ANALYSING PALAEO CIRQUE GLACIER EQUILIBRIUM ALTITUDES AS INDICATORS OF PALAEOCLIMATE ACROSS SCANDINAVIA

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PROJECT AIMS

To use a high density of palaeo cirque ELAs and the relationship to climate to analyse for subdivisions within a single region.

The use of palaeo equilibrium line altitudes (ELAs) estimates could potentially be used to hone in on different palaeo climates and give some reference to the conditions in the alpine environment.

**Cirque ELA & Climate**

At the equilibrium line altitude, Ohmura (1992) and Ohmura and Boettcher (2018) established a quantitative relationship

\[
P = a + bT + cT^2
\]

\(P\) = Precipitation @ ELA

\(T\) = Temperature @ ELA

\(a = 966, b = 230, \) and \(c = 5.87\)

This relationship is used readily in reconstructing palaeoclimates based on the ELA of a glacier.

Figure is reconstructed from the data used to establish the Ohmura equation.
METHODS

- 3784 cirques were mapped by John Jansen’s team
- Locations are provided on the map
- A GIS tool for Automated Cirque metric extraction (ACME) by Spagnolo et al., 2017 was used to discover all the physical properties of the cirques

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<th>Variance Statistic</th>
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• Comparison With GLaRE tool
  - GLaRE is a semi-automated tool for calculating ELAs, flow lines need to be hand drawn, thus the tool takes 10-20min per glacier
  - With 3800 examples, it was impractical to analyse each glacier with GLaRE
  - GLaRE creates a reconstructed palaeo glacier surface which then can be used to calculate the ELA (Pellitero et al., 2015; Pellitero et al., 2016)
  - Instead, we used cirque floor altitudes (CFAs) as a proxy for ELA as recommended (Barr & Spagnolo, 2015)

Accuracy of GLaRE vs. CFAs
- Example of 20 cirques from the Dovre region
An R-squared of 0.73 is fairly high but that results is a median difference of 138 m between the two measurements, which is still fairly substantial
PRELIMINARY RESULTS

- Here, we investigate patterns with different sub-regions, to see if there is any sort of pattern within the overall dataset.
- To understand the controls on CFAs and thus the proxy for ELA
The CFAs reflect the typical pattern of increasing with distance from the coast.

This is a result of topographic availability, distance to the moisture source and moisture availability.
RESULTS - ASPECT

The mean vector is 67° (thick black line) but the vector strength is very low.

This uncharacteristic pattern for the northern hemisphere, could be a result of sampling bias during the mapping of the cirques.

It could also reflect the lack of glacier occupied cirques – this analysis only includes cirques without any ice present.
WHAT IS NEXT?

- Since this is all fairly new data, we plan on taking time to expand testing of the GLaRE tool precision versus CFAs to other regions to see if there is any relationship
- We plan on comparing the rock type to the aspect results
- We plan on adding in a dataset of modern cirque glaciers to see if that adjusts the mean aspect
- More testing by elevation to look for signatures within the dataset
- Skewness & Kurtosis tests need to be completed to use the median instead of the mean
- A palaeo sea level needs to be implemented as some of the cirques are ‘at modern sea level’
- Expanding some of the high density areas to cover more of E/W Swaths
REFERENCES


Questions: please contact Rachel Oien
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