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Additional study and exploration will provide the solutions to many of the various problems relating to the Delaware Basin area. Resulting data will not only prove of value academically, but will no doubt hasten the time when this important feature, already a producer of the world's largest deposits of potash minerals, takes its place as a major province of petroleum.

THE ORIGIN AND DEVELOPMENT OF THE CARLSBAD CAVERNS

by

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Carlsbad Caverns National Park

Carlsbad Caverns, viewed by hundreds of thousands annually, stands unrivaled as an underground scenic attraction. Few of the visitors passing through and gazing in awe and amazement at the beauty of the myrid secondary structures, however, give thought to the slow processes involved in the creation of the gigantic cavity. For them beauty alone is sufficient. Nevertheless, lying as it does in the limestone upland of the Guadalupes near the edge of a great escarpment, rising abruptly from the flat plains to the south and east, which extends as a prominent barrier some 45 miles from El Capitan to the vicinity of Carlsbad where it dips underground, certain questions arise in the minds of almost everyone. How did the escarpment originate? Why are the caverns located as they are with the only opening some 700 feet above the valley floor?

The escarpment is, of course, but a relatively small segment of a great barrier reef, encircling the Delaware Basin, which developed during upper Guadalupian time. The key to its location however, is to be found in landscapes of the late Pennsylvanian and early Permian periods for on these inherited structures depended the successful development of the encircling reef.

During late Pennsylvanian narrow mountain chains, which had their origin early in the Pennsylvanian period and split this area into semi-isolated subrhomboidal basins, were rejuvenated and continued to act as positive elements throughout most of the Permian.[1]

1. Adams and Frenzel – Journal of Geology – July, 1950.

Structural hinge lines separated rapidly subsiding areas, such as the Delaware Basin, from the less actively negative ones and upon these platforms extensive shallow water, marine limestones developed. These hinge lines were favorable places for the growth of reef building organisms for here the water was clear and shallow enough for sunlight to penetrate to the bottom. Such penetration was mandatory for the growth of algae, the reef forming organisms primarily responsible for the formation of the Capitan Reef. It was also the limiting factor governing the depth at which the reef could establish itself. The clean bottom furnished an excellent surface for the attachment of fixed organisms, while water rising along the slope from the deep basins furnished an abundant supply of food. As a result reefs, beginning as isolated mounds, grew laterally, joined, and by mid-Guadalupian time had succeeded in encircling the Delaware Basin as a continuous barrier.

From mid-Guadalupian time onward the reef continued to alternate between periods of upward and seaward growth. During periods of active subsidence the reef grew rapidly upward in order to maintain its crest in the zone to which sunlight could penetrate and thus avoid drowning. During periods of slow subsidence it grew seaward on a talus slope of its own construction. In the main the reef grew vigorously and without interruption from back reef sediments moving into the Delaware Basin. At times, however, as illustrated by two deposits in the New Mexico Room which strike N68° to 70° E and dip 20° to 30° S and N40° E, 38° S respectively, sands, probably Yates in age, buried certain portion of the reef and emerged on the seaward face as foreset beds. However, reef organisms quickly re-established themselves and growth continued uninterrupted.

Toward the close of Guadalupe time the Delaware Basin was cut off from access to the open sea, probably by the formation of a barrier reef across a channel to the southwest just as the Capitan Reef cut off the Midland Basin. For a time the reef continued to grow upward and seaward but slowly back reef sediments encroached upon ut and by the end of Guadalupe time had buried much of the reef. In the vicinity of the entrance to Carlsbad Caverns the Tansill formation covers the reef to a depth of well over 100 feet.

At maturity the crest of the reef stood, in places, as much as 1800 feet above the basin floor and in the northern end of the Delaware Basin had advanced as much as 30 miles from its point of origin though, in most places, the advance probably averaged less than 5 miles.[2] In this thick, competent bed of reef limestone lies the key to the tremendous vertical development of Carlsbad Caverns.

