# A temporal sediment record of microplastics in Haukadalsvatn, Iceland

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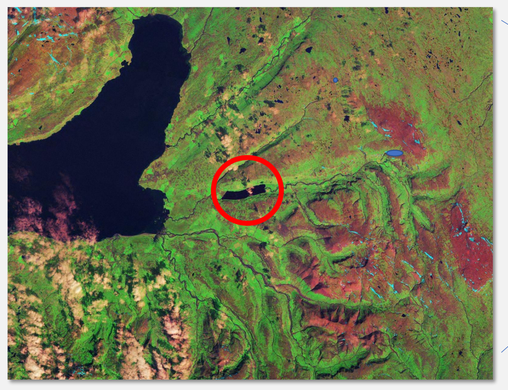
## Introduction

The atmospheric transport of microplastics (MPS) is still poorly understood but data exist indicating the capability of MPS to travel by air (Allen et al.). Data regarding the deposition of MPS in Sub-Arctic/Arctic areas is seriously lacking. The team capitalize on the fact that Icelandic lake basins act as sinks, preserving valuable information on climate and environmental changes through time due to the continuous, high-resolution sediment accumulation (Geirsdóttir et al., 2019). The exceptionally secure age models depend on the high sedimentation rates, radiometric age determination (210Pb/137Cs) and the well-known historical tephrochronology of Iceland. Analysis of the sediment's organic geochemistry provides proxy information on pollutants occurrence evolution within the catchment and in the lakes. In the presented study the team analyses MPS in dated sediment layers of lake Haukadalsvatn, with the aim to identify the first MPS in Icelandic environment as well as providing important information on the time related deposition rates, size and polymer type distribution.



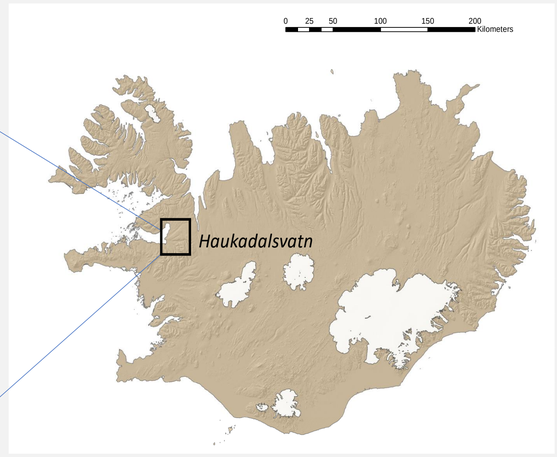



Fig. 1- Location of Haukadalsvatn where the lake sediment core was obtained and subsampled for MPS

## Materials & methods

**Sampling and age determination:** The lake (3,2 km$^2$ max depth 40m) is located the west of Iceland (Fig. 1), 140 km northwest from Reykjavík. A sediment core (diameter: 7 cm, length: ~1m in) was obtained in the year 2003 following Glew (1991), to capture the sediment-water interface and undisturbed upper sediments plus the last approximately 100 years (Fig. 2; Geirsdóttir et al., 2009). The sediment core was sampled every 2.5 cm for 210Pb and nearly every centimeter through the key time interval for 137Cs. 210Pb was measured by alpha spectrometry (Eakins and Morrison 1976). Unsupported 210Pb calculated by subtracting supported activity from the total activity measured at each level and dates determined according to the constant-rate-of-supply model (Appleby 2001). 137Cs activity was measured using an Ortec-EGG high-purity, germanium crystal well, photon detector coupled to a digital gamma-ray spectrometer. Maximum deposition of 137Cs associated with above ground nuclear bomb testing occurred during the period 1963–1964. Tephra layers were identified visually within the sediment cores; tephra from key horizons were taken for analysis by electron microprobe CAMECA SX50. The geochemical composition of the tephra layers was then used to identify the source volcano and eruption according to Jóhannsdóttir (2007) and Harning et al. (2019).

**MPS analysis:** 51 sub sections (2,5 cm) of the initial core were obtained and pooled to obtain 11 composite sediments samples, covering a time series of ≈ 10 years. This allowed processing ≈. 100 gr per sample. MPS were extracted by a density separation with $ZnCl_2$, filtration through 1 µm stainless steel filter, multi-step procedure based on combined enzymatic and oxidizing treatments (Gomiero et al., 2019). Enzymes from Sigma were filtered on 0.7 µm (Whatman™ GF/F ™) and stored in sterile containers. The obtained purified extracts where deposited on a ZnSe window and scanned by a Nicole iN10 Infrared Microscope (ThermoFisher). Dust traps were used to evaluate possible contamination from airborne particles and procedural blanks were analyzed as part of the QA/QC procedures.

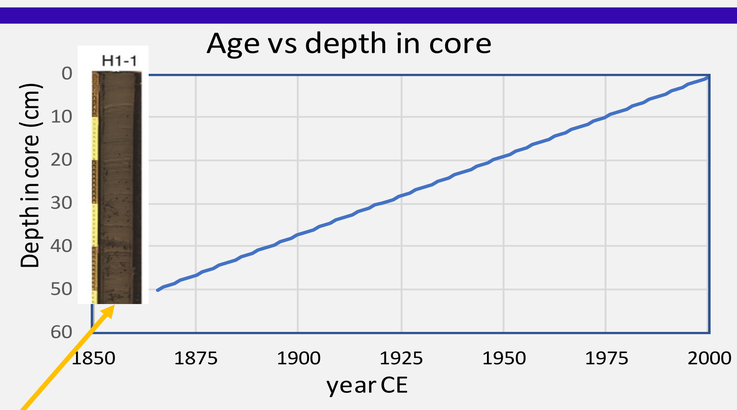




Fig.1 – - Age vs dept of the investigated core.

