

The Ice Cave at Decorah, Iowa*

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The Decorah Ice Cave is the largest glacière in North America east of the Black Hills. While the exact date of its discovery is unknown, this Iowa cave has figured prominently in the literature on glacières since 1860 and, during the last quarter of the nineteenth century, enjoyed an international reputation.

Ice deposits underground were the subject of much speculation, beginning in 1586, when Benigene Puissenôt suggested that the cold of winter produced the ice at Chaux-les-Passavant, France. In 1898, however, Alois F. Kovarik, an instructor at the Decorah Institute, Decorah, Iowa published the results of an extended series of meteorological observations at the Decorah Ice Cave which clarified the mechanics of static glacières and rationalized the seemingly incongruous features of such caves. The endorsement of Kovarik's work by E. S. Balch in his monumental "Glacières or Freezing Caverns" (1900) assured its acceptance and established the Decorah Ice Cave as the type example of static glacière in North America.

*The preparation of this report would not have been possible without the assistance of William E. Davies (U.S. Geological Survey), who helped to complete the bibliography, and of Dr. William R. Halliday (Seattle, Washington), who furnished much useful information from his own experience. Other essential data were provided by Stanley Scarvie, manager of the Decorah Ice Cave during its years of commercial operation, and by Barbara Hunt of the Decorah Newspapers. W. P. Ronan arranged with Otto Klimesh, a nephew of Alois F. Kovarik, for us to obtain the portrait of Kovarik accompanying this article. Pat Quinlan edited a preliminary version of the manuscript. Special thanks must be given to the many Decorah residents who granted interviews to Professor Knudson.

The Decorah Ice Cave was developed and shown to tourists by Stanley Scarvie and others from 1929 until 1941. Despite its scientific importance, however, the cave was found to be too small to support a commercial venture after larger and more scenic caves were discovered nearby. The cave now is included in the City of Decorah park system and, although described in many regional tourist handbooks, seems largely to have been forgotten until its dedication in 1973 as an Iowa State Preserve.

THE EXPANSION OF THE POPULATION of the United States from the eastern seaboard into the Midwest and West during the nineteenth century was accompanied by the discovery of many amazing natural objects and phenomena. Among these were caves in which ice deposits form in the springtime and melt in the fall.

Glacières, that is to say caves *containing* ice during the summer in regions where the mean annual temperature is greater than 32°F (as contrasted with caves *developed in* ice [true "ice caves"]) and with caves containing ice in permanently frozen regions) occur in the East both in Pennsylvania and in the New England States. Very few, however, are to be found between the Alleghenies and the Black Hills. Most of those known to exist in the latter region are located in a five-county area of northeastern Iowa.

The measure of a glacière, in the days before mechanical refrigeration, was whether or not it would yield enough (about fifteen pounds) ice on the Fourth of July to make ice cream. At least six Iowa caves did meet that criterion, of which five are known to be extant: the Decorah Ice Cave in Winneshiek County, the Brainard Ice Cave in Fayette County, the Canton Ice Cave in Jones County, and the Sampson and Bixby ice caves in Clayton County. The sixth and, perhaps, largest Iowa glacière, the Postville Ice Cave in Allamakee County, was sealed about 1952.¹

The Decorah Ice Cave, the largest glacière in North America east of the Black Hills, has been the best-known Iowa Glacière. During the last quarter of the nineteenth century, it was the best-

¹W. R. Halliday, "Ice Caves of the United States," *National Speleological Society Bulletin*, 16 (1954), 12.



Courtesy of author

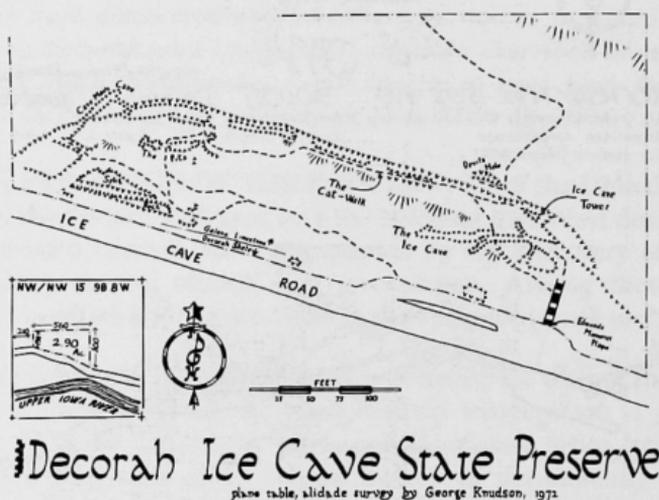
Figure 1. Map of the Decorah Ice Cave.

known glacier in all of North America and was the most famous cavern (of any kind) in the entire Midwest.

