Subterranean periglacial landforms in Ledena jama pod Hrušico cave, Slovenia

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Background

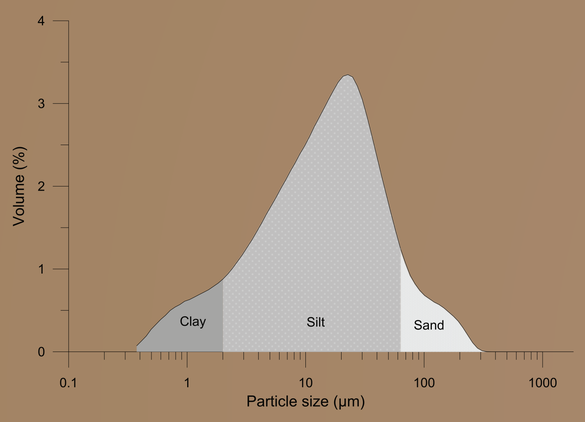
In ice and cold caves, ground temperatures can drop significantly below the average air temperatures. Low temperatures are a consequence of specific microclimatic conditions related to air circulation, where winter air is entering the cave but the influence of summer warm air is limited. Such low temperatures can support existence of a periglacial environment and ice bodies. Periglacial features such as sorted circles and stripes have been observed in some of the ice and cold caves of Slovenia.

Study site

The ice cave *Ledenica pod Hrušico* is located 750 metres above sea level on the Hrušica karst plateau in the Dinaric Mountains of Western Slovenia. It formed in Cretaceous limestone by a subsurface stream that also transported and deposited fine sediments. The cave consists of a single passage in the NW-SE direction and was formed along bedding planes. It is 30 metres deep and 60 metres long, and accessible through a ceiling collapse with vertical walls (see cave map). A debris cone under the entrance shaft consists of boulders, organic debris and perennial ice.

Sediment properties

The fine sediment present in the cave was likely deposited by a sinking stream that transported sediment from adjacent impermeable flysch rocks. This sediment is abundant in part of the SE passage, where it rises from its foot to completely fill the back of the passage. Silt is the prevalent grain size of the sediment, which makes it very frost-heave susceptible.

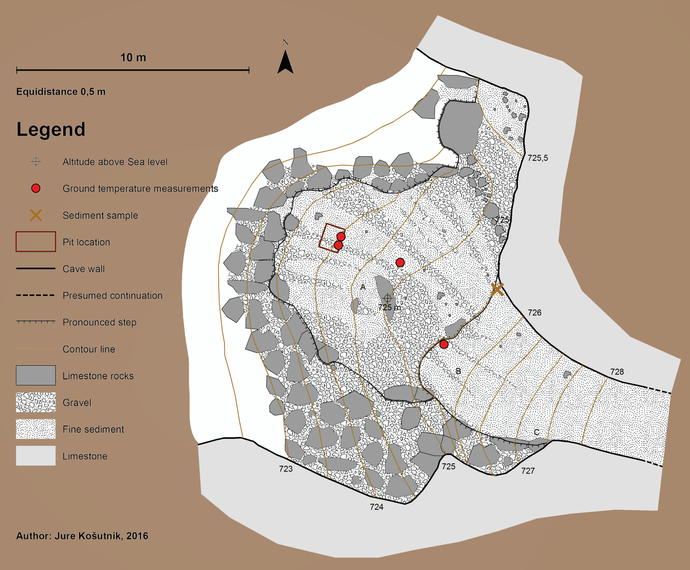


Patterned ground

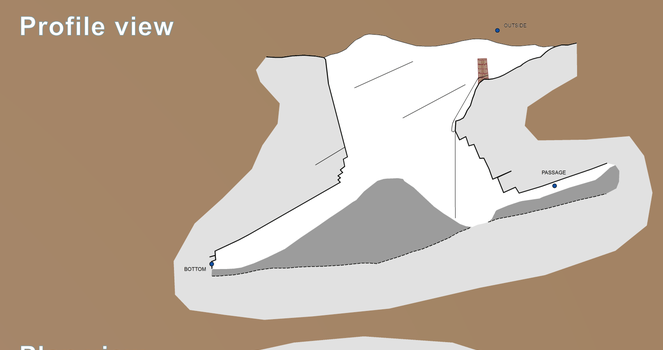
SE passage with cave sediment and sorted stripes

Side view on sorted stripes

The SE passage slopes towards the debris cone at between 10 and 20°. The fine-grained sediment is mixed there with coarse autochthonous limestone debris. Several sorted stripes, a few decimetres wide, have developed on this slope. Simple feature tracking showed that material is moving downslope several centimetres per year. The thickness of fine sediment is approximately one metre. No permafrost was observed at this depth (temperature in August was around 4°C).



Cave map

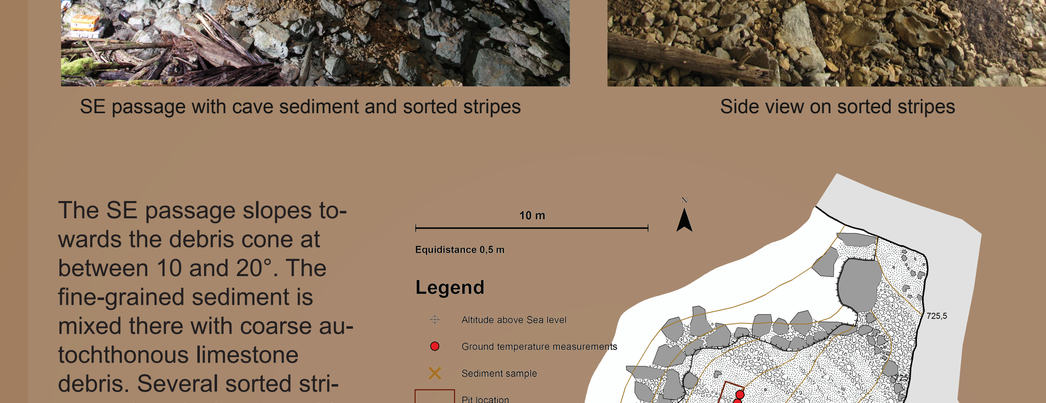


Entance shaft

Debris cone under the entrance shaft

Air temperatures

Air temperatures were measured at three different locations; outside, in the passage and in the bottom cave part (see cave map). The results show that cave air temperature remains relatively constant during the summer, when the cold air is trapped in the cave. Opposite to that, cold winter air enters the cave when outside air temperature drops below the cave air temperatures. Its morphology and air temperature characteristics classify it as a static ice cave. Temperatures in the winter of 2013 showed frequent temperature oscillations around 0°C, which are crucial for freeze-thaw cycles.



Outlook

The *Ledenica pod Hrušico* cave offers a unique opportunity to study patterned ground, since environmental conditions are less variable than outside the cave. For this reason the factors controlling cryoturbation and ground sorting can be identified and monitored easily. The following activities were undertaken in summer 2015 or are planned for the future:

- Installation of several temperature sensors in a vertical profile that would enable better understanding of relation between cave and outside air temperature.
- Ground temperature monitoring at different depths separately in coarse and fine parts of the patterned ground (see the figure of patterned ground).
- Particle motion detection using photogrammetry for identifying the rates of debris movement.
- Detailed sediment analysis for identifying the role of sediment properties in ground sorting.

UiO : University of Oslo

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