Organ Cave

13

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Abstract

Organ Cave with a length greater than 38 miles (62 km) is the second longest cave in the Greenbrier Karst. It is located beneath a fragment of the Big Levels karst surface bounded by the Greenbrier River to the north, Second Creek to the south and west, and shales and sandstones to the east. Organ Cave is a contact cave with the active drainage cut into the underlying Maccrady shale. It displays a dendritic drainage system with multiple streams merging to a common resurgence on Second Creek. The geologic setting of the cave, both stratigraphic and structural, is presented in considerable detail. The main trend of the cave is along the Caldwell Syncline. Chert horizons in the Hillsdale Limestone and steep folding and minor faulting have all served to guide passage development. The cave has a long exploration history extending back to the mid-twentieth century.

13.1 Introduction

The Organ Cave Plateau is located in Greenbrier County under the community of Organ Cave (Fig. 13.1). To date, ten entrances to the system have been discovered, and 38.452 miles of passage have been mapped. The Organ Cave System is one of 46 caves, which have been found on the Organ Cave Plateau. The surface of the plateau is generally at an elevation of 2200 ft above sea level; however, some residual hills rise another 100–200 ft and several sinkholes are over 100 ft deep. The Greenbrier River and its tributary Howard Creek bound the plateau on the north. The Greenbrier River also forms the plateau's western edge. Second Creek and its tributary Carpenter Creek bound the plateau on its south side. These boundaries cut into the plateau causing escarpments of 400–600 ft. White Rock Mountain runs in the north–south direction at elevations of up to 3100 ft above sea level and forms the eastern boundary.

The Organ Cave Plateau is underlain by limestones of the Middle Mississippian Greenbrier Group. On the Organ Cave Plateau only its two lowest members, the Hillsdale and Sinks Grove Limestones, remain; the upper units have been completely eroded away. The limestones are about 200 ft thick in the area of the Organ Cave System. The cave-bearing limestones lie stratigraphically on the clastic red sandstone and shale sequences of the Maccrady and Pocono Formations which outcrop on the eastern surface of the plateau and along its north and west escarpments.

The Organ Cave Plateau is located near the eastern edge of the Allegheny Plateau physiographic province. Structurally, the plateau consists of gentle anticlines and synclines that are the result of the Appalachian orogeny. The more severely folded rocks of the Valley and Ridge Providence are only nine miles to the east. Locally, the main stream passage (Hedricks and Big Canyon) of the Organ Cave System is formed along the Caldwell Syncline, which plunges toward Second Creek at approximately 4° along a bearing of N30°E. Near the structural axis, the limestones are occasionally steeply dipping and overturned. There is also local faulting, which has influenced cave development.

Electronic supplementary material
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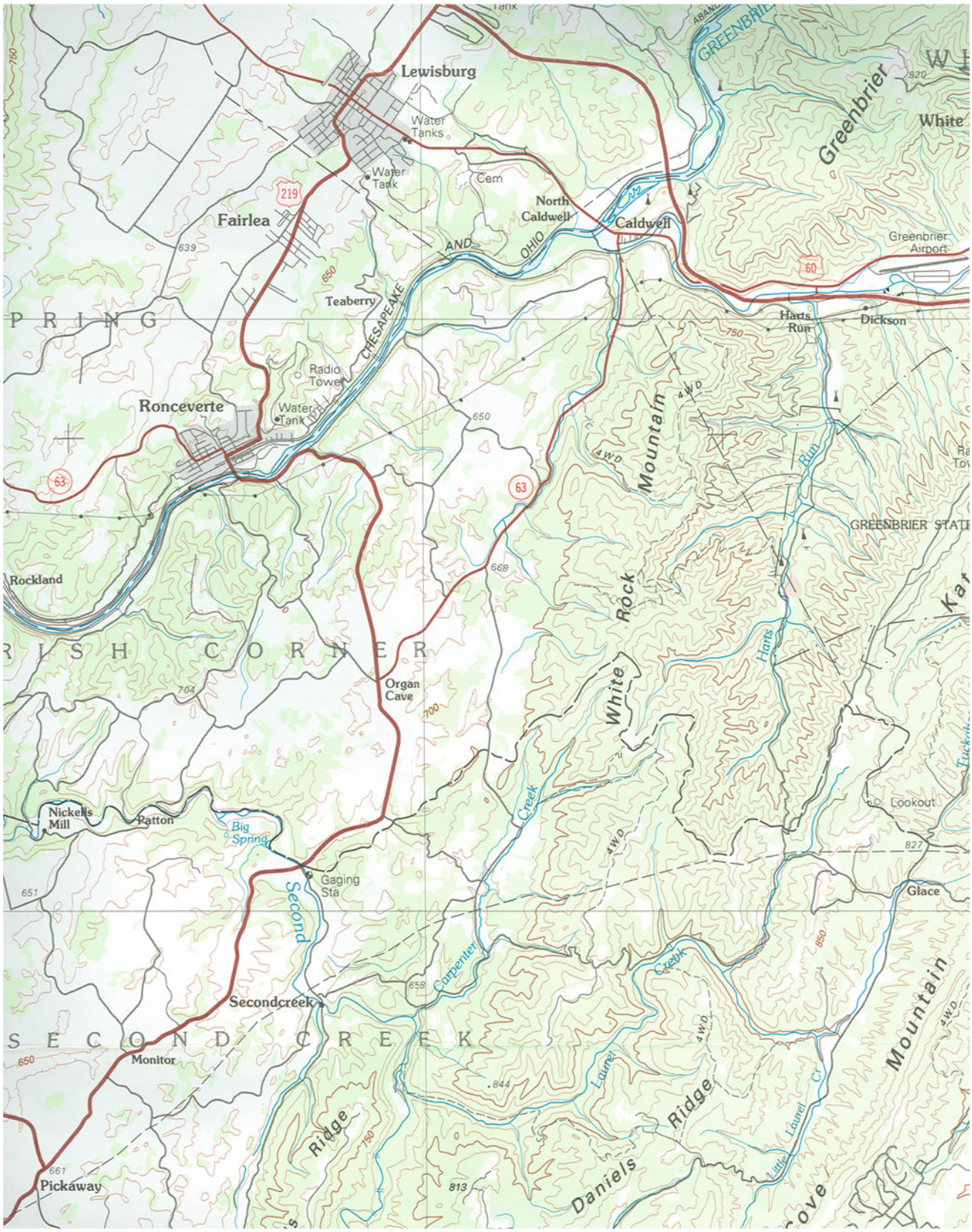

Fig. 13.1 Location map of the Organ Cave Plateau. Segment of US Geological Survey 1:100,000 Lewisburg sheet. Note this is a metric map with 50-m contour interval

The Organ Cave Plateau receives about 37 in. of precipitation annually which is evenly distributed throughout the year. Small surface streams drain from the shale into blind valleys and dolines and sink near the limestone contact. This drainage and direct percolation circulates through an underground drainage network to exit at a series of springs along Second Creek and the Greenbrier River. The underground streams have downcut 10–30 ft into the shale at a few points within the caves, but the shale generally acts as a relatively impermeable boundary.

Various fauna are found in the caves on the plateau, and the Organ Cave System is the type locality of several troglobitic species of crustaceans and snails. A variety of vertebrate fossils have also been discovered including those from armadillo, mastodon, and saber-toothed cat. Organ Cave was mined for saltpeter during the early 1800s and the American Civil War. While accounts of the cave date back to the late 1700s, modern exploration did not begin until 1948. Much of the early exploration of the Organ Cave System was conducted by members of the Charleston Grotto of the National Speleological Society (NSS) and the West Virginia Association for Cave Studies (WVACS). Members of the District of Columbia Grotto (DCG) of the NSS continued the exploration and survey of the system during the 1970–1982 time period. Since then members of both organizations have worked to further the project. As a result of these efforts, detailed maps of the caves were developed.

13.2 Historical Background

13.2.1 History of the Region

Organ Cave lies in the Irish Corner District of Greenbrier County named after its early settlers many of whome were Scotch Presbyterians from the Province of Ulster in the northern part of Ireland. They settled the area just prior to the start of the American Revolutionary War in 1776 (Humphreys 1926; Rice 1970). Prior to their settlement, the land was a popular hunting area for the Indians who camped here in large numbers. The French claimed the region before the French and Indian War (1756–1763), but did not establish settlements. There were repeated attempts by the English to settle Greenbrier County between 1749 and 1768, but the French and Indians killed or drove the settlers out (Stuart 1971). In the early 1800s saltpeter, an essential ingredient of gunpowder was mined from Organ Cave. The Old Virginia Saltpetre Route terminated at Uniontown (now Union, WV), and "it is very probable that Uniontown was a collecting and trans-shipping center" for Organ Cave and the other saltpeter-producing caves in the area (Faust 1964). Prolix (1837) describes a visit he made into the cave and mentions the existence of a saltpeter section. The cave's 1812 Room, just off the main entrance passage, is the site of saltpeter mining reputed to have occurred during the War of 1812. It still contains the decaying remains of several saltpeter vats.

The Saltpetre Room on the current commercial tour route was used for saltpeter mining by the Confederacy during the American Civil War (1861–1865). There are over 37 vats in the room, and some of them are in excellent condition. During the war, water was carried in wooden buckets from the Main Organ Stream and dumped into the vats. After dissolving the calcium nitrate in the saltpeter dirt, the water was collected in wooden troughs and carried out of the cave in buckets and placed in kettles along the entrance road. This mother liquor was mixed with the leachings from wood ashes, filtered, and then boiled to crystallize potassium nitrate, an essential ingredient of gunpowder (Sively, G., personal communication, 1985).

Cave visitors of the early 1800s not only mined saltpeter, they explored the cave. Several dates can be found written on the wall of the Upper Stream Passage more than a half mile from the Organ Entrance.

13.2.2 Organ Cave as a Tourist Attraction

Organ Cave was named after a calcite formation which resembles a pipe organ in a large auditorium (Fig. 13.2). The speleothem is about a half mile into the cave and is easily accessible by tourists. Early descriptions of it indicate that it was formed by "white stalactites" and gave "an exact reproduction of a large pipe organ-at least by striking on the different pipes notes of remarkable purity and strength are reproduced" (Cole 1917).

The first recorded owner of Organ Cave was John Gardner who was granted the land from the Commonwealth of Virginia in 1783. Ownership of the cave passed to Thomas Cox in 1819 and then via his heirs to John Rogers in 1822. By then, the resorts at White Sulphur Springs (Greenbrier County) and Salt Sulphur Springs (Monroe County) were well established with turnpikes between them and the tide-water counties of eastern Virginia. Stage coaches regularly ran between these resorts hauling both passengers and mail. Often the coach would stop at John Roger's Organ Cave. One visitor of that era wrote:

> The mouth of the Organ Cave is situated nearly under the road, at the bottom of a deep ravine, which seems as if it had formerly discharged a large stream of water into the cave… The approach is very romantic, descending the steep and wooded side of the ravine, by a zig-zag path which leads by a easy slope to the black and yawning chasm. The preparation for exploring one of these cyclopean caves consists of a supply of pitch-pine sticks, faith in your guides, and folly in yourself. The sticks are about two feet long and each one as thick as a thin finger; fifteen or twenty of which being held together in the hand, and fired at the upper end, make the best of torches, will burn bright for two

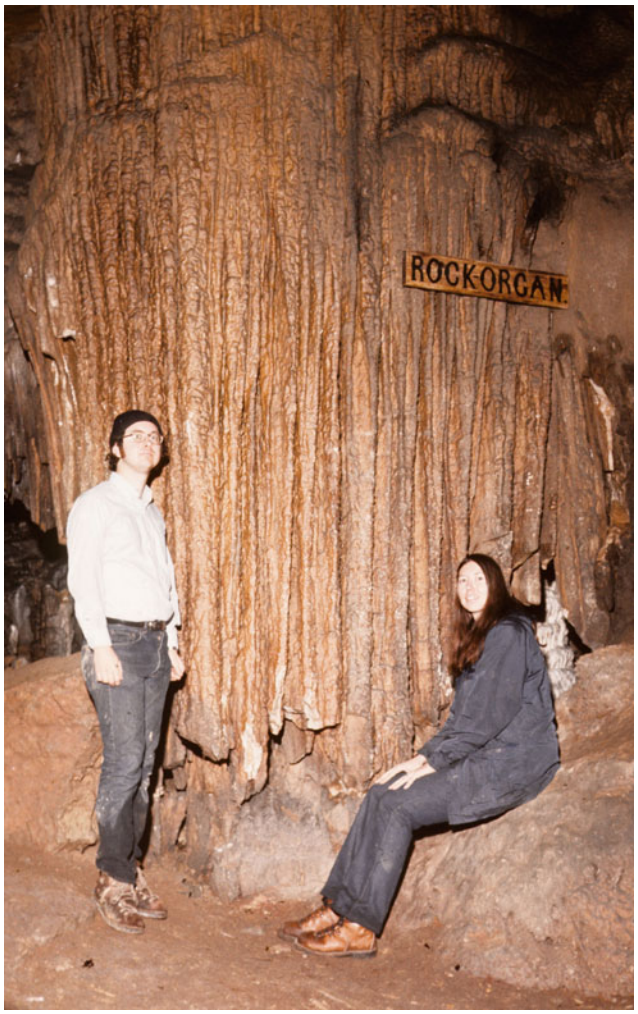

Fig. 13.2 The Rock Organ with Ray and Susan Cole. The Rock Organ is the best known speleothem in Organ Cave System, and the cave is named after it

> hours, and distinctly show the floor, sides and roof of the cave through the palpable obscure. Little magazines of sticks are judiciously left at intervals of a Quarter of a mile, as you penetrate deeper and deeper into the bounds of the land, to replenish from time to time the moribund luminaries. (Prolix 1837)

John Rogers sold the land containing the cave in 1836 to James Robinson who willed it to his daughter Elizabeth Boone, wife of George Boone. They in turn deeded the property to their son, James H. Boone, in 1878. While primarily a farmer, Boone opened the cave commercially in the early 1900s when every third visitor was given a candle to light the way for groups walking through the cave. In 1914 Boone completed the development of built-up pathways through the commercial section of the cave and installed Edison light bulbs powered by a Delco generator and 72 storage batteries (Sively, personal communication, 1983). Cole (1917) later wrote:

> Organ Cave has been made an object of interest to the tourist at considerable cost and labor by its owner, J. H. Boone. A perfect lighting system for lighting the cave has enhanced the scenes of the underground auditorium, some of which are extensive. Good walks lead to any and all points of interest along shore lines of miniature lakes, and through many long subterranean avenues and vast underground caverns. Hundreds of electric lights illuminate the darkened passageways and some thousands of dollars have been expended to make visits here of worth and long to be remembered. As a natural wonder it has to be seen to be appreciated.

James Boone sold the cave in 1926 to George Carter and Seth Sively of Sweet Chalybeate, VA, who moved onto the land in early 1927. While they were primarily farmers, they opened the cave each summer for tourism. The cave was also used for community dances and church services. The photograph of the Organ Cave Entrance circa 1927 (Fig. 13.3) shows the entrance building used by tourists to store their umbrellas (it was very fashionable then to carry one) and obtain candles and candle holders for their trip into the cave. By this time a dam had been installed in the commercial section of the cave to create a lake for trout as a tourist attraction. When George Carter died in 1942, his share of the ownership was willed to his daughter, who was then the wife of Seth. Upon the deaths of Seth in 1964 and Edna in 1978, ownership passed to their children, George Sively and Lorraine Sively Withrow. George Sively and his wife Lee continued to open the cave to tourists each summer, and Lee was principally responsible for the tourist operation. After the death of George Sively the property was put up for auction in 1994. Local residents Janie and Sam Morgan purchased the cave entrance and an adjacent parcel of land. The Morgans made improvements in the cave lighting, Civil War interpretation, and built a new gift shop and have kept the cave open for commercial tours. They also offer trips into the wild portion of the cave.

In the 1950s the US Government built a storage shed in the Organ Cave Entrance room and stocked it with survival

Fig. 13.3 Early entrance photograph circa 1927. Photograph reprinted from a postcard

supplies so it could serve as a shelter in case of nuclear war. However, the supplies soon degraded in the cave environment. More recently, the entrance room has been the scene of community dances and slide shows. The tourist entrance known as Organ Cave is now known to be one of the ten entrances to the Organ Cave System. None of the other entrances has been developed or used for any purpose other than caving, and most are rarely entered.

13.2.3 History of Cave Exploration

While areas of Organ Cave were well known in the 1700s, there is no record of systematic exploration prior to the late 1940s, when members of the newly formed Charleston Grotto of the National Speleological Society became interested in the Organ Cave Plateau. They began by exploring some of the other local caves in the hope that one of these would lead into an extensive system. On a photograph trip for *Life* magazine in 1946, they visited Hedricks Cave which was then considered only a small but pretty cave. During that trip Alice Williams (in a bathing suit for camera) negotiated a wet crawl and returned to report that the cave opened up and continued (Rutherford and Handley 1976). Bob Handley and Bob Flack returned to Hedricks Cave on December 12, 1948, for another photograph trip and to check the passage Alice Williams had found. During that trip Bob Handley found a bypass around the "water hazard" which had previously marked the end of the cave and the two cavers proceeded south along Hedricks Stream past its junction with the Masters Stream and "downstream to point where [the] ceiling is very low," the Hedricks Sump.

The following April, Bob Flack and Bob Handley returned with others to survey from the Hedricks Entrance to the Masters–Hedricks Junction. They then proceeded to explore up the Masters Stream until they found the North Entrance (Masters Entrance).

> [Then] on May 23, 1949 the three Charleston cavers Bob Flack, Bob Barnes and Bob Handley accomplished a long-hoped-for feat and virtually the 'dream of every caver' when they emerged from the commercial Organ Cave entrance amidst electric lights, tourists and the consternation of the cave owners after a three and one half hour underground journey from the Hedricks Cave entrance. [The] one way journey was made in record time through a fast trip down the known passage to its end, and a fortunate choice among the three possible routes. Added to the known sections of Organ Cave, the Hedricks mileage makes this network probably the most extensive known cave east of Kentucky. As Mac McGriff, Sarah McFarland, Charles Wray and Don Engel will testify after an 11-hour trip 'looking out' [for] additional possibilities, there are still a wealth of unexplored passages awaiting further investigation. (Flack 1949)

The discoveries continued at a fast pace. Over the July 15, 1949, weekend Bob Barnes, Don Engel, Bob Flack, Bob Handley, Mac McGriff, Sara McFarland, and Glen Musser found the Flack Room and Floyd Collins Avenue.

Bob Handley was one of the original explorers of the Organ Cave System. He explored the Hedricks Maze section of the cave in 1949 and is shown climbing Handley's Climb (Fig. 13.4), a 20-foot flowstone-covered vertical wall leading to The Great White Way, Handley Room, and the Waterfall Room in a series of trips. That October, Bob Flack, Bob Handley, and Siegel Workman discovered and explored the Cyclops Hall area, and in November Bob Flack, Bob Handley, Bert Ash, and Earl Walters explored Hedricks Maze including the Sarver Room and Bone Room. A fourth entrance, Sively #2, was rediscovered, having been known during the early 1800s (Humphreys 1926), at the end of a passage above the Rock Organ. The stream in Foxhole Cave (which lies above the Organ Cave System) was also dye-traced and found to feed into the waterfall of the Waterfall Room (Rutherford and Handley 1976). Thus ended the initial phase of exploration (Fig. 13.5).

Fig. 13.4 Bob Handley ascending Handley's Climb circa 1949. Photograph by Flack (1949)

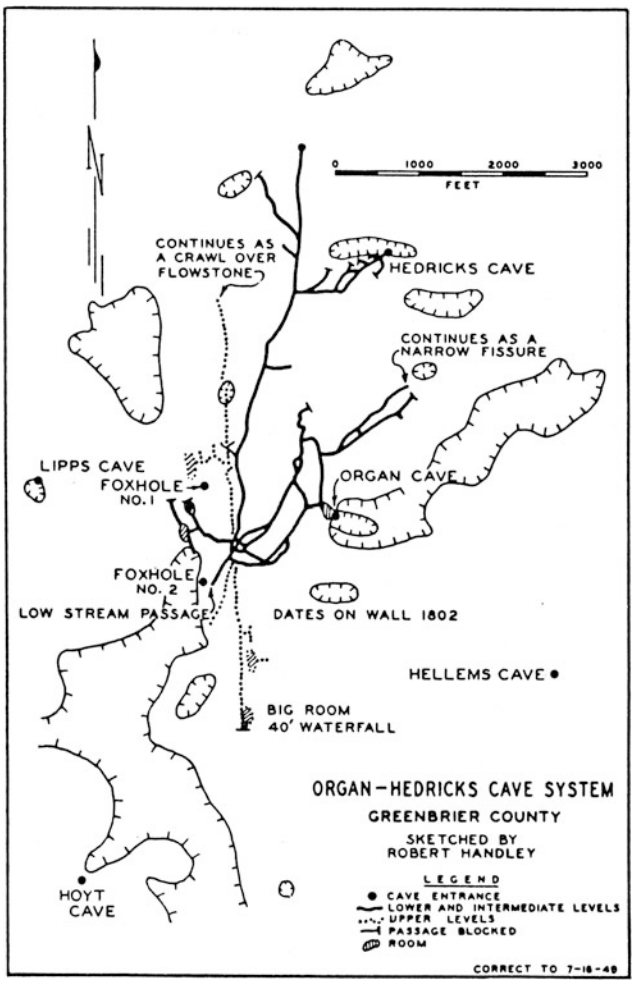

Fig. 13.5 The Organ–Hedricks Cave System as of July 1949. From Davies (1958)

The second phase began in 1951, when Handley, this time accompanied by John Rutherford, made more major discoveries. First in Humphreys Cave (for several years erroneously referred to as Erwin Cave) and then in Lipps Cave, lying to the west of Organ–Hedricks, they found drops which led to 40-ft-high stream passages. The Humphreys and Lipps trunk passages were quickly found to form a second major drainage net roughly parallel to, but a considerable distance west of, the Organ–Hedricks drainage. A second Lipps Entrance (Deems Entrance) was found nearby. Upstream exploration in Lipps–Humphreys was blocked by massive breakdown in each passage. About this same time, additional passage, continuing beyond the Waterfall Room, was found in Organ–Hedricks by David Bowen. This passage is a continuation of the Foxhole Cave drainage route, which formerly crossed the Waterfall Room at ceiling level. It quickly led to the Bowen Room, containing a 100-ft drop down the face of a huge flowstone cascade. At the bottom of the drop, the Big Canyon was found. This was a 40–60-ft-high and 6–10-ft-wide passage, which headed south for about 3500 ft until it was blocked by a sump. Ironically, David Bowen never descended the drop. Near the end of Big Canyon, a long rimstone crawl, named the Meatgrinder, led to the Rutherford Room and crawls beyond. Although the promising leads began to dwindle once again, the concept of the Greenbrier Caverns (Organ Cave System) had now been born needing only a connection of Lipps–Humphreys with Organ–Hedricks.

The third phase of work began with mapping in Organ–Hedricks by Earl Thierry. Because many of the early explorers had moved away from the area, the search for the connection proceeded slowly until Hugh Jones and Conrad Revak, two budding young cavers from Charleston, had to be rescued from the drop in Lipps after becoming stuck. Undaunted by their awkward introduction to the system, they eagerly joined Handley in the search for the connection by a systematic check of all leads in the northwest part of Organ–Hedricks. Working off the Handley Room, they ultimately pushed a series of rocky crawls westward into Jones Canyon, another stream passage which lay between and parallel to the two parts of the presumed system. Then, working through a maze of crawls, the three cleared a breakdown choke and finally made the connection with Lipps in September of 1958 (Rutherford and Handley 1976).

By now, the cave system was well known in the caving community and caving traffic was at an all time high. Unfortunately, some cavers failed to treat the landowners and their property with respect; as a result, caver–landowner relations gradually deteriorated until most of the entrances were closed.

In the summer of 1958, several cavers left the rails off the pit opening that is the Hedricks Entrance. A calf fell in causing the landowner inconvenience and loss of property. Subsequently, friends of the owner wired a bale of old fence wire securely in the entrance to prevent access—in lieu of it being sealed. In the summer of 1960 several determined thoughtless spelunkers cut their way through the reel of wire and entered the cave. Other cavers camped on the owner's land without permission. As a result of these incidents, the owner has sealed the cave permanently with fieldstone and concrete.

In 1959 cavers camped in and near the Lipps entrance without permission leaving a mess. On another occasion, inexperienced spelunkers stranded themselves down a pit and required rescuing. Because of incivilities at the commercial Organ Entrance, the owners installed a gate and lock. In the winter of 1960 cavers entered the Organ Entrance without permission and, upon emerging, built a bonfire adjacent to the souvenir stand (Stafford 1961).

In 1964 Hartline (1964) told of other incidents and reported that the local landowners had closed the entrances to Organ, Foxhole, Hedricks, Lipps, and Hellems due to the actions of discourteous cavers since 1958.

In 1961 the West Virginia Association For Cave Studies (WVACS) was formed by many of the cavers who had been active in exploring the Organ Cave System (which they called Greenbrier Caverns) to promote the exploration and study of all West Virginia caves. During WVACS's early years exploration in Organ Cave System was suspended until landowner relations improved. In 1964 WVACS members Charles Maus and Henry Stevens quietly resumed surveying in the less heavily traveled Lower Lipps portion of the cave. Their goal was to resurvey the system so as to bring the survey up to WVACS's new standards. The strategy they adopted was to first survey the trunk passages in order to create a multiple loop baseline from which to branch out. In the process they found new passage to the west of the Lower Lipps Stream and a connection from the lower end of Jones Canyon to the Rutherford Room and the Big Canyon. Surveying continued well into 1970. Over 16 miles of passage was resurveyed in comparison with the 23 miles mapped in the previous survey effort. During this period, John Fisher, Jack Gravenmier, and Bob Amundson maintained the survey data in a computer database.

The year of 1970 was a period of transition between the survey efforts of WVACS and DC Grotto members. Originally, DC Grotto members led by Pat Moretti were just going to survey the route between the commercial entrance and Lipps, but they became more interested in the cave. After much frustration and negotiation between the two groups, they met in September 1970 and agreed to a joint venture to study the cave system with full cooperation and exchange of working teams. The goal was to publish a joint map in a future West Virginia Speleological Survey Bulletin (Stevens 1982). As part of the agreement WVACS turned over its current survey data, computer program, working maps and briefed DC Grotto members on exploration potentials. However, because of a lack of a mutual spirit of cooperation, the two organizations did not actively join forces. Communication remained open on a limited basis during the early 1970s, and the joint venture was not consummated until the next decade (Fig. 13.6).

Trips to Organ Cave by DC area cavers were frequent throughout 1970 with large survey efforts occurring every other week. But as winter approached, progress was threatened by cold weather which made camping in the Organ Cave parking area increasingly unattractive. Then George Sively offered the use of an old tenant house in his back pasture. The DC area cavers moved into the house that December and started the refurbishment effort which was to last through most of 1971 (Fig. 13.7). As 1970 ended, Pat Moretti announced that DC Grotto members had mapped 33 miles of the Organ Cave System. Throughout 1970 and 1971 the principal focus of DC cavers was the resurvey of the cave's main passages. This fifth phase of exploration was led by Pat Moretti (then DCG chairman), Bruce Boss, Ray Cole, Dick McGill, and John Walker. In February 1971 the National Speleological Society recognized their efforts and chartered the Organ Cave Project with Pat Moretti and Bruce Boss as co-chairmen.

