Experiment 3: Permafrost and buildings in high mountains

In the section of „permafrost, rockslides, debris flows" (experiment 1) the term permafrost has already been defined. Additionally, the consequences of melting permafrost caused by the rising temperatures have also been discussed. Here is another experiment that you can try out.

Certainly you know that people also construct buildings in the high mountains for example lodges, transmitters or buildings in the skiing sector like brackets of ski lifts. Of course these buildings can be constructed on an underground where permafrost is located. If the ice in the substratum melts the underground as well as the buildings above can get instable.

With the following experiment you can try out what happens if permafrost melts:

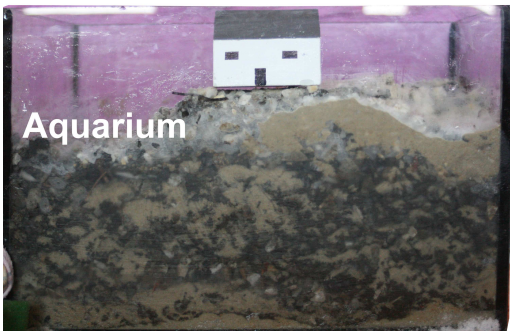
Material:

- stones, grit and water
- aquarium
- a model of a building (e.g. a self made transmitter, a small toy house etc.)
- water nozzle or a spray filled with water
- infrared lamp as the "sun"

How to do it:

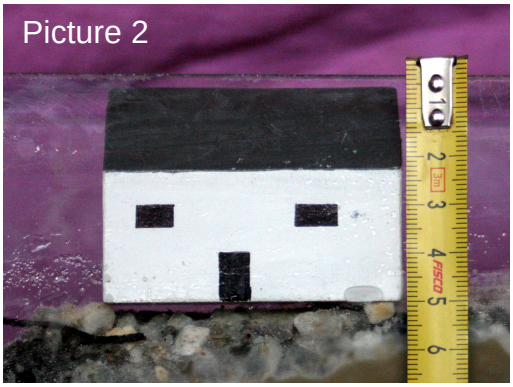
1st step:
Fill two-thirds of a small aquarium with little stones and grit and form an undulated surface.

Picture 1



2nd step:
Now fill the aquarium with water so that all hollows between the stones and the grit get filled with the water. Only use as much water as necessary to cover the stones. Our self made underground should not be underwater or flooded.

3rd step:
Construct a flat underground at the peak of the undulated surface on which you place your building.



4th step:
Now the aquarium should be put into the fridge for at least one day. Because water extends when it freezes, the whole stone-grid-mix gets boosted. This is because the ice in the hollows gets pulled apart. This phenomenon is called frost heave and it also happens in nature in the high mountains.

5th step:
Put the building on the ground you built before (picture 1). It needs to stand straight.

6th step:
If you hang a measuring tape beside the aquarium (as you can see in picture 2) you can see how the house lowers.

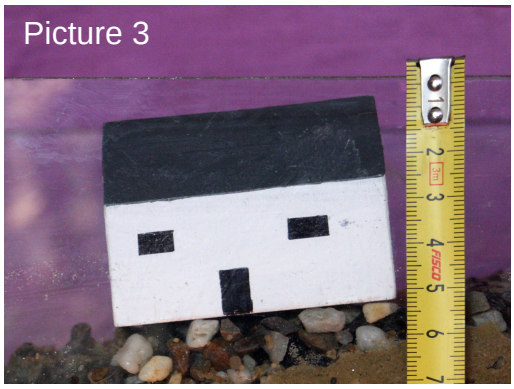
7th step:
Now the melting can begin. This can take quite a long time and therefore, you can speed up the process by heating up the aquarium with a hairdryer or a heating lamp.

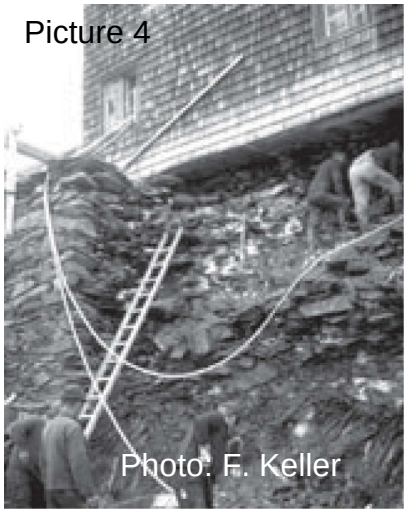
8th step:
Observe how the ground and the building change. Because this can take up to several hours it would be a good idea to look at the aquarium a few times over the day. If the experiment succeeds, you will find the building a little bit lower and aslope. This happens because of the melting of the ice the ground starts to sink (picture 3)

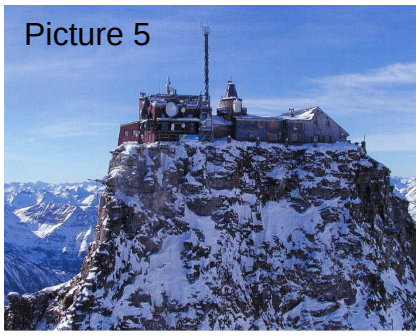
The success of the experiment depends on the stratification of the stones. Therefore, it might happen that the experiment will not succeed the first time. If the stones are to stable wedged together, the surface will stay the same. However, it is much more instable and it easier slumps afterwards. With the water nozzle you can simulate rain and trigger a slide.

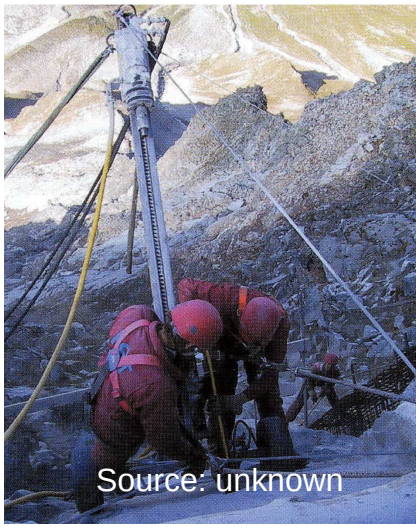
There have been cases where buildings were affected by melting permafrost in the high mountains of the Austrian Alps. Here are two examples:

1. Parts of the “Erzherzog-Johann-refuge” subsided on the Adlersruhe (in 3454 meters above the sea) on the Großglockner. This happened because of the melting underground. Picture 4 shows this lodge with the ice in the underground.
2. On Sonnblick (3106 m above the sea) the summit needed to be stabilized with a high technical effort by concrete-injections so that the observatory on the peak of the mountain was save again (picture 5).


Picture 3


Picture 4
Photo: F. Keller


Picture 5


Source: unknown