Quaternary Newsletter
Report
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RESOLVING LATE HOLOCENE CLIMATE CHANGE, NORTH ICELAND

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Background and Rationale

The Arctic region is experiencing surface air temperature increases of twice the global average. To better understand Holocene Arctic climate variability, there is the need for continuous, high-resolution palaeoclimate archives. Iceland is located at the confluence of warm water and air masses from the south, and cold polar water and air masses from the north, making it highly sensitive to North Atlantic and Arctic climate change. However, at present the region is highly understudied, lacking any high-resolution climate reconstructions.

Sediment cores from proglacial lakes can provide such climate archives, and have the potential to record past environmental change in detail. Vatnsdalur, a valley in northern Iceland, hosts small, climatically sensitive cirque glaciers that became independent from the Iceland Ice Sheet after its retreat following the Last Glacial Maximum (c. 15 ka BP). To address this, we use first high-resolution analysis of proglacial lake sediments, to examine northern Iceland Late Holocene environmental change.

Results

Following fieldwork in north Iceland, a 350 cm sediment core (SKD-P1-18) from the proglacial lake Skeiðsvatn was retrieved and analysed for sedimentological (dry bulk density, loss-on-ignition, grain size), geophysical (magnetic susceptibility) and geochemical (X-ray fluorescence) parameters. We identify three main sedimentary facies (LIF-1 to LIF-3) from these analyses, indicating variations in glacial input and catchment environmental conditions.

SKD-P1-18 is divided into three lithofacies on the basis of visual stratigraphy, supported by sedimentological and geochemical data. Visual analysis of the core shows transitions between laminated and non-laminated sections, differences in colour, and embedded organics. White and pale-orange laminations are identified at several core

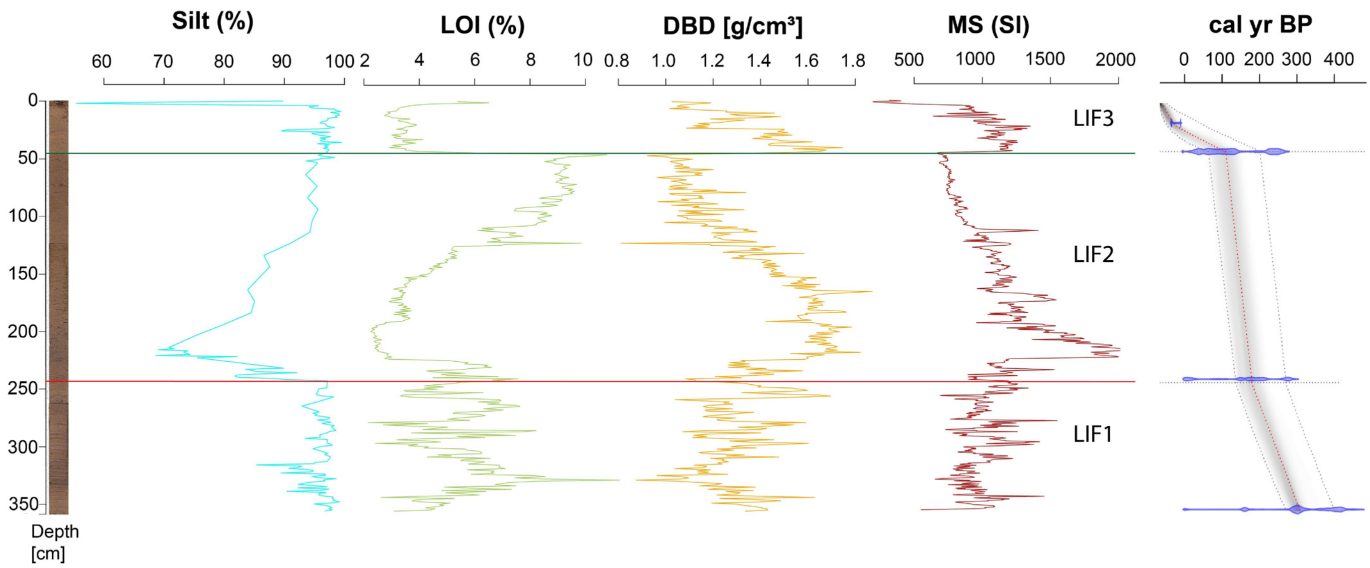

Figure 1. Overview of physical sedimentological analyses on SKD-P1-18, showing (from left to right): silt fraction (blue), loss on ignition (green), dry bulk density (yellow), magnetic susceptibility (red) and an age depth model for chronological control.

