Chronology of Montana’s glacial Lake Missoula: Current Status

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Glacial Lake Missoula

- Recognized for >105 years, no tephra or fossils documented
- Previous work on geochronology
  - Ice dam: 19-21 ka to ~14 ka (poorly constrained)
  - Lake drained prior to Glacier Peak “G” tephra (13.7-13.4 cal. ka B.P.)
  - $^{14}$C in uppermost lake 14.13 ± 0.18 cal ka B.P. (Hofmann & Hendrix, 2010)
  - Optical dating of quartz
    - Three published ages, one on basal sand
- 16 new preliminary ages from quartz at 7 basal sand sites
Sample Locations

Basal Sand Samples

Glacial Lake Missoula

Pleistocene glacial ice

Pine needle in Lake core

Ninemile section

Missoula

Lake Pend Oreille

Ice Dam
Multi-grain OSL measurements

• 180-250 µ; 10% HCL & H$_2$O$_2$ treatment
• Heavy liquid separation (2.58 g cm$^{-1}$)
• 40% HF - Quartz purity tested using OSL IR depletion ratio
  – If failed purity screen, some quartz samples etched again with 40% HF
• SAR protocol: post-IR OSL signal from quartz
• Large aliquots, 5-8 mm stainless steel cups*

* Murray et al. (2015) Radiation Measurements; Thomsen et al. (2016) Quaternary Geochronology
Test for Quartz bleaching

- Quartz bleaches in sunlight much more readily
- Compare Quartz ages to K-Feldspar ages (uncorrected for fading)
- Expected lower uncorrected Feldspar ages show that Quartz is likely well bleached
Dose rate measurements

• Two dose rate samples were prepared for each sample
  – Material in tube
  – From ~30 cm around tube
• 100-250 g sample cast in wax cups
• High-precision gamma spectroscopy with conversion factors of Guerin et al. (2011)
• Estimated water content
  – Average of in situ and saturated for each sample: 13—27%
Lake filled to >1,180 m (>65% of capacity) at least 11 times by ~20.9 ± 1.3 ka.
Basal sand at Cyr

- Five samples
- Nine dose rate samples
- Range:
  \[ 17.36 \pm 1.13 \text{ ka} - 19.23 \pm 1.32 \text{ ka} \]
- Average:
  \[ 18.15 \pm 1.17 \text{ ka} \]
Basal Sand with gravel at Tarkio

23.9 ± 1.5 ka
Mix of younger and older ages near large flood bedforms
1) Deep lakes filled ~11 times ~20.9 ± 1.3 ka

2) Basal sand at Cyr & Heron possibly represent ~15% of lake capacity

3) Sediment preservation shows last lake drained non-catastrophically

4) Sediments preserved near giant gravel bars suggest large floods may be pre-last glacial

5) More work to be done with future M.S. grad students
Summary

- Sparse interlayering of basal sand with glaciolacustrine sediment suggest age ranges caused by hiatuses in record.
- Glacier Peak G tephra (13.4-13.6 $^{14}$C yr BP) sets minimum age for the lake.
- At highest altitude (deepest lake) site, the lake rose and fell >6 times between 20.4±1.4 (n=4) to 19.3±1.1ka (n=2).
- Basal sand ages of 17.6±2.2–18.2±0.4ka (n=5), possibly representing as little as 15% of lake capacity.
- Preservation of 32.3±3.4ka fluvial sediments below glaciolacustrine deposits at Superior suggest large floods that formed giant gravel bars may be older than the last glacial.
- The lake did not drain catastrophically from its last stand.