The Decorah Ice Cave underlies a wooded bluff on the left bank of the Upper Iowa river, along Ice Cave road in Ice Cave Park, Decorah, Iowa. Geologically, it is an expanded joint. Originally a barely-perceptible crevice in Ordovician Galena limestone, it was enlarged by the seasonal growth within it of an ice wedge during the Wisconsinan (last) glacial stage of the Pleistocene ice age.² Wedging was especially pronounced at this loca-

²James Hedges, "Expanded Joints and other Periglacial Phenomena along the Niagara Escarpment," *Biuletyn Peryglacjalny*, 21 (1972), 108.

tion as a result of the steepness and favorable exposure of the bluff. Several other, analogous, openings are present in the immediate vicinity of the cave (figs. 1, 2, 3). All are interconnected.



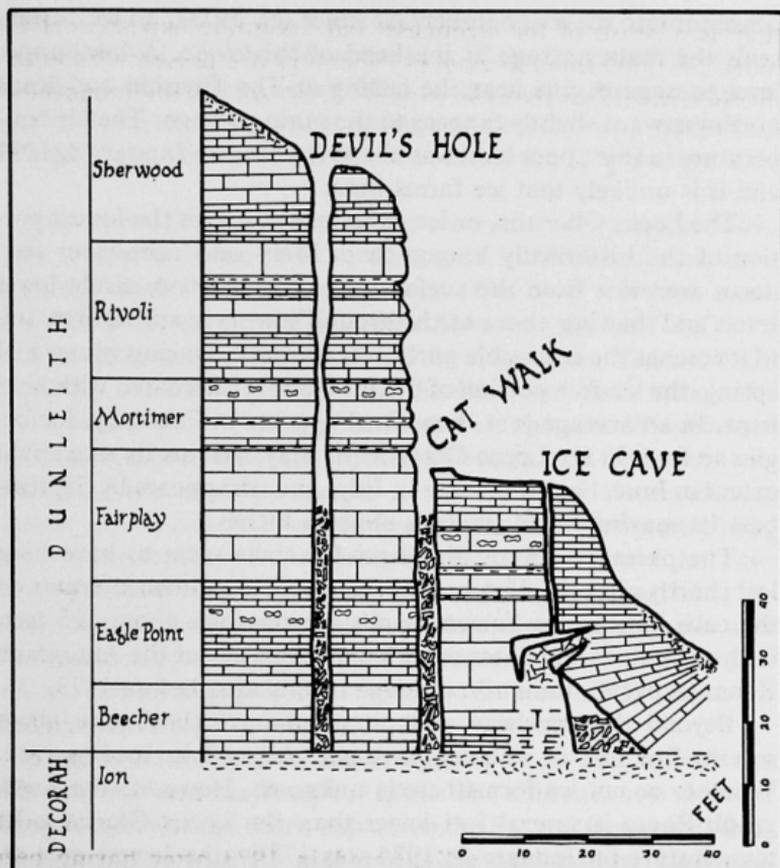
Courtesy of authors

Figure 2. Map of the Decorah Ice Cave State Preserve.

The cave entrance faces east. Originally about five feet high, it was enlarged sometime before 1898.³ At the entrance, the cave now is fifteen feet high and six feet wide. A passage high and wide enough for easy walking extends westward for 120 feet. A small opening at this point, rediscovered in 1973 after having been blocked by ice and fallen rock since about 1880, ends at a pit twelve by twenty-four inches in diameter and twelve feet deep. The passage below contains inscriptions dated 1878 and 1879.

In the north wall of the cave are exposed thin, level beds of the Beecher and Eagle Point members of the Galena group. The south wall also consists of Galena limestone but, as a result of the sagging of the beds underlying the bluff after their displacement by the ice wedge, the limestone dips steeply northward, toward the cave. The cave floor consists of limestone fragments spalled from the walls. The ceiling of the cave is formed by the upper portion of the inward-leaning south wall.

³Alois Kovarik, "Decorah Ice Cave and its Explanation," *Scientific American Supplement* (1898) No. 1195, 19158.



Courtesy of authors

Figure 3. Stratigraphic Section of the Bluff at the Decorah Ice Cave (after C. O. Levenson and A. J. Gerk, manuscript report to the Iowa State Preserves Board, 1972).

The cave floor rises slightly inward. Ten feet from the entrance, a low, narrow passage leads steeply upward to the left and intersects the bluff. Beyond, the floor slopes moderately downward toward the ice chamber. The floor is covered with ice from this point to the Locus Glacialis during a favorable summer.

