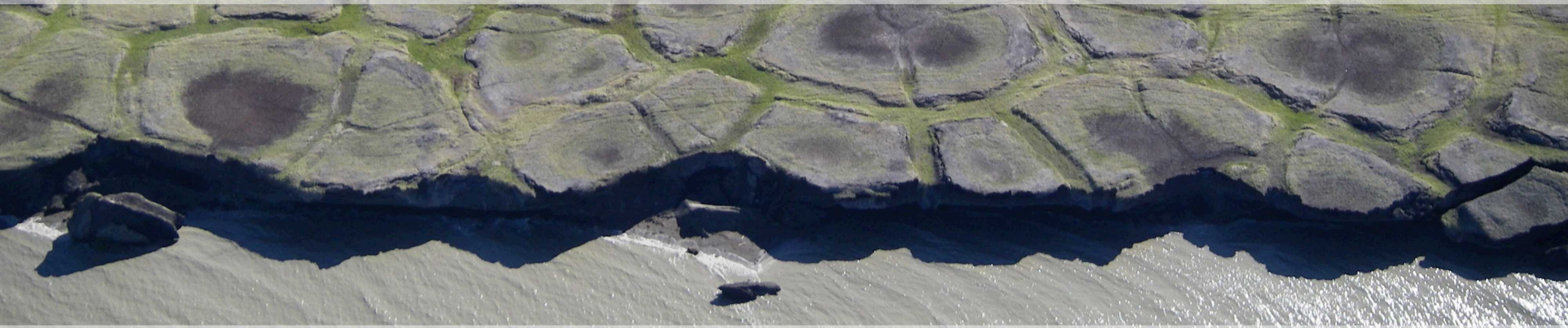
Photo by Cameron W. Wobus

SAND2019-2131C

Biogeochemistry of eroding soils along the Beaufort Sea coastline:

Results from permafrost cores collected at Drew Point, AK



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The Beaufort Sea Coast

Sea is frozen 8-9 months of year; highly seasonal environment.

Continuous permafrost, ice-wedge polygons, shallow lake basins.

Shallow lagoon ecosystems along coast support productive fisheries and migratory bird populations.

PC: Ben Jones

Arctic warming drives erosion

Accelerating erosion due to:

- ~40% decline in sea ice since 1979 (NSIDC/NASA)
- Increasing length of the ice-free season
- Increasing sea water temperatures
- Warming permafrost

A threat to infrastructure

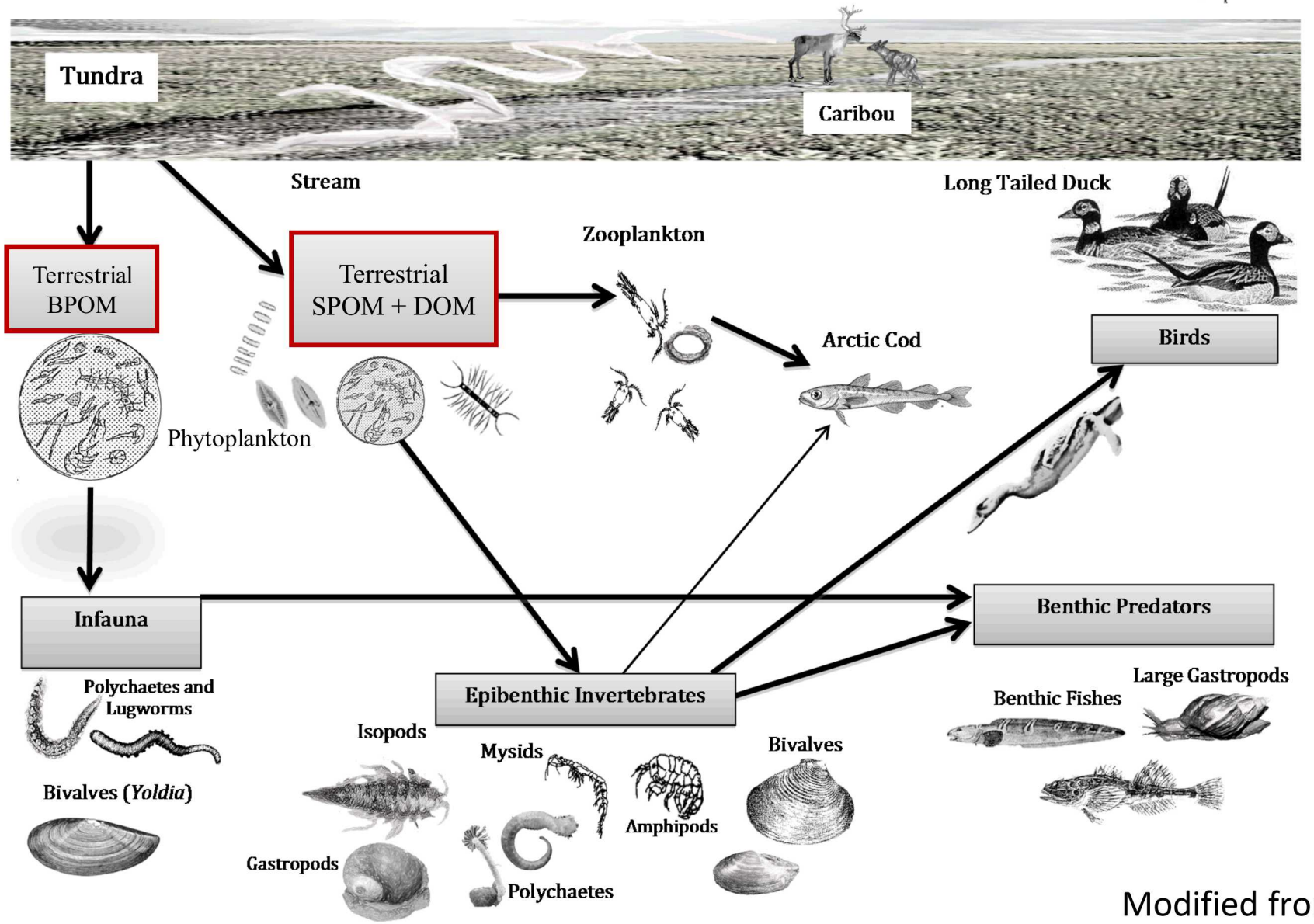
Average rate of shoreline change on the Beaufort Sea coast is -1.7 m yr^{-1} (Gibbs and Richmond 2015)

