

Ice Cave Research Aids Management and Interpretation

Editor's Note: James Sleznick, Jr., superintendent of Lava Beds National Monument, sent the following article to Park Science, with the observation that "this information is extremely important to the interpretation of caves - even to explaining caves without ice. The temperature effects are due to the lava and the air circulation, and Charlie has definitely thrown into some doubt the old cave theories on which we had been basing our interpretation."

By Charles L. Arnold

Lava Beds National Monument presents a fascinating picture of the different kinds of cave temperature patterns that can be produced, depending on whether they are controlled by the surrounding rock temperatures or by air circulating through the caves. The following information, which I believe to be useful in both managing and interpreting the caves at Lava Beds, summarizes the early findings in five caves between July 1982 and April 1984. Valentine cave is used as the reference cave because of its unique characteristics.

To fully appreciate the wide range of cave characteristics at Lava Beds, a visitor should first visit Mush Pot, leaving Valentine till last. For a really well-rounded look at this Monument, the visitor also should visit the Lava Beds in winter.

Valentine is unique among the caves easily visited. Three characteristics distinguish it from the others:

- air circulation from outside is minimal;
- the temperature at the end of the cave is warmer in winter than in summer, and
- the cave is almost free of collapse rock.

Air from outside Valentine cave tends to circulate around the central pillar just inside the entrance. It penetrates the cave on the left as one enters; displaced air must leave the cave on the slightly higher right side of the entrance. This configuration limits the influence of air circulation to within approximately 300 feet of the entrance.

On a cold winter morning, the visitor may see a plume of steam rising from the cave mouth. Later in the day, when the plume no longer is visible from outside, the inside observer may notice a light fog as the circulating air leaves the cave.

Temperature changes at Valentine are unlike any of the other easily visited caves at Lava Beds. Near the entrance, the thermometer reflects the seasonal changes found in all the caves, but at the end of the cave (1,000 feet from the entrance) the temperature pattern is directly at odds with the season outside . . . colder in summer, warmer in winter.

Cave interpretation can include an explanation of this paradoxical phenomenon, starting with the 30-foot thickness of the lava that overlies the far end of Valentine cave. Summer heat and winter chill take approximately six months to work their way from the surface through the lava and into the cave. The result is that the warm wave of summer surface temperature arrives at the cave level in winter and the cold wave of winter surface temperature arrives in summer.

The uniqueness of Valentine's floor is its exceptionally clean condition. It consists of ropy lava, generally damp or wet, and is uncluttered except for a few blocks of collapse rock.

The following chart summarizes the difference between Valentine, where the surrounding rock temperature, which is 52 degrees, controls the overall cave temperature, and the rest of the caves, where air circulation is the controlling temperature factor.

	Observed		Annual Average
	High	Low	
Valentine	53	51	52.5
Sentinal (at steps)	51	36	42.8
(at bridge)	63	38	44.9
Indian Well	41	26	34.8
Skull	34	28	32.6
Merrill	34	30	32.5