Some thirty feet further on, the passage divides. The high, narrow passage to the left at The Division extends toward the bluff, but ends in rubble before reaching it. A small amount of ice forms in this passage. The short, steep slope to the right, where fragments of a wooden stair occur beneath debris on the floor,

descends into the ice chamber. At times (cf. 1971), an ice curtain seals the main passage at the head of this slope. A low, upper level passage begins near the ceiling at The Division and leads northwestward slightly tangent to the main passage. The air temperature in this upper level was above freezing on January 8, 1974 and it is unlikely that ice forms here.

The Locus Glacialis, or ice chamber, occupies the lowest portion of the historically known cave. Melt- and rain-water seep down a crevice from the surface, freezing at successively lower levels and thawing above as the ground warms in springtime, until it reaches the accessible portion of the cave. During winter and spring, the ice-free portion of the ice chamber is coated with hoar frost. In an average year, hoar frost appears in February. Ice begins to form in the Locus Glacialis in May, attains its maximum extent in June, begins to thaw in July, and disappears by September. Its maximum thickness is about 6 inches.

The passages beyond the locus Glacialis seem to have been lost shortly after the discovery of the cave. No published report on the cave indicates a known length greater than about 125 feet. Only the names and dates scrawled on the walls of the Autograph Room testify to human knowledge of this area before 1973.

Beyond the crawlway and pit mentioned above, are about seventy-five feet of walking passages. All end in broken rock. Whether or not ice forms here is unknown. However, the Autograph Room is several feet lower than the Locus Glacialis. Its temperature on January 8, 1974 was 17°F—the lowest ever recorded within the cave. The Autograph Room should be at least as effective a refrigerator as the Locus Glacialis!

Several impenetrable fissures extend from the accessible portion of the cave into the adjacent rock mass. These, presumably, are connected with the extensive system of crevices visible in the bluff and are the channels by which means air chilled elsewhere within the permeable mass of limestone is conducted by gravity through the ice chamber and out the cave entrance. One such fissure, the Devil's Hole, opens at the top of the bluff, about fifteen feet back from the crest. It parallels the bluff face, is two to four feet in width, is thirty feet long at the surface, and has been explored downward nearly to the level of the ice chamber. Another is Cave Man's Cave (see Fig. 1). These and other, parallel, fis-

tures between the ice chamber and the main body of limestone insulate the ice chamber from the heat of the Earth (47°F at this latitude and elevation), in addition to functioning as a great heat sink, chilling relatively warm spring and summer air by exposing it to the frozen limestone before it reaches the ice chamber.

The Decorah Ice Cave was first mentioned in print in 1860, when a brief description of it, written by a "JWH" of Decorah, appeared in the *Scientific American*. The cave was next mentioned in 1868, also in the *Scientific American*, by one "O," who lived in the Hardin neighborhood of Allamakee County. "O" states that, in 1868, the Decorah Ice Cave had been known for about twenty years—since about the time that the Winnebagoes had been removed from the "neutral Ground" (in 1848) and the area about the cave was opened to settlement. A flour mill was erected by William Painter, an immigrant from Greene County, Ohio, at nearby Dunning's Spring in 1849.⁴ Discovery of the cave must have occurred shortly thereafter. "O" mentions that, already, several thousand people had viewed the ice deposits and that boys in the community mined ice from the cave on the Fourth of July and sold it in Decorah. Neither "O" nor "JWH" has been identified in historical records.

The State Geologist of Iowa, Charles A. White, visited the Decorah Ice cave on June 1, 1869. He subsequently devoted nearly an entire page of his report on the Second Geological Survey of Iowa to it, saying that it was the only glacier known to exist in Iowa and that it "has consequently excited much popular attention."⁵ White's interpretation of the cave (viz.: an opening created when the river oversteepened the bluff and a block of limestone slumped down across the underlying shale) until recently was generally accepted in the scientific community.⁶

⁴A. T. Andreas, *Illustrated Historical Atlas of the State of Iowa* (Chicago, 1875), 433. Painter's was not the "Ice Cave Mill." The latter, built in 1874, was located at the end of a long millrace, on the north-eastern edge of Decorah. The concrete intake gates may still be seen opposite the Ice Cave, about 50 feet south of the present river bank.

⁵C. A. White, *Geology of Iowa*, 1 (Des Moines, 1870), 80.

⁶White's geological interpretation of the Decorah Ice Cave recently was challenged by Hedges in his discussion of periglacial features along the Niagara escarpment. Although it seems likely that the Ice Cave is periglacial in origin, the cave is not in itself a convincing example of expanded joint.

His hypothesis that the evaporation of water in the cave absorbed enough heat to cause the remaining moisture to freeze was disputed in the *Burlington Hawk-Eye* by "O," who suggested that the cause of ice formation was the lag in penetration of surface temperatures underground. Both hypotheses, although initially plausible, failed and were discarded by later workers. Heat imported into the cave from other sources is vastly greater than the amount removed by evaporation and absorbed by annual rock temperature fluctuations at depth. "O" did correctly surmise that "the reason why ice does not form there during the winter months is, probably because the surface soil being frozen, it withholds its tribute of moisture. . . ."