Closing Guadalupian deposition the Delaware Basin was uplifted and tilted gently eastward filling, during Ochoa time, with evaporites which were capped by a thin layer of anhydrite and limestone and covered with thin Permian redbeds. Not until the Cretaceous did conditions conducive to marine deposition return to the cavern area. Then the Comanche Sea invaded the region and in Washita time probably extended over the rocks in which the caverns later developed.[3] Subsequent to the retreat of this sea no evidences of marine deposition are to be found.

By the close of the Permian period and, in fact, by the end of Guadalupe time the limestone in which the caverns were to be created had been deposited. By late in the Cretaceous events had set the stage for the first cycle in cavern development. While some of the joints, as suggested by King, may be older it is felt that the major portion of the jointing is late Cretaceous or younger. Along these joints ground water began, by solution, the slow process of excavating the gigantic cavities forming Carlsbad Caverns.

Dr. William Morris Davis' two cycle theory of cavern development predicates first a phreatic phase, during which cavities are formed by the dissolving action of ground water, taking place below a land surface either peneplaned or almost so and a vadose phase, during which these same cavities are refilled with silt and secondary structures, occurring during a later cycle of erosion when by uplift or a lowering of base level the water table had dropped. This theory, along with a modification suggested by Swinnerton[4] which places the zone of major solutional activity at or immediately below the water table and thus furnishes an explanation of the development of cavern levels, is the one relied upon for an explanation of the formation of Carlsbad Caverns for although streams have flowed through the caverns they have been late and small having neither developed them nor modified the general solutional pattern. They have, rather, simply utilized already existing passageways.

From the end of the Cretaceous onward until late Pliocene or early Pleistocene the conditions postulated by Dr. Davis as necessary for the phreatic stage of cavern development persisted. This area remained a low lying one of little elevation and slight relief. Peneplanation may have and probably did occur. Under these conditions ground water, with carbon dioxide as the corrosive agent, removed millions of tons of limestone as a soluble bicarbonate and hollowed out the capacious rooms and corridors forming Carlsbad Caverns today. At first, action must have been exceedingly slow as migrating ground water enlarged cracks and fissures and removed the more soluble portions of the enclosing rock. Gradually, however, as passageways were enlarged and opened ground water movement and consequent solution became more rapid. This movement was channelized along joints existing in the limestone so that the general cavern pattern is joint determined. The major areas of development follow closely the general northeast-southwest, northwest-southeast alignment of the joints.

In its earliest stages Carlsbad Caverns was composed of an intricate maze of small passageways and solution pockets with ground water working on all exposed surfaces. The area now containing the great rooms and galleries must have appeared much like an enormous honeycomb or sponge, riddled with small corridors superimposed upon and paralleling one another and rotten with solution cavities. Excellent examples of this early stage of cavern development appear in the Lower Cave and the Left Hand Tunnel and can be viewed from the scenic trail at the Boneyard, a section near the lunchroom. In these areas the work of phreatic water and the control exercised by jointing can be seen unmasked by collapse which conceals it so effectively elsewhere. Here small passageways, developing along a set of joints, parallel one another with only thin partitions intervening, connecting corridors, also joint determined, cross at right angles, turns are abrupt while floors, walls and ceilings are so shot with solution pockets that a rotation of 90 or even 180° would not materially change the appearance of the area.

Following Swinnerton's theory of major development taking place at or immediately below the water table Carlsbad Caverns exhibits three well defined levels,

2. Adams and Frenzel – Journal of Geology – June, 1950.
3. Lang, W.B. – Bulletin of Amer. Petroleum Geologists, August, 1947.
4. Swinnerton, A.G. – Bull. Geological Society of Amer. September, 1932.

the highest, some 180 feet below the present surface, is represented by the Bat Cave, Auditorium, Devil's Den bridge section. A second, the Big Room, Left Hand Tunnel lies at 750 with the lowest, represented by the Kings Palace complex and the Lower Cave lies at 830. A possible, and in fact probable, fourth level, represented by minor remnants at the floor of the Devil's Den, may have existed at about 450 feet. These highly developed areas may well represent long periods during which the water table remained relatively constant.

