Holocene salinity variations in Great Salt Lake, Utah

Application of the ACE salinity proxy and other GDGT indices

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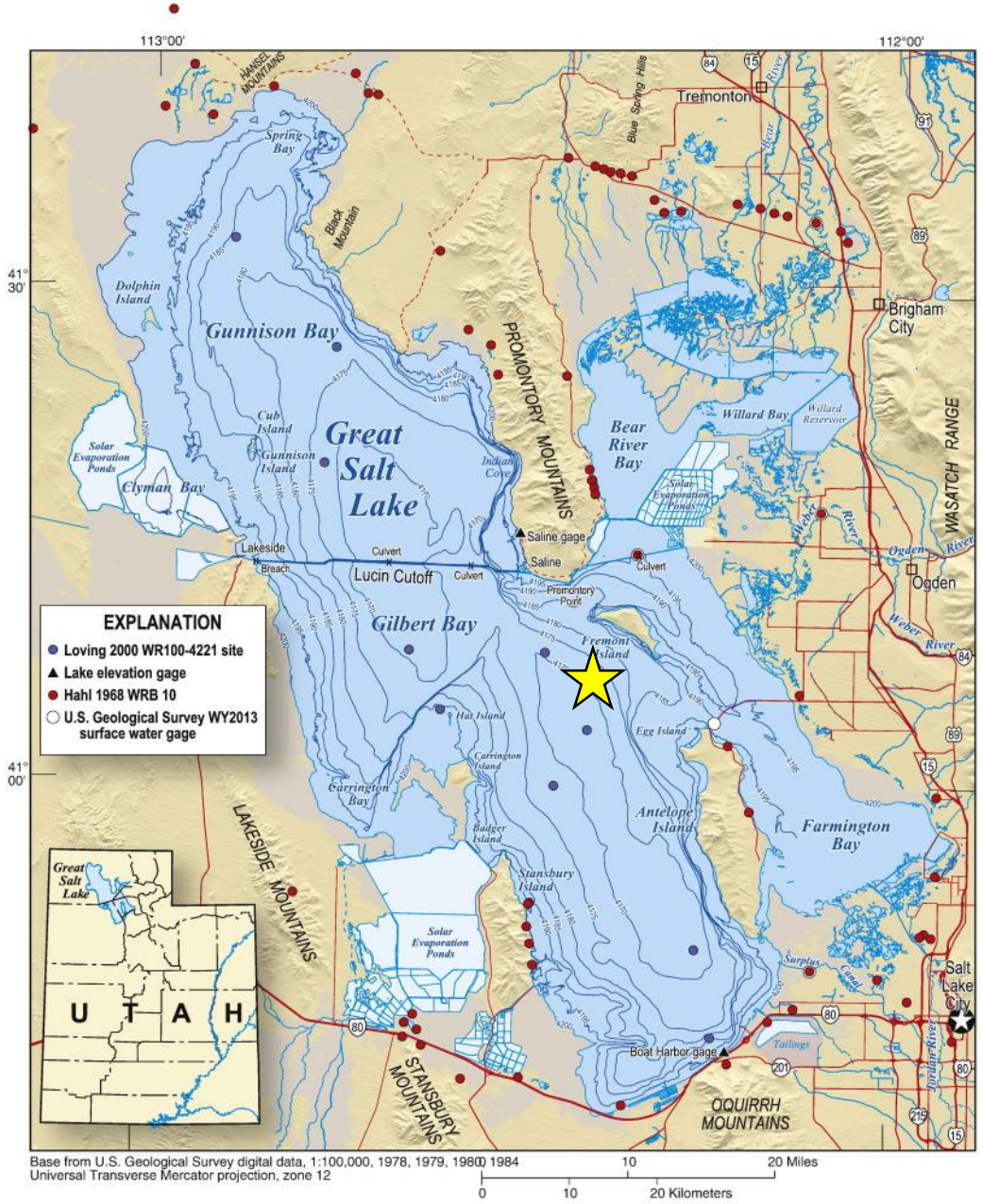
GSL Project details

- Holocene paleosalinity record
- Sediment from GLAD core 1B
  - 35 samples
  - 7206 to 291 cal yr BP
  - Bowen et al. (2019) age model
- Modern GSL conditions
  - Salinity range: 40-275 psu
  - pH: 8-9
  - Salt Lake City MAAT: 11.5°C
  - Salt Lake City MAF: 14.1°C