Millions of dollars of infrastructure at risk:

- 3 Iñupiat communities: Utqiaġvik (Barrow), Kaktovik, Nuiqsut
- Department of Defense sites
- Prudhoe Bay oilfields


PC: Andrew Burton, NPR

Ecological and biogeochemical effects



Modified from Dunton et al. 2012

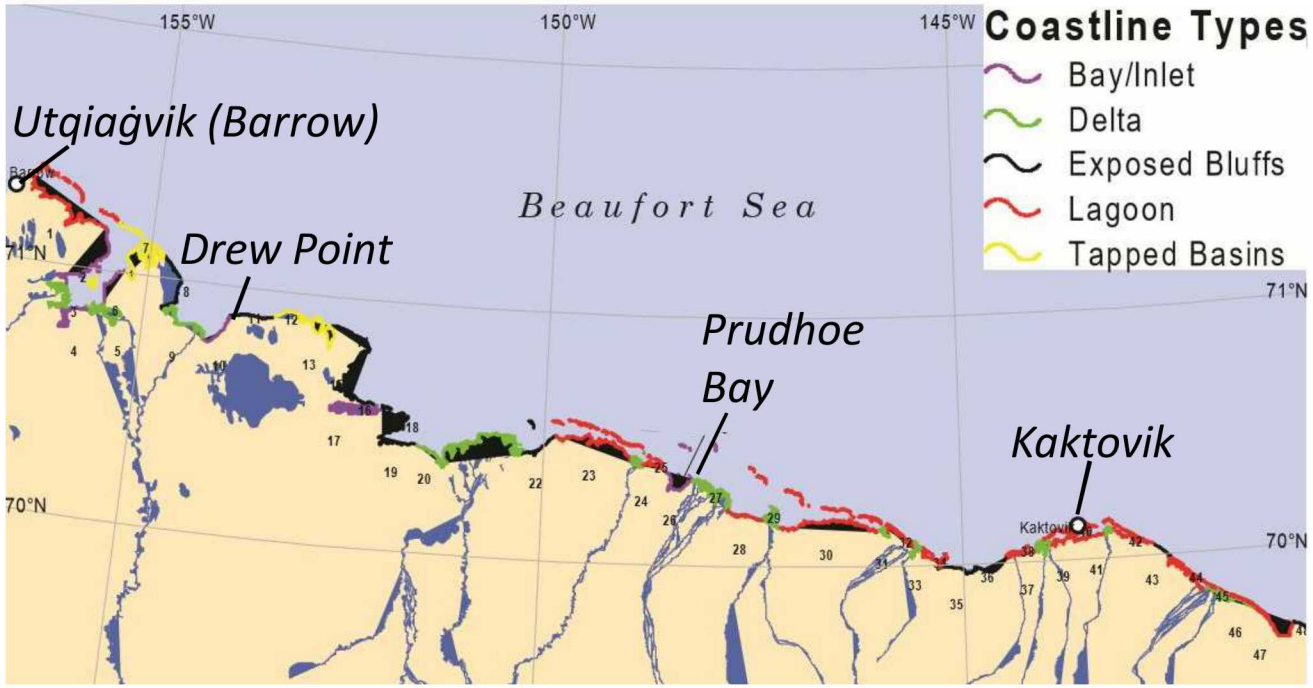
