Cave of the Winds Activity Seven: It's a Small World

Lesson for Grades 6-8
One 50 minute class period

Satisfies Colorado Model Content Standard for Science:

Standard 1, Benchmark #2 for grades 6-8. Use appropriate tools, technologies and metric measurements to gather and organize data and report results.

Standard 3, Benchmark #8 for grades 6-8. There is a flow of energy and matter in an ecosystem (for example: as modeled in a food chain, web, pyramid, decomposition).

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Objectives

Students will:

1. Describe various natural microclimates.
2. Explain why caves are microclimates.
3. Search for and describe microclimates found around their school building.

Vocabulary

Circulation
Dense
Microclimate

Background

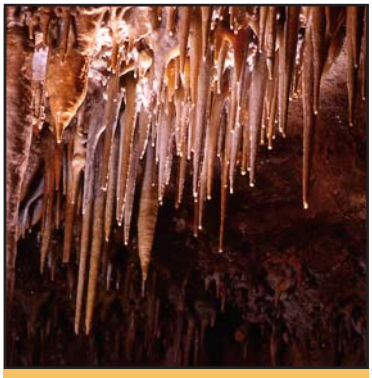
All caves have their own unique climates. These microclimates, as they are called, are determined by many factors such as entrance elevation, available moisture in the cave, shape and size of the passages, and mean annual temperature.

When air on the surface cools during the fall and winter months, it becomes more dense. As the air near a cave entrance becomes denser, it begins to flow into the cave and down. It will continue to flow deeper into the cave until it reaches the lowest level of the cave or meets a layer of air with the same density. Meanwhile, the air in the cave is heated by the surrounding rock, causing it to become less dense and rise. In this way, convective cells of air circulation are set up in a cave system. Cool, drier surface air sinks in along the lower portion of cave passages, while warmer, more humid air from the cave rises along the ceiling toward high points in the cave.

This seasonal inflow causes seasonal fluctuations in temperature and humidity along the main pathways leading to the depths of the cave. However, along some passages, such as blind passages that have an entrance, but no outlet, there is very little air circulation. In these areas, the annual temperature and humidity variations are minimal.

Local tectonics and stratigraphy play a major role in the availability of moisture in a cave. Perched aquifers can intercept infiltrating water above one section of a cave and divert it to another. Additionally, cracks in the bedrock, or joints, provide preferential pathways for groundwater flow. Frequently these joints will cut across a perched aquifer, providing a pathway for water to descend toward the cave. As the groundwater flowing along joints intercepts a cave passage, a wetter section of the cave will be formed. In that region, flowstone, stalagmites, stalactites, draperies, columns, pools, and rimstone dams may be abundant.

The entrance area of a cave is a special climate zone. The cooler temperatures, increased humidity, availability of water, and shelter of the rock make this zone a haven for desert wildlife. Cave swallows frequently build nests along the cliffs found around cave entrances. These birds can be seen returning from a day of feeding just as the bats that live in the cave are leaving for a night foraging in the desert skies. Ringtail cats, skunks, porcupines, squirrels, and snakes are just a few of the other animals that enjoy the special ecosystem that exists in a cave entrance. Insects, arachnids, arthropods, and many smaller creatures thrive in the entrance as well. Guano deposits usually mark the path leading from the bat roost area to the entrance. Within these deposits, a microscopic world of living organisms is found.



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Materials

Sling psychrometer (Celsius) ***NOTE: Alcohol thermometers are strongly recommended, rather than mercury!***
Thermometer (Celsius)

Procedure

Warm up

1. Ask students to estimate the temperature outside. Ask them to estimate the temperature inside the classroom. Ask them to estimate the temperature in the principal's office. Ask if they believe the air outside is more or less humid than the air inside.

2. Describe the concept of microclimates to the students. Point out that around a school, several microclimates can exist. On a hot, summer day, there can be a difference of several degrees between the hot, sunny, south side of the building and the comparatively cooler, shady, north side. Additionally, the humidity can vary in those areas as well. In this lab, students will look for several different microclimate zones in, and around, their school building. They will then compare those to the microclimates found in caves.