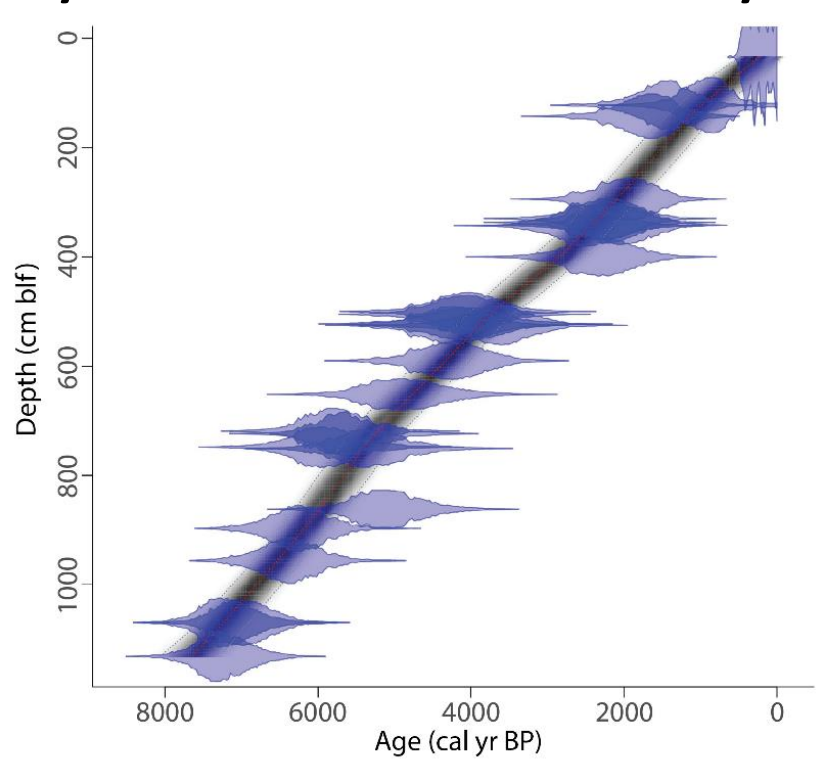


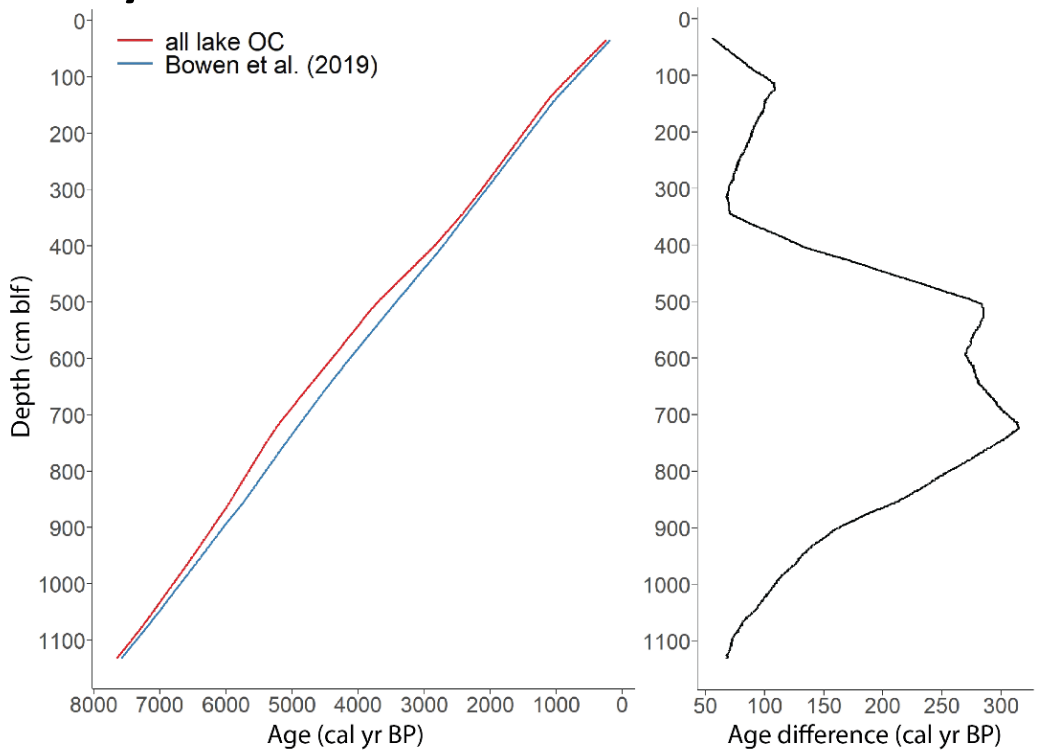
Shope and Angeroth (2015)

Radiocarbon Age Model

- Used more data points from Bowen et al. (2019) to constrain BACON age model
- Includes all lake-derived organic matter
- <300 yr difference from cyst-only model