As solution continued walls and partitions separating small corridors and enlarging solutions pockets began to disappear. Ground water ate away at intervening structures and by undermining and loosening blocks along joints and fissures caused them to collapse carrying others with them in their fall. Through the combined processes of solution and collapse innumerable small galleries and cavities coalesced into larger and larger ones. This process of collapsing, inaugurated during the phreatic phase of cavern formation, undoubtedly was accelerated as the cavern passed into its vadose phase for the vast piles of debris, in places 300 feet thick, masking the floor of the Main Corridor show little of the effects to be expected had they fallen into any considerable quantity of water. In fact it is quite obvious that much, if not the major portion, of the collapsing in the Main Corridor occurred after drainage for there great stalagmites six to eight feet in diameter and ten to fifteen feet in height have been broken by collapses taking place from the north wall. This collapsing shortened immeasurably the total mileage of passageways but accounts for the awe-inspiring size of Carlsbad Caverns' chambers and corridors. Occurring primarily in areas where long continued solution had riddled and rotted the enclosing rock collapse has masked the processes by which the caverns developed. In portions of the Lower Cave and Left Hand Tunnel, however, either the period of active solution was shorter or the waters there were almost saturated and the action less effective for in those areas little collapse has occurred. Smaller and less spectacular than the sections visited by regular visitors they, nevertheless, display, naked and unconcealed, the evidences of the phreatic origin of the caverns.

Until the close of the Pliocene or the beginning of the Pleistocene little change took place in the area to disturb the slow removal of limestone by solution and the slow growth of the cavities which later became Carlsbad Caverns. It remained a section relatively low lying and of little relief although Dr. Bretz has suggested that during the Pliocene the Capitan reef may have emerged as a low scarp rimming the Delaware Basin.[5] Certainly the water table was lowering for erosion has exposed remnants of caverns which had passed through a vadose phase lying higher in the section than Calrsbad, Nevertheless, the streams draining this area were those developed on a land surface of low relief as amply evidenced by the drainage pattern stenciled on the present landscape.

Late in the Pliocene or early in the Pleistocene occurred the faulting responsible for the formation of the Guadalupe mountains.[6] The area was lifted and tilted gently to the northeast. Streams were rejuvenated, erosion accelerated, and the developing Pecos began to play its part in determining the local base level. As the streams, inherited from the older land surface, trenched the rising limestone upland and as the Capitan Reef began to emerge softer sediments, filling the Delaware Basin, were more rapidly eroded than were the resistant reef deposits the water-filled cavities began to drain. This lowering of the water table effectively brought to a close, in those areas where drainage occurred, further enlargement of the cavern system although, as mentioned earlier, collapsing, by integrating numerous small cavities into single large ones, continued the process of developing huge and awe-inspiring chambers and galleries within the reef. Below the drained zone solution continued. In it the vadose stage, during which caverns are destroyed, began.

During the vadose cycle redeposition of carbonate deposits, silts, and other secondary materials tend to fill and destroy caverns. Gone is the rugged strength and barren structure of maturity. In decadence and old age beauty blossoms like the last rose of summer. Pendant stalactites drip like jeweled chandeliers from the ceilings, majestic stalagmites rise from the floors, ribbon stalactites, hanging like huge draperies, soften harsh outlines and a mantle of flowstone smooths and conceals the walls. Carlsbad Caverns, unrivaled in its wealth of decorations, wears its badge of decadence proudly. It is, of course, this autumnal beauty which draws hundreds of thousands to it annually to view the almost endless variety of sculptured forms which nature,

5. Bretz, J. Harlen – Journal of Geology – September 1949.
6. King, P.B. – U.S.G.S. Professional Paper, No. 26.

with a lavish hand and infinite patience, has provided.