By July 1972 the main passages had been resurveyed and exploration of North Upper Level Organ (NULO) was well underway. Bruce Boss and Fred Stork's trips to Erwins Cave during this period were especially grueling as they surveyed to the base of the Third Waterfall. Gradually, many of the original DC cavers became less active and were replaced by newcomers Mike Dyas, Dave Engel, Jim Gildea, Larry Lilly, Dick Nigon, Tommy Shifflett, Cady Soukup, and Paul Stevens. Bruce Boss and Ray Cole became project co-chairmen in September, 1973, when Moretti resigned to take a job out of the area; Boss also resigned later that year when he moved to California. Late in 1973 Purgatory Way was surveyed and the Erwins and Sively #3 entrances were connected to the system. Throughout 1974 the project continued to be active with the Four Domes area of Lower Lipps one of its principal focuses. Jim Borden and Mike Dyas surveyed most of Lewis cave in the 1974–1975 period. As unprocessed survey data piled up, the project began to lose momentum. Early in the period Moretti quickly distributed copies of the map of recently surveyed passage. After he moved from the area, those exploring the cave no longer saw the fruits of their labor. The crisis was solved when Dick McGill and Paul Stevens replotted all the data in the project's computer database and, with the help of the others remaining on the project, pasted the individual line plots together to construct a new baseline plot of the cave. Then, over the next several years the map of the cave was redrawn based upon the integrated line plot. Missing survey data were duplicated by resurveying the passage. In 1975 Paul Stevens was named project co-chairman. 1976 was a very active year. George Dasher led the resurvey of Lipps Maze, the northern parts of Jones Canyon and Left Hand Passage area. Rich Hall, Liz Hall, Paul and Lee Stevens discovered the Great Escape entrance. Forrest Wilson and Sheck Exley dove the 270-foot-long Bowen Sump with scuba gear and surveyed several thousand feet of virgin passage. Rich Hall, Lee Stevens, Tom Vines and John Rue followed by connecting the Borehole with NULO on New Year's eve, opening up NULO to further exploration. The following year Sheck Exley and David Morrow repeated the Bowen Sump dive and surveyed to David's Dungeon, an impenetrable sump. Most of the remaining activity in the cave concentrated on field checking the map and resurveying areas where the map was poor. The resurvey of the Revak Room area was one of the largest efforts, and it was led by Tom Kaye. The project was also very active at home with evening and weekend work meetings to sketch cave passages using baseline *Calcomp* plots.

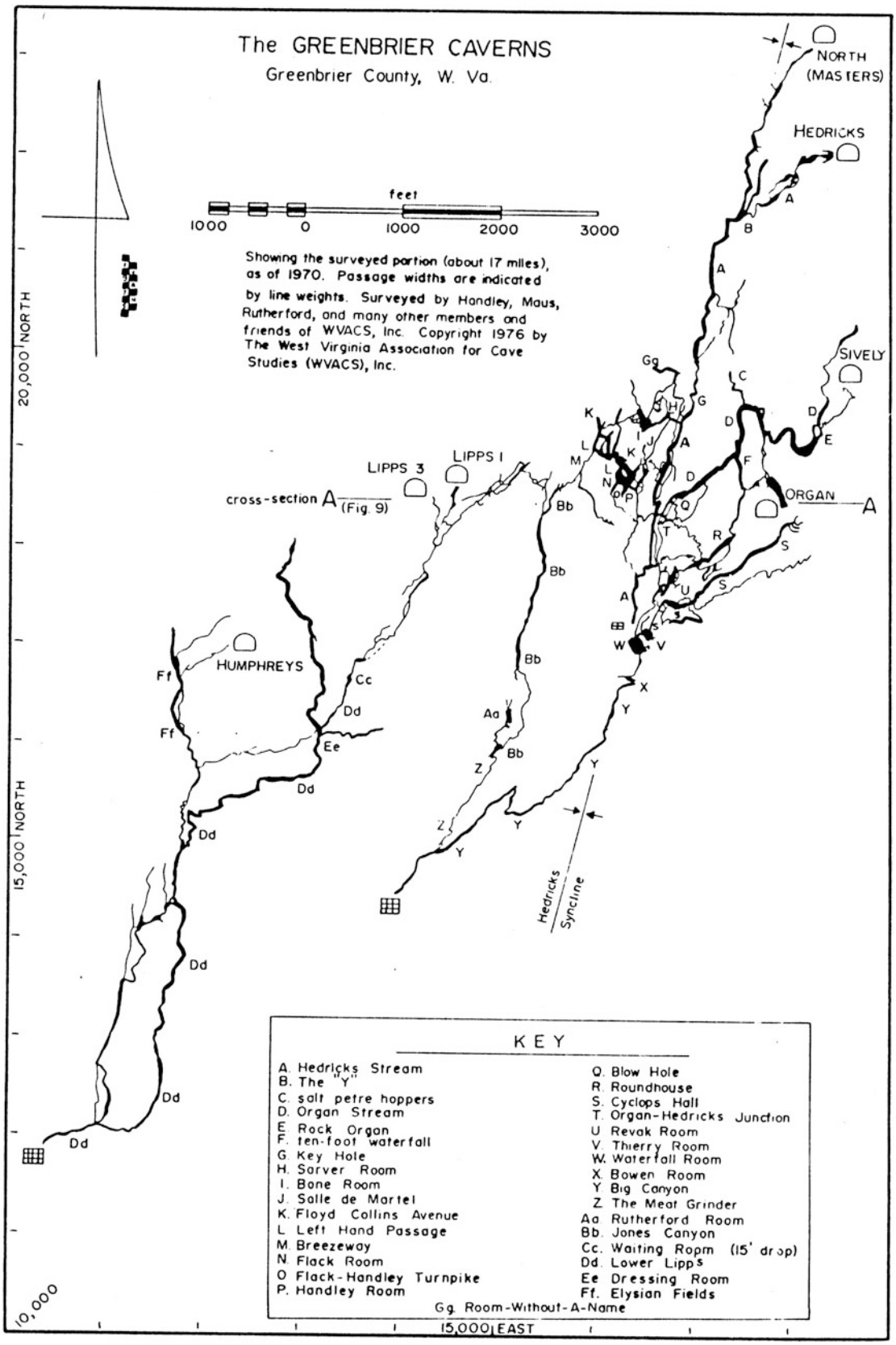

Fig. 13.6 Greenbrier Caverns (Organ Cave System) as of 1970. From Handley and Rutherford (1976)

Fig. 13.7 Organ Cave fieldhouse

In May 1977 Paul Sevens led a major effort to create a database with each survey station having a unique name. During the next 2 years he keypunched all of the cave survey data into a format acceptable for input into a computer processing program by Bob Thrun. The entire cave survey database was integrated together for the first time and could be run on a computer simultaneously. Bob Thrun was able to provide computer processing support to the project for a while, but his other commitments soon prevented continued support. During 1979 and 1980 the project was without computer processing support, but Don Major came to the rescue by converting Bob Thrun's program called *CMAP* to run on a mainframe computer. Don Major provided computer support for the project through 1982 when Bob Hoke assumed the responsibility.

During the late 1970s and early 1980s, work in the caves continued with George Dasher leading the resurvey of Cricket and Foxhole caves; Tom Kaye leading the dig into the Raccoon Room; and Forrest Wilson unsuccessfully attempting to dive the Organ resurgence at Second Creek. Rich Hall, Bob Hoke, Larry and Klaye Lilly and Paul and Lee Stevens continued to field check the map compiled from surveys done in the early 1970s. In the process many passages were resurveyed. Ray Cole and Tommy Shifflett led a theodolite survey on the surface to accurately tie together the cave entrances (Fig. 13.8).

Later, Ray Cole designed a cave radio and tied the theodolite surface survey to the Bowen and Lipps sumps, Lipps–Humphreys Junction, and entrance to Fat Man's Misery (Fig. 13.9). The more accurate surface surveys and cave radio locations formed constraints to "fix" the position of the major passages, so they would remain fixed as additional surveys were added. Dave West led another series of efforts to connect Organ with Foxhole, but without success. Dave West and George Dasher also attempted to dig a bypass around Bowen Sump, but that was abandoned after many trips. Chris Welsh and Bob Anderson were more successful in their attempt to get into a hanging lead above the Masters stream and in the process discovered Novice Odyssey in 1980.

Fig. 13.8 Tommy Shifflett using an electronic distance meter (EDM). A theodolite and EDM were used to create an accurate surface survey

By the end of 1982, the survey of the Organ Cave System and surrounding caves was essentially completed, though unattractive leads remained scattered throughout the system and nearby caves. The large project weekends at the fieldhouse were no more. Since 1982, study of the cave was done by small groups on an infrequent basis. During this period, George Deike and Bill Jones made frequent trips to the cave to develop their interpretation of the cave's geology and hydrology. George Dasher completed the survey of Cricket Cave; Bill Balfour led the survey of Whites Cave; George Dasher, Sonja Ostrander, and Paul Stevens surveyed Hellems Cave; Ray Cole, Paul and Lee Stevens surveyed Sheep Shelter Cave; and Fred Grady searched for vertebrate fossils. Ed Swepston and Giff Lindsey continued the pursuit of an Organ–Foxhole connection with a dig just north of the Revak Room. Bob Hoke and Paul Stevens continued to debug the cave survey database, and Paul Stevens inked the maps and

Fig. 13.9 Pat Moretti operating the Organ Cave radio at the Lipps–Humphreys Junction. Photograph by Paul Stevens. Used with permission

led the editing of the West Virginia Speleological Survey Bulletin. During 1985 and 1986 the maps and manuscript were extensively reviewed by members of both DC Grotto and WVACS. The final result was the publication of the West Virginia Speleological Survey Bulletin 9 titled *Caves of the Organ Cave Plateau* (Stevens 1988). This publication and maps represent the efforts of more than 400 cavers over half a century. The detailed map sheets were scanned and are included in the electronic map files (M-13.1).

13.3 Physical Description of Organ Cave

Perhaps the principal features that distinguish the Organ Cave System are its long, large stream passages littered with breakdown. One of the best examples is the Organ Main Stream Passage, in the tourist section of the cave. Another notable feature of the system is its large rooms, such as the Waterfall Room and Handley Room. However, the dominant impression left with most visitors to the wild portion of the cave is its length, 38.5 miles of passage. With ten entrances, a variety of "through trips" are possible. The most common through trip is between the Organ and Lipps Entrances. The system also has areas with a maze of passages to confuse the newcomer, for example Lipps Maze. To attempt a description of such a large cave, it is convenient to divide it into individual sections (Fig. 13.10).

With the exception of the Rock Organ area, the cave is not known for its speleothems; however, it does contain some good examples scattered throughout the cave, often in remote areas. The Organ Cave System has a significant collection of well-preserved saltpeter vats from the Civil War period. These are located in the tourist section of the cave (Fig. 13.11).

13.3.1 Masters–Hedricks (Lower Level) Section

The Masters–Hedricks (Lower Level) Section of the cave system consists of four miles of passage, most of which is large stream passage at base level. It is bounded on the north by the Masters, Hedricks, and Great Escape entrances and includes the Masters Stream Passage, Hedricks Stream Passage, and the Borehole which all join at the Masters–Hedricks Junction, a large gravel-floored room. The combined passage (Hedricks Stream Passage) proceeds downstream and south along the axis of the Caldwell Syncline for almost a mile to the Hedricks sump with occasional side passages formed by tributary streams. Much of the passage is floored by large breakdown blocks and in two locations by shale collapse piles. At its junction with the Organ Main Stream Passage, the passage is large with a gravel floor. Silt banks line the Hedricks Stream Passage as it approaches its sump.

The most northern entrance to the cave system, the Masters Entrance, is located at the low end of a shallow elongated sink just south of the surface drainage divide for the Organ Cave System basin. The entrance crawl is normally dry; however, a stream is encountered just beyond a climbable ten-foot drop. The cave proceeds downstream as a large breakdown passage for 250 ft before degrading into a short belly crawl in the shallow stream. After another 400 ft of walking passage the ceiling again drops forcing a second short belly crawl in the stream.

Now 750 ft from the entrance and wet, the caver is rewarded by a large display of rim stone pools which mark the intersection of a stream to the northwest and the difficult, overhung climb into the Novice Odyssey section. A short distance downstream from the rimstone dams is the Totem Pole, a tall column in the center of large passage, and 750 ft later, the Masters stream joins with the Borehole and Hedricks Stream Passages.

The Hedricks entrance was sealed with concrete in 1960 and remains blocked. The nearby Great Escape entrance is extremely tight and covered by debris. Just inside, the cave opens into a large well-decorated room. The 1,000 ft of passage between the entrance room and Masters–Hedricks Junction is mostly breakdown-floored with a stream occasionally visible. Along the way is the Big Room which, because of its breakdown and low ceiling, serves to confuse the route.

The Masters–Hedricks Junction also serves as the downstream end of the Borehole, a very large trunk passage going north for 400 ft before ending in a massive breakdown collapse. A low passage at the base of the wall on the east edge of the breakdown pile can be followed up through the breakdown into North Upper Level Organ.

The Hedricks Stream Passage proceeds downstream to the south of the Masters–Hedricks Junction as a large

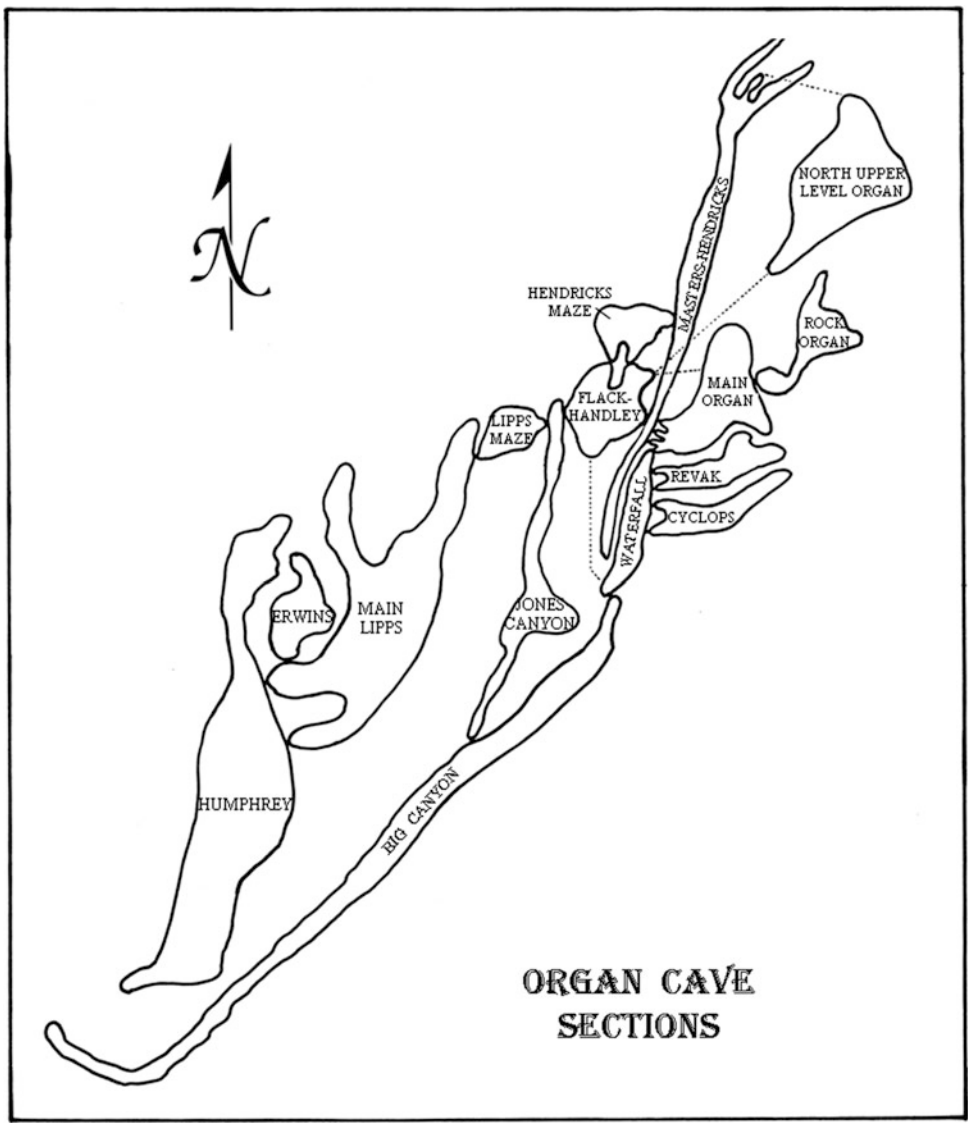

Fig. 13.10 The sections of the Organ Cave System

breakdown-floored stream passage until it is interrupted by Shale Room #2 with its massive shale pile. Along the way is a dry side lead to the southeast, the Paleo Saltpetre Passage, which runs 1,000 ft in a direct line toward the Saltpetre Vat Passage in the tourist section of Organ Cave, gradually becoming too low to continue just 250 ft short of the vats. Along the way, the Paleo Saltpetre Passage intersects the Rimstone Ceiling Passage, a 1,500-foot-long tributary stream passage tending northeast which joins Hedricks Stream Passage 500 ft south of Shale Room #2.

After traversing 1,000 ft of breakdown-filled stream passage south of Shale Room #2, the Hedricks Stream Passage is again interrupted by a shale collapse just before reaching its junction with the Hedricks Maze stream coming in from the northwest. The junction area is notable for its gravel floor and no breakdown. There are two routes to the west into the Hedricks Maze area of the cave, and the south route via Sarver Room is the easiest. Continuing past the Hedricks Maze stream junction, it is another 1,100 ft downstream through monotonously familiar breakdown passage before one first encounters a west lead toward the Fun and Flack Rooms and then the Organ–Hedricks Junction with the Organ Main Stream coming in from the east. Again, the junction area is characterized by its gravel floor and lack of breakdown.

Just 400 ft further down Hedricks Stream Passage, one intersects the Old Saltpetre Route, an overflow route for water entering the Organ Entrance during periods of high flow. Normally, this passage is dry. Hedricks–USP Connector, a climb up to the Upper Stream Passage leaves this junction just inside Old Saltpetre Route.

With only 700 ft to go before its sump, Hedricks Stream Passage continues with its typical breakdown floor, proceeds through the Slickenside Room (Slate Creek enters low from

Fig. 13.11 Saltpetre Vat in Organ Cave

the northwest), and then changes character dramatically. The last 300 ft is gravel-floored with silt banks along the side and free of breakdown. The ceiling gradually lowers until one is forced to belly crawl in water a short distance before reaching a large room where the stream sumps.

13.3.2 North Upper Level Organ (NULO) Section

Above the Masters–Hedricks (Lower Level) Section lies NULO with its 3.2 miles of passage. At its northern end NULO is a maze of small- and medium-sized passages, connected to the rest of the system by a vertical route through the breakdown at the north end of the Borehole. The principle passages of north NULO are the vadose Right and Left Hand Perpendicular Passages, which have small streams that join to form the Upper Stream Passage. Just downstream of the junction of the Right and Left Hand Perpendicular Passages, the Upper Stream Passage is a narrow crawl opening at the top of a waterfall into a small room. With skill, the drop can be negotiated without rope. The passage proceeds south, downstream past the tributary East Passage, to join the rest of the cave system at the Sand Room.

The northern end of NULO is a maze of small muddy crawls and canyons with incised streams that form a dendritic pattern feeding the Upper Stream Passage. Serpentine Way, a dry walking passage with an uncluttered floor, is unusual for the area and forms the route from the top of the Borehole breakdown climb into the maze. The Left Hand Perpendicular Passage (LHPP) is reasonably large for its northern most 900 ft, but breakdown slows one's pace. It then degrades into a stream crawl before joining the Right Hand Perpendicular Passage (RHPP). The RHPP trends upstream to the northeast from its junction with LHPP as a deep narrow canyon which can be traveled laboriously along its top for 1,000 ft before enlarging into trunk passage. It intersects a maze of passages at its northern end, one of which proceeds west to LHPP.

In the ceiling of the Waterfall Room below the LHPP–RHPP Junction, a passage heads south to East Passage forming what appears to be the ancient LHPP–RHPP water route. Downstream of the waterfall, the Upper Stream Passage degrades into a breakdown crawl shortly before intersecting a small tributary stream to the northwest coming from Peggy's Tear Room. After 400 ft of shallow stream walking passage, the Upper Stream Passage is joined by the stream in East Passage. Just north of this junction is a short narrow vertical squeeze followed by a short pool where the ceiling drops enough to require a caver to get wet. East Passage trends northeast for 1,500 ft as canyon passage before becoming too tight to continue. It breaks into several parallel passages along its course which rejoin near its end. The junction of East Passage and Upper Stream Passage has been located by radio fix to be 15 ft east of the Hedricks Stream Passage and 30 ft higher than the Hedricks Stream. From this junction, cavers could hear another party below in Hedricks Stream.

The Upper Stream Passage proceeds south from its junction with East Passage for 1,300 ft as a shallow stream walk initially with no breakdown, though the final section requires canyon straddling. At one point it is interrupted by a large block of breakdown and can be traversed only by climbing the block and belly crawling along its wet top.

13.3.3 Hedricks Maze Section

The 1.7 miles of passage in the Hedricks Maze section are dominated by the large breakdown-floored Bone and Sarver Rooms and is connected to the rest of the system by: (1) Rat Alley Crawl, a low, straight eastward lead leaving the Bone Room at its ceiling and entering Floyd Collins Avenue at its ceiling; (2) Octopus Alley, a straight southern lead leaving

the Sarver Room at its ceiling and entering the Fun Room at its ceiling; and (3) two separate stream passages which join the Hedricks Stream Passage in a gravel-floored area just downstream from a shale breakdown pile. North of the Sarver Room is a maze of passages dominated by the very large breakdown-filled Room Without A Name (RWAN). Considerable surface debris has been found at the upstream terminus of the RWAN and Car Room stream passages. Their termini are near the head of a blind valley on the surface which contains a small wet weather sinking stream.

Cavers typically enter the Hedricks Maze section using the route from the Hedricks Stream Passage to Sarver Room. The route begins 10 ft off Hedricks Stream behind a breakdown pile along the west wall and quickly enters Sarver Room via a short down-climb. Just before descending the drop into the Sarver Room, a belly crawl can be followed up to Octopus Alley, the dry walking passage between Fun Room and Sarver Room. Octopus Alley enters at the ceiling of the Sarver Room with a 30-foot drop to the stream below. To enter the Bone Room to the west, one must climb breakdown and negotiate a crawl through steeply folded rock strata. While the Bone Room is quite large, its very large breakdown blocks and irregular floor and ceiling hide the fact well. A perched stream passage enters the room's ceiling and provides a small waterfall. This passage can only be entered with the aid of a scaling pole. Rat Alley Crawl takes off high along the west wall and proceeds as a hands and knees crawl over to Floyd Collins Avenue; unfortunately, a short stretch of the crawl is typically muddy. Just south of the entrance to Rat Alley Crawl, a protrusion of the Bone Room gradually becomes stream passage ending under the breakdown pile of Salle de Martel. Going upstream into the passage to the northwest, the route ends in the Car Room when the passage becomes a narrow slit. Old Pepsi bottles and other surface debris were found here, and the room was named when the original explorers heard periodic rumbles which they attributed to passing cars on US 219. North of the Bone and Sarver Rooms is a maze of passages leading to the breakdown-littered and steeply sloped trunk passage known as Room Without a Name (RWAN). Upstream the passage gradually becomes a crawl with much surface debris from the blind valley across US 219 from Mr. Sarver's house. Along the west wall of RWAN are two crawls which lead to the top of Handley's Climb (Fig. 13.4) and the Great White Way with its white gypsum-covered walls.

13.3.4 Rock Organ Section

The Rock Organ section consists of one mile of passage, mostly breakdown-floored stream passages at base level. The Sively #2 and #3 entrances form its northern boundary. The Sively #2 entrance is a short pit requiring rope; the low passage at the base of the pit is often plugged by silt and surface debris. The Sively #3 entrance requires a tight squeeze to enter a confusing breakdown crawl before finding a large stream passage a short distance from the entrance. The Sively #2 and #3 stream passages proceed south (downstream) to join at the Rock Organ at a pile of breakdown. The "Rock Organ" (Fig. 13.2), namesake for the cave system, is a large drapery formation near the north end of the tourist tour. A large, meandering breakdown-floored stream passage (Organ Main Stream Passage) results and leaves the Rock Organ area to join the rest of the cave system near the dam in the tourist section of Organ Cave. Electric lights and a built-up tourist path are present between the dam and the Rock Organ.

13.3.5 Main Organ Section

The Main Organ section of the cave contains 2.7 miles of passage including most of the tourist section of Organ Cave, including the Saltpetre Room. Its eastern boundary is the Organ Entrance. A surface stream flows into the entrance during wet weather and sinks at the west end of a large entrance room; during drier weather the stream sinks in the entrance breakdown. The stream reappears in the 1812 Route and joins the Organ Main Stream at a ten-foot waterfall just downstream from the Saltpetre Room. The tourist trail leaves the Organ Entrance Room via a short route which enters at the ceiling of Organ Main Stream Passage downstream from the Rock Organ. Organ Main Stream Passage proceeds as a large breakdown-floored passage until just before its junction with the Hedricks Stream, at which point its low ceiling makes an upper bypass route more convenient for cavers. The Main Organ section also joins the remainder of the system through several leads which leave the Organ Main Stream Passage at its ceiling and ascend until they ultimately join the continuation of the Upper Stream Passage at the Throne Room.

The tourist entrance to Organ Cave is directly under highway WV 63 at the base of a large east facing escarpment which forms the terminus of a broad valley. The 75 foot wide by 25 foot high entrance opens into a 250-foot-long room of similar dimensions. The tourist trail follows a built-up path along the north side of the room leaving its west end through a 450 long walkway that leads to Organ Main Stream about 800 ft downstream from the Rock Organ. The tourist trail splits into two paths; one goes to the Rock Organ and the other proceeds downstream along Organ Main Stream for 300 ft past a dam and enters the Saltpetre Room via Fat Man's Misery. The Saltpetre Room contains 37 vats, some of which are in excellent condition (Fig. 13.11).

While the tourist trail ends here, Organ Main Stream continues downstream from the entrance of the Saltpetre Room as a large stream passage with little breakdown. After 450 ft it intersects a high lead entering from the south which carries the Organ Entrance Stream forming a ten-foot-high waterfall at the junction. Proceeding down Organ Main Stream the route becomes littered by large breakdown. Discovery Passage leaves Organ Main Stream at its ceiling along its south wall and continues as mostly walking passage to the "T"-Room where it intersects Straddle Alley. Straddle Alley is a keyhole-shaped passage to Organ Main Stream intersecting it just before it joins the Hedricks Stream Passage. Gypsum Passage leads to the south of T-Room as a crawl to the 1812 Room and A-Trail leads to the west of T-Room ascending in a mixture of walking and crawling passage to the Upper Stream Passage at the Throne Room.

Along the south wall of the Organ Entrance Room is a 250-foot-long crawlway intersecting the Rotunda Room at its ceiling. The passage to the north of the Rotunda Room captures the Organ Entrance Stream and carries it in walking passage to the waterfall at Organ Main Stream just downstream from the Saltpetre Room. The passage to the south of the Rotunda Room forms the Old Saltpetre Route, a large breakdown-floored passage which proceeds through the 1812 Room and hence to Hedricks Stream Passage. While saltpeter was mined in the 1812 Room perhaps even earlier than 1812, only the badly decayed remnants of a few vats remain.

13.3.6 Waterfall Section

The 1.6 miles of passage in the Waterfall section joins the Main Organ and Big Canyon sections of the cave. Two isolated cave sections (Revak and Cyclops) branch off it to the east. The section includes the continuation of the Upper Stream Passage starting at the Throne Room and disappearing into breakdown at the base of the Waterfall Room. The Waterfall Room is the largest room in the cave. It is over 100×150 ft in size, and its floor is covered by large breakdown. The Foxhole Cave stream and another stream of unknown origin enter at the ceiling of the Waterfall Room to form the waterfalls. At the ceiling, at the opposite (south) end of the Waterfall Room, is The Highway, a dry passage to the top of Bowen Drop (into Big Canyon). The Thierry Room and its feeder stream passages lie above and to the north of the Waterfall Room.

The Upper Stream Passage is joined by the A-Trail at the Throne Room (named for a rock shaped in the form of a chair/throne) and proceeds south for 1200 ft as 10-by-10-foot breakdown-floored stream passage. Along the way it intersects the entrance to the Revak Room and the normal route to Cyclops Hall. Just before entering the base of the Waterfall Room, a short side lead to the east goes to the base of the Thierry Room (which can be entered by ascending through very unstable breakdown) and PD-60. A waterfall descends through the Thierry Room breakdown into this passage and into the hole in the floor at PD-60. The hole opens into a tight twisting passage down to the Cyclops stream. Upstream and through a short sump is Cyclops Hall.