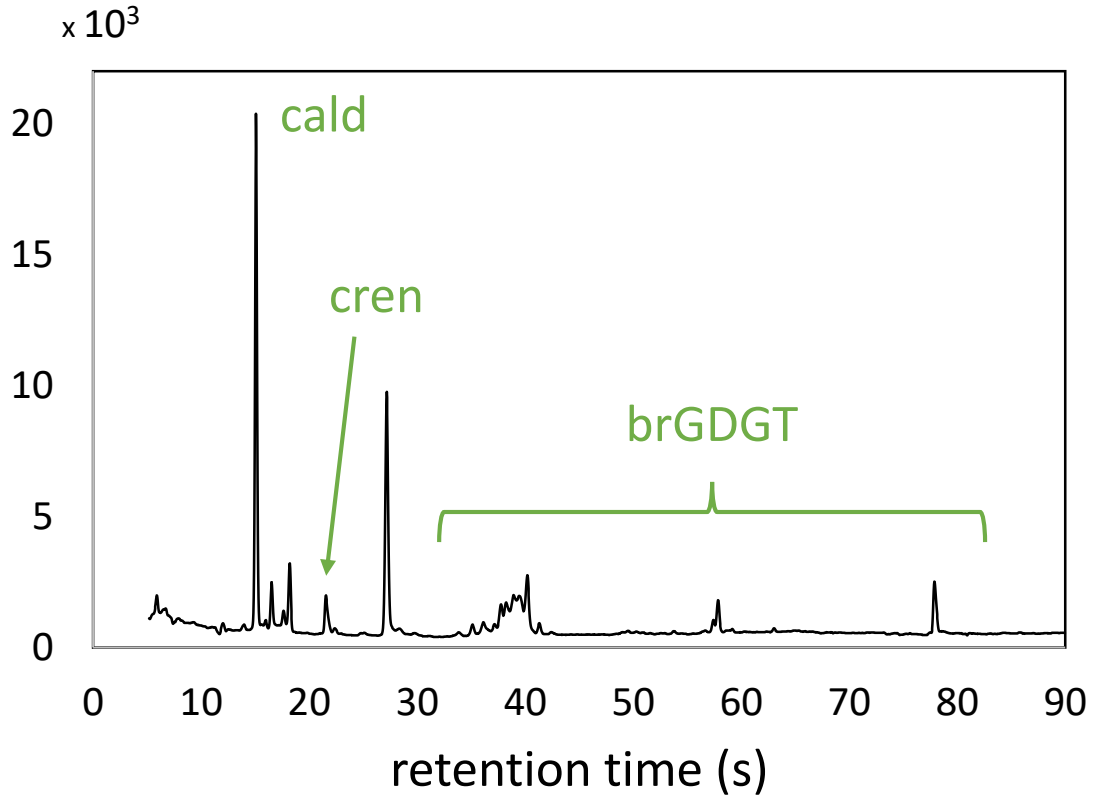
Bowen et al. (2019)

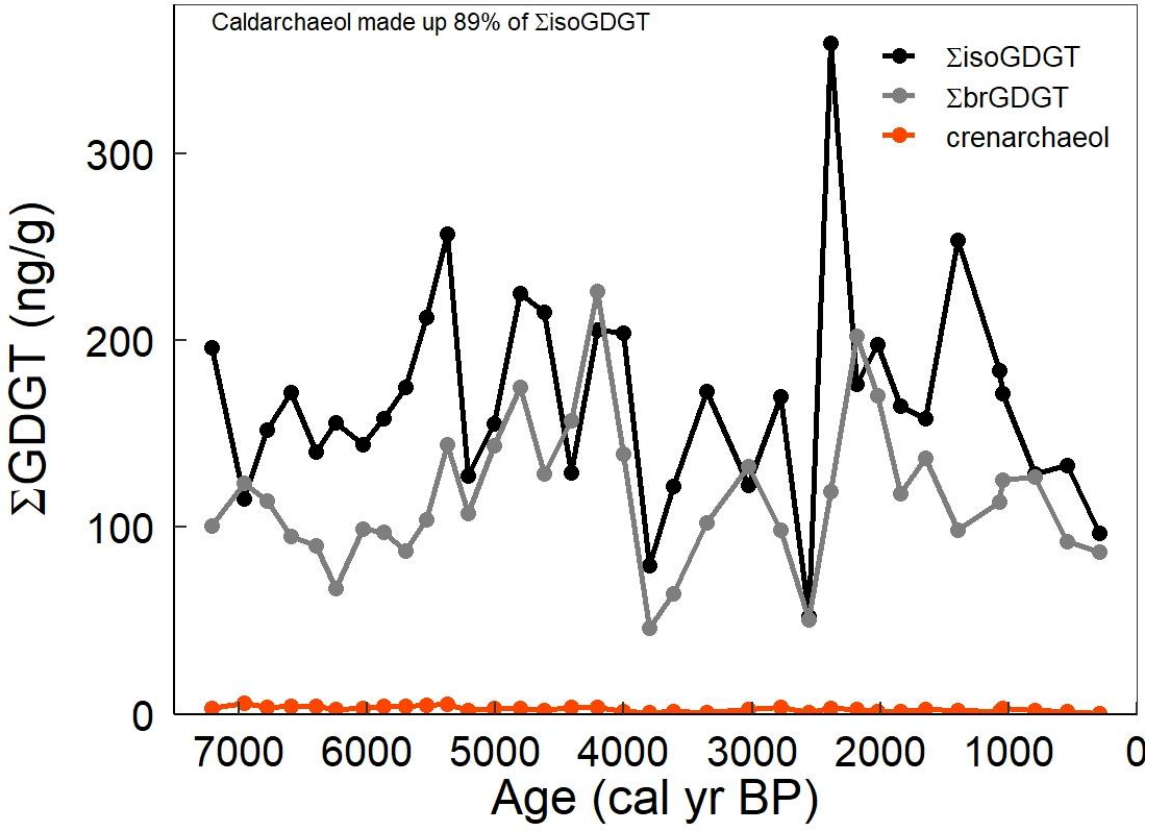




GSL microbial community lipids

- Caldarchaeol dominates isoGDGTs (89%), used for salinity proxy
- Crenarchaeol trivial, low lake production
- BrGDGTs used for temperature proxy