Just as water, through solution, was responsible for the formation of Carlsbad Caverns so is it the major instrument in its destruction. Water falling on the surface in the form of rain or snow picks up and takes into solution carbon dioxide as it passes through air and decaying vegetation. Weakly acid, it passes through the limestone cover as it seeks the water table. In so doing it takes some of the limestone into solution as a bicarbonate and as it appears on the ceiling of an air filled cavity and hangs there as a droplet the loss of carbon dioxide through evaporation forces the precipitation of the soluble bicarbonate as a ring of carbonate. Then, as droplets continue to appear in the same spot, the ring lengthens into a hollow tube and a stalactite is born. Excess water drips to relatively dry floors and there, by a similar process in which the loss of carbon dioxide is more rapid, builds stalagmites upward. Ribbon stalactites develop as water trickles slowly down sloping surfaces. Eventually they may grow into huge, pendant draperies such as decorate many portions of Carlsbad Caverns and are so beautifully displayed in the Queen's Chamber and Papoose Room. Fantastically gnarled and twisted forms called helictites appear sparingly in the Cavern rooms. While considerable discussion still rages about their mode of origin artificial ones have been developed under laboratory conditions by hydrostatic pressure upon a closed tube, by a slow rate of flow and by critical aperture.[7] Apparently rate of flow is the critical factor in their development.

Lacking in coloration Carlsbad Cavern depends for its beauty on a lavish display of form. Infinite variation in shape and size delights the eye and helps to compensate for the lack of color. Because the limestone cover has so little of the minerals impurities which, in other caves, sometimes provide considerable color cavern formations here are, in the main, a milky white. Iron oxide provides the pigmentation responsible for shades ranging from faint cream through rust red. Some lemon yellows and faint pinks appear but much of the color actually present is masked both by the opaque scale developed as formations dry and the low intensity of cavern lighting. Pastel shades predominate throughout.

The secondary structures which adorn Carlsbad Caverns can, of course, hardly be older than Pleistocene in age for not until that time could the major portion of the now existing cavern system have been drained and the stage set for the introduction of the vadose cycle. Many, and in fact, most are probably no older than mid-Pleistocene. It is to be expected that since the upper portions of the cavern drained first the formations there would be the oldest. However, in these upper sections, sequence after sequence of collapse has scaled walls and ceilings and buried floors so that older formations have been destroyed. The rather barren Main Corridor, where collapse has played a prominent part in cavern development, contrasts sharply with the highly decorated scenic rooms at its western end for there collapse is almost non-existent and secondary structures have been well preserved with almost everything deposited there still in its original condition. In these areas, as well the Lower Cave, water lingered long after it had drained from the Big Room level for here, in contrast to the highly decorated ceilings, the silt covered floors are relatively barren. This lack of stalagmites can only indicate conditions under which the floors were water covered. In all probability formations in these lower areas are approximately of the same age as those in the upper sections for the opaque scale covering many of them; which develops as formations lie dormant, is as thick as it is upon those of identical size and shape in the upper level.

To determine the age of the formations beautifying Carlsbad Caverns by any means other than inference is, at present at least, impossible. Size is, of course, no indicator for so erratic is the development of these carbonate deposits that no average rate of growth, applicable to all, can be established. The primary factors involved are the amount of bicarbonate brought through to the ceiling and the rate at which carbon dioxide is lost after reaching them. Without effort at least a half dozen minor factors spring to mind which would influence the two major ones. These include the quantity of water arriving at the ceilings, the amount of carbon dioxide in such water, the thickness and solubility of the rock through which it passes, and the relative humidity within the air filled cavity which in turn depends upon temperature and rate of air flow. All these variables make it impossible to establish an average rate of growth for even one formation. As an indication, however, of possible rates of precipitation under present conditions the growth rate of the Crystal Spring Dome, the largest active formation within the cavern is of interest. Growth of this massive stalagmite wsa measured in 1942. At that time this formation was adding to its volume at the rate of 1.75 cubic inches per year. To further complicate matters the precipitation of calcium carbonate has not been continuous. Just as the caverns are today dry