Just before the Upper Stream Passage reaches the base of the Waterfall Room, the stream disappears into the east wall never to be seen again. However, a stream from the Waterfall Room appears 50 ft down the passage along the east wall, crosses the passage and continues to the west in a breakdown-choked lead along the base of the Waterfall Room. The Waterfall Room is a 150-foot-long, 100-foot-wide, and 50-foot-high breakdown-floored void. The waterfall along its north wall is fed by two streams, the east one of which has been traced to Foxhole #1 Cave. The east stream passage above the waterfall can be followed for 300 ft before becoming too low to continue. To the side of the east stream passage above the waterfall is the cone-shaped breakdown-floored Thierry Room with two tributary stream passages feeding it. The west stream passage above the waterfall can be followed upstream for 200 ft before being blocked by a flowstone bar.

The stream passages feeding the waterfall enter the north wall of the Waterfall Room at its ceiling. On the opposite side of the room, The Highway, an apparent continuation of these passages, leads from the south wall of the Water fall Room at its ceiling to the top of the Bowen Drop and a 130-foot vertical descent into Big Canyon.

13.3.7 Revak Section

The Revak section is an upper-level maze of 1.5 miles of passages connected to the remainder of the system along the Upper Stream Passage between the Throne Room and the Waterfall Room. The section is named for its only large room, the breakdown-floored Revak Room. Surface debris has been found in the Raccoon Room, another section room located near the surface, by the Organ Entrance.

The Revak Room is normally entered from the Upper Stream Passage via a large short side lead which ascends steeply up its breakdown-covered floor. A large low side passage leaves the Revak Room and proceeds north to a highly inclined route (Revak Silo) down to Upper Stream Passage. Another low side passage leaves the Revak Room and proceeds south to Crowbar Crawl, a low, dry, alluvium-filled passage, and a small room where the Foxhole #1 stream enters one side and exits on the other. Along the west wall of the Revak Room and at its ceiling is Moretti's Turnpike, a passage which climbs steeply before ending in breakdown from above. Moretti's Turnpike, Crowbar Crawl,

and the top of Revak Silo are the closest section of Organ Cave to Foxhole #1 Cave.

The passage leaving Revak Room to the east goes about 400 ft to the 15-foot-wide, 40-foot-long mud-floored Cathedral Room. At the northeast end of the Cathedral Room is Walker's Climb which leads to a small crawlway which continues almost to the Organ tourist entrance before ending. A hole in the floor of the Cathedral Room leads to a 470-foot cobble crawl that enters the Racoon Room. At the far end of the Racoon Room is a chimney which may lead to the surface just south of the Organ Cave gift shop.

The final Revak Room lead is a phreatic tube that begins near the entrance to Crowbar Crawl and crosses over the Revak Room, which can be seen through cracks in the floor, then intersects the passage between Revak and Cathedral Rooms at its ceiling. About 25 ft into this tube, it is possible to slide under a false floor and enter a well-hidden crawlway that trends toward the Waterfall Room area. The passage becomes larger and soon contains a stream. The Hard Roll and Walker's Ramble are located in this area.

13.3.8 Cyclops Section

The 1.8 miles of passage in the Cyclops section are dominated by the breakdown-covered Cyclops Hall, with headwaters under the Organ Cave parking lot. The passage gradually becomes smaller and lined with silt as the stream flows west and approaches its sump located near the base of the Waterfall Room. It connects to the Waterfall section at PD-60 via a tight ascending passage just beyond its initial short sump. Entry to the Cyclops section is usually done via a lead off the Upper Stream Passage. The lead enters Cyclops Hall through a small "eye" in the ceiling.

The lead to Cyclops Eye leaves the Upper Stream Passage 150 ft south of the entrance to Revak Room. As it meanders 600 ft to the Eye, the caver is forced through a 50-foot-long belly crawl, the Drag Strip, and then a long canyon straddle. A rope or cable ladder is required to negotiate the 20-foot drop at the Eye to the floor of Cyclops Passage.

From the Eye, the large breakdown-floored Cyclops Hall proceeds northeast for 1200 ft before splitting into two large passages which both quickly end. Southwest of the Eye, the large breakdown-floored Cyclops Passage continues for 400 ft before changing into a muddy silt-covered stream passage which gradually forces cavers to crawl through a short sump and on to the connection with a chimney up to PD-60.

At the ceiling on the wall of Cyclops Hall opposite the Eye is a lead to the top of the Pool Room. However, cavers normally enter the Pool Rom from below by proceeding southwest from the Eye to the side lead just before Cyclops Hall becomes muddy. The Pool Room rimstone pools are filled by a 25-foot waterfall fed by the stream from Crystal Palace Gallery, 500 ft to the south. The route to Crystal Palace Gallery is a tall stream canyon which ends upstream of the Gallery in a flowstone wall that has yet to be climbed.

At the floor of the wall of Cyclops Hall opposite the Eye is Davis Folly, a stream passage, initially breakdown-choked, that goes 1300 ft to the northeast before breaking up into various small leads. The stream passage has one dry side lead, Gypsum Way, which goes 1,000 ft toward the Pool Room before ending.

13.3.9 The Flack–Handley Section

The Flack–Handley section contains 4.9 miles of passage. It is a complex maze of passages with over 200 ft of vertical relief. The section includes the large, overlapping Flack and Handley rooms and two large, overlapping trunk passages: Left Hand Passage and Floyd Collins Avenue. It is bounded on the east by the lower-level Hedricks Stream and Hedricks Maze sections and the North Upper Level, Organ, Main Organ and Waterfall sections. On the west it connects to the north end of Jones Canyon (Fig. 13.12).

Fig. 13.12 Flack–Handley Turnpike. Ray Cole crossing the Flack–Handley Turnpike from the Handley Room into the Flack Room. Photograph by Bruce Boss

The following description and the accompanying map consider the Flack–Handley area as divided into two levels: (1) Fun and Flack Rooms and Floyd Collins Avenue—Lower Level; (2) Handley Room and Left Hand Passage—Upper Level.

Cavers entering the area from Hedricks Stream Passage enter the lower level near the Fun Room or via Hedricks Maze and the Rat Alley Crawl. Cavers entering the area from Jones Canyon to the west enter the upper level at Left Hand Passage. Cavers entering the area from Upper Stream Passage to the east enter the upper level via the Sand Room. Cavers can traverse between levels only via the Flack–Handley Turnpike.

The Flack–Handley area can be entered from Hedricks Stream Passage using the first passage going west, just a short distance upstream from the junction of Organ and Hedricks Streams. The breakdown passage gradually ascends and after 200 ft turns north up Slate Creek to reach the base of the Fun Room 150 ft later.

Slate Creek continues as a large stream passage going north 500 ft before ending in a breakdown pile at Salle de Martel. About 200 ft into it are ceiling leads along the west wall that lead up to Octopus Alley and a short low passage to the Centrifugal Room. The Centrifugal Room can be climbed to its ceiling to join a belly crawl that opens on an overlook on the east wall of the Flack Room. Octopus Alley continues north to an overlook at Sarver Room and south to the upper level of the Fun Room. The Fun Room is a two-level room, the top level of which has a floor you must see to believe. The floor is contoured with an intersecting pattern of 3-foot-deep grooves forming a series of rounded "tables." A northwest route from the upper level of the Fun Room runs up into the Flack Room, a 100-by-150-foot room with breakdown along the west side.

The Flack Room has several major exits plus numerous minor routes. The Subway leads from the west side of the Flack Room for 400 ft downhill to the junction of Salle de Martel and the Fun Room, coming out under a large breakdown block. The Flack–Handley Turnpike is a narrow ledge along the south wall near the ceiling that provides the only connection with the upper-level Handley Room. Floyd Collins Avenue is a 60-foot-wide walking passage heading north for 600 ft before ending in breakdown at the junction with Rat Alley Crawl, a low, occasionally muddy crawl east to the Bone Room.

The Flack–Handley area can also be entered by proceeding north from the Throne Room 350 ft and bearing left at each opportunity until reaching the Sand Room. On the way two junctions are passed, each of the other passages also go to the Sand Room, but via a more difficult way. The eastern side lead at the first junction gets to the Sand Room via Sally's Waterfall. The northern stream route proceeds up the Upper Stream Passage through a tight section that makes travel difficult before opening as a canyon in the floor of the Sand Room. The Upper Stream Passage continues north from Sand Room into the North Upper Level Organ Section.

Fig. 13.13 Bruce Boss in the T.T. Crawl

In addition to these three passages, there are two others which intersect the Sand Room. The Nine Foot Bat Passage heads southwest from the Sand Room for 250 ft into a multilevel maze, and Ascending Way goes west toward the Handley Room. The western passage branches 75 ft from the Sand Room with the northern branch heading into the base of the Flack Room and, by another route, into the Sarver Room. The western branch continues west for another 75 ft before bending sharply north at a junction with a high trickle stream coming in from the south (a miserable passage, never pushed to its end). The main passage goes north for about 400 ft before gradually becoming too small; however, after 125 ft of large passage there is a narrow opening in the west wall that leads up the steeply ascending Handley Silo into the Handley Room.

The Handley Room is a 300-foot-long, 40-foot-wide room with an arm, the Left Hand Passage, trending west from its northern end. The 20-by-20-foot Left Hand Passage breaks up in about 250 ft into a series of large fingers going north for 300 ft before ending. The Earthquake Passage is the first of these fingers, and it leads north to the Fossil Room by way of T.T. Crawl (Fig. 13.13).

13.3.10 Big Canyon Section

The Big Canyon section consists of 2.7 miles of tall stream passage at base level fed by the Hedricks Stream resurgence at its north end (at the bottom of Bowen Room Drop). It proceeds downstream and south as a gravel-floored passage for 4,000 ft to the Big Canyon sump. Beyond the 270-foot-long sump, the passage (known as Wilson's Watery Wonderland) again assumes its tall canyon character and proceeds downstream and south another 6,500 ft before

finally ending at David's Dungeon in an impenetrable sump. An unexplored stream passage from the north intersects it via a waterfall about half way between the Big Canyon sump and David's Dungeon.

Big Canyon can be entered by rappelling the 130-foot flowstone-covered Bowen Room Drop. A stream from a side lead forms a waterfall over the center of the drop; however, it is possible to stay out of the water except at the bottom of the rappel. Once off rappel, cavers can step to a dry area to remove their vertical gear. At the base of the drop a large passage heads north a short distance before ending under the Waterfall Room in a breakdown pile that provides an easier route than the Bowen Room Drop. This route was opened up after the original map was published.

The Hedricks Stream resurges off to one side of the bottom of the drop, pools, and then flows south down Big Canyon. After wading the first 3-foot-deep pool and passing the first of many flowstone cascades, cavers can walk down the gravel-floored shallow stream in passage 10 ft wide and 25 ft high for the next 4,000 ft interrupted only occasionally by breakdown and pools no more than 3 ft deep. About 1,500 ft downstream from the drop, a stream enters from the east over a flowstone cascade marking the route into the East Loop. Another 2,000 ft downstream Big Canyon intersects the Meatgrinder passage entering high on the west wall and the character of Big Canyon begins to change. Silt banks become evident and the ceiling drops until one must crawl a short distance in mud before the passage opens into a room where the stream sumps. Just upstream of the Big Canyon sump, Dave's Red Wagon Dig was dug through silt for 200 ft before ending at a rock constriction, but the passage continues to blow air.

The 270-foot-long Big Canyon sump is three ft high, but has been blocked by silt banks on occasion. It opens into Wilson's Watery Wonderland, large canyon passage much like northern Big Canyon. Just downstream of the sump, the stream is ponded by a breakdown pile and thereafter it continues as a low-gradient stream. About 2,000 ft downstream, Harold's Falls enters from the north marking a virgin lead not entered. After another 2,000 ft of similar high canyon stream passage, the passage widens and fills with breakdown at the Peanut Room with Cowart's Crawl coming in from the south. The breakdown clears as one heads downstream, but reappears 500 ft later for several hundred feet above Seekin's Falls, a series of short cascades. In the next 1,000 ft the canyon narrows and enters the Scarlet Pimpernel section with its red tinted speleothems before dividing into two separate passages. The passages rejoin at a large breakdown-floored room, David's Dungeon, with the stream ponding and disappearing under the breakdown.

13.3.11 Jones Canyon Section

The 1.9 miles of passage in the Jones Canyon section is bounded on the north by the Lipps Maze and the Flack–Handley sections, which provide its tributary streams. They join to form a large breakdown-floored stream passage which proceeds downstream and south until interrupted by a breakdown pile at the First Waterfall where it joins the upper-level Belfry stream passage. The main passage continues at the higher level until it abruptly ends and the caver is forced to descend to the lower stream passage. The stream passage gradually becomes a belly crawl until intersecting the top of a 25-foot dome at the Second Waterfall. The Jones Canyon Maze stream passage also intersects the top of the dome. The two streams join, but quickly flow over the Third Waterfall into the silt-floored Canfield Room and down to the Rectal Sump. The Jones Canyon Maze is a series of upper-level rooms connected by a maze of passages. It provides a route from Jones Canyon to the Big Canyon via the Meat Grinder Passage.

The Breezeway provides the narrow exit from the spacious Left Hand Passage into Jones Canyon. While initially walking passage, it soon becomes a short belly crawl followed by a 200-foot dry stoopway until it intersects the Treasure Passage. The Pendulum, a rock hung from the ceiling which swings when set in motion, marks the intersection. The Treasure Passage goes for about 800 ft, the last several hundred of which were dug open. Its current end is in the maze at the end of the Nine Foot Bat Passage, but it does not connect.

Continuing south from the Pendulum, the passage gradually opens up and after 900 ft intersects Skid Row, a stream passage exiting Lipps Maze. Downstream Jones Canyon continues as a 20-by-20-foot breakdown-floored stream passage with large conspicuous gravel banks along the way. Its character changes dramatically after 600 ft where it is blocked by breakdown. Ascending through the breakdown, the caver enters a large upper level with the Belfry Passage stream entering near the ceiling and forming the First Waterfall. The passage continues south; a large, dry route with occasional canyons across the floor to the stream below. The upper level ends about 1,000 ft south of the First Waterfall in a muddy passage. About 150 ft north of the end, one can duck under the east wall along the floor, traverse over the Three Inch Ledge, and gradually descend to the stream below. While the route initially allows walking in a shallow stream, the ceiling gradually descends and suddenly one must turn sharply west and proceed through a very narrow four-foot-high passage for 15 ft before regaining the wider stream passage.

The four-foot-wide passage proceeds south gradually forcing cavers to belly crawl in the shallow stream before opening up just before the top of the Second Waterfall. The passage continues downstream below the 20-foot drop at the Second Waterfall as a high canyon, but is quickly interrupted by another 20-foot drop at the Third Waterfall. The stream passage continues lined with silt banks for 200 ft before ending in Rectal Sump.

Standing in the Jones Canyon stream at the top of the Second Waterfall, one can see a second stream passage entering the top of the dome from the west at the same level. Crossing the dome is precarious, but once across, walking up this 2-foot-deep stream is the route to Jones Canyon Maze. By ascending through a hole in the ceiling, one enters the large room, Grand Central Station. If instead one stays in the stream passage and proceeds upstream, the route becomes a belly crawl in a shallow stream eventually opening up and providing access to the Lost Lamp Room, Romper Room, and House of Cards.

High leads going north from Grand Central Station lead to the Rutherford Room and Big Mother Pit. At the south end of Grand Central Station is a very short tight squeeze into the Meat Grinder Passage which proceeds as low, dry passage for 1,200 ft to its junction with Big Canyon.

13.3.12 Main Lipps Section

The Main Lipps section has 3.5 miles of passage consisting of a mile-long stream passage with supporting tributaries. It is bounded on the north by the Lipps and Deems Entrances and on the south by its connection with the Humphreys Stream. The large, dry, high-level Lunar Way passage runs east–west between the Lipps and Humphreys Stream Passages and intersects both of them at their ceilings. Near the middle of the Lipps Stream Passage the entrance stream is pirated at Lipps Piracy; however, just south a new stream enters and occupies the passage. The middle section of Lipps Stream Passage is noted for its high, narrow canyon (Hell's Fissure) which requires cavers to repeatedly ascend and descend in order to proceed. Farther south, the Lunch Room marks the intersection of three large passages: Lipps, Lunar Way, and Handley's Lost Sandwich Passage. Handley's Lost Sandwich Passage is a large breakdown-floored stream passage which is abruptly terminated at its north end by a breakdown pile. It was in this breakdown that Bob Handley lost his paper bag which contained a sandwich.

The Lipps and Deems entrances are located at the base of very small sinkholes. The passages leading south from the two entrances combine and form the Lipps Stream Passage, about 600 ft downstream from the Lipps Entrance. The Deems Entrance looks more like a rabbit hole and is rarely used. The Lipps Entrance is 2 by 3 ft and quickly opens into an entrance room with a short drop that can easily be climbed down to a stream. The passage downstream is littered by breakdown, but walking is easy until the stream turns sharply and enters a low breakdown-clogged passage to the west which serves as the route to Lipps Maze. However, a dry crawl continues straight ahead to a climbable drop into the Deems Stream just upstream of its junction with the Lipps Stream.

The Lipps Stream continues south from the junction in easy walking passage for 350 ft before passing a high lead on the west marking the entrance to T.H.E. Crawl, a dry passage requiring over 3,000 ft of hands and knees crawl before reaching the top of a 90-foot drop into the Waiting Room. Along the way there are plenty of opportunities to descend back into the Lipps Stream Passage which parallels T.H.E. Crawl in a deeply incised canyon as much as 40 ft below. About 600 ft from the entrance to T.H.E. Crawl, the Bone passage takes off to the west and splits into a myriad of muddy crawls. Another 300 ft south and the passage is almost blocked by a well casing from a well dug in the late 1970s.

Downstream 900 ft from its junction with T.H.E. Crawl, the Lipps Stream Passage has degraded into a narrow 6-foot-high canyon. Suddenly, the Lipps Stream disappears into Lipps Piracy Passage through one of many inconspicuous potholes. The Lipps Piracy Passage is a low crawl over a gravel floor which proceeds for 250 ft to the southeast before the ceiling and gravel come too close to allow further pursuit. However, the paleo-Lipps Stream canyon continues as before, but gradually becomes the very tall, narrow Hell's Fissure interrupted by numerous water-filled potholes separated by passage constrictions which force the caver to constantly change elevation. A new stream enters the fissure, and 400 ft downstream it cascades over a 21-foot drop from the base of Hell's Fissure into the Waiting Room.

The Waiting Room is a high dome with a 20-by-50-foot base. Both the 21-foot and 90-foot drops into the room require use of a rope or ladder. Proceeding 300 ft south in dry, breakdown-littered passage, one encounters the 50-foot-diameter Lunch Room with its large breakdown collapse pile at the convergence of five major passages.

The largest of the passages entering the Lunch Room is Handley's Lost Sandwich Passage which meanders 2,300 ft to the north as a breakdown-floored stream passage, typically 40 ft wide and 20 ft high. A considerable amount of silt covers the walls, floor and breakdown. This character is interrupted about 1500 ft from the Lunch Room by a collapse dome which completely fills the floor of the passage and forces the caver to ascend into the shale at the top of the dome 90 ft above. Coming back down to stream level the passage continues 40 by 20 ft until it abruptly ends in a breakdown collapse. Several routes have been found under the breakdown, but none have been found that lead to the hopefully large passage beyond.

To the west of the Lunch Room, Lunar Way runs 1,300 ft as a dry 20-by-20 foot silt-floored walking passage to Humphreys Stream Passage. The entrance to Lunar Way from the Lunch Room is on a high shelf along the west wall. Unfortunately, there is a short tight constriction before one can enter the large passage beyond. Lunar Way appears to continue to the east of the Lunch Room for 700 ft as Lunar Way Extended, low passage with several low wide rooms. Again, silt is present and may be responsible for closing Lunar Way Extended for each of its branches ends in silt.

The Lipps Stream flows south from the Lunch Room for 2,300 ft as breakdown-floored stream passage, sometimes as large as 50 ft wide by 25 ft high. Large silt banks line the route in sections.

13.3.13 Lipps Maze Section

The Lipps Maze section is a complex maze of 1.6 miles of predominately low, dry passages located between the Main Lipps Stream and the upstream end of Jones Canyon. To enter the maze from the Lipps Entrance, one only has to follow the stream discovered just inside the entrance for about 400 ft and then leave it for the first lead on the left (northeast). After 600 ft of stoopway and some crawling, the passage breaks into the west edge of a maze at the tight Rehajo Connector. It is not difficult to take the wrong turn in the mile of predominantly low, dry passages that in broken spider web fashion converge in an east–west central area.

The eastern edge of the maze is marked by the wide Flat Room from which eight short leads radiate. The southernmost lead off the Flat Room quickly becomes the western arm of Skid Row, a high narrow canyon that contains an intermittent stream and winds 300 ft south to its junction with Jones Canyon. About 100 ft downstream from the Flat Room, Skid Row splits in two. The right fork meanders, crosses the left passage, and then intersects with the eastern arm of Skid Row. The eastern arm of Skid Row can be followed 400 ft upstream in a 20-by-20-foot trunk passage to a breakdown collapse, or 150 ft downstream through a narrow stream fissure to its junction with the western arm of Skid Row.

13.3.14 Erwins Section

The Erwins section is bounded on the north by the Erwins entrance and on the south by Lunar Way. The water in its 0.4 miles of narrow stream passage is often deep, and three drops are encountered before the passage deteriorates into a belly crawl (often a sump) just before connecting with the Lunar Way. The Erwins section is the least attractive part of the entire cave system and is rarely visited.

The 2 foot high by 6 foot wide Erwins entrance captures the intermittent wet weather stream of a small valley. The entrance passage is a low, dry crawl for 200 ft before turning south into a stream canyon with a stream entering from the northeast. The next 800 ft of passage is low narrow stream passage with many pools requiring cavers to become totally wet before arriving at the 25-foot First Waterfall drop. After another 250 ft of similar passage a 19-foot drop is encountered at the Second Waterfall followed quickly by the 8-foot Third Waterfall drop. The ceiling gradually lowers until 150 ft later the caver is crawling in mud entering a 25-foot-long belly crawl through a seasonal sump. Once through the sump area, it is only 200 ft of dry cobble crawl to the junction with Lunar Way, a large dry trunk passage that intersects the Humphreys Stream Passage 450 ft to the west. The Erwins stream disappears in the cobbles and has not been traced further.

13.3.15 The Humphreys Section

The Humphreys entrance, Lunar Way and the Lipps Stream Passage provide access to the 5.1 miles of passage in the Humphreys section of the cave. The entrance passage is a low stream crawl initially over gravel, then scalloped rock, until the First Drop (23 foot) is reached. A low side lead to the west above the first drop provides a bypass; however, it also encounters a drop before rejoining the main passage. The combined passages continue low over a gravel floor until the 31-foot Second Drop enters The Highway, a large stream passage at base level with a breakdown floor. The Highway drains a maze of passages in North Humphreys which lie below the entrance passage. The Highway proceeds downstream and south as a large passage past the junction with the Lunar Way before it narrows and enters breakdown. It opens into large passage again at its junction with the Lipps Stream and continues south past a high side passage which leads to the Stadium and "S" rooms and the maze of passages along the west edge of the system. The combined Lipps and Humphreys Streams continue downstream and south for almost a mile in a wide passage with large breakdown. The Lower Lipps Stream Passage gradually narrows into a canyon and becomes smaller with a gravel floor before ending at the Lipps sump. The streams from Four Domes and the "S" Room form the Pythagorean Room waterfall and flow south into the Lipps Stream just before its sump.

The Humphreys entrance is in the same narrow valley as the Erwins entrance and downstream from it. It captures the overflow of the wet weather stream that normally enters Erwins and is separated from Erwins by a series of natural bridges. The Humphreys entrance is 6 by 6 ft, but quickly narrows due to a collapse pile from a skylight just inside the

entrance. Immediately after the pile, the cave becomes 200 ft of gravel-floored stoopway with occasional shallow pools and surface debris, ending in a short drop into walkable stream canyon passage. In the early 1970s the same passage was a belly crawl up to the French Connection. The French Connection, a 1 foot wide by 2 foot high slit near the ceiling, was the normal route in preference to continuing through a short stoopway in 3-foot-deep water. Hurricane Camile cleaned out much of the gravel, and the 3-foot pool in the bypass to the French Connection has not been observed since. In fact, the original WVACS explorers said they did not use this entrance because it changed after each major flood event.

Once in the walkable stream canyon beyond the French Connection, it is 250 ft to the First Drop. It is easy to rig a rope or cable ladder out of the 23-foot waterfall which cascades into the shallow pool at the base of a high room. The passage continues as a crawlway, much of which is on gravel that filled the passage after Hurricane Camile, for 700 ft to the Second Drop. While the First Drop is along a wall and dry, the Second Drop is 31 ft long with the last half overhung and partially in the spray of the waterfall. The drop enters the ceiling of The Highway and deposits the caver on a large breakdown pile.

The 40-by-40-foot Highway runs upstream to the north for 1,200 ft to a sudden breakdown terminus. While most of the way is littered by breakdown, the gravel floor of Elysian Fields is especially pleasant. Just north of Elysian Fields are the large breakdown blocks of the Wombat Room with several high leads off to the east.

From the Second Drop it is 1,300 ft south to the junction of the Lipps and Humphreys Streams. While the first 500 ft after descending the breakdown pile is easy walking beyond the high junction with Lunar Way, the passage continues clogged with breakdown. The route requires a lot of scrambling, and dead end forays are common. The breakdown finally departs at the Lipps–Humphreys Junction, a flat area with a gravel floor (Fig. 13.9). Five hundred feet downstream from the junction is a flowstone cascade marking the entrance to the Rimstone Passage, and 500 ft further the cave floor is exposed showing polished rock with a blue tint. The gigantic breakdown block just to the south lies across from the overhung entrance of Purgatory Way.

Rimstone Passage includes several hundred feet of stream cascading down rimstone pools, the largest of which is 3 ft deep. The entrance to the Stadium Room is via a small hole near the ceiling just beyond this deep rimstone pool. Along the south side of the Stadium Room the passage drops into a stream way which winds south for 500 ft as stoopway to the 28-foot drop into the "S" Room. The "S" Room is more a section of walking passage that winds back upon itself, than a room. At its far end, a side lead takes off 1,000 ft to the north as a narrow stream passage to a series of Four Domes. A rope was left hanging in the fourth dome to allow ascending to the domes beyond. Just downstream from the "S" Room is the 27-foot waterfall and drop into Pythagorean Room where Purgatory Way joins at the floor. The passage continues downstream for 600 ft before dividing into upper and lower routes; the dry upper Angel Passage being much preferable. The crawl through Angel Passage joins the Lower Lipps Stream Passage 500 ft later just upstream from Lipps sump.

Returning to the section of exposed blue tinted bedrock in the Lower Lipps Stream Passage, the ceiling channel above enters the suspended Purgatory Way implying it was the paleo-water route. To enter Purgatory Way from this side requires traversing a 1-foot-wide overhung shelf along the west wall near the ceiling from the nearest breakdown block to the entrance, a very precarious and exposed route. Once in Purgatory Way, it continues west as a dry stoopway for 500 ft to a series of quick turns in tight passage before intersecting a north–south stream way. While the north stream passage soon breaks up and becomes small, the downstream route continues for 700 ft to the base of Pythagorean Room. But the downstream route is narrow, torturous canyon requiring constant changes in elevation to squirm through the constricted route.

The Lower Lipps Stream Passage south of the junction with Purgatory Way is a large two-level stream passage in which the correct route is sometimes the high level and sometimes the lower one. Inevitably, you will chose the wrong route and end up blocked by breakdown in the lower level, or suspended up high with no way to proceed. After 2,500 ft of trying multiple levels and scrambling over breakdown, the stream passage narrows and leaves most of the breakdown behind. After straddling a 3-foot-deep pool, it is an easy walk to the short stretch of breakdown marking the junction with Angel Passage.

