Towards A Late-glacial Lake-level History For Glacial Lake Missoula, Montana

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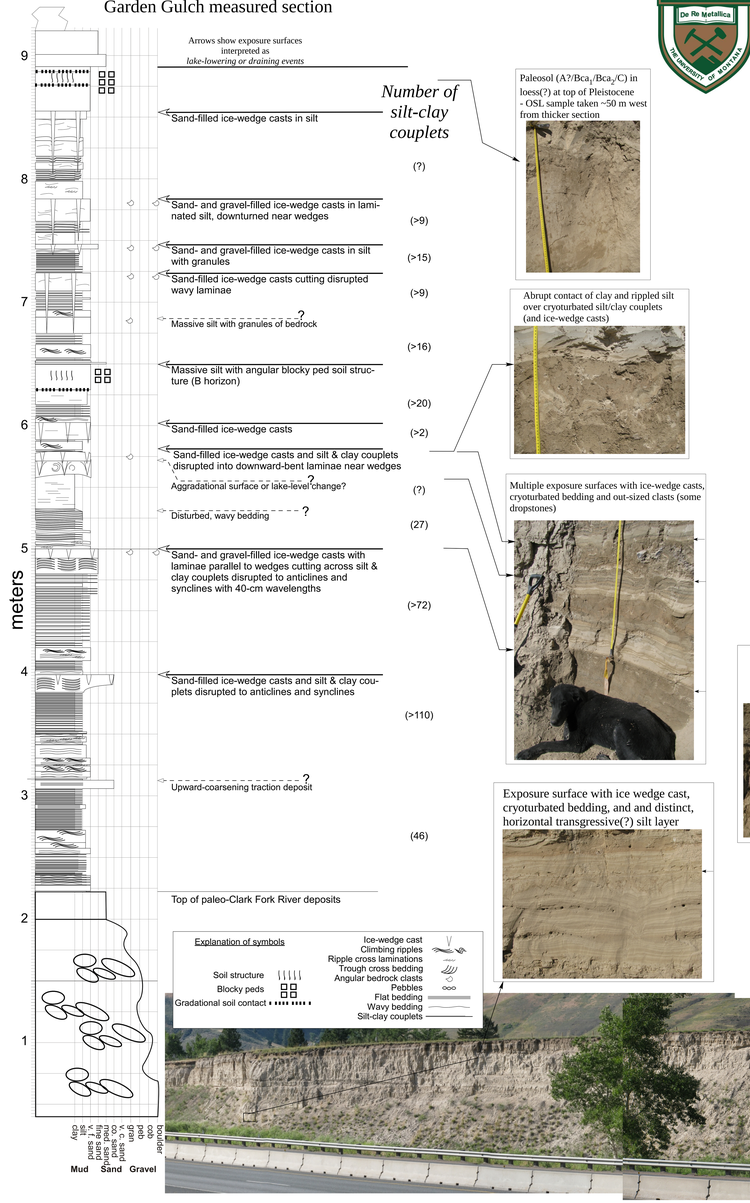
Garden Gulch measured section



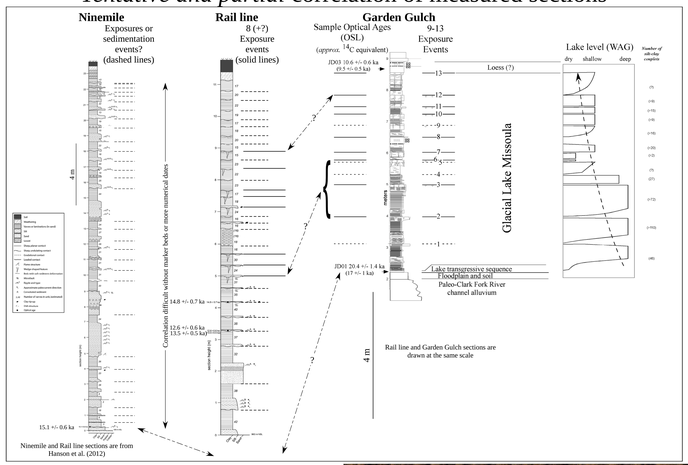
Paleosol (A?/Bca$_1$/Bca$_2$/C) in loess(?) at top of Pleistocene
- OSL sample taken ~50 m west from thicker section

Abrupt contact of clay and rippled silt over cryoturbated silt/clay couplets (and ice-wedge casts)

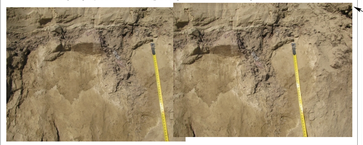
Multiple exposure surfaces with ice-wedge casts, cryoturbated bedding and out-sized clasts (some dropstones)

Exposure surface with ice wedge cast, cryoturbated bedding, and and distinct, horizontal transgressive(?) silt layer

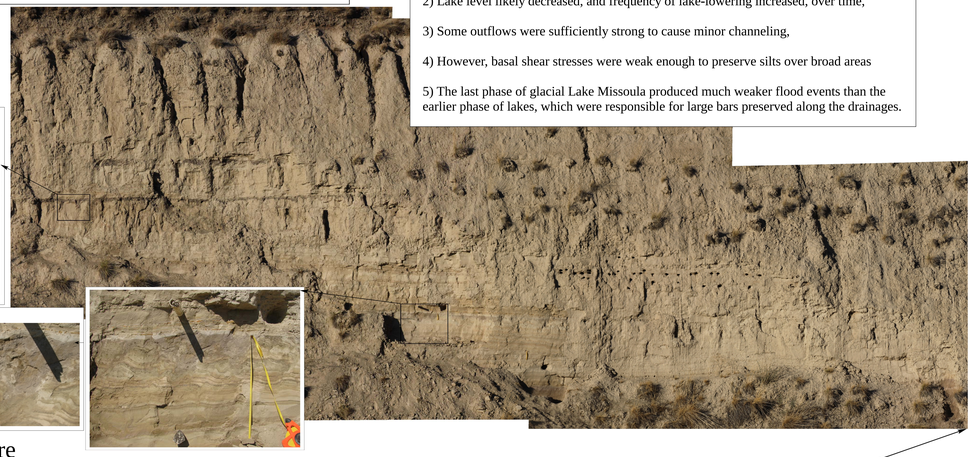
Tentative and partial correlation of measured sections



