



Research at the Confluence of Archaeological and Environmental Sciences in the Central Andes of Peru

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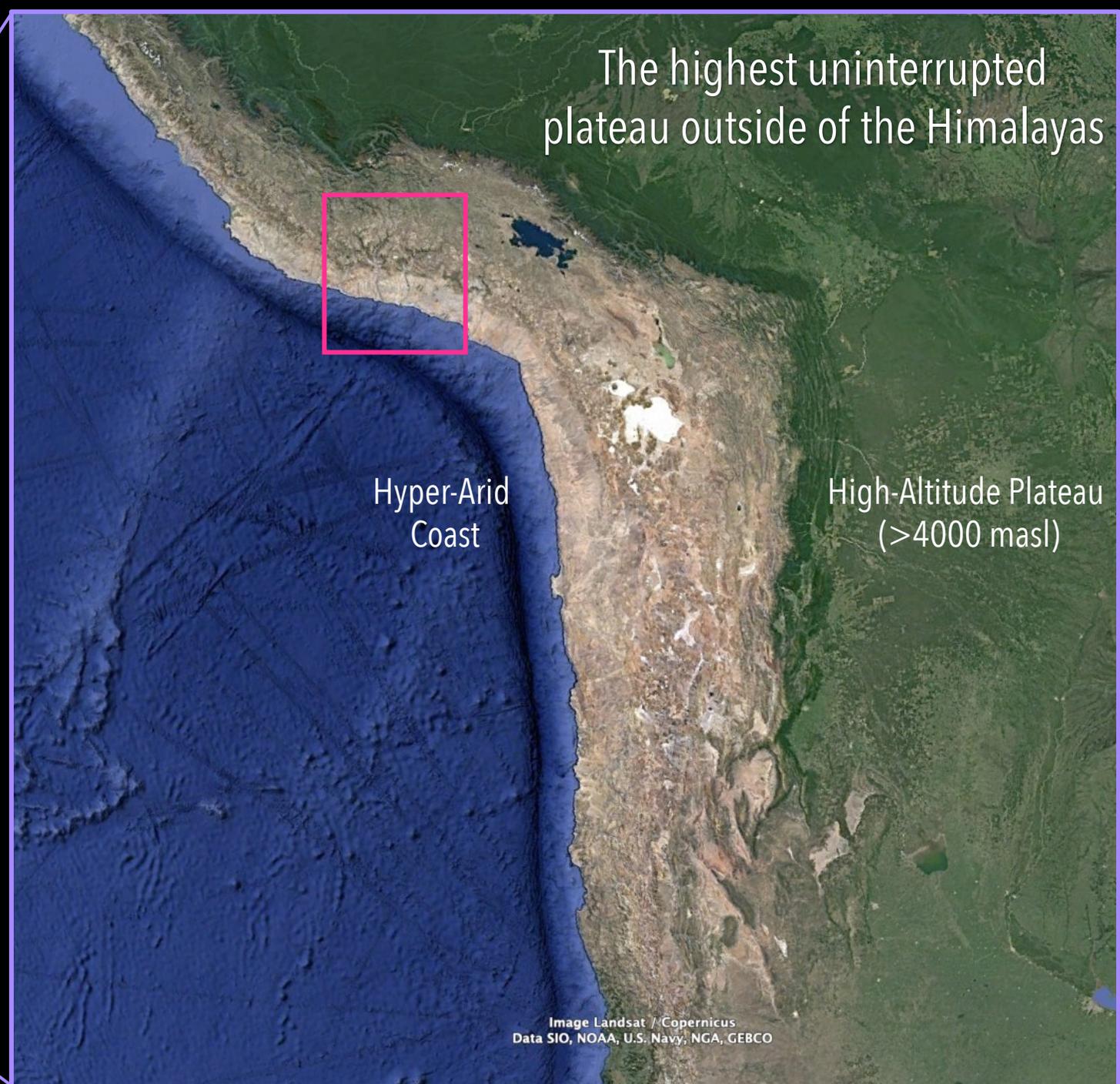
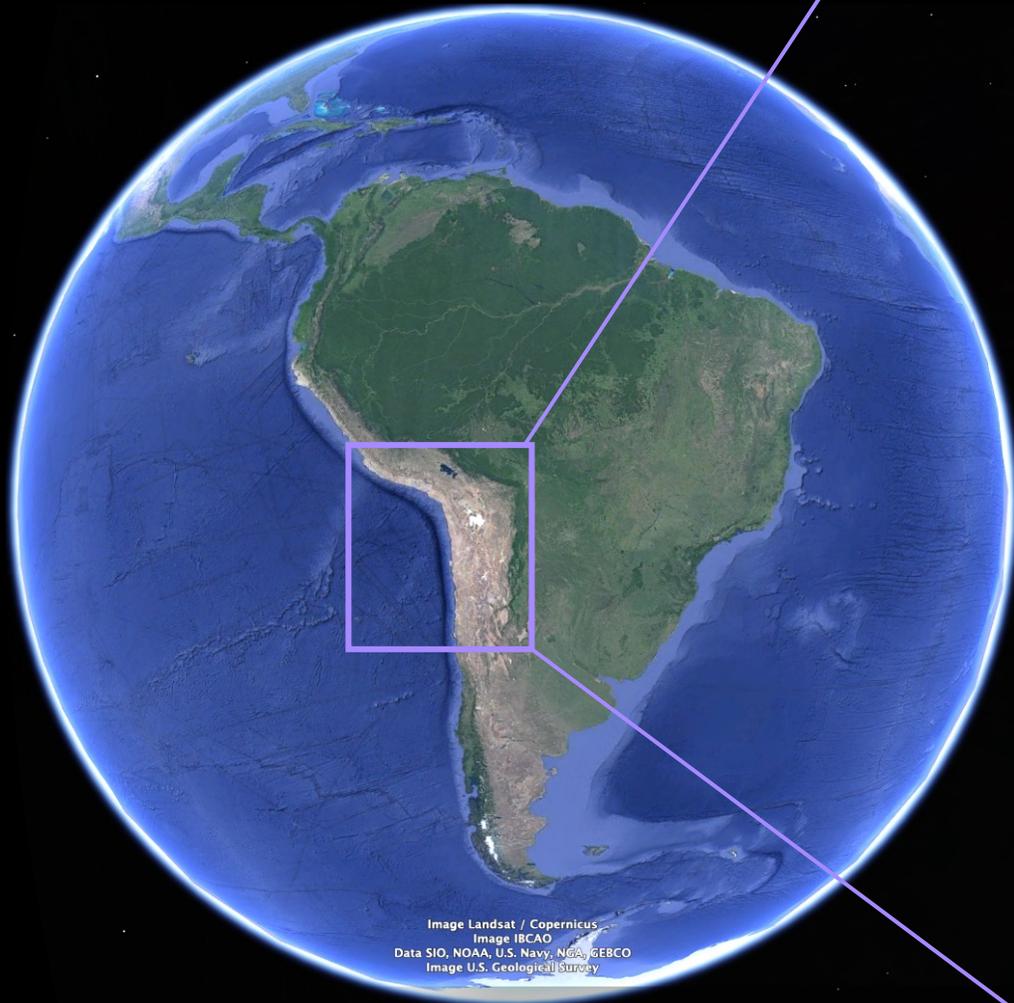
About This Talk