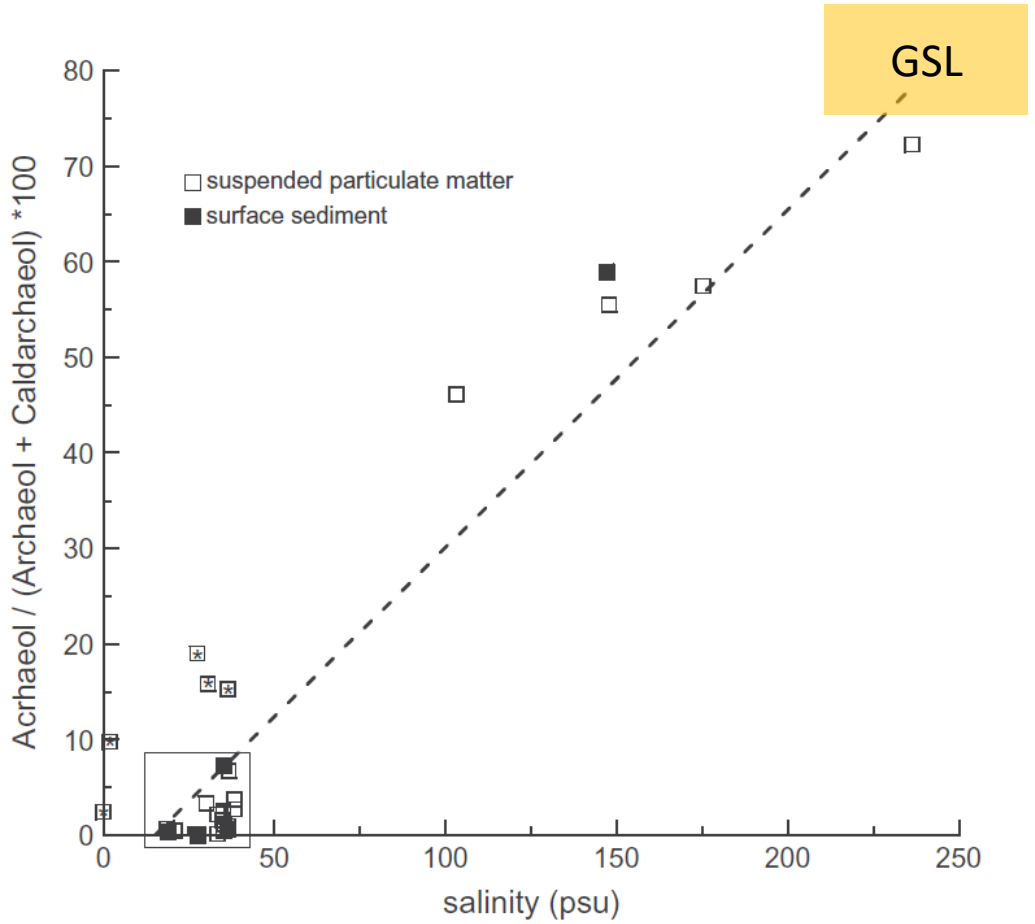
ACE Salinity Proxy

- Turich and Freeman (2011)

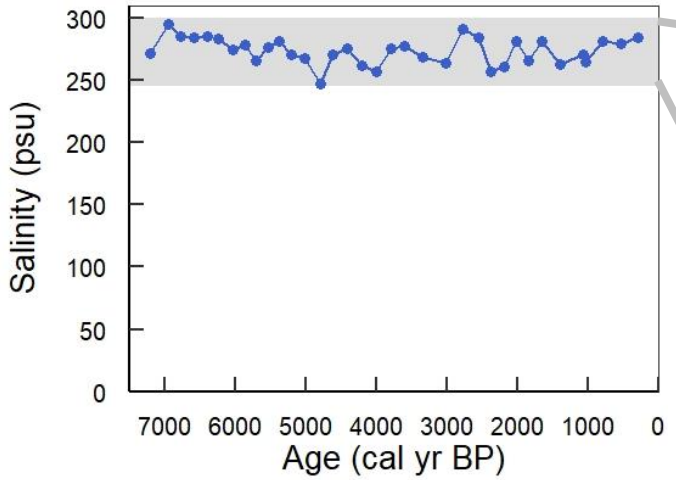
$$ACE = \frac{archaeol}{archaeol + caldarchaeol} \times 100$$

