


Ice Age Floods and the Landscape They Created – HILR – Fall, 2021



Class Notes Session 4

Class Topics

- A tour of Glacial Lake Missoula
- Ripples
- Pardee's observations of giant ripples
- The implications for Bretz's Flood
- An overview video

Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 2

Evidence for Glacial Lake Missoula

- Shorelines of an ancient lake in the Missoula Valley


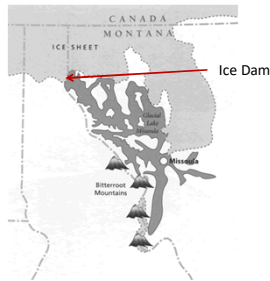


Photo by Don Hyndman, courtesy of the University of Montana, Missoula, Montana


Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 3

How Far Did These Shorelines Go?

- As early as 1910, Joseph Pardee, a USGS Geologist in Montana, had studied the boundaries of these ancient shorelines, and identified a large Glacial Lake, reaching a maximum altitude of 4200', with a water depth of 2000' at the ice dam.
- We examine his 1910 article (on the website)




Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 4



### A Failure of Scientific Communication

- In 1925, Pardee wrote to Bretz telling him that Glacial Lake Missoula might be the water source for his flood
- Bretz did not take up the suggestion ....


Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 5



### Pardee and Ripples

- In 1940 at a meeting of the Geological Society of America, late in the session at which various researchers had proposed non-Bretz mechanisms for the formation of the scablands, Joseph Pardee, a USGS Geologist working in Montana, presented a paper entitled
  - “Unusual currents in glacial Lake Missoula, Montana”
  - In it, he described the observation of giant ripples that would be consistent with a catastrophic emptying of Glacial Lake Missoula
  - The audience applauded
  - Pardee’s paper (published in 1942) is on the web site. It doesn’t reference Bretz.


Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 6



### Lets Study Ripples

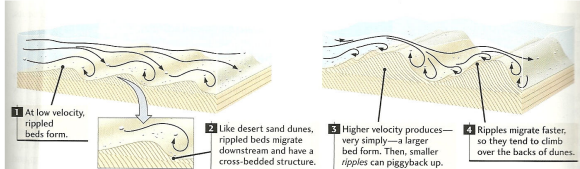


Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 7



### The Mechanism

- Flat sand is not stable under flowing water.
- Individual grains get picked up and are re-deposited in a series of peaks and valleys



1 At low velocity, rippled beds form.

2 Like desert sand dunes, rippled beds migrate downstream and have a cross-bedded structure.


3 Higher velocity produces—very simply—a larger bed form. Then, smaller ripples can piggyback up.

4 Ripples migrate faster, so they tend to climb over the backs of dunes.

Figure 14.4 The change in the form of a sand bed with increasing flow velocity. [After D. A. Simmons and E. V. Richardson, “Forms of Bed Roughness in Alluvial Channels,” *American Society of Civil Engineers Proceedings* 87: 87–105 (1961).]

From Press Chapter 14


Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 8



### Detailed Mechanism

- At the edge of a bounded flow, the flowing fluid exerts a force on the wall. (This is called a boundary-layer effect)
- For a solid wall, this is no problem.
- For a wall made up of sand, the force can displace the grains of sand, building up dunes.
- This same mechanism can produce, at high flow rates, erosion of blocks of basalt.
  - This will be illustrated on the white board

Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 9



### We Look at Several Videos

- Simulations based on the physics of beds of grains interacting with a unidirectional flowing fluid
  - [http://www.youtube.com/watch?v=-sS-h\\_EjCwg](http://www.youtube.com/watch?v=-sS-h_EjCwg)
- Experiments in a wave tank (with reciprocal flow)
  - <http://www.youtube.com/watch?feature=endscreen&v=uY2QdZLLRP8&NR=1>

Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 10




### What Did Pardee See?



Camas Prairie – from hugefloods.com

Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 11



### Ripples on Google Maps

- We go on a Google map search of the Camas Prairie

Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 12


 **There are Many Sets of Ripples**



Photo near Roxboro, WA (ESE of Drumhuller Channels)

We can check these out on Google Maps

Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 13

 **Videos**

- We will now watch two videos
- A short video about ripples at West Bar on the Columbia River Gorge
- [https://www.youtube.com/watch?v=GuP\\_MlfK5zk](https://www.youtube.com/watch?v=GuP_MlfK5zk)
- A short "tourist" video about the Missoula flood.
- The rest of the session will be for discussion, as needed.

Ice Age Floods and the Landscape They Created      Class Notes – Session 4 - 14