7. Huff – Journal of Geology – August-September 1940.

and inactive so have they been at times in the past. Cross-sections of both stalactites and stalagmites reveal that periods of decay and desiccation have alternated with periods of growth indicating fluctuations in climatic conditions from times of humidity to times of aridity. Probably these cyclic variations were associated with climatic changes induced by various periods of glaciation although some of the growth bands are so narrow as to indicate other causes of fluctuation in the supply of moisture available for the development of secondary deposits. The very forms of these precipitated structures, particularly the stalagmites, serve as keys to the conditions under which they arose. Broad, massive domes indicate an abundant supply of drippage. Where these are smooth the quantity of water was sufficient to cover the formation completely; where ribbed, the flow, insufficient to film the structure, trickled down in tiny rills. Formations alternately spreading and contracting show beautifully the effect of the increase and diminuation of water falling on them. Those domes with smoothly rounded tops died swiftly as their source of moisture disappeared with relative rapidity. Others, rising as regular cones display the effects of a slowly and regularly diminishing flow. Some have even developed with an inverted conelike shape and these exhibit the results of a constantly increasing supply of moisture. Their flat tops, however, announce the speed with which their source of drippage disappeared. A regular rhythm of dormancy and rejuvenation marked the development of Carlsbad Caverns' wealth of decorations. Cycles of growth alternated with cycles of dormancy as secondary structures slowly attempted to refill the caverns. Perhaps it will, at some future time, be possible to correlate these cycles with climatic cycles occasioned by Pleistocene glaciation. At present the idea remains only a working hypothesis.

Just as the formations have been subject to fluctuation in their development so has the cavern. Having passed from the phreatic to the vadose stage certain areas have again returned to the phreatic. All through the lower portions of the caverns this return to phreatic conditions is apparent. At least two and perhaps three of these returns have left obvious evidence behind. Probably there were even more. Stalagmites and stalactites, formed during the vadose phase, have been redissolved by water unsaturated with bicarbonate. These are best displayed in the Left Hand Tunnel and the Mystery and New Mexico Rooms. In the Big Room evidence indicates that long after massive formations had developed these returns to phreatic conditions involved once a precipitation of carbonate deposits, and at another date the deposition of sulphates.

Most of the formations in the Big Room and the lower, scenic ones are covered with a clinker-like deposit of calcium carbonate deposited during an episode of reflooding. From the line of precipitates observable in the Hall of Giants it would appear that this room was flooded to a depts of twenty feet or more and that, of course, the lower chambers were completely refilled. Remnants of a vast gypsum fill, whose tops still stand some 12 to 15 feet above the floor, are widely scattered throughout the Big Room. In the Lower Cave this deposit has been completely removed. This material could not have come from Ochoan sediments overlying the caverns for long before these areas had been drained those deposits had been removed. There is a remote possibility that the gypsum may have been derived from the deposits of the back reef. It is, however, much more likely that the source lay in the Castile sediments of the Delaware Basin where, even now, gypsum is known to approach within twenty feet of the reef. That this material is secondary and records a return to phreatic conditions and is not the remnant of a gypsum lens as suggested by Darton and others is amply evidenced by the fact that it engulfs secondary carbonate structures and blocks of limestone which have fallen from walls and ceilings. Exactly when these returns to phreatic conditions occurred is unknown. Certainly, however, they record climatic conditions radically different from those pertaining today so that it may be reasonably assumed to have occurred before the end of the Wisconsin glaciation.

Since the deposition by, far the major portion of this vast gypsum fill has been removed, in the Big Room at least, by the action of dripping water. The remaining blocks, usually lying in protected alcoves or under overhanging ceilings where little drippage has occurred, are riddled with tubes, developed both chemically and mechanically, and have suffered a loss of at least 60% of their apparent volume.