The next published report on the cave appeared in the *Scientific American* in 1879. An article, "The Ice Cave of Decorah, Iowa," presents a brief, but surprisingly accurate, narrative of the cave. The request for assistance with which it begins precipitated a spate of replies and catapulted the Decorah Ice Cave into international prominence. The author, who gave his address as Mansfield, Ohio, is identified only as "HMW." He begins:

Some years ago I visited the 'Ice Cave' of Decorah, Winneshiek County, Iowa, and having since been unable to receive any explanation of the wonderful phenomena exhibited by it, I write, hoping that you or some correspondent may explain the paradox.

The first response to "HMW" appeared in the *Science Observer*, (1879, Volume 2, 57-58) in which N. M. Lowe of Boston formulated an hypothesis that air is entrained by water descending along fissures above the cave, is compressed, and gives up its heat of compression to the adjacent rocks. Subsequently liberated in the cave, the air expands and absorbs heat from the cave, cooling it below the freezing point. That ice forms only in summer, Lowe thought, is due to the land surface above the cave being frozen in winter. Thus, the entry of air and water into the fissures leading to the cave is prevented. Lowe previously had visited some glaciers in New England, but had not himself seen the Decorah Ice Cave.

There followed a lively debate in issues of the *Science Observer*, *Scientific American Supplement*, and in *Proceedings of the Boston Society of Natural History*, as well as in *The Decorah Republican* about the scientific cause and nature of ice caves such

as the one at Decorah. The several arguments produced no satisfactory explanation of the origin of *glacières*. None was forthcoming until many years later when the work of Alois Francis Kovarik became known.

Kovarik was born on March 8, 1880 in Spillville, Iowa, an agricultural village about ten miles southwest of Decorah. He attended the Decorah Institute, graduating in 1896 at age sixteen, and taught chemistry and physics there from 1896 to 1900. He later graduated from the University of Minnesota a member of Phi Beta Kappa, won a doctorate in physics there in 1909 and, after remaining on the Minnesota faculty until 1916, became professor of physics at Yale University. He retired in 1948, after achieving international renown in the field of nuclear physics. Alois Kovarik died at Spillville on November 13, 1965 and lies buried there.



Courtesy of Otto Klimesh

Alois Kovarik, ca. 1891.

At the time of his work at the Decorah Ice Cave, Kovarik was an instructor at the Decorah Institute.⁷ He seems to have been familiar with earlier speculation on the formation of subterranean ice, for he expresses absolute disbelief in the ability either of evaporation or of the expansion of air to cause the formation of ice unassisted. It may have occurred to him that the conjunction

⁷The Institute had been founded in 1874 by John Breckenridge, an administrator who came from the East in 1866 to become superintendent of schools in Decorah. The Institute offered classical subjects, in addition to business courses, and became a respected preparatory school attended by students drawn from as far away as the east and west coasts. Many of its alumni went on to become quite well-known, as did Kovarik. Breckenridge died on April 21, 1899 and Kovarik returned to assist his wife as Director of the Business Department and Associate Editor of the *Decorah Institute* magazine during the spring, 1900 semester. Mrs. Breckenridge finally closed the Institute in 1911.

of ice formation in the cave with thawing of the soil above the cave demonstrated conclusively that the water which later froze to ice was derived by infiltration from the land surface above, not by condensation from the air in the cave.

It remained only to associate these processes mentally, one with another, and to demonstrate their efficacy by the regular collection of meteorological data throughout the year. Kovarik did so from 1896 to 1900, publishing a tabulation and discussion of the data in the *Scientific American Supplement* in 1898, a supplementary table covering the 1898-1899 season in *The Decorah Public Opinion* on September 29, 1899, and a third report (in which he ridiculed grossly exaggerated accounts of the cave in the eastern press) in the *Decorah Institute* in 1900. Kovarik also visited some freezing wells near Decorah and the small *glacière* at Brainard, Iowa, but seems to have had no other experience with natural refrigerators.

The mechanism of ice formation, as correctly deduced by Kovarik, is as follows: Cold winter air enters the cave freely through the entrance. It sinks into the ice chamber, cooling the surrounding rocks, and, being warmed (relatively) thereby, ascends out of the cave through fissures in the roof. Meanwhile, more cold air is drawn in through the entrance to replace the warmed air lost via the ceiling fissures. This simple gravity circulation, driven by the temperature differential between the (warmer) cave and the (colder) outdoors, occurs almost continuously throughout the winter. The walls of the ice chamber are, thus, cooled far below freezing. The ground above being frozen, however, no water can seep into the cave and no ice forms. There may, however, be enough moisture in the air to yield a coating of hoar frost by condensation.