A [brief] narrative on the importance of *interdisciplinary* work.

Take Home 1: Why social scientists need the Earth Sciences

Take Home 2: The Earth Sciences needs interdisciplinary social scientists

RESEARCH AREA



Part 1: An Archaeological Problem



Cuncaicha Rockshelter: occupied from 12,500 kya
Elevation: 4485 meters (14,715 feet)

- Important site for understanding high-altitude adaptation
- Three Early Holocene Human Burials (9,300 – 8,000)
 - Did these individuals live at high-elevation?

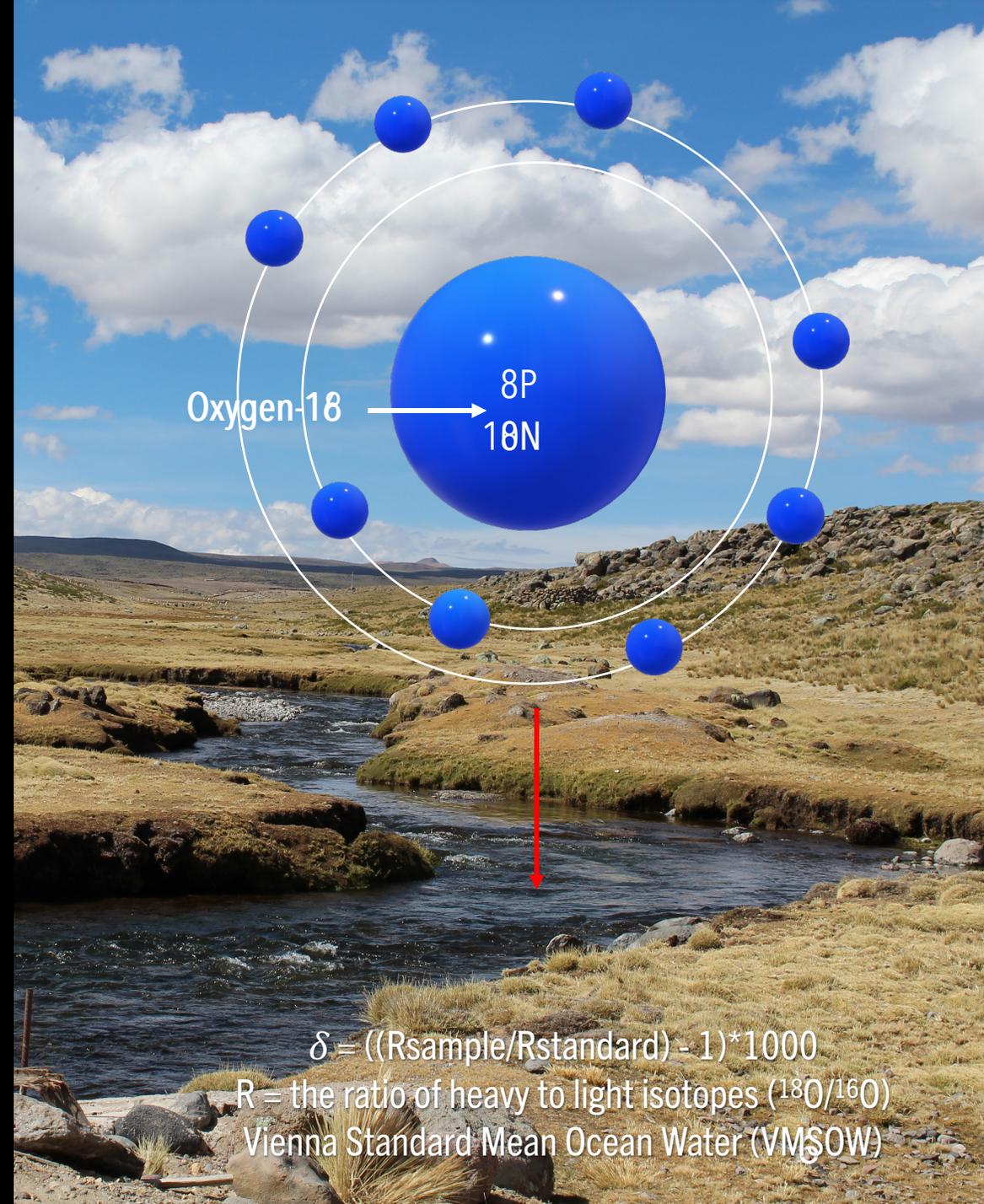
This question requires a measure of mobility!

How do archaeologists study mobility/residence at altitude?

Popular method: oxygen isotopes

SOME BASICS

- Present throughout our global waters
- Predictable & measurable spatial variation
- Spatial controls: latitude, temperature, distance from the source and ... altitude!
- Oxygen values are inversely correlated with elevation (low elevation = high oxygen values)
- Incorporated into human tissues (bones, teeth, hair, etc.) via drinking over time
- We can measure archaeological materials to understand past drinking behavior/location