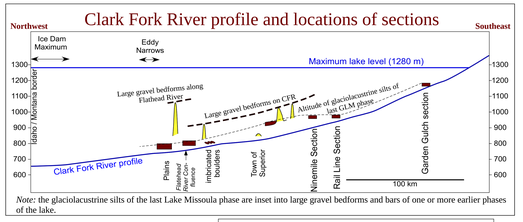
Stereo pair of ice-wedge casts near 5.0 m, note:
- laminated fill showing multiple seasons of fine- and coarse-grained fill
- vertical penetration of ~40 cm
- *Is there any significance to the spacing between ice-wedge casts?*



Stereo pair close-up of ice wedge cast



Clark Fork River profile and locations of sections



Note: the glaciolacustrine silts of the last Lake Missoula phase are inset into large gravel bedforms and bars of one or more earlier phases of the lake.

Previous work

Detailed descriptions of a complete section recording initial transgression to final regression have been published for only one locality, the Ninemile section (Chambers, 1971; Hanson et al., 2012). Interpretations of these and partial sections along the Flathead River (Levish, 1997) and the Rail line section in Missoula Valley have come to conflicting conclusions on whether one, a few, or multiple dozens of lake stands are represented in the silt sections (Hanson et al., 2012).

Purposes

- Describe detailed stratigraphy of lake-bottom silts deposited in the last phase of glacial Lake Missoula
- Document nature of recognized exposure surfaces
- Attempt correlation of exposure surfaces in upper reach of Clark Fork River

Significance

- These sections are only descriptions of exposure surfaces in the lake basin
- Do exposure events at different elevations reflect draining, or only lake-lowering?
- Correlations among multiple sections are required for understanding the lake-level history

Conclusions

1) The lake filled to within ~100 m of full pool 9-13 times during the latest impoundments,

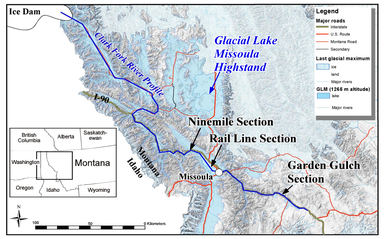
2) Lake level likely decreased, and frequency of lake-lowering increased, over time,

3) Some outflows were sufficiently strong to cause minor channeling,

4) However, basal shear stresses were weak enough to preserve silts over broad areas

5) The last phase of glacial Lake Missoula produced much weaker flood events than the earlier phase of lakes, which were responsible for large bars preserved along the drainages.

Location



ABSTRACT

Previous workers proposed that fine-grained glaciolacustrine sediments deposited in the last phase of Pleistocene glacial Lake Missoula represent up to 80 filling and draining cycles. Proposing an accurate lake-level history requires correlating multiple stratigraphic sections that record initial transgression to final regression. Although cyclic sedimentation may suggest filling and draining cycles, subaerial exposure surfaces within the glaciolacustrine section is clear evidence for lake-level lowering. Correlation between sections in the basin is required to differentiate between full and partial lake drainage, as deposits range in elevations between the outlet at ~660m and the highstand water elevation of ~1280 m.

Outcrops near Garden Gulch, in the upper reaches of the Clark Fork River valley, allow documentation of a lake-level history near a highstand position, full-pool location. This section is at 1170-1183 masl, thus the lake-level history for this site reflects the number of times the lake reached within ~100 m of full pool. The section contains glaciolacustrine sand, silt, and clay with exposure surfaces delineated by paleosols and by periglacial features, such as sand wedges, ice-wedge casts, and cryogenically disrupted bedding. Thin massive silt (loess?) and fining-upward sequences of glaciolacustrine sediments overlie exposure surfaces. At least 8 such sequences are recognized; 4 additional lake-lowerings have equivocal evidence, such as coarsening-upward sequences in massive silts. Along 5 of the exposure surfaces, currents were capable of carrying angular cobble-sized clasts from nearby bedrock outcrops across the exposed lakebed during or after the lake-lowering events. The gravel was then periglacially modified.

Optical dating of two quartz sand samples, from near the base and top of the section support correlation of the Garden Gulch section to those in the Missoula area, 80–100 km downstream. Correlations of stratigraphic sections suggest 8-12 lake-level lowerings of >200-300 m from late deep-lake phases. Sections near Missoula record 34 lake-level lowering events, suggesting many partial fillings during most lake cycles. Whether the cycles represent complete or only partial lake-drainage requires further correlations between deep-lake and shallow-lake positions.

Full Garden Gulch Exposure

REFERENCES

Chambers (1971) Sedimentation in Glacial Lake Missoula: [M.S.] Univ. of Montana 100 p.

Hanson, Lian, and Clague (2012) The sequence and timing of large late Pleistocene floods from glacial Lake Missoula: QSR 31, p. 67-81.

Levish (1997) Late Pleistocene sedimentation in glacial Lake Missoula and revised glacial history of the Flathead Lobe of the Cordilleran Ice Sheet, Mission valley, Montana: [PhD] Univ. of Colorado, 191 p.