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CAVES OF MONTANA

BY

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YAKIMA VALLEY COMMUNITY COLLEGE

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MONTANA COLLEGE OF MINERAL SCIENCE AND TECHNOLOGY
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ABSTRACT

Nearly three hundred caves are now known in Montana. Most are at altitudes ranging from 5,000 to 9,000 feet and are developed in Paleozoic carbonate rocks that flank many of the central and western mountain ranges. Many of these caves are small and vertical, but caves containing more than nine miles of passage have been found. The principal cave-forming rock is the Mission Canyon Limestone of the Madison Group (Mississippian). Caves also are found in Precambrian, Cambrian, and Devonian carbonate rocks and in travertine deposits of Pleistocene age.

Most of the caves are thought to have been formed along fractures at or just below the water table by slowly moving acidic ground water slightly undersaturated with respect to carbon dioxide. Sulfuric acid may have assisted in forming caves found near mining districts. Several caves seem to have been formed in the vadose zone, by gravity sliding or downward movement of meteoric water. Caves in Montana are unlikely to be found in carbonate rocks containing much magnesium. Because dolomite is nearly as soluble as calcite, factors other than solubility, such as kinetic and flow conditions, must be taken into account to explain that situation.

Secondary features in caves form after the water table has been lowered and the cave becomes air filled. Carbon dioxide escaping into the cave air causes precipitation of calcium carbonate as speleothems. Although cave "formations" are generally lacking in most Montana caves, several caves, notably Lewis and Clark Caverns, contain well-developed stalactites, stalagmites, flowstone, and other secondary features. Ice caves are found in some high mountain areas where poor circulation prevents escape of cold air from the cave. Cave temperatures vary with altitude and latitude, but in Montana they range from 32 to 50°F.

The exact age of Montana caverns is uncertain. Some caves may have been formed in Mississippian time, infilled and buried as early as Late Mississippian time, exposed by uplift and erosion beginning with the Laramide Revolution, and then re-excavated sometime during Late Cenozoic time.

INTRODUCTION

Caves are found in almost every state in the United States, and Montana is no exception. Although Montana boasts a large number of caves, except for Lewis and Clark Caverns they are unknown to the average Montanan. Visited only by an occasional rancher, sheepherder, or local cave explorer, these caverns remain anonymous and virtually unexplored. Very large cave complexes, such as Mammoth Cave or the Flint Ridge Cave system in Kentucky, have not yet been found in Montana; however, one cave, Big Horn Caverns, contains more than nine miles of passage and is still not completely mapped. Though most are small, Montana caves are numerous and occur in almost every mountain range in the state and within a short drive of nearly every major city (Fig. 1).

OBJECTIVE

The goal of this paper is to make available in a single source detailed information on Montana caves. After a general discussion of the geology and origin of limestone caves and the rocks in which they occur, an up-to-date master list of all Montana caves is provided. Maps, general locations, and a brief description of each of the caves accompany this report. Although some rock shelters and shallow caves—"Indian caves"—are mentioned in this report, no attempt has been made to describe all of the numerous sandstone caves found in Montana.

TOPOGRAPHY AND CLIMATE

The word "Montana" means mountain, and about half the state's area of 147,138 square miles can be called mountainous (Fig. 2). Caves in mountainous regions are at altitudes of 5,000 to 10,000 feet above sea level. Precipitation in these regions is 20 to 40 inches per year, either as snow during the winter months or as rainstorms and squalls in the summer. These factors restrict successful cave exploration to June, July, August, and September. Temperatures during these months range from 50 to 80°F during the day and 20 to 40°F at night.

The Montana Bureau of Mines and Geology provided financial and technical assistance in the preparation of this report. Roger Campbell and Jim Chester served as field assistants during the summer of 1970 and provided assistance on cave locations and descriptions.

Howard McDonald and Harley Leach added much information on cave locations in Montana and contributed several cave maps used in this report. The National Speleological Society provided information about Montana caves and allowed the publication of the Pryor Mountain Cave maps.

CAVE USE

ANCIENT MAN

Caves have long been used for shelter and protection by ancient man. On other continents man is known to have inhabited small caves and rock shelters as early as 150,000 B.C. In the United States, the oldest known bones of ancient man (called Los Angeles man) came from an excavation in southern California and are approximately 24,000 years old. Because of early man's fear or his lack of adequate light, he did not venture far beyond the opening of any cave, no matter what its size, so one seldom finds artifacts or bones much beyond the entrance. Thus, only rock shelters or shallow caves with large entrances are important archaeological sites.

BIOLOGICAL VALUE OF CAVES

Until recently, the investigation of cave life was more of a hobby than a science to many biologists. Much of the early work consisted of classifying and describing the unusual creatures found underground. "Albino" insects and eyeless fish were regarded as curiosities, but no ecologic study of such cave life was attempted.

Now, however, biologists find caves to be increasingly valuable in studying life processes. For example, a group of plants (fungus and other parasites) can live underground without chlorophyll, a substance formerly thought necessary for plant life. Not only do these plants exist without chlorophyll but they also exist in places nearly devoid of food. In studying these plants, biologists have learned more about food synthesis by plants, and this information has been useful for growing mushrooms in caves and mines on a commercial scale.

Bats have recently been subjected to extensive studies by biologists. It has long been known that bats can navigate through dark passages without colliding with the walls. A radar-like mechanism was suspected, but now we know that the bat navigates by emitting a high-pitched squeak. The noise bounces or echoes off passage walls and is picked up by the bat's ears. On the basis of the time elapsed between echoes, the bat can estimate the distance to the object. Thus, the bat's navigational system is more like sonar than radar.

Bats are known to be carriers of rabies, and occasionally a rabid bat will bite a dog or other animal, transmitting the disease. Attempts at controlling such rabies outbreaks have led biologists to investigate caves, which

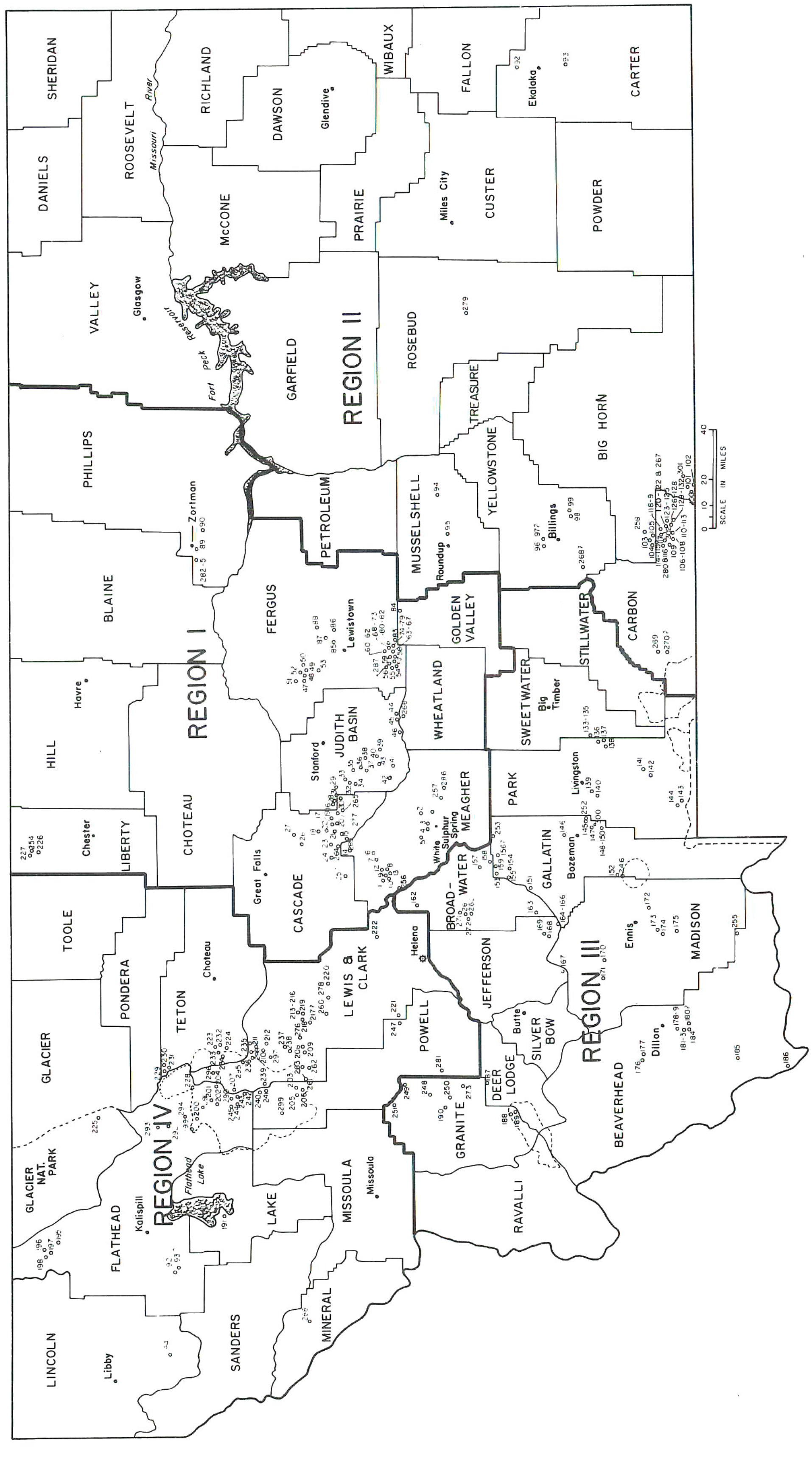


Figure 1.—Montana caves index map.

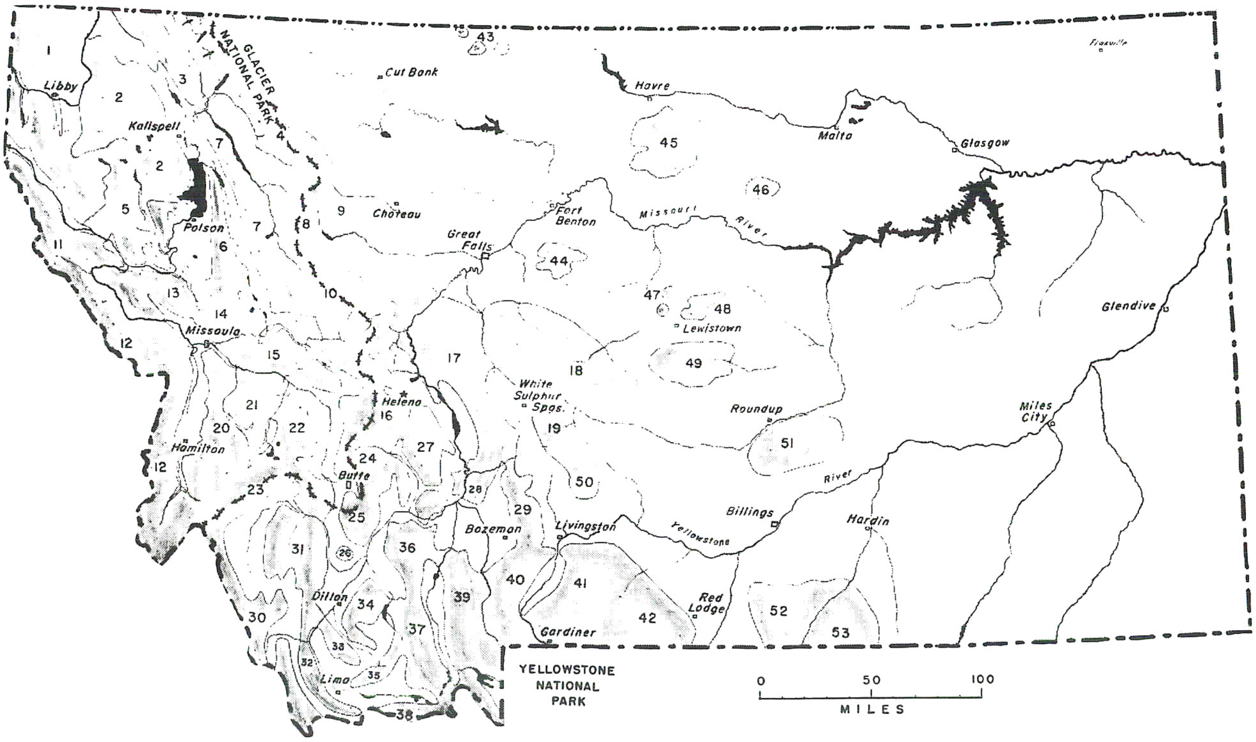


Figure 2.–Map showing mountain areas in Montana. Rocky Mountains – 1. Purcell Mountains; 2. Salish Mountains; 3. Whitefish Range; 3a. Galton Range (Canada); 4. Glacier Park Range (Lewis Range); 5. Cabinet Mountain; 6. Mission Range; 7. Swan Range; 8. Flathead Range; 9. Sawtooth Range; 10. Blackfoot Range; 11. Coeur d'Alene Mountains; 12. Bitterroot Mountains; 13. Squaw Peak Range; 14. Jocko Range (Missoula Hills); 15. Garnet Range; 16. Helena Mountains; 17. Big Belt Mountains; 18. Little Belt Mountains; 19. Castle Mountains; 20. Sapphire Mountains; 21. John Long Mountains; 22. Flint Creek Range; 23. Anaconda Range (Pintlar Area); 24. Main Range; 25. Highland Mountains; 26. McCartney Mountain; 27. Elkhorn Mountains; 28. Horseshoe Hills; 29. Bridger Range; 30. Beaverhead Range; 31. Pioneer Mountains; 32. Tendoy Mountains; 33. Blacktail Range; 34. Ruby Range; 35. Snowcrest Range; 36. Tobacco Root Mountains; 37. Gravelly Range; 38. Centennial Range; 39. Madison Range; 40. Gallatin Range; 41. Snowy Mountains (Absaroka Range); 42. Beartooth Plateau . . . . Plains Mountains – 43. Sweetgrass Hills; 44. Highwood Mountains; 45. Bearpaw Mountains; 46. Little Rocky Mountains; 47. Moccasin Mountains; 48. Judith Mountains; 49. Big Snowy Mountains; 50. Crazy Mountains; 51. Bull Mountains; 52. Pryor Mountains; 53. Bighorn Mountains.

are the natural habitat of bats. Their search for new information on bat migration and diet has greatly aided in rabies control.

Cave life is generally more abundant in the warmer caves in the southern part of the United States, but cave plants and animals, though not common, can be found in many Montana caves. Because few biological studies have been made in Montana caves, more research is needed in this field.

GEOLOGICAL USES OF CAVES

Caves have even provided the geologist with answers to some problems. Although most ground water moves very slowly through the small pores of fine-grained sediments, large underground streams flow through a few cave systems and, once located, can be tapped for surface use. For example, tunnels drilled into the mountains of France and Spain to tap underground streams have provided domestic water and water for generating electric power. Hydrologists in France continue to search for additional water-filled cave systems. In Montana, the cavernous parts of the Madison Limestone may yield significant quantities of water when adequately explored.

The mining industry has made use of caves. Bat droppings (guano) and cave rat droppings contain a large percentage of nitrates, chemical compounds that have long been used in the manufacture of gunpowder. During the Civil War many of the caves in the United States were mined for guano, which was processed to yield saltpeter for use in making gunpowder. At present, gunpowder is made by other methods, but bat guano continues to be mined for fertilizer, especially from caves in the southwest. Because so few bats inhabit Montana caves, finding a commercial deposit seems unlikely although some guano is present in almost every cave.

Paleontologists know that caves are good places to find bones of ancient animals. The natural protection of caves offered a good home for many varieties of animal life of the past. Predators dragged much of their prey into caves to be eaten, and the bones were left to become fossilized in time. In caves, the lack of bacteria and the protection from weathering allow bones and even hair and hide to be preserved. For example, Thomas Jefferson found bones of a giant ground sloth, a prehistoric animal about 5 feet high, in a cave in Virginia. More recently, caves in Arizona have yielded bones, hair, and hide of specimens of these sloths that died more than 10,000 years ago. These creatures might never have been known had not the cave environment preserved them so well. Caves also serve as natural traps. Many deep sinkholes contain bones of ancient horses, mountain lions, and mountain sheep that have fallen into these pits. One deep pit in Montana is just beneath a steep cliff long used by Indians as a "buffalo run". Many of the buffalo that were stampeded over the cliff fell into the cave, which is about 200 feet deep. Dozens of buffalo skulls were observed by the explorers who first descended into this sinkhole.

Caves have also been used to help prove new theories in geology. The question of earth tides caused by the gravitational pull of the moon on solid rock (just as the ocean tides are produced by the gravitational pull on water) was partly resolved through the use of caves. Scientists argued that many of the fractures in rocks making up the earth's crust were caused by earth tides (Davis and Moore, 1965). Sensitive instruments placed underground indicate that fractures widen very slightly with each rotation of the earth. Over the ages, the resultant flexing may cause extensive fracturing of the rocks.

Recently, caves have received much study as possible fallout shelters. In fact, several Montana caves have been designated as fallout shelters, but the humidity, problems of ventilation control, and the irregular floor areas indicate that they are unsuitable for that purpose.

COMMERCIAL CAVE USE

Perhaps the best use for caves, in terms of numbers of persons involved, is as a tourist attraction. More than 150 caves in the United States are open to the public, and nearly a million visitors are accommodated each year. Caves offer an attraction unique in all of nature, and views of underground rooms filled with stalactites and stalagmites have thrilled people of all ages. Although Azure Cave in the Little Rockies and Big Ice Cave in the Pryor Mountains have been open on a limited basis, Montana has only one commercial cave, Lewis and Clark Caverns near Whitehall. It is among the most beautiful to be seen anywhere, and from June to September, guided tours are available.

ROCK UNITS

Even though large caves are known to occur in gypsum and as lava tubes in volcanic rocks, few Montana caves have been found in rocks other than the carbonate rocks. The geologic column showing the rock units found in Montana (Fig. 3) indicates that limestone and dolomite are abundant only in rocks of the Paleozoic Era. Younger rocks formerly covered most of the state, so only where uplift and subsequent erosion have exposed Paleozoic rocks, as in the western mountains, are caves likely to be found.

PRECAMBRIAN ROCKS

Carbonate rocks are known in two parts of the Precambrian sequence. The oldest are in Cherry Creek strata; somewhat younger carbonate beds are in Belt strata.

CHERRY CREEK ROCKS

These rocks, first described and named from exposures at Cherry Creek south of Ennis, consist entirely of metamorphic rocks. Maximum total thickness is almost 9,000 feet; maximum thicknesses of all marble units may total as much as 6,000 feet. Marble is most abundant in the Ruby Mountains southwest of Dillon, where single units as much as 1,500 feet thick are exposed (Heinrich and Rabbitt, 1960, p. 4), but marble is reported in the Cherry Creek in several mountain ranges in the southwestern part of the state. Composition ranges from relatively pure calcareous marble to dolomitic marble (Perry, 1949, p. 33), but the units generally contain enough dolomite to restrict cave development. Some marble layers are also silicified, further inhibiting cave formation. Only one cave has been found in the Cherry Creek marble, but in areas where the magnesium and silica content are low, other caves may exist.

BELT STRATA

Belt rocks are younger than the Cherry Creek and are more widespread. They were deposited in a broad shallow basin that included most of western Montana

Geologic age	Formation		Approx. thickness (feet)	Dominant character
Quaternary				Stream deposits, local travertine
Tertiary			1,000	Stream and lake deposits, local limestone
Cretaceous	Montana Group Colorado Group Kootenai		4,500	Sandstone and shale Sandstone and shale Red beds, some limestone in west
Jurassic	Morrison		300	Sandstone and shale
	Ellis Group			Sandstone, shale, limestone, gypsum
Triassic	Chugwater, etc.		400	Red sandstone and shale, gypsum
Permian	Phosphoria		500	Sandstone, shale, and phosphate rock; some limestone
Pennsylvanian	Tensleep-Quadrant		500	Quartzite or sandstone, some limestone
Mississippian	Amsden		100	Limestone, some red shale
	Big Snowy Group		800	Shale and sandstone, gypsum, some dark ls.
	Madison	Mission Canyon Lodgepole	1,000	Massive crystalline limestone Pure and shaly limestone
Devonian	Three Forks		1,000	Shale and impure limestone
	Jefferson			Dolomite and dolomitic limestone
Ordovician	Big Horn		400	Dolomite
Cambrian	Dry Creek		2,000	Impure shale and sandstone
	Pilgrim			Dolomite
	Park			Shale
	Meagher			Limestone and dolomitic limestone
	Wolsey			Shale
	Flathead			Quartzite
Precambrian	Belt Series			Quartzite, argillite, impure limestone in Newland Formation and equivalents
	Cherry Creek Series			Gneiss, schist, marble
	Pre-Cherry Creek			Gneiss and schist

Figure 3.–Geologic formations associated with limestone and dolomite beds in Montana (after Perry, 1949).

and adjacent areas. Although they crop out over extensive areas, especially in northwestern Montana, they remain covered by younger rocks in most of the original basin of deposition.

The rocks consist of marine sediments, predominantly clastic, that have undergone low-grade metamorphism; some carbonate rocks are found in the Little Belt and Big Belt Mountains and in the Glacier National Park-Kalispell area. In the Belt Mountains as much as 2,200 feet of Newland Limestone and 2,400 feet of Helena Limestone have been measured. Maximum thicknesses of 2,300 feet of Altyn Limestone and 4,000 feet of Siyeh Limestone crop out in the Glacier National Park area (Ross and others, 1963).

Most of these carbonate units are thin bedded and contain interbedded shale and argillite, and many contain a large amount of silica and magnesium. Ross and others (1963, p. 47) gave the analyses of ten samples of Belt carbonate rocks, which averaged 37.1 percent SiO_2, 7.4 percent MgO, and 21.6 percent CaO. The middle part of the Siyeh Limestone and parts of the Altyn Limestone contain the greatest percentage of CaO. At least five caves have been formed in the Siyeh Limestone. The Altyn Limestone contains several caves associated with thrust faults along the eastern edge of Glacier National Park. The rest of the Belt limestone is unsuitable for cave development.

PALEOZOIC ROCKS

CAMBRIAN ROCKS

Cambrian rocks are second in importance only to Mississippian rocks as cave formers in Montana, partly because of their smaller outcrop area. Caves have been found in Cambrian strata in both southwestern and northwestern Montana, and many others may still be undiscovered in the northern Rocky Mountains. Cambrian rocks range in thickness from 500 to 2,000 feet and generally contain more carbonate in western Montana than farther east. In Montana, Middle Cambrian rocks rest unconformably on Precambrian rocks; Lower Cambrian strata have not been found.

Southwestern and Central Montana

Cambrian rocks in southwestern and central Montana are subdivided into six formations: (1) Flathead Sandstone, (2) Wolsey Shale, (3) Meagher Formation, (4) Park Shale (all Middle Cambrian), (5) Pilgrim Formation, and (6) Red Lion Formation (Upper Cambrian) (Fig. 4). The Meagher Formation is known to contain caves.

The Meagher Formation is 1,000 feet thick south of Ennis but thins eastward to about 50 feet in the Big Snowy Mountains and at Beartooth Butte, Wyoming. The average thickness of the Meagher in the mountains of southwestern Montana is 450 feet (Table 1).

The Meagher Formation consists of mottled dark-gray and tan limestone and dolomitic limestone, including some limestone conglomerate in the top 50 feet. East of a north-south line between Helena and Ennis, the Meagher is predominantly thin-bedded limestone, but west of this line it is massive dolomite (Hanson, 1952, p. 14). The Meagher is thought to be equal in age to the Death Canyon Member of the Gros Ventre Formation in Wyoming and is roughly equivalent to the Pagoda Limestone and Dearborn Limestone of northwestern Montana (Fig. 4). Silica content is erratic, and where silica is abundant it tends to limit cave development.

The Pilgrim Formation is 100 to 400 feet thick and is similar in character and extent to the Meagher Formation. The Pilgrim Formation consists of light- to dark-gray crystalline limestone or dolomite, thin to medium bedded, containing some shale partings. Like the Meagher Formation, it is more dolomitic to the west. The Pilgrim Formation characteristically contains a flat-pebble or "edgewise" conglomerate consisting of ½-inch to 5-inch pebbles of gray limestone. The upper third of this formation is more massive, and caves have been found in this portion. The Pilgrim is thought to be equivalent to the Devils Glen Dolomite of northwestern Montana (Fig. 4).

Northwestern Montana

The Cambrian of northwestern Montana is thicker than in the southwest and has been divided into nine recognizable units (Deiss, 1933): (1) Flathead Sandstone, (2) Gordon Shale, (3) Damnation Limestone, (4) Dearborn Limestone, (5) Pagoda Limestone, (6) Pentagon Shale, (7) Steamboat Limestone, (8) Switchback Shale, and (9) Devils Glen Dolomite. These have been correlated with the Cambrian of southwestern and central Montana by Hanson (Fig. 4).