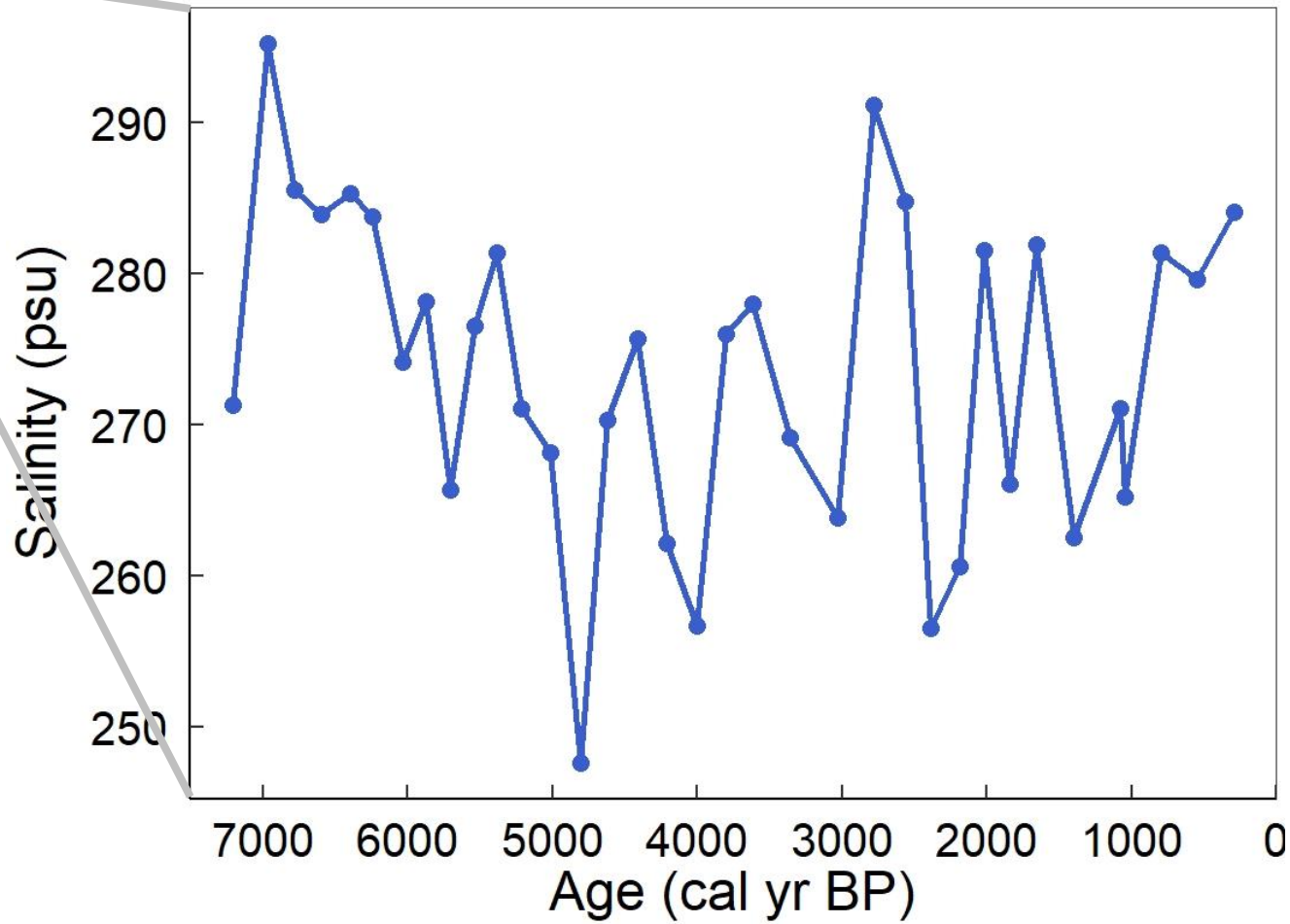
$$ACE = 0.35 \times salinity - 5.4$$

- Low proxy sensitivity at upper end of ACE index (0.8-1)