When the temperature outdoors nears the freezing point, air circulation through the ice chamber ceases (warmer air cannot displace cold from any point below the entrance threshold; refer to map, Fig. 1). The temperature at Locus Glacialis, thus, remains well below freezing and, as soon as the frost goes out of the bluff above the cave, water enters the ice chamber and is frozen. The importation of heat by water, eddies of air, conduction through the ground, and cave explorers causes the temperature of the ice chamber to rise gradually as the season progresses. By the middle of summer, the temperature of the ice chamber has been

raised above freezing and the accumulated ice begins to thaw. The cave usually is free from ice before cold weather arrives in autumn and remains so throughout the winter.

The data summarized above are presented in more detail and with much more eloquence in Kovarik's three papers. It is doubtful, however, that they would have succeeded in challenging the prevailing notions about the causes of subterranean ice had not the prominent Philadelphia scholar Edwin Swift Balch endorsed Kovarik's viewpoint.⁸

Balch apparently had not heard of Kovarik prior to his visit to Decorah on September 30, 1898, for he went to the cave with another Decorah resident. Kovarik had seen Balch's "Ice Caves and the Causes of Subterranean Ice" in the *Journal of the Franklin Institute* (1897, 147, 161-178), but his initial report on the Decorah Ice Cave (published in November of 1898) must have been written before the date of Balch's visit to Decorah, for he does not mention having met Balch. Kovarik's work may have been inspired by Balch's 1897 article, because his series of measurements began in July, 1897, following publication of Balch's paper. The two men seem to have arrived at the correct explanation of static *glacières* independently, however—Balch by means of single observations of many such caves over a period of years; Kovarik as a result of the intensive study of a single cave during one year.

Kovarik deserves more credit than usually is allowed him for his contribution to our knowledge of *glacières*. His study was the first and, to date, only methodical investigation of the meteorology of a North American *glacière*. Unfortunately, his work was overshadowed by Balch's later and more comprehensive opus. Kovarik, of course, contributed to the obscurity of his own speleological contributions by abandoning this line of research after 1900 and devoting himself to nuclear physics. Although his views often have been overlooked by many writers, most recently by L. G. Pratt, who attributed ice in the cave to "condensed moisture during the summer," they never have been seriously questioned.⁹

⁸E. S. Balch, "Subterranean Ice Deposits in America," *Journal of the Franklin Institute*, 147 (1899), 292; *Glacières or Freezing Caverns*, (Philadelphia, 1900), 88-90, 177-179, 292-293.

⁹L. G. Pratt, *A Guide to Historic Iowa*, (Des Moines, 1968); Several experi-

The problem of the formation of subterranean ice having been solved by Kovarik and by Balch, one would think that subsequent accounts of the Decorah Ice Cave should have been clear and unambiguous. The next extended discussion of the cave, by Samuel Calvin, in fact does show an acquaintance with the work of both men but, after Calvin, ignorant speculation once again became the rule.

Samuel Calvin, Iowa State Geologist from 1892 until his death in 1911 (excepting the period 1904-1906), visited the Decorah Ice Cave several times beginning in 1877. He devoted four pages to the cave in his "Geology of Winneshiek County" in the *Annual Report of the Iowa Geological Survey*, (1905). Calvin endorsed White's theory as to the physical origin of the cave and Kovarik's explanation of the ice, quoting extensively from the latter's work.

Calvin also endorsed Kovarik's belief that the Devil's Hole and other fissures linked with the accessible portion of the cave constitute a great heat sink. Millions of cubic feet of cold air are drawn through these crevices during the winter by the gravity circulation identified by Kovarik. In summer, the circulation is reversed: Warm air is drawn in at the top of the bluff and cold air is discharged through the cave entrance. A net heat deficit is preserved in the ice chamber, however, because the ice chamber lies below the elevation of the entrance—the relatively warm air currents of summer follow higher openings and do not disturb the cold air trapped within it. This great reservoir of "cold" supplements the thermal capacity of the ice chamber walls and contributes materially to the maintenance of freezing conditions within the cave.

W. H. Norton, a prominent groundwater geologist and educator on the faculty of Cornell College, allotted half a page to the Decorah Ice Cave in his report on the "Underground Water Resources of Iowa, published in *The Annual Report of the Geological Survey* (1911). He advanced a slightly different mode of origin for the cave, suggesting that it was "formed in part by the en-

ments have substantiated Kovarik's hypothesis. One of these occurred (inadvertently) at the Decorah Ice Cave during the period of commercialization, when a solid wooden door was placed in the entrance. This almost completely blocked the flow of air, as may be seen in contemporaneous photographs, and is said to have "ruined the cave" insofar as its ice deposits were concerned. Removal of the door and of associated partitions allowed the ice deposits to be restored naturally.

largement of a master joint and in part by the creep of the massive Galena over the underlying shale," but does not elaborate on the idea.