Total thickness of Cambrian rocks in this area ranges from 1,700 to 2,350 feet. The best potential cave formers are the Steamboat, Pagoda, and Dearborn Limestones. The dolomitic content of the Devils Glen tends to inhibit cave development in that unit. The Damnation Limestone contains numerous green shale and orange clay partings and is too thin bedded to be an important cave former even though small horizontal caves may be developed along layers of pure limestone.

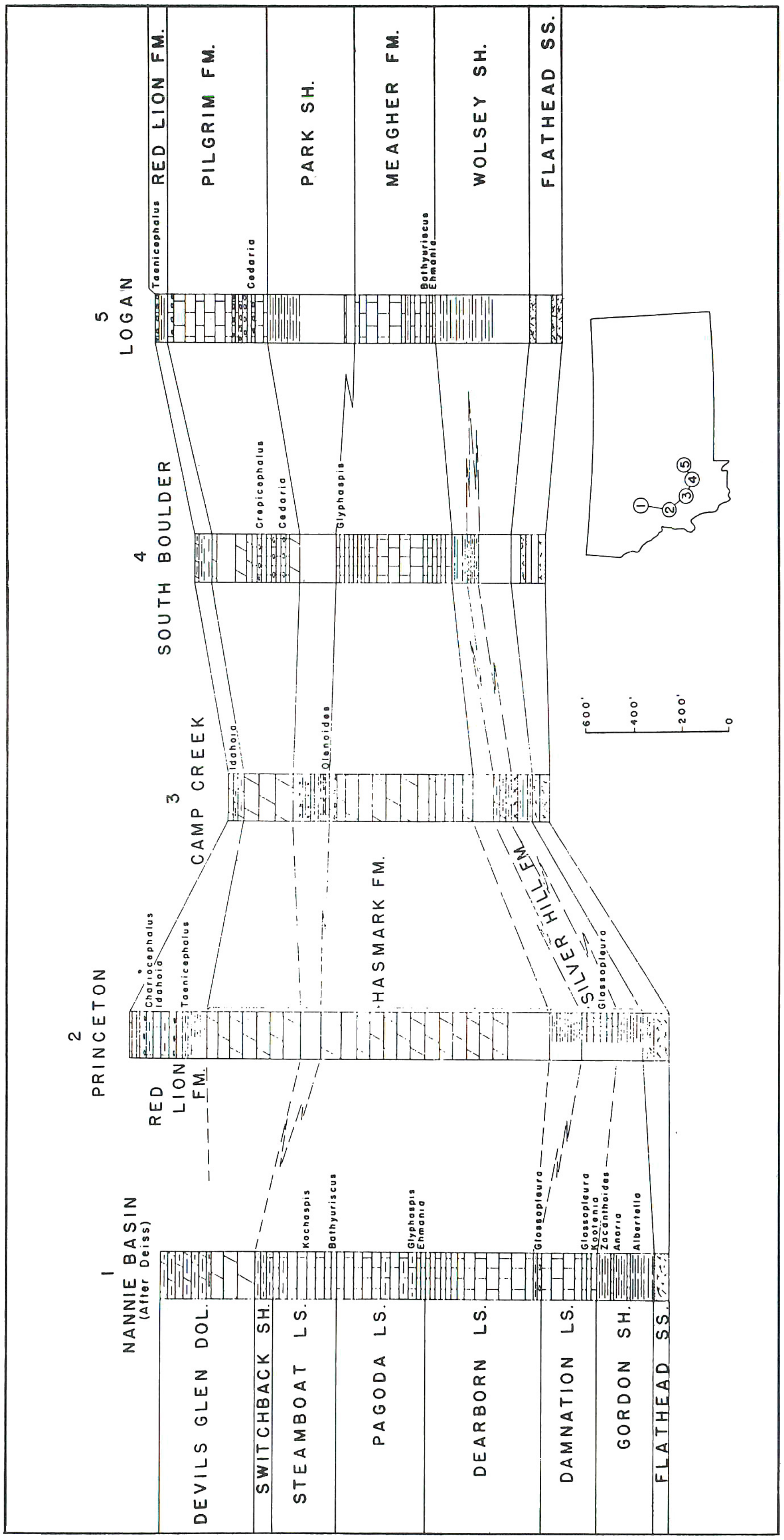


Figure 4.–Correlation of the Cambrian system in western Montana (after Hanson, 1952).

Table 1.–Thicknesses of Meagher and Pilgrim Formations (Cambrian) in various mountain ranges of southwestern and central Montana.

Area	Thickness, ft. Meagher Fm	Thickness, ft. Pilgrim Fm	Source
Limestone Hills	490-570	380-510	Klepper and others
Tobacco Root Mountains	460	360	Reid
Highland Mountains	300	300	Sahinen
Ashbough Canyon, SW of Dillon	573	137	Hanson
Sheep Mountain, Madison County	372	493	Hanson
South Boulder, Madison County	464	356	Hanson
White Sulphur Springs	209	394	Hanson
Logan	336	412	Hanson

Many of the caves in the Bob Marshall Wilderness and adjoining Scapegoat Wilderness are formed in Cambrian rocks.

ORDOVICIAN ROCKS

In western Montana, Ordovician rocks are missing. In eastern Montana, the Ordovician system is widespread in the subsurface, but the carbonate-bearing Bighorn Dolomite (Middle Ordovician) crops out only in the Pryor, Bighorn, Beartooth, and Little Rocky Mountains. It consists of yellowish-brown to gray, fine to coarsely crystalline massive dolomite. The magnesium content limits cave development, and although caves have been reported in Wyoming in this formation, none are known in Montana.

SILURIAN ROCKS

Silurian rocks are not exposed in Montana. They are known in the subsurface only in the Williston Basin in eastern Montana.

DEVONIAN ROCKS

Two Devonian formations contain sufficient carbonate rocks to form caves. The Jefferson Formation (Upper Devonian) is 300 to 1,500 feet thick and consists of massive limestone or dolomite interbedded with silty limestone or siltstone laid down as a cyclic deposit. The dolomite is light to dark brown and medium crystalline; the limestone is dark gray and dense to finely crystalline. The excessive magnesium content and the cyclic nature of the Jefferson limit cave development in some parts of Montana. In southwestern and northwestern Montana, however, thick limestone layers in the Jefferson Formation contain several large caves.

The Three Forks Formation, which overlies the Jefferson, is composed of soft silty limestone and shale not generally suitable for cave development. In northwestern Montana, however, where the Three Forks Formation is nearly 600 feet thick (Mudge, personal communication, 1969), it consists of solution-brecciated limestone suitable for cave development. Several large caves have been found in the Three Forks Formation in this region.

MISSISSIPPIAN ROCKS

By far the most important cave-forming rocks in Montana are the carbonate rocks of the Madison Group (Mississippian). More than 90 percent of the known caves in the state were formed in these strata. Figure 5 shows the extent of Madison rocks within Montana. Nearly every mountain range within the state contains Madison carbonate rocks; they are exposed in the foothills, flanks, or crests of the mountains as a series of light-gray cliffs. The Madison Group can be divided into three parts: the Charles, the Mission Canyon, and the Lodgepole Formations (or their equivalents). The Charles Formation is primarily evaporitic and occurs only in the subsurface as seen in well cores in central and eastern Montana. It is never found at the surface, although many authors (discussed by Roberts, 1966) believe that the solution breccia in the upper part of the Mission Canyon is equivalent to the subsurface Charles Formation. If so, the Charles Formation would be equivalent in age to the upper part of the Mission Canyon. Whether a Charles Formation equivalent or not, the upper 100- to 200-foot segment of the Madison Group includes solution breccia, which probably resulted from the leaching of evaporites when the Madison was exposed to surface erosion (Sloss, 1952; Laudon and Severson, 1953).

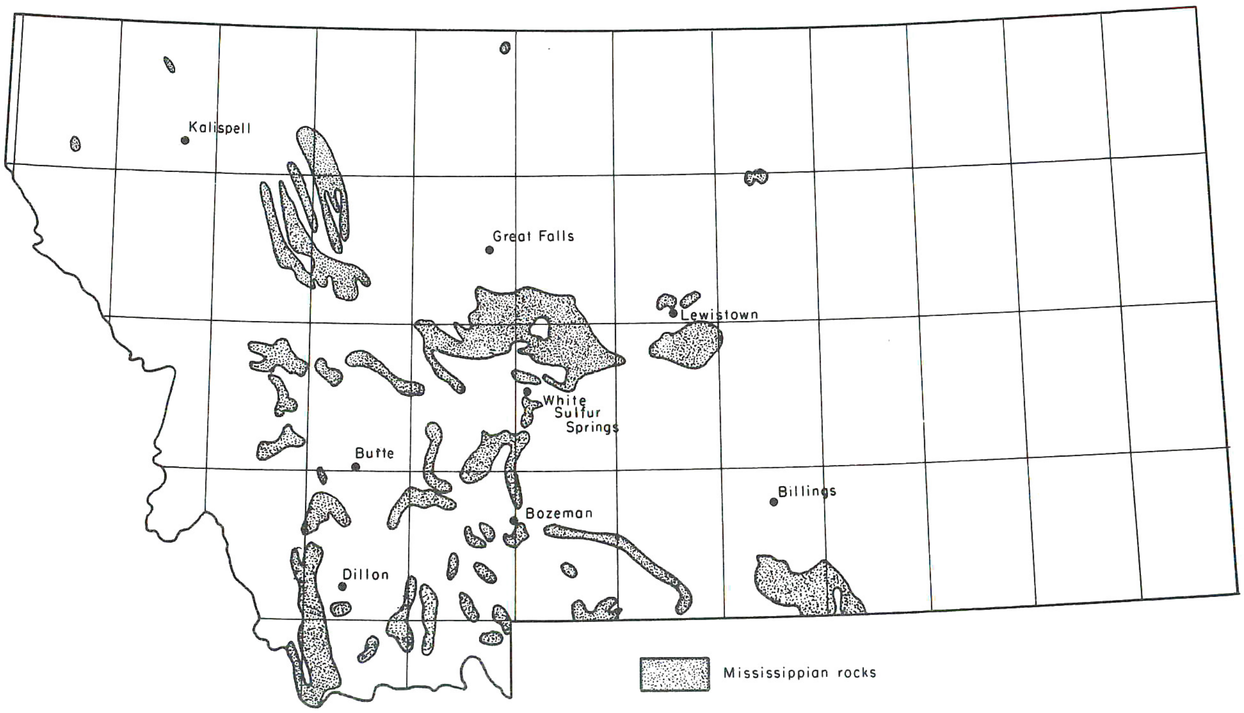


Figure 5.–Extent of Mississippian rocks at surface in Montana.

Exposures of the Madison Group in several mountain ranges in the state have been measured and described by several authors. Table 2 shows the relative thickness of the Madison Group in mountain ranges where caves are prominent.

Lodgepole Formation

The Lodgepole Formation, the lower part of the Madison Group, consists of thin gray to gray-brown limestone and dolomitic limestone beds separated by clay or siltstone partings. It forms ledges overlying the weakly resistant Three Forks Formation (Devonian). The yellowish-brown or yellowish-gray tone and thin bedding of the Lodgepole Formation distinguish it from the overlying Mission Canyon Formation. Where predominantly limestone, the Lodgepole is gray and finely crystalline to dense, but where dolomitic, it appears brownish. The Lodgepole Formation is commonly fossiliferous and cherty. Attempts have been made to divide it into two members (Sloss and Hamblin, 1942), but this subdivision is difficult to recognize in many areas of the state (Fig. 6). In northwestern Montana the name Allan Mountain Limestone is applied to rocks thought to be about the same age as the Lodgepole Formation (Mudge and others, 1962).

The shale partings, abundance of chert, and the thin bedding of the Lodgepole tend to retard cave development. Most caves in the Lodgepole are small and developed along a single limestone layer between shale interbeds. The clay and silt tend to plug solution zones and thereby stop development of complex cave passages.

Mission Canyon Formation

The Mission Canyon Formation ranges from 400 to 1,000 feet in thickness and is thickest in central Montana (Table 2). It consists of massive brown to dark-gray dense or finely crystalline limestone or dolomitic limestone that weathers light gray. It produces steep cliffs and ledges. Chert beds and nodules are not as common as in the Lodgepole Formation. The Mission Canyon is nearly pure carbonate (typical analysis 95 to 99 percent soluble material), and the lack of silt and silica impurities and its massive nature make it an ideal rock for cave development. Not surprisingly, therefore, most Montana caves are in this formation.

In numerous places the top of the Mission Canyon is brecciated. The solution breccia is thought to have resulted from the leaching of evaporites from the top of the Mission Canyon as the area underwent erosion during late Mesozoic or early Cenozoic time (Roberts, 1966).

Table 2.–Thicknesses of Madison Group and Mission Canyon and Lodgepole Formations in mountain ranges where caves are prominent.

Area	Mission Canyon thickness, ft.	Lodgepole thickness, ft.	Total Madison	Source
Pryor Mountains	Undivided	Undivided	700+	Richards
Little Rockies	335	500	835	Sandberg*
Little Belts	1,107	650	1,757	Klepper and others
Sun River Area	810	575	1,385	Mudge
Silvertip Basin	Undivided	Undivided	1,000+	Mudge
Big Snowy Mountains	1,025	640	1,665+	Well cores, L.A. No. 1 Jackson
Dillon Area	Undivided	Undivided	1,545	Sandberg*
Sixteenmile Area	800±	600±	1,400	Robinson
Livingston Area	656	480	1,136	Roberts
Limestone Hills	1,107	650	1,757	Klepper and others
Highland Mountains	Undivided	Undivided	1,250	Sahinen
Garnet Range	1,130	505	1,635	Kauffman

*Personal communication, 1969.

Also present at the top of the Mission Canyon in many areas are collapse breccias thought by many authors to be caused by the collapse of sinkholes and caves (Sloss and Laird, 1945; Sando, 1967). The collapse features were formed as a direct result of the formation of a karst terrane on the top of the Madison.

Very few caves extend from the Mission Canyon into the underlying Lodgepole Formation. Where the Mission Canyon is thin, deep caves cannot be expected.

In northwestern Montana, the equivalent of the Mission Canyon Formation is the Castle Reef Dolomite (Mudge and others, 1962). It contains as much as 47 percent MgO and is darker and more coarsely crystalline than the Mission Canyon elsewhere. Caves are not nearly as abundant there, probably because of the large amount of magnesium in the rock. Further discussion of the Mission Canyon Formation will include the Castle Reef Dolomite.

Other Mississippian Rocks

The Mission Canyon Formation may be overlain by the Big Snowy Group or by the Amsden Formation. Rocks of the Big Snowy Group are predominantly sandstone and shale. Because the few limestone beds in this group are thin and silty, they are unsuitable for cave development. The Big Snowy Group crops out only in central Montana. The Amsden Formation (in part Pennsylvanian) rests on the Mission Canyon in most other regions. The basal red shale unit of the Amsden is a distinctive marker for the top of the Madison Group. In most places, the Amsden is composed of readily weathered red siltstone and shale and a few silty dolomite beds. Many caves developed in the Mission Canyon Formation contain red clay from the Amsden Formation. In some caves the clay seems to have choked off further passage development; it also blocks further exploration of some passages. At what date in geologic time the caves were filled and whether all caves in the Mission Canyon were once full of clay and only recently excavated are questions pertinent to the age and origin of Montana caves. They will be discussed later.

Origin of the Madison Group

Carbonate sediments of the Madison Group were deposited on a broad marine shelf extending from Wyoming into Canada and from Idaho to North Dakota. The shelf dropped off into deeper waters of a geosynclinal trough to the west and the Williston Basin to the east. An east-trending sag through central Montana received a thicker accumulation of carbonate. For such thicknesses of limestone to accumulate, shallow marine conditions including warm, clear water must have persisted, subsidence keeping pace with deposition so that the depth of water remained fairly constant. Conditions could be compared to those in the Bahamas and Florida Keys today, where reef and lagoonal carbonate is produced by lime-secreting algae and grasses and by deposition of hard parts of coral and shellfish. Dolomitization of original

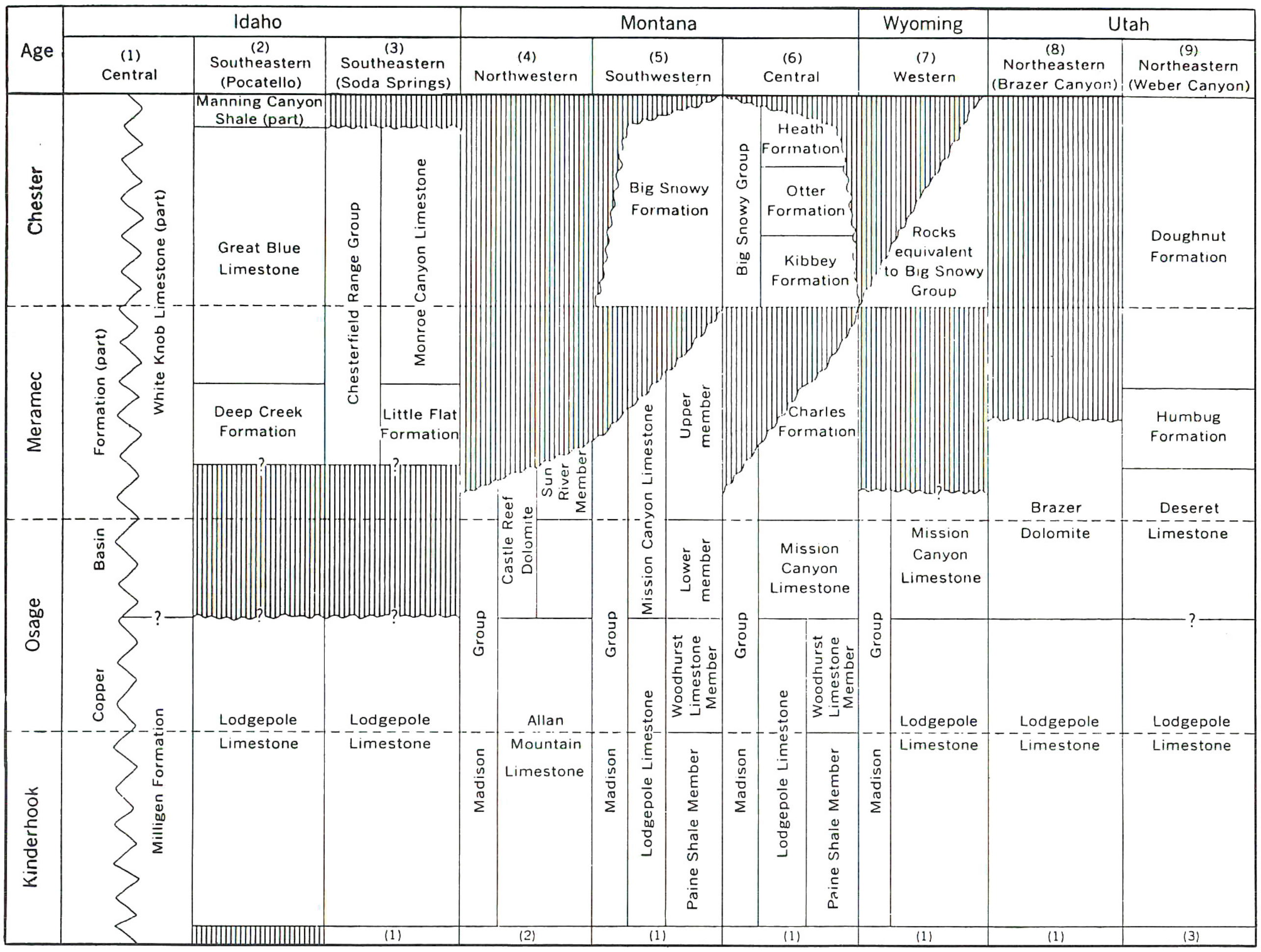


Figure 6.–Correlation and stratigraphic relations of the Madison Group in southwestern Montana and other areas in Montana, Idaho, Wyoming, and Utah. Numbers in parentheses at bottom of chart indicate (1) Three Forks Formation (part), (2) Exshaw Shale (part), and (3) Three Forks (?) Formation (part) (After Roberts, 1966).

limestone probably occurred soon after deposition. Cyclic deposition produced alternating layers of thin-bedded silty limestone and massive layers of limestone and dolomite. Slight emergence at the end of Madison time stopped the deposition of carbonate. Karst topography developed on this emergent surface, and the caves and sinkholes were filled with clay and breccia.

PENNSYLVANIAN AND PERMIAN ROCKS

Pennsylvanian rocks in southern and western Montana include the Amsden and Quadrant Formations. The upper part of the Amsden contains a small amount of thin-bedded silty limestone and dolomite. The overlying Quadrant Formation is composed almost entirely of sandstone but contains a few thin silty orange dolomite beds. Neither unit contains rocks suitable for cave development. Permian rocks are restricted to southwestern Montana, and the few carbonate strata are strongly mangesian. No solution caves have been found in Pennsylvanian or Permian rocks.

MESOZOIC ROCKS

Rocks that were deposited during the Mesozoic are sandstone, shale, siltstone, and some impure limestone. The only two limestone deposits suitable for cave development are in the middle part of the Ellis Formation and near the top of the Kootenai Formation.

The Ellis Formation (Jurassic) includes a middle unit of limestone 50 to 100 feet thick (Perry, 1949) bounded by shale and sandstone; it could contain small caves. The "gastropod limestone" member of the Kootenai Formation (Cretaceous), so named because it includes large quantities of fossil snails, is relatively pure calcium carbonate. It could contain caves where it reaches a thickness of 75 feet in southwestern Montana. Two limestone caves have been reported in Mesozoic rocks in Montana.

Numerous rock shelters and small one-room caves have been found in Cretaceous sandstone in central and eastern Montana. Descriptions of several of the larger ones are included in the section on cave location.

CENOZOIC ROCKS

The most common Cenozoic rocks are shale, sand, gravel, and volcanic rocks. Local spring deposits of travertine are thick enough to produce caves. Travertine is principally calcium carbonate, and caves are easily developed in such rocks. A large travertine deposit at Gardiner, near the north boundary of Yellowstone Park, was described by Chelini (1965). Another deposit as much as 250 feet thick lies in the southern part of the North Moccasin Mountains. Other small travertine deposits occur in the South Moccasin and Judith Mountains in central Montana. Small fissure caves have been found in nearly all of these travertine deposits and are thought to have been formed by gravity sliding. The small areal extent of travertine deposits makes finding large caves unlikely. The travertine is white to yellow brown, earthy, very porous, and massive. Calvert (1909) estimated the age of the travertine as Early Pleistocene. The extreme and almost uniform porosity and permeability of the travertine may allow ground water to pass through the rock almost equally well in any direction, thereby reducing the tendency to form channels. (See section on cave formation.)

CAVE ORIGIN

SOLUTION

Caves may develop in carbonate rocks as water charged with carbon dioxide, CO_2 (in the form of carbonic acid, H_2CO_3), dissolves the carbonate minerals in the rock. Most caves are formed in limestone rocks. Few caves develop in carbonates such as dolomite or marble because of kinetic and solubility differences as well as because of water flow considerations.

Rainwater contains some carbon dioxide accumulated from the atmosphere. As the rainwater passes into the soil, more CO_2 will be derived from the soil atmosphere. Most of the CO_2 in the water at this time is derived from the soil horizon rather than from the atmosphere. Limestone beneath the soil may be partly dissolved by this water if the CO_2 content is great enough. Conversely, the loss of CO_2 gas sometimes results in the precipitation of calcite such as commonly found in caves.

The interested reader is referred to more detailed analyses of these solution processes in Adams and Swinnerton (1937), Carroll (1962), Holland and others (1964), Thrailkill (1968), Jennings (1971), Sweeting (1973), and Waltham (1974).