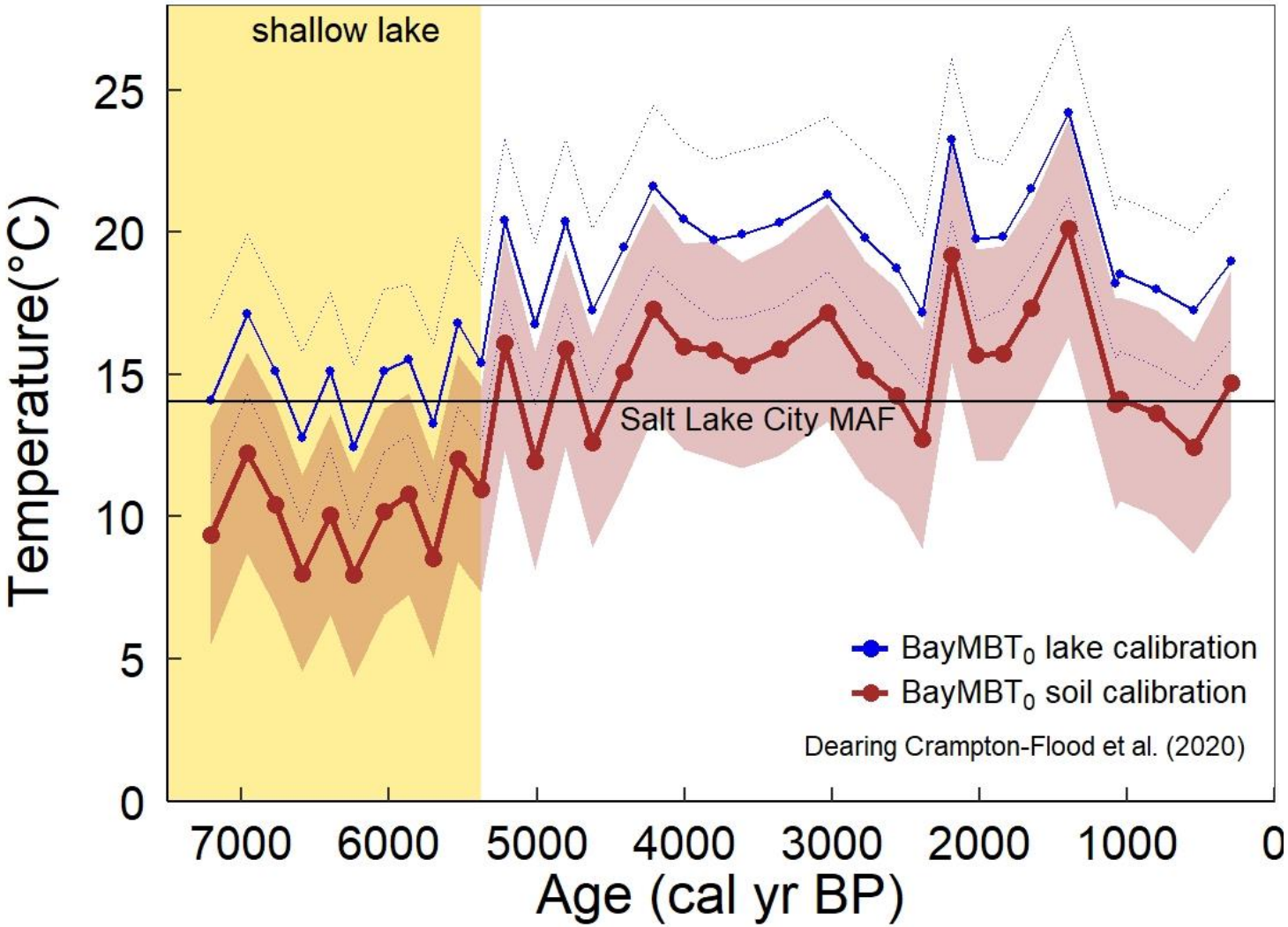


ACE detects hypersalinity and <50 psu variability in Holocene GSL Record





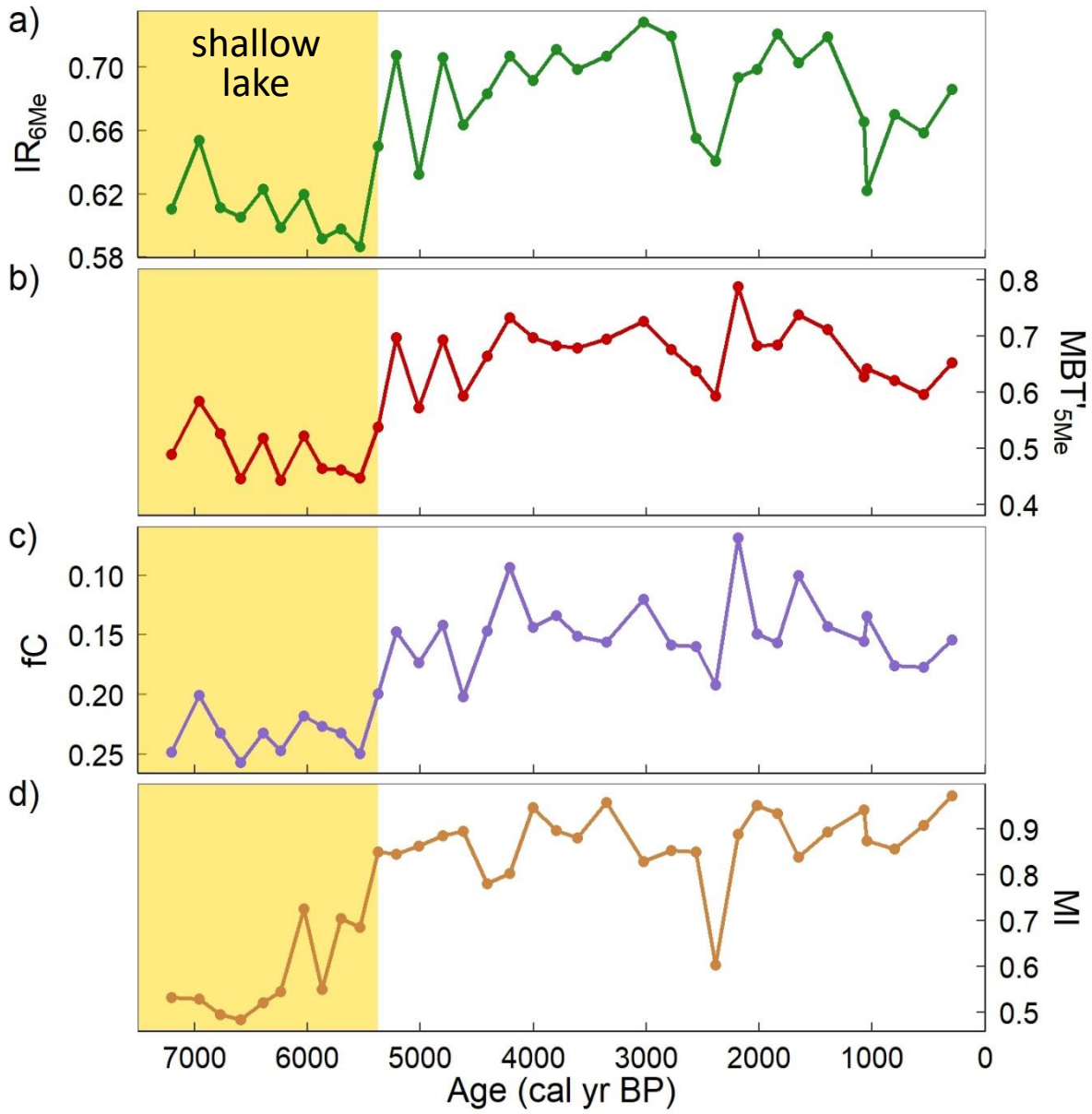
MBT'_{5Me}: Soils calibration suggested for hypersaline lakes