depths, potentially representing datable tephra horizons. Silt (4 - 63 µm) is the dominant grain-size class throughout the core. Small fractions (up to 4 %) of clay (clay < 4 µm) are present in all samples. Very fine sand (63 - 125 µm) and fine sand (125 - 250 µm) is present in some samples close to the top of the core as well as in the middle core section.

Initial geochemical results from XRF show Fe and Ti as abundant, important elements representative of the geochemical variability through the core. Principle component analysis identified 10 principle components (PC) to represent the geochemical variability of the sediment core. Combined, PC1 (49.6 %) and PC2 (38.8 %) explain more than 88 % of the geochemical variance (Fig. 2). Ti appears to co-vary with magnetic susceptibility and dry bulk density, and correlates negatively to loss on ignition. This suggests that the Ti signal could reflect inwash of minerogenic material (e.g., Olsen *et al*., 2010; Davies *et al*., 2015; Adamson *et al*., 2018). Thus, increases in Ti potentially reflect periods of climatic deterioration and glacier advance (Fig. 3).

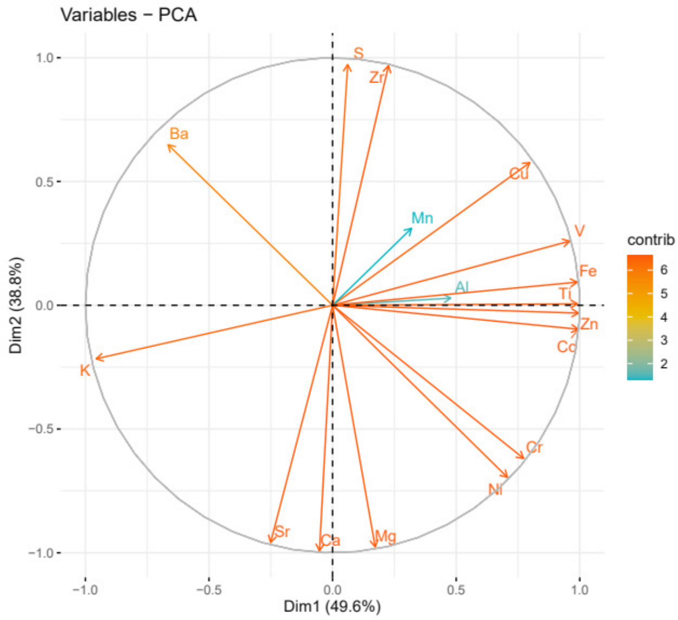

Figure 2. Biplot of PC1 and PC2 elements, also showing elements' contributions to the PCs.

Radiocarbon dating of lake macrofossils, supplemented by tephrochronology, provides a chronological framework, suggesting the sediment