ACIDITY AND SATURATION

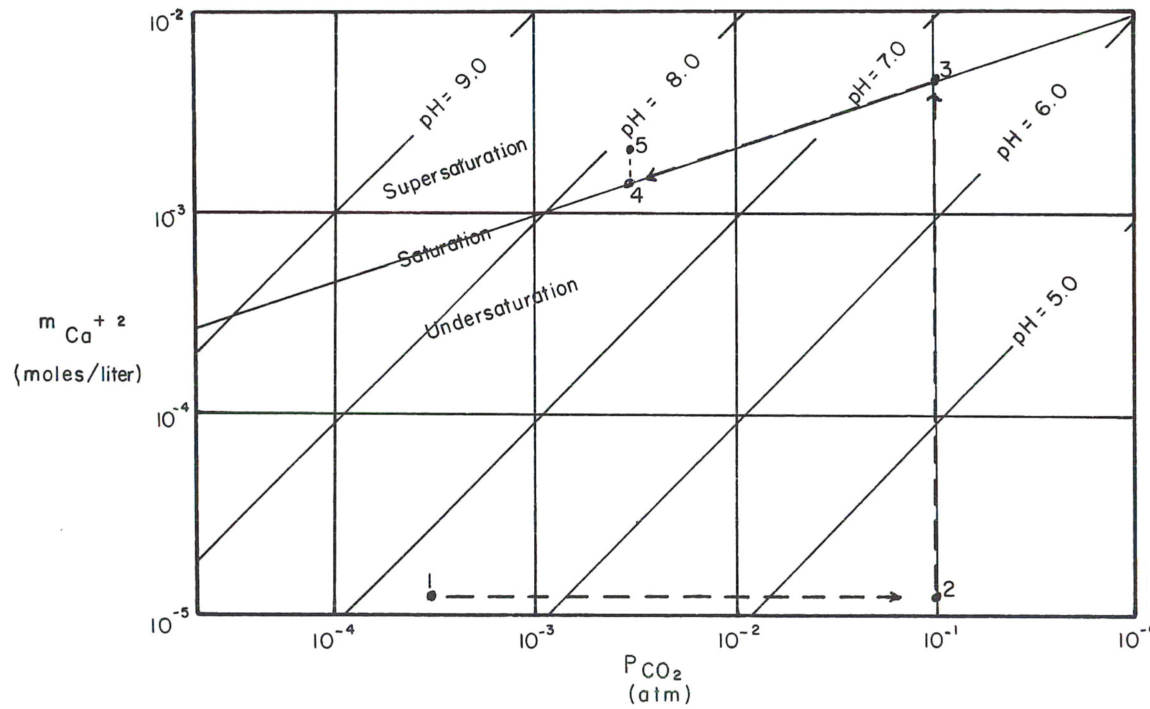
As rainwater enters the soil and begins to move downward toward the water table, the water will become saturated, possibly even supersaturated, with respect to calcite, and at the same time, its pH will change. Figure 7 is a plot of changes in saturation and acidity of ground water as it moves toward the water table. Point 1 shows for normal rainwater the pH and the saturation with respect to calcite at 10°C. As it percolates through the soil, the water becomes charged with more CO_2 and the pH drops (point 2). As the water seeps into carbonate rocks under the soil, the pH rises and the water becomes saturated with respect to calcite (point 3). If the saturated solution should encounter an open cave somewhere below the surface, some of the CO_2 may escape from solution, causing precipitation of some of the $CaCO_3$. The escape of CO_2 is a function of the P_{CO_2}* of the cave air; if the P_{CO_2} of the air is lower than that of the saturated solution, CO_2 will be lost from solution. To restore equilibrium, precipitation of $CaCO_3$ will take place. The P_{CO_2} of the cave air approximates that of the atmosphere if the cave is open to surface ventilation. (Holland and others, 1964, gave a value for cave air of 0.86×10^{-3} atm.) The escape of CO_2 causes a general shift to point 4 on the graph; if the loss of CO_2 is very rapid the solution may even become supersaturated with respect to calcite (point 5). Points 4 and 5 are associated with the deposition of secondary calcite in caves, a subject to be discussed later in this report.

Although the above discussion implies that ground water entering a carbonate rock becomes saturated and dissolves the host rock near the surface, most caves are now believed to form at or slightly below the water table. The reasoning for this belief will be presented later.

DOLOMITE

Paleozoic carbonate rocks contain various amounts of the mineral dolomite, $CaMg(CO_3)_2$, and the amount

*P_{CO_2}—partial pressure of carbon dioxide, CO_2.



1) rain water; 2) water in soil; 3) ground water containing dissolved calcite; 4) ground water entering ventilated cave; 5) ground water losing CO_2 to cave air.

Figure 7.–Calcite saturation diagram at 10°C. Plot of log $m_{ca}+2$ (moles/liter) vs. log equilibrium P_{co_2} (atm). (After Thrailkill, 1968)

of dolomite in the rock may affect its solubility. Although earlier publications indicated that dolomite is more soluble than calcite, later reports (Krauskopf, 1967, p. 87; Thrailkill, 1968a; Holland and others, 1964, p. 41) have shown that the solubilities of dolomite and of calcite are roughly the same in similar environmental conditions. Recently published values for the solubility product of dolomite are about 10^{-17} at 25°C.

From the foregoing information, one might expect as many caves to develop in dolomite as in limestone, but field evidence suggests otherwise. Dolomitic rocks such as the Jefferson Formation (Devonian) contain almost no caves, whereas nearby Mississippian limestone may contain numerous caves. In areas where the Mission Canyon Formation (Mississippian) is dolomitic, caves are much less numerous than in areas where the limestone is more nearly pure calcite.

The problem of the relative insolubility of dolomite has not yet been solved. Thrailkill (1970, personal communication) has suggested that the answer lies, not in equilibrium solubilities, but perhaps in the reaction kinetics. Natural processes may dissolve dolomite more slowly than calcite. Another suggested possibility is that because dolomite has more intergranular permeability, ground water may pass through the dolomite more quickly than through limestone, resulting in a slower rate of cave formation. More research is needed before the "dolomite problem" can be solved.

SULFURIC ACID

Recent studies indicate that in some places sulfuric acid may be present in ground water and may help to excavate caves. Morehouse (1968) described several caves in Iowa thought to have been formed by H_2SO_4. The source for the acid is pyrite or marcasite in the bedrock. These minerals react as follows:

$$4FeS_2 + 15\,O_2 + 2H_2O \rightarrow 2Fe_2(SO_4)_3 + 2H_2SO_4$$

More sulfuric acid is formed from $Fe_2(SO_4)_3$:

$$2\,Fe_2(SO_4)_3 + 12\,H_2O \rightarrow 4\,Fe(OH)_3 + 6\,H_2SO_4$$

The sulfuric acid then reacts with carbonate as follows:

$$8\,H_2SO_4 + 8\,CaMg(CO_3)_2 \rightarrow 8\,Ca^{++} + 8\,Mg^{++} + 8\,SO_4^{-} + 16\,HCO_3^{-}$$

This method of cave excavation may help to explain the abundance of caves near some mining districts in Montana, e.g., Little Belt Mountains and the Dillon area. Where Paleozoic limestone has been intruded by igneous rock, some ore bodies containing pyrite or other sulfide minerals have been emplaced at the contact between limestone and igneous rock. There the excavation of caves should proceed at a faster pace than normal, owing to a combination of sulfuric and carbonic acids. The Iowa cave study indicated a pH of 6.6 for cave water there, and also an abundance of limonite stain [$Fe(OH)_3$] on the cave walls. Further checking of Montana caves for limonite stains and for determining the pH of the cave water may substantiate these findings.

FRACTURES AND CAVE DEVELOPMENT

Rocks and material composed of rocks may contain voids, interstices, or open spaces between mineral or rock grains or particles; the percentage of total volume occupied by such space is called *porosity*. Porosity generally means the relative amount of water a saturated rock can absorb or hold. *Permeability* is the capacity of a water-bearing rock or material to transmit water. Permeable rocks have connected void spaces, which may be visible to the naked eye.

Porosity and permeability are classified as *primary* (present when the rock was formed) or *secondary* (formed by later changes in the rock). Carbonate rocks have a typical porosity range of 8 to 15 percent (Pray, 1966, personal communication). The presence of impurities such as clay minerals and chert will reduce porosity and permeability. In general, the Paleozoic carbonate rocks have negligible primary porosity, and ground-water movement is along fractures and other secondary features.

Fractures, ranging in size from microscopic to miles in length and several feet in width, may be enlarged by the dissolving action of moving ground water. Fracturing is caused by earth phenomena, including tidal forces (Davis and Moore, 1965), compressional tectonic imbalances that result in folding and faulting, extensional imbalances that result in gravity sliding (Campbell, 1968), sheeting structures, and localized ice wedging.

In carbonate rocks, the principal channels for ground-water movement usually develop along bedding planes and joints. Caves develop because unsaturated vadose and phreatic water is forced to move through a few channels, which grow in time (Fig. 7). When the regional ground-water base-level drops, portions of the enlarged passageways are drained. Joint planes can control cavern formation by allowing water to move in a specific direction through the rock. A good example of joint-controlled cavern formation is Anvil Cave, Alabama (Fig. 8).

RELATIONSHIP OF CAVES TO THE WATER TABLE

Early investigators believed that caves were formed above the water table by downward-moving vadose* water. Their reasoning was that ground water became saturated with respect to calcite near the ground surface, and that by the time it reached the water table, further solution was not possible. Some early authors even believed that caves were formed entirely by mechanical erosion by underground streams.

Papers by Davis (1930) and Swinnerton (1932) led the way for modern thinking on cave development. Those authors believed that major cave passages were formed at the water table or slightly below it in the phreatic zone.* More recent investigations support this theory. Most scientists now believe that caves originate in the phreatic zone. Further studies indicate that: (1) circulation of CO_2-charged ground water extends below the water table, (2) joint planes control the direction of cavern development, (3) the local base level of surface streams controls the downward development of caves, (4) caves may contain two or more levels developed as a result of downcutting of surface streams, (5) mechanical erosion may play a part in excavating passages but only after the cavern is well developed, and (6) only after water has drained out and the cave has become air filled are secondary features such as stalagmites developed (Thornbury, 1954; Jennings, 1971).

CIRCULATION

Water may flow in carbonate rocks through small joints, cracks, or even large caves or through intergranular pores. The water table reflects this difference and may consist of an irregular surface controlled by the joint pattern (Fig. 9).

In karst areas, ground-water circulation can be treated as a combination of deep circulation modified by joints, fissures, and caves (Fig. 10). Rainfall moves down through sinkholes and joints to the water table. Most of the water moves laterally along the top of the saturated zone toward surface streams (creating a "level" of caves in the process).

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*In this publication *vadose* is used in the sense of ground water above the water table, and *phreatic* for the saturated zone below the water table.

Figure 8.—Part of Anvil Cave, Alabama, showing joint-controlled passages. Map by Huntsville Grotto of National Speleological Society.

Circulation below the water table is also controlled by the fracture pattern. At great depths slow circulation does occur. In Montana, the Madison Group contains water-filled caverns that have been intersected by deep drill holes. Madison rocks in the deep subsurface may yield fresh water under artesian conditions. Caverns at this depth are far below the water table and are many miles from recharge sites. Their origin is uncertain, but they may represent caves that were formed near the surface prior to the deposition of overlying formations (Swenson, 1968).

LOCAL BASE LEVEL AND DOWNCUTTING

Caves may be controlled by the presence of surface streams where the water table slopes to the level of surface streams. When these streams erode downward to a new base level, the water table is also lowered, and cave passages will drain and become air filled (Davies, 1960). Multilevel caves may result, and close correlation between the altitudes of cave levels and those of stream terraces can be seen (Fig. 11).

GEOCHEMICAL CONSIDERATIONS

Ground water will dissolve limestone only when it is undersaturated with respect to calcite ($CaCO_3$). Studies by Thrailkill (1968) indicated that temperature, mixing, and flooding conditions explain how phreatic water may become undersaturated with respect to calcite and thus dissolve limestone at or below the water table.

Calcite becomes increasingly soluble in water as temperature decreases (Fig. 12). Water moving downward may start out saturated with calcite but becomes undersaturated as it cools at depth. This cooling allows more $CaCO_3$ to be dissolved at lower levels.

Mixing of cave waters may also cause undersaturation at the water table (Thrailkill, 1968, p. 32). If vadose water mixes with phreatic water at the water table, undersaturation may result because of differences in the partial pressures of carbon dioxide in the two solutions.

High water in surface streams may cause backflooding into the nearby cave passages by chemically undersaturated stream water, diluting the water in the cave and allowing more $CaCO_3$ to go into solution. Flash floods or heavy runoff may force vadose water downward so rapidly that it will not be completely saturated with calcite before it reaches the water table. Flooding may also cause mechanical erosion of the cavern floor and walls. Cave excavation by flooding may take place only during the spring runoff of snow meltwater.

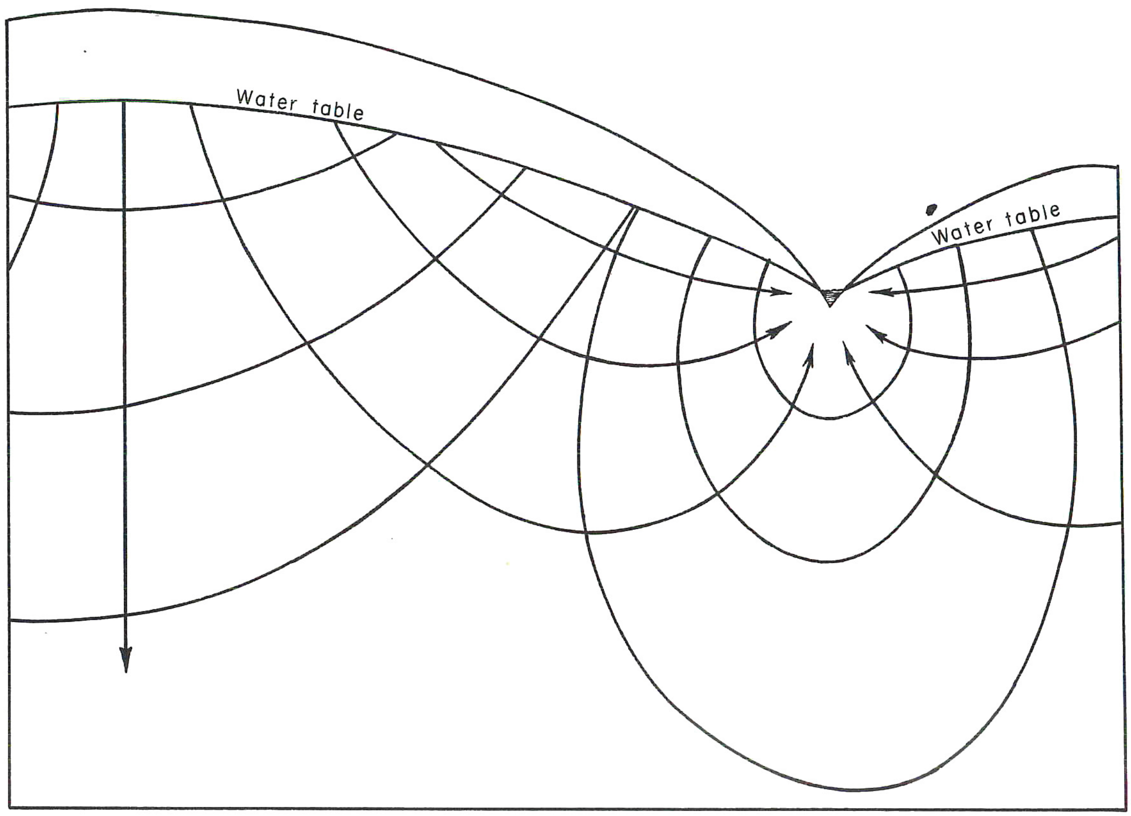


Figure 9.—Patterns of ground-water flow below the water table.

CAVES IN THE VADOSE ZONE

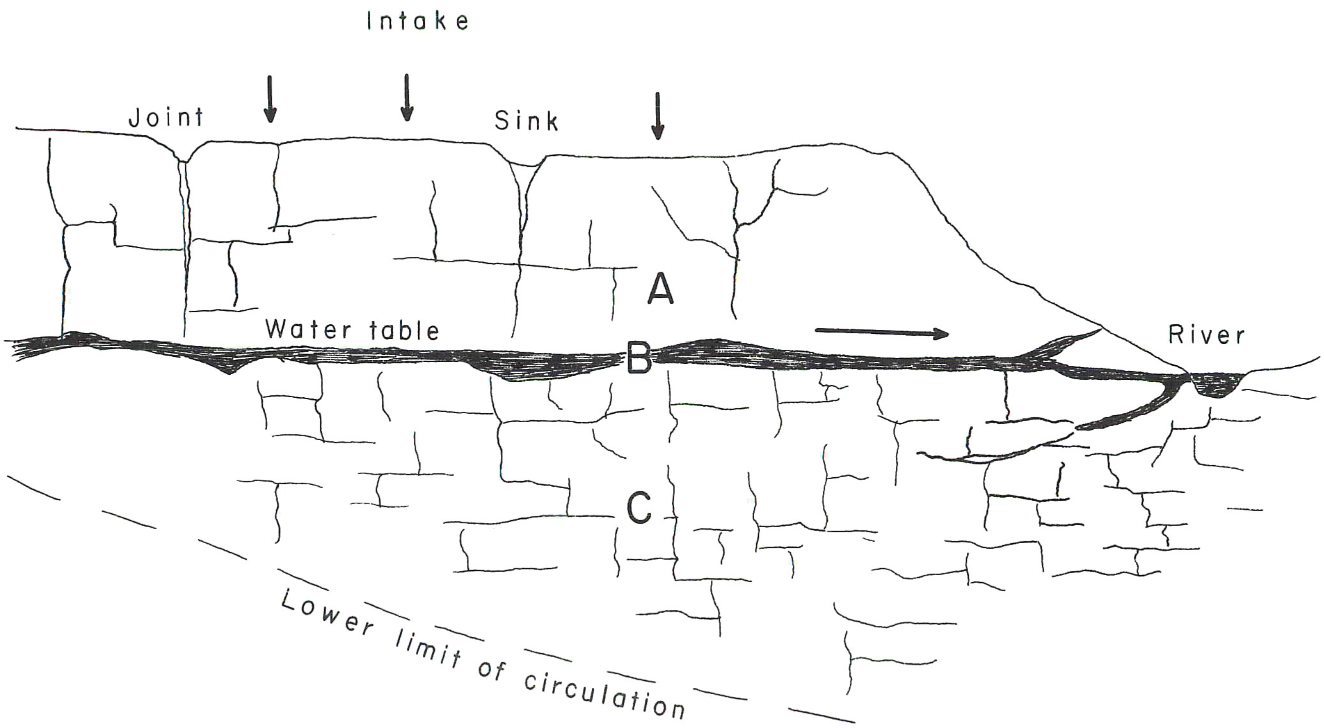
Caves can form above the water table, however. One method is by the formation of domepits, which are vertical shafts that rise above the highest known cave passage. Domepits form where meteoric water on its way down to the water table widens a few select joints until they are very large. The pits, some of which have fluted edges, extend from near the surface toward the water table. They show little relationship to any horizontal passages and seem to be concentrated near the edges of ridges. They are thought to be a late stage in cavern development (Pohl, 1955; Merrill, 1960). Some Montana caves are known to contain domepit-like shafts (e.g., Whitaker Sink, Little Belt Mountains), but because Montana caves seem to be in an early stage of cavern development, most vertical shafts are thought not to be domepits. Because most pits and deep sinkholes are found in areas of high relief, they probably do result from solution by meteoric water on its way to the water table, although a few of the sinks may result from roof collapse of underlying caves.

Other caves developed above the water table include the numerous fissures formed by gravity sliding (Campbell, 1968). Blocks of carbonate rocks that slide downslope open up vertical fissures that may be slightly modified by vadose water entering the fractures. Many other vertical shafts in Montana, long thought to be formed entirely by solution, may have originated as a fracture opened by gravity sliding.

In summary, most caves form at or beneath the water table by slowly moving phreatic water and are related to the level of the water table and nearby surface streams. If surface streams lower their base level, successive cavern levels may develop. Some vertical caves in Montana seem to originate in the vadose zone, either by gravity sliding or by downward movement of meteoric water.

KARST TOPOGRAPHY AND STAGES OF DEVELOPMENT

As caverns develop in an area, progressively more of the surface runoff is channeled underground through fractures and cave passages. Certain fractures are enlarged to cavern size by solution. The resultant enlargement may cause the surface area above the fracture to become depressed or sunken; these depressions are called



A) Sinkholes and joints in the vadoze zone (seepage water); B) Water-filled caves (some air-filled openings at low water); C) Water-filled joints and bedding planes.

Figure 10.–Cross-section of circulation in a carbonate aquifer under karst conditions.

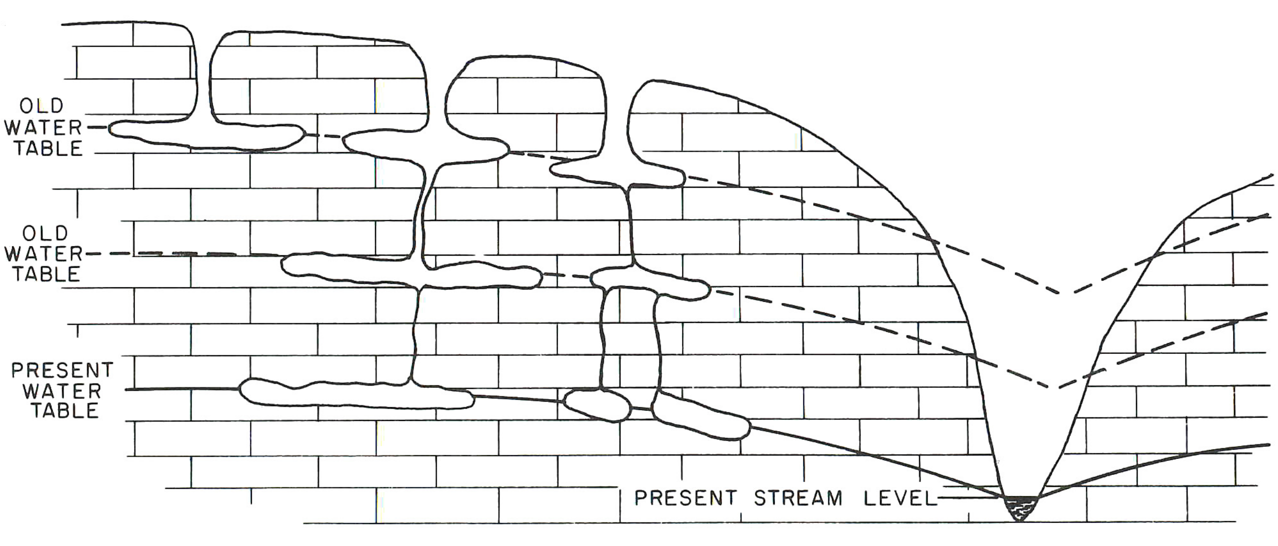


Figure 11.–Diagram showing how lowering of surface streams can produce multiple cave levels.

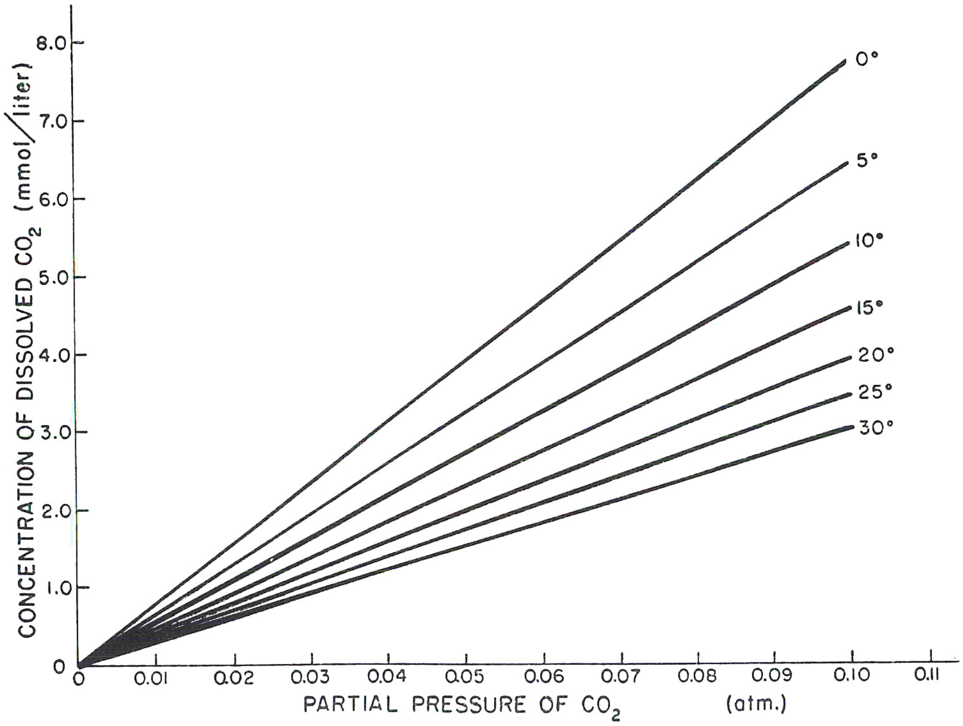


Figure 12.—Relationships between concentration of CO_2 dissolved in water, CO_2 pressure in the vapor phase, and temperature of the system between 0° and 30°C (after Holland and others, 1964).

sinkholes. In addition, roofs of some caverns may collapse leaving a depression (or pit) at the surface. Therefore, surface drainage is nearly absent in some areas, and the landscape is dotted with sinkholes. This special kind of topography is called karst. Karst is common in Indiana and Kentucky where thousands of sinkholes per square mile dot the ground surface. In Montana, few areas have well-developed karst terrane. Parts of the Sawtooth and Flathead Ranges, the Dry Range, the Big Snowy Mountains, and the Pryor Mountains have sinkholes but nowhere more than 40 per square mile. In addition, surface drainage is still present. For these reasons, karst in Montana may still be in the early stages of development. Thornbury (1954, p. 351) outlined a geomorphic cycle for development of caverns and karst features:

(1) Youth (early)—mostly surface drainage with few sinkholes. Master streams in the area have downcut so that large areas of limestone lie above the stream base level.