- Lake calib. has warm bias in saline lakes
- Soil calib. has realistic estimates after ~5.5 ka
- Proxy indicates stable T after ~5.5 ka

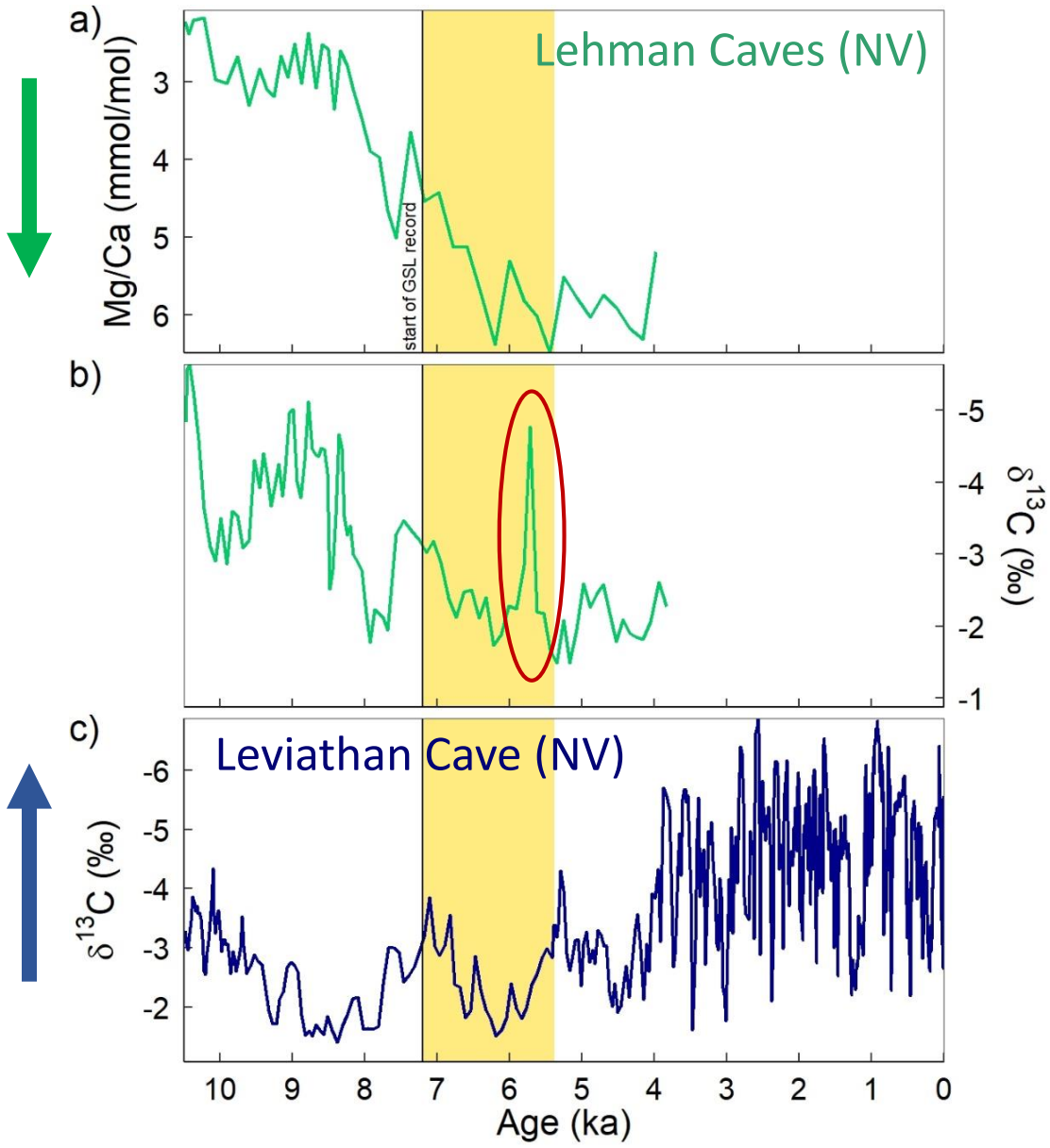
~5.5 ka step change in IR_{6Me}, MBT'_{5Me}, fC, MI