To accept, as we must on the basis of visual evidence, the phreatic origin of Carlsbad Caverns is not to deny that in many instances underground streams, during the vadose phase, do play a part in modifying the general solutional pattern of caverns. Moving through passageways opened in an earlier stage they, by erosion, alter and change them, modifying their shape, size, and alignment. At Carlsbad Caverns, however, this has not been the case. Although streams have flowed through it they have been obviously too small and too short lived to have influenced its pattern of development. At least three streams have flowed through the cavern. Entering from the north, from the direction of Walnut Canyon, they turned west, traversed the floor of the Main Corridor, passed through the lunchroom and into the Lower Cave still flowing westward. In the vicinity of the Jumping Off Place they turned northward, away from the reef front, and after flowing some three hundred yards in that direction disappeared in an impassable maze of tubes and siphons. The conditions governing the flow of these streams and the areas into which they discharged remains an unsolved problem.

The first stream must have been almost phreatic in its lower reaches and its discharge area relatively high or its conduits insufficient to handle its volume for it evidently moved rather slowly. In the Lower Cave it deposited beds of fine, red, sandy, silt as much as twenty feet deep. While these sediments may possibly have been derived from the cave itself they resemble more closely the decomposition products of the sandy beds near the head of Walnut Canyon. In some deposits in the Left Hand Tunnel the silt appears varved and these may have been deposited under conditions when increased volume or restricted flow produced local pondings.

Following this episode, during which silt was deposited, a second, more vigorous, stream trenched the silts and built cobble bars and terraces some twelve feet or more below its top and four feet or more above the present, abandoned stream bed. These cobbles appear to be composed entirely of reef limestone. Transportation has fairly well rounded these blocks which range up to eight inches in length, six in width, and four or more in thickness. Their size attests to the velocity and volume of the stream transporting them. Subsequently the deposits of this second stream were eroded by a third whose abandoned bed forms much of the present floor of the Lower Cave. This last stream, while evidently of small volume and relatively low velocity was, nevertheless, able to transport the body of a ground sloth into the caverns. Under the Devil's Den the lightly covered bones of this sloth, a creature the size of a small deer, were discovered in the silty bed of this third stream. While these fossil bones do not date the period of flow exactly they do set a minimum age at which it was active.

Under present climatic conditions Carlsbad Caverns is, and has been for several thousand years, undergoing a slow process of disintegration. The small amount of rainfall received annually is insufficient to keep the formations active. It has been estimated that less than five percent of the formations within the cavern are still wet and growing and this figure probably is in error on the optomistic side. Slowly the secondary structures disintegrate as they dry. First an opaque scale develops and as the process continues they break down, as have portions of Fairyland, into a crystalline powder. While this process of destruction has occurred time and again only to be reversed by more humid climatic conditions and it is, therefore, not impossible that this may happen again. Such changes involve such long periods of time, measured by human standards, that it is imperative that what is be preserved. To preserve and protect the matchless beauty of this gigantic, awe-inspiring cavern, Carlsbad Caverns National Park was established.

Passing from a consideration of the slow, impersonal forces responsible for its development to man's cognizance of it we find that the first humans to view its yawning mouth were Indians. Pictographs on the walls of the entrance and a sandal found there stand as proof that the Basketmakers knew it. While, at its purest sites, the phase of this culture represented at Carlsbad Caverns is normally dated at around 700 A.D. it is by no means certain that here in southeastern New Mexico, a rather backward area where cultural traits changed slowly, it can be assigned such an early date. However, it can be reasonably assumed that as much as a thousand years ago these people had discovered the entrance and used it as a shelter. Besides their pictographs these people left, as evidence of their use of the area, the surrounding ridge tops dotted with "mescal" or cooking pits, circles of broken, fire scorched, rocks, in which they and the Apaches, who followed later, cooked the hearts of plants such as agave and sotol.

Not until almost the close of the last century did Americans discover this jewel of the Guadalupes and even then some forty years elapsed before the explorations of Jim White and others and the investigations of Robert Holley had sufficiently publicized its grandeur and beauty to secure its preservation for the American people. In 1923 a proclamation by the then President Coolidge established it as a part of the National Park System as Carlsbad Caves National Monument. In 1930 by Act of Congress, the monument boundaries were extended to provide protection to other caverns in the area and Carlsbad Caverns National Park, destined to play host to more than half million visitors yearly who come to gaze at the awe-inspiring size of the caverns' rooms and corridors and the beauty of its matchless decorations, was established.