(2) Maturity (middle)—maximum underground drainage and sinkhole development.

(3) Late maturity—collapse of cave roofs and roofs of underground stream channels.

(4) Old age (late)—a return to surface drainage with only isolated hills of limestone remaining. (Such hills are known as tower karst.)

In Thornbury's classification, Montana's major cave areas seem to be in the youthful stage of development. The Bighorn-Pryor Mountains typify a youthful stage. The master river, the Bighorn River, has cut a deep channel so that large areas of Madison Limestone (Mississippian) lie above the base level. Sinkholes in this area are widely scattered, underground drainage is just developing, and most of the runoff is still by surface streams.

Karst topography is probably best developed in flat-lying limestone. Steeply dipping carbonate beds are exposed along the flanks of many mountain ranges in Montana. In such areas, surface exposures of limestone are relatively small. Although karst topography can develop under these conditions, it may form more slowly and less uniformly than in areas of flat-lying limestone.

SECONDARY FEATURES IN CAVES

Secondary features are developed after the cave has been excavated and drained. Stalactites, stalagmites, flowstone, and ice are secondary features. The word speleothem is used to include these and other "formations" in caves.

METHODS OF DEPOSITION

Speleothems are most commonly composed of calcite ($CaCO_3$), gypsum ($CaSO_4 \cdot 2H_2O$), and aragonite ($CaCO_3$), but many less common minerals have been found in caves. For more information about cave minerals, read Hill (1976). Calcite is by far the most common mineral and is deposited when vadose water, saturated with $CaCO_3$, reaches a cave. Equilibrium in the cave air pressure is reached by the release of carbon dioxide (CO_2) and the related precipitation of calcite when the partial pressure* (P_{CO_2}) is lower in the cave air than in the vadose water percolating into the cave. Evaporation of the cave water plays a minor role in caves, but it may take place in caverns that are well ventilated and subject to temperature change. Basically, the partial pressure of cave air rather than cave temperature determines whether secondary calcite will be deposited.

Surface temperature influences the relative amount of secondary calcite deposited. Soil bacteria destroy organic matter and liberate CO_2, thus making more CO_2 available to form carbonic acid (H_2CO_3), which dissolves limestone. In turn more $CaCO_3$ is available for redeposition underground. Production of CO_2 in the soil is not uniform but varies with the seasons. Bacterial activity leads to increased CO_2 production in the summer months. Consequently speleothem growth is greatest in the summer. In warm climates bacteria are more abundant because of higher annual temperature and denser vegetation. Caves in southern states would therefore be expected to develop larger speleothems.

CALCITE AND ARAGONITE

Calcite and aragonite are the most common minerals found in caves. Calcite forms scalenohedral, rhombohedral, or hexagonal crystals. Aragonite forms orthorhombic crystals and is a metastable polymorph that changes or converts to calcite in time. Aragonite is precipitated when the cave water is supersaturated with respect to both calcite and aragonite. Both minerals might be expected to precipitate simultaneously, but sometimes only aragonite comes out of solution. Aragonite is about 16 percent more soluble than calcite and will be deposited when minor impurities such as strontium (Sr), lead (Pb), or magnesium (Mg) are present. Although the geochemistry of calcite and aragonite has been studied extensively (Curl, 1962), much is left to learn about the precipitation of these minerals from solution.

*Partial pressure is that part of the total pressure related to the carbon dioxide content.

Many caves in the United States have speleothems composed entirely of aragonite. It has been reported in specimens from Montana caves (Schultz, 1969, p. 14).

GYPSUM

Under certain circumstances, sulfate minerals may be deposited in caves. Gypsum ($CaSO_4 \cdot 2H_2O$) is the most common sulfate mineral associated with cave deposits. In Montana, small amounts of gypsum are found in several caves—notably those in the Pryor-Bighorn Mountains. The source of the gypsum is probably the Charles Formation (Mississippian), which has yielded gypsum and anhydrite in well cores.

OTHER CAVE MINERALS

Minerals other than calcite, aragonite, and gypsum are rare in Montana caverns. Although hematite (Fe_2O_3), limonite ($FeO \cdot OH \cdot nH_2O$), hydrozincite ($7Zn \cdot 3CO_2 \cdot 4H_2O$), and tyuyamunite ($CaO \cdot 2UO_3 \cdot V_3O_5 \cdot 8 \pm H_2O$) have been tentatively identified, x-ray determinations have not yet been made. X-ray identification is needed for these minerals as well as for clay minerals found in cave mud.

DESCRIPTION OF MONTANA CAVE SPELEOTHEMS

STALACTITES AND STALAGMITES

Water dripping from the ceilings in caves deposits icicle-shaped masses of $CaCO_3$ called stalactites. Where the dripping water strikes the floor, more $CaCO_3$ is deposited, building cone-shaped forms called stalagmites. An extensive study (Moore, 1962) determined that stalactites and stalagmites are formed by water dripping from fractures in the cave ceiling. As $CaCO_3$-saturated water runs out of the fracture, a drop of water forms on the ceiling (Fig. 13); before the drop falls, CO_2 escapes from the surface of the water drop where it is in contact with the ceiling, and a thin film of $CaCO_3$ is deposited in a ring around the drop. Each time a new drop appears, more $CaCO_3$ is deposited, and a cylinder of calcite is built downward from the ceiling. Such early-formed stalactites, which may reach several feet in length, are called "soda straw" stalactites and have dimensions of soda-straw size. As long as a hole remains in the center, the stalactite will grow downward and remain thin. If the holes becomes plugged or water begins to seep down the outside of the stalactite, then calcite will begin to be deposited on the outside of the tube. The stalactite will then become thicker and icicle shaped. The precipitation of calcite may be cyclic, giving a tree-ring appearance to the stalactite when viewed in cross section or on a broken surface. The inner cylinder of a "soda straw" is

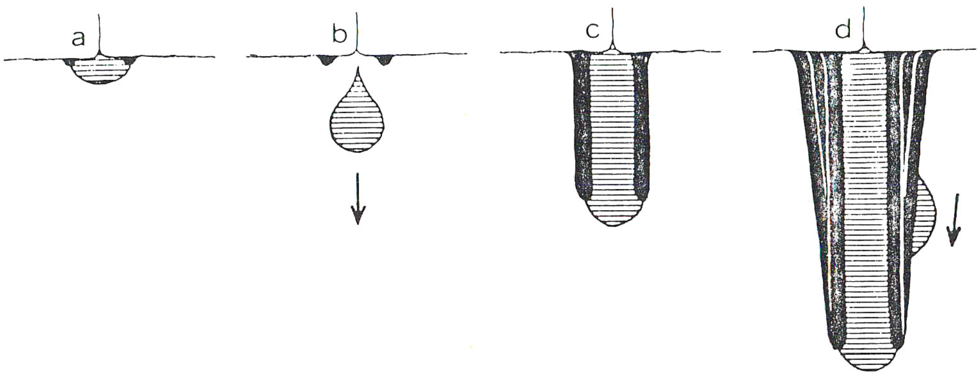


Figure 13.–Development of a stalactite. (A-C) growth of a tube from dripping water; and (D) deposition of the outer layers from flowing water (twice actual size) (after Moore, 1962).

composed of calcite grown into a single crystal; thus it has a smooth outer surface. Subsequent layers formed on the outside of the stalactite consist of many small intergrown crystals of different sizes and shapes, thus giving an irregular shape to the outside of the stalactite.

The water droplet that fell from the ceiling still contains dissolved $CaCO_3$; upon hitting the floor of the cavern, the impact breaks the drop apart, thus increasing the surface area and driving off CO_2 so that more calcite will be deposited. Because the force of the water striking the floor tends to spray it over a larger area, the calcite will be built up into a broad-based cone. For this reason, stalagmites tend to be thicker and more massive than the stalactites above them.

FLOWSTONE

When water runs out of a fracture near a cave wall, it may flow down the wall to the cave floor as a thin film and may wet large portions of the wall. While the water is flowing downward, CO_2 escapes into the cave air, and $CaCO_3$ may be deposited as sheet-like layers to form a mass known as flowstone. In time, whole walls of drapery-like flowstone may develop, completely covering the original cave wall.

GLOBULITES (CAVE POPCORN)

Globulites consist of knobs and bulbous masses of calcite that grow from the walls and floor of many Montana caves. Broken cave popcorn shows a series of concentric layers similar to those of a broken stalactite. One way in which cave popcorn is formed is by water seeping out of fractures so slowly that the drops of water remain stationary for long periods of time. A globular film of $CaCO_3$ is formed around the drop, and successive layers are built by water seeping through the calcite already deposited, much as water seeps through a sponge, keeping the outside moist and allowing more $CaCO_3$ to be deposited.

HELECTITES

Another form of speleothem developed by seeping water is helectites, strange twisted forms that have been found in only three of Montana's caves. Although many explanations for their development have been suggested, their origin is still uncertain. A helectite has a small hole running lengthwise through its center. As water seeps through this small hole and out the end, calcite is deposited in crystal form. Each crystal of calcite is asymmetrical and fastens to other crystals at various angles. The chemistry behind such growth is not yet known.

GYPSUM FLOWERS

In at least one Montana cave, blade-like masses of gypsum protrude from the cavern walls. Gypsum, because it is very soluble in water, forms only in very dry parts of a cave. Water containing dissolved gypsum fills pores and very small fractures in the cave walls. As gypsum comes out of solution, it pushes out any gypsum already deposited. The result is a long fibrous mass, or if the gypsum is pushed out in several directions, a flower-shaped form. Any increase in ground-water flow is likely to cause the gypsum to be redissolved and removed in solution.

AGE AND RATE OF GROWTH OF SPELEOTHEMS

The rate of growth of cave deposits is of interest because it gives a general idea of how long the cave has been air filled. Of the many kinds of cave deposits, only the rate of growth of stalactites and stalagmites has been studied in any detail. Many measurements have been made by commercial cave operators, and they indicate growth rates of less than three millimeters per year (Moore, 1962, p. 99).

Attempts have been made to compute growth rates by counting the rings in stalactites, on the assumption that each ring represents one year. Stalactite rings differ in thickness, and the difference may correspond to wet and dry cycles of the surface climate or to the wet and dry seasons of the year. Rings in Montana stalactites have not yet been counted, but in other parts of the country the growth rates for single rings have been computed as 1 to 4 millimeters per year.

Broecker and Olson (1959) have applied carbon-14 dating to the growth rate of cave formations. Accuracy of ±2,000 years in 30,000 seems possible. Broecker and others (1960) have shown the growth rate of stalactites as measured by the C^{14} method to be .06 millimeter per year. Thompson (1970, 1971) has been successful using U^{234} to date stalactite in Canada and the United States.

CAVE BREAKDOWN AND CAVE FILL

After a cave is excavated, the roof becomes relatively unstable and may collapse. Blocks of limestone that have fallen from the cave ceiling onto the cave floor are called breakdown. Piles of breakdown in almost every Montana cave have undoubtedly destroyed speleothems and blocked many passages. In several caves stalagmites develop on top of breakdown, indicating that the ceiling has stabilized.

Cave fill is a term applied to gravel, sand, and clay that have washed into the cave from the surface. Some clay-size material may have accumulated as insoluble residue after carbonate solution. In Montana, much of the cave fill is red, especially in caves formed in Mississippian carbonate rocks. The source of this red sediment is thought to be either the Amsden Formation or the Kibbey Formation of the Big Snowy Group. The ends of most cave passages are choked by a thick layer of cave fill. If this clay were removed, many Montana caves would be much larger; undoubtedly, large sections of cave passages lie beyond the present extent of such sediment-blocked caves.

ICE CAVES

Ice caves form where the secondary mineral deposited is frozen water. Speleothems of ice are formed by the same processes as calcite deposits. Ice stalactites and stalagmites, ice "flowers", and ice flowstone are found in several Montana caves. The one requirement for ice formation is that the cave temperature be 32°F or less. Normally this means that ice caves are at higher altitudes. Some of the world's largest ice caves are above 9,000 feet in the Pyrenees in France. In Montana, ice caves are common in the Big Snowy and Pryor Mountains at altitudes about 8,000 feet above sea level. Yet altitude alone will not ensure the formation of an ice cave. For example, Spanish Cave in Colorado lies nearly 12,000 feet above sea level but has little year-round ice. Only five of more than twenty caves in the Big Snowy Mountains are ice caves.

Any well-ventilated cave, even at 8,000 feet in Montana, will probably not retain ice permanently, because warm air moves into the cave during the summer months, and displaces the colder air and melts the ice. In poorly ventilated caves, especially those that have only one entrance and few ceiling fractures, cold air moves into the cave during the winter and ice forms. When warmer weather heats the surface air, the cold air will remain trapped below the surface. Cold air is slightly denser than warm air, and with no circulation in the cave, the warm air cannot get in to displace the cold air, thus ice will remain all year. Caves with entrances facing the north might be more likely to contain ice, but there seems to be no favored direction for ice-cave entrances in Montana.

CAVE AIR

AIR TEMPERATURES

The temperature of cave air is fairly stable and fluctuates within a narrow range over the entire year. This means that caves will be cooler than surface air in summer but warmer than surface air in winter. The temperature of cave air is usually close to the mean annual surface air temperature. Although the air temperature within a few feet of the cave entrance may fluctuate slightly with the seasons, air in cave passages 50 feet or more below the surface normally varies less than 1°F throughout the year. The air temperatures of three Montana caves were taken at three-month intervals in October, January, April, and July:

		Temperature (°F)			
Cave	Altitude	Oct.	Jan.	April	July
Lick Creek	5,800	38	38	38	38
Ram's Horn	5,250	41	41	41	41
Little Ice	8,180	32	31	32	33

The above figures show that Montana cave temperatures do not vary appreciably with the seasons.

The stable cave temperatures are due to the slow movement of cave air, which assumes the same temperature as the rock in the cave. In a few caves, however, temperatures do show wide seasonal variation. Davies (1960) studied Martens Cave in West Virginia and observed that temperatures varied from 27 to 53°F over a 12-year span. Such changes may occur when air moves rapidly between two large entrances or when fast-moving water, such as an underground stream, heated or cooled by surface air, transmits heat to or absorbs heat from the cave air. Montana caves that receive a large amount of snow meltwater would be expected to show fluctuations in temperature and to be colder than normal for that altitude and latitude.

Cave temperatures decrease with increase in altitude, owing to the colder annual surface temperatures at high elevations. Figure 14 is a graph comparing the temperatures of some Montana caves to their entrance altitudes. The average temperature change is about 3°F for each 1,000 feet of elevation.

Cave temperatures also vary with latitude. A cave isotherm map of the United States by Moore and Nicholas (1964) shows that caves in the south are much warmer than those in the north (Fig. 15). An isotherm map of some Montana caves (at equal altitudes) shows the effects of latitude change within the state (Fig. 16).

AIR PRESSURE

At the entrance of many caves, or in tight constricted passages within a cave, one may feel a breeze caused by air moving within the cave. Cave folklore commonly mentions hats being blown off and lamps being extinguished by strong winds. Most of these reports are exaggerated, but some caves do have strong winds blowing into or out of the cave. Winds at the entrance of Wind Cave, South Dakota, have been measured at speeds as much as 25 miles per hour.

Changes in barometric pressure or temperature of the surface air cause the air to move into or out of the cave. Barometric pressure at the surface increases at night because the air becomes more dense as it cools. At night, air will move into the cave to equalize the pressure. During the day when the surface temperature rises, air is heated, becomes less dense, and moves out of the cave. When this movement is slow, only a light breeze can be felt. During a storm the barometric pressure changes rapidly. If this change is added to the daily pressure

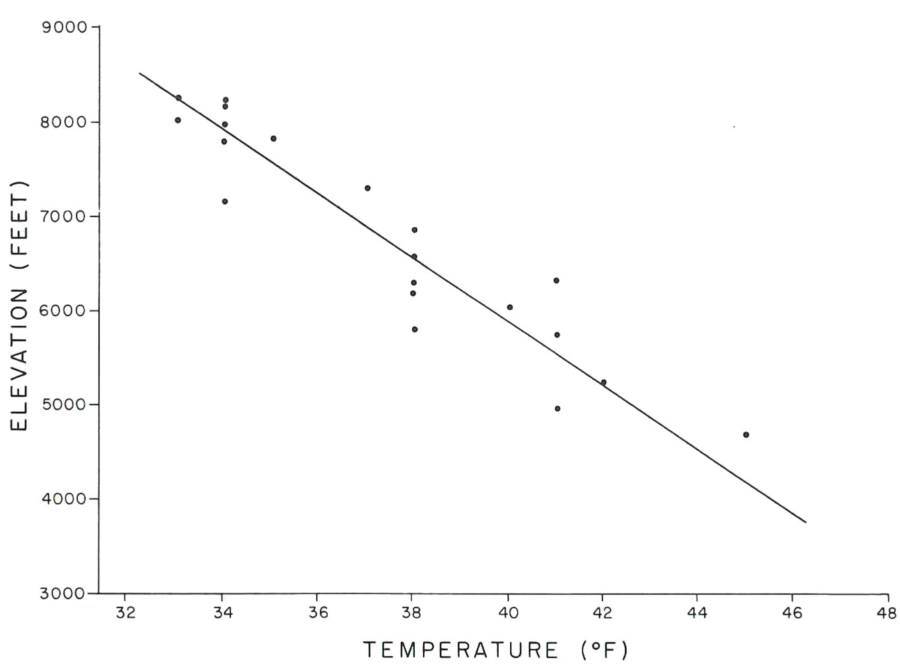


Figure 14.–Graph of cave temperatures of some Montana caves at varying elevations (all approximately latitude 47°). Reproduced by permission of the publisher from *Speleology*, by Moore and Nicholas, copyrighted by D. C. Heath and Company, Lexington, Massachusetts.

change, air may move into or out of the cave at a much faster rate, creating a wind.

A cave with two entrances, one higher than the other, may have air moving through it for a different reason. In winter the warmer air inside the cave flows out the top entrance and is displaced by colder air flowing in the bottom. In summer the cold cave air, being denser than surface air, flows out the bottom and is replaced by warmer air. Moore and Nicholas (1964) used this "chimney theory" to explain abnormally strong winds in some caves. Conn (1966), in an extensive study of Jewel and Wind Caves in South Dakota, found that strong winds were developed only as the result of barometric changes in surface air pressure. These caves developed strong winds at their entrances (with a slight delay) whenever a large change in barometric pressure occurred. Jewel Cave has only one known entrance, so the "chimney effect" could not account for this wind.

Fairly strong winds have been observed in Ophir, Granite Mountain, and Ram's Horn Cave in Montana, but no detailed studies have been made to determine the source of the wind.

AGE OF CAVERNS

Caves have been formed in rocks ranging in age from Precambrian to Recent, but the caves were probably not excavated until the last few million years. Caves are relatively unstable structures and tend to collapse or be filled with sediment in a short period of geologic time. Evidence suggests that several caves in Montana may have been preserved since the Paleozoic, but most caves in the United States are probably less than 10 million years old.

RELATIONSHIP TO GEOMORPHIC FEATURES

One of the best ways to date caves is to compare the development of the cave with the development of the surrounding surface features. For example, a cave formed on an uplifted peneplain is younger than that peneplain because uplift preceded the downcutting by surface streams and the consequent lowering of the water table. Stream terraces can also be used to date caves; Davies (1960) found that the levels of two caves in West Virginia matched surface-stream terrace levels. Each terrace corresponded to a cave level, and the ages of the terrace and the cave were equivalent; caves on the north end of the Bighorn Mountains may be dated by this method. Several caves on an old erosion surface can be dated as upper Miocene to Pliocene, according to Richards (1955, p. 80). Unfortunately, in other Montana mountain ranges exact dating of terraces is not always possible, and in some areas no erosion remnants are present to aid in age determination.

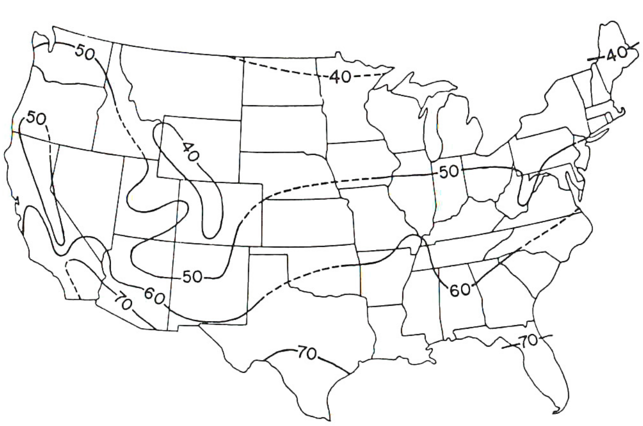


Figure 15.–Cave temperature map of part of the United States in degrees Fahrenheit. The temperature of a cave is approximately equal to the average annual temperature of its surroundings. (after Moore, 1964) Reproduced by permission of the publisher from *Speleology*, by Moore and Nicholas, copyrighted by D. C. Heath and Company, Lexington, Massachusetts.

Glacial features may help to date caves; caves older than Pleistocene may be filled with glacial debris if ice covered the cave area. Ford and Goodchild (1968) believed that such infilling took place in Nakimu Caves in southern British Columbia. C^{14} dating of the infilled material indicated a Pleistocene age. Caves younger than Pleistocene should contain no glacial debris. Probably some northern Montana caves were collapsed and filled by glacial action. Several caves in the northern Rocky Mountains and Sweetgrass Hills show evidence of partial infilling by glaciers.

Caves formed by gravity sliding can be dated if the cause of sliding is known. Where sliding can be attributed to periglacial activity, an age of Pleistocene is indicated. Most gravity sliding in Montana is thought to be very recent, as broken trees and displaced vegetation can be found associated with sliding.

CAVE DATING BY FOSSILS AND C^{14}

Using fossils for cave dating is generally unsuccessful. Fossils may give a minimum age for the cave, as they can indicate only how long the cave has been open to the surface. Caves may exist for long periods of time before becoming open to the surface. Because bone fragments can be washed in by surface streams, vertebrate fossils

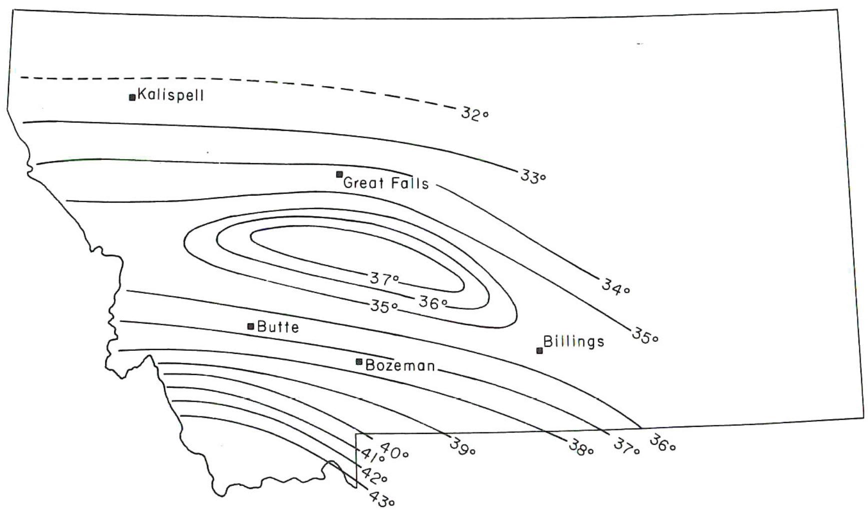


Figure 16.–Isotherm map of Montana showing the effect of latitude on cave temperature. (caves all at 7,000 feet elevation.)

must be found in place. Although vertebrate fossils have not been studied extensively in Montana, they have been used to date caves in the midwest. Hawksley (1966) described Pleistocene bear fossils from a Missouri cave; bears used the cave from Pleistocene to Recent. A descending age sequence of bear bones was found as the cave was excavated. These fossils, not moved since deposition, indicate that the cave must be older than Pleistocene. Natural Trap Cave, in northern Wyoming, has yielded fossils dated by Rushin (1973) as late Pliocene or younger.

Microfossils in cave sediments might be useful in dating caves, but no work has been done on cave microfossils except for a pollen study of some sinkhole ponds in Kentucky (Wright and others, 1966). Where successive layers of clay have built up, dating by microfossils might be useful. An attempt by the author to date cave fill using conodonts has so far been unsuccessful (Campbell, 1977).

