Teachers' Guidelines

Title of the package: Caves and humans

Information about the package:

Brief description: Caves are naturally formed voids in rocks of such size that a person can enter them (crawl, squeeze in, but also run or climb up, seeing with difficulty their walls and ceilings in the light of even strong lamps). It is a mysterious world of corridors, halls, vertical wells and rising chimneys, underground rivers and lakes; a world in which one can still be an explorer and set foot as the first man.

How does the package relate to STEAM education: The package deals primarily with issues related to Earth sciences (*science*). It introduces the distribution of caves in different parts of the world, their types, and also focuses on explaining what karst and pseudokarst phenomena are.

Keywords: karst, karst caves, glacial caves, karst phenomena, cave exploration, speleology

Age range: 14-18

Didactical hours: 2 hours + "Activities" section that might be treated as e.g. homework

Learning objectives:

Student will:

- name several types of caves and indicate their locations on the map
- understand what karst phenomena are and explain the chemical reaction that is responsible for them
- knows that phenomena similar to karst (so-called pseudokarst) occur in other materials, e.g. glacier ice

Content of the package and guidelines for teachers:

Link to the package: https://graasp.eu/s/0hx6at

We encourage teachers to copy the graasp package to their own graasp space to become "owner" and modify the content, hide or unhide some materials, add quizzes, etc. Moreover, teachers may share the package with their students and check the progress of each student.

A short video tutorial on how to do it is available at:

https://view.genial.ly/5f7ef81f1b2b330d2efa3411/video-presentation-tutorial-graasp

If you don't have access to the graasp package, contact us: **edukacja@igf.edu.pl**

The package consists of 8 sections described in detail below:

1. **Introduction**

Students will read a brief overview of human activity in caves and then watch a video that shows a cave explorer.

EDU-ARCTIC 2: from polar research to scientific passion – innovative nature education in Poland and Norway receives a grant of ca. 240 000 EUR received from Iceland, Liechtenstein and Norway under EEA funds. The purpose of the EDU-ARCTIC 2 project is to: enhance the knowledge about nature, geography, natural resources, political specificities concerning polar regions and increase awareness of environmental issues and climate change, increase of interest in pursuing STEM education and careers due to enhancement of knowledge about scientific research, and their place in the modern world, familiarizing young people with scientific career opportunities; introduce innovative tools by way of an e-learning portal and effective methods of teaching science in schools.

Materials:

- Presentation “Caves and human” (slides 2-3)
- Film: https://youtu.be/KYijFbTreoc
- “Introduction” section on graasp.eu

Estimated time: 10 minutes

2. Going deeper

In this section, students will learn about the types of caves and what their characteristics are. They will have a task in which they have to compare two processes: suffosion and erosion, and a summary exercise about the types of caves.

Materials:

- Presentation “Caves and human” (slides 4-10)
- Worksheet ex. 1
- “Going deeper” section on graasp.eu

Estimated time: 20 minutes

3. Karst caves

This section is dedicated to karst phenomena - how and where they are formed and what karst forms we can observe. Students will learn that karst phenomena can occur not only in limestone, but also in other types of rocks. They will have two exercises to do - concerning a chemical reaction connected with karst phenomena and a task in which they should indicate basic karst forms on a drawing.

Materials:

- Presentation “Caves and human” (slides 11-17)
- Film: https://youtu.be/vAOcqHgwTfg
- Worksheet ex. 2 and 3
- “Karst caves” section on graasp.eu

Estimated time: 15 minutes

4. Glacier caves

This section of the toolkit concerns glacier caves. Students will learn what pseudokarst phenomena are and what glacial forms, caused by water activity, we can see.

Materials:

- Presentation “Caves and human” (slides 18-21)
- Glacial karst definition: https://polarpedia.eu/en/glacial-karst/
- “Glacier caves” section on graasp.eu

Estimated time: 20 minutes

5. Human in caves

From this section, students will learn about the importance of Denisova Cave in the study of human origins and learn about the oldest cave paintings made by humans. This topic will also be covered in an exercise in which students are asked to identify the location of the paintings.

Materials:

- Presentation “Caves and human” (slides 22-25)
- Film: https://youtu.be/ZjejoT1gFOc
- Worksheet ex. 4
- “Human in caves” section on graasp.eu

Estimated time: 10 minutes

6. Activities and Wrap-up

Section "Exercises" can be treated as additional homework, so the time to complete it depends on the form chosen by the teacher. The worksheets are available in two variants – less (No. 1 with hints) and more (No. 2 without hints) advanced. On the graasp.eu platform the more advanced version is in the section "Exercises for advanced", which is hidden and can be made public at any time.

Answers to some tasks can be found below in the "Answer Key".

Materials:

- Presentation “Caves and human” (slide 26)
- Worksheet ex. 5-10
- “Activities” and “Wrap-up” sections on graasp.eu

Estimated time: to be determined (“Wrap-up” ca. 15 minutes)

7. Additional materials

In this section there is a list of additional materials that may be useful to the teacher.