Outline

1. Permafrost core collection
2. Age profile
3. Geologic history
4. Organic matter (C and N)
5. Porewater chemistry

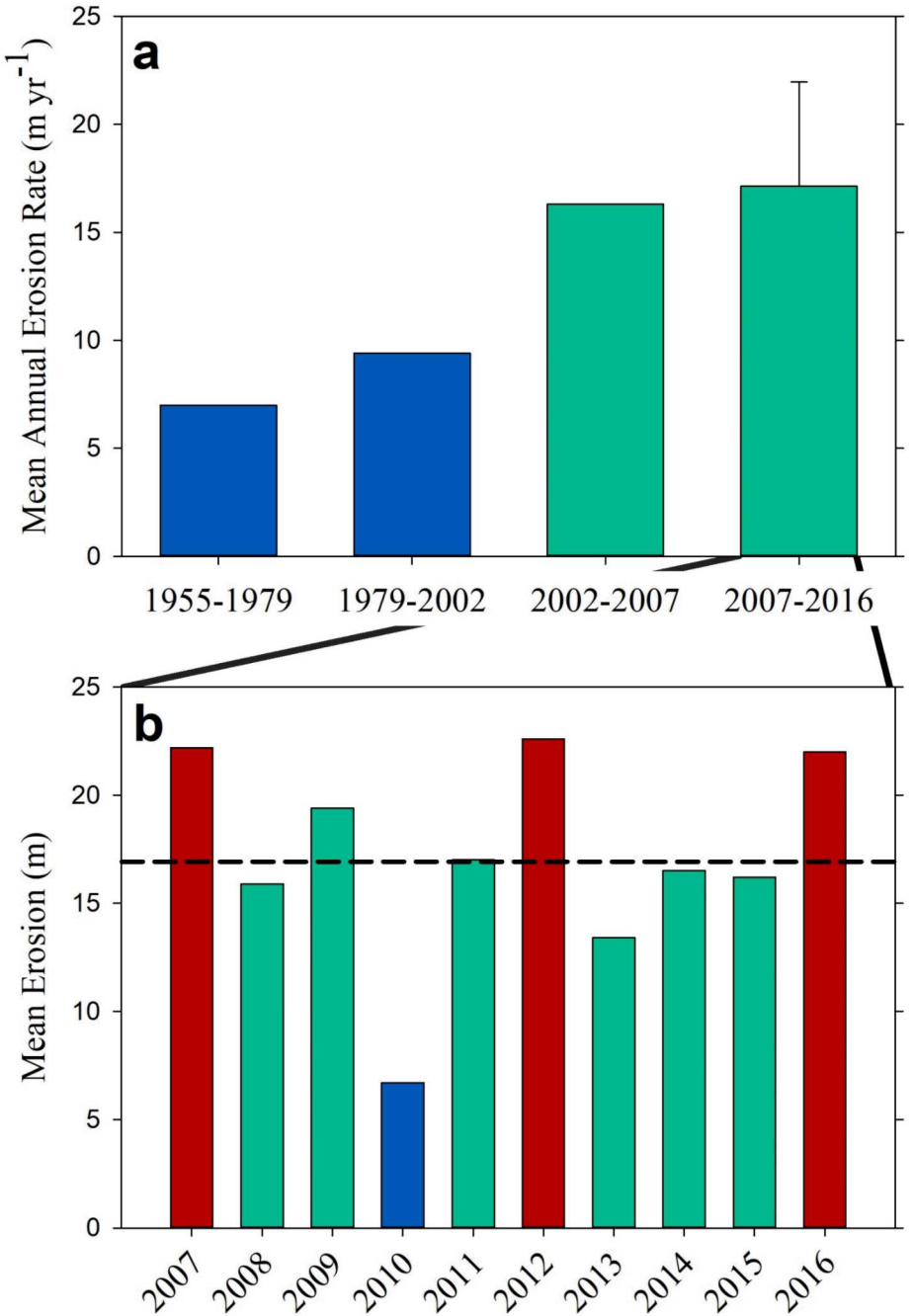
Drew Point, AK

Highest erosion rates on the Beaufort Sea coast, ~ 17.2 m yr^{-1} (Jones et al. 2018)