Five hundred feet downstream from the junction with Angel Passage, the Lower Lipps Stream sumps in gravel. This section is pleasant walking passage with a gravel floor and gravel banks along the walls. A tributary stream enters from the southeast just before the sump, but its passage is too small to push.

13.3.16 Foxhole Cave

Although not physically connected, Foxhole Cave overlies the central portion of Organ Cave. Multiple generations of cavers have tried to connect Foxhole to Organ Cave by pushing tight leads and doing multiple digs to no avail.

The uppermost entrance is developed in a headwall at the downstream end of a broad sink. Thirty feet inside this entrance the cave passage is interrupted by a steep-sided trash-filled sinkhole. Foxhole Cave is developed in the

Hillsdale Limestone along the axis of the Caldwell Syncline. The cave is 2.75 miles in length.

Foxhole is a classic dendritic cave system; all three of the cave's major passages converge in the largest room in the cave, Desolation Row, located in the south. To the east of this room, a dry crawlway, True Grit, leads 1100 ft to several tight pinches. To the northwest, an intermittent stream way is developed 1300 ft to the Entrance Maze area and the two entrances. To the north, the major stream passage leads 1300 ft first through the Talcum Powder Room, then to the two-level Aztec Two Step, and Litsey's Leap. North and below Litsey's Leap is Handley's No-Go, a short, damp gravel crawlway that leads to the February Extension, a northern continuation of the Foxhole Main Stream. Developed along the Extension are the Debevoid, Hensley's Dome, Borden's Abortion, and the Jewel Box, a low formation area 900 ft north of the No-Go.

To the southeast of Desolation Row is a three-dimensional maze and to the west is the second-largest room in the cave, the Mynock Room. This room and the Debevoid are the only portions of the cave west of the Foxhole Main Stream and the Caldwell Syncline. Vertical and overturned strata can be observed above and west of the Debevoid.

South of Desolation Row a large walkway is developed south for 450 ft. This passage quickly becomes a stoopway, then a hands and knees crawl, and finally continues as a belly crawl. Its southern terminus is a clay plug. Immediately south of Desolation Row is a large pit with fluted walls. The pit's drain leads north to the Southern Maze, and an exposed lead under the pit accesses a north–south breakdown crawl that traverses the entire length of the higher larger room.

The stream from Hensley's Dome has been dye-traced into Desolation Row where it becomes lost in breakdown, later reappearing at Southern Maze and then exits the cave. It reappears in the Organ Cave System at Crowbar Crawl for a short distance before disappearing again, later flowing out of the base of the Thierry Room, down past PD-60 to Hedricks Sump and hence to Big Canyon. The Foxhole Stream has also been dye-traced to the east waterfall of the Waterfall Room.

13.4 The Geologic Framework of Organ Cave

Organ Cave is one of the best studied geologically of the caves in the Greenbrier Karst. The sections that follow (Sects. 13.4–13.8) are drawn from Deike (1988), courtesy of the West Virginia Speleological Survey.

13.4.1 Exposed Stratigraphy in Organ Cave

The cave contains extensive exposures of bedrock. Solutionally weathered walls reveal bed thickness and chert and shaly layers quite well. However, fractured surfaces, which are very common, often conceal even the presence of chert. Mud and silt obscure the details in many areas. The Maccrady–Hillsdale contact can be observed in many areas such as in the Organ Main Stream Passage along the tourist route, at the Fun Room and Salle de Martel, in the Sarver Room, in Hedricks Maze, and in Lower Lipps Stream Passage (Fig. 13.14).

Fig. 13.14 Maccrady shale and base of Hillsdale Limestone exposed at the *bottom* of the Salle de Martel. The dip of the beds increases rapidly to near vertical about 100 ft to the *right* of the area shown in this photograph. Photograph by W.K. Jones

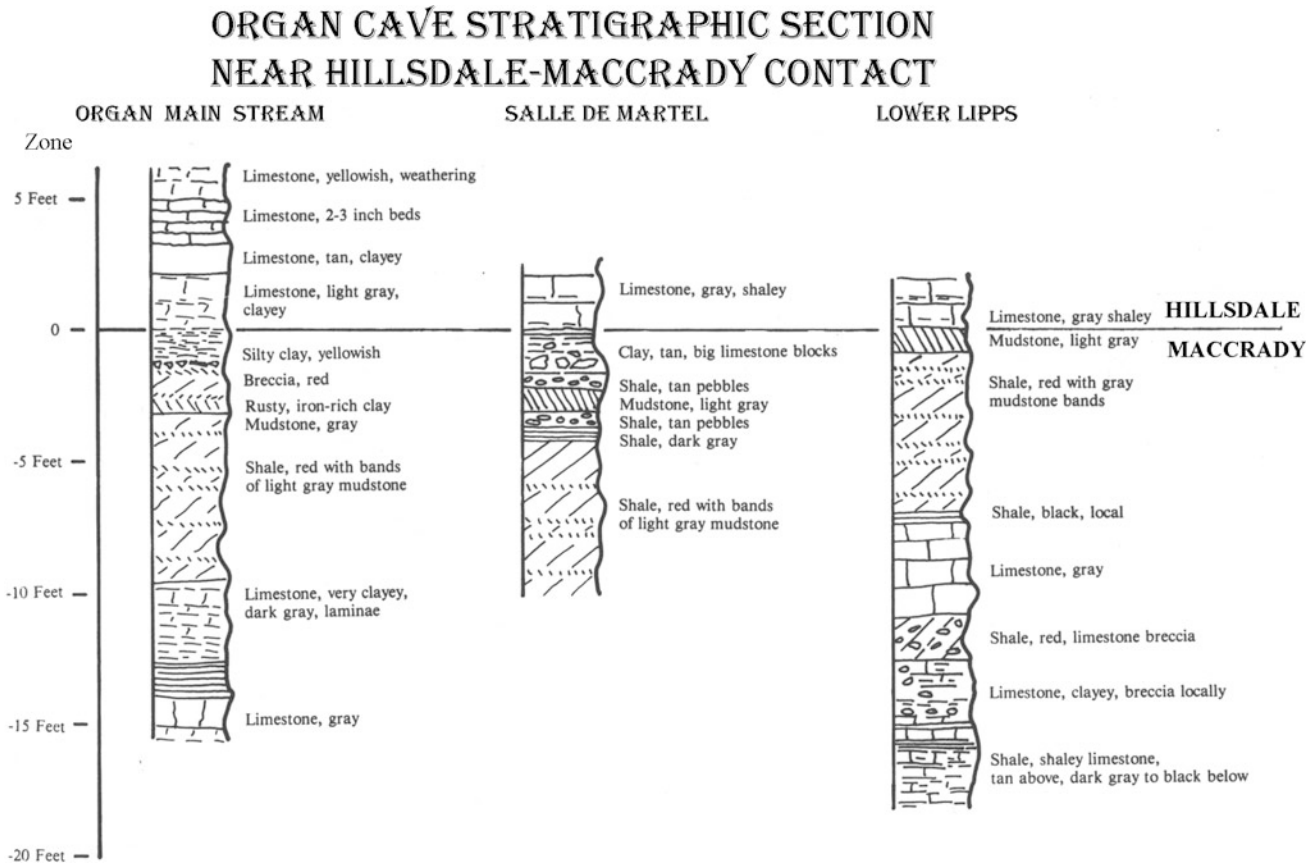

Fig. 13.15 Stratigraphic section in Organ Cave at the Maccrady–Hillsdale contact

Figure 13.15 presents several sections of the contact zone. In general, some thin to shaly beds occur in the Hillsdale Limestone above the Maccrady shale contact. A very shaly bed 3–4 ft above the contact is exposed above the waterfall in Organ Main Stream Passage. A gray or tan mudstone 8 in. to 2 ft thick often marks the top of the Maccrady Formation. Locally, thin tan or even white beds occur in the red shales. In Lower Lipps and in Floyd Collins Avenue, a limestone is exposed 8–10 ft below the top of the Maccrady, and in Lower Lipps another calcareous bed is about 16 ft below the contact. Heller (1980) reports frequent discontinuous layers of yellow to tan argillaceous limestones and calcareous shale in the uppermost Maccrady.

At most exposures the contact seems gradational, but some sections, including those near Salle de Martel, show tan shale pebbles in the shale matrix in the top foot or two of the Maccrady, the "reworked" Maccrady of Rutherford and Handley (1976). In Lower Lipps red shale breccia is exposed 10 ft below the Maccrady contact.

In most parts of the cave no special solution features were noted at the shale contact which seems to have been reached by solution and erosion in passages which originated 10–15 ft above the contact in the limestone beds. This situation is different from that reported in Ludington Cave by Palmer (1974), where major passages originate by solution of the basal Hillsdale beds at the Maccrady shale contact and were enlarged primarily by erosion of the underlying shale. The seeps which have deposited considerable flowstone in Floyd Collins Avenue are mainly found 3 ft above the contact, but some seeps are 2–3 ft down in the shales. The lower Hillsdale and the upper Maccrady are a productive aquifer for wells in Monroe and Greenbrier Counties. On the basis of chemical differences between well water and water in cave–spring systems, Heller (1980) concludes that the well water is drawn from a confined diffuse-flow aquifer. Fracturing which produced blocky weathering in the upper Maccrady might explain its being permeable to water, and dolomitic rock reported in lower Hillsdale (Heller 1980) may also be porous. Probably much of the well water is from the coarse-grained horizons in the lower Hillsdale, where dissolution is also very common. The cherty zone 15–25 ft above the contact in the Organ Cave System is typical of this permeable and easily weathered zone.

The Greenbrier Group rocks exposed in the east and central parts of Organ Cave System (east from Flack Room) are illustrated in Fig. 13.16. The section has been labeled

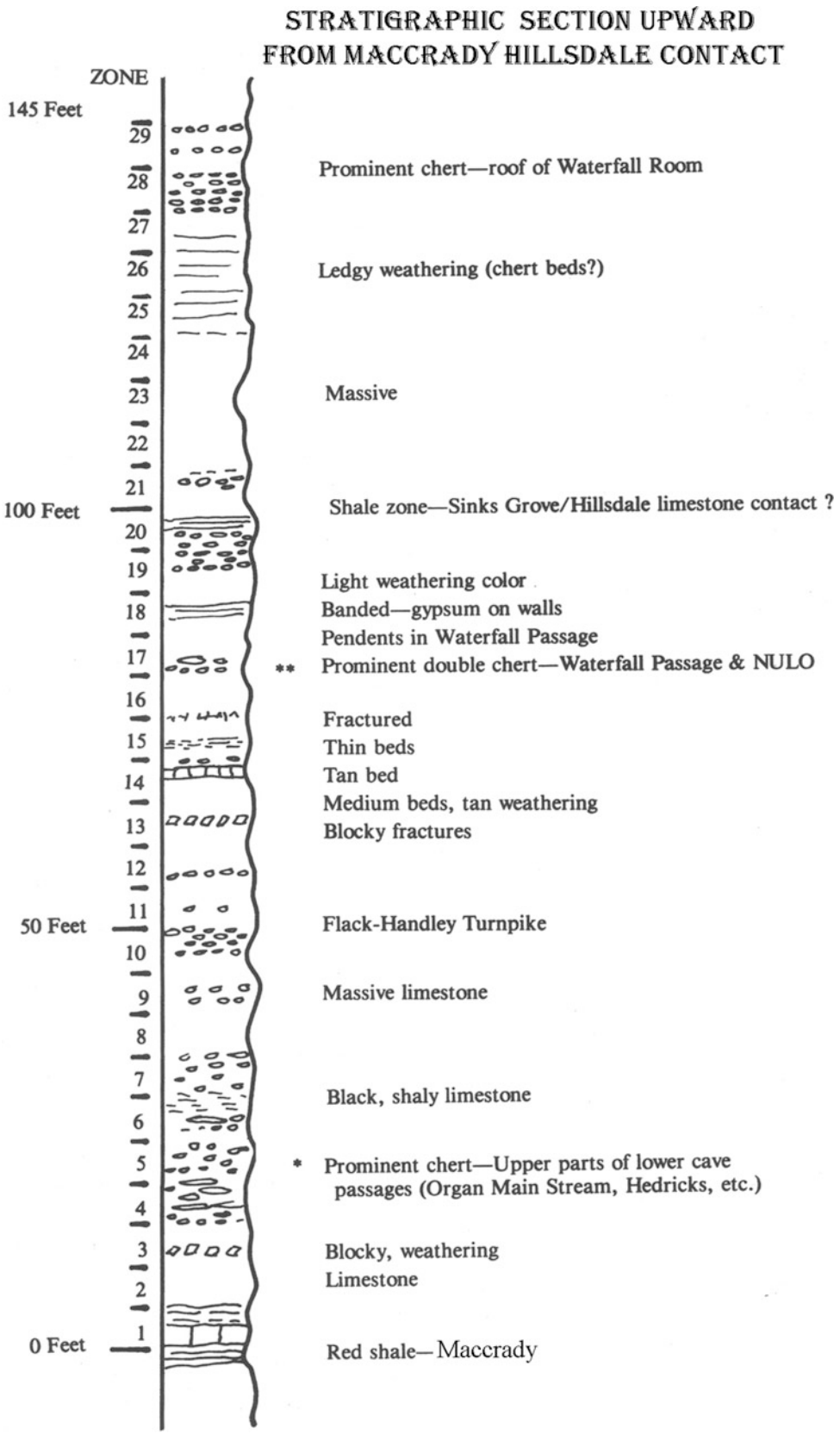

Fig. 13.16 A 145-foot stratigraphic section upward from the Maccrady–Hillsdale contact. East side of cave system

"zones 1–29" in 5-foot intervals upward from the Maccrady shale contact. The lowest 25 ft (zones 1–5) is widely exposed in the Organ Main Stream and Hedricks Stream Passages, in Lower Lipps, and in numerous other passages at or immediately above the Maccrady contact. Zones 14–19 are exposed in the Upper Stream Passage and adjacent passages. The beds between zones 7–13 are best seen in the USP–Hedricks Connector, the chimney that connects Old Saltpetre Route near Hedricks Stream Passage with the overlying Upper Stream Passage, where the section seems to be undisturbed. Other exposures of this section between Organ–Hedricks and Upper Level Organ are in areas of folding and/or faulting.

The rocks exposed in the cave system in and west of Flack Room and Handley Room are shown in Fig. 13.17. The lower part of this section including the top of the Maccrady shale is exposed in Lower Lipps. The section up to zone 16 is visible in Humphreys entrance passages, where it is unusually cherty. The section can be followed upward from its base to the prominent double chert in zone 18 in Hells Fissure. This chert horizon is widely exposed near the roofs of passages from Lipps through Jones Canyon and Left Hand Passage to Handley Room. Rocks above this chert are seen in the Belfry above Jones Canyon.

The section shown in Fig. 13.17 is separated from that shown in Fig. 13.16 by faulting in the Flack Room–Handley Room area. As far as observed it differs somewhat in detail because of lateral variations in stratigraphy. For example, the cherty zone 4 is present, but the nodular cherts of zone 5 are not obvious in Lipps. Zones 6 and 7 are very cherty in Humphreys, but show only isolated chert beds in upper Lipps or Organ. The double chert seen in Waterfall Passage and NULO is about 82 ft above the Maccrady shale in Fig. 13.16. The prominent double chert in passage roofs west from Handley Room is about 85 ft above the Maccrady shale in Fig. 13.17. Thus, this zone 17 chert (Fig. 13.16) is considered to correlate with the zone 18 chert of Fig. 13.17. In the outcrop above Humphreys entrance there are thick shaly beds about 90 ft above the base of the limestone. This is quite possibly the shale used by Ogden (1976) to mark the top of the Hillsdale, but they do not correlate easily with the thinner shaly horizons seen in the east side of the cave. Careful examination of the Humphreys entrance area, and of beds exposed in the high walls of the Waterfall Room, may well clarify the relationships. One particularly interesting bed is zone 6, which collapses to form piles of black shaly limestone chips in some areas. Examples are in the south end of 1812 Room (Fig. 13.18), in Octopus Alley, and notably in the "Shale Rooms" along Hedricks Stream upstream from Sarver Room.

A fault isolated section occurs in the Revak Room and passages to the east toward Raccoon Room, Fig. 13.19. The paired cherts in this section may correlate with cherts of zone 17 in Fig. 13.17. Correlation of the section in the cave with published reports is problematic. Wells (1950) reports abundant chert in the lower Hillsdale, but Ogden (1976) does not. Ogden reported chert as common in the overlying Sinks Grove, but only scattered chert is usually mentioned in these beds. In Organ Cave System there is fairly abundant chert throughout most of the section. The position of the Hillsdale–Sinks Grove (or Denmar) contact has not been fixed. The top 10–15-foot shaly bed Ogden used to mark the top of the Hillsdale was not identified. The highest thin-bedded or shaly zone identified in the cave (Fig. 13.16) is in the middle of zone 20, 97 or 98 ft above the base of the Hillsdale formation. The thicker shaly beds exposed above Humphreys entrance (Fig. 13.17) are about 90 ft above the base of the Hillsdale formation. This is conveniently near the reported thickness of the Hillsdale in the area, but only more detailed work might locate the contact with certainty.

13.4.2 Stratigraphy of Foxhole Cave

Foxhole Cave lies along the axis of the Caldwell Syncline 150–200 ft above the horizon of the Maccrady shale. The entrance maze lies in and below a coarse limestone with fossils and some chert. Immediately above is a thick cherty zone. About 18 ft below the fossiliferous limestone is a sequence of very cherty beds about 17 ft thick. This is followed downward by 22 ft of limestone which is massive above and thin-bedded below. There is some chert in the beds just below these limestones.

The observed section, some 60 ft thick, is probably all in the Sinks Grove Limestone. No definite correlation with the rocks exposed in Organ Cave System has been established. The extensive chert seen in the roof of the Waterfall Room is 140 ft above the base of the Greenbrier Group and are the only rocks in Organ Cave System that might correlate with any of the cherty horizons in Foxhole Cave.

13.4.3 Relation of the Cave to Geologic Structure

The Organ Cave Plateau is developed in the center of the Caldwell Syncline, whose axis is shown in the county geologic map (Price, 1939) as 0.25 mile west of the Organ Entrance. In fact, the Hedricks Stream Passage in the cave is rather close to this axis. The fold has a 2–3° plunge to the southwest. Regional strike and trend of the fold axis is about N30°E. Complex details of the structure of the syncline are revealed in the cave. The axis of Brown's Mountain Anticline lies about four miles away to the southeast, while that of the Sinks Grove Anticline is about 3.5 miles northwest. The Caldwell Syncline is bounded nearby by minor

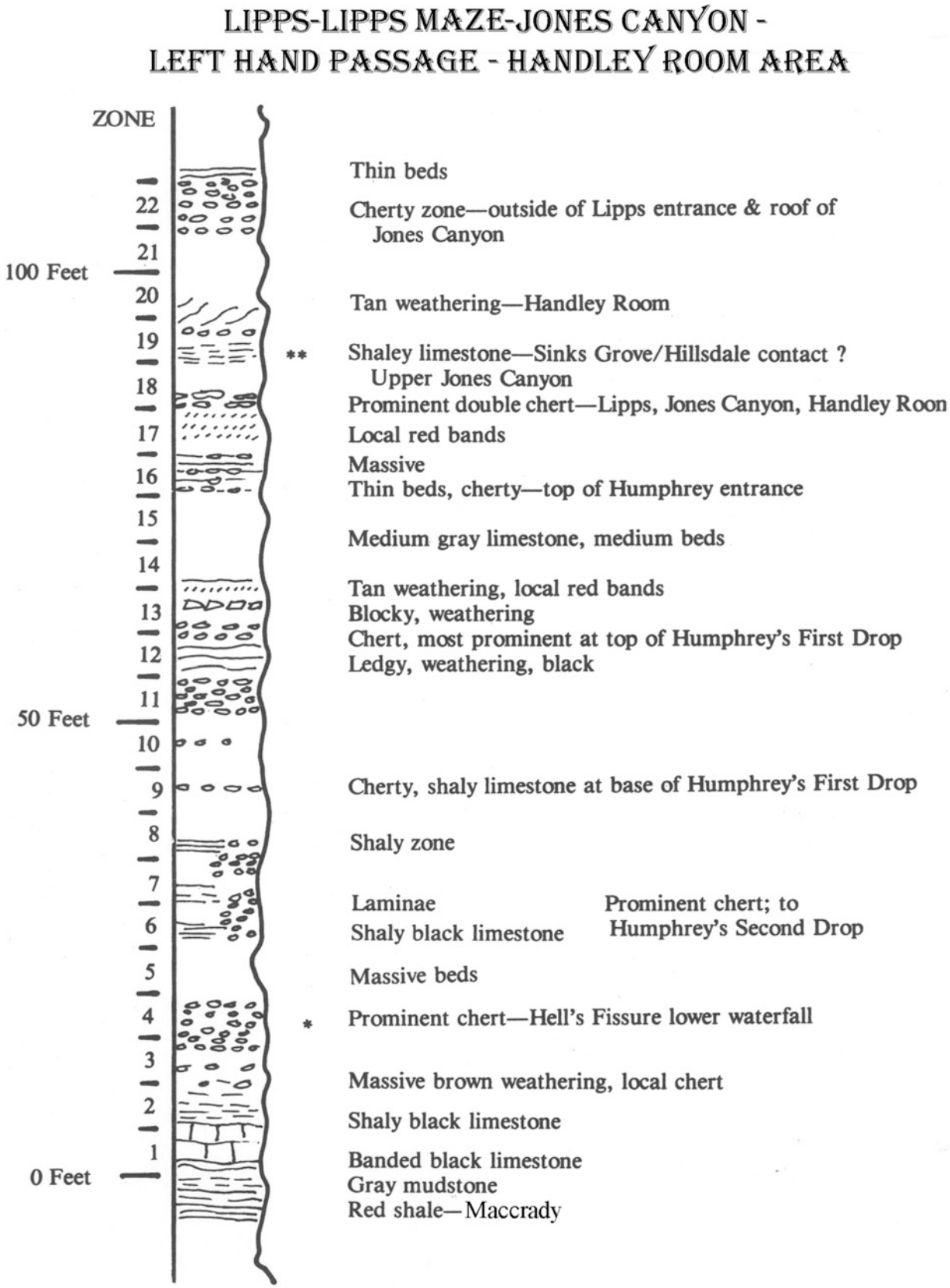

Fig. 13.17 Stratigraphic section in Lipps–Lipps Maze–Jones Canyon–Left Hand Passage–Handley Room area

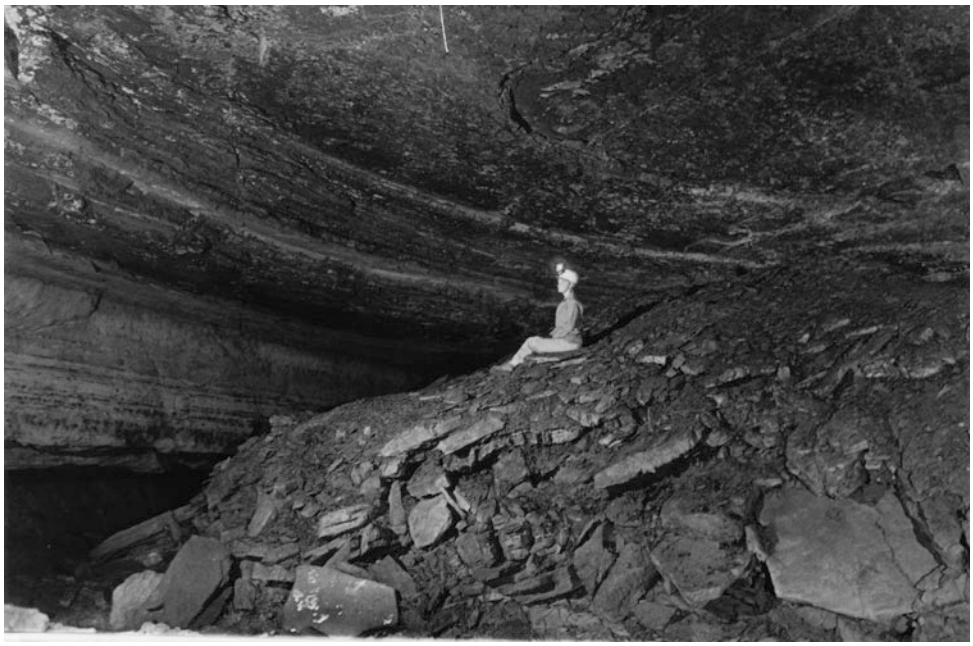

Fig. 13.18 Shale outcrop and breakdown pile in 1812 Room. Photograph by W.K. Jones. Used with permission

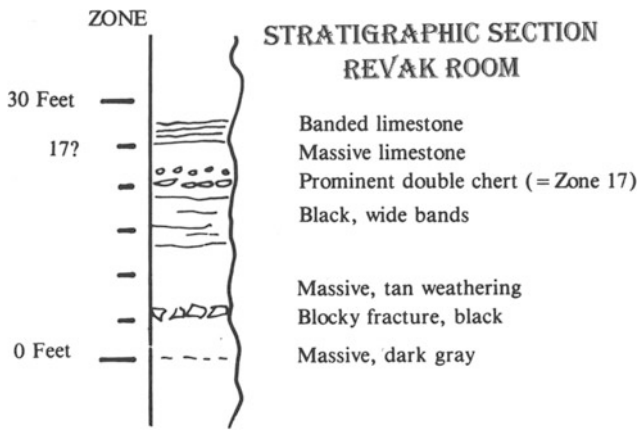

Fig. 13.19 Stratigraphic section in the Revak Room

anticlines, the Maple Grove Anticline about 3500 ft southeast of the synclinal axis, and an unnamed anticline about 9,000 west. The cave does not extend to either of these. Ogden (1976) says he agrees with Price (1939) on the location of these fold axes where they cross the county line at Second Creek. Actually, Ogden's detailed map seems to place the synclinal axis about 600 ft further west than Price's map. Ogden's location would place the axis about in line with Wilson's Watery Wonderland, the downstream continuation of Organ–Hedricks Stream beyond Hedricks and Bowen sumps.

Ogden reports that Winslow and Baroody (1976) mapped minor folds and many small faults in the Pocono Group near the county line. Ogden found only a few reverse faults in the Greenbrier Group, mostly with displacement estimated at 20 ft or so. Some beds of the Greenbrier also exhibit swarms of vertical clay-filled partings interpreted as solution pressure cleavage. The solution cleavages may account for considerable compression of the Greenbrier rocks. Fairly numerous small reverse faults, with displacements usually less than 2 ft may be observed. These sometimes splay from bedding planes into overlying beds. In addition, breakdown often reveals slickensides on inclined rock surfaces where the displacement seems small, but cannot be determined. Slickensides are also found on bedding in areas of deformation where the dip is steep. Finally, there is reverse faulting, with known displacement in one case of 20 ft, associated with the abrupt monoclinal folds that border the axis of the Caldwell Syncline in the cave. The lower Greenbrier has undergone considerable complex deformation, and this has had notable effects on the development of the Organ Cave System.

Jointing is not nearly as well developed as in the folded Appalachians, but numerous joints with rather irregular spacing and often limited extent are present. Ogden (1976) measured 873 joints in Monroe County, finding the most common set at around N37°E, parallel to regional fold axes. Diagonal joints at about N27°W and N85°W were fairly

common, as were cross joints at about N58°W. Jointing has had an effect on orientation in various passages in Organ Cave System.

13.5 Passage Development and Stratigraphic Relations in the Basal Hillsdale

The passages in the Organ Cave System show a great deal of stratigraphic control. Extensive parts of the system are developed in zones 1–5, the basal 25 ft of the Greenbrier Group (Fig. 13.20). The major passages are the main stream passages (Hedricks, Organ Main Stream, Lower Lipps), with free-surface streams which have eroded into the underlying Maccrady in many places, sometimes to a depth of more than 15 ft. Weathering and erosion of the Maccrady shales has permitted widespread collapse of the Greenbrier limestone. There does not appear to be much evidence of initial solutional development in the contact zone.