Located in the foothills of the rugged Guadalupe mountains, in a land of little rain which barely escapes being a true desert, the vegetation and the animals dependent on it bear the mark of deficient moisture. Only plants which have adapted themselves to this sparse environment have survived. Some have done so by evolving moisture conserving structures and habits, cacti, for instance, having dispensed with leaves by using chlorophyl in special adaptations of its stems while the ocotillo drops its leaves during periods of drouth. Most of these protect themselves by wicked thorns or an unpalatable taste. Others take advantage of the scanty rainfall by springing quickly to life, blossoming, maturing their seed rapidly and then disappearing.

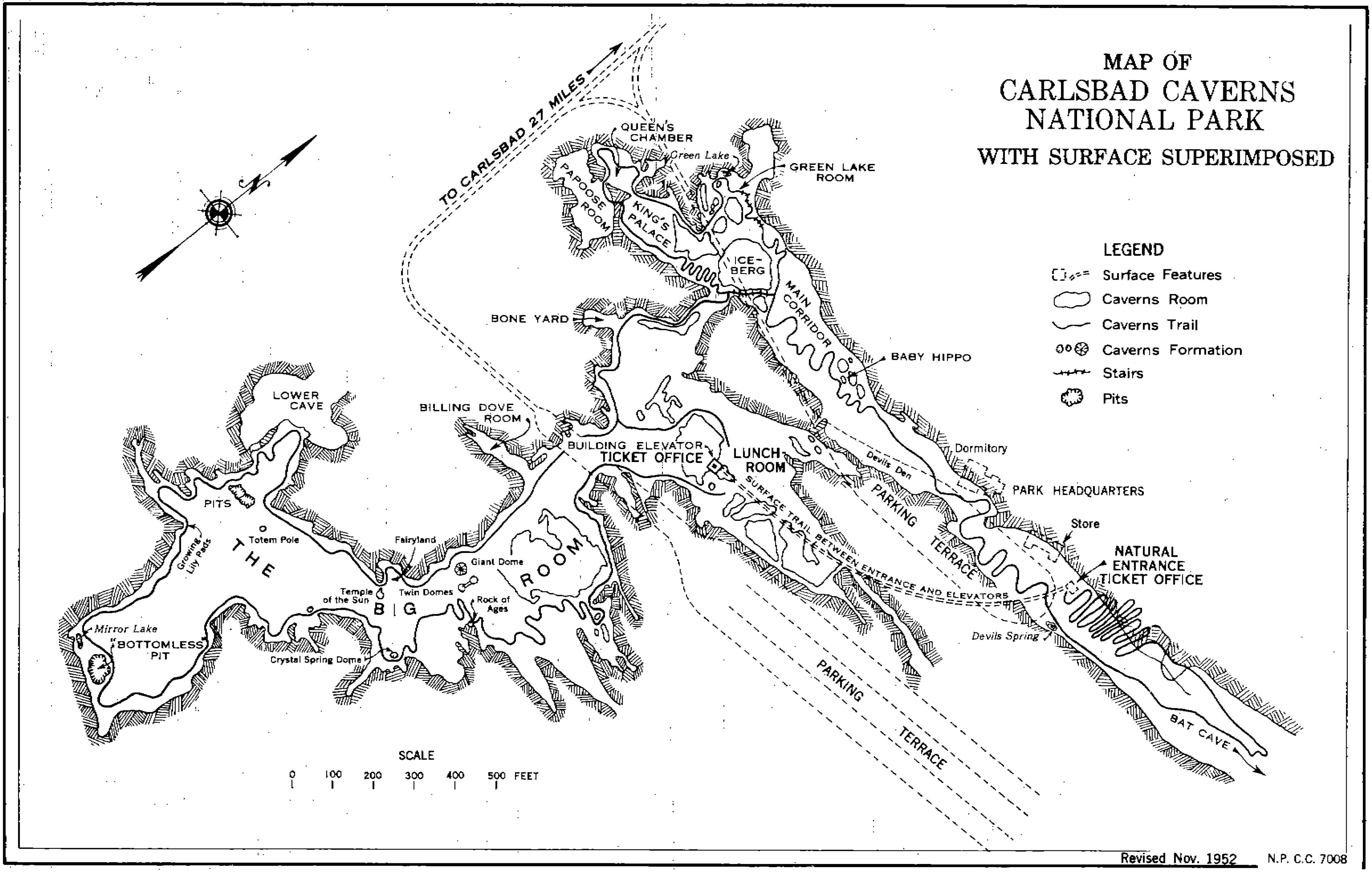
Within the Park's boundaries grow the stately, palm-like Torreys and the more delicate Soaptree Yucca. Several specie of cacti decorate the stony hillsides. In the springtime, they, the ocotillo, mescal bean, and Mexican buckeye, splash vivid patches of color on canyon floors and valley walls. Of the cacti the prickly pear, walking stick, claret cup, and strawberry pitaya are the most conspicuous as their brilliant blossoms brighten the rocky slopes. The ubiquitous lechuguilla, a Lower Sonoran indicator plant, mantels the flat ridge tops and spills down the slopes. Mingling with it juniper, indicator, along with pinyon, of an Upper Sonoran environment dot the hillsides. In the canyons and where seeps supply moisture, walnuts, soapberry, hackberry, desert willow, madrone, and grey oak form clumps of shrubby trees. In the higher reaches of the park, pinyou and ponderosa pine appear.