- Regional climate dry in Mid-Holocene
- Change in lake ecology after ~5.5 ka
- MI increases after ~5.5 ka
- Increased methanotrophs and deep (>10 m), stratified lake



Great Basin Speleothems

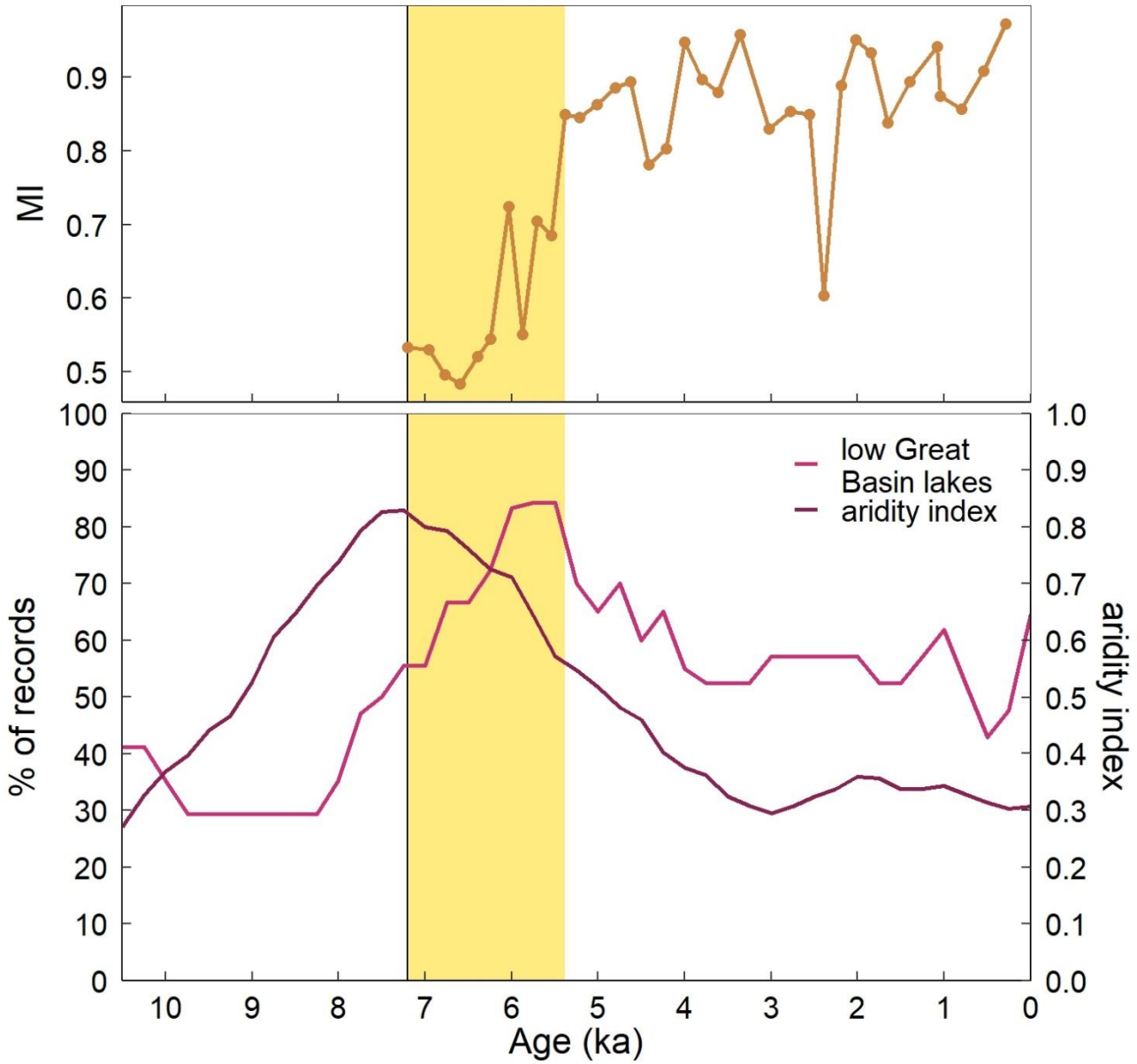
- 8 ka onset of aridity
- Spike in water infiltration before step change
- Increased effective moisture after 4 ka



Steponaitis et al. (2015)
Lachniet et al. (2020)

GSL and Regional Climate

- Peak aridity in SW US at ~7.5 ka.
- Large number of low lakes in Great Basin ~6 ka.
- Coincide with GSL GDGT step change



Steponaitis et al. (2015)
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Holocene GSL conclusions

- Hypersaline throughout record, <50 psu of salinity variability, near upper limit of ACE index
- MI detects threshold in lake depth (~10 m)
- BayMBT$_0$ soil calibration better for Late Holocene GSL
- Evidence for Mid-Holocene drought
- Varying hypersaline lake chemistry, lake ecology, and stratification affect proxy functionality
- Future work is to expand regional ACE calibrations

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