Most of the passages extend upward into zones 4 and 5, a coarse bioclastic limestone with chert beds (particularly in zone 4) and nodules and rods (mostly in zone 5). The passages generally have ceiling channels and joint crevices in these beds. There is some anastomosing of the channels, and some lead away from the present stream passages, for example the Discovery Passage (Fig. 13.21). Many of these diverging passages are blocked by sediment. They tend to be tubular (sometimes with incised canyons) or fissures showing joint control. It is likely that the passages had their beginnings in a network of water-filled tubes which followed zones 4 and 5. They are often of considerable size and probably became part of a loosely organized conduit flow system before they were abandoned. The lower and larger parts of the passages are much modified by breakdown, but appear to be the result of solution and erosion by free-surface streams such as those that now occupy them.

The Hedricks Stream Passage extends thousands of feet down the plunge of the Caldwell Syncline, so that there is an elevation difference of more than 400 ft from the upstream (blind valley) to downstream (sump) end of the passage. For any point along this route there would have been a time when the passage downstream was water-filled, while upstream the passage contained a free-surface stream. The water-filled parts would still be particularly sensitive to stratigraphy and structure and apparently composed of a somewhat complex series of tubes. Heller found that well water, usually from a diffuse-flow aquifer, was chemically different from cave and spring water from conduit flow systems. Presumably, the water in these passages in Organ Cave System was not carried into a diffuse-flow aquifer. Spring outlets must have been established before the openings could enlarge significantly, and conduit flow was then quickly established.

Upstream (and up-plunge) the free-surface streams selected a single route with very few loops, dissolved and eroded to the base of the Greenbrier Group, and have continued to erode into the Maccrady shale. The process of concentration to a single flow route probably began in the water-filled passages in response to high-flow conditions and might be expected to have been nearly completed before the passages became air-filled, but there is little evidence of an enlarged water-filled conduit visible in the stream passages today. Careful observations by divers might clarify the picture, since the downstream ends of Organ Cave System passages are still water-filled.

13.5.1 The Organ Main Stream Passage

Organ Main Stream Passage presents a complex case (Fig. 13.21). It lies on the east flank of the Caldwell Syncline. The passage trends down-dip in most of the Organ Cave tourist section, with development in zones 4 and 5, and downcutting well into the Maccrady in many places. Open passages in beds 4 and 5 join at Organ Main Stream Passage and Fat Man's Misery, and there are some sediment-filled openings in these horizons as well.

Some 200 ft downstream from Fat Man's Misery the Organ Main Stream Passage becomes strike-oriented, and the original, upper part of the passage continues 800 ft along the strike toward the 1812 Room above the waterfall that enters Organ Main Stream here. The 1812 Route is in zones 2 and 3, and any continuations of the development in the cherty 4 and 5 zones are lost until the Rotunda Room. From here through the 1812 Room the Old Saltpetre Route is in zones 4 and 3, again showing some sign of initial development in the cherty zone 4, particularly south of the 1812 Room. The trend here is diagonally down-dip.

The Lover's Leap Passage leads from the 1812 Room in zones 5 and 6, and its dissolutional walls and irregular roof profile suggest phreatic development. Toward its silt-filled termination it has risen through the beds into zones 6–9, but its elevation is about 50 ft below the strike-orientated reach near Rotunda Room. Its elevation suggests it continues as part of Revak Room, but it is separated from those passages by a major fold and faulting. Lover's Leap was probably the earliest flow route used by the ancestral Organ Main Stream south of Organ Entrance.

A route the full length of the 1812 Room was next to develop. Beyond the south end of the 1812 Room, flow then continued south a short way to enter Lover's Leap Passage. Flow paths which developed from here followed cherty zones 4 and 5 down-dip, dropping 110 ft in elevation along

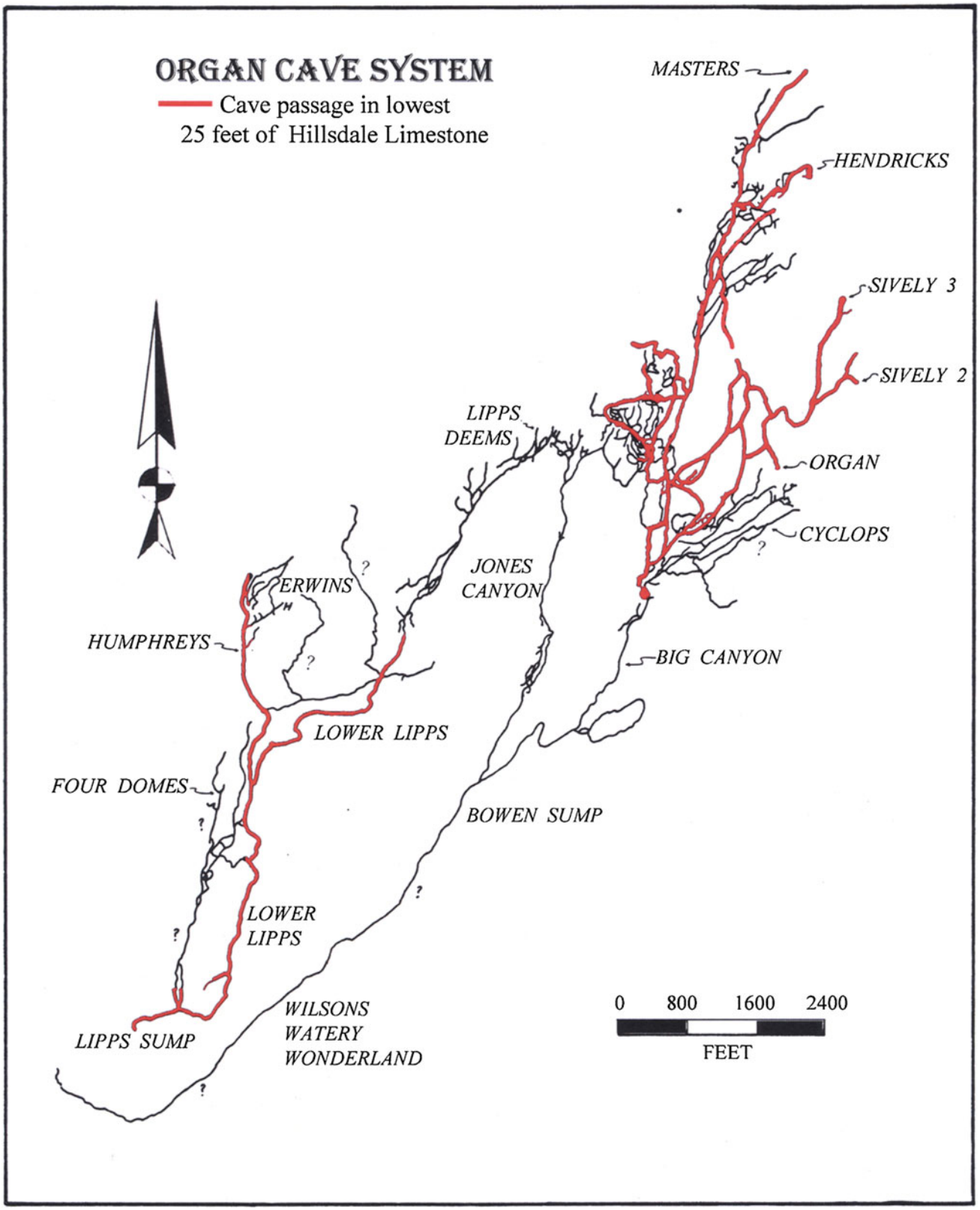

Fig. 13.20 Cave passage in the lowest 25 ft of the Hillsdale Limestone

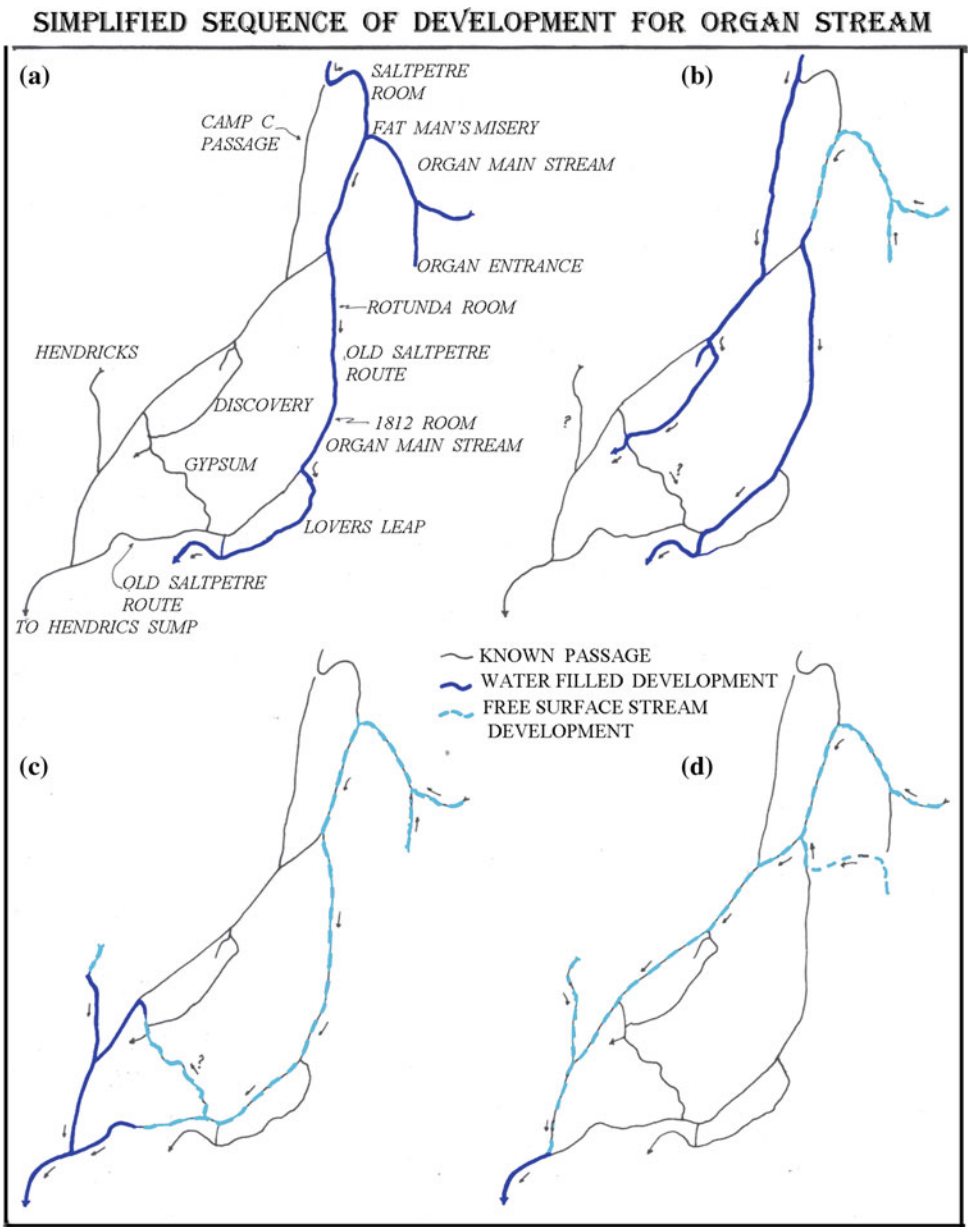

Fig. 13.21 Simplified sequence of cave development in main organ area

the Old Saltpetre Route to the vicinity of the present Organ–Hedricks Stream. Two routes down the steepening dip were developed under phreatic conditions. The Old Saltpetre Route (and Gypsum Passage) may have originally developed to carry water from evolving Hedricks Stream upward to join early Organ Main Stream at this point, as described later. The Organ Main Stream was diverted from this route by development of the present route beyond the waterfall. The 1812 Room–Old Saltpetre Route continues to be enlarged by occasional flow from the Organ Entrance Stream.

From the waterfall to its junction with the Hedricks Stream, the Organ Main Stream Passage is oriented diagonally down-dip at varying angles. In this reach there are extensive openings in zones 4 and sometimes 5: Camp C Passage, Discovery Passage, and Gypsum Passage (which extends all the way to Old Saltpetre Route). These are continuous with various ceiling channels in the Organ Main Stream Passage. The Organ Main Stream seems to have used these preexisting openings to develop a new route down to the Hedricks Stream Passage. Some of these passages may already have been carrying water from the Hedricks Stream route, either from Paleo Saltpetre Passage via Camp C Passage, and/or through the ceiling tubes just upstream from Organ–Hedricks Junction. The first flow from the waterfall area of Organ Main Stream could conceivably have followed Gypsum Passage to Old Saltpetre Route and Lover's Leap. It might also have temporarily gone up to Throne Room in Upper Stream Passage, which is about 20 ft lower in

elevation than Lover's Leap. These must have been very temporary routes, because they consist of small passages. The Organ Main Stream must have made the transition from the 1812 Room route to the present route in a rapid sequence of shifts. This makes it seem probable that the Hedricks Stream became a free-surface stream near the present Organ–Hedricks Junction soon after the new route developed.

A possible history (Fig. 13.21) is then: Organ Main Stream develops the strike-oriented route toward 1812 Room close the base level. At this time Hedricks Stream would have reached its sump far upstream, above Rimstone Ceiling Passage junction. Indeed, there is evidence that the water from the ancestral Hedricks Stream joined Organ Main Stream by way of the Paleo Saltpetre Passage and the Saltpetre Room as described later. While base level fell 150 ft and Hedricks opened and developed its down-plunge route near the synclinal axis, Organ Main Stream continued to traverse the 1812 Room, 800 ft to the east and up the flank of the fold, by now a free-surface stream. Development of Camp C Passage and Discovery Passage would date from this interval, the water derived from Hedricks. Hedricks water may even have followed the beds upward along Old Saltpetre Route to join Organ Main Stream at one time. Organ and Hedricks water first joined with minor flow through Gypsum Passage. Fairly early in this interval the Organ drainage began to use or open the Old Saltpetre Route down toward the synclinal axis. Finally, the Organ Main Stream developed a cutoff from the waterfall into the Camp C Passage–Discovery Passage openings and integrated a new route all the way to the present Organ–Hedricks Junction.

13.5.2 Organ Entrance Stream

The stream which presently drains the large blind valley into the Organ Entrance has had a complex history. During recent vadose development of this part of the cave the stream probably entered Cyclops Avenue for a long period of time, but finally abandoned Cyclops for Organ Entrance. Organ Entrance is 400 ft further downstream in the blind valley than Cyclops, diagonally down the dip of the top of the Maccrady shale. The elevation is about 40 ft lower than Cyclops. The phreatic ancestors of this drainage developed the high-level passages leading toward Revak Room from the area of the Raccoon Room. The same drainage later initiated the lower passages including Cyclops.

In Organ Entrance the stream went down-dip to enter the 1812 Room and followed Old Saltpetre Route down to Organ–Hedricks Stream. This route is still used in high water. But very recently bulldozer work in the creek bed 50 yards upstream from the entrance caused the creek to sink short of Organ Entrance at low water stages. The water now bypasses the 1812 Room and follows the passage north to the Waterfall, where it drops into Organ Main Stream.

13.5.3 Hedricks Stream

At the time Organ Main Stream was flowing to the 1812 Room, Hedricks Stream would have reached base level near the present junction with Rimstone Ceiling Passage or Paleo Saltpetre Passage, 2000–2500 ft upstream from the present Organ–Hedricks Junction. In that area of Hedricks there are several large passages lying east of the Hedricks Stream Passage (Fig. 13.22).

At Paleo Saltpetre Junction, the upper half of Hedricks Stream Passage, developed in zones 4–6, goes to the east to become Paleo Saltpetre Passage, while the lower half in beds from zone 3 down into the Maccrady shale continues as modern Hedricks Stream Passage. With a broad canyon as its floor, the Paleo Saltpetre Passage continues a little east of the synclinal axis to a junction with Rimstone Ceiling Passage. The canyon is lost in fill at the bend only 50 ft from the junction. From here it probably followed a different route, now filled, developed in zones 4 and 5, to join the present Hedricks Stream Passage route at or near Shale Room.

The tubular upper part of the Paleo Saltpetre Passage joins the upper part of Rimstone Ceiling Passage coming down-dip from the northeast. These flows combined to follow Paleo Saltpetre Passage to the south along the strike, in zone 5, probably to continue through the Saltpetre Room of Organ Cave, to join Organ Main Stream drainage and go down the 1812 Route thence on through 1812 Room. Most of this route was water-filled during development. The elevation difference along this strike-orientated route from Paleo Saltpetre Junction to Rotunda Room is about 60 ft. The next route opened was the upper tube of Rimstone Ceiling Passage south to its junction with modern Hedricks Stream Passage. This might be the first time Hedricks water used its present course from there south toward Hedricks sump.

Another possibility, suggested by the ceiling tubes and development in zones 4 and 5, is that Hedricks water got only as far as 100 ft above Organ–Hedricks Junction, then went east through "T"-Room and up Gypsum Passage to join Organ Main Stream beyond 1812 Room. Water following this route, perhaps including water from Organ Main Stream as it developed a route toward Organ–Hedricks Junction, may next have forced the route upward into Upper Stream Passage at Throne Room. The next development could have been the passage parallel and east of Hedricks Stream downstream from Organ–Hedricks Junction. The flow might have been upward along zones 4 through Old Saltpetre Route, and/or up the chimneys of the

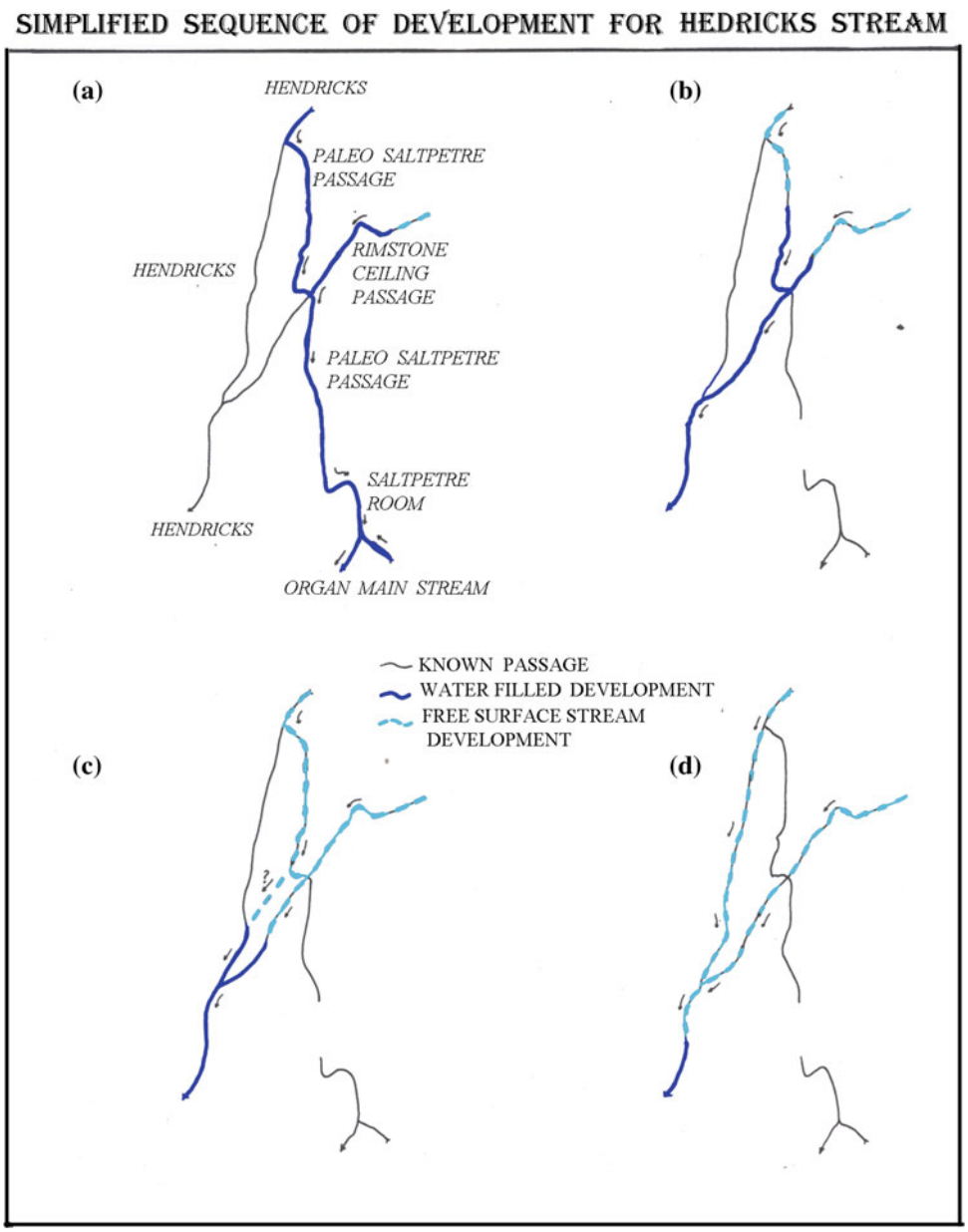

Fig. 13.22 Simplified sequence of cave development for Hedricks Stream Passage

USP–Hedricks Connector to Upper Stream Passage. Last would be opening the route to Hedricks sump. After a short interval the flow developed the hypothesized route to Shale Room and another segment of modern Hedricks Stream, from there to Rimstone Ceiling junction. The water from upstream Rimstone Ceiling Passage continued to use that passage all the way south. Both streams incised canyons in their routes, both were now free-surface streams. Finally, the main flow forced a route from Paleo Saltpetre Passage junction to Shale Room, partly in zone 2 at first, in an area where the stream is now incised 10 ft into the Maccrady. Thus, the Hedricks Stream shifted in stages to follow the synclinal axis as base level fell.

13.5.4 Lower Lipps

Humphreys and Lower Lipps Streams are developed mostly in the base of the Hillsdale. The Humphreys entrance is high in the stratigraphic section, about 75 ft above the Maccrady. The First Drop is over cherty beds, and its base is at a shaly horizon in zone 9. Second Drop is over very cherty beds of zones 6 and 7. Some cherty horizons (zones 4 and 5, zone 17 in eastern Organ) seem susceptible to initial phreatic development, but the chert horizons in Humphreys entrance passage are holding up downcutting by the free-surface streams. Humphreys and Lipps Streams have initially developed in cherty zone 4 and above, much like the

situation seen in Organ–Hedricks Stream, and both are downcut to or below the Maccrady shale contact. This situation continues nearly 1000 ft downstream from the Lipps–Humphreys Junction, but at Rimstone Passage and finally at Purgatory Way, the openings in zone 4 trend off to the west into a complex of passages that were probably the earlier route of this drainage, lying further up-dip.

Approaching Purgatory Way, the passage floor is cut ever deeper into Maccrady rocks, revealing a bluish limestone bed 9 ft below the contact. At Purgatory Way the development in zone 4 leaves the present Lipps Stream and follows Purgatory Way to the west. Just below Purgatory Way the Lower Lipps Stream Passage is entirely in Maccrady: the upper tube in shale, the lower canyon in limestone and clayey limestone below. Some 600 ft downstream the passage is developed in a few feet of basal Hillsdale, but cut 17 ft into shale, limestone, and limestone breccia. The dip of bedrock and passage gradient increase for about 400 ft with similar rocks exposed, then the gradient flattens and in 300 ft the shale passes beneath the floor and cherty beds of zone 4 appear again in the roof. This part of Lower Lipps is the best case observed for flow beginning a new route at the contact and even in the Maccrady shales. The reason why the water was able to initiate development of part of the route below Purgatory Way in these rocks is not known in detail, but obviously they were permeable, apparently locally more so than the lowest Hillsdale beds. This shaly contact zone is locally a principal aquifer for area water wells.

From Skyline Caverns Crawl to the junction with Angel Passage the roof of Lower Lipps Stream Passage is usually in zone 4, and the floor either bedrock- or gravel-covered is several feet above the Maccrady shale. In the last 400 ft of this section the passage turns west, nearly parallel to the strike, no longer running obliquely down-dip.

In the final 500 ft to the Lipps sump the whole Lower Lipps Stream Passage rises through the stratigraphic section, and the roof finally reaches the top of zone 6, about 15 ft above cherty zone 4 and 35 ft above the Maccrady shale. The passage follows the local dip direction as it climbs through the bedding. In part, this dip is near west, away from the Caldwell Syncline, and there must be a local wrinkle in the structure, almost a small anticline, to account for this. At the sump the dip steepens to 8° in the direction of the plunging folds. The original tube was not graded and gained elevation in the downstream direction in part of this area. It is now downcut by a free-surface stream.

The elevation of the sump is about 30 ft above the elevation of the Organ resurgence, which is about 3500 ft distance at S75°W. This would place the Maccrady–Hillsdale contact at Lipps sump at the same elevation as at the resurgence. David's Dungeon, the final Organ sump, is 1,500 ft in the same direction. Its stratigraphic horizon is unknown, but it is likely well above the Maccrady. Near the resurgence the dip is reported as 15° toward the synclinal axis. This is enough that the beds may rise to bring the contact to the surface at or near the resurgence. But it is also possible that the resurgence is from beds 100 ft to 200 ft up into the Greenbrier Group.

13.5.5 Fun Room–Flack Room–Floyd Collins Avenue

There is extensive development of passage in the lowest 25 ft of the Hillsdale in the Fun Room–Flack Room–Hedricks Maze area west of the synclinal axis. These passages carry water from a blind valley west of US 219, 3,000 ft north of its intersection with WV 63. The large passages trend down-dip to the Hedricks Stream Passage near the fold axis.

Floyd Collins Avenue (Fig. 13.23) has a roof in zones 2 and 3, and the floor usually extends into Maccrady shale. Zone 4 cherts are exposed in the room at its north end, but development of solution passage in this bed at this location is a continuation of strike-oriented Rat Alley Crawl, which is a tubular conduit in zone 4, not obviously related to the development of the Floyd Collins Avenue.

Down-dip Floyd Collins Avenue opens into Flack Room, where the cherty zones 4 and 5 are exposed in the upper walls and ceiling. At the southeast end of the Flack Room the dip steepens from about 10° to as much as 40° for nearly 200 ft before flattening out nearer the synclinal axis. This monoclinal fold shows some faulting. Several passages follow the beds down the fold to reach Slate Creek Passage at or near the Fun Room (Fig. 13.23).