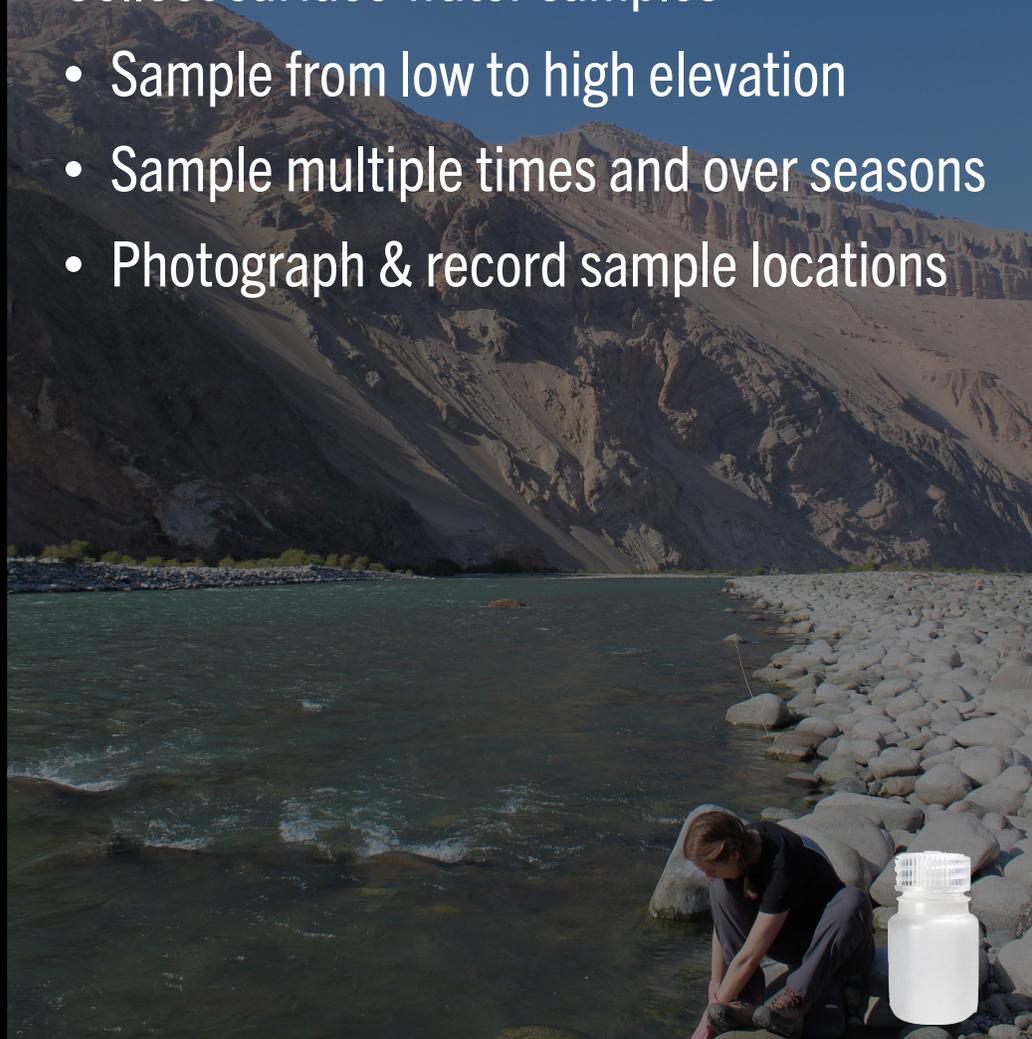


The big question: is altitude the primary control for oxygen isotopes in the western Central Andes, or does the spatial patterning of surface waters represent other processes??

