Cryoconite: Small particles, big impact

Introduction

Have you ever wondered where the dark spots on glaciers come from? They are called cryoconite and consist of tiny particles that collect on glacier surfaces in summer. The word comes from ancient Greek: *krýos* means ice and *konía* means dust.
Cryoconite consists of a mixture of organic materials such as algae and bacteria and inorganic materials such as rock dust.

The Dachstein glacier in winter (left) and in summer (right) - the dark deposits are clearly visible.

But why is cryoconite so important?
It plays an important role in glacial melting. The dark color of rock dust and algae absorb sunlight. Instead of reflecting the light, as white snow does, cryoconite particles absorb the energy of the sunlight and thus warm the surface of the glacier. This causes the ice to melt more quickly.

The composition of cryoconite is crucial to its effects. When algae and bacteria multiply in the cryoconite particles, more dark spots are created and absorb even more sunlight. This increases the melting process. These algae can also release nutrients that favor the growth of other types of algae, which promotes the melting.

Research on cryoconite is important to understand the complex interplay between organic and inorganic materials and to find possible solutions to limit glacier melt. After all, the better we understand the role of cryoconite, the better we can take action to mitigate the effects of climate change on our glaciers.

In the following experiment, we determine the organic part of the cryoconite (the part that consists of algae and bacteria) and determine the composition of the inorganic part (that is the part that consists of rock dust).

picture: https://glaciereducation.com/wp-content/uploads/2023/05/Winter-Sommer-scaled.jpg

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Instructions

Material

- Water jet pump
- Suction bottle
- Rubber seal
- Buechner funnel
- Filter paper
- Porcelain crucible
- Cartridge burner
- clay triangle
- Tripod
- Scales
- Spatula
- Hydrochloric acid
- Cryoconite sample
- Rocks for comparison

Instructions

1) Filter your cryoconite sample and allow the filter and residue to dry.
2) Weigh a porcelain crucible and note the mass m_{empty}.
3) Carefully scrape the residue off the filter and pour it into your crucible.
4) Weigh the crucible and its contents again (m_{full}) and determine the mass m_1 of the cryoconite.
5) Now ash your sample: Place the crucible in a clay triangle over a cartridge burner and ignite it.
6) After about 5 minutes, take the crucible out of the fire with a crucible tongs (turn off the cartridge burner!) and let it cool down. Determine the mass.
7) Place the crucible in the fire for another 2 - 3 minutes and determine the mass again. If the mass has not changed, you can determine the final mass of your sample m_2.
8) Put a little bit of your sample on a Petri dish. Carefully drop some hydrochloric acid into it.
9) Smoldering test: Light a wooden stick, blow it out and hold the still glowing part directly over the reacting sample (you may have to add some hydrochloric acid).

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Evaluation sheet

Observation

1) Describe how the cryoconite sample changed during the ashing process. Describe the change in mass, colour and smell.

2) Describe what you could see and hear when you dropped the hydrochloric acid on your sample.

Results

1) The organic part was burnt through the ashing. What remains is the inorganic part m_2. Calculate the percentage of the organic material.

Part of the cryoconite consists of dust and small stones from the surrounding rocks. In the Alps, these rocks consist to a large extent of lime - or as we chemists call it: Calciumcarbonate ($CaCO_3$).
When lime reacts with hydrochloric acid, calcium chloride ($CaCl_2$), water and a gas are produced, which you detected with the smoldering test.
Which gas was produced?

2) Formulate a reaction equation that describes the reaction of lime with hydrochloric acid.

To Dos

Glacial microbiologist Joseph Cook studies organisms that live on the surface of ice sheets. One of these organisms is an algae that produces a dark dye. Cook says "These algae are like a black T-shirt for the glacier [...]". Discuss this statement and the influence of such organisms in relation to glacier melt. Tip: Remember the experiment on albedo.