James H. Lees, Iowa Assistant State Geologist from 1906 to 1934, in discussing some geological aspects of conservation before the Iowa Academy of Science in 1917 touched upon the Decorah Ice Cave. Few geologists trouble themselves to learn much about caves and, despite his competence as a field geologist, Lees was typical. In fact, only two Iowa geologists have made significant contributions to speleology. The first of these was Samuel Calvin (mentioned above). The second was J. A. Udden, a member of the faculty of Augustana College and, later, State Geologist of Texas, who wrote extensively on Iowa geology.

Lees employed White's views on the origin of the cave, but advanced a novel (and inexcusably absurd!) idea on the origin of the ice.

The limestones of the region are honey-combed with fissures and into these the cold air of winter is drawn, to be forced out during the warm days of spring and summer. Coming into contact with the warm air of the cave this colder air causes the precipitation of moisture along the inner wall of the cave and forms during the early summer months a coating ice. . . .¹⁰

However, the cave, being a part of the fissure system, also contains cold (not warm) air; precipitation of moisture from air results in hoarfrost deposition, not in the formation of large ice masses. *Sic transit gloria*, and only seventeen years after Kovarik left Decorah.

Lees' 1917 paper was reprinted, sans illustrations, in the 1919 report of the State Board of Conservation, "Iowa Parks." The same report includes another article by Lees, which repeated the same theory advanced in 1917. A third exposition of the theory appeared in 1933, during the course of a popularized discussion of the geology and topography of northeastern Iowa.¹¹ In the latter piece, Lees attributed the ice wells near Decorah and the cold water of Dunning's Spring to the same cause!

¹⁰J. H. Lees, "Some Geological Aspects of Conservation," *Proceedings of the Iowa Academy of Science*, 24 (1917), 136.

¹¹J. H. Lees, "The Geology and Topography of Northeastern Iowa," *Iowa Journal of History and Politics*, 31 (1933), 19.

The 1919 report of the State Board of Conservation devotes two paragraphs to the Decorah Ice Cave, written by B. W. Hoadley. His remarks are a confused amalgamation of earlier hypotheses:

The cave is merely one opening into a vast network of fissures; penetrating the underlying rocklayers for miles around. In the fall as the air cools and contracts in volume, it enters the cave from which it emerges as a cool draught when the sun's warmth again penetrates the rock layers. At the mouth of the cave, where the expansion is most rapid, ice forms on the north wall. The cold, then, is merely the stored up cold of the former winter.

E. C. Bailey's views, reprinted in the Board of Conservation report from the April 1918 issue of *Iowa Magazine*, show a lack of knowledge about freezing caverns: "The only other ice caves of importance known to the scientific world are located in Kentucky and Russia."

Kovarik's data had convinced the experts. Lees' conjectures, unfortunately, had a wide circulation in the popular and educational literature in Iowa. Whereas the earlier scientific reports were not readily available to the general public, Lee's material appeared in state-sponsored publications which were widely distributed and his position as Assistant State Geologist lent them credibility.

Lees must have chosen to ignore Kovarik's work, although he never published a formal defense of his own theory. In any event, communication between specialists and the popular mind was lost and two separate traditions came into being: a speleological viewpoint traceable to Kovarik and a lay viewpoint traceable to Lees.

Such was Lees' influence that, even after his death in 1935, Iowa authors felt obliged to append his hypothesis to the correct theory of the cave. For example, in a widely used geography textbook written for public school use by G. F. Kay, a prominent stratigrapher and State Geologist from 1911 until 1934, the cause of the ice is correctly attributed to the stored-up "cold" of winter and to the freezing of water which seeps into the cave after the ground thaws in springtime. After thus enlightening the children, however, Kay defers to Lees, saying: "When, too, in the spring, warm damp air enters the cave from the outside, the moisture is

changed to ice on the walls of the cave."¹²

The Decorah Ice Cave was the second Iowa cave to be operated as a commercial venture.¹³ It had been a popular attraction almost from the time of its discovery and, although privately owned until 1954, the City of Decorah promoted it vigorously and was showing it informally in 1929. A register placed by the City at the cave entrance on the last Sunday in July of that year showed that 621 people visited the Ice Cave that day, of which only twenty-four gave Decorah addresses! The guides at that time included the Larson boys, Nort Kjome, and others who hung around the cave with flashlights, hoping to earn a dime by escorting visitors through it.