Materials:

- Presentation “Caves and human” (slides 26-27)
- “Additional materials” section on graasp.eu
- Aubert M., Lebe R., Oktaviana A.A., Tang M., Burhan B., Hamrullah A.J., Budianto Hakim A., xin-Zhao J., MadeGeria I., Hadi Sulistyarto P., Sardi R., Brumm A. 2019. *Earliest hunting scene in prehistoric art*, Nature, 576 19/26 Dec. 2019, https://doi.org/10.1038/s41586-019-1806-y.
- Aubrecht R., Brewer-Carías Ch., Šmídac B., Audy M., Kováčike L. 2008, *Anatomy of biologically mediated opal speleothems in the World's largest sandstone cave: Cueva Charles Brewer, Chimantá Plateau, Venezuela,* Sedimentary, Geology 203:181-195.
- Audy I., Audyova J., 1993, *The Moravian Karst*, Time and Stone, FORMAT, Boskovice.
- Bennett P.C., 1991, *Quartz dissolution in organic-rich aqueous systems,* Geochim, Cosmochim. Acta 1991, 55(7): 1781-1797, https://www.sciencedirect.com/science/article/abs/...
- Blij de H.J., Muller P.O., 1996, *Physical Geography of the Global Environment*, JOHN WILEY & SONS. N. York.
- Bögli A., 1978, *Karsthydrographie undphysische Speläologie*, Springer – Verlag Berlin Heidelberg New York.
- Courbon P., 1972, *Atlas des grands gouffres du monde.*
- Cousteau J.Y., Diole Ph., 1971, *La vie et la mort des coraux,* Flamarion.
- Pontes H.S., Fernandes L.A., De Melo M.S., Guimaraes G.B., Massuqueto L.L., 2020, *Speleothems in quartz-sandstone caves of Ponta Grossa municipality, Campos*

Gerais region, Parana state, Southern Brasil, International Journal of Speleology 49(2): 119-136.

- Sauro F., Mecchia M., Piccini L., De Waele J., Carbone C., Columbu A., Pisani L., Vergara F., 2019, *Genesis of giant sinkholes and caves in the quartz sandstone of Sarisariñama tepui, Venezuela*, Geomorphology, 342, 223-238.
- Slee A., McIntosh P.D., 2019, *Are the orthoquartzite towers and caves on the Borradaile Plains, Tasmania, formed by dissolution and arenisation?* Helictite, (2019) 45: 27-37.
- Smida B., Brewer-Carias Ch., Audy M., Mayoral F., Baksic D., Vicek L., Stankovic J., 2010, *Churi–tepui Cave System: Iside the second largest quartzite caves in the world*, NSS News, July 2010.
- https://speleoatlas.ru/caves/veryevkina-5828
- USGS Scientific Investigations Report 2008 – 5023

Answer key:

Answers to the exercises 5-9 (Worksheet No. 1 and 2):

exercise 5

Solution:

h = 15 + 50= 65 [m]

V = (2 x 9,81 x 65) ^{½} = 35,71 m/s

If: outflow velocity 17,16 m/s gives the outflow volume 200 l/s, then, in proportion

17,16 : 200 = 35,71 : x

x= 416, 2 l/s

exercise 6

h= 15 + 100 = 115 [m]

V= (2 x 9,81 x 115)$^{1/2}$ = 47,5 m/s

17,16 : 200 = 47,5 : x

x= 553,61

exercise 7

Outflow velocity:

17,16 : 200 = x : 450

x = 38,61

38,61 = (2 x 9,81 x X) ^{½}

(38,61)^2 = 19,62 X = 75, 99

So the level should be higher p 60,99 m

exercise 8

1. 1 cm on a map at a scale of 1:25000 is 250 m in the field
2. So 1cm^2 area on a map is 62 500 m^2 in the field
3. Depression area is 16,55 x 62 500 = 1 034 375 m^2
4. Volume of compacted snow is 1 034 375 x 1,30 m^3 = 1 344 687,5 m^3

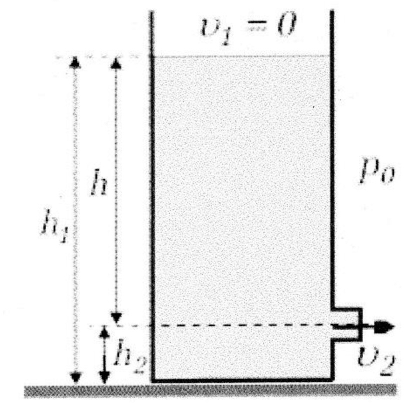
5. The equivalent amount of water is 1 344 687,5 x 0,350 = 470 640,632 m^3 of water
6. Respectively for snow compacted by the wind:
   1 034 375 x 1,75 x 0,2= 362 031,25 m^3 of water
7. In total 832 671,825 m^3 of water has gone

exercise 9

Assuming that the outflow follows Torricelli's law, the outflow velocity is:

$$\upsilon_2 = \sqrt{2 \cdot g \cdot h}$$

Where: V - outflow velocity [m/s], g – standard gravity 9,81 [m/s^2], h - height [m]



For an outflow area of 146.0 m, the discharge velocity will be 53, 521 m/s.

With an exit channel cross-section of 1 m^2, 53.521 m^3/s will flow through it.

It would take only 15,558 s, or 259 minutes and 18 seconds, or 4 hours 19 minutes and 18 seconds for the entire volume of meltwater to run off while keeping the well completely filled.

<u>Answer to the exercises 10 (Worksheet No. 2):</u>

exercise 10

For this to happen, 53.521 m^3 of water per second would have to flow into the well. Assuming that the average density of snow was 300 kg/m^3, 160 m_3 of snow would have to melt every second, i.e. 0.15 mm of snow would have to be lost for every square meter of the depression area. The melting of such a quantity of snow seems probable, while the runoff of such a layer of water from the depression area is not. It seems that the runoff of such amount of water could be an episode at the end of the ablation period when the surface runoff network is well developed on the depression surface (supraglacial streams).