An Icelandic glacier in the Anthropocene: The story of Sólheimajökull

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Glaciers around the world are retreating at an accelerating rate as a result of climate change. As the ice melts and exposes more land, bacterial populations in the soil change in response to their new environment. We are exploring the evolution of microbial populations at one of Mýrdalsjökull's outlet glaciers, Sólheimajökull, in southern Iceland using 16S rRNA analysis. We use historical accounts, GIS models, and in-field lichenometry to assign date ranges for each sample spot in the forefield. We aim to characterize how the glacier and underlying microbial population have evolved over the past 100 years.

Method

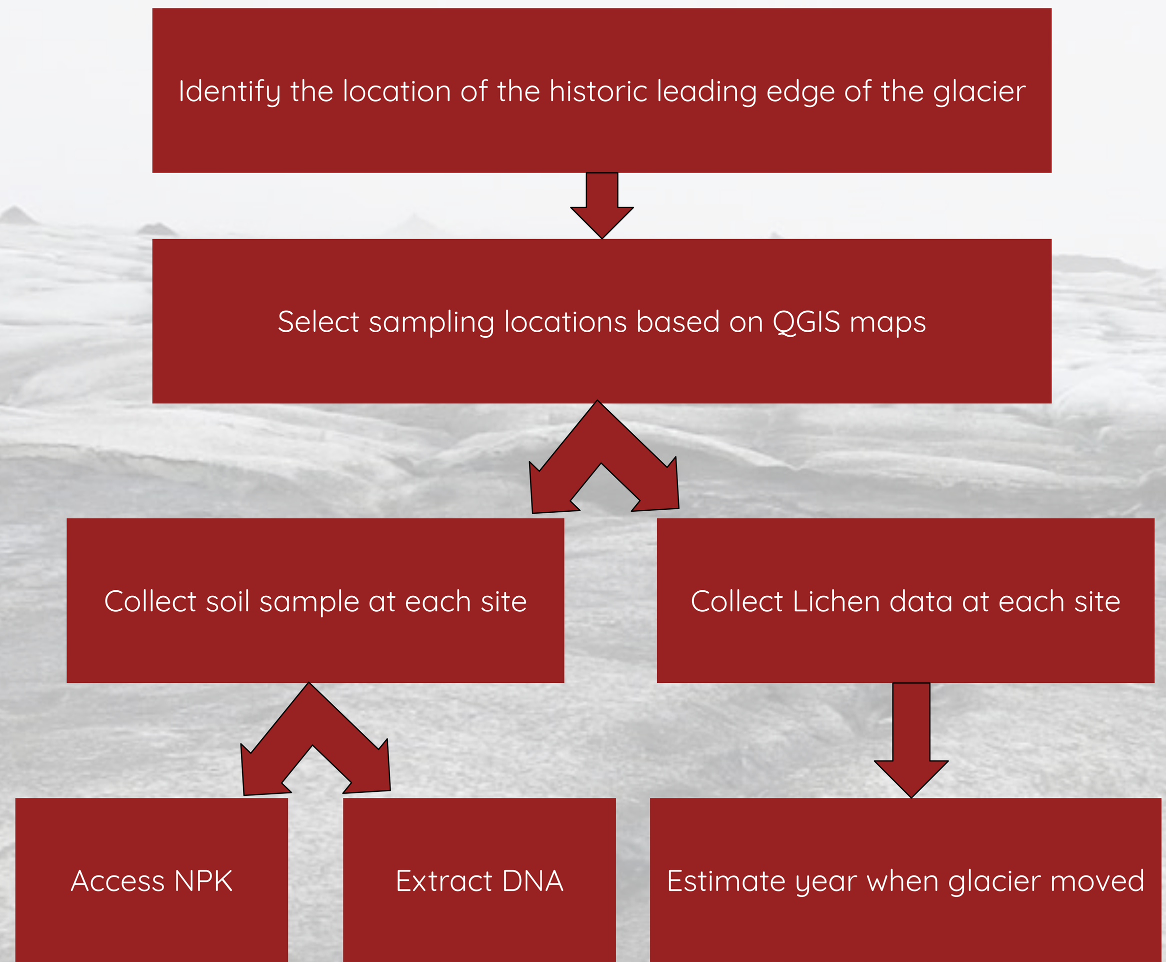

Figure 1: Flow chart representing our research methodology.

