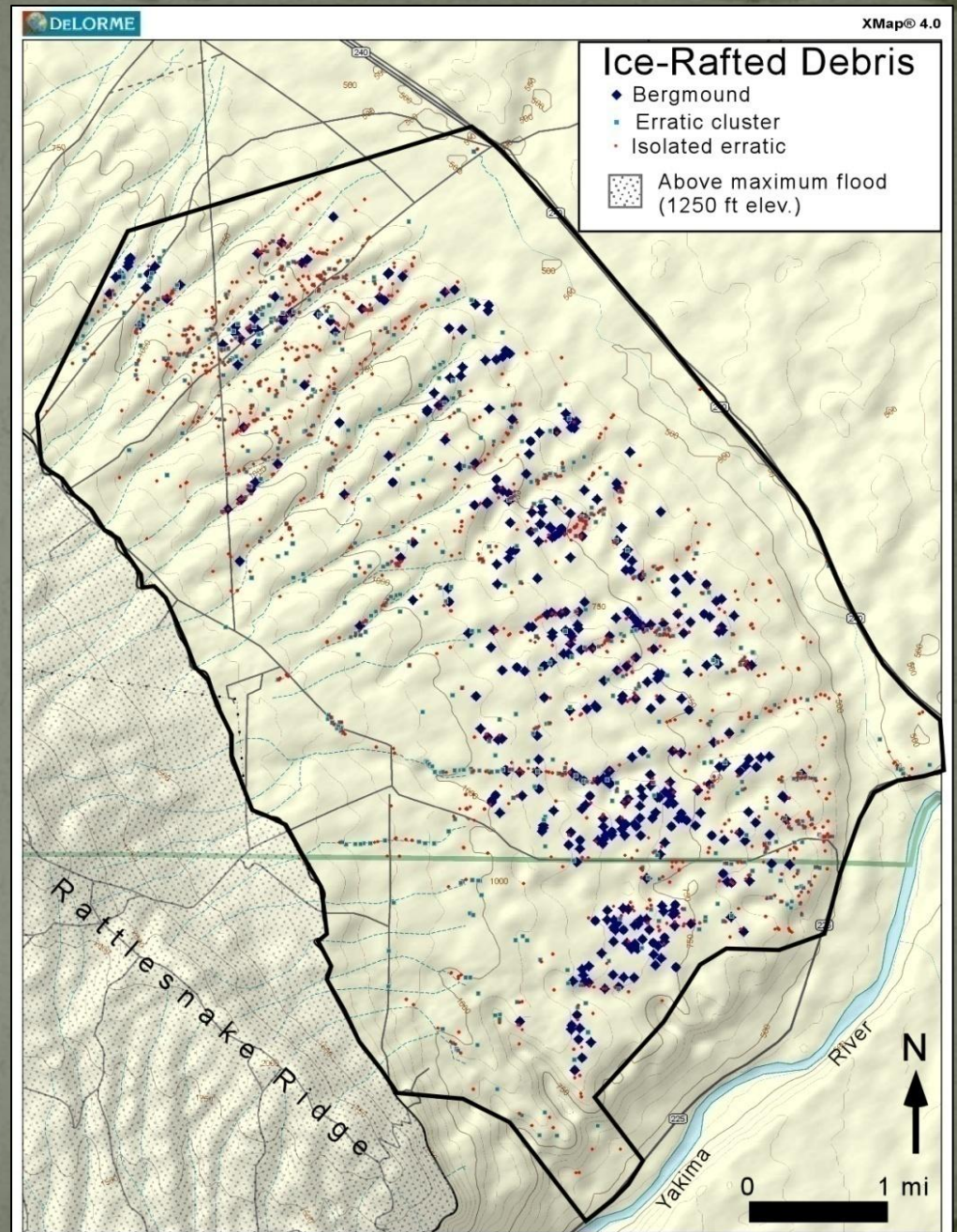
# Size of Erratics

- Different-sized erratics are distributed randomly
- Majority of erratics are smaller than a suitcase – only a few percent are larger than a sofa