The Subway is developed in zones 3, 2 and l, and leaves Flack Room behind breakdown to the southwest. Locally eroded into Maccrady, it reaches Slate Creek at lowest floor level. The route directly to Fun Room is a group of wide interconnected openings following cherty zones 4 and 5 down the monocline. These become a single wide tube on top of the false floor of the Fun Room, where they are joined from the northeast by strike-oriented Octopus Alley, also in zones 4 and 5. Fun Room joins Slate Creek as the upper part of that passage, whose floor is in Maccrady shale. There is a lower level to Fun Room, in zones 1–3, eroded into the Maccrady. This level carries some modern drainage, probably from Floyd Collins Avenue. Under the east wall of Flack Room another passage begins in zones 6 and 7, but soon drops to zones 4 and 5 as it drops steeply down the dip to intersect Octopus Alley and continue to Slate Creek. A canyon in its floor also crosses Octopus Alley. Directly above this passage is a wide opening in zone 17, at ceiling level of Flack Room, with a canyon cut below it. This passage leads by two routes to the Centrifugal and, hence, to Sand Room on the Upper Stream Passage level of the cave, all in the same stratigraphic horizons. These two exits from

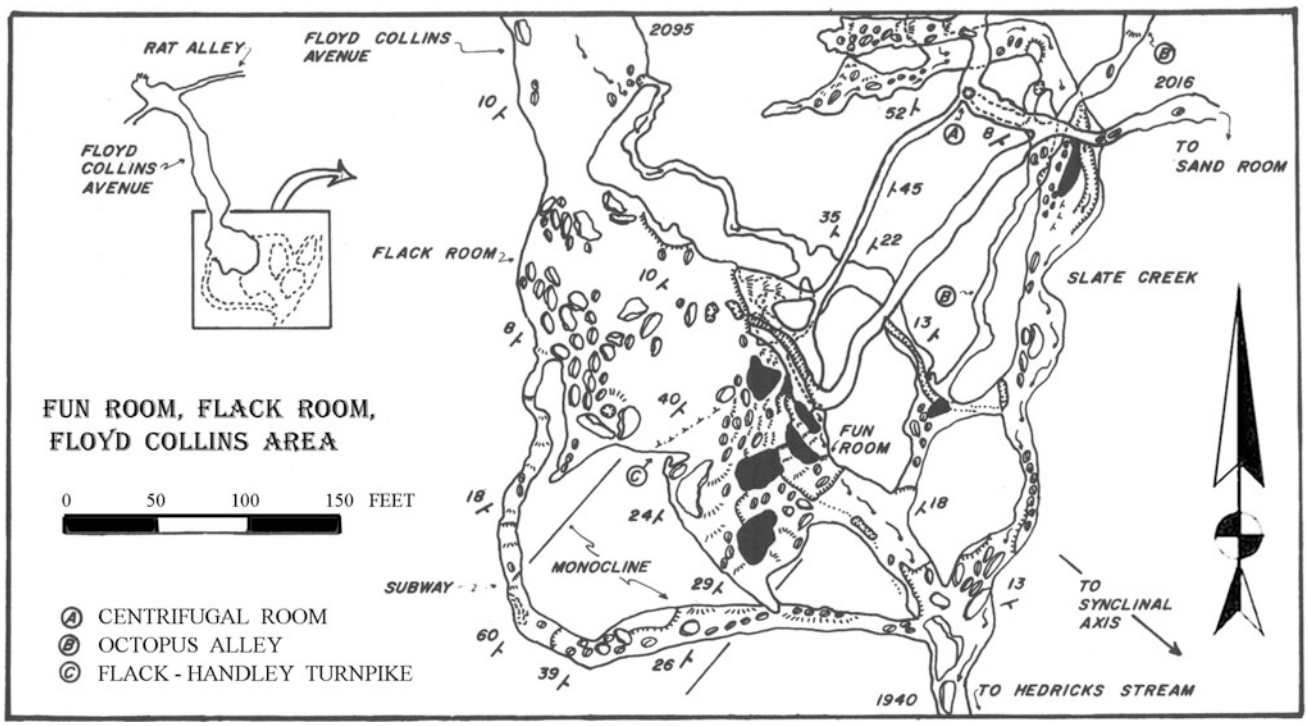

Fig. 13.23 Fun Room–Flack Room–Floyd Collins Avenue area

Flack Room are perhaps 30 ft apart vertically, but in beds 50 ft apart stratigraphically: Faulting accompanies the monoclinal fold here. A final passage from this end of the Flack Room leads upward through the stratigraphic section above Flack–Handley Turnpike, to enter the overlying Handley Room. A possible history of Floyd Collins Avenue and its downstream branches takes as a starting point that the route has developed specifically to carry water from the surface drainage ancestral to the present blind valley. No evidence suggests its evolution from earlier passages. Development did not begin in the cherty 4–5 zones, but closer to the Maccrady contact, quickly opening a single route down-dip as far as the Flack Room. If the route once terminated at, and was tributary to, Rat Alley Crawl, this is not evident—probably it did not and base level was as low as about 2075 ft elevation, the roof of Flack Room, when this new route from the surface to the main cave conduits developed. This is approximately the same elevation as the horizontal strike-oriented development in the 1812 Room.

From the Flack Room the routes, except for Subway, all exhibit wide phreatic solution of particular beds. The highest route exits upward along faulting to Handley Room. Other routes lead to Octopus Alley and the upper parts of Slate Creek. These passages in zones 4 and 5 would have been as much as 100 ft below water level at this time. The water would have flowed to the water-filled Hedricks Stream Passage route, which was developing in zones 4 and 5. There is no known development out of Flack Room between the high route to Centrifugal and the much lower outlets to Slate Creek. At some time Flack Room was filled almost to its roof with gravel and fine sediment, burying breakdown blocks. This might have been at a time (or times) when a large opening admitted the surface stream, which deposited the sediment in deep water standing in Flack Room. Flood water may have backed up into the Handley Room, which is part of the earlier history of the cave.

Then followed a period of lowering base level when water entering Flack Room used various exits to lower levels and removed large amounts of sediment as well. Earliest was the route to Sand Room following zone 17. Starting on a sediment floor a small free-surface stream ran down the steep bedding, gradually carving a 15-foot canyon at its exit from Flack Room. It cut shallow canyons in passages beyond, but probably entered water-filled passages before reaching Sand Room. Later outlets coursed down-dip directly toward Slate Creek. The northernmost one was in use long enough for a canyon to be eroded 10 ft deep crossing Octopus Alley to reach Slate Creek, which became the main stream way. The route through Fun Room was not incised by any stream, but a lower level was opened which still carries water. Subway is a tributary to the bottom of Slate Creek, just above the Maccrady, and it seems it must have had a late origin after Slate Creek was enlarged downward well below zones 4 and 5. Except at its lower end

it seems to be the work of a free-surface stream, without obvious phreatic beginnings. It may have been a temporary route at a time when the other routes toward Fun Room became sediment-choked.

13.5.6 The Hedricks Maze

The Hedricks Maze is developed on the west flank of the Caldwell Syncline, and many of the passages are developed in the steeply dipping rocks of the same monoclinal fold seen between Flack Room and Fun Room. From the fold axis near the Hedricks Stream to Sarver Room the dip increases to 30°, and the same deformation is seen here as is seen in the stream passage 200 ft north of Sarver Room. Beyond Sarver Room the dip flattens to as little as 10°, then steepens again to at least 34° entering the Bone Room. Further north this second steepening of the dip reaches 45° in Hedricks Maze itself, and beds are locally vertical close to Handley's Climb. Where Room Without A Name crosses this structure, 550 ft north of Bone Room, the dip increases to as much as 54°.

Most passages in this section have developed in cherty zones 4 and 5, with development extending below into the Maccrady shales at various places. Breakdown has extended the Bone Room roof into zone 10. Free-surface streams presently traverse Bone Room–Sarver Room and Room Without A Name to reach the Hedricks Stream. At least in part these routes are of later origin than the maze.

Of particular interest is the Hedricks Maze itself, a series of interconnected phreatic tubes with minor free-surface stream modification that are developed in zones 4 and 5 which here are dipping at 20°–45°. The tilted maze occupies a vertical range of 70 ft and is filled with deposits of large, rounded cobbles. Water left the maze through the tube of Octopus Alley, which crosses the Sarver Room at its roof and extends to the Fun Room. For some 250 ft south of Sarver Room the passage is immediately adjacent to the place where the beds make their second fold to steeper dips toward the synclinal axis. This fold dies out toward Fun Room, and from there the water must have followed Slate Creek and crossed over to the Organ–Hedricks Junction area.

When the maze was water-filled, the Hedricks drainage would have been using the Paleo Saltpetre Passage and 1812 Room, based upon their elevations. Thus, water from Hedricks Maze may have first developed the Organ–Hedricks Junction area, which was later utilized by Hedricks Stream, and joined by Organ Main Stream later still. Alternatively, the water may have followed the beds upward from Fun Room into the location of Flack Room, and left by a now lost route, or even followed faulting on up into Handley Room, which could still have been active at that time.

13.6 Passage Development and Stratigraphic Relations in the Upper Hillsdale

13.6.1 The Upper Stream Passage–Sand Room Area

Only a few passages, Lover's Leap Passage for example, are known in the rocks of zones 7–12. The extensive Upper Stream Passage is developed in zones 13–21, from 65–100 ft above the base of the Hillsdale. This passage contains a stream perched 60–70 ft above Hedricks Stream near the axis of the Caldwell Syncline. For much of its length south of East Passage junction, Upper Stream Passage has a nearly straight alignment at N15°E, as does Hedricks Stream below, pointing to probable fracture control.

In several reaches of Upper Stream Passage between East Passage and the Waterfall Room the ceiling is at a chert bed in zone 17. This chert bed is often double, with a thin chert bed 6–10 in. above the major bed. In these areas there are often rounded solution forms in the limestone just below, and sometimes above, the chert, which might mark where solution of the passage began. But the roof is as much as 7 ft below the chert bed in much of NULO and rises 5 ft into overlying zone 18 close to Sand Room. The floor is an incised canyon cut by a free-surface stream and also rises about 12 ft in stratigraphic horizon. It is in zone 12 at East Passage, but is most commonly in 15 or upper 14 overall.

South of Sand Room the roof of Upper Stream Passage is commonly at or above the chert in zone 17, with local tubular side loops and ceiling channels in zone 18 south of Throne Room. The floor remains in zone 14 much of the way to the Revak Room, beyond which the passage is mostly in zone 16–18, with prominent pendants in 18 close to the Waterfall Room (Fig. 13.24).

There is some evidence that the coarse sparry limestone containing chert in zone 17 was the bed initially dissolved, and that the stream downcut to zone 14 before becoming perched on that horizon. The upper part of 14 is dark fine shaly or thin-bedded limestone and may indeed be impeding further deepening of the passage, but upstream at East Passage erosion has reached 7 ft below zone 14, only 35 ft above the roof of Hedricks Stream. Apparently no continuous route through joints exists that would let the water reach that lower passage.

Sand Room is crossed by the Upper Stream Passage canyon and predates it (Fig. 13.25). A ceiling tube 2 ft higher than Sand Room's roof came from NULO and is silt-filled to the south, above the canyon. Sally's Waterfall Passage is in zone 18, Sand Room in 18 and upper 17, and together they may form a strike-oriented tube looping around the synclinal axis. Nine Foot Bat Passage leads south out of

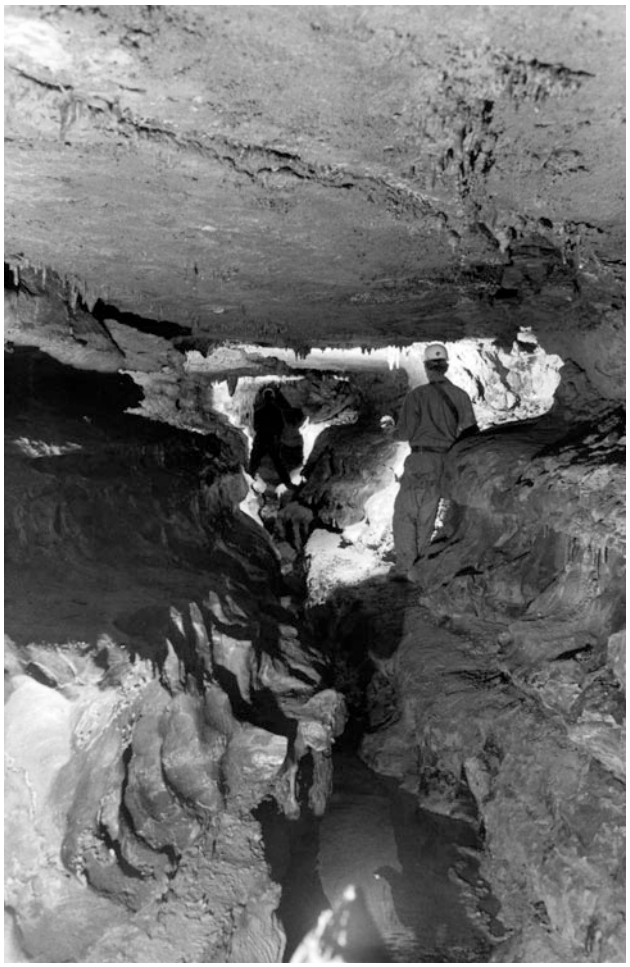

Fig. 13.24 Passage south of Sand Room. Keyhole passage in North Upper Level Organ (NULO) just south of sand room. The zone 17 chert is at the level of the person's feet. Photograph by W.K. Jones

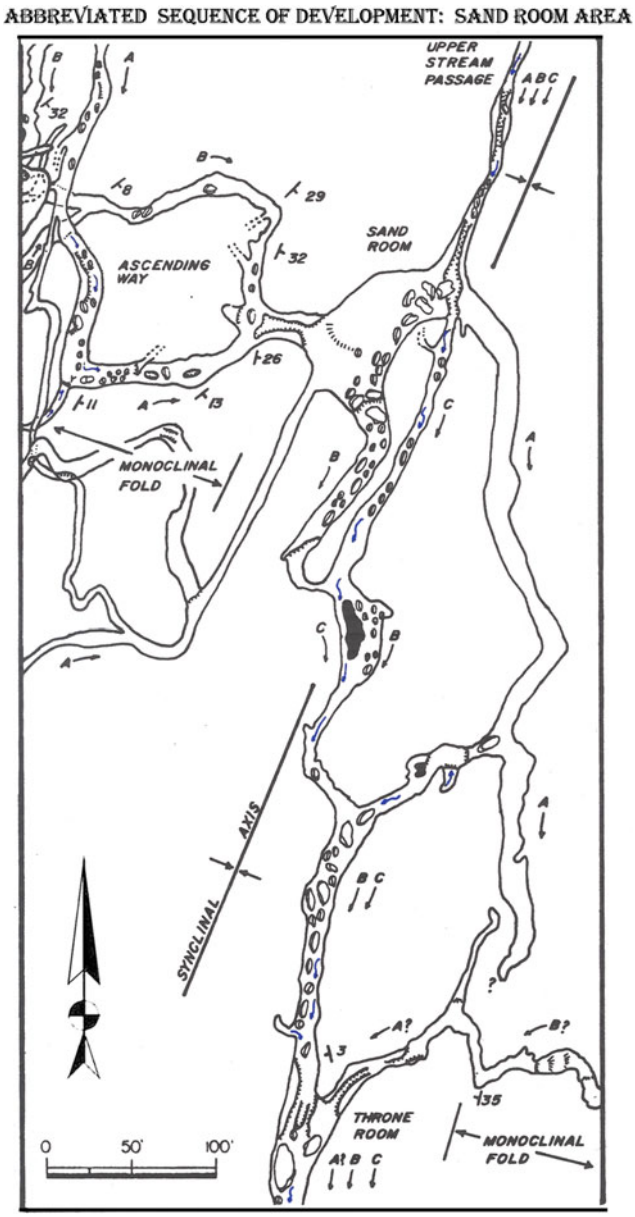

Fig. 13.25 Abbreviated sequence of development of Sand Room area

Sand Room in the same horizon, but eventually turns west into a maze that turns upward into the steeply folded monocline mentioned in describing the Flack Room area. This maze lies beneath the end of Treasure Passage and may have derived water from the far west side of the Organ Cave System.

The passage west from Sand Room forks 50 ft from the room in an area where the dip quickly increases to 30°. The north fork begins in zones 15–17, and although the floor varies, the chert horizon in 17 can be followed to the Centrifugal, and also up the dip which steepens again to the high route out of Flack Room already described. All of these passages near Sand Room were considerably influenced by solution along the zone 17 chert. These passages were water-filled at the time of development, and probably during part of the time when water from Flack Room flowed through some of them. There may also have been water entering from the Upper Stream Passage and from Nine Foot Bat Passage. Indeed, Sand Room may be in part the original phreatic extension, 50 ft under water, of the free-surface drainage coming down Floyd Collins Avenue to Flack Room. Flow into zone 17 at Flack Room was along faulting, and this route along soluble horizons was much shallower (had less phreatic head) than flow down the monocline in zones 4 and 5, a more prominent soluble horizon.

The left part of the west passage from the Sand Room passes into a zone of lower dip and rises through the stratigraphic section to enter a northeast trending passage developed in zones 19–21, where there is another cherty horizon. This solution canyon may always have been tributary to Sand Room and still contains a small stream. A side passage follows bedding west to the area of the

monocline, but here the beds quickly become vertical to slightly overturned in the Handley Silo, which leads up the Handley Room. This tributary carried water from points unknown under the Handley Room, excavating sediments out of the Handley Silo from below. Water in Sand Room originally exited by Sally's Waterfall Passage, which probably rejoined the present Upper Stream Passage at Throne Room.

Upper Stream Passage south of Sand Room is interpreted as a more recent development fed by NULO water, water from the left fork of the west passage and perhaps originally also from the right fork and Flack Room. Sally's Waterfall Passage was not used by these free-surface streams. There is evidence of an early water-filled stage in parts of the passage, including local use of preexisting tubes in zone 18 south of Throne Room. These may be remnants of the earlier Sally's Waterfall route. Pendants suggest a period of standing water at about 1950 ft elevation near the south end of the passage close to the Waterfall Room (Fig. 13.26).

Fig. 13.26 Ray Garton at the pendants just north of the Waterfall Room

13.6.2 Handley Room, Upper Lipps, and Other High-Level Passages

From Handley Room through Left Hand Passage, Jones Canyon, Lipps Maze and Upper Lipps, the roof of most passages is in a light limestone with two prominent beds of chert, 6–10 in. apart. Although they cannot be followed continuously across the faulting between Handley Room and Flack Room below, these cherts (zone 18 in Fig. 13.14) are considered correlative with those of zone 17 (Fig. 13.16), based upon stratigraphic position. Solution channels in this horizon suggests that over a wide area solution of the passage began in zone 18. The dip of the beds is 6°–9° over most of this area.

The Handley Room (Fig. 13.27) is a large trunk passage fragment. The roof and upper walls are in gently dipping rocks including zone 18 chert, which dips 12° southeast. Lower walls, the Silo, and passage down to Flack–Handley Turnpike and Flack Room are in steeply dipping rocks separated by faulting from those above (Fig. 13.28). The room tends at an angle of about 40° to the strike of the beds in its roof and adjacent Left Hand Passage, but nearly parallel to the strike of the steeply dipping beds below. Handley Room is probably a major early stream route toward Second Creek, originating in zone 18, and downcut by a free-surface stream in the manner of Hedricks Stream, 160 ft lower in elevation. The room is blocked in both directions by gravel fill, and the floor is breakdown and sediments with no obvious sign of a former vadose stream course.

The Left Hand Passage and its large branches extend northwest up-dip from Handley Room about 600 ft, rising almost 100 ft in elevation following zone 18 (=17) and beds just below it. Anastomosing ceiling channels are developed in zone 18 in several areas, but quite a number of the passage roofs are in zone 17 (=16), a massive bed just below the chert layers. In the Breezeway area are several joint passages in zones 18 and 19 that cross and probably predate major development of Left Hand Passage.

While the initial openings, often in zone 18, were water-filled, the Left Hand Passage was probably soon transformed into a large branching system carrying free-surface streams from blind valleys ancestral to those presently feeding Floyd Collins Avenue, and perhaps Jones Canyon as well. The water entered the trunk passage at Handley Room. These passages were abandoned when Floyd Collins Avenue and Jones Canyon developed, but small streams, some still active, incised a complex of canyons below their floors. The abandoned canyon closest to Handley Room is cut 27 ft below zone 18 through zone 13 which is very cherty, but does not intersect the faulting, although it encounters steepening dip just as it reaches Handley Room.

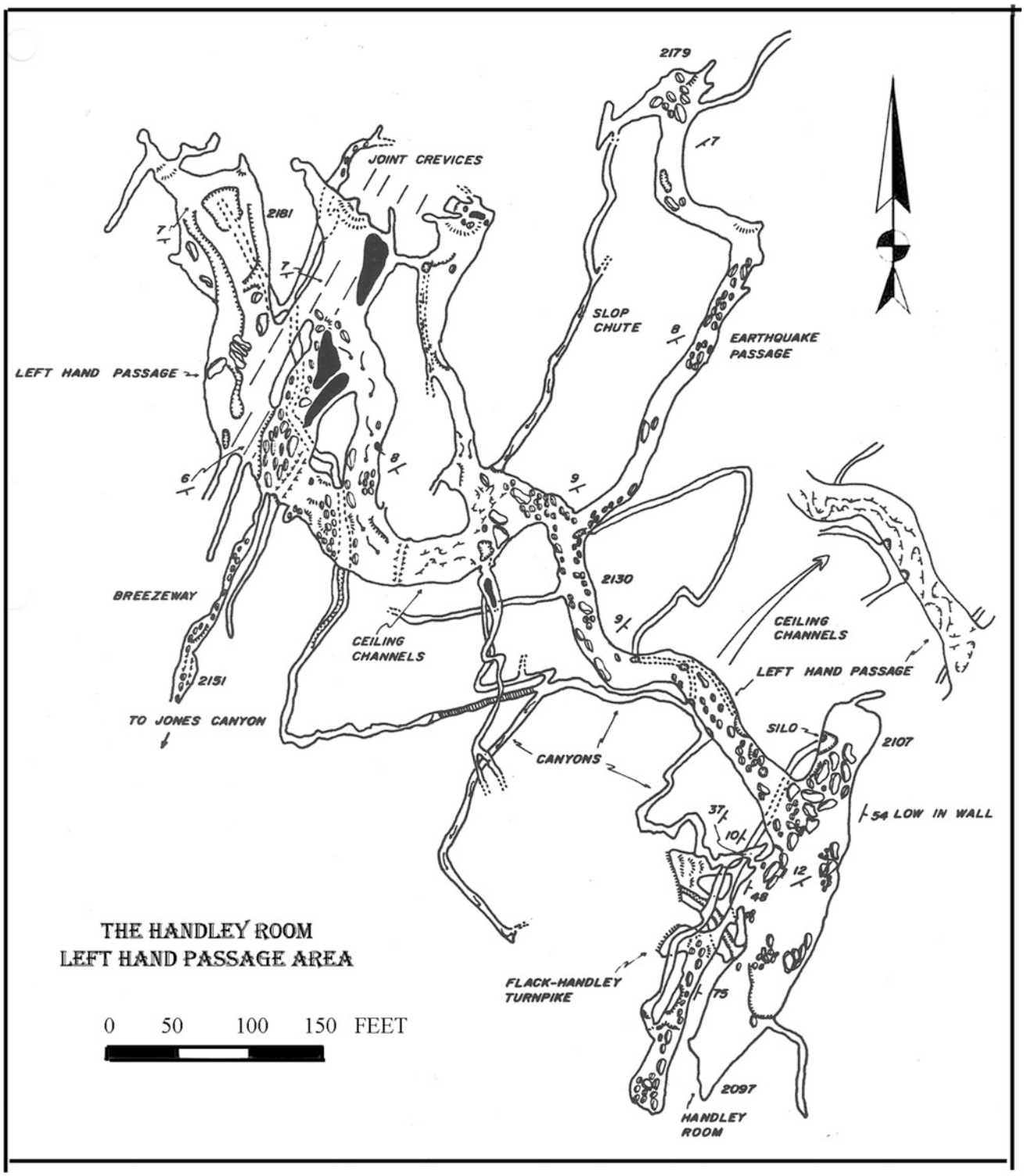

Fig. 13.27 The Handley Room–Left Hand Passage area

Lipps Maze consists of mostly small tubes, some joint controlled, developed in zones 17–19, with zone 18 and its prominent chert. The area of maze development extends from near the Lipps entrance 1,000 ft east along the strike and ranges through more than 70 vertical feet at least from 2160 to 2230 ft elevation. It is quite likely that the head of Jones Canyon, Breezeway, Treasure Passage and the solution of tubes and open joints of upper Left Hand Passage are

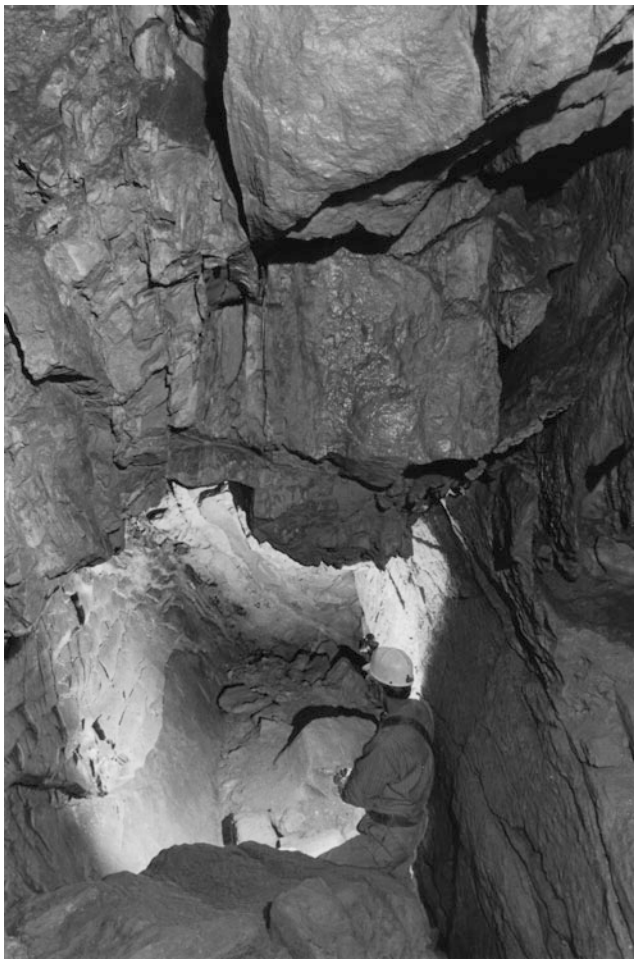

Fig. 13.28 View looking down Handley Silo. Note vertical orientation of beds exposed in the roof. The beds below this passage level out to a dip of about 20°. Beds 40 ft higher in Handley Room are nearly horizontal above an intervening fault. Photograph by W.K. Jones

part of this development extending 1,500 ft from the Lipps Entrance. The maze is phreatic in origin with some later canyon development by small free-surface streams. Treasure Passage follows the beds down-dip below any other part of these passages and apparently took water from the head of Jones Canyon before that route was opened.

Jones Canyon trends diagonally down-dip. Development was begun close to zone 18, now exposed in the roof. Subsequent development was by the free-surface stream that still follows the canyon. At the Belfry there are solution tubes 15–20 ft above zone 18; their relationship to Jones Canyon is probably accidental. Jones Canyon has not been examined south of Belfry.

Jones Canyon encountered the maze passages and made minor use of them in developing the present route. The present drainage from Lipps Maze has cut the canyon of Skid Row keeping nearly at grade with Jones Canyon. The water that now follows Jones Canyon may formerly have gone to Left Hand Passage.

In upper Jones Canyon, near Skid Row, red bands can be seen in zone 17 and low in zone 15. These zones are at least 75 ft above the horizon of the Maccrady shales. In upper Lipps Stream, development in zone 18 continues down-dip at a low angle to the strike all the way through Hells Fissure to Lipps Drop. Various tubes and branches at roof level are in these beds, while the Hells Fissure stream canyon cuts deeper into the underlying beds until below the drop it is about 85 ft below zone 18, at the top of the Maccrady shale. The passage remains at roughly the same horizon from the base of the drop to the junction with Humphreys, where the floor is about 5 ft above the base of the Hillsdale formation. Lipps Stream above the Lunch Room has probably used both some preexisting solution tubes, and developed some, opening the route to larger passages at the Lunch Room. Doline development over parts of the maze of tubes has expanded to develop the small drainage basin that feeds Lipps Stream, which has always been a small stream compared to that in Jones Canyon, for example. The whole development of upper Lipps Stream is probably a late event in the cave history.

13.6.3 The Revak Room

The Revak section is developed in about 30 ft of rock represented in Fig. 13.19. These rocks have gentle dip and are separated by a fault from the steeply dipping rocks which are continuous with those of the Upper Stream Passage below. The situation is like that at Handley Room where the rocks of Handley Room–Lipps, etc., meet those of Flack Room, but it is on the east side of the synclinal axis. Correlation with other stratigraphic sections is tentative; the double chert shown may be identical to that in zone 18 on the west side of the cave system, and to that in zone 17 in Upper Stream Passage.

The highest passages above Revak Room are developed in the chert zone and the zone above in this section, while Revak Room, the lead to Revak Silo, the passage to Cathedral Room, and the loop through Walker's Ramble are mostly in the 10 ft of rock below the chert. Thus, development of these mostly tubular passages is above or below the chert, sometimes with the chert forming a bridge between levels. The passages are oriented diagonally down-dip. They show shallow canyons and other free-surface stream modification, and gravel bars testify to the competence of the water which once flowed here. All are ancient flow routes from the Organ Entrance blind valley, but none ever seems to have concentrated the drainage in a single path. Such a single path developed under vadose conditions through Cyclops Avenue at a later time in the cave's history.