Little work has been done using C^{14} methods, but this technique offers much promise for younger caves. Again, as with fossil dating, C^{14} gives only the minimum age of the cave. To the author's knowledge, no C^{14} dating has ever been attempted for Montana caves. Ford and others (1972) used U^{234} to date speleothems and caves in Canada. Dates of more than 400,000 years are possible using this method.

EXCAVATION OF OLDER KARST TERRANE

Many authors have recognized a karst plain at the top of the Madison Group (Mississippian) in Montana and Wyoming. Roberts (1966, p. 20) summarized those studies and presented conclusive evidence that karst must have been developed in Madison time.

Sinkholes as deep as 200 feet, now filled with limestone breccia and red clay, are found in the upper part of the Mission Canyon Member of the Madison Group. After the deposition of the Mission Canyon carbonate strata, the region must have been exposed to subaerial erosion for the karst topography to develop. The karst surface was formed no later than Mississippian, because red clay of the overlying Amsden and Kibbey Formations (Mississippian) fills many sinkholes; deposition of these formations destroyed many caves. Solution breccias filling collapsed caves and sinkholes have been reported by many authors, including Roberts (1966, p. 20). Some caves were not destroyed but were preserved by infilling of sediment from above.

Several authors (Schultz, 1969, p. 11; Deal, 1962, p. 128; and White, 1970, personal communication) have suggested that caves formed during Madison time remained buried until Tertiary time, when uplift and subsequent erosion exposed them to the surface. Re-excavation of sediment and additional enlargement have developed the caves to their present size.

Certain evidence tends to support these conclusions. First, sinkholes and caves containing Amsden or Kibbey clay and breccia have been found. Second, many caves in steeply dipping Mississippian limestone follow the dip of the bedding. Lillyguard Cave in the Little Belt Mountains is a good example. The dip of the Mission

Canyon Formation is 34°, and all cave passages are developed along the dip at an angle of 34° (Fig. 27, p. 50). This concordance is not usual in other areas where caves have developed in steeply dipping limestone. Davies (1960) and Moore and Nicholas (1964), in studying caverns in steeply dipping limestone, showed that caves form along the water table and develop horizontal passages across the bedding. The fact that many Montana caves do dip steeply with the bedding suggests that they formed when the bedding was still horizontal in pre-Laramide time.

In order to prove that the caves formed in Mississippian time, it is necessary to explain how the sediment was removed from the cave after uplift and erosion; two possibilities should be considered. First, the original cave may have been only partly filled with sediment. If portions of the unfilled passages were interconnected, then circulation of ground water after uplift could remove the fill and enlarge the cavern system. If parts of a Mississippian cave were unfilled, the cavern roof must have been strong enough to withstand the weight of overlying sediments until erosion removed the overburden in Tertiary time. By the same reasoning, many caves must still lie far underground, yet to be examined. Deal (1962) and Swenson (1968) support this theory.

Second, the caves may have been completely filled with sediment. Mining operations in the Pryor and Bighorn Mountains have uncovered solution cavities that are completely filled. Roofs of these caves seem to be supported by the infilling material. The problem of how the insoluble sediment is removed from a filled passage has not been completely solved, but White (1970, personal communication) has suggested that, after uplift, a hydrostatic head was generated that had sufficient force to push water through the cavern system with enough velocity to move the sediment. Work on sediment transport in limestone caves (White and White, 1968, p. 122-126) indicated that open channel flow is not necessary to move the sediment, but instead only enough velocity (in tenths of a foot per second) is required to create a shearing action. The shearing action of the ground water will drag sediment grains along as bedload or suspended load. Analysis of the sediment in six Montana caves showed that they contained an average of 24 percent soluble material (Campbell, 1977). Some of the fill may have been removed by solution, partly reopening the cave. The clay fill could then be removed by fast-moving water.

Caves containing blind pockets or channels filled with Pennsylvanian sediment cut off or bypassed by ground-water flow would indicate that re-excavation actually occurred. The material in these blind channels must be of proved Pennsylvanian age and not Recent sediment carried during re-excavation.

Whether all caves in the Madison Group are of this origin and age is doubtful, for passages in some caves are developed across the bedding and seem to correlate with surface stream terraces of Late Tertiary age. Many Mississippian caves do seem to be rejuvenated, however; these caves were probably formed in Late Mississippian and re-excavated sometime after the Laramide Revolution.

CAVE LOCATIONS AND DESCRIPTIONS

Montana caves can be grouped into four distinct geographical and geological regions: (1) central region (I), (2) Pryor-Bighorn region (II), (3) southwestern region (III), and (4) northwestern region (IV). Figure 1 divides the state by region and gives the location, by number, of every known cave.

CENTRAL REGION (I)

Caves in the central region are found in the Big Belt and Little Belt Mountains, the North and South Moccasin Mountains, the Big Snowy Mountains, the Judith Mountains, and the Little Rocky Mountains. Caves have also been found in the Dry Range (part of the Little Belts), 20 miles north of White Sulphur Springs.

Briefly, the mountains in this area are either domal or anticlinal, formed as a result of vertical uplift. The cores of most mountains are laccoliths or stocks exposed by erosion. Paleozoic and Mesozoic rocks flank the igneous core and dip steeply outward.

Most of the caves are in the Little Belt and Big Snowy Mountains, but each range has a few caves. Except for several small caves developed in Pleistocene travertine and two caves formed in the Jefferson Formation (Devonian), the Mission Canyon Formation of the Madison Group (Mississippian) is the host rock for every cave in the Central Region. The Madison Group averages about 1,200 feet in thickness in this area and is as much as 1,700 feet thick south of the Big Snowy Mountains.

Many caves are vertical, consisting of a single drop and no additional passages. A few larger caves have a network of passages and rooms, many of which developed downdip rather than across the bedding. Most passages end with silt or clay plugs and are littered with piles of breakdown. Most entrances are on top of cliffs or dip slopes; few cave entrances are at the base of limestone outcrops. One of the deepest caves in Montana (Ram's Horn Cave, -496 feet) as well as the deepest vertical shaft (Twin Sister—south shaft, -228 feet) are in Region I; and fifteen caves have single vertical drops exceeding 100 feet.

Speleothems are poorly developed in most caves and are almost limited to flowstone and popcorn, although Azure Cave in the Little Rockies contains abundant stalactites and stalagmites. A general description of each Region I cave follows.

CASCADE COUNTY

Belt Meteor Crater (Belt Sandstone Sink)

Cave no.:	27	Range:	Little Belt foothills
County:	Cascade	Map coverage:	Belt 1:62,500
Location:	sec. 14, T. 18 N., R. 6 E.	Altitude:	4,050 ft.

The Belt "Meteor Crater" is 5 miles south of Belt, on cliffs overlooking Belt Creek. The cave consists of a 150-foot-square sink that is 35 feet deep. The sinkhole developed in Kootenai Sandstone (Cretaceous) that strikes N. 40° W. and dips 7° SW. No limestone is visible at the base of the sink and, except for being developed in massive crossbedded sandstone, the depression looks like any solution sinkhole.

Numerous theories have been proposed to explain this feature, but none are completely satisfactory. The most logical explanation is that the sink formed from the collapse of a limestone cave underneath. The Ellis Formation underlies the Kootenai Formation in this area and does contain caves (see Flint Cave), but about 300 feet of Kootenai Formation is exposed in Belt Creek Canyon nearby, and the Ellis Formation is not visible there. Any cavern collapse would involve lowering several hundred feet of ceiling rock; this is unlikely because the carbonate part of the Ellis Formation is less than 50 feet thick.

Fresh-water carbonate rocks have been reported in the Kootenai. A layer of carbonate under the cave could account for the sandstone collapse, but no carbonate crops out in nearby Belt Creek Canyon.

The sandstone is too well cemented to "drain" out a fissure in the bottom of the sink, and no evidence indicates that a meteor caused the depression.

Big Baldy Cave

Cave no.:	277	Range:	Little Belt
County:	Cascade	Map coverage:	Yogo Peak 1:24,000
Location:	sec. 22, T. 13 N., R. 8 E.	Altitude:	10,000 ft.

This cave, as reported in the May 31, 1894, issue of the *Helena Western Herald,* was supposed to have been intersected by a mining tunnel driven into Big Baldy Mountain near Neihart, somewhere near the head of Snow Creek. The cave or fissure was reportedly ice filled and was not entered. The cave is thought to be near the contact of Mississippian and Precambrian rocks.

Flint Cave (J. B. Long Cave)

Cave no.:	26	Range:	Little Belt foothills
County:	Cascade	Map coverage:	Mahoney Hill 1:24,000
Location:	sec. 4, T. 18 N., R. 5 E.	Altitude:	3,750 ft.
		Temperature:	50° F

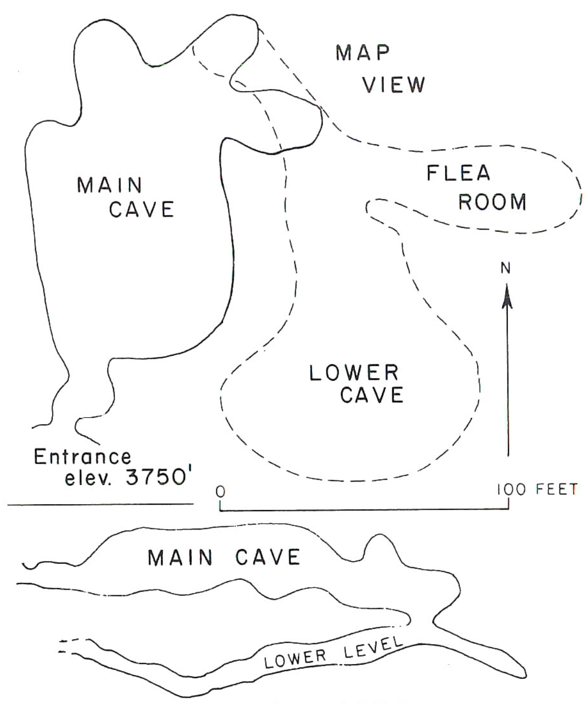


Figure 17.–Flint Cave

Flint Cave is about 7 miles southeast of Sand Coulee on the J. B. Long Ranch. The entrance is a 4- by 6-foot opening on a south-facing cliff. The cave contains two large rooms, an upper breakdown-filled room about 150 feet long and 30 feet high, and a lower room nearly filled with mud and breakdown.

The cave developed at the base of a 30-foot layer of massive gray limestone in the Ellis Formation (Jurassic). The lower level probably developed in a 5-foot layer of silty brown limestone below. The bedrock trends N. 60° E., 3° NW. The limestone is capped by massive sandstone, but no collapse of the sandstone has taken place. All of the breakdown in the cave is either carbonate material or clay.

One room supposedly contained abundant red "carrot-like" stalactites but these were not observed and may have been destroyed. Only a few broken speleothems remain.

Hunt Cave

Cave no.:	289	Range:	Little Belt
County:	Cascade	Map coverage:	Thunder Mountain 1:24,000
Location:	sec. 36, T. 15 N., R. 6 E.	Altitude:	7,200 ft.

This cave lies on the south side of Thunder Mountain in fairly heavy timber. The cave is supposed to be large but no other information is available. The cave probably developed in Cambrian carbonate rocks.

Lick Creek Cave

Cave no.:	23	Range:	Little Belt
County:	Cascade	Map coverage:	Evans 1:24,000
Location:	sec. 19, T. 16 N., R. 6 E.	Altitude:	5,805 ft.
		Temperature:	38°F

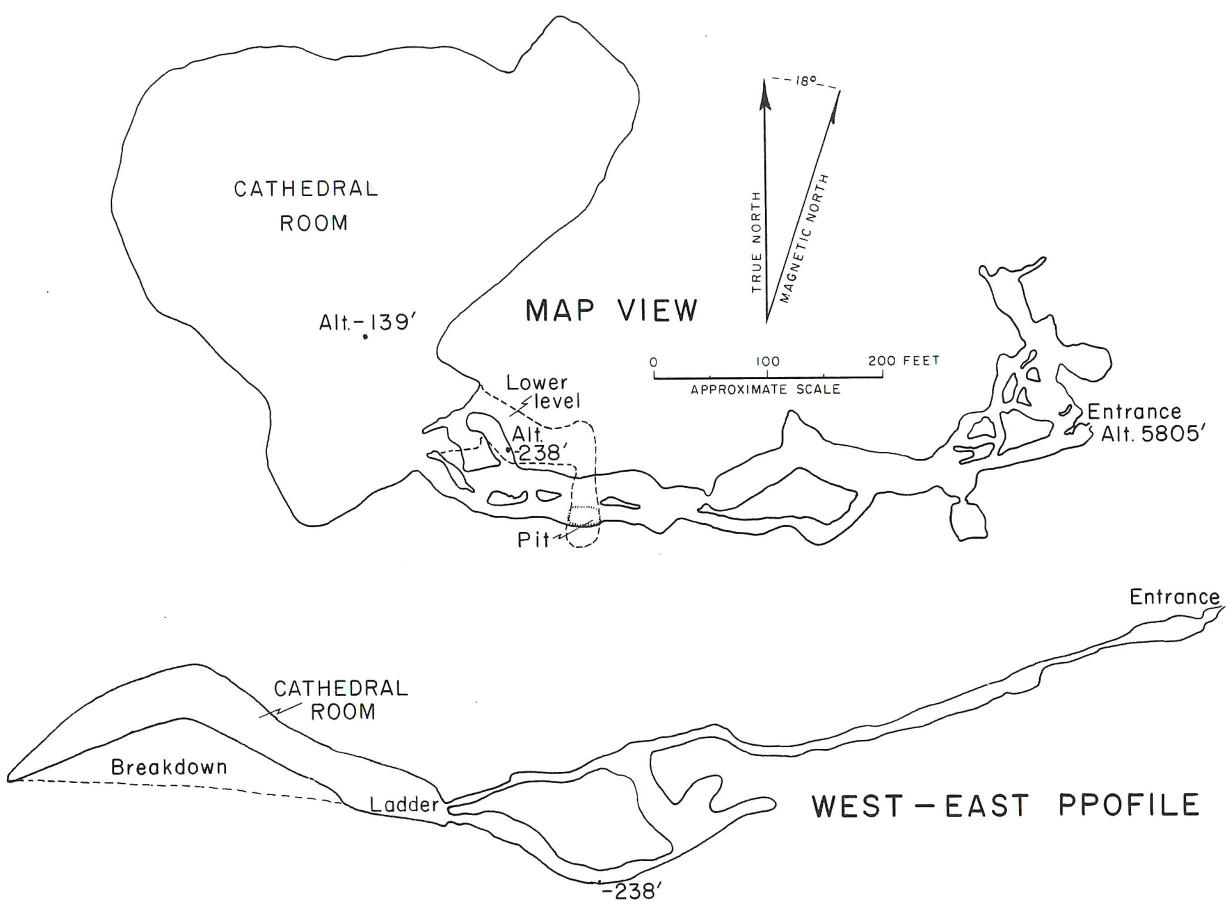


Figure 18.–Lick Creek Cave

This cave is 10 miles west of Monarch, on Logging Creek. The entrance is on an east-facing slope in light timber and has a 2- by 3-foot opening. The entrance leads to an interconnecting maze of passages that slope steeply downward for about 1,000 feet in a westward direction (Fig. 18). The passages eventually connect with the Cathedral Room—the largest room in Montana. It measures 405 by 465 feet and contains a huge pile of breakdown; one pit, about 40 feet deep, is the passageway to this large room. The Forest Service surveyed 2,741 feet of passage in the 1930's; a depth of 238 feet was reached.

The cave is controlled partly by joints and partly by the dip of the Madison Limestone (N. 25° E., 16° W.). The cave seems to be formed just beneath a solution-breccia zone in a massive carbonate layer about 20 feet thick. Collapse of the overlying breccia has covered the host rock in many places and left rooms and passages littered with breakdown. The permeability of the breccia may be less than that of the underlying carbonate, thus allowing ground water to be channeled downdip along a single layer.

Parts of the cave are still wet and muddy from vadose water. Speleothems consist mainly of popcorn, flowstone, and small stalactites—all heavily vandalized.

Logging Creek Cave

Cave no.:	264	Range:	Little Belt
County:	Cascade	Map coverage:	Great Falls 1:250,000
Location:	T. 15 N., R. 5 E. ?		

This cave is near Lick Creek Cave somewhere along Logging Creek. It is supposed to lie at creek level near an old flume and to contain a stream. It probably formed in Madison Group carbonate rocks.

Millegan Canyon Caves (Black Canyon Caves)

Cave no.:	25	Range:	Little Belt (Dry Range)
County:	Cascade	Map coverage:	Lingshire NE 1:24,000
Location:	sec. 10 or 11, T. 13 N., R. 3 E.	Altitude:	4,800 ft.

These caves are in Black Canyon on the Millegan road south of Great Falls. The caves (or rock shelters) formed high on the walls of the canyon in steep cliffs made up of Madison Group carbonate rocks. These caves are nearly inaccessible and may never have been entered.

Ming Coulee Cave

Cave no.:	24	Range:	Little Belt
County:	Cascade	Map coverage:	Great Falls 1:250,000
Location:	probably T. 17 N., R. 4 E.		

This cave is reported to be somewhere on the north side of Ming Coulee, about 20 miles south of Great Falls. The August 9, 1926, issue of the *Great Falls Tribune* mentioned a cave in this area. A thick section of Madison carbonate rocks can be found on both sides of Ming Coulee in this area.

Missile Caves

Cave no:	265	Range:	Little Belt
County:	Cascade	Map coverage:	Great Falls 1:250,000
Location:	T. 15 N., R. 8 E.	Altitude:	approximately 6,000 ft.

These small caves and rock shelters are near the A-4 "Minuteman" missile site east of Monarch; nothing else is known about them. They probably formed in Madison Group carbonate rocks.

Monarch Bear Cave

Cave no.:	17	Range:	Little Belt
County:	Cascade	Map coverage:	Monarch NE 1:24,000
Location:	sec. 30, T. 16 N., R. 7 E.	Altitude:	5,600 ft.

This cave is along the north rim of Belt Creek Canyon overlooking Monarch. The entrance is a small fissure about 15 feet deep, which is plugged at this level but seems to go deeper; debris would have to be removed. The cave formed in the Mission Canyon Formation.

Monarch-Belt Creek Caves

Cave no.:	18	Range:	Little Belt
County:	Cascade	Map coverage:	Great Falls 1:250,000
Location:	T. 16 N., R. 6 E.	Altitude:	approximately 5,000 ft.

These caves are a group of small holes and rock shelters along Belt Creek between Monarch and Riceville. They formed in the Mission Canyon Formation.

Monarch Grade Cave

Cave no.:	19	Range:	Little Belt
County:	Cascade	Map coverage:	Monarch NE 1:24,000
Location:	sec. 22, T. 16 N., R. 7 E.	Altitude:	5,400 ft.

This cave is a half mile north of Monarch, in a small east-trending coulee. The entrance is a 2-foot-square opening on a grassy slope near the head of the coulee.

The entrance widens into a 20-foot solution pit that is 79 feet deep. The bottom of the pit is filled with clay; the pit has no side passages. A small amount of flowstone is on the cave walls. The pit developed in horizontal Mission Canyon Formation.

Monarch Sink

Cave no.:	20	Range:	Little Belt
County:	Cascade	Map coverage:	Riceville 1:24,000
Location:	sec. 19, T. 16 N., R. 7 E.	Altitude:	5,600 ft.

This sinkhole is on the north rim of Belt Creek Canyon overlooking Monarch. The sink may be the largest in Montana; it measures 150 by 200 feet and is 50 feet deep. No passages lead from the bottom. A small pool of water remains in the bottom during most of the year; it was once used as a water source by homesteaders, and a collapsed pumphouse and pipe remain. The sink formed in nearly horizontal Mission Canyon Formation.

Otter Creek Cave

Cave no.:	28	Range:	Little Belt
County:	Cascade	Map coverage:	Great Falls 1:250,000
Location:	probably T. 16 N., R. 9 E.		

This cave is near the head of Otter Creek, according to an article in the November 11, 1885, *Great Falls Tribune*. The cave reportedly had a very small entrance, which opened into a

30-foot-square room walled with crystal speleothems. A pool of water was found in the room and several passages led off in various directions. The cave was not fully explored. A search in 1960 failed to locate this cave. It probably developed in Madison Group carbonate rocks.

Pilgrim Creek Cave

Cave no.:	21	Range:	Little Belt
County:	Cascade	Map coverage:	Great Falls 1:250,000
Location:	probably south half, T. 6 N., R. 6 E.		

This cave is on the ridge overlooking Pilgrim Creek to the north. Reports indicate that the cave is horizontal and extensive, but it has not been visited recently. The cave probably developed in Mission Canyon Formation.

Pine Tree Caves

Cave no.:	22	Range:	Little Belt
County:	Cascade	Map coverage:	Riceville 1:24,000
Location:	sec. 14, T. 16 N., R. 6 E.	Altitude:	4,800 ft.

These two caves are at the junction of Logging Creek road and Belt Creek. Each cave has a 20- by 30-foot entrance high on the cliffs of Belt Creek, and each has one room with no side passages; they formed in the Mission Canyon Formation.

Three Sisters Cave

Cave no.:	16	Range:	Little Belt
County:	Cascade	Map coverage:	Barker 1:62,500
Location:	sec. 15, T. 15 N., R. 8 E.	Altitude:	5,600 ft.

This cave lies between Hughesville and Monarch, in a canyon between Finn Creek and Smoke-in-Hole Creek. The entrance is a small sink that has a 20-foot pit at the bottom, which leads to a room containing a small lake at one end. Two other rooms are at the ends of short crawlways. The total length of the cave is about 200 feet. The cave is partly filled with clay and breakdown. A few stalactites and flowstone are the only speleothems present. The cave developed in the Madison Group (Mississippian).

Thunder Mountain Cave (Smoke Cave)

Cave no.:	15	Range:	Little Belt
County:	Cascade	Map coverage:	Thunder Mountain 1:24,000
Location:	sec. 16, T. 15 N., R. 7 E.		

This cave is near the top of Thunder Mountain near Monarch. An article in the February 8, 1925, *Great Falls Tribune* described the entrance as a twisting pit that often emits steam on cold mornings. The pit was reported to be about 200 feet deep and opened into a large room. About 10 feet below a small hole in the base of the room is a second room. Exploration was halted because of loose rock and lack of equipment. The cave was reported to be in black "volcanic rock".

The Thunder Mountain area contains Cambrian carbonate rocks and Tertiary intrusive rocks. The cave may be formed along the contact between the two rock types.

FERGUS COUNTY

Bear Park Bone Cave

Cave no.:	47	Range:	North Moccasin
County:	Fergus	Map coverage:	Lewistown 1:250,000
Location:	sec. 7, T. 17 N., R. 18 E.	Altitude:	4,600 ft.

This cave is near the south edge of Bear Park. The entrance is a 20-foot pit in one of the area's long easterly depressions. A ladder has been placed in the cave to ease descent. The cave consists of a narrow east-trending crack about 3 feet wide and 150 feet long. Bones of deer and buffalo formerly littered the floor of the cave. Several buffalo skulls have been removed and are on display at a local guest ranch.

This cave is one of many gravity-slide caves developed in the south end of the North Moccasin Mountains. All of the caves, formed in travertine deposits, are thought to be Pleistocene in age. The travertine, about 70 feet thick, is slowly sliding southward over Cretaceous shale, creating fissures and cracks. Collapse of the upper part of the fissures has created caves. The sliding movement is fast enough to bend and break trees; broken blocks of rubble below the cliffs show that the caves are rapidly being destroyed. A series of depressions indicates that new caves are forming as far back as ½ mile behind the cliff face.

Bear Park Sink (Bear Park Ice Cave)

Cave no.:	48	Range:	North Moccasin
County:	Fergus	Map coverage:	Lewistown 1:250,000
Location:	sec. 7, T. 17 N., R. 18 E.	Altitude:	4,605 ft.
		Temperature:	36°F

Bear Park Sink is near the south edge of Bear Park on the south end of the North Moccasin Mountains. The cave contains at least four entrances, all opening from a depression trending N. 30° E. The cave formed along this depression as a result of gravity sliding (see discussion, Bear Park Bone Cave). No vadose or phreatic solution features exist in this cave; features on one wall match up with those on the opposite wall. The main entrance is a 10-foot opening about 15 feet deep; its floor slopes downward to a somewhat flat-bottomed crack that is floored with about 1 foot of ice. Ice also coats boulders and the lower walls of the cave. The cave trends N. 30° E. for at least 394 feet. It formed in Pleistocene travertine. Meat racks hanging in the cave indicate that it is sometimes used for temporary cold storage.

Blake Creek Sink

Cave no.:	63	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 30, T. 12 N., R. 18 E.	Altitude:	8,025 ft.
		Temperature:	34°F

Blake Creek Sink, at the head of Blake Creek near the crest of the Big Snowy Mountains, is formed in Madison Limestone. The entrance is a 2-foot-square opening at the bottom of a 15-foot sinkhole. The cave is vertical, and rope is needed to enter. The entrance opens into a 30-foot wide crack; 70 feet down, the crack opens into a 30- by 80-foot room. The bottom of the room is filled with at least 3 feet of red mud. Side passages and speleothems are absent. The final 30 feet is a free drop and must be made in a small waterfall (a wetsuit is advised).