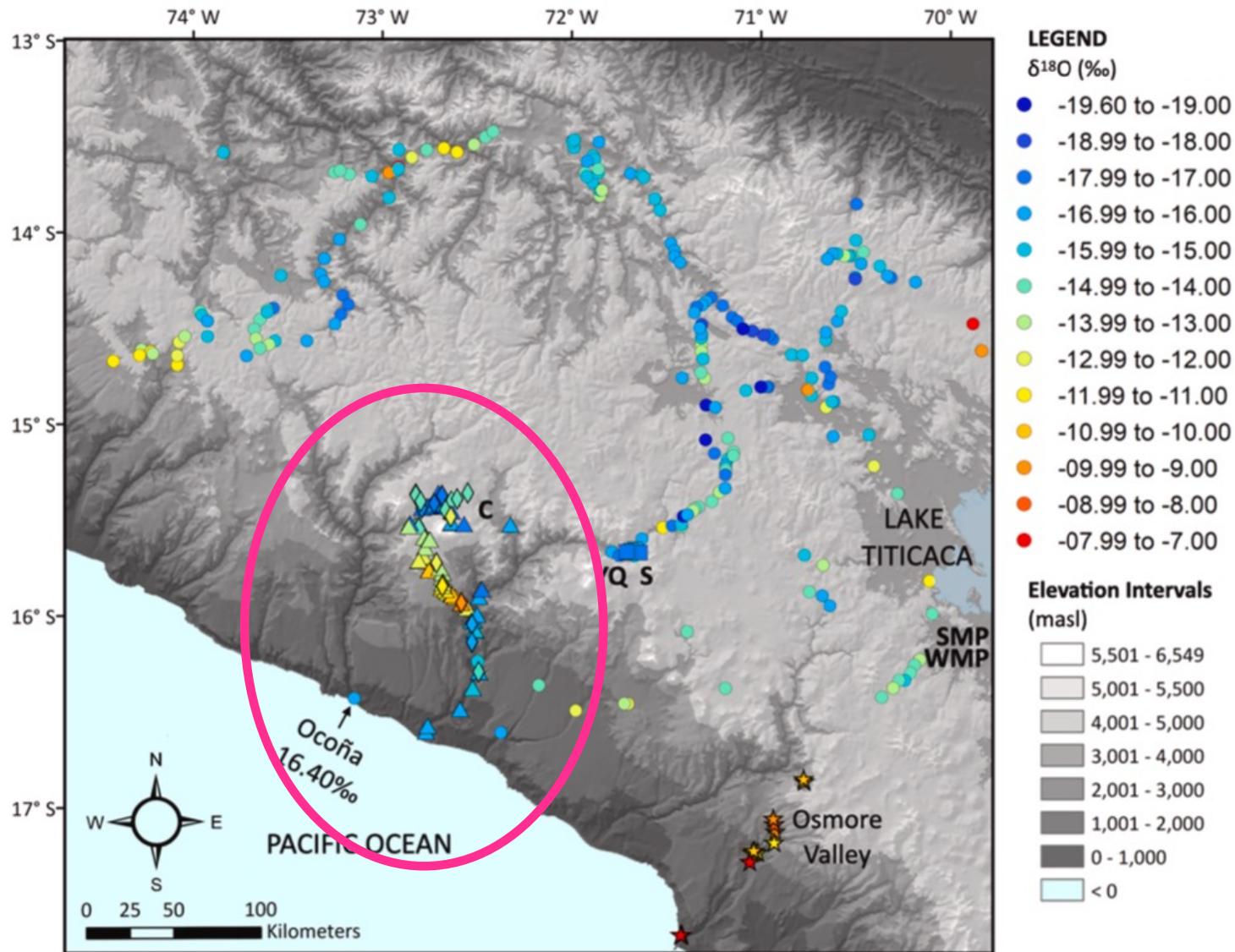
Field Methods

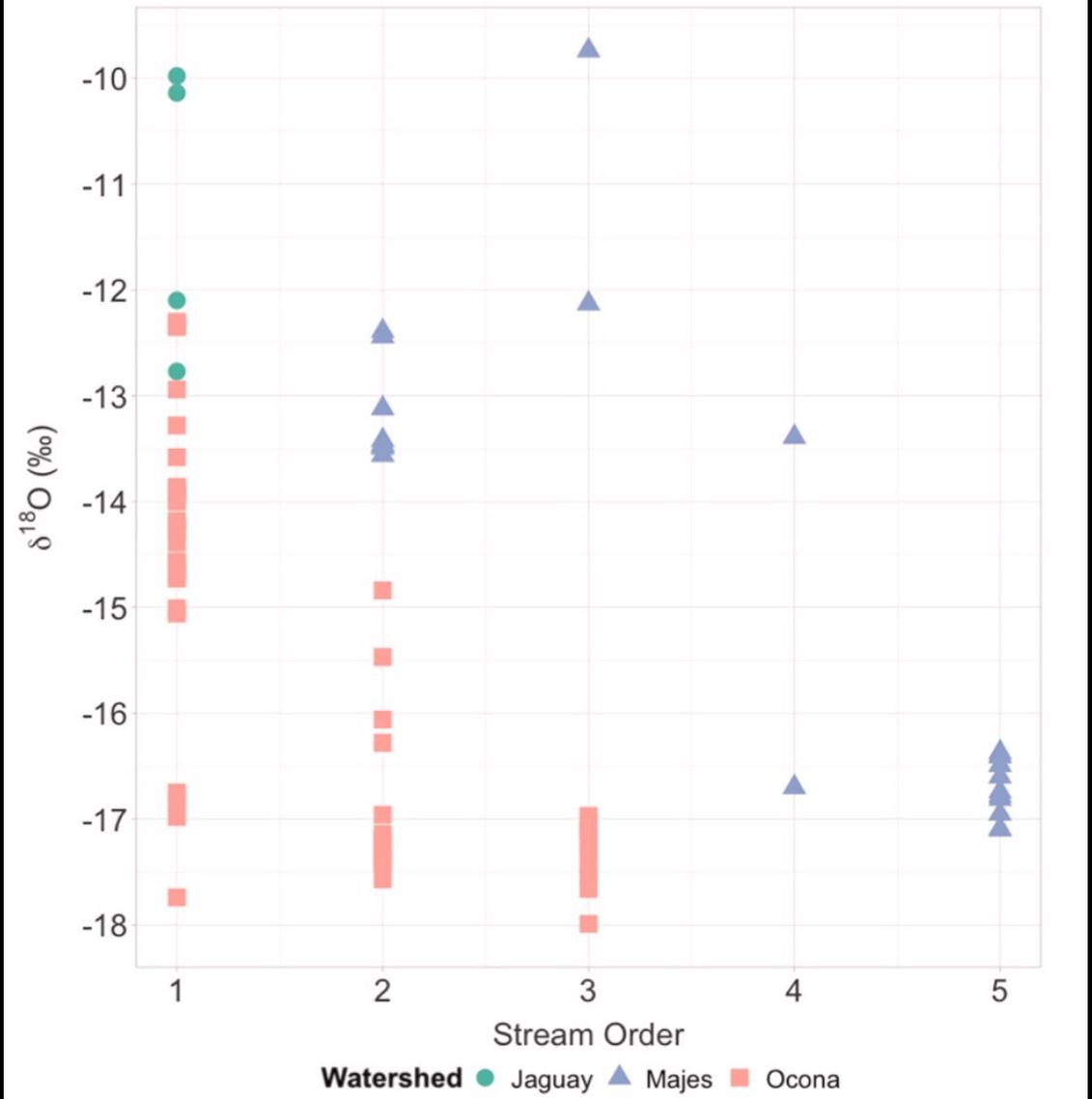