Passages in Foxhole Cave lie 180 ft and more above Hedricks Stream, close to the synclinal axis. Development is in limestone with prominent cherty horizons, and, as in the Organ Cave System, the initial development was often in the cherty beds, now seen close to roof level of the passages.

13.7 Structure Controls in the Organ Cave System

13.7.1 Joints and Minor Faults

Joint control of passage orientation is clearly visible in some passages in the Organ Cave System. Examples are found in Lipps Maze, Breezeway, Nine Foot Bat Passage, Discovery Passage, Walker's Ramble area, and various other places. These straight reaches with joints exposed are most common in passages developed underwater. Even then, perhaps only 20% of the total length shows clear joint control, although the map suggests some joint influence on perhaps 50% of the passages. Most of the observed joint control is exercised by the joint set at N15–30°E, roughly parallel to the strike. Joints in other directions were used occasionally as seen in Gypsum Passage.

The northeast orientation of many passages, especially the major stream passages, suggests that the major joint set was used where convenient in the development of these passages, but direct evidence in the passages is scant. Most of the ceiling tubes show only local joint influence. There are exceptions. Organ Main Stream has a ceiling channel for 250 ft above Organ–Hedricks Junction area that is oriented N25° E. Joint control is quite evident at the acute bend 1,300 ft upstream from Big Canyon sump.

Minor faulting is seen at many places in the cave. Faulting often involves only a few beds, presumably passing into slip along bedding planes, and speaks of considerable compressional movement within the limestone. Slickensides on breakdown blocks attest to the considerable influence fault planes have on rockfall (Fig. 13.29). Very large fallen blocks in the Slickenside Room separated from the ceiling along a fault plane that dips N70°W at 35°. Movement was just about east, at a 20° angle to the dip of the fault plane.

Several faults can be seen in Upper Stream Passage south of Throne Room. Just south of Throne Room a reverse fault dipping 19° east offsets the chert bed at ceiling level about 20 in. The ceiling tube here developed on the fault plane.

About 300 ft south of Throne Room, at the USP–Hedricks Connector, there is a reverse fault dipping 24° west, displacing the chert bed 24 in. A silt-filled ceiling tube seems to follow this fault, and it may have directed the original flow in the larger passages in beds above the chert. Its influence cannot be followed very far along the passage.

Fig. 13.29 Slickenside Room. The large breakdown block is parted along the fault plane of a reverse fault. Slickensides on hanging wall of fault are visible on the roof. Photograph by W.K. Jones

Joints and reverse faults of small displacement both directed dissolution and free-surface stream erosion to some extent where they were conveniently oriented with regard to the potentiometric gradient. Jointing had the greater influence. Minor faulting had more visible influence on breakdown than on dissolution.

Faults with displacement of 20 ft or more were noted in a few places in the cave. Most notable is the faulting between Flack and Handley Rooms, which had considerable effect on local water movement, as discussed above. Faulting near Revak Room probably involved considerable displacement, and its influence on water movement has been mentioned.

There is a fault with apparent large displacement in Foxhole Cave at the pit in Desolation Row that leads into the Southern Maze. If the cherts at the base of the pit are the same as those in Desolation Row, vertical displacement is about 25 ft, and total displacement about 70 ft. Minor features of rooms and passages are influenced by this fault, but it has no major impact on passage trend or elevation. Nearly all of Foxhole Cave is in rocks above the fault plane.

13.7.2 The Caldwell Syncline: The Influence of Strike and Dip

Several sections of the cave system have been mentioned as strike-oriented. The Paleo Saltpetre Passage and part of the 1812 Route, Octopus Alley, and Rat Alley Crawl were strike-oriented passages. The Lipps Maze complex also extends along strike. These are routes developed under phreatic conditions.

Passages developed directly down-dip include the Left Hand Passage and underlying Floyd Collins Avenue, Room Without A Name and some of Organ Main Stream. These passages are primarily of vadose origin. Smaller dip-oriented

passages include the Old Saltpetre Route and routes from the Flack Room to the Fun Room. Some of these smaller passages are phreatic in origin and development. Many of the major passages are oriented diagonally down-dip, as seen in Upper Lipps, part of Lower Lipps, Jones Canyon, Organ Main Stream, and Cyclops.

The longest passages in the northeastern part of the cave, Hedricks Stream Passage and Upper Stream Passage, trend down the plunge of the Caldwell Syncline, usually quite close to the axis of the fold. Figure 13.30 presents a structure contour map of the rocks in which Organ Cave System is developed. Contour is on top of the Maccrady shale. Solid contours represent good control from observation in the cave, although it should be remembered that the elevations are derived from cave surveys of variable accuracy. Dashed contours are approximate. In Fig. 13.30, the axis of the Caldwell Syncline is clearly defined as far south as the Waterfall Room. The plunge to the southwest is about 350 ft in 5,000 ft, averaging about 4°. In the cave the plunge is seen to vary from 0° to 6°. South of the Waterfall Room the location of the axis and the plunge is uncertain. Figure 13.30 shows the axis as located by Price and Heck (1939) on the county geologic map.

The elevation of the top of the Maccrady shale where the fold axis crosses Second Creek was approximated as follows: Ogden (1976) reports that Dickson Spring is at the base of the Patton Limestone, which is 300 ft stratigraphically above the Maccrady. The elevation of Dickson Spring

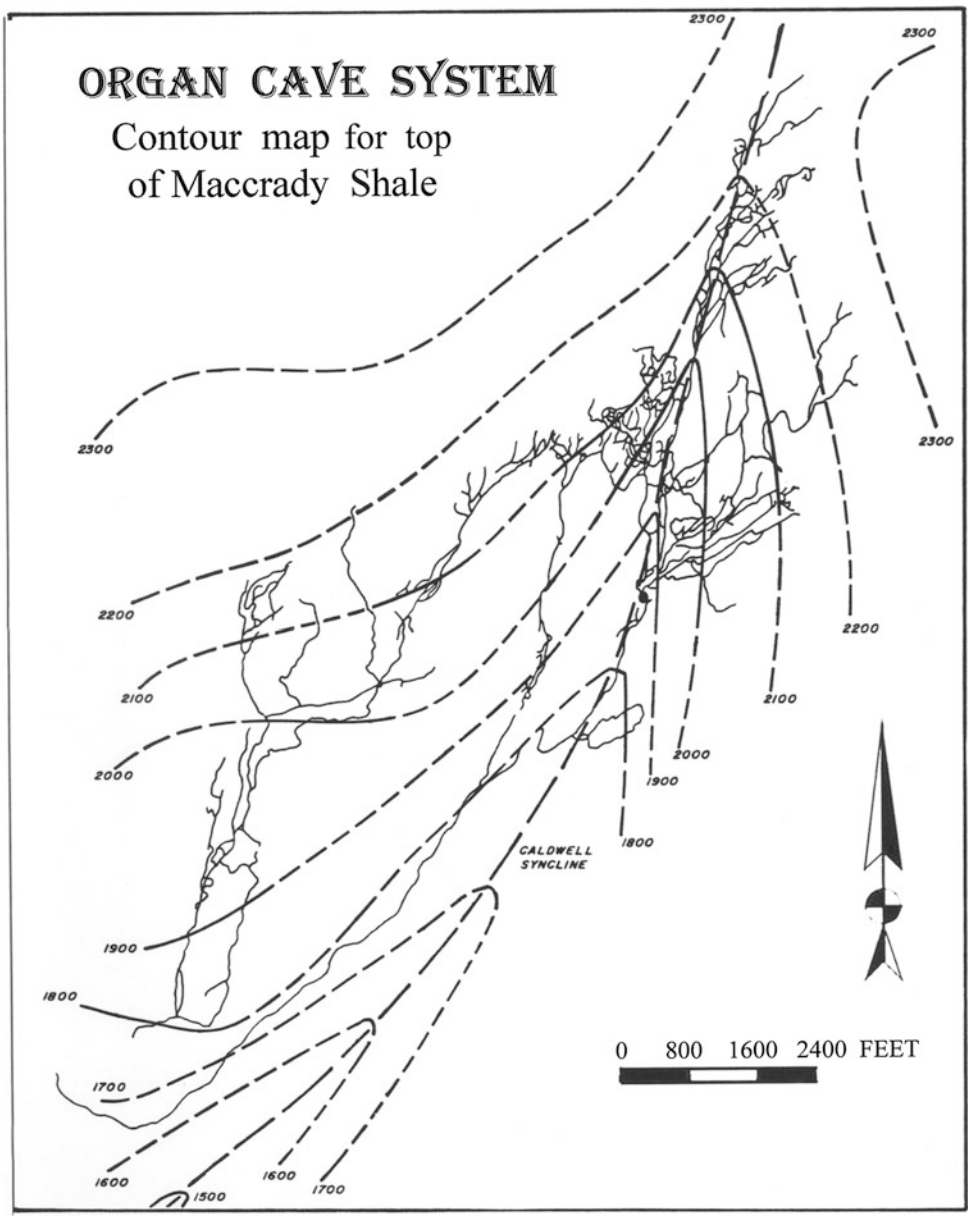

Fig. 13.30 Contour map of the top of the Maccrady shale

is about 1800 ft, so the top of the Maccrady is at about 1500 ft. Ogden reports the dip at Dickson Spring as 13° east, and the synclinal axis is more than 1,000 ft further east on the county map. Thus, the Maccrady should be at least 100 ft lower, 1400 ft, at the axis. Hedricks sump is in zone 3 at elevation 1825, so the Maccrady shale is about 1810 at the sump, or approximately 1800 at the base of Bowen Room Drop. The result is a plunge from there to Second Creek of about 400 in 11,000 ft, or less than 2°. Dashed contours were drawn on this basis.

Figure 13.30 makes it clear that Big Canyon and Wilson's Watery Wonderland probably do not follow the axis of the Caldwell Syncline very far south of Bowen Room Drop. The more nearly the axis is followed, the more these low-gradient passages must rise through the beds, possibly several hundred feet above the Maccrady shale in this case. Some passages do rise (or fall) stratigraphically, but most show considerable stratigraphic control. Thus, low-gradient passages, like Big Canyon and Wilson's Watery Wonderland, tend to follow the strike. It is most likely that these passages are more strike-oriented than they seem in Fig. 13.30 and remain in the Hillsdale at least until they pass the adjacent Lower Lipps Stream Passage. At the stratigraphic horizon of the cave the synclinal axis may well be further east than shown in Fig. 13.30.

The 1800 foot contour in Lower Lipps follows what must be a minor fold. Wilson's Watery Wonderland turns northwest to David's Dungeon in a manner suggesting it is following the strike around the same fold. At the Lipps sump, the Maccrady shale is already below 1800 ft elevation. The contours imply it would be more than 100 ft lower at David's Dungeon, which would then be well up in the section. The actual relations of the area beyond Big Canyon sump to stratigraphy and structure are unknown.

The complex northeastern part of the Organ Cave System is developed in an area where the syncline has a steeper plunge and is more tightly folded, than elsewhere in the cave system. Some passages parallel the strike around the syncline. Most of the many passages east of the axis run obliquely down-dip toward or to the synclinal axis. Passages on the west limb of the fold are less numerous and usually trend more directly down-dip toward the synclinal axis.

13.7.3 Deformation Near the Synclinal Axis

The monoclinal fold and associated fault seen on the west limb of the Caldwell Syncline between Flack Room and Room Without A Name has not been seen further north. It is reported in Debevoid in Foxhole Cave, which lies above the passages of Hedricks Maze. To the south the structure can be traced as far as the Nine Foot Bat Maze about 300 ft south from Flack Room. It might be found in the House of Cards area down in Jones Canyon, which was not examined.

The similar fold seen in Revak Room on the east limb of the syncline can be seen 250 ft south in the lead to Cyclops Hall, in Old Saltpetre Route 300 ft north at a lower level, and crossing Organ Main Stream 900 ft north, about 350 ft upstream from Organ–Hedricks Junction, where it is subdued (Fig. 13.31). No evidence of it can be seen 2,000 ft further north where the Rimstone Ceiling Passage and other passages reach far up the east limb.

Figure 13.32 shows a section through the monocline on the east limb of the Caldwell Syncline, following Old Saltpetre Route and Revak Silo, which is almost directly above Upper Stream Passage. The Hedricks Stream is approximately 100 ft east of the synclinal axis here. Old Saltpetre Route follows the cherty beds 4 and 5 and beds just below, conforming to the irregular dip, which reaches more than 40° at the steepest part on the monocline. The passage generally does not reach down to the Maccrady shale, and the Hedricks Stream is 5 ft above the shale here.

The Upper Stream Passage–Hedricks Connector is shown in Fig. 13.32, although its connection above is not shown as it is 90 ft out of the line of section. This is the route that reveals a seemingly continuous stratigraphic section up to zone 17, the horizon with chert beds seen in Upper Stream Passage and NULO. Upper Stream Passage is further from the fold axis, and the rocks dip 8° to the west. Revak Silo follows the beds below cherty zone 19 up the monocline. Dips reach 58°, and the beds are not strictly parallel to those in Old Saltpetre Route below.

At the top of the Revak Silo the cherty beds in the Revak Silo roof dip 30° west and are overlain by the series of beds which dip 8° west in the high passages around Revak Room.

Fig. 13.31 View looking upstream showing the Organ–Hedricks Stream Junction. The Hedricks Stream enters from the *left*, and the Organ Main Stream enters from the *right*. Low-angle thrust faults in the center of the photograph appear to be truncated against the ceiling. The contact of the Maccrady shale is about one foot above floor level. Chert of zone 4 is exposed in the ceiling. Photograph by W.K. Jones

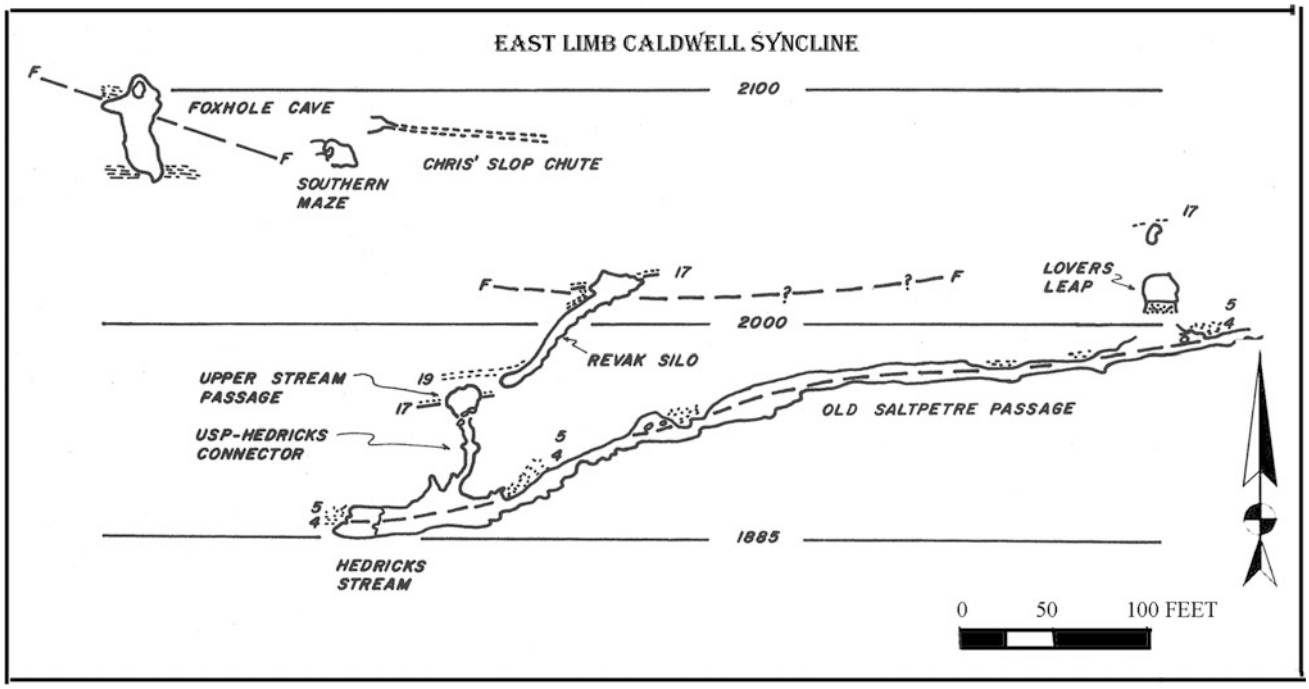

Fig. 13.32 Section along the east limb of the Caldwell Syncline

A similar disharmony of the rocks at the top of the monocline is seen in Revak Room, 190 ft to the south. The maximum dip there is about 40° and continues upward at about 25° to run into the overlying series with a dip of 6°. Just above the Revak Silo there is a wedge of cherty beds dipping 18° east between the two rock series which dip west toward the synclinal axis. The rocks series are evidently separated by faults. A probable reconstruction of the fault plane is shown in Fig. 13.32, showing it as a very low angle reverse fault that passes into the bedding to the east. This makes it possible that the chert beds in Revak series correlate with zone 17 in the rocks below as postulated elsewhere. The separation of zone 4 and zone 17 at Upper Stream Passage–Hedricks Connector is the same as the separation of zone 4 and the Revak chert beds near Lover's Leap, within the accuracy of the surveys.

Faulting or monoclinal folding of the Revak series of rocks has not been seen, but could lie just west of Revak Room. Beds 20 ft thick below the Revak cherts, observed in passages to the east, are absent in the west wall of Revak Room and above the Revak Silo, so the fault is evidently cutting up through the section to the west. The fault shown in Foxhole Cave lies about 240 ft west of and 80 ft above Revak Room. It is related to, if not identical with, the fault in Revak Room.

Figure 13.33 shows a section of the monoclinal fold developed on the west limb of the Caldwell Syncline as seen at Room Without A Name. In this figure, the elevation of NULO, derived from survey data, appears to be too great considering the stratigraphic horizon in which it is developed. Debevoid in Foxhole Cave is drawn from the map, and its geologic structure added from notes on rough map sheets and hearsay. It was not visited during this study. Hedricks Stream is very close to or at the synclinal axis in this section. Two zones of steep dip are visible, the lower one projected from the drain from Room Without A Name, located 250 ft further southwest along the strike. Hedricks Stream flows on the Maccrady shale, and the Room Without A Name is cut into the Maccrady shale. The ceilings of both passages are in cherty zones 4 and/or 5. Minor faulting is suspected in the area of steep dip (up to 50°), but no major displacement is obvious. More severe deformation is known 200 ft southwest, where the dip increases to vertical at Handley's Climb, and in Debevoid in Foxhole Cave, which lies about 150 ft higher in the stratigraphic section.

The section shown in Fig. 13.34 is through the Bone and Sarver Rooms and higher-level Fossil Room which are developed 500–600 ft southwest of Room Without A Name. Here Hedricks Stream is slightly west of the synclinal axis, and dip is 3°. The geometry of the double monocline is different here, with an abrupt lower fold with more relief than seen to the north. The lower passages have floors cut into Maccrady shale, except for the Hedricks Stream Passage, where the floor is about 5 ft above the contact. The roofs of the passages are often developed in cherty zones 4 and 5, and major connecting tubes leading to Hedricks Maze, including Octopus Alley, are in these zones.

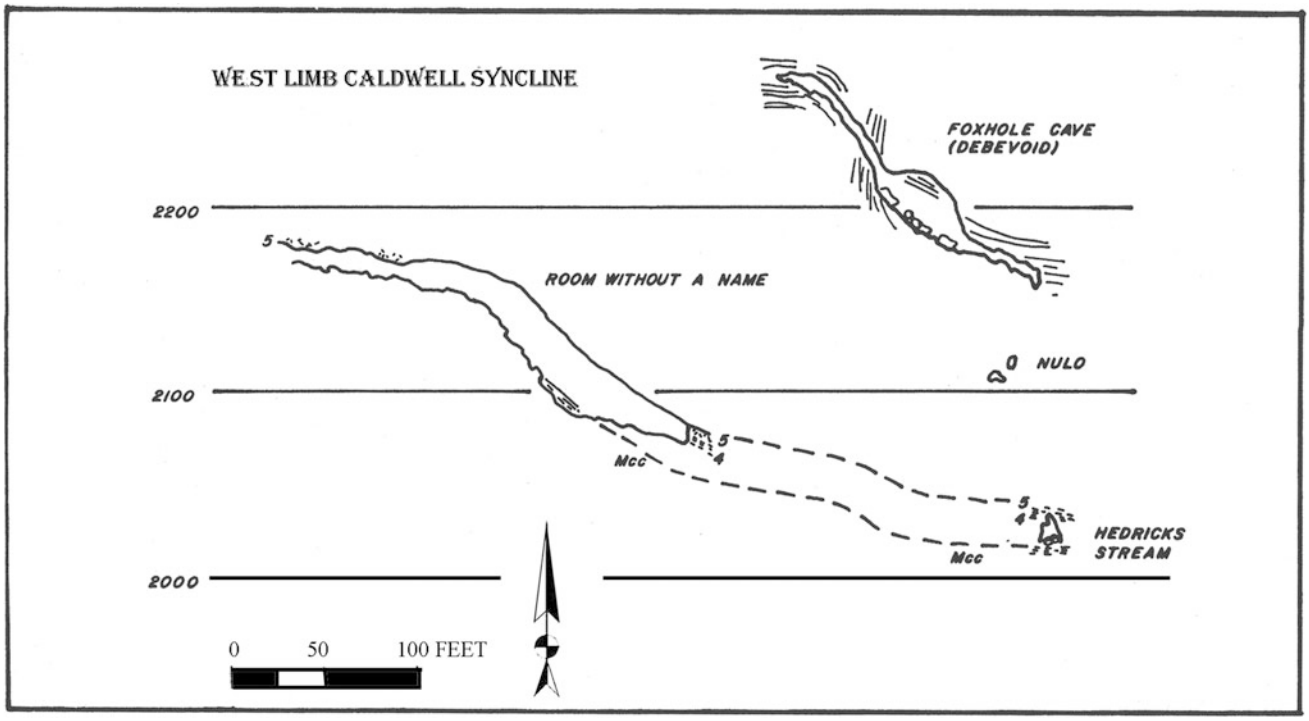

Fig. 13.33 Section along the west limb of the Caldwell Syncline

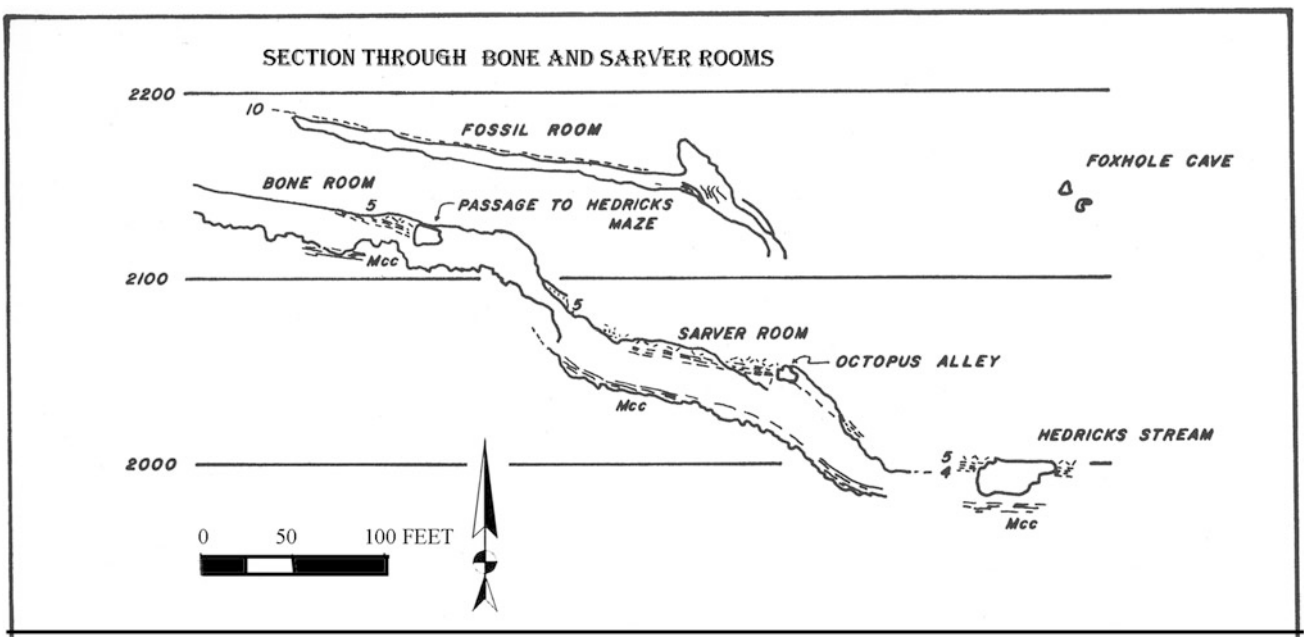

Fig. 13.34 Section through the Bone and Sarver Rooms

No major faulting has been noted, although a zone of prominent fractures can be seen at the bottom of the steep climb up to the Bone Room. Good exposures in Hedricks Maze 100 ft northeast show no faulting, but there is a local area of 45° dip, steeper than that observed in the Bone Room. Minor features of structure have considerable local variations in short distances.

Fossil Room overlies Bone and Sarver Rooms, only 60 ft away at its northwest end, 100 ft at the southeast end. Its roof lies just at and beneath the zone 18 chert as shown in

Fig. 13.17. The separation of this horizon and zones 4 and 5 in Bone Room is about what is expected; it has not been altered by faulting.

Beds in Fossil Room dip 7° southeast to the south end of the room, where they abruptly turn down to dip as steeply as 72° in as little as 15 ft distance. Some beds are intensely fractured perpendicular to bedding in the tight folds. There is apparent drag-folding and disharmony between folded beds and those above. The nature of the structure in Fossil Room is not clear, but it involves severe deformation and probably faulting not seen in Bone and Sarver Rooms.

Figure 13.35 shows a section through the north end of Handley Room at the Handley Silo, extending to Sand Room. All passages shown are in zones 14–21, on the NULO level of the cave, except for Handley Room which is in zones 14–17 in the western section (Fig. 13.17). The Handley Silo is 350 ft southwest along strike from Fossil Room. Here a double structure is visible in these horizons 80 ft above the Maccrady shale. The eastern fold is a monocline with dips observed as steep as 32°. The western fold abruptly becomes vertical to slightly overturned in the Handley Silo, and faulting is in evidence. Beyond Centrifugal there is a room only 40 ft north of the Handley Silo, in rocks just below zone 17, where the exposed structure includes 60° dips and intersects very deformed rocks 60 ft west and 20 ft below Handley Room. Thus, the folds can be interpreted as drag folds beneath a low-angle reverse fault, as shown in Fig. 13.35. Handley Room is thus located on the fault.

The relationship of this structure to the upper sequence of beds exposed in Handley Room is striking. Fifteen feet of beds in the west wall of Handley Room directly above the Handley Silo are undisturbed except for slight folding at their bases. Handley Room ceiling, in zone 17 (Fig. 13.17) five ft below zone 18 chert, dips uniformly east at 8°. In the east wall less than 2 ft of undisturbed rock lies below the roof horizon, then a few feet of fractured rock, and the lower 4 ft of the 8-foot wall is a very cherty bed that dips 50° east. The fault apparently passes upward into this wall. It may cut the zone 18 chert a short way further east, but this relationship is not clear in Fossil Room where the beds below zone 18 can be seen to fold down steeply, but zone 18 involvement was not observed. No major folding or faulting was observed in Foxhole Cave, about 450 ft east of Handley Room and in part at about the same elevation.

Figure 13.36 depicts a section through the cave at Flack and Handley Rooms about 150 ft southeast of Fig. 13.35. The Hedricks Stream is a little distance east of the synclinal axis, and the dip is about 3° west. In the lower part of the section just above the Maccrady shale the monocline interrupts the gentle dip seen in Floyd Collins Avenue and Flack Room. Dip in Flack Room roof increases abruptly to 40° and prominent cherty zones 4 and 5 appear to be offset about 20 ft by reverse faulting. No faulting is seen in the Maccrady contact in the Subway just south of this section, and the fault may pass into bedding plane slip to the west, possibly on the contact zone. The fault seems to be next to the wall south of Flack–Handley Turnpike and at floor level on the north side of Flack Room just north of the high-level outlet where zone 17 is exposed. The ceiling above the high-level outlet route is extensively fractured with zone 17 on the floor of the bedding opening, but zones 4 and 5 in Flack Room roof are very close by.