The cave seems to be developed along a single joint trending N. 20° E. Solution breccia of the Mission Canyon Formation is visible in the lower room.

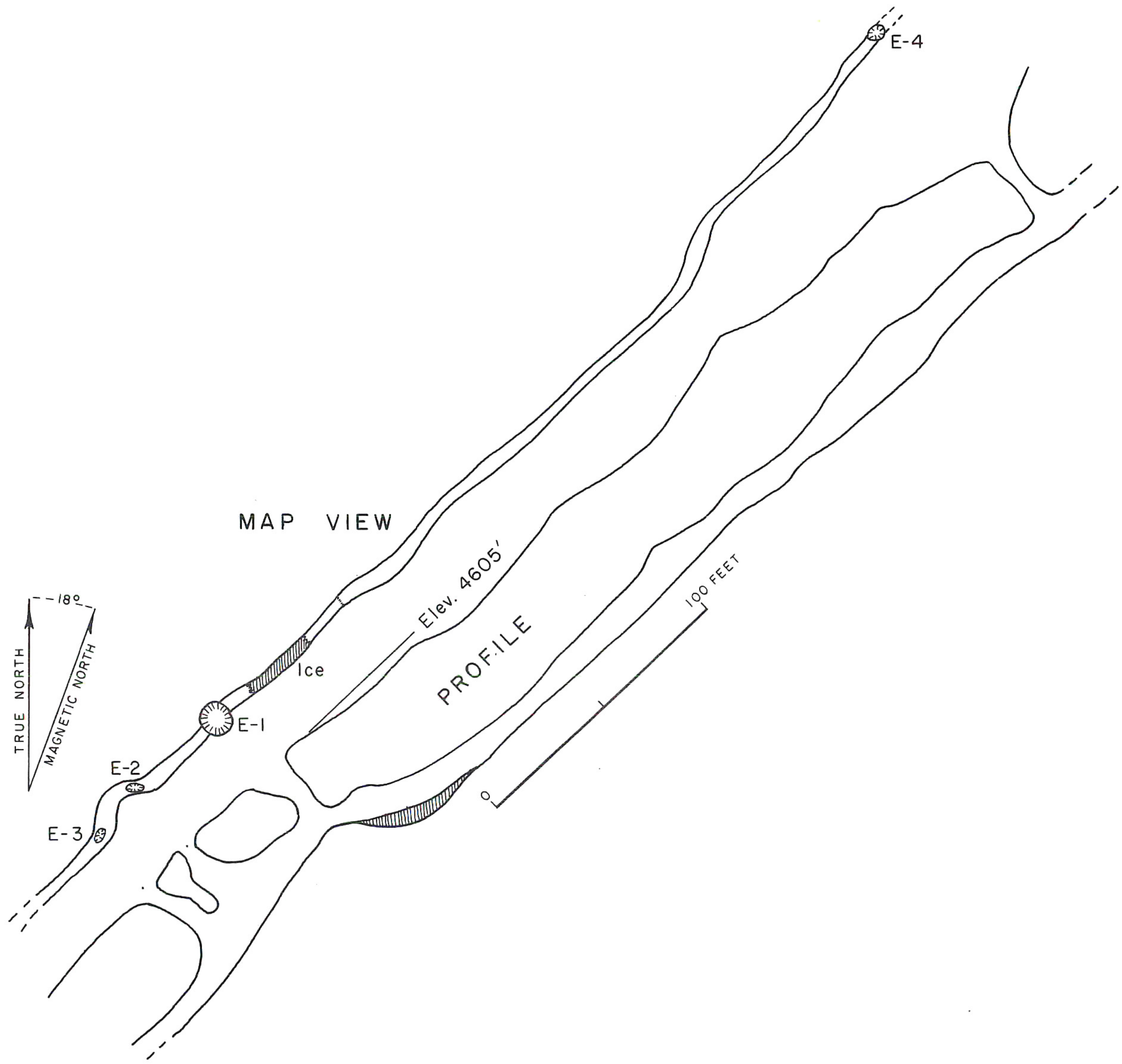


Figure 19.—Bear Park Sink

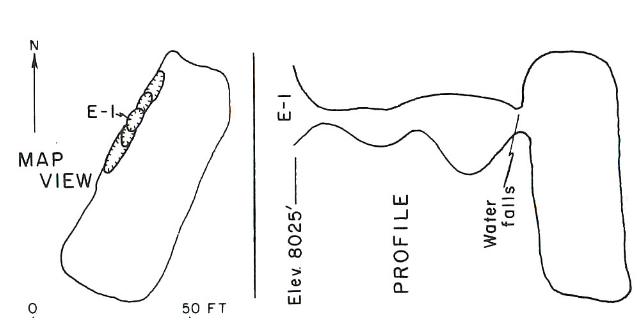


Figure 20.—Blake Creek Sink

Bone Cave (Snowy Mountain)

Cave no.:	66	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 34, T. 12 N., R. 18 W.	Altitude:	8,100 ft.

Bone Cave, east of the Timber Creek drainage along the summit trail, consists of a small sink with a 20-foot deep pit. Animal bones in the bottom of the pit seem to be those of deer and smaller animals of Recent age. The cave developed in flat-lying Madison Limestone.

Boneless Cave

Cave no.:	67	Range:	Big Snowy
County:	Fergus	Map coverage:	Crystal Lake 1:24,000
Location:	sec. 26, T. 12 N., R. 17 E.	Altitude:	8,125 ft.
		Temperature:	40°F

Boneless Cave is a small solution pit west of the Ice Cave near the summit trail. The entrance is a 5-foot sink that has a 10- by 2-foot crack at the bottom. The crack is about 10 feet deep but rock blockage prevents access to a larger fissure beneath. The cave developed in Mission Canyon Limestone that strikes N. 35° W., and dips 11° NE.

Bottomless Pit

Cave no.:	83	Range:	Big Snowy
County:	Fergus	Map coverage:	Half Moon Canyon 1:24,000
Location:	sec. 30, T. 12 N., R. 19 E.	Altitude:	8,200 ft.

Bottomless Pit lies on the summit trail near the northern edge of Knife Blade Ridge. The entrance lies beneath a low ledge and is about 5 feet wide and 10 feet long. The opeining leads to a 100-foot pit that bells out downward to form a 50-foot room at the bottom. A talus slope at the bottom suggests a connection with a nearby sink. A small hole in the east end of the room leads downward to a sloping crawlway, which ends in breakdown at a depth of 127 feet.

The cave has a long history of unsuccessful attempts to reach bottom. At one time, a winch was constructed to lower a man to the bottom. When the cave was fully explored in 1960, remains of the old winch were found, along with a Forest Service sign reading "Jefferson National Forest–The Bottomless Pit–Don't Fall In!! - Be Careful!!!" Cattle bones were found at the base of the pit. No speleothems were observed.

The cave is formed in flat-lying Mission Canyon Formation, but the platy limestone and silt interbeds in the lower crawlway suggest that the cave bottom is in the Lodgepole Formation. Solution probably took place along an east-trending joint that was gradually enlarged to its present size.

Boy Scout Cave

Cave no.:	82	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 26, T. 12 N., R. 18 E.	Altitude:	8,250 ft.

Boy Scout Cave is on the crest of the Big Snowy Mountains north of Windy Peak. The entrance is a 3-foot high by 5-foot wide opening under a low ledge. The cave is horizontal and consists of a single room 100 feet long, 50 feet wide, and less than 5 feet high. The cave was first found by a group of Boy Scouts on a mid-winter snow survey. A few soda straws decorate the ceiling of the cave, and breakdown fills most of the room. The cave formed in the Madison Group along a single bed of limestone.

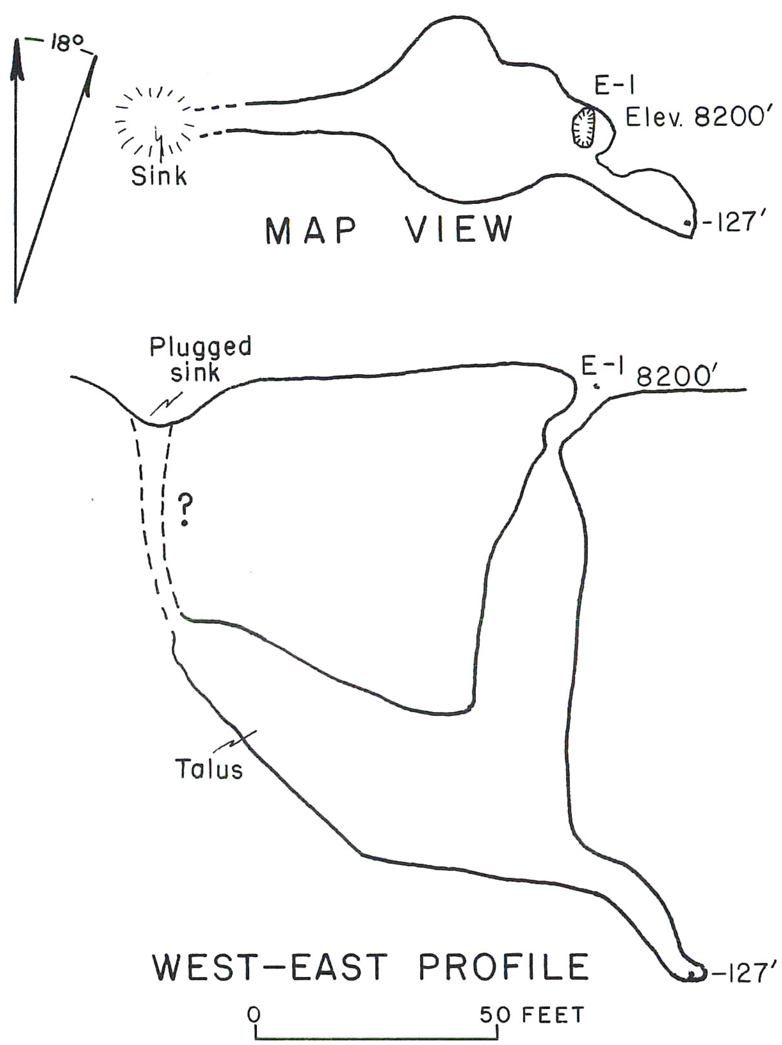


Figure 21.–Bottomless Pit

Brown's Coulee Cave

Cave no.:	54	Range:	Big Snowy
County:	Fergus	Map coverage:	Crystal Lake 1:24,000
Location:	sec. 22, T. 12 N., R. 17 E.	Altitude:	8,150 ft.

This cave is supposed to be at the head of the west fork of Neil Creek Canyon (Brown's Coulee) near the mountain crest. The entrance is reported to be a small hole less than 5 feet in diameter and in light timber. The cave, found by hunters, is said to be a very deep pit; a search in 1961 failed to locate it. Snowslide Cave lies near Brown's Coulee and may be the same cave.

The Chasm (Chasm in the Snowies)

Cave no.:	58	Range:	Big Snowy
County:	Fergus	Map coverage:	Crystal Lake 1:24,000
Location:	sec. 25, T. 12 N., R. 17 E.	Altitude:	7,775 ft.
		Temperature:	40°F

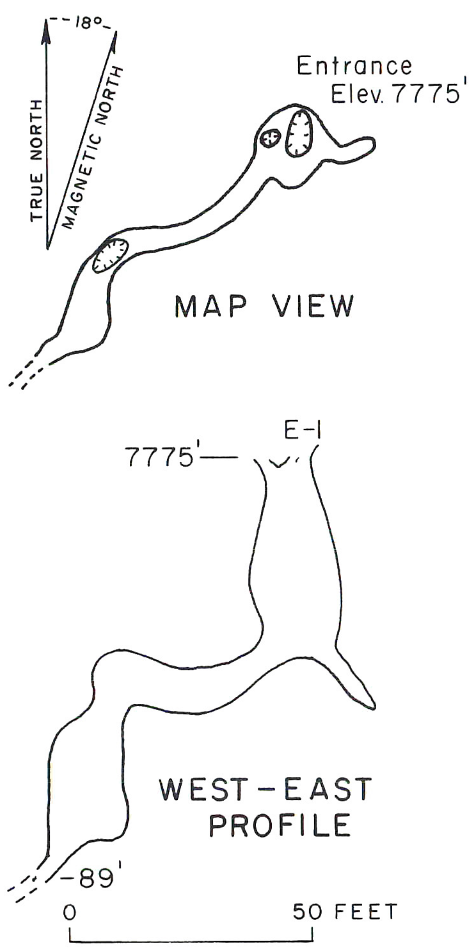


Figure 22.–The Chasm

The Chasm is about 300 feet east of the Snowy Mountain Ice Cave in the middle of a talus slope. The entrance is a 3-foot opening that bells outward to form a 20-foot-wide pit that is 42 feet deep. From the base of the pit, a southwest-trending crack continues and eventually feeds into a 28-foot pit. The bottom of the second pit is choked with rubble and contains a small intermittent stream.

The cave was first explored in 1941 by Ranger Berle Davis, who stated that other pits to the east could connect with this one. A search in 1961 failed to locate any nearby caves or connections.

The Chasm developed in Mission Canyon Formation, which here strikes N. 35° W. and dips 11° NE. The cave developed along a single joint that trends S. 50° W. Although solution breccia was observed in outcrop less than 100 feet away, none was observed in the cave. The cave is rapidly being destroyed by headward erosion of the west fork of Blake Creek. When visited in 1970, collapse of the roof had opened a second entrance; no speleothems were observed.

Crystal Cave, New Year (Judith Crystal Cave, New Year Mine Cave)

Cave no.:	87	Range:	Judith
County:	Fergus	Map coverage:	Lewistown 1:62,500
Location:	sec. 11, T. 16 N., R. 19 E.	Altitude:	5,000 ± ft.

This cave is in the New Year mine at the ghost town of New Year about 15 miles northeast of Lewistown. The main adit of the New Year mine intersected the cave, but the mine is now collapsed and the cave is not accessible. The cave was reported (old WPA Guidebook) to be large; one room was said to be more than 300 feet long and to contain cave popcorn and calcite crystals. The cave formed in Madison Group carbonate rocks.

Devil's Chute Cave (Ice Cave No. 2, New Ice Cave)

Cave no.:	59	Range:	Big Snowy
County:	Fergus	Map coverage:	Crystal Lake 1:24,000
Location:	sec. 25, T. 12 N., R. 17 E.	Altitude:	8,025 ft.
		Temperature:	33°F

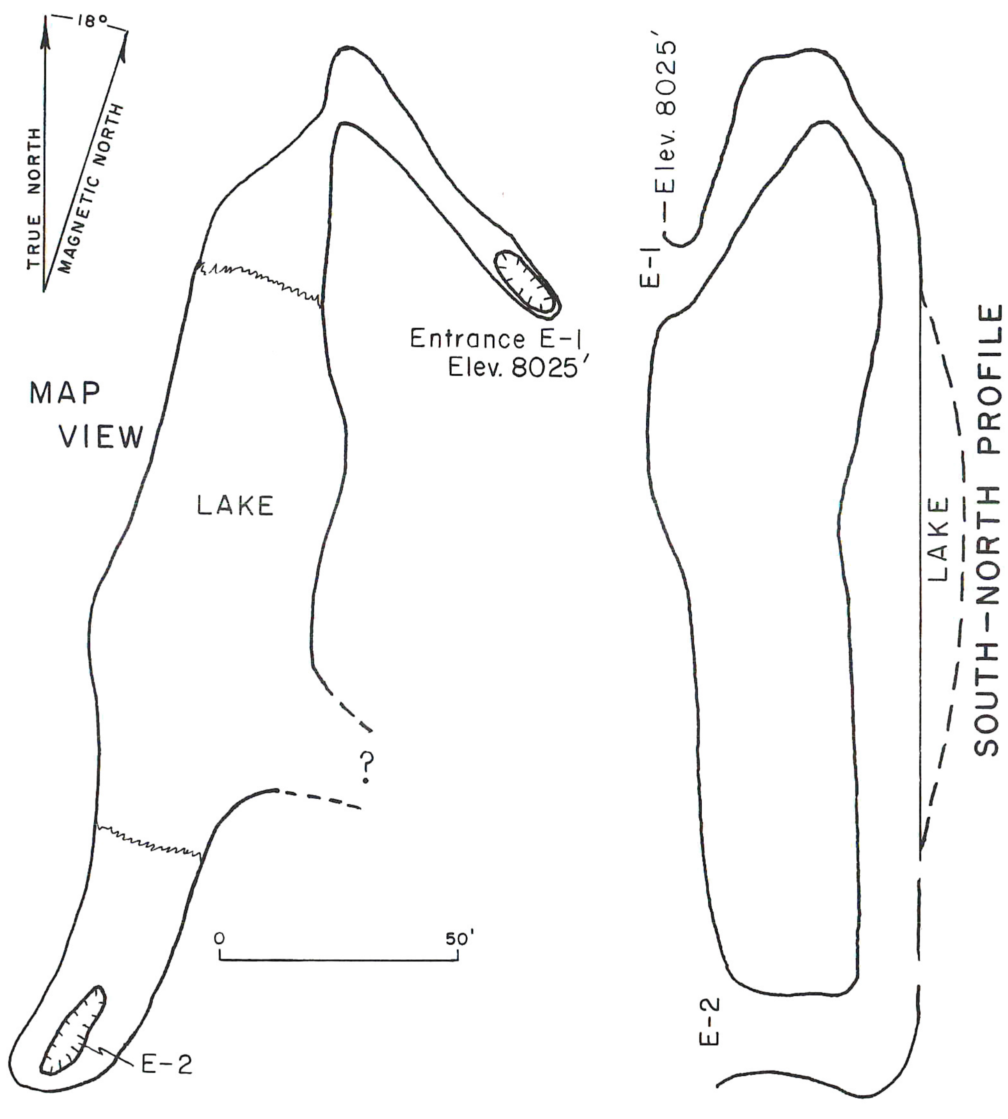


Figure 23.—Devil's Chute Cave

Devil's Chute Cave is about a half mile east of Snowy Mountain Ice Cave near the summit trail and has two entrances, one a walk-in opening, the other a vertical pit. The walk-in entrance is a 5- by 15-foot opening that slopes steeply downward to a 100- by 50-foot room that contains a lake. The lake is at least 5 feet deep but the bottom is usually obscured by ice. The vertical entrance, 33 feet deep, opens to the opposite side of the lake. Some ice stalactites hang from the ceiling.

The cave developed in the solution-breccia part of the Mission Canyon Formation. The breccia zone, which is about 50 feet thick here, controls the depth of the cave.

Dry Pole Sink

Cave no:	56	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 23, T. 12 N., R. 18 E.	Altitude:	7,950 ft.

This cave is at the extreme head of Dry Pole Creek about a half mile north of West Peak. The entrance is a 10-foot sink with a 20-foot pit; rope is necessary to enter. The cave has never been entered but could connect with a large plugged sink to the south. The cave developed in flat-lying Mission Canyon Limestone.

Forgotten Sink

Cave no.:	68	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	probably sec. 34, T. 12 N., R. 18 E.		

This cave is probably one of the many sinkholes that lie on the Big Snowy crest near Trailside Cave, but no other information is available. The sink developed in Madison Group carbonate rocks.

Gopher Hole

Cave no.:	69	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 34, T. 12 N., R. 18 E.	Altitude:	8,200 ft.

The Gopher Hole is a small cave near the summit trail east of the Big Timber Creek drainage. The entrance is a 1-foot-wide crack that slopes steeply downward for 33 feet. The bottom of the crack is choked with debris. The cave formed in Mission Canyon Formation along a single vertical joint.

Hay Canyon Cave

Cave no.:	60	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 10, T. 12 N., R. 18 E.		

This cave lies somewhere on the north side of Hay Canyon near Lime Cave. It was reported to be horizontal and fairly large. A search for this cave was made in 1961 but was unsuccessful.

Honeywell Cave

Cave no.:	51	Range:	North Moccasin
County:	Fergus	Map coverage:	Lewistown 1:250,000
Location:	sec. 23, T. 18 N., R. 17 E.	Altitude:	4,750 ft.

This cave is on the west side of the North Moccasin Mountains, about 3 miles east of the Archie Honeywell ranch. The cave, found by Honeywell, lies in heavy timber about halfway up the west side of the mountain. The entrance is a 5-foot hole that drops for an unknown distance. Honeywell estimated the depth of the pit at more than 100 feet. The cave formed in Mission

Canyon Formation that strikes north and dips 85° west. Total relief between the cave entrance and the valley floor nearby is more than 300 feet, so the cave could be deep. To date, no attempt has been made to descend the pit.

Hunter's Hole

Cave no.:	70	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 34, T. 12 N., R. 18 E.		

This cave lies somewhere on the summit crest trail in the Windy Peak area. The cave, found by hunters, is supposed to be vertical and deep. A search for it in 1961 was unsuccessful; it may have been confused with Trailside Cave.

Snowy Mountain Ice Cave (Snowy Cavern, Ice Cave No. 1, Old Ice Cave)

Cave no.:	57	Range:	Big Snowy
County:	Fergus	Map coverage:	Crystal Lake 1:24,000
Location:	sec. 25, T. 12 N., R. 17 E.	Altitude:	7,750 ft.
		Temperature:	34°F

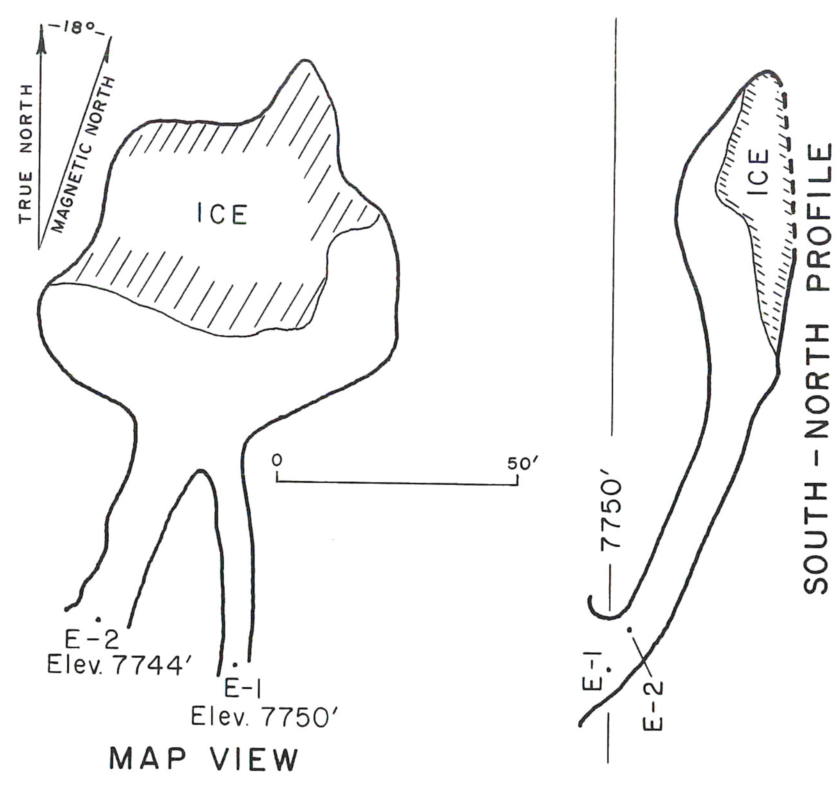


Figure 24.–Snowy Mountain Ice Cave.

This cave lies at the summit of the Big Snowy Mountains about a half mile east of West Peak. It has two south-facing entrances, both 5 by 10 feet, which slope steeply downward to a room about 100 feet long and 75 feet wide. The lower half is filled with ice, which varies in thickness from 12 feet in early spring to about 5 feet in late fall. Ice stalactites and stalagmites are present but ice crystals are rare.

The cave was once used as a water hole for sheep when grazing was allowed on the mountaintop. A few rusty pieces of pipe are all that remain of the pumping system used to raise water 50 feet to troughs above the cave.

The cave developed in or just under a well-developed solution-breccia zone in the Mission Canyon Formation. Angular fragments of gray dolomitic limestone as large as 2 feet across are cemented by red calcareous siltstone. The tight seal formed by this breccia is probably the reason for ice forming in the cave. The breccia seal prevents cold air from escaping and allows ice to remain all year. The bottle-shaped cave, its entrances high above the room level, presents a classic configuration for a typical ice cave (see map).

Jaw Bone Cave

Cave no.:	71	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 27, T. 12 N., R. 18 E.	Altitude:	8,250 ft.

This cave lies near the summit trail northeast of the Timber Creek drainage. The cave consists of a sink 5 feet wide and 20 feet deep; the bottom is plugged with red clay. Many bone fragments, among them several jawbones, lie on the cave floor. The bones seem to be from sheep and deer. The cave formed in horizontal Mission Canyon Formation.