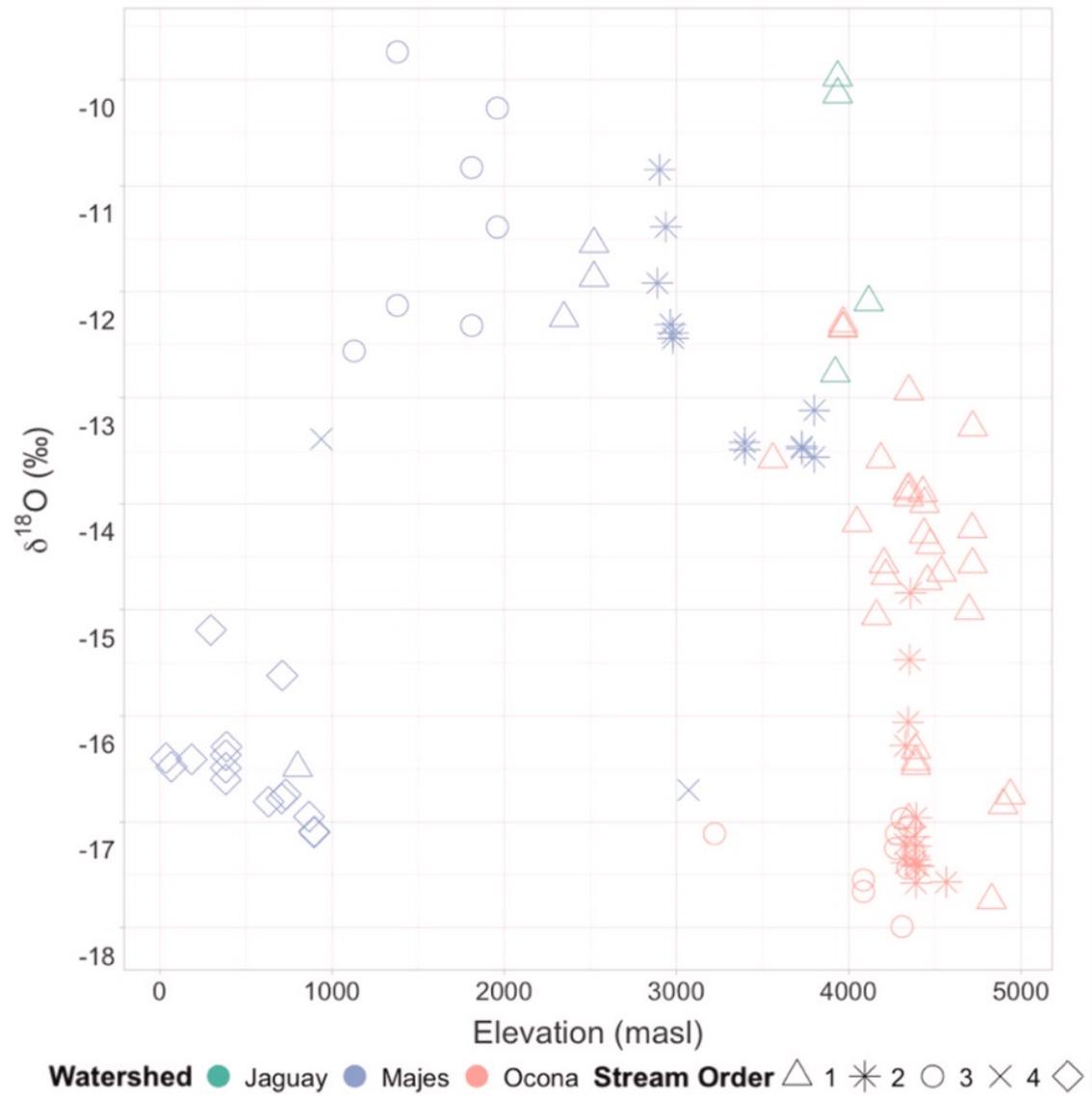
Collect surface water samples