The fault seems to pass upward above the Turnpike, and the route from there up to Handley Room follows it. The

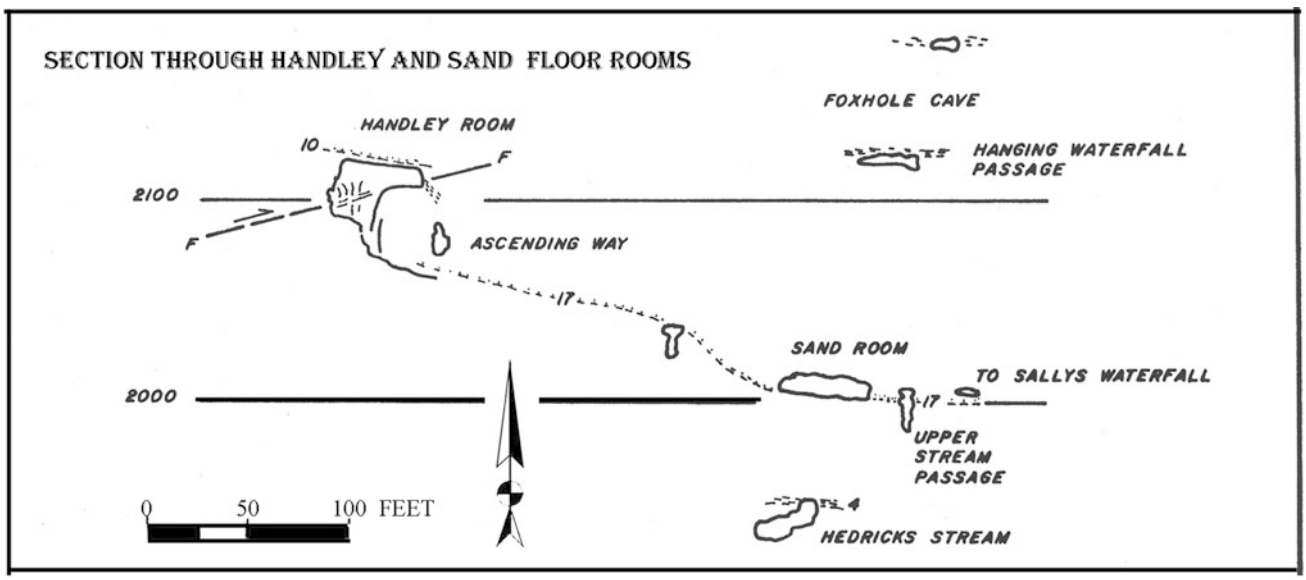

Fig. 13.35 Section through the Handley and Sand Floor Rooms

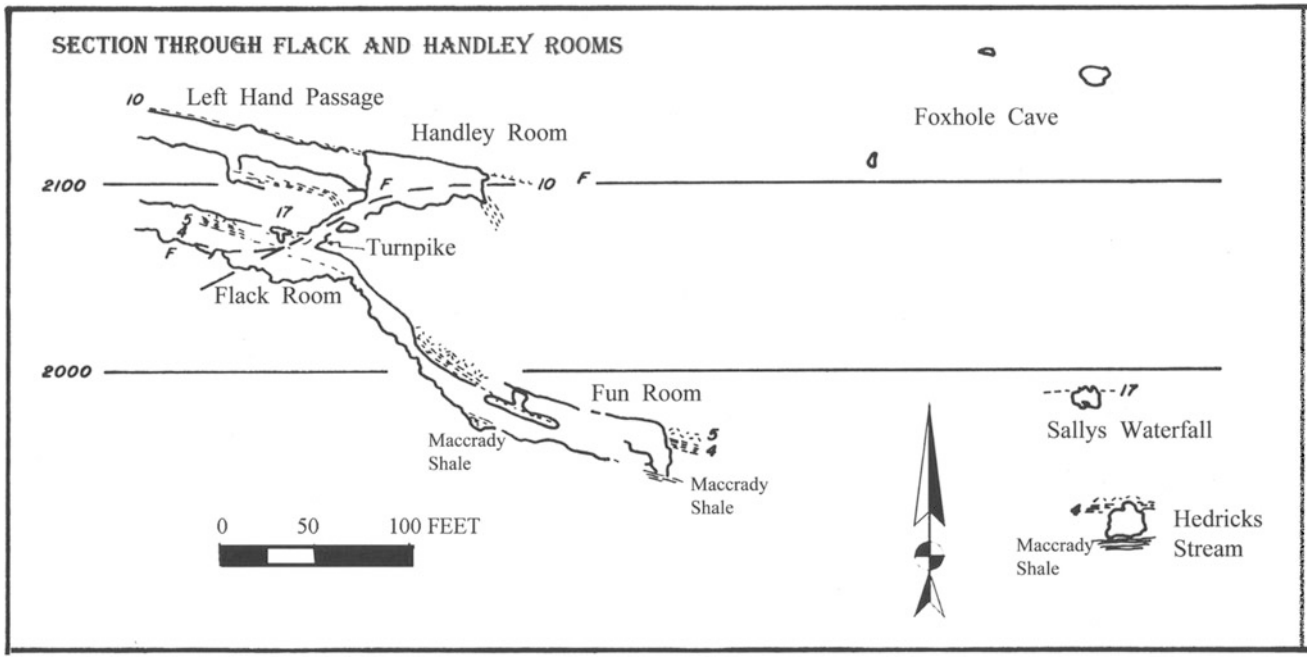

Fig. 13.36 Section through the Flack and Handley Rooms

relationship observed on the east wall of Handley Room is the same as that at Handley Silo, and this is presumably the same faulting seen at Handley Silo.

Above the fault lie the little disturbed rocks of zones 12–18 (west section). In the canyon extending from under Left Hand Passage to Handley Room the cherty zone 13 can be seen folded sharply to dip 37° east above the fault. A zone of fracturing in the west wall of Handley Room above Flack–Handley Turnpike is about 13–20 ft below zone 18 chert. This should be above the fault plane and implies multiple fault planes or brecciation in the area of drag folds.

The separation between zone 18 chert and the Maccrady shale is about 80 ft just west of Handley Room, but the maps suggest it decreases to about 55 ft at the upstream end of Floyd Collins Avenue. This change could be due to horizontal stratigraphic changes or could be a result of loss or repeat of beds due to faulting. The first is unlikely, and although faulting nearly parallel to the bedding is possible, it is not demonstrated. The difference may be an artifact of computer fitting of diverse surveys.

Figure 13.36 is a composite sketch of the structure of the synclinal axis area. Offset beds do not seem to line up on single faults, but this is probably due to including sketches far out of any single line of section.

As noted with regard to Flack Room and Subway, the Maccrady shale contact is involved in folding, but perhaps is not usually offset by faulting. Faults in the rock above may pass into bedding plane slip in the uppermost shales of the Maccrady. Some of the fragments in the "reworked Maccrady" seen in various outcrops might be breccia resulting from slip along the top of the formation.

The upper sections with chert (18 in Lipps and 17 in Revak Room) have not been observed offset by faulting, so that there is a visible disharmony with underlying folded and faulted beds. But on both flanks of the syncline the faults may cut these beds a little closer to the fold axis, where no exposures have been examined. The reported structure in Debevoid suggests that the faulting on the west limb of the fold cuts on upward through the section. Certainly, the pattern of faulting is complex and deserves further investigation.

There is a similarity between the passages leading diagonally down-dip to Revak Room area and those leading more directly down-dip to Handley Room. In both cases the dip-oriented passages reach toward the synclinal axis only as far as the fault zone at the top of the monoclinal folding. Large passages (Handley Room and Revak Room) then develop parallel to the fold, where the beds which were followed to this point encounter the fault plane. Revak Room is 1100 ft from Handley Room, with its sediment floor about 100 ft lower in elevation. Revak Room is probably more recent in origin. Base-level elevation may have played a role in the location of this room, but more important was the restriction of movement further down-dip by the structure and the availability of the fault as an avenue of water movement.

Eventually passages following the steeply dipping beds below the fault at Revak Room developed to lower levels. From Handley Room the passages followed the fault down in the direction opposite to the dip to reach steeply dipping zones 4 and 5. Most of these steep passages have been used by free-surface streams, but are largely phreatic in development. While they can be interpreted as routes where the water found its way to lower levels, in each case it is quite possible that the flow was originally upward.

Time below base level probably consisted of several types of passage, all largely stratigraphically controlled. There are segments (often with at least 70 ft of vertical relief) that parallel the strike, probably developed in the shallow phreatic zone. Other segments lead down-dip at angles, perhaps to depths of 100–150 ft. Finally, there are segments that lead back to shallower depths, sometimes by following beds up-dip, usually in areas of steep dip, sometimes by following faults or otherwise cutting across beds to horizons higher in the stratigraphic section.

Later in the cave history free-surface streams developed a system of routes that follow dip and plunge more closely using parts of the preexisting system, and adding new passages as necessary to carry the drainage. Parts of these new routes had phreatic beginnings, but soon were converted to free-surface flow. Even the Hedricks Stream had tubular phreatic beginnings, still evident in its roof, and does not strictly follow the axis of the Caldwell Syncline down the plunge, although it is fairly close to it as far as Bowen Room Drop.

13.8 Sediments

13.8.1 Clastic Sediment

The most common sedimentary deposits in the Organ Cave System are silty and sandy gravels. The gravel is often only partially rounded by stream transport. Particle sizes from 1/2 to 4 in. are common, and individual deposits differ in grain size.

These sediments often form terraces in both large and small passages, although only occasional terrace surfaces have survived later erosion. The deposits are found nearly to the ceiling of many passages, and at most if not all elevations in the system. Some of the breakdown common in large passages is or has been buried in these deposits. Thus, at some time in the history of most passages there was water flow with competence to move coarse sediment, and a supply of sediment sufficient to nearly fill the passages. It is possible that much of the sediment was carried through the parts of the cave that were in the vadose zone to be dumped wherever the water entered the phreatic zone, building bars and deltas into the standing water, and grading terraces upstream from those points. Some coarse sediment would be carried on into the phreatic zone, where water volume and passage size produced sufficient velocity to move it, as in times of high water. As base level fell, existing deposits would be eroded by free-surface streams, and the material carried further downstream to be redeposited. It is not necessary to postulate enough sediment to nearly fill the whole cave system at one time.

There are some deposits of silt. These are often found on top of other sediments and on top of breakdown. They probably speak of backwater from high water levels in floods. There are also passages with deposits of limestone slabs barely worn by the water that moved them, as in Left Hand Passage. These are the beds of free-surface streams with open access to surface sinks and probably were continuations of large sinking streams.

13.8.2 Breakdown

Breakdown is extremely common in large passages in the cave and makes travel slow and difficult in many of the stream passages in the basal Hillsdale Limestone (Fig. 13.37). It may be that the shaly zone 6 is responsible for much of this rockfall, but this was not investigated. Certainly, breakdown has extended above zone 6 in some areas and occurs in passages like Jones Canyon that are not in the basal Hillsdale. Slickensides are visible on breakdown at various places, and fault planes, where present, are evidently important planes of weakness leading to collapse.

Fig. 13.37 Overflow Passage just south of the 1812 Room. Zones 4 and 5 cherts are visible in the upper walls and ceiling channel. Local joint control influenced passage development. The terraced gravel and limestone slab fill is well displayed. Photograph by W.K. Jones

13.9 Hydrology

The discussion of hydrology is from Jones (1988), courtesy of the West Virginia Speleological Survey.

13.9.1 The Hydrogeologic Setting

The Organ Cave System is developed in a synclinal plateau which has the lower part of the Greenbrier limestone exposed to the surface in a southwest trending "trough" which is bounded to the east and west by the underlying Maccrady shale. Small surface streams drain from the shale into blind valleys and dolines near the limestone contact. The underground streams have downcut 10–30 ft into the shale at a few points within the cave, but the shale generally acts as a relatively impermeable boundary. The drainage divides are based on the position of surveyed cave passages, results of dye-tracer tests, topographic divides, geologic contacts, and water budget analysis of the known springs. The positions of the divides are not exact and are least certain on the western and southern margins of the Organ Cave basin. The mature karst developed on the plateau has obliterated all traces of any original surface stream channels. There is no evidence that the present catchment area has changed very much from the time just prior to the onset of karstification. Recharge to (and runoff from) the basin may have been much higher at earlier stages in the development of the basin. Large stream gravels in some of the fill deposits in the higher-level canyons of Organ Cave System seem to suggest periods of very high discharge (velocity) through the system.

Lewis Cave, situated to the north of the Organ Cave basin, drains north to Soloman Springs (elevation 1950 ft) which discharges in a steep valley tributary to the Greenbrier River. Cricket, Hellems, and Destitute caves all drain to a spring on the north side of Second Creek 600 ft upstream of the US 219 Bridge. Several additional small springs emerge on the north side of Second Creek between US 219 and Patton. No tracer tests have been conducted to these springs, but they presumably account for water sinking near the bluff above Second Creek and sinkholes immediately south of the Organ Cave basin. Storage, which maintains all of the main cave streams under base flow conditions, may be mostly in the epikarst which overlies the cave passages (Williams 1983).

A water budget analysis of the Organ Cave resurgence suggests that the spring should account for all the drainage from this system. The Organ Cave Plateau receives about 37 in. of precipitation annually which is evenly distributed throughout the year. The mean temperature is 52 °F, and potential adjusted evapotranspiration is 27 in. (Thornthwaite equation). Since all runoff from the Organ Cave basin is subsurface, the predicted spring discharge is 10 in. or a mean annual discharge of 3.11 cubic feet per second (cfs) from a 3.1 square mile catchment area. The closest karst basin for which actual discharge data are available is the Davis Spring basin which drains 74 square miles and is situated about five miles to the northwest of Organ Cave. The Davis Spring basin is in a similar hydrologic and climatic setting and has a mean discharge of 140 cfs or about 15 in. of runoff. This suggests that precipitation can rapidly infiltrate into the karst drainage system and a soil moisture deficiency exists during most of the summer months (Jones 1973). Based upon a linear comparison of the Organ Cave resurgence discharge per square mile ratio with that for Davis Spring, the base flow discharge at the Organ Cave resurgence should be about 0.3 cfs, mean annual discharge about 7 cfs, and peak discharge over 100 cfs. This implies that over half of the annual discharge comes from a few storm events and that most of the year stream flow is minimal. This may help to explain the very underfit streams which flow in the large canyon passages of the cave.

The Organ Cave resurgence is situated at base level on Second Creek and appears to be the only outlet from the cave. Under low-flow conditions the water appears to rise from several openings in the bottom of the spring pool. A direct accurate measurement of discharge is not possible because the spring is always in backwater from Second Creek. Base flow was roughly measured using tracer dilution techniques (September 21, 1985) at 0.4 cfs.

The stream passages are generally large with gradients averaging over 400 ft per mile in the upper reaches of the system. The cave stream levels respond very rapidly to storms.

The maximum relief on the plateau is about 180 ft, and no major (or permanent) surface streams drain onto the limestone. Much of the recharge to the cave system is from rainfall, but full passage flooding is rare except immediately above the permanent sumps. The lower canyons (Lipps and Big) have a lower gradient (Lower Lipps averages 254 ft per mile, and Big Canyon averages only 47 ft per mile), and the two terminal sumps (elevation 1800 ft) are very near base level for the Organ Cave resurgence on Second Creek (elevation 1770 ft). The average elevation on the plateau is 2300 ft, so there is over 400 ft of relief between base level and the upper parts of the cave system. An upward flexure of the Maccrady shale in Lower Lipps canyon is exposed for about 1000 ft parallel to the stratigraphic strike without any apparent change in the passage gradient. The upper levels of the cave were developed before the establishment of present base level and lithologic and structural influences predominate. The relative gradients of the main stream passages parallel to the strike are shown in Fig. 13.38, and the cross section in Fig. 13.39 shows the relative positions of main passages plotted perpendicular to the strike.

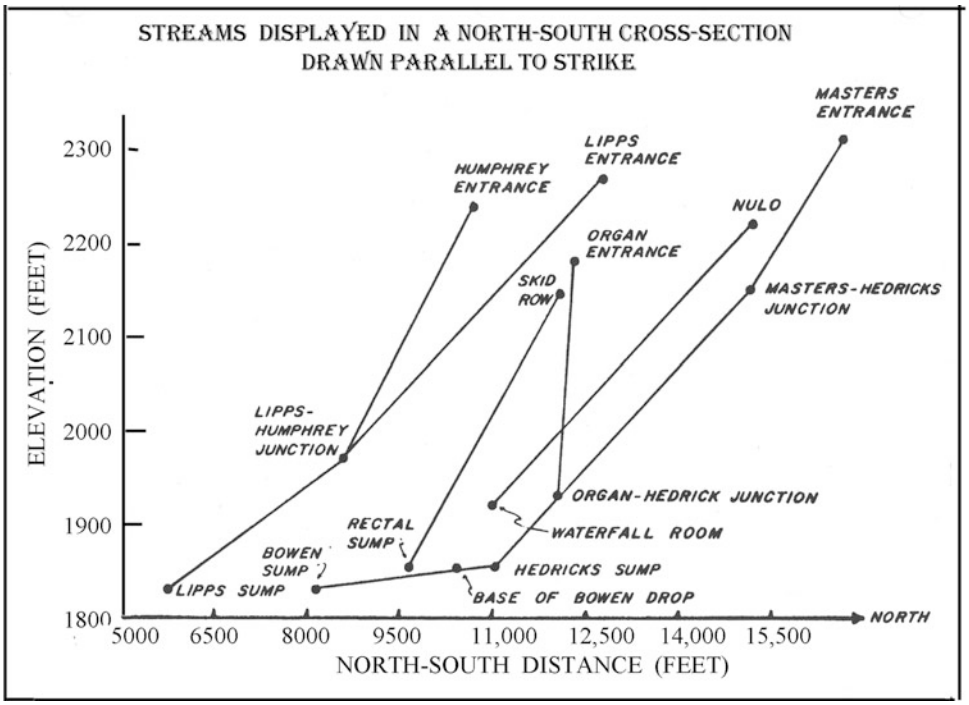

Fig. 13.38 Streams displayed in a north–south cross section drawn parallel to strike. Observed stream gradients in the upper (northern) reaches of the system are greater than those for streams in the downstream (southern) part of the cave (15X vertical exaggeration)

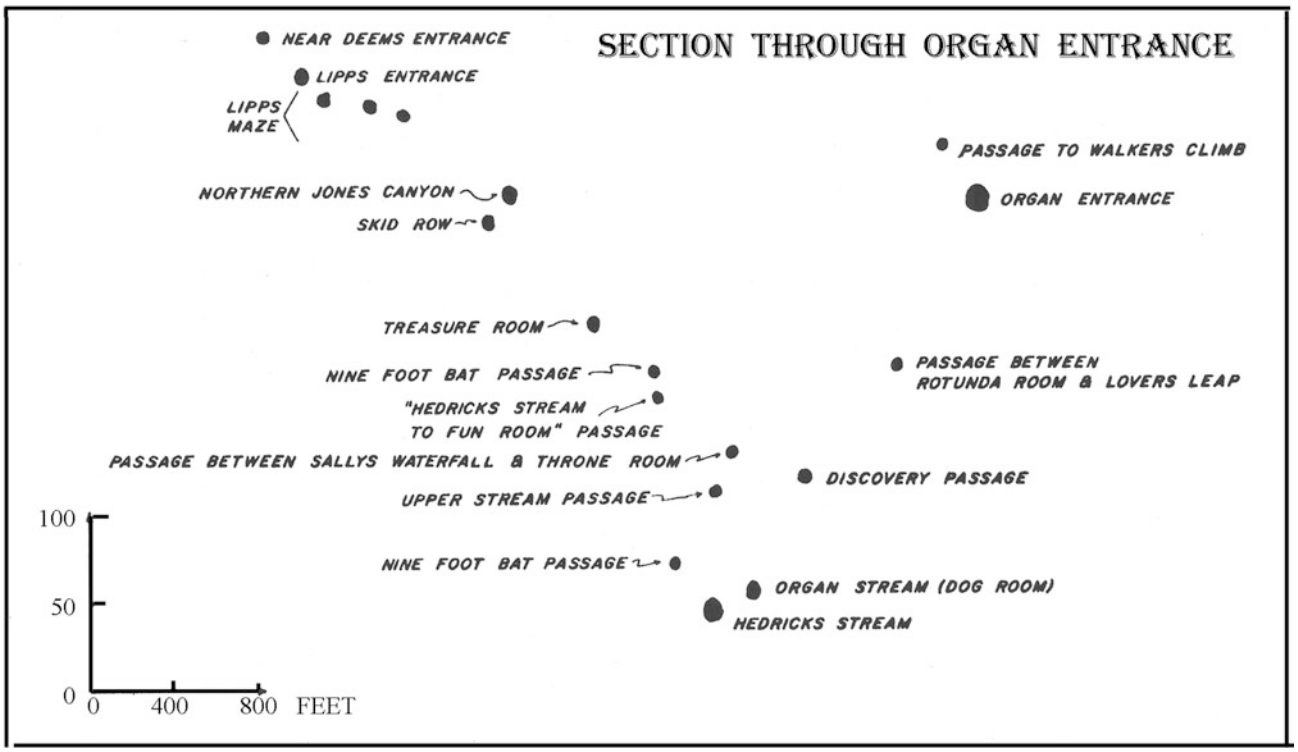

Fig. 13.39 East–west cave passages drawn in cross section perpendicular to strike through the Organ Cave Entrance. Observe influence of Caldwell Syncline. The Hedricks Stream is close to the axis of the syncline (8X vertical exaggeration)

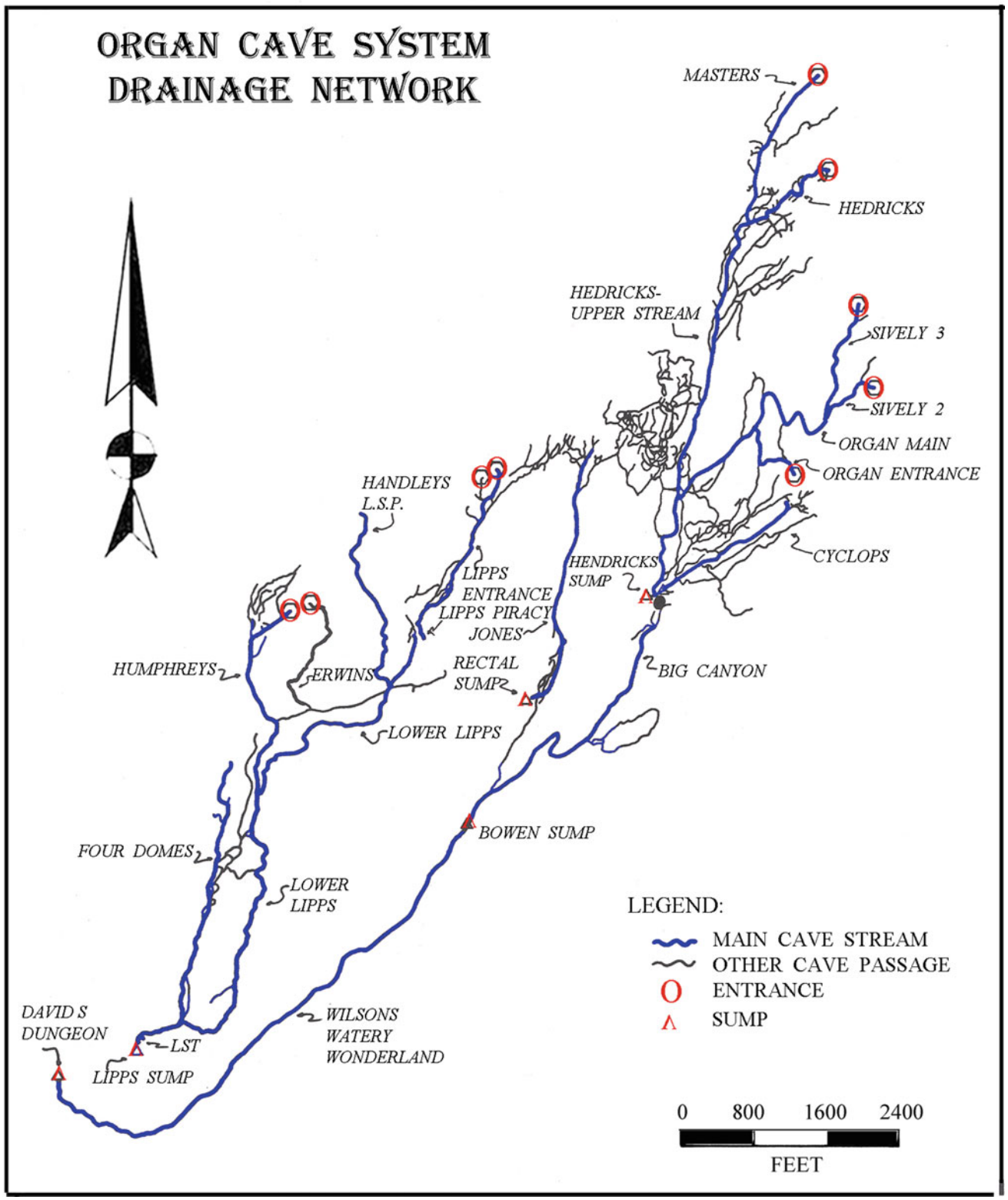

Fig. 13.40 Organ Cave System drainage network

13.9.2 Contemporary Drainage Patterns

The cave is presently drained by two master streams which trend parallel to the strike and probably merge before their resurgence on Second Creek. The Organ–Hedricks–Big Canyon stream closely follows the trough of the Caldwell Syncline, at least until it reaches the Bowen sump. At this point the stream appears to veer up-dip to the west (possibly perched on the Maccrady shale) and has been mapped to within 2,700 ft of the resurgence. The final sump at "David's Dungeon" is also directly in line and below the Lower Lipps canyon which is the second major stream canyon to the west of, and subparallel to, the Organ–Hedricks–Big Canyon passage. Intra-cave dye-tracing has shown that all of the tributary and distributary passages are accounted for at or before reaching the Bowen or Lipps sumps (Fig. 13.40). The overall drainage pattern of the system is an anastomatic dendritic network of passages in the upper (northeast) part of the cave. All converge prior to reaching the Organ Cave resurgence. The three-dimensional nature of the Organ Cave System drainage network is illustrated by the Upper Stream Passage stream which is perched on a chert layer and flows directly above the Hedricks Stream Passage for 4,500 ft (Fig. 13.39).

Extensive stream tracing work was done in conjunction with the survey of the cave, and the results are summarized in Fig. 13.40 and in Jones (1988). The principal tracer was fluorescein sodium, although a few tests were conducted using Rhodamine WT. Dye injection amounts were usually 50–100 g, and passive detectors of activated charcoal were used to recover the dye. For several of the tests, the charcoal packets remained in the cave for over 1 year before they were retrieved and tested. Clear positive tests for fluorescein were obtained, but high background fluorescence in the 580 nm range produced ambiguous results for the Rhodamine analyses.

Several distributary routes were found within the Organ Cave System. One is the stream passage which can be followed from the Lipps entrance down to the piracy passage where all the water (at normal flow conditions) disappears to the east in a gravel-floored passage which gradually becomes too low to follow. This stream does not reappear in the Jones Canyon stream, but reemerges just upstream from Lipps sump along with the water diverted from Jones Canyon at the Rectal Sump. This suggests that another as yet undiscovered stream passage must lie between Jones Canyon and Lower Lipps Canyon.

Another branching of flow exists under high water conditions when water flowing into the Organ tourist entrance is pirated from the west side of the large entrance room to the Rotunda Room where some of the water flows north down the Waterfall Passage and some flows south through the 1812 Room to Hedricks Stream.

Fig. 13.41 Paul Stevens negotiates the French Connection near the Humphreys entrance

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