Storms undercut exposed bluffs, leading to block failure



Jorgenson and Brown 2005



Jones et al. 2018

Drew Point: Permafrost core collection

Ancient Drained Lake Basin

- Bluff height: 5.2 m
- Core length: 7.5 m

Young Drained Lake Basin

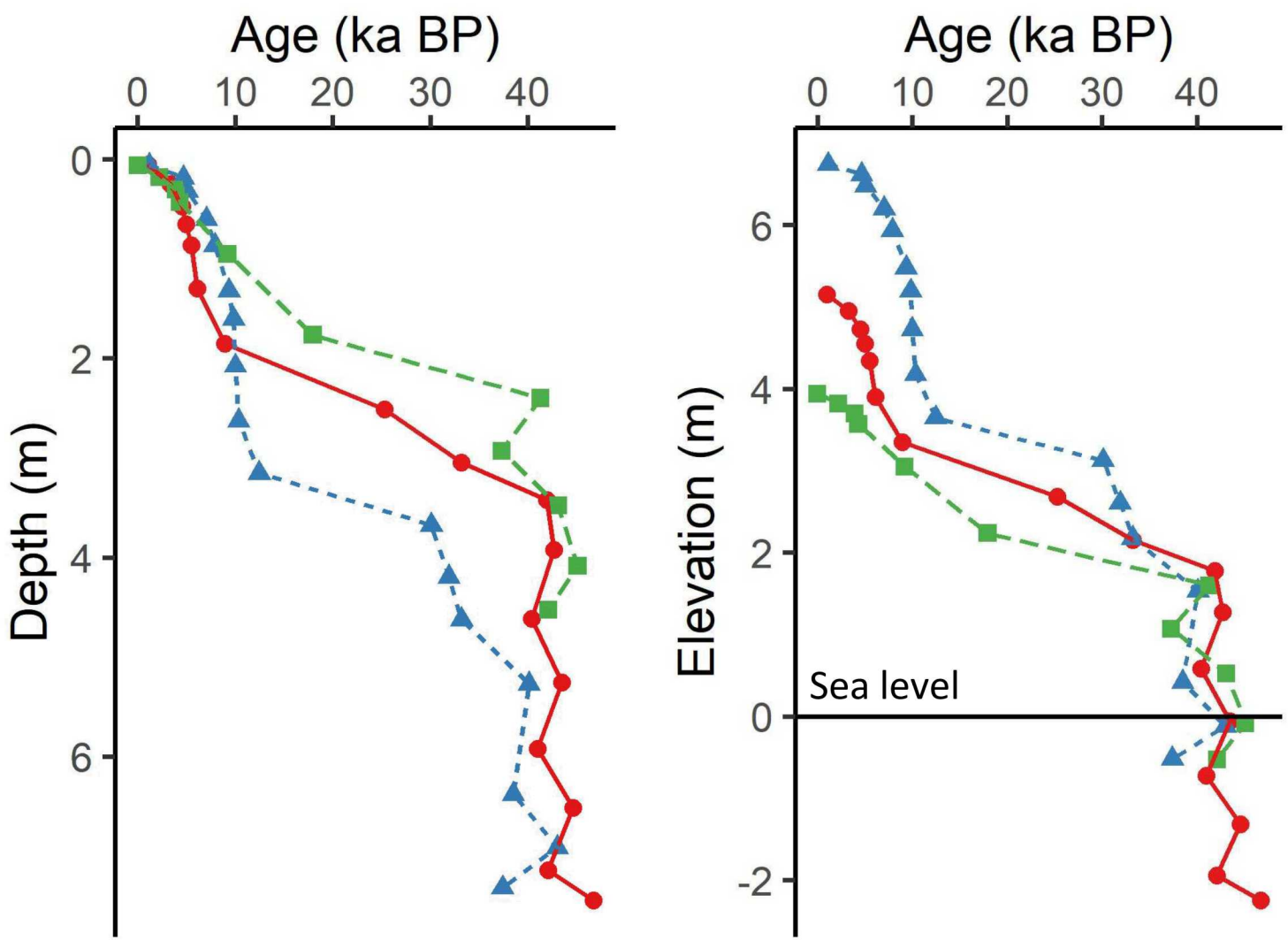
- Bluff height: 4.0 m
- Core length: 4.6 m

Primary Surface – less common

- Bluff height: 6.8 m
- Core length: 7.4 m

Collected in an April 2018 field campaign led by Ben Jones.