Judith Mountain Ice Cave

Cave no.:	88	Range:	Judith
County:	Fergus	Map coverage:	Lewistown 1:62,500
Location:	probably sec. 23, T. 17 N., R. 19 E.		

The cave is reported to be on Judith Peak in the Judith Mountains north of Lewistown. A search in 1960 did not find this cave but did uncover an abandoned mine adit half filled with ice. Because the peak is composed of igneous rock, the "ice cave" may actually be the ice-filled adit. The mine is in shattered syenite porphyry; the first 150 feet of the adit is covered by about 3 feet of ice.

Kelly Hole

Cave no.:	86	Range:	Judith
County:	Fergus	Map coverage:	Lewistown 1:62,500
Location:	sec. 35, T. 16 N., R. 19 E.	Altitude:	4,900 ft.

This cave lies on the north side of Kelly Hill, about 10 miles east of Lewistown. Kelly Hill is in part made up of a Recent travertine deposit about 75 feet thick. Gravity sliding has cracked the travertine, forming a series of fissures and depressions. Most of the fissures are small and inaccessible, but a few can be entered. Kelly Hole has been reported to be more than 100 feet deep, but a search of the area in 1960 failed to find any fissure more than 20 feet deep.

Lime Cave

Cave no.:	62	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 2, T. 12 N., R. 18 E.	Altitude:	7,010 ft.

This cave is on the north side of Hay Canyon just below the canyon rim. The entrance is a low crawlway 2 feet high and 8 feet wide that opens into a small room. The rest of the cave has a cracklike appearance and runs northward for nearly 300 feet. The crack is not vertical but dips 75° westward and ranges from 1 to 4 feet in width. The floor of the cave is uneven and drops or rises in 5- to 10-foot ledges; height of the cave is about 20 feet.

The cave developed along a single joint in north-dipping Madison Group carbonate rocks. Lime Cave contains the best moonmilk speleothems in Montana. Moonmilk is a wet, spongy mass of $CaCO_3$, usually white, from which water can be squeezed. One entire side of the cave is coated with moonmilk. No other speleothems exist in the cave.

Lime Kiln Cave (Hell's Half Acre Cave)

Cave no.:	85	Range:	Judith
County:	Fergus	Map coverage:	Lewistown 1:62,500
Location:	sec. 20(?), T. 16 N., R. 19 E.		

This cave, near Lewistown, is near the head of the Lime Kiln Gulch in an area known as Hell's Half Acre, which developed in Madison Group carbonate rocks.

Several conflicting reports have been submitted regarding the cave. One report states that it is an ice cave. Originally found by Boy Scouts, the cave has remained almost unvisited. It is supposed to be small and difficult to find.

Little Snowy Mountain Cave

Cave no.:	84	Range:	Little Snowy
County:	Fergus	Map coverage:	Roundup 1:250,000
Location:	probably T. 11 N., R. 21 E.		

This cave is on the property of A. W. Eiselein of Roundup. Little is known about the cave, and permission to visit is difficult to obtain. One report states that the cave is a 10- to 15-foot-deep crack in sandstone; a second report mentions H_2S and CO_2 gases emanating from the cave mouth. More than one cave may exist in the Little Snowy Mountain area, but no other information is available.

Moss Cave

Cave no.:	72	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak
Location:	sec. 29, T. 12 N., R. 18 E.	Altitude:	8,210 ft.

This cave is north of the summit trail between Blake Creek and Timber Creek. The entrance is a 3- by 10-foot crack about 20 feet deep. At the bottom is a smaller fissure too narrow to enter, that is visible for 15 feet. Rocks dropped in the fissure roll and bounce for at least 50 feet. The cave seems to widen at depth but has not been explored beyond the 20-foot level. The inside of the sink is coated with a moss-like lichen. The cave formed in horizontal Mission Canyon Formation.

Nearside Cave

Cave no.:	73	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 34 or 35, T. 12 N., R. 18 W.	Altitude:	approximately 8,200 ft.

This cave is near the summit trail in the Windy Peak area. No other information is available.

No-Name Cave

Cave no.:	74	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 34(?), T. 12 N., R. 18 E.	Altitude:	approximately 8,100 ft.

No-Name Cave reportedly is east of the Timber Creek drainage at the Snowy Mountain summit. No other information is available.

North Moccasin Caves

Cave no.:	50	Range:	North Moccasin
County:	Fergus	Map coverage:	Lewistown 1:250,000
Location:	sec. 7, 8, 12, T. 17 N., R. 17 E.	Altitude:	approximately 4,600 ft.

These caves are a series of east-trending cracks and fissures developed in Pleistocene travertine, which forms a flat bench on the south side of the North Moccasin Mountains that is known as Bear Park. The travertine, overlying Cretaceous shale, is slowly sliding southward. Fissures from sliding are visible along cliffs making up the south edge of Bear Park and can be found as far as ½ mile behind the cliff face. Some of the fissures are collapsed and filled, but many can be entered to a depth of 50 feet.

The caves known as Travertine Cave, Bear Park Sink, Ice Cave, and The Slot are all included in this group of gravity-slide caves. Many other caves in the area are unnamed, and some have never been entered.

The Slot (No. 1 and No. 2)

Cave no.:	49	Range:	North Moccasin
County:	Fergus	Map coverage:	Lewistown 1:250,000
Location:	sec. 12, T. 17 N., R. 17 E.	Altitude:	4,600 ft.

These are gravity-slide caves (discussed under North Moccasin Caves) that consist of narrow fissures 1 to 2 feet wide and 30 to 40 feet deep and that parallel (N. 80° E.) the escarpment developed by sliding travertine blocks (Pleistocene). Part of the upper 10 feet of each fissure is clogged with debris, which gives the effect of a single cave with multiple openings. Other fissures nearby (The Slot No. 3, No. 4, etc.) have never been entered; they have the same origin.

Slow Hole

Cave no.:	75	Range:	Big Snowy
County:	Fergus	Map coverage:	Crystal Lake 1:24,000
Location:	probably sec. 25, T. 12 N., R. 17 E.	Altitude:	approximately 8,100 ft.

This cave is at the summit of the Snowy Mountains. No other information is available.

Snake Hole

Cave no.:	76	Range:	Big Snowy
County:	Fergus	Map coverage:	Roundup 1:250,000
Location:	T. 12 N., R. 18 E.		

Snake Hole lies somewhere on the east end of the Big Snowy Mountains at the summit. No other information is available.

Snow Chute Cave

Cave no.:	55	Range:	Big Snowy
County:	Fergus	Map coverage:	Crystal Lake 1:24,000
Location:	sec. 26, T. 12 N., R. 17 E.	Altitude:	8,220 ft.
		Temperature:	34°F

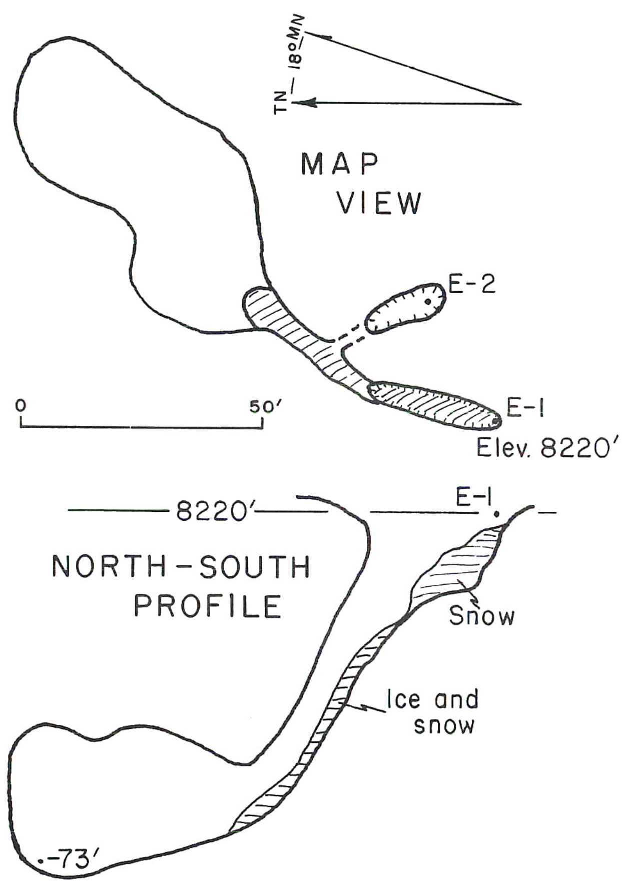


Figure 25.–Snow Chute Cave

Snow Chute Cave is at the summit of West Peak and has two entrances. The south entrance is too narrow to enter, but the north entrance has a 5- by 20-foot opening that trends N. 25° E. The entrance opens at the top of a 30- by 82-foot room, and the descent can usually be made down a long snow and ice slope. The entrance is often blocked by snow during early spring, and ice is present in the entrance all year. No side passages lead from the large room below.

The cave developed in solution breccia of the Mission Canyon Formation and seems to be formed along a joint trending N. 25° E. The cave has no speleothems.

South Moccasin Cave

Cave no.:	53	Range:	South Moccasin
County:	Fergus	Map coverage:	Spring Creek Junction 1:24,000
Location:	sec. 34, T. 17 N., R. 17 E.	Altitude:	4,700 ft.

This cave is on the northwest side of the mountain in a heavily wooded canyon. A natural bridge stands near the entrance and may once have been part of the cave. The entrance is a 2- by 2-foot hole that slopes steeply downward to a large room. Total length of the cave is about 150 feet. When visited in the winter of 1959, fresh cougar tracks were observed at the entrance; chewed bones inside indicated that the cave was used as a den. Twenty bats were counted, but the species was not identified.

The cave formed in Mission Canyon Formation that here strikes N. 40° E. and dips 42° NW. There are no speleothems in the cave.

Stalactite Cave

Cave no.:	61	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	probably sec. 10, T. 12 N., R. 18 E.	Altitude:	Approximately 6,500 ft.

This cave, on the north side of the Snowy Mountains in the Jump Off Peak area was found by ranchers fighting a fire on Jump Off Peak. The entrance was said to be small but it abruptly opened into a large room containing numerous stalactites. Several side passages were observed but none were entered.

A search in 1961 located the old burn but not the cave. This cave may contain the only sizeable speleothems ever found in the Big Snowy Mountains. It probably formed in Madison Group carbonate rocks.

Timber Creek Sink

Cave no.:	77	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 34, T. 12 N., R. 18 E.	Altitude:	8,175 ft.
		Temperature:	34°F

Timber Creek Sink lies at the extreme head of Timber Creek south of the summit trail. The entrance is a 30-foot sink clogged with breakdown. A small hole under the breakdown leads to a low 15-foot crawlway. At the end of the crawlway is an 80-foot pit with a second 30-foot pit leading off the bottom. Rope is required to descend both pits. Water as much as 2 feet deep lies at the bottom of the upper pit. Timber Creek Sink is the deepest known cave in the Big Snowy Mountains.

The cave developed along a N. 62° E.-trending joint in Madison Group rock. Many gastropods, crinoids, brachiopods, and bryozoans were found "weathering out" of the cave walls. Snow usually lies in the sink until late summer. Wet conditions and unstable rock make this the most difficult cave to explore in the Big Snowy Mountains.

Tin Can Sink

Cave no.:	64	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 29, T. 12 N., R. 18 E.	Altitude:	8,100 ft.

Tin Can Sink lies in heavy timber at the crest of the Big Snowies and along the summit trail. The entrance is a 5-foot sink about 15 feet deep. Tin cans, rotten timber, and rocks clog the sink at this point but the cave seems to be deeper. The sink was probably used by

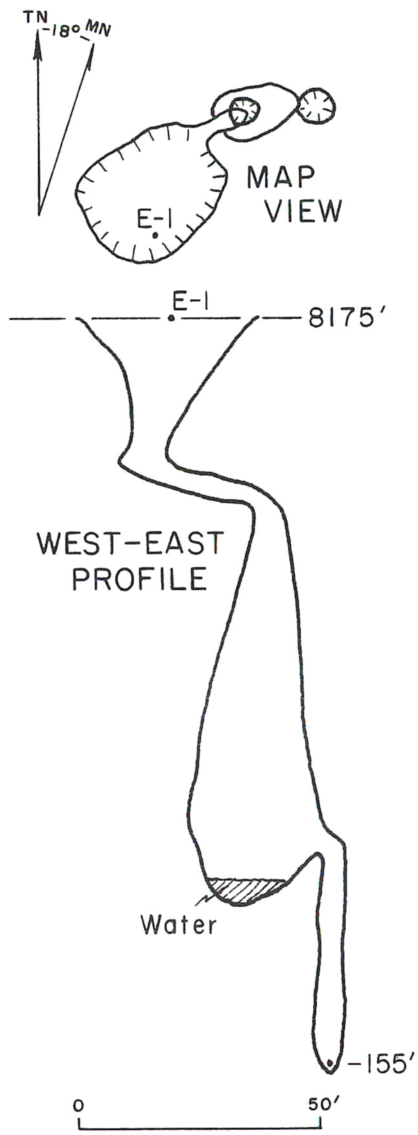


Figure 26.–Timber Creek Sink

the Civilian Conservation Corps as a garbage dump during construction of the summit trail in the 1930's. The cave formed in horizontal Mission Canyon Formation.

Too-Tight Cave

Cave no.:	78	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 28, T. 12 N., R. 18 E.	Altitude:	8,150 ft.

This cave is near the summit trail in the cluster of sinkholes east of Timber Creek drainage. The entrance is a narrow fissure that slopes steeply northward and narrows to a 2-foot-high crawlway. The crawlway continues to a depth of 35 feet, where it narrows to a 6-inch crack. The cave formed in nearly horizontal Mission Canyon Formation.

Trailside Cave

Cave no.:	65	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 34, T. 12 N., R. 18 E.	Altitude:	8,250 ft.

Trailside Cave, a sink, is on the summit trail near Windy Point. The entrance is a 20-foot sink that drops vertically for an unknown depth. The snow- and ice-filled entrance is accessible only in late summer. Although it has never been entered, the pit is known to be at least 75 feet deep. The pit bottom is usually concealed by an overhanging cornice of snow, but there is a good possibility that the cave has a second vertical drop below the entrance pit. Trailside Cave developed in Mission Canyon Formation; the formation in this area strikes due east and dips 8° north. This and several other smaller sinks nearby seem to be formed along a series of north-trending joints.

Travertine Cave

Cave no.:	52	Range:	North Moccasin
County:	Fergus	Map coverage:	Lewistown 1:250,000
Location:	sec. 7, T. 17 N., R. 18 E.	Altitude:	4,600 ft.

This cave is one of the many gravity-slide fissures found at the south end of the North Moccasin Mountains (see discussion, North Moccasin Caves). The entrance is a 1-foot crack in a small gully about 200 feet from the escarpment that forms the south side of Bear Park. The cave has been explored for about 150 feet, where it becomes plugged with breakdown. This cave formed in Pleistocene travertine.

Twin Room Cave and Sink

Cave no.:	80 and 81	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 25, T. 12 N., R. 18 E.	Altitude:	8,325 ft.

This cave and nearby sinkhole are close to the Snow Saucer, a cirque-like canyon on the south side of the Big Snowy Mountains. The system is said to contain one large room and a pit; other details are lacking. The cave formed in Madison Group carbonate rocks.

Under Trail Cave

Cave no.:	79	Range:	Big Snowy
County:	Fergus	Map coverage:	Jump Off Peak 1:24,000
Location:	sec. 34, T. 12 N., R. 18 E.	Altitude:	8,250 ft.

This small cave lies in the Windy Peak area on the summit trail. The entrance is a small sink open to the south. The cave consists of a sloping crawlway 45 feet long and 25 feet deep that runs under the summit trail. The cave developed along a single joint in horizontal Mission Canyon Limestone.

West Peak Cave

Cave no.:	287	Range:	Big Snowy
County:	Fergus	Map coverage:	Crystal Lake 1:24,000
Location:	sec. 26, T. 12 N., R. 17 E.	Altitude:	8,220 ft.

West Peak Cave is a small solution pit about 3 feet wide by 5 feet long by 20 feet deep. The bottom of the pit connects with a N. 10° E.-trending crack too small to enter. The crack drops off to an unknown depth. Deer and sheep bones now litter the floor of the pit. The cave, formed by solution enlargment of a N. 10° E.-trending joint, developed in Mission Canyon Formation that here strikes N. 55° W. and dips 10° SW.

JUDITH BASIN COUNTY

Bower Canyon Sink (South Fork Bone Cave)

Cave no.:	39	Range:	Little Belt
County:	Judith Basin	Map coverage:	Indian Hill 1:24,000
Location:	sec. 7, T. 12 N., R. 12 E.	Altitude:	5,400 ft.

This cave, near the south fork of the Judith River at the head of Bower Canyon, has its entrance on a grassy knoll on the east side of the canyon rim. The cave is accessible through a small hole in the ceiling of a 40-foot diameter room; rope is required to make the 20-foot drop to the cave floor. A short side passage leads to a second 10- by 20-foot room. The floors of both rooms are covered with clay and littered with bones of several kinds of vertebrates. Although some buffalo skulls were observed in the cave, most of the bones seem to be from sheep and deer. The depth of the cave fill was not determined but is at least three feet. The cave developed in a solution breccia of the Mission Canyon Formation.

Crowder Cave

Cave no.:	34	Range:	Little Belt
County:	Judith Basin	Map coverage:	Mixes Baldy 1:24,000
Location:	sec. 35 or 36, T. 15 N., R. 9 E.	Altitude:	approximately 6,400 ft.

This cave, 20 miles west of Stanford at the head of Butcherknife Gulch, was found in the 1960's by a deer hunter who explored part of the cave; he reported that it was large, but no other information is available. It formed in the Mission Canyon Formation.

Granite Mountain Cave

Cave no.:	29	Range:	Little Belt
County:	Judith Basin	Map coverage:	Great Falls 1:250,000
Location:	sec. 36, T. 16 N., R. 10 E.	Altitude:	6,250 ft.

This cave is 10 miles south of Geyser on the south side of Granite Mountain. One entrance is a 2-foot crawlway at the base of a limestone cliff, but a second vertical entrance exists in the cliff above. The two entrances join about 15 feet inside the cave. The cave is mostly horizontal and contains about 300 feet of passage. Most of the passages become more constricted and plugged with clay after a short distance. One short passage near the entrance leads to a 15-foot pit, which gives access to two small rooms at a lower level. A few small stalactites and some flowstone decorate the cave. Much of the cave passage formed along a series of north-trending joints in Madison Limestone dipping 10° north and striking due east.

Hoover Springs Cave

Cave no.:	41	Range:	Little Belt
County:	Judith Basin	Map coverage:	Hoover Spring 1:24,000
Location:	probably sec. 31, T. 12 N., R. 10 E.	Altitude:	approximately 7,000 ft.

This cave, north of Hoover Springs at the head of the South Fork of Lost Fork Creek, was discovered by Ted Key of Moore. Key visited the cave twice in the late 1950's, but the author's attempt to find the cave in 1970 was unsuccessful. The cave is a large sinkhole estimated by Key to be more than 250 feet deep. The cave, which has never been entered, probably developed in Mission Canyon Formation.

Lillyguard Cave

Cave no.:	38	Range:	Little Belt
County:	Judith Basin	Map coverage:	Woodhurst Mountain 1:24,000
Location:	sec. 16, T. 14 N., R. 11 E.	Altitude:	6,335 ft.
		Temperature:	38°F

Lillyguard Cave, about 20 miles southwest of Stanford, is near the head of a small canyon that drains southward into Sage Creek. The entrance is a 2-foot hole that opens into a 20- by 30-foot room. This room connects with a larger 200-foot-long room that is nearly filled with breakdown (Fig. 27). A second entrance joins the cave at the upper side of this room. From this point on the cave dips steeply; most cave passages dip 24° west, the same as the bedrock. At the bottom of the large room is a small crawlway leading steeply downward for about 800 feet. Two small pits and several small rooms are encountered, but most of the passage is less than 4 feet high. At the end of the crawlway, the cave opens into a long narrow room that is plugged with clay at its lower end. The lower part of the cave is wet and muddy. The cave's passages, totaling 1,407 feet, descend to a depth of -401 feet.

Speleothems consist of a few stalactites and broken helectites and scattered patches of cave popcorn. Several patches of white, hairlike fungus were observed but not identified.

Lillyguard Cave is an excellent example of a cave formed in the geologic past (Mississippian); the cave remained buried until uplift and erosion re-exposed and re-excavated it. The development of the entire cave along the dip of the bedding and the numerous blind leads filled with clay suggest that this cave was once buried and perhaps filled with red sandy clay and only recently reopened. Solution breccia of the Mission Canyon Formation is visible in the ceiling of several rooms, but the cave itself may be formed along a single carbonate bed just below the breccia zone. Breakdown obscures this layer in many places.

Limonite and hematite stains on the walls of the cave suggest possible solution by H_2SO_4 or at least some iron being carried into the cave by vadose water. An iron deposit, formerly mined, is about one mile from the cave entrance and may be providing the iron (and the sulfur necessary to form H_2SO_4) in the water.

Lone Tree Ice Cave

Cave no.:	31	Range:	Little Belt
County:	Judith Basin	Map coverage:	Mixes Baldy 1:24,000
Location:	sec. 9, T. 15 N., R. 9 E.	Altitude:	6,080 ft.

This cave is near Anderson Peak about 10 miles south of Geyser. The entrance is a large sink in a small heavily timbered gully. The cave consists of one room floored with ice. Local sources say that during dry years the ice recedes enough to give access to a much larger cave. The cave was visited in a fairly dry year in the fall; because the ice at that time was thin, existence of a larger cave behind the ice seems doubtful. The cave formed in Madison Group carbonate rocks.

