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Holocene Paleohydrological Reconstruction Using Lake Sediments from North Yolla Bolly Lake, Mendocino National Forest, California

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Abstract:

This study seeks to create a reconstruction of Holocene hydrologic variability of the Northern Coast Range of California using sediment cores collected from North Yolla Bolly Lake (Tehama County California). North Yolla Bolly Lake is a glacially formed-lake in the Northern Coast Range of California. At 40.2° N latitude, the lake is located at the average latitude of the California (CA) precipitation dipole, which is the leading mode of winter precipitation spatial variability in California (Wise 2010). As a result North Yolla Bolly Lake (NYBL) is well-situated for examining changes in the average position and strength of the CA precipitation dipole throughout the Holocene. In order to develop a record of Holocene Hydrologic variability, a multi proxy methodology was followed. The methods include cm-scale magnetic susceptibility, organic and carbonate content via loss-on-ignition, grain size determination, C(org):N(total) ratios, and XRF. Age control is based on AMS dates (n=15) taken from macroscopic organic material such as conifer needles, seeds, or charcoal. For this part of the project we focus on the interval between 10-2 kcal BP. Based on this data the Holocene is characterized by a wet (i.e. deep lake) early-to-mid Holocene (11.7-4.2 kcal BP) with a shift to drier (i.e. shallow eutrophic lake) during the late-Holocene (4.2-2 kcal BP). Superimposed on this millennial scale changes are variations in precipitation-related runoff as inferred from sand content, with major precipitation events recorded at approx. 6.1 and 9.2 kcal bp. Our interpretations will be compared to other hydrologic reconstructions from CA both to the north and south of the CA precipitation dipole, such as Lake Elsinore (33.6° N), Lower Bear Lake (34.2° N), Silver Lake (35.3° N), Tulare Lake (36.0° N), Barley Lake (39.5° N), and Sanger Lake (41.9° N). Potential climatic forcings driving the inferred hydrologic changes are also examined, such as Milankovitch forcings, Pacific Ocean SSTs, and North Atlantic Meridional Overturning Circulation.

Research Question:

- What was the local climate of the Northern California Coast Range like throughout the early to mid Holocene?
- How has the California precipitation dipole varied in location and intensity through the early to mid Holocene?
- How does the early to mid Holocene record of hydrologic activity at our study site compare to other records along the western coast of North America?

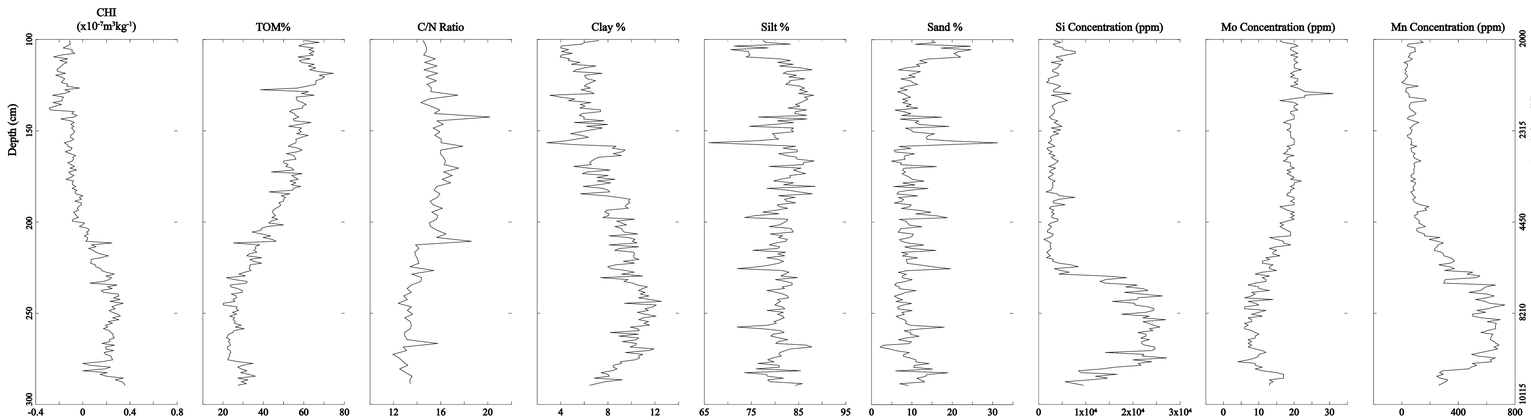

Figure 1: Graphs showing the different parameters observed compared to depth of core; magnetic susceptibility, total organic matter, carbon nitrogen ratio, clay %, silt %, sand %, silica concentration, molybdenum concentration, and manganese concentration.