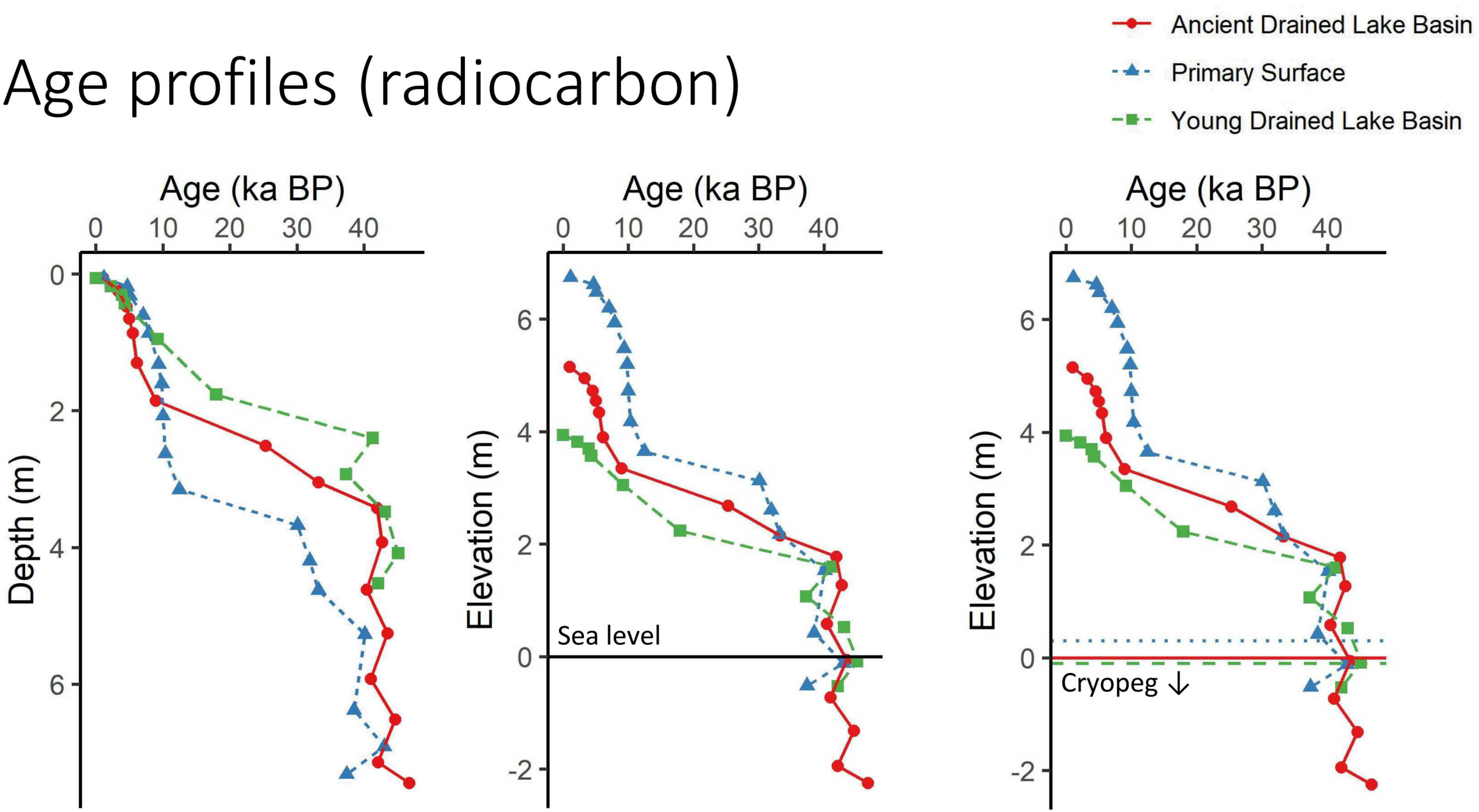
Age profiles (radiocarbon)



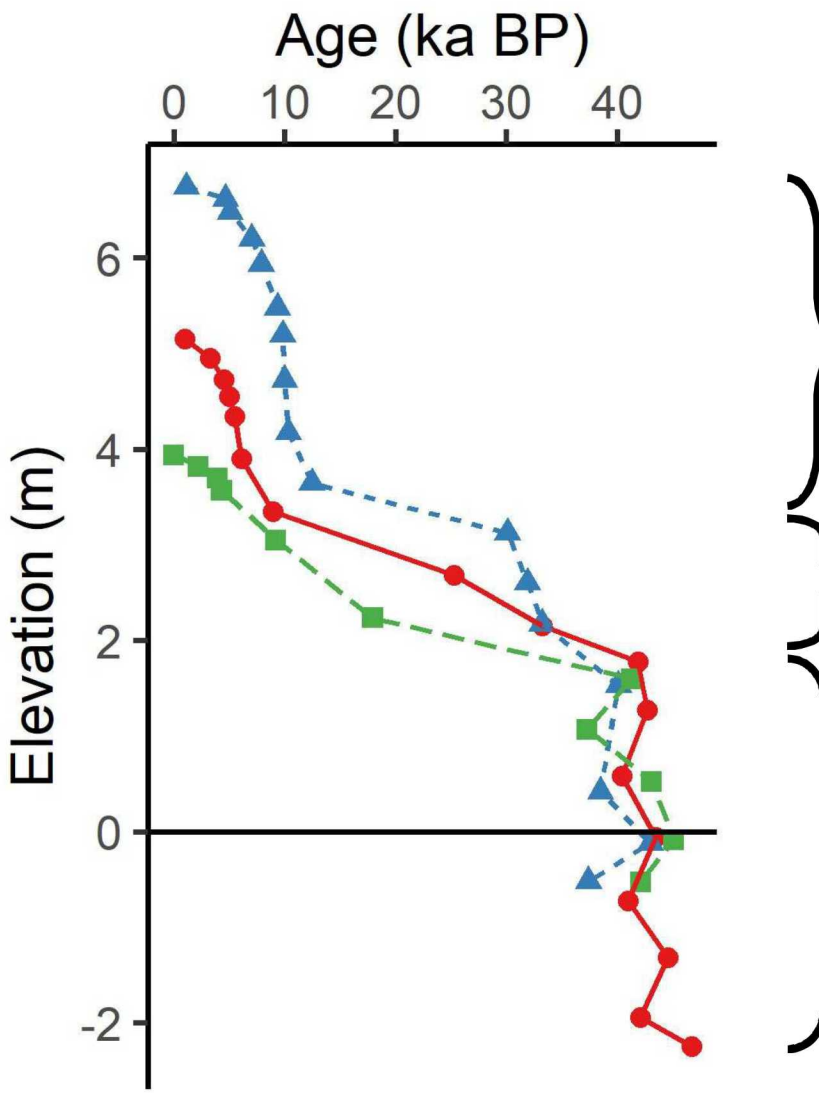
Organic matter age ranges from modern to ~47,000 yBP.