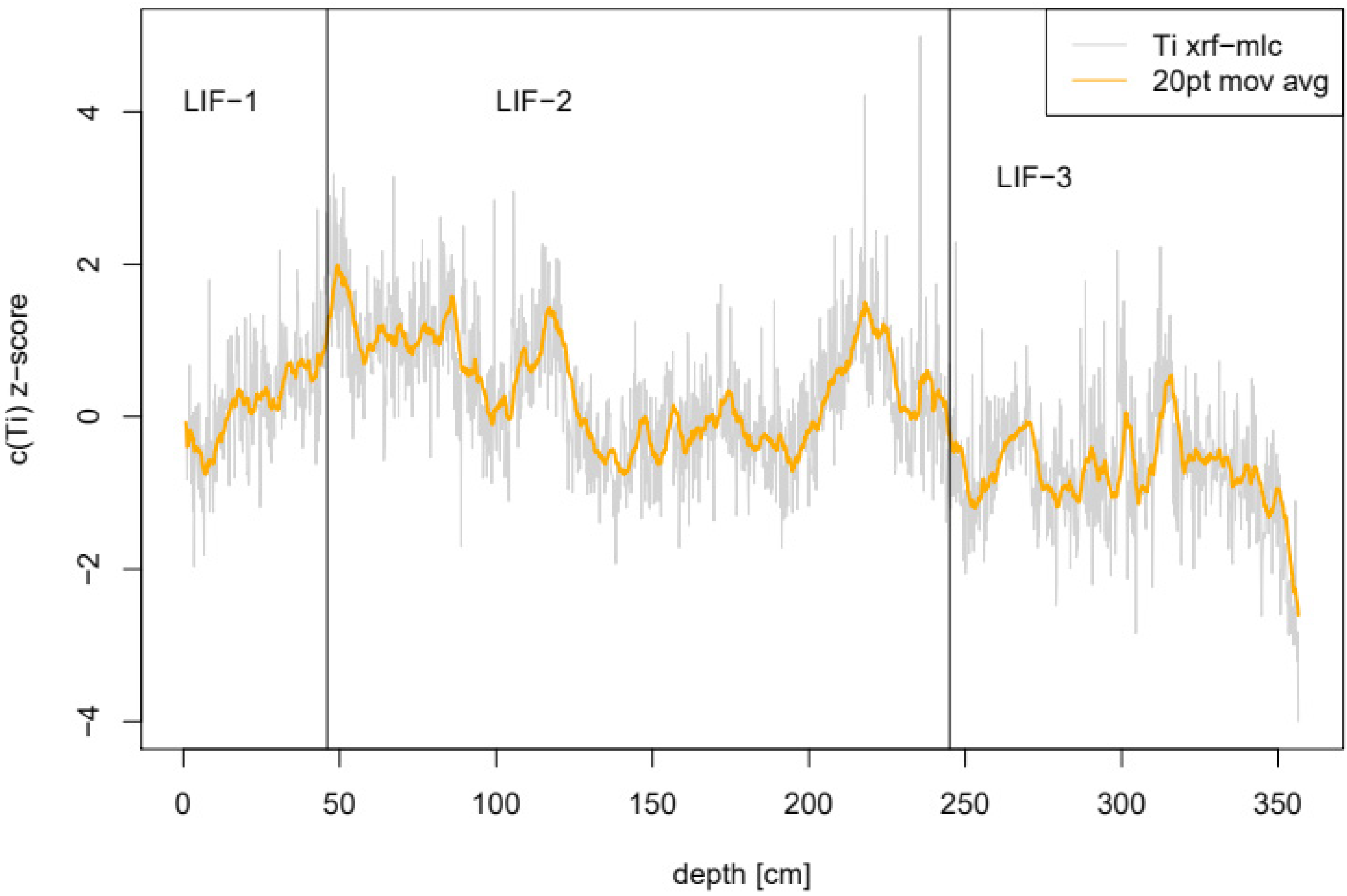

Figure 3. Standardised calibrated Ti concentrations from XRF measurements. Unsmoothed concentrations shown in grey, with smoothed data in orange.

sequence accumulated in 378 yrs. Based on this, the average accumulation of LIF-1 is 0.86 cm/yr , LIF-2 is 2.92 cm/yr and LIF-3 is 0.17 cm/yr. The age-depth model of our core gives accumulation rates largely in line with accumulation ratios reported for glacial Hvítárvatn at Langjökull in central Iceland (Larsen *et al*., 2011; Geirsdóttir *et al*., 2013). Sedimentation rates for south-east Greenland show an increasing trend from 0.5 to 1.4 cm/yr for the last 500 years, with a drop about 200 cal yr BP and an absolute peak in the first half of the 20th century (Balascio *et al*., 2015).

Significance

Our preliminary results indicate the disappearance and reformation of small, climatically sensitive cirque glaciers in Vatnsdalur. We interpret the data to show an abrupt return to a glaciated catchment during in the last 200 yrs, coincident with the Little Ice Age. Our results fill a geographical gap of high-resolution proglacial sediment studies in the Arctic-North Atlantic region.

References

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