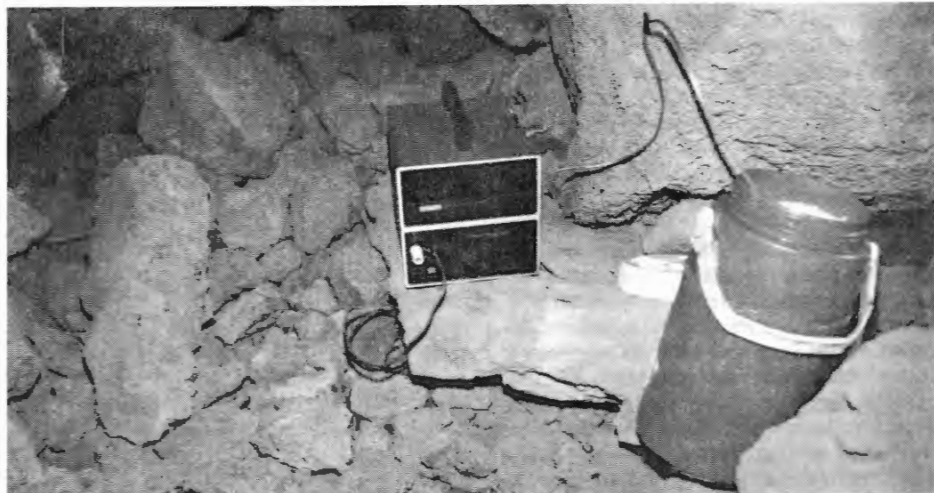
Indian Well cave is a classic cold trap. Its entrance faces north, which prevents direct sunlight from heating the interior. It also is closed at the bottom, but has an opening to the surface at the south end. Warm air rising to the roof easily vents to the outside, leaving the cold air to remain undisturbed at the cave bottom.

Note that Indian Well has the coldest observed temperature of any of the caves studied.

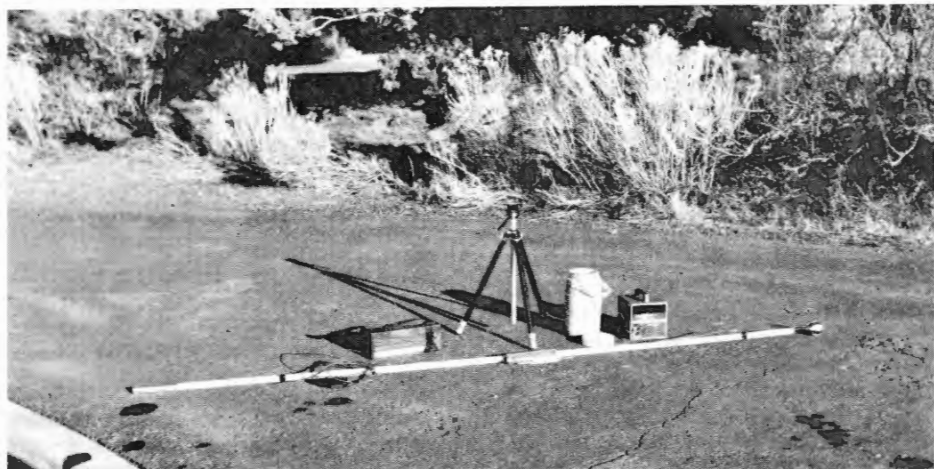
Skull and Merrill are ice caves that have a continuous, but restricted, air circulation. Each of these ice caves is believed characteristic of the other ice caves in the Monument, and each has a small passage that limits the rate at which air can enter or leave the cave. The source of heat causing the circulation evidently is the surrounding rock, which a short distance from the cave would be the same temperature as Valentine. An oddity appears where Skull was observed to reach a colder temperature than Merrill, but Merrill's average temperature is colder than Skull's. This may be explained in part by the fact that the restriction to air circulation in Merrill is located at the top of the steps into the lower level, while the restriction in Skull is beyond the steps into the lower level.

The average daily mean temperature for the Lava Beds NM is 47.3 degrees Fahrenheit. Comparing the temperatures of the caves to the annual average daily mean temperature suggests that Valentine must be controlled by the surrounding rock temperature and the other caves by the air that circulates through them.

Arnold is a permafrost engineer from Albany, Calif., studying ice caves as unique examples of permafrost. Presently Arnold is on assignment in China for the Bechtel Corporation.



Temperature indicator shown here is reading a thermocouple imbedded in cave rock. The ice bucket is used to calibrate each thermocouple reading.



Here's what it takes to take a cave's temperature. Back row, left to right: flashlight, tripod to support pole with thermocouple for roof temperature, ice bucket for calibrating thermocouple reading, and temperature indicator. Front row: Pole with thermocouple for roof temperature and pocket sling psychrometer.