- Sample from low to high elevation
- Sample multiple times and over seasons
- Photograph & record sample locations



Expectation: higher oxygen at lower elevations.

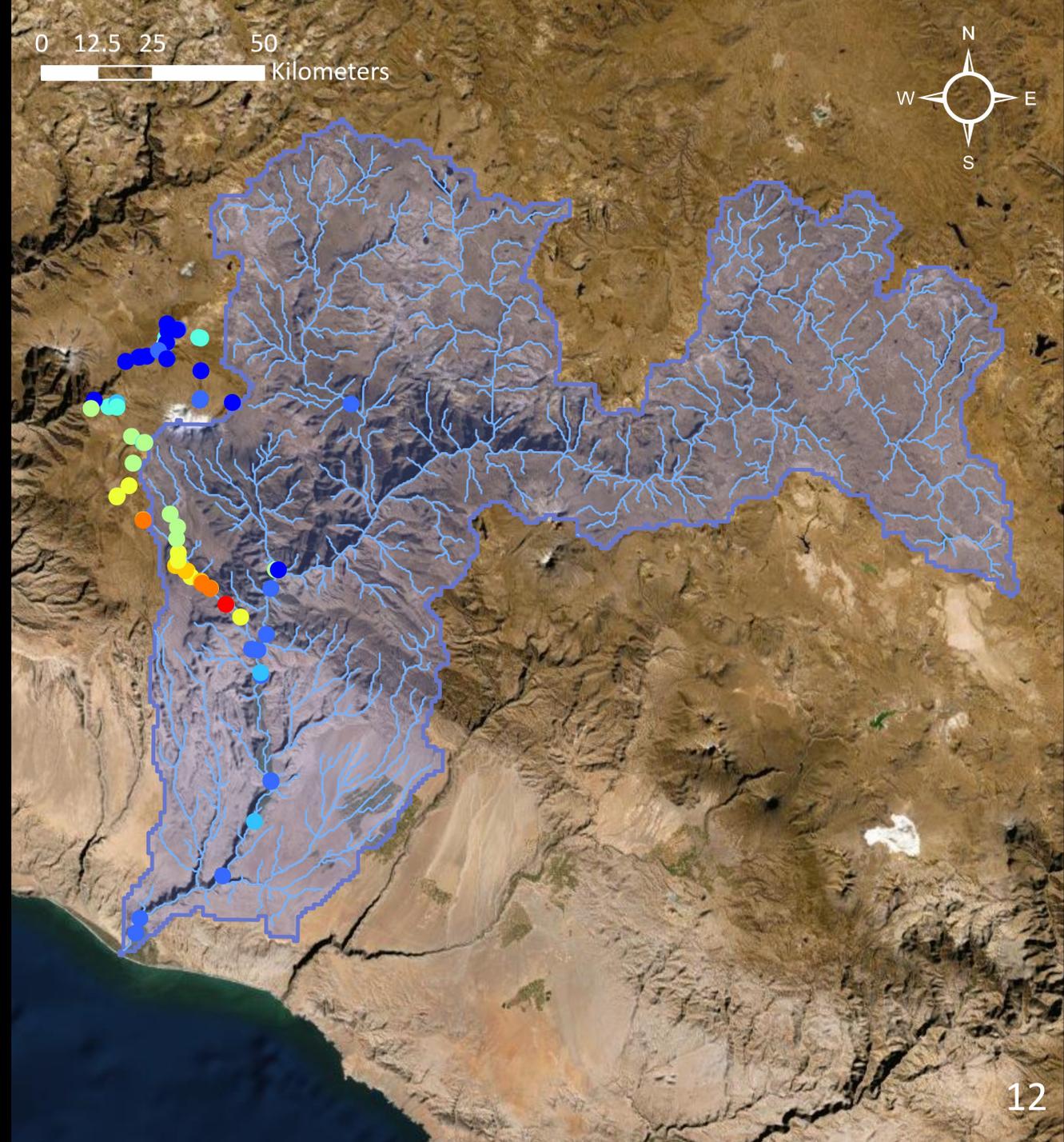




Surface Processes Matter!

In the complex topography of the western Andes, the primary freshwater inputs to lowland surface waters are high-elevation sources fed by Atlantic-derived precipitation. As a result, waterbodies at intermediate elevations and near the Pacific coast reflect “non-local” $\delta^{18}\text{O}_{\text{water}}$ from the interior Andes, incongruous with OIPC predictions. We call this the “Watershed Effect.”

Milton et al. 2022



FINDINGS

- Oxygen isotopes are NOT suited for use in archaeological mobility studies in the Central Andes
- Future work should focus on temporal variability & the effects of water infrastructure
- Cross-disciplinary use of methods also requires interdisciplinary framing



Examining surface water $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values in the western Central Andes: A watershed moment for anthropological mobility studies

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ABSTRACT

Oxygen isotopes are commonly applied to study archaeological human and animal mobility among the vertical ecological zones of the Central Andes in South America. Such research assumes that oxygen and hydrogen isotopes in meteoric waters demonstrate an inverse relationship with elevation. However, because the primary source of precipitation in the Central Andes is the Atlantic Ocean, this expectation is likely complicated by surface-level processes on the western Andean slope. We evaluate the spatial patterning of stable isotope values in surface waters along a coast-highland transect in southern Peru (~15–17°S). Surface water $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values in the study area are consistent with regional and global meteoric waters. However, lowland and highland surface waters demonstrate wide variability and overlapping ranges of surface water isotope values. Therefore, it is challenging to discern the origin of surface waters based on elevation alone. Rather, surface