Activity

1. Have the students list several places around the school building where they believe differences in temperature and humidity may be found. As a class, or in groups, select three or four of those locations to study.
2. At each of those locations, record the temperature and the wet and dry bulb readings from the psychrometer. Remember, the fabric sock on the wet bulb of the psychrometer must be moistened prior to use, preferably with distilled water. The psychrometer must then be spun gently for several minutes and checked periodically. This continues until the wet bulb temperature stabilizes. ***(NOTE: Inexpensive sling psychrometers are available from several science supply houses. Some thermometers have a small eye at the top to which a string could be attached. However, this is not recommended, as these eyes tend to break fairly easily under these conditions. Simple student psychrometers can be built by taping, or gluing, small, inexpensive thermometers to a support, such as a thin piece of wood, and attaching a sock made of gauze to the bulb. The dry bulb temperature can be obtained from the regular thermometer being used to determine air temperature.)***
3. Once the students have obtained their data, they can determine the relative humidity of their microclimate zones by using the data table provided with the psychrometer, or the data table student worksheet provided in this lesson. On the data table, they will need to find the dry bulb temperature along the vertical axis. They will need to calculate the difference in the wet and dry bulb temperatures and find this value on the horizontal axis of the table. Once both numbers have been found, the relative humidity can be determined.

Wrap Up

1. Discuss any difference in temperature and relative humidity that the students observed.
2. Have the students attempt to explain why those differences were found. They should consider such things as shading, protection from wind, proximity to a source of moisture (leaky faucet, condensation dripping from evaporative cooler, evaporative coolers, etc.).
3. Have students list any factors they can think of that would be responsible for the existence of microclimates in a cave. Have them list and describe the consequences of several possible microclimates. As an example, a high amount of water and drier, inflowing air will result in increased evaporation and more speleothems.

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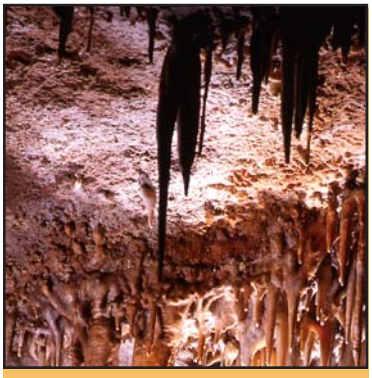

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4. End with a discussion of the various organisms that utilize the unique ecosystem and microclimate found in and near the entrance of a cave.

Assessment

Have students:

1. Describe several factors that contribute to the development of microclimates in caves.
2. Describe procedures and equipment that might be used by speleologists when studying microclimates in caves.

Extensions

Have students:

1. Use the equipment from this lab to study microclimates around their community and to evaluate the impact these microclimates have.

Resources

Feather, Ralph, et al. 1999. *Glencoe Earth Science.* Westerville, OH: Glencoe/McGraw-Hill. (Contains a lab activity for using a sling psychrometer on pp. 428-429, 719.)

Hill, Carol, 1987, *Geology of Carlsbad Cavern and Other Caves in the Guadalupe Mountains,* New Mexico and Texas. Socorro, NM: New Mexico Bureau of Mines & Mineral Resources Bulletin 117.

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Relative Humidity in Percent
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Dry Bulb – Wet Bulb Temperatures (°C)

T_{db} (°C)	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
2	84	68	52	37	22	8									
4	85	70	56	42	29	26	3								
6	86	73	60	47	34	22	11								
8	87	75	63	51	39	28	18	7							
10	88	76	65	54	44	33	23	14	4						
12	89	78	67	57	47	38	29	20	11	3					
14	89	79	69	60	51	42	33	25	17	9					
15	90	80	71	62	54	45	37	29	22	14					
18	91	81	73	64	56	48	41	33	26	19	6				
20	91	82	74	66	58	51	44	37	30	24	11				
22	91	83	75	68	60	53	46	40	34	27	16	5			
24	92	84	76	69	62	55	49	43	37	31	20	9			
26	92	85	77	70	64	57	51	45	39	34	23	14	4		
28	92	85	78	72	65	59	53	47	42	37	26	17	8		
30	93	86	79	73	67	61	55	49	44	39	29	20	12	4	
32	93	86	80	74	68	62	56	51	46	41	32	23	15	8	1
34	93	87	81	75	69	63	58	53	48	43	34	26	18	11	5
36	93	87	81	75	70	64	59	54	50	45	36	28	21	14	8
38	94	88	82	76	71	65	60	56	51	47	38	31	23	17	11
40	94	88	82	77	72	66	62	57	52	48	40	33	26	19	13
42	94	88	83	77	72	67	63	58	54	50	42	34	28	21	16
44	94	89	82	78	73	68	64	59	55	51	43	36	29	23	18

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