Slow net accumulation between ~12,000 and ~35,000 yBP.

Age profiles (radiocarbon)



Geologic History



Ancient Drained Lake Basin

Primary Surface

Young Drained Lake Basin

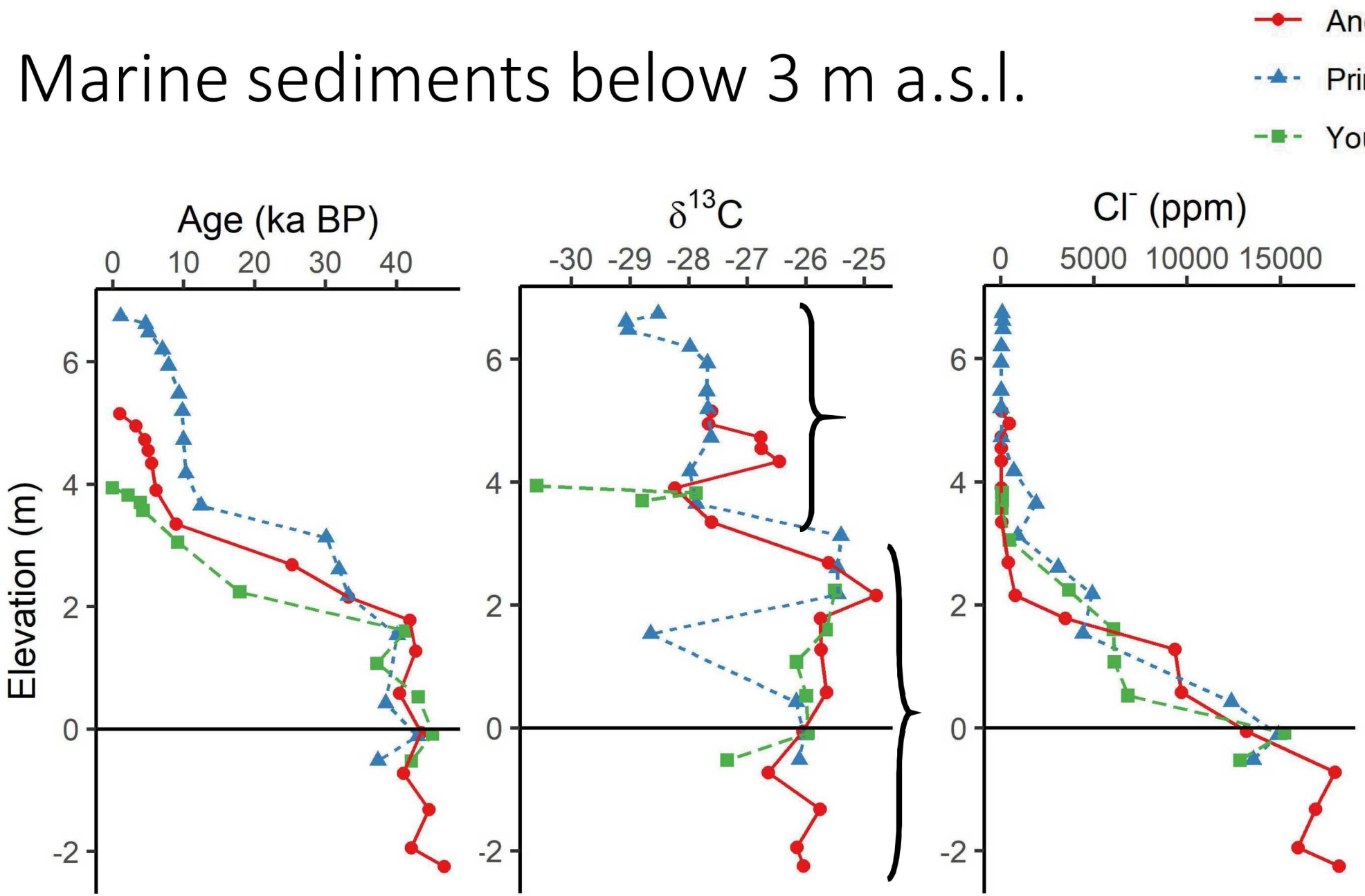
~12,000 kaBP to Present: warmer conditions; thaw lakes form