Animals, like the plants, have adapted themselves to semi-desert conditions. Visitors to the park are rarely aware of its wealth of wildlife for these creatures, in order to escape the heat, wisely conduct their activities during the cooler hours. Late in the evening, throughout the night, and in the coolness of early morning, they feed and frolic. The land is not as barren of life as it seems. Small rodents such as mice, rats, rabbits, and gophers, the bread and butter of the smaller carnivores, abound. Upon them feed raccoon, ring-tail cats, skunks, weasels, fox, and bobcats. Mule deer range the area and upon them feeds the occasional mountain lion observed here. Bear and mountain sheep, now driven to the higher, more rugged portion of the Guadalupes, once ranged the park.

No mention of Carlsbad Caverns would be complete without some consideration of the bats. For thousands of years Mexican free tail bats have inhabited portions of it. The accumulation of guano below their roosts gave rise to the first commercial use of the caverns. It was while working for concerns mining this deposit that Jim White did the major portion of his exploration. As food conditions fluctuate, so does the number of bats who live in the caverns. The size of the group varies from as few as 100,000 to as many as 8,000,000. Each summer evening they fly forth for food and water. A good flight is as spectacular a biological phenomenon as the caverns is a geological one. Tremendous quantities of insects are destroyed nightly by this swarming host of winged mammals. With the first frost flights cease, most of the bats migrating, but with the return of spring flights are again resumed.

To return to the park's major attraction, it bears repeating that the development of Carlsbad Caverns, through a span of time almost incomprehensible to man, was essentially the work of water from beginning to end. In the Permian sea algae laid down the great mass of limestone which alone made possible its immense vertical development. Ground water slowly, with infinite patience, dissolved the rock along zones of weakness until enormous cavities developed. Following drainage, water, in the form of rain and snow began to destroy it. In so doing the magnificient decorations, which made it a thing of beauty and a joy forever, came into being.

Hidden in the forbidding ridges of the Guadalupes its discovery came late enough to save it from destruction at the hands of thoughtless individuals. Now, as part of the National Park System, it belongs to the nation as a whole to be enjoyed but not exploited; to be used so that its beauty will bring pleasure and recreation, in the best sense of the word, not only to us but to future generations as well. Justly famed for the magnificance of its almost limitless wealth and infinite variety of decorations, the general outlines of its development known, it, nevertheless, offers a series of challenging problems to the inquiring mind.



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