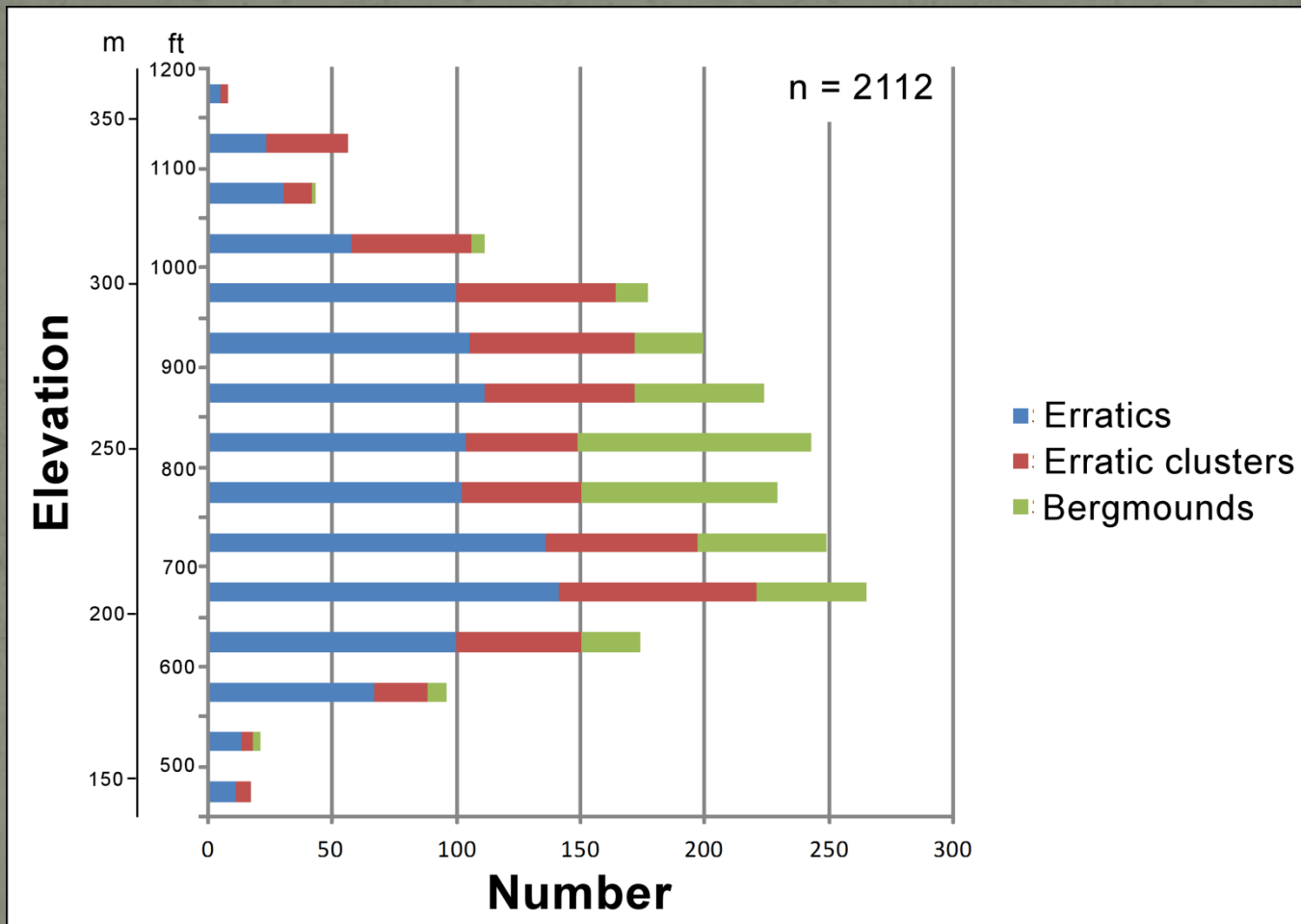


# Bergmounds Missing at Higher Elevations



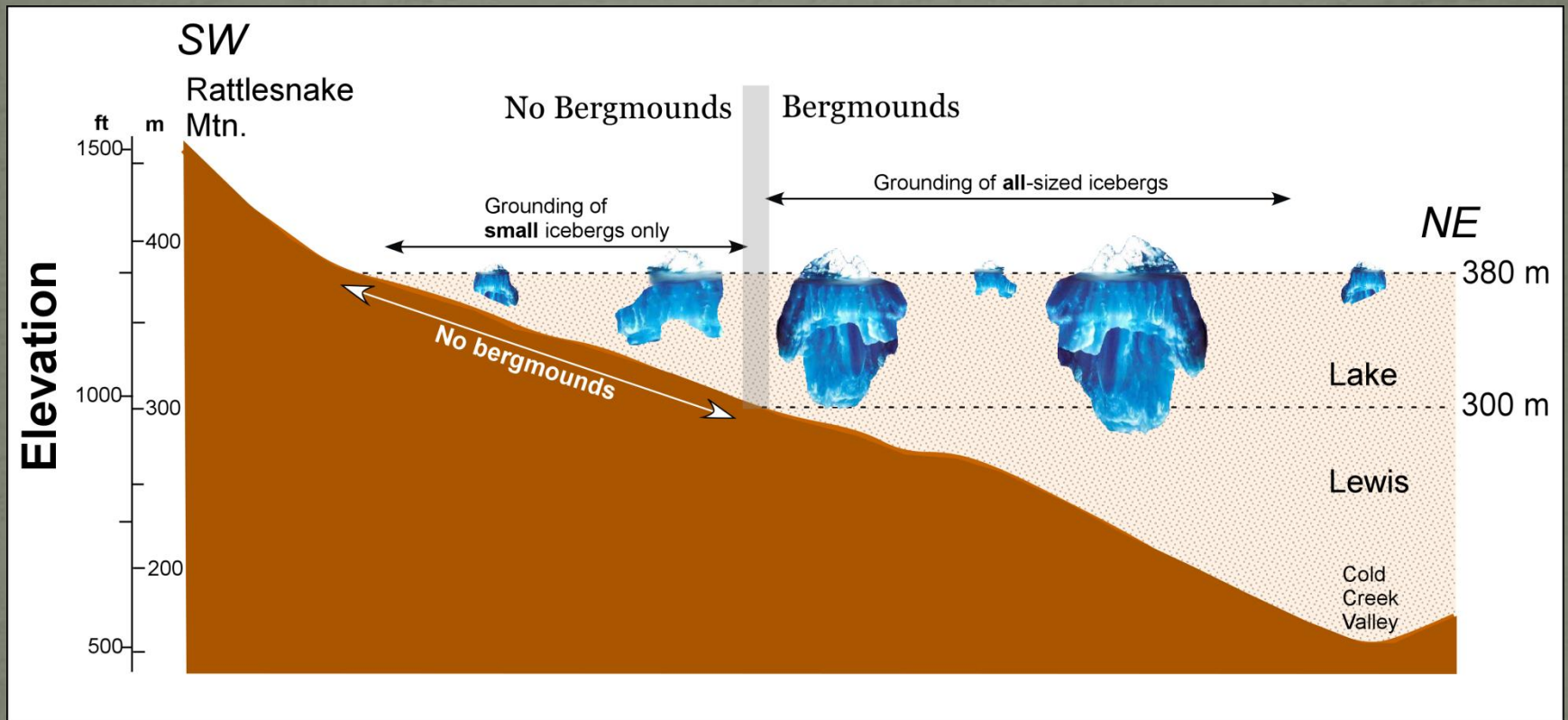


# Ice-Rafted Debris by Elevation



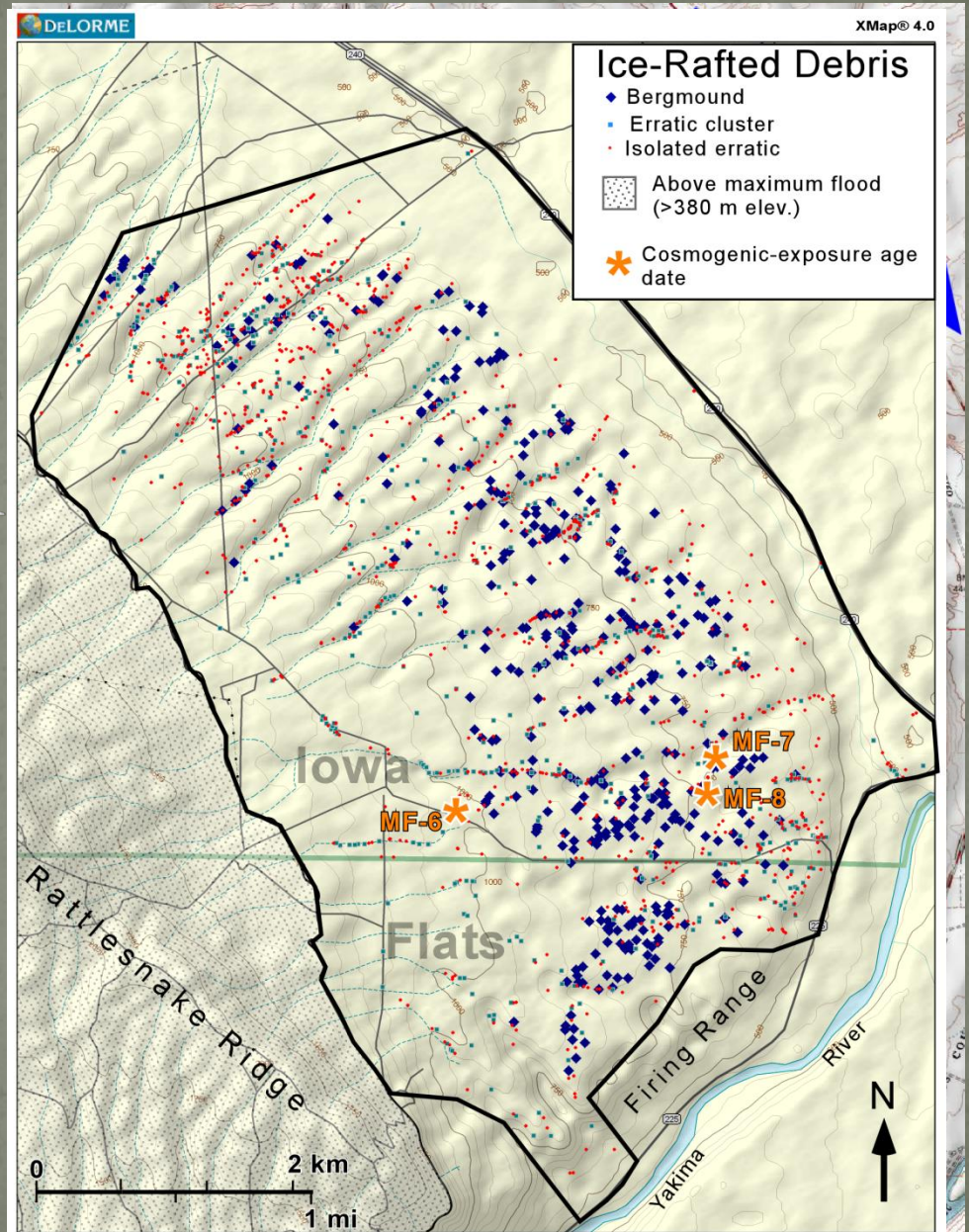


# Explanation for Bergmounds being Restricted to Lower Elevations



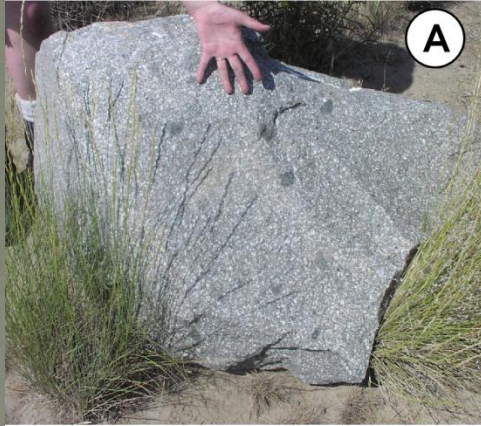


Erratic Debris  
Concentrated  
Along Upstream  
Sides of Gullies  
Due to Eddy  
Currents





# Weathering and Roundness of Erratics Highly Variable



**Unweathered**



**Moderately  
Weathered**



**Strongly  
Weathered**



# Questions?