Mid/Late Wisconsinan: cooler, drier climate → less vegetation, slow peat accumulation

Early/Mid Wisconsinan: Glaciomarine sediments from Simpsonian transgression (Flaxman member of the Gubik formation)

Black 1964, Black 1983, Carter et al. 1988, Rawlinson et al. 1993, Jorgenson 2011

Marine sediments below 3 m a.s.l.



Less depleted ^{13}C in sediments >35,000 yBP

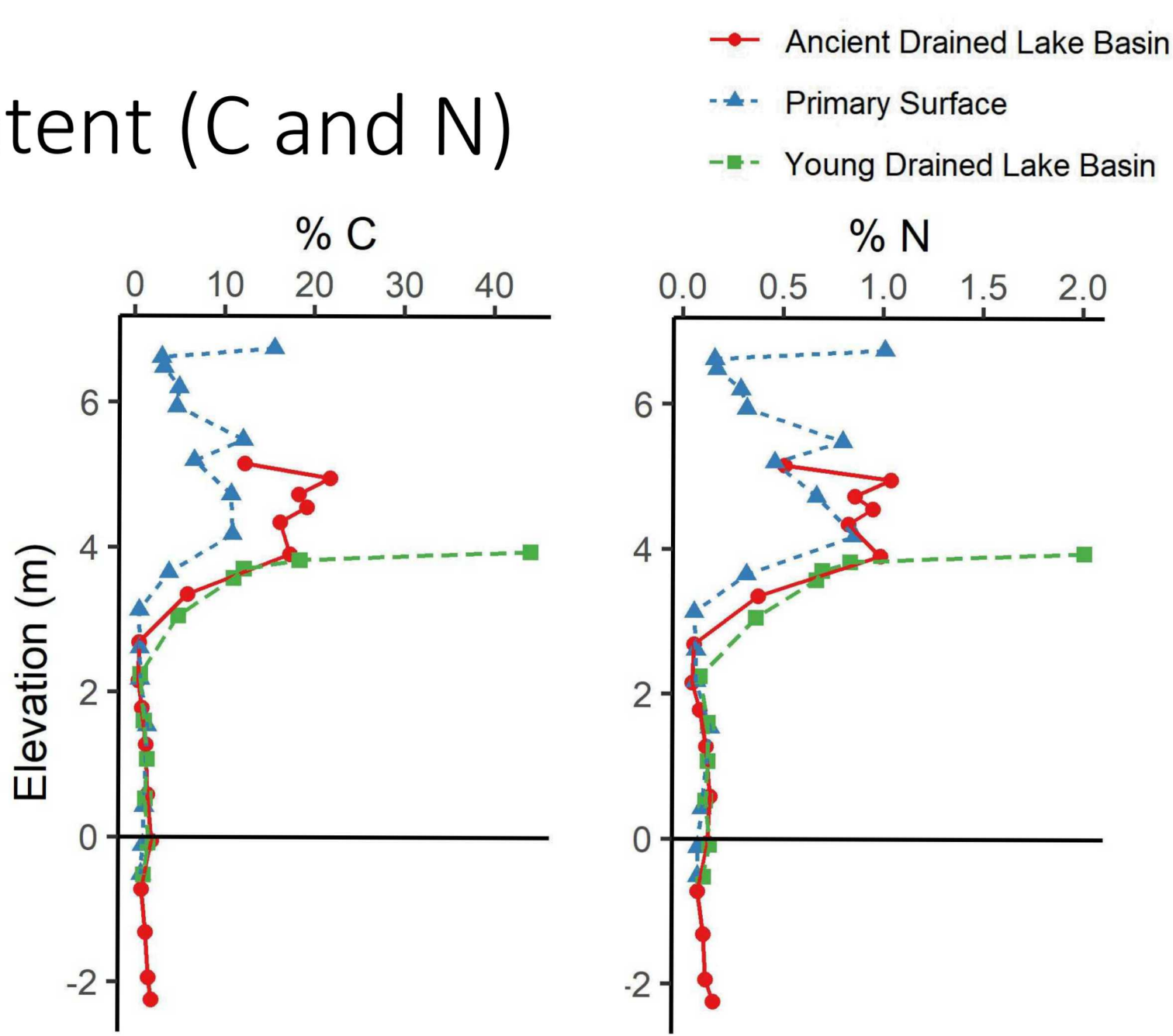
Cl^- and Br^- concentrations increase after $\delta^{13}C$ shift