Mapping and Sampling at Sólheimajökull

By examining the location of the glacier over a period of time, and reading several written accounts, we used layering withing QGIS to determine when specific areas were first exposed. We select sites that have been exposed for different amounts of time, ranging between 20 and 100 years.

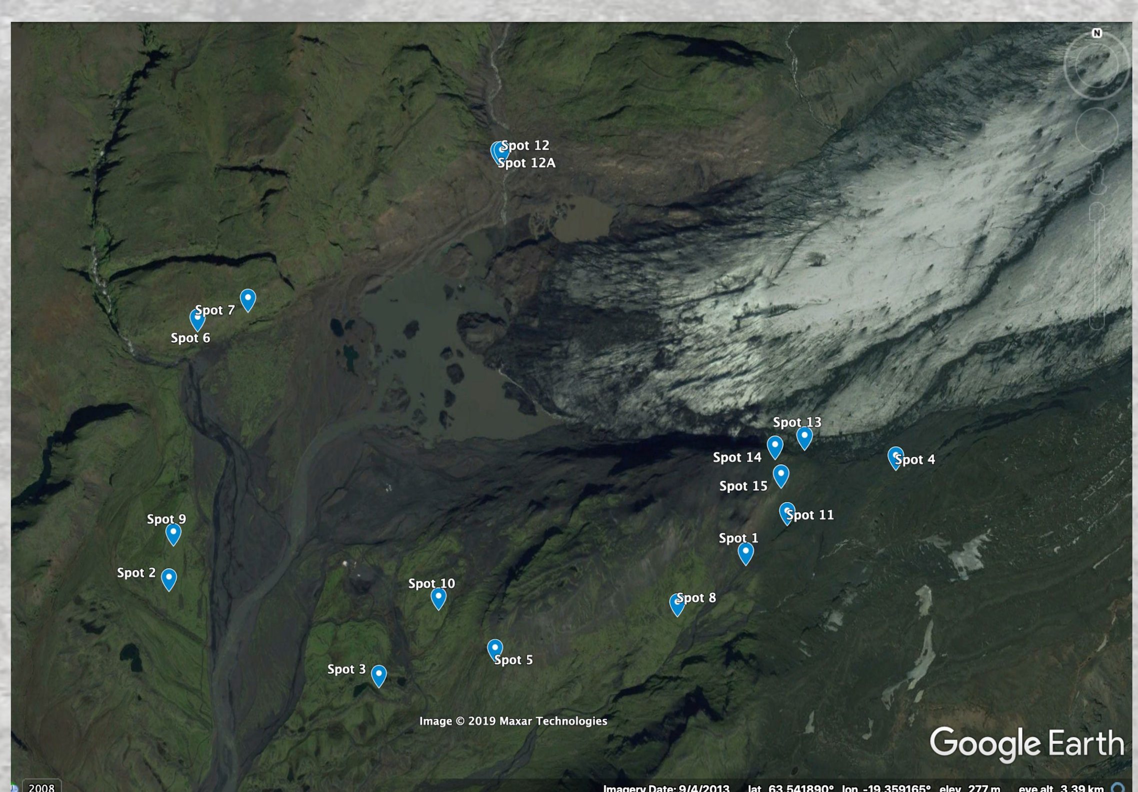

Figure 2: Google Earth map of sampling locations. Each placemark represents a location where a sample was collected.

Figure 3: Collecting soil samples. Teams hiked to each location and used sterile techniques to collect soil samples. Lichen size on a nearby rock was measured and recorded. Field Day was used to record images and meta-data.

Dating Sólheimajökull Moraines with Lichenometry

As the terminus of a glacier retreats, it leaves behind material, creating end moraines. We were able to study the relative ages of these end moraines using lichenometry. Lichenometry is a geomorphological dating technique based on the size of lichen growing on a substrate. The lichen species *Rhizocarpon geographicum* (map lichen) grows at a relatively constant rate. We measured lichen on boulders close to our sample sites to confirm our dates.