Leo TeKippe, a longtime Decorah resident and one of the discoverers of Niagara Cave, Minnesota, related to us that, in the 1920s, Congressman Fred Biermann (who was very instrumental in establishing the Decorah park system, Malanaphy Spring Park, Cold Water Spring Park, and others) was trying to promote interest in the Ice Cave. He wrote to reporters in several nearby cities, inviting them to come to Decorah. Unfortunately, they didn't arrive until late in the summer, after all of the natural ice had melted. Biermann, anxious to salvage his enterprise, hired the local iceman to put some stored river ice in the cave. However, the reporters spotted a little sawdust which had not been washed off the ice and the fraud was exposed!

An old photograph reveals that the entrance to the Decorah Ice Cave had been walled up and fitted with a door sometime before 1890. This wall and door have long since vanished. No information has come to light concerning their purpose, or who was responsible for constructing them.

In the 1919 State Board of Conservation report, Lees states that the Ice Cave Road was built by the local Chamber of Commerce. This must have occurred after 1906, for according to reputable authority, Ole Vold sold the right-of-way to the city about 1906. In Kovarik's day, the cave was accessible only by means of a footpath leading from the Ice Cave Bridge. Carleton

¹²G. F. Kay, *Our Home State and the New World*, Iowa Edition, (Cincinnati, 1944), 45.

¹³The first was Timmen's Cave, located in Eagle Point Park, Dubuque. Timmen's Cave was electrified and opened sometime prior to 1917.

P. Baker of Decorah told us he thinks that the stone steps leading up from the road to the cave entrance were constructed by the WPA early in the 1930s, although this has not been documented.

Formal commercial operation of the Decorah Ice Cave began on March 31, 1930, when Stanley Scarvie leased the cave and all property within 500 feet of it from its longtime owner, Ole Vold. The lease was for \$200/year and ran for five years.

The commercial season at the Ice Cave ran from April until Labor Day. The maximum display of ice occurs between these dates. In the absence of ice, there literally is nothing for the layman to see in the cave. The Devil's Hole and other features of the bluff make an interesting supplementary exploration project, however. Some of these were included in the tour. Scarvie reports that about 5,000 people came to the cave each year. They came from as far as states on both the east and west coasts. A few were from foreign countries.

Scarvie's improvements consisted of four 32-volt electric lights (powdered by batteries recharged by a portable generator), a wooden stairway at The Division, cleated planks laid over the ice on the floor, and a small, bark-covered, "cave house" cabin adjacent to the parking area (see Fig. 2). Framing and a door were placed in the cave entrance, preventing unauthorized entry but allowing some circulation of air. Nothing now remains of the door or of the facilities inside the cave except the stairs, although remains of the lighting system were still to be seen about fifteen years ago. The concrete footings and apron of the cave house can be found near the parking area.

The "grand opening" of the cave was advertised for the week of June 15, 1930. Scarvie initially charged 10¢ for a tour of the cave; a self-guided tour of the bluff was 10¢ additional (15¢ if a guide was furnished). By 1937, the fee had risen to 15¢. Scarvie states that he sold "the usual souvenirs." He also distributed a leaflet entitled the "Ice Cave News." A copy of Volume 3 is in the Luther College Library. No copies of the two previous volumes have been located. This leaflet may have taken the place of a cave brochure. Gary Soule, America's leading collector of commercial cave brochures, reported that he has not been able to locate a copy of a Decorah Ice Cave brochure.

The Decorah Ice Cave received nationwide publicity in December, 1932, when it was featured in Ripley's "Believe it or Not"

syndicated newspaper column as the "Cave of Paradox." In spite of this and of other promotional efforts, however, business declined after the first year of operation due to competition from other local caves.

Public records show that Vold leased the cave to Glen Larson on April 29, 1938. The lease was for \$225/year and ran until January 1, 1945. Larson had arrived in Decorah in 1933 and shortly thereafter became associated with Scarvie in searching for a cave to exhibit in competition with others in the area. His search eventually led to Wonder Cave, which he and Scarvie opened together in 1936. Wonder Cave was not a big money-maker, however, and Larson, who by now had become Scarvie's brother-in-law, exchanged his interest in it for Scarvie's interest in the Ice Cave.

Larson relied upon Scarvie and other local men to supervise the operation. His father ran the cave from 1938 until 1941, aided by Lars Sampson (who usually acted as the guide). Larson's wife remembers her father-in-law sitting out at the cave all day on busy summer week-ends. Mrs. Larson would go out of an afternoon and lend him a hand. Business continued to decline, however. Glen Larson assigned his interest in the cave to his mother, Mary M. Larson, on October 16, 1940. There is no mention of the Ice Cave in the Decorah newspapers after 1940 and we assume that to have been the final year of its operation.