water $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values appear to reflect hydrologic processes including seasonality, stream order, catchment size, and distance from the source. We identify the “Watershed Effect,” which precludes the use of $\delta^{18}\text{O}$ and $\delta^2\text{H}$ in Andean bioarchaeological studies of inter-zonal mobility. Moreover, changing hydroclimate over the Holocene and present sampling precision for biological analytes confound existing interpretations of $\delta^{18}\text{O}$ derived from archaeological bioapatite. Given the regional complexities of $\delta^{18}\text{O}_{\text{water}}$ presented here, isotopic assessments of human paleomobility require better baseline data than those currently available for the Central Andes. We contend that previous archaeological datasets using $\delta^{18}\text{O}_{\text{bioapatite}}$ to assess mobility between high and low elevations should be re-evaluated. Further, future studies should provide adequate baseline data to justify archaeological analyses and support subsequent interpretations.

Part 2: Some Reasons Earth Science Needs Interdisciplinary Anthropologists



More Data [& from Remote Areas]

Name ^ v	Modified ^ v
 2018-2019 Surface Water Data	
-  OSF Storage (United States)	
 Milton2022_AboutTheseData.pdf	2022-08-18 03:46 PM
 Milton ENRI May 2019 H2O - 1-49.csv	2022-08-18 03:46 PM
 Milton ENRI May 2019 H2O - 1-49.xlsx	2022-08-18 03:46 PM
 Milton ENRI Sept 2019 H2O - 1-53.csv	2022-08-18 03:46 PM
 Milton ENRI Sept 2019 H2O - 1-53.xlsx	2022-08-18 03:46 PM
 Milton Field Data.csv	2022-08-18 03:46 PM
 Milton Field Data.xlsx	2022-08-18 03:46 PM

Peruvian Andes Surface Water Isotope Repository /

2018-2019 Surface Water Data

Contributors: [Emily Beatrice Peterson Milton](#)

Date created: 2022-08-16 04:35 PM | Last Updated: 2022-08-18 03:48 PM

Identifier: DOI 10.17605/OSF.IO/29U5K

Category:  Data

Description: *Add a brief description to your component*

License: *Add a license*

Intentional curation of data for interdisciplinary access and use.

Water Quality & Infrastructure Monitoring



[dams]



[contamination]

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