Methods:

- Magnetic susceptibility: Used to measure of magnetic detrital material in the sediment.
- Organic and carbonate content: Used to measure the percentage of organic carbon, and Carbonate contained within the sediment
- Grain size: Used to measure of the size of sediments e.g. sand vs clay.
- Carbon-nitrogen ratios: Used to measure the ratios of Carbon to Nitrogen found in sediment.
- X-ray fluorescence: Used to measure of the prevalence of different elements in sediments.
- Bayesian Statistical analysis of ^{14}C dates (Blaauw, 2011)

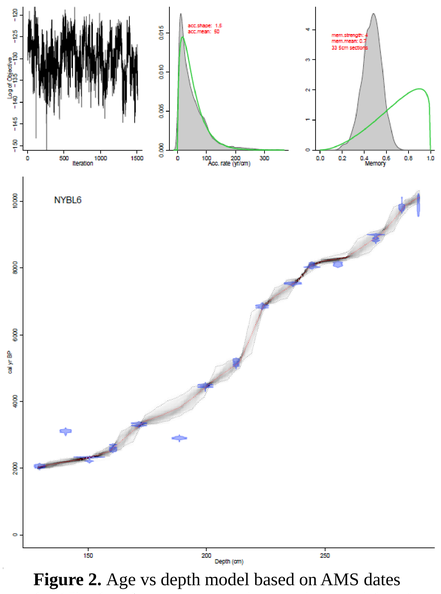

Figure 2. Age vs depth model based on AMS dates (n=15) taken from macroscopic organic material such as conifer needles, seeds, or charcoal for early to mid Holocene 10.0-2.0 Kcal BP

Results:

Based on our observations the Paleoclimate of the Northern Coast Range of California through the Early to mid Holocene is characterized by:

- A wet (i.e. deep lake) early-to-mid Holocene (11.7-4.2 kcal BP) with a shift to drier (i.e. shallow eutrophic lake) during the late-Holocene (4.2-2 kcal BP).
- These late-Holocene eutrophic conditions are consistent with other paleoclimatic lake records to the North of our study site (e.g. Mumbo lake & Sanger Lake)
- Superimposed on these millennial scale changes are variations in precipitation-related runoff as inferred from sand content, with major precipitation events recorded at approx. 6.1 and 9.2 kcal bp.

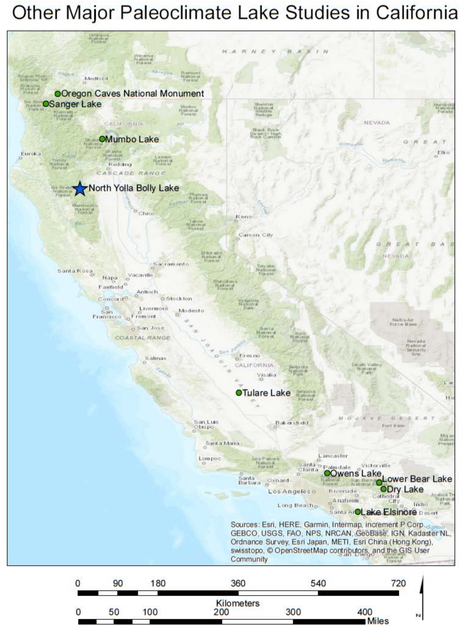

Figure 3. Locations of other major paleoclimatic lake studies conducted in California, which this study will is being compared to.

Study Site:

- North Yolla Bolly Lake, a permanent natural lake in the Northern Coast Mountain Range of California.
- Surrounding mountain range is primarily composed of granites and various metamorphic facies (Blake, 1983).
- Hydrologic record of the lake covers the last12,000 cy BP.

California Precipitation Dipole:

Precipitation along the Western coast of North America is defined by multiple ocean atmosphere interactions, the two most important being the El Nino Southern Oscillation (ENSO), and the Pacific Decadal Oscillation (PDO). The interactions of these two oscillations creates a distinctive atmospheric phenomenon, the California precipitation dipole which determines whether precipitation events (atmospheric rivers) are routed either north or south of the location of the dipole (Wise, 2016)

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