Organic matter content (C and N)

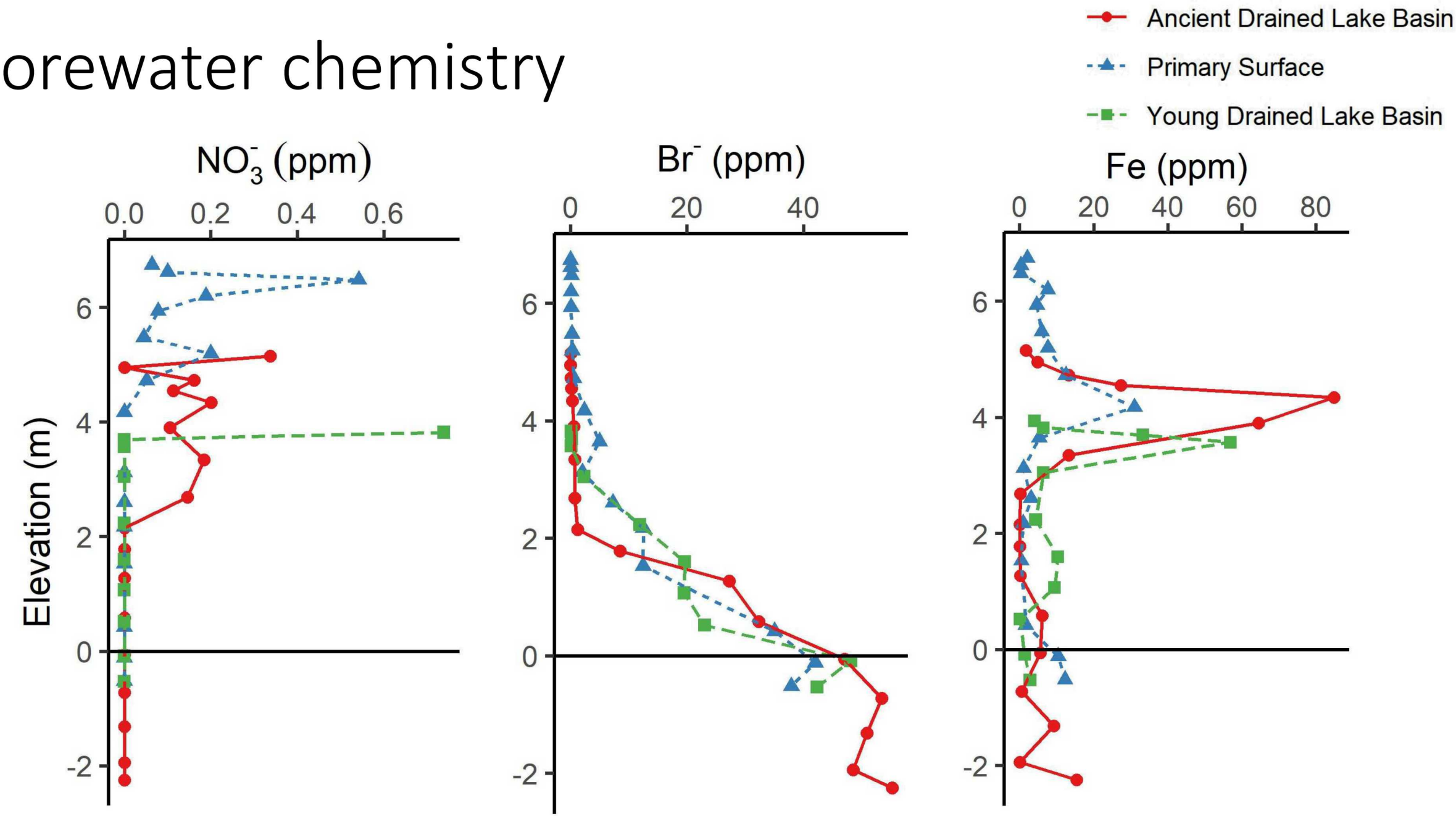
High but variable C and N content at top of cores

Low, uniform values below ~2.5 m a.s.l.

Low, uniform values associated with sediments > 35,000 yBP



Porewater chemistry



PC: Ben Jones

Summary

- Beaufort Sea coastline is rapidly eroding, mobilizing permafrost soils up to 40,000 yBP
- Rapid accumulation of organic material in past 12,000 years
- Younger soils > ~3 m a.s.l. have high concentrations of C and N
- Cryopeg below sea level associated with marine sediments

Integrate biogeochemical analyses with physical erosion models to estimate land-ocean C and N fluxes.