Two scientific papers mentioning the cave appeared during the period of commercial operation. One of these was an annotated list of caverns, ice caves, sinkholes, and natural bridges published in 1932-33 by Junius Henderson, Professor of Natural History at the University of Colorado.¹⁴ On page 124 of this work, Henderson cites Kovarik's work and quotes Calvin's statement that the fissures beyond the cave constitute an immense heat sink.

The second was an abstract of a paper discussing ice caves by J. E. Smith of the Iowa State College Geology Department. Smith's remarks indicate some knowledge of glaciers, but he adopted Lees' theory on the origin of the ice, to wit:

The cold heavy air [of winter] fills the cave, and condenses the warmer, moist air below the freezing point, forming ice as the two diffuse slowly

¹⁴Junius Henderson, *Caverns, Ice Caves, Sinkholes, and Natural Bridges*, 19 (University of Colorado Studies, 1932-33), 124.

at the entrance. If the air chamber is large enough and the cave opening small enough, the diffusion and ice-forming will continue throughout the year, as in the cave at Bixby State Park. If not there will be an ice-free period as in the ice-cave near Decorah.¹⁵

Following the publication of Smith's abstract in 1932, there was no mention of the Decorah Ice Cave in the literature until 1950. Occasional references to it occurred in travel guides, however—in the two pot-boilers prepared under the auspices of the WPA, and in a better compilation by Swisher.¹⁶ A short survey of ice caves, including the Decorah Ice Cave, was published in 1950 by Patricia Merriam.¹⁷

One hundred two acres of the Vold farm, including the Ice Cave, were condemned by the City of Decorah on December 28, 1954 and added to the city's park system in order to protect the river bluffs from commercial developers. Jennie Edmunds Moss donated \$5,000 of the awarded price (\$7,000) in memory of her brother, Roger F. Edmunds. A plaque attesting to the donation is affixed to the base of the Ice Cave stairway. At present, the Decorah city park system includes twelve areas totalling 340 acres. In size relative to the population served and in the variety of facilities included, it is one of the finest in the world. Not least among its treasures is the Decorah Ice Cave.

In 1972, the Decorah Ice Cave became the 26th area to be declared an Iowa state preserve. The dedication ceremonies, held May 2, 1973, were attended by Governor Ray and three plane-loads of dignitaries. The Iowa State Preserves System was established in 1965 in order to save outstanding portions of our natural and historical heritage for future generations. The organic act (Ch. 111.8, Code of Iowa 1966) provides that state preserves shall be managed to prevent the alteration of the features which led to their establishment. Destructive uses and recreational uses other than observation are not allowed. The amount and type of visita-

¹⁵J. E. Smith, Ice Caves (abs.), *Proceedings of the Iowa Academy of Science*, 39 (1932), 196.

¹⁶Works Projects Administration, *Iowa, A Guide to the Hawkeye State*, (New York City, 1937), 20, 344; Works Projects Administration, *Guide to Cedar Rapids and Northeast Iowa*, (Cedar Rapids, 1938), 40-41, 53, 56; J. A. Swisher, "Some Historic Sites in Iowa," *Iowa Journal of History and Politics*, 32 (1934), 210.

¹⁷Patricia Merriam, "Ice Caves," *National Speleological Society Bulletin*, 12 (1950), 34.

tion is restricted to that which will not disturb the local environment. A wise management plan should assure the continued existence of the cave and of its unusual properties.

Many previous misconceptions about Iowa glaciers were corrected by W. R. Halliday in his introduction to the Johnson Reprint Corporation edition of E. S. Balch's *Glaciers or Freezing Caverns* (New York City, 1970, xiv). Unfortunately, however, Halliday confused scenic value with scientific importance and proceeded to deprecate the significance of the Decorah Ice Cave, saying: "The numerous early accounts of this cave were due to its accessibility rather than to its importance as a cave or a glacier."

In fact, it was the accessibility of the cave which made it important as a scientific site. Some of the larger western glaciers were discovered at about the same time. None of those, however, were as accessible to scholars as was the Decorah Ice Cave and, lacking that necessary attribute of convenient location, they failed to play a significant part in the development of scientific thought on the causes of subterranean ice.

The Decorah Ice Cave is the largest glacier in North America east of the Black Hills. No less than four distinct meteorological hypotheses were based upon it: The air-entrainment hypothesis, the atmospheric expansion hypothesis, the condensation hypothesis, and the natural refrigerator theory. Few American caves, and no others in the Midwest, have had so great an influence on the development of scientific thought. Easily accessible for continued research and for public education, its future safety legally assured, the Decorah Ice Cave is a naturally unique and uniquely valuable asset.

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