## Results

The first 2,5 cm layer was dated as 2002 and the last (at 49,51 cm depth) as 1865. A total number of 22 polymer types were characterized. The earliest occurrence of plastic material identified in the composite sample covering the time span 1942 - 1952 were celluloid (CL) particles and rayon's fibers (RA). On a later stage in the sediments dated as from 1953-1964, the appearance of Bakelite (BaK) particles, polyvinyl acetate (PVA) and polyvinyl chloride (PVC) is recorded (Fig. 3). Since 1974, nylon (Ny), polyethylene (PE), cellulose acetate (CeA), polystyrene (PS) and polypropylene (PP) made their stratigraphic appearance. While the latest entry polymer types such as polyurethane (PU), polyacrylates (PCy) and polyethylene terephthalate (PET) appeared in the 1986-1992 composite sediment sample. Overall, on average 62% of the characterized particles were within 40 and 60 µm size range while the smallest were 20 µm (the limit of detection) and the largest 197 µm (Fig.2). The total number of particles progressively increased through time starting by 0,3 particles/g (DW) in the 40's up to 9 particles/g (DW) in the 90's.

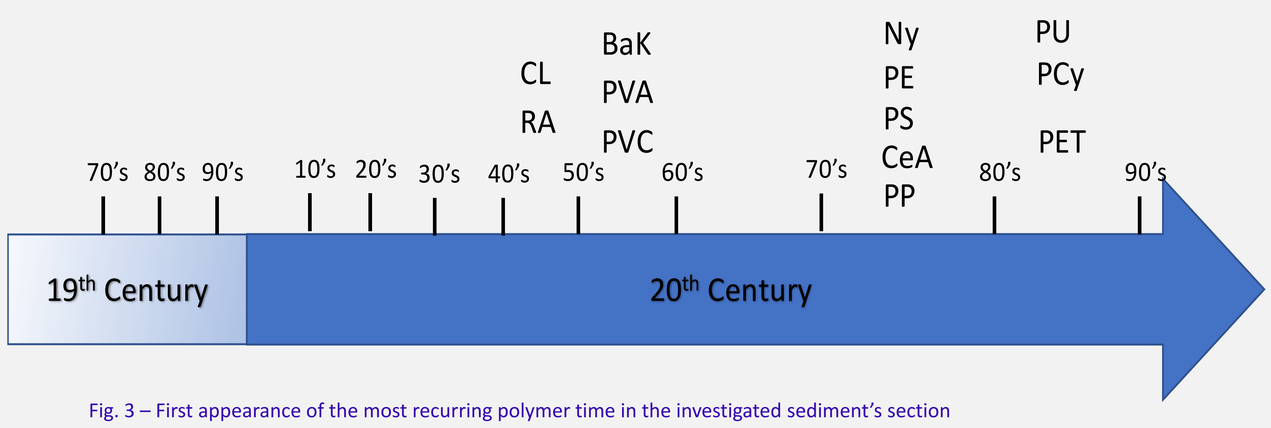



Fig. 3 – First appearance of the most recurring polymer time in the investigated sediment's section

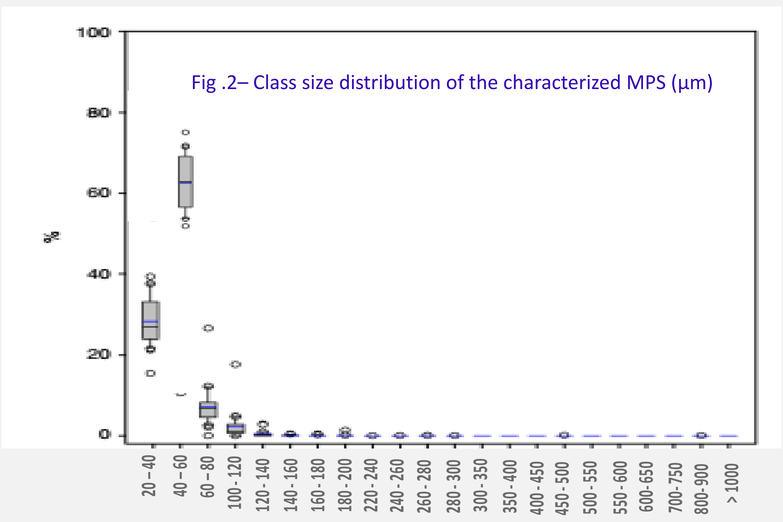



Fig .2– Class size distribution of the characterized MPS (µm)

## Discussion and Conclusions

The observed polymers' appearance sequence corresponds with the start of global mass production, use and waste-generation of plastic (Zalasiewicz et al. 2016; Geyer et al. 2017). Once accumulated within sedimentary strata, plastic particles are likely to have a variable, but generally good preservation potential. The results of the present work indicate that plastic particles are already present in enough numbers to be considered as one important permanent record of human presence on Earth. The current advances in sediments temporal trend analysis and polymer type chemical characterization enables the assessment of plastics in sedimentary strata in lake sediments in sparsely populated Arctic/Sub-Arctic regions. This offers a unique opportunity to investigate the temporal trend in plastics distribution as well as changes in the deposition rates. The support of imaging FTIR includes the far more informative infrared region of the spectrum from the very onset of the analysis and enables the detection of particles down to 20 µm, which are likely overlooked by visual inspection and therefore not included in the majority of the previously published studies in the field.

## References

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