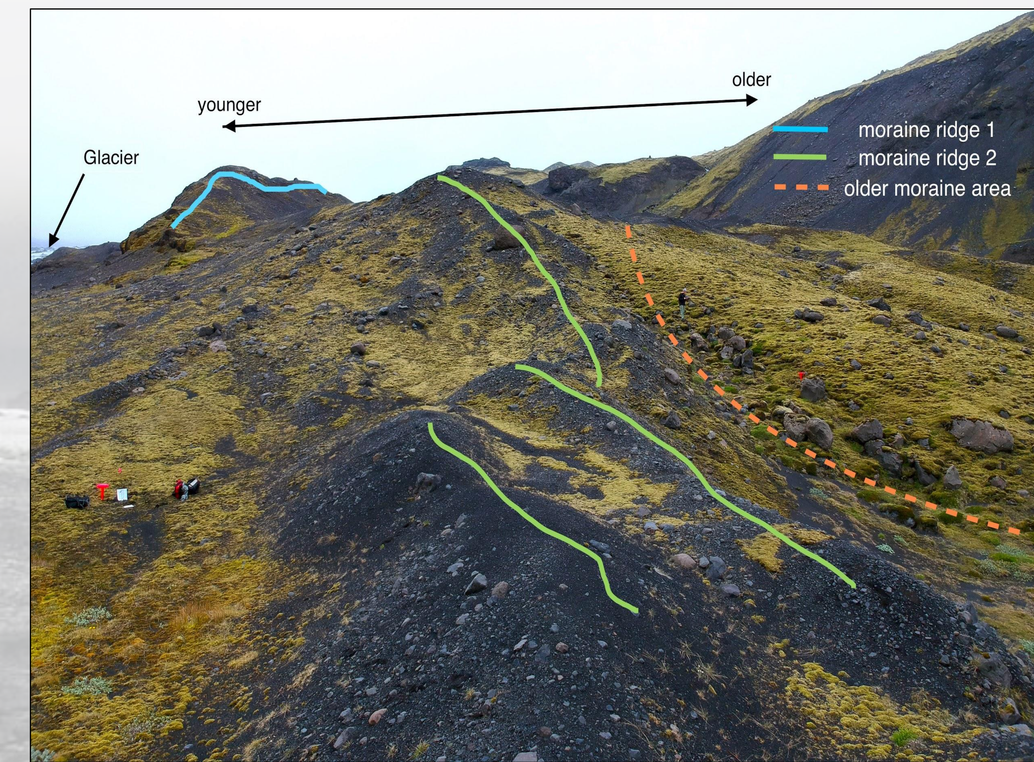

Figure 6: Lichenometry Method. Based on the work of Evans *et al.* at Mýrdalsjökull we were able to use their calculated lichen growth rate of .8mm/year. This information allowed us to measure the longest axes of lichen found on glacial erratics and calculate the relative ages between certain moraines.

NPK and pH Measurement

After sample preparation we measure the nitrogen (N), potassium (P) and phosphorous (K) content and pH of each sample using LusterLeaf's Rapidtest kits. Soil is dried in an oven and sifted to separate soil from rocks and other contaminants. The concentrations are ranked from 0-4 using a visual scale. Icelandic soils are known to be poor in nitrogen, as seen in our data. Most of our samples were high in phosphorus and varied in potassium.

Spot ID	Nitrogen (N)	Phosphorous (P)	Potassium (K)	pH
1	0	4	4	7
2	0	4	3	7
3	4	0	0	7
4	0	4	0	7
5	0	4	1	7
6	0	4	3	7
7	0	3	9	7
8	0	1	0	7
9	0	4	0	7
10	0	4	1	7
11	0	4	3	7
12	0	4	3	7
12A	0	4	4	7
13	0	4	4	7
14	0	4	1	7
15	0	4	4	7

DNA Extraction and Future Work

We are currently extracting DNA from our 2019 samples. Once this DNA is sequenced, we will use Mothur, a 16S rRNA analysis tool, to learn what types of bacteria are present at each location, and in what amounts. We will continue to monitor the changes of these microbial populations over time to learn how the soil recovers as the glacier retreats.

Acknowledgements: Gummi Magnússon, IFS students & faculty from 2013 to 2019.

Evans, D. J. A., Archer, S., & Wilson, D. J. H. (1999). A comparison of the lichenometric and Schmidt hammer dating techniques based on data from the proglacial areas of some Icelandic glaciers. *Quaternary Science Reviews*, *18*(1), 13-41.