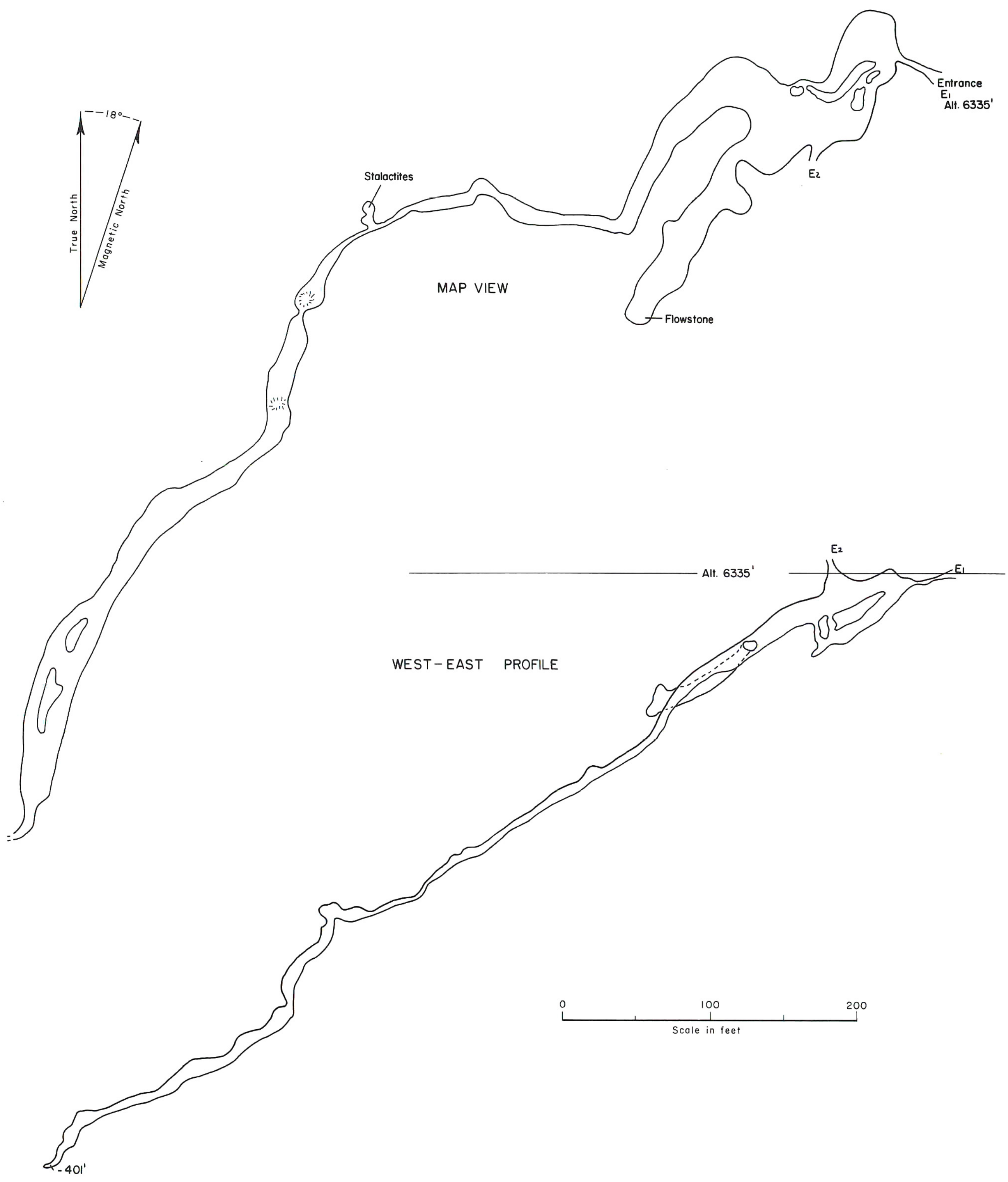


Figure 27.–Lillyguard Cave

Lost Fork Cave

Cave no.:	42	Range:	Little Belt
County:	Judith Basin	Map coverage:	Sandpoint 1:24,000
Location:	sec. 29, T. 12 N., R. 9 E.	Altitude:	7,840 ft.
		Temperature:	35°F

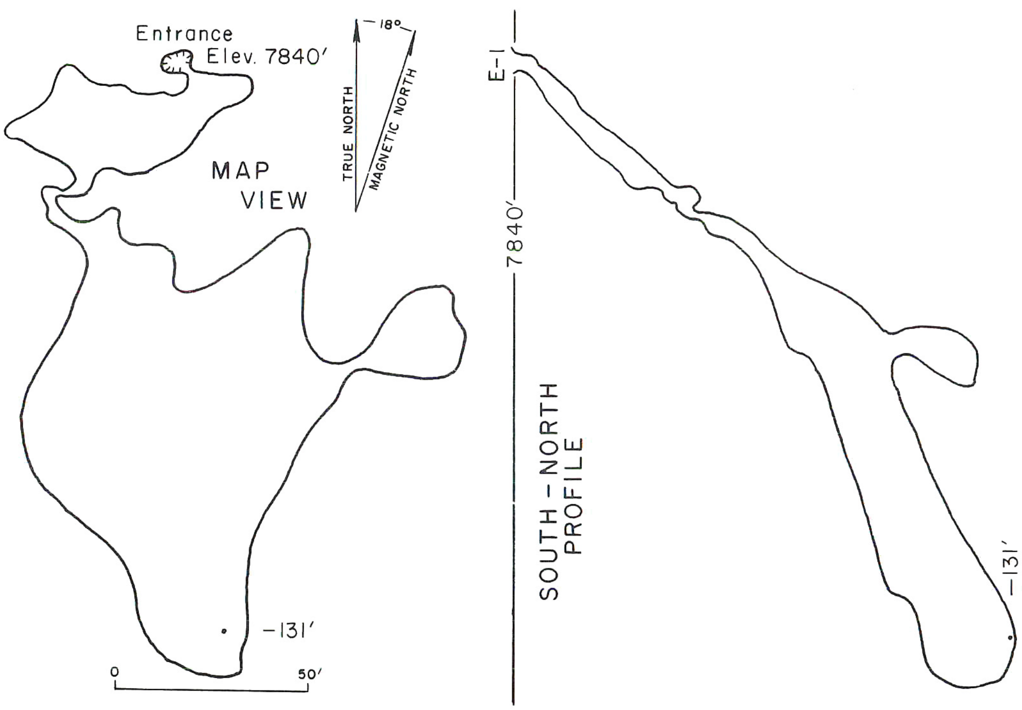


Figure 28.–Lost Fork Cave

Lost Fork Cave is 30 miles southwest of Stanford, at the head of the West Fork of Lost Fork Creek. The cave entrance lies in heavy timber and is at the base of a 15-foot sink; it leads to a sloping room, 50 feet wide and 10 feet high, which is choked with breakdown at the lower end. A 15-foot crawlway through the breakdown leads to a large room, 125 by 70 feet, that is piled with breakdown, which is well cemented by deposits from vadose water. One small room opens off the large room but no other passages exist. The cave has a few small stalagmites and contains large quantities of moonmilk, spongy $CaCO_3$.

The cave formed in the Jefferson Formation (Devonian). It developed in a 20-foot platy gray limestone bed sandwiched between two black fetid dolomite layers. The breakdown that fills the cave is insoluble dolomite that falls from the ceiling into the cavity, which was created by the removal of the more soluble limestone. The cave, developed downdip (16° south), slopes more steeply than the bedding dip because of ceiling collapse. Total horizontal length of the cave is 233 feet and the depth is -131 feet. The rock contains stromatoparoids and a few small corals.

Mount High Caves

Cave no.:	46	Range:	Little Belt
County:	Judith Basin	Map coverage:	Haymaker Narrows 1:24,000
Location:	T. 11 N., R. 12 E.	Altitude:	approximately 8,000 ft.

Mount High lies 20 miles north of Twodot, on the east end of the Little Belt Mountains. It consists of a long ridge capped with Mission Canyon carbonate rocks. Several sinks, two of them supposedly deep, are reported on this ridge, but nothing else is known about the caves. Because two deep pits (Twin Sisters Caves) are in the area, chances are good that the caves actually exist.

Old Dry Wolf Station Cave (Dry Wolf Cave)

Cave no.:	32	Range:	Little Belt
County:	Judith Basin	Map coverage:	Mixes Baldy 1:24,000
Location:	sec. 31, T. 15 N., R. 10 E.	Altitude:	6,320 ft.
		Temperature:	41°F

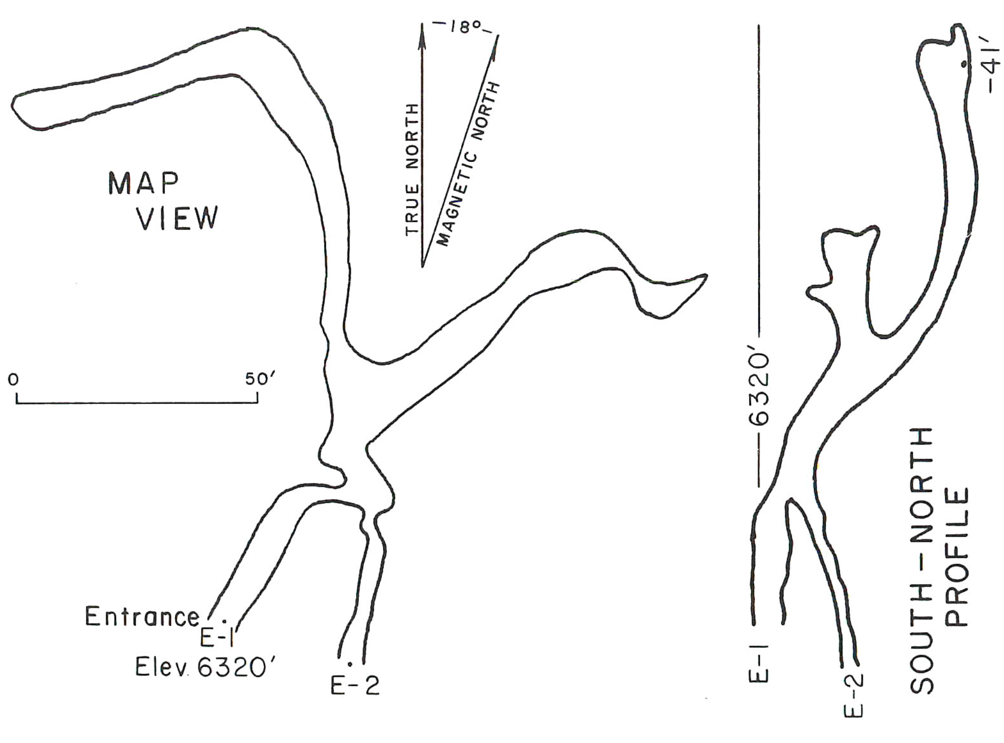


Figure 29.–Old Dry Wolf Station Cave

This cave is on the north side of Dry Wolf Creek Canyon about 15 miles southwest of Stanford. The main entrance is a small crawlway formed at the base of one of the "needles", a hoodoo formed in the Mission Canyon Formation. The cave follows the dip of the bedding (15° NE) and begins as a winding passage about 6 feet high. About 100 feet into the cave the passage splits into smaller passages. The total length of the cave is 340 feet.

The main passage has a distinctly fluted appearance as if it were part of an old stream channel. Although the cave has no stream-rounded pebbles in it, abundant clay fills part of the cave and plugs the ends of the passages.

The cave is fairly dry, and much bat guano litters the floor; 63 bats were counted during the winter of 1964. There are no speleothems.

The cave seems to be formed in a single massive limestone layer about 40 feet thick. No solution breccia was observed, but it is common in nearby outcrops.

Running Wolf Cave

Cave no.:	36	Range:	Little Belt
County:	Judith Basin	Map coverage:	Bandbox Mountain 1:24,000
Location:	probably T. 14 N., R. 10 E.		

This cave is in the upper part of Running Wolf Canyon, 20 miles southwest of Stanford. The cave, found by a local geologist (Norman Whitaker), was reported to the National Speleological Society in 1956. The cave probably contains more than 3,000 feet of passage but has not been mapped or completely explored. Personal communication with Whitaker in 1962 confirmed its existence but not its location. It is horizontal and developed in Mission Canyon Formation.

Sir Walter Raleigh Mine Cave

Cave no.:	37	Range:	Little Belt
County:	Judith Basin	Map coverage:	Bandbox Mountain 1:24,000
Location:	sec. 10, T. 14 N., R. 10 E.	Altitude:	7,000 ft.

This cave is 20 miles southwest of Stanford, on the Sir Walter Raleigh mine property (abandoned) near the head of Running Wolf Creek. The main shaft of the mine intersected a cave at the 300-foot level. The cave contains a large lake, which flooded the mine and contributed to the decision to cease mining. Seemingly, the cave was never explored.

When visited in 1964, the shafthouse was collapsed but the main shaft was still accessible for more than 200 feet. The sides are not shored, and although the mine may be caved below the 200-foot level, rocks that were dropped down the shaft struck water.

The mine and cave are in nearly flat lying Madison Limestone.

South Fork Cave

Cave no.:	40	Range:	Little Belt
County:	Judith Basin	Map coverage:	Indian Hill 1:24,000
Location:	sec. 1, T. 12 N., R. 11 E.	Altitude:	4,975 ft.
		Temperature:	41°F

South Fork Cave is about 30 miles south of Stanford, on South Fork Creek. The entrance is a 1-foot-square opening that lies in the ditch north of the South Fork road; most of the cave is directly under the road. Inside the small entrance, the cave opens into a north-trending fissure

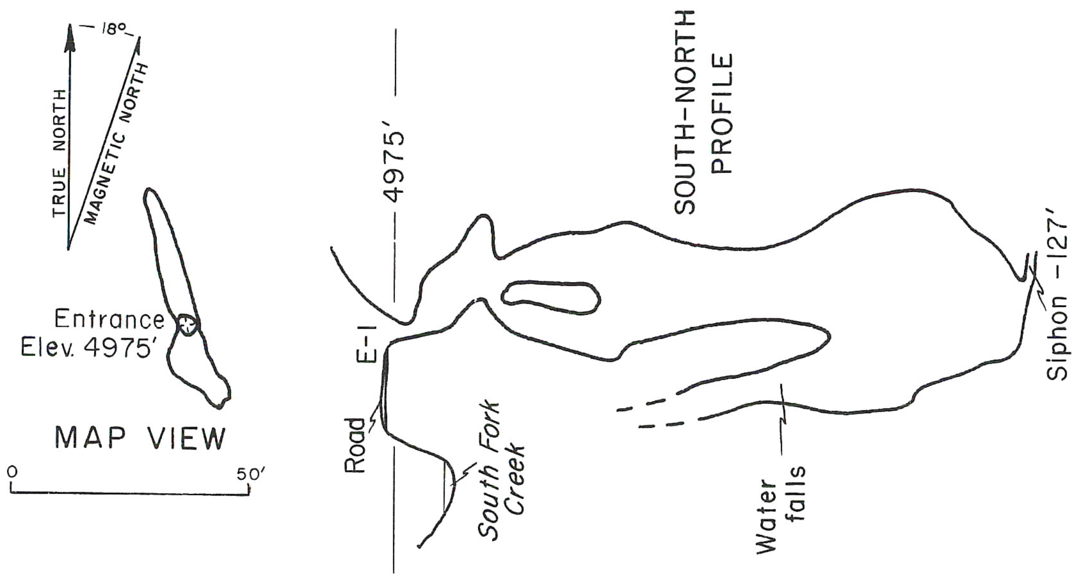


Figure 30.–South Fork Cave

30 feet long, 5 to 10 feet wide, and 125 feet deep, which can be climbed without rope. At the bottom is a small stream (estimated flow, 25 gal/sec), which is actually part of South Fork Creek that enters the cave near the entrance and plunges in a falls 100 feet to the cave bottom. The stream siphons at the cave bottom into an opening too small to enter. More cave probably exists beyond this point.

This cave developed along a N. 15° W.-trending joint and may have originated in the vadose zone. Here the Mission Canyon Formation strikes N. 30° W. and dips 8° NE. No speleothems are in this cave, but the walls do contain numerous brachiopods that have "weathered out".

The cave has been periodically closed by the Forest Service to prevent cattle from falling into the hole. When visited in 1970, dirt and planks sealed off the entrance.

Twin Sister Cave – South Shaft

Cave no.:	44	Range:	Little Belt
County:	Judith Basin	Map coverage:	Jellison Place 1:24,000
Location:	sec. 6, T. 11 N., R. 14 E.	Altitude:	7,000 ft.

This cave is 15 miles west of Judith Gap, near Twin Sisters Peak. The 2- by 10-foot entrance fissure, north of Sawmill Canyon, opens into a pit 113 feet deep. Although the bottom of the pit is filled with clay, a side passage leads to a 60-foot-wide room partly filled with breakdown; there are no other side passages. Moonmilk was the only speleothem found in the cave, which formed in the Mission Canyon Formation along a single northwest-trending joint plane.

Twin Sister Cave – West Shaft

Cave no.:	45	Range:	Little Belt
County:	Judith Basin	Map coverage:	Twin Sisters 1:24,000
Location:	sec. 35, T. 12 N., R. 13 E.	Altitude:	7,350 ft.

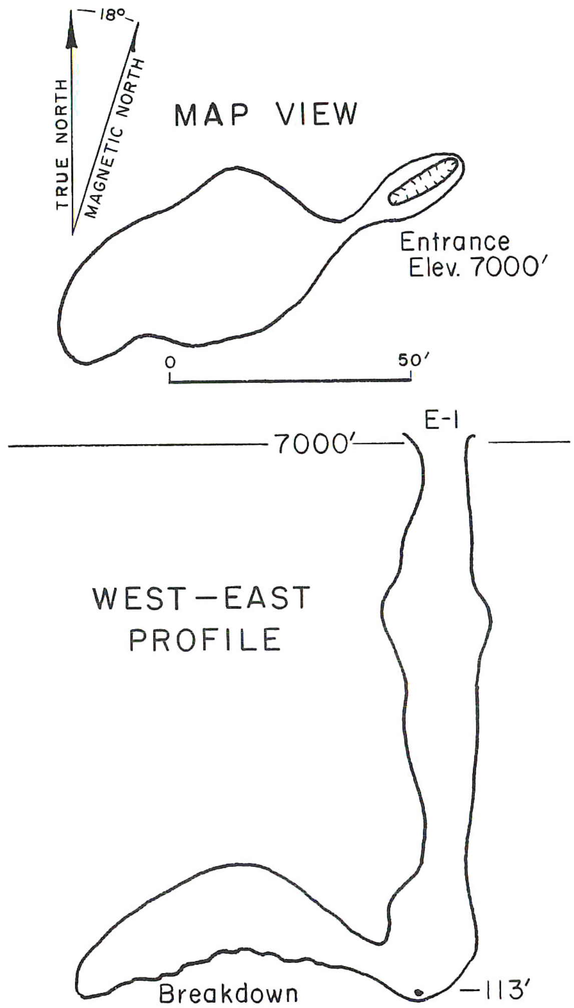


Figure 31.–Twin Sister Cave – South Shaft

This cave is about 15 miles west of Judith Gap, on Twin Sisters Peak. The entrance is a 6- by 20-foot hole on top of a ridge just north of the peak. The cave consists of a pit 228 feet deep, which is Montana's longest single vertical drop. At the bottom of the pit is at least 30 feet of clay fill. Flowstone coats the walls of the lower 50 feet of the pit. No side passages were encountered. The cave formed in the Mission Canyon Formation.

Whitaker Sink (Satan's Pit)

Cave no.:	35	Range:	Little Belt
County:	Judith Basin	Map coverage:	Great Falls 1:250,000
Location:	sec. 2, T. 14 N., R. 10 E.	Altitude:	6,572 ft
		Temperature:	38°F

Whitaker Sink is 20 miles southwest of Stanford, on the Dry Wolf-Running Wolf divide. The cave lies on claims originally called the Whitaker Iron mine. Norman Whitaker discovered the cave and explored part of it in the early 1950's, but it was not completely explored until 1962.

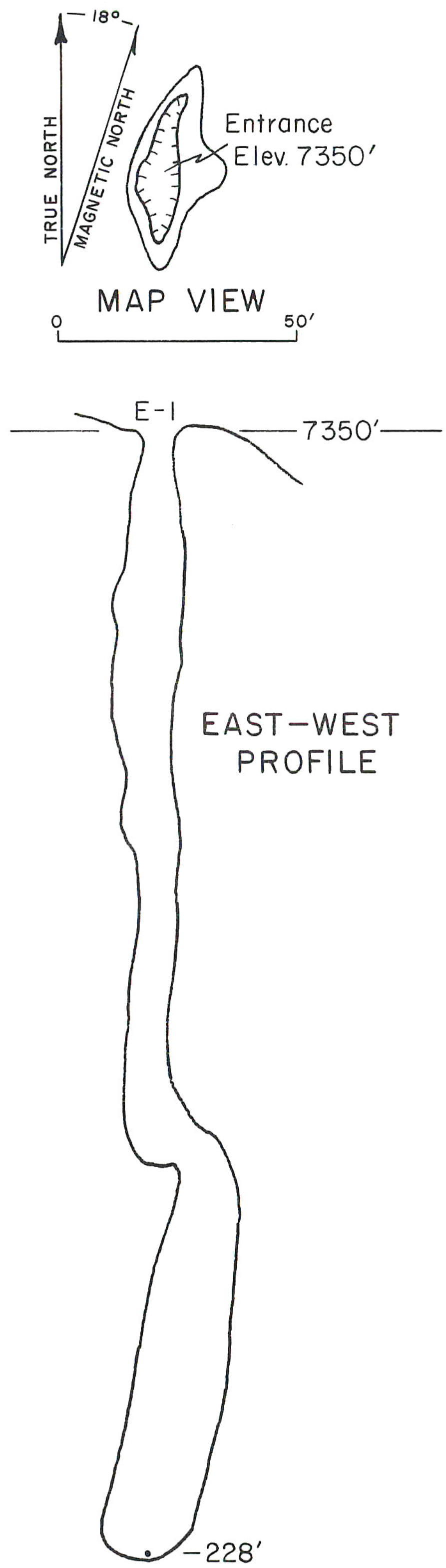


Figure 32.–Twin Sister Cave – West Shaft

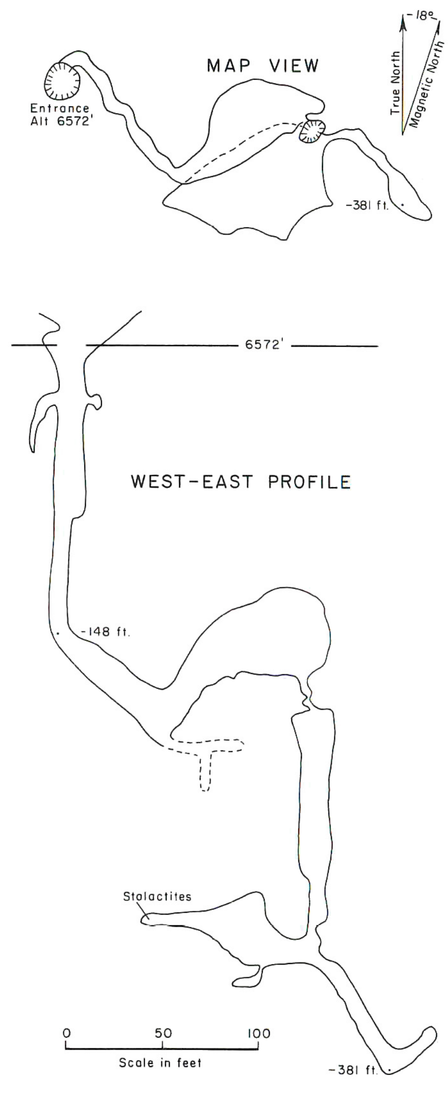


Figure 33.–Whitaker Sink

The entrance consists of a 40-foot sink that narrows to an impressive pit 20 feet wide and 140 feet deep. The upper 90 feet of the pit is circular but the lower 50 feet narrows to a 10-foot-wide fissure (Fig. 33). At the bottom of the pit the fissure continues downward at a steep angle and opens into a large high room. Several short passages lead from the breakdown-filled room. A narrow crack opens downward to a second deep pit at the rear of the chamber. This shaft is a 160-foot free drop and opens into the ceiling of a second large room. A steeply dipping passage leads downward to the lowest point in the cave, -381 feet.

Several groups of small stalactites can be observed in the lower room. A large colony of bats occupies the cave in the winter months.

The cave formed in Mission Canyon Limestone that here strikes due north and dips 7° west. A single joint, trending S. 60° E., seems to be the major feature along which the cave developed. The first large room may have been formed during a pause in the lowering of the water table by surface stream erosion.

Malachite and limonite stains were observed on the cave walls. Because the cave is only 200 yards from a sizeable iron deposit, pyrite and other sulfide impurities in the ore body may have contributed sulfuric acid to the ground water to help excavate the cave more rapidly than normal.

Underground River

Cave no.:	33	Range:	Little Belt
County:	Judith Basin	Map coverage:	Great Falls 1:250,000
Location:	sec. 14, 28, and 29, T. 15 N., R. 10 E.	Altitude:	5,250 ft.

The "Underground River" is actually a part of Dry Wolf Creek, 15 miles southwest of Stanford, in the Blacktail Hills area. Dry Wolf Creek sinks into the underlying Madison Formation and, depending on the spring runoff, disappears at various points along a 2-mile segment of the creek bed. This is a well-known intake area for ground water into the Madison Formation. Whether cave passage actually exists is unknown but local inhabitants assert that it does. One source stated that a well at the Old Dry Wolf Ranger Station intersected a large cave. Another rumor places a cave opening in the creek bed in sec. 14, which was closed by bulldozers to prevent livestock from entering the cave.

Water enters a small fissure at one point along Dry Wolf Creek but the opening is only 3 inches wide. The crack may open into a cave at depth.

In some stories, this cave has become confused with a second one, Old Dry Wolf Station Cave, which lies about 300 feet above Dry Wolf Creek in the same area.

Wirtala Cave

Cave no.:	30	Range:	Little Belt
County:	Judith Basin	Map coverage:	Great Falls 1:250,000
Location:	probably sec. 33, T. 16 N., R. 9 E.	Altitude:	approximately 6,600 ft.

This cave, near Geyser, on the south side of Pederson Mountain, was found by a hunter in the late 1950's. The entrance is a small crawlway under a 12-foot limestone ledge. The crawlway leads to a small room with four side passages that have not been explored. The cave has not been re-entered since the original discovery, and searches by the author and by a U.S. Geological Survey field party failed to locate it. As Pederson Mountain is capped by Madison Group carbonate rocks, a cave could exist in this area.

Yogo Creek Cave

Cave no.:	43	Range:	Little Belt
County:	Judith Basin	Map coverage:	Indian Hill 1:24,000
Location:	sec. 34, T. 13 N., R. 11 E.	Altitude:	5,200 ft.

This cave is located at the junction of Yogo and Middle Fork Creeks and has two small rooms open to the surface. The cave formed in Mission Canyon Formation.

MEAGHER COUNTY

Brammer Cave

Cave no.:	257	Range:	Castle
County:	Meagher	Map coverage:	White Sulphur Springs 1:250,000
Location:	Unknown		

This cave is supposed to be 20 miles southeast of White Sulphur Springs, in the Castle Mountains. The cave was explored by an English professor from Montana State University who reported "pits that required rope and several hundred yards of passage". Existence of the cave (and professor) is unverified; this cave may be confused with the Rice Hole, also unexplored to date.

Castle Mountain Crystal Cave

Cave no.:	1	Range:	Castle
County:	Meagher	Map coverage:	Willow Creek Reservoir 1:24,000
Location:	sec. 12(?), T. 9 N., R. 7 E.	Altitude:	6,190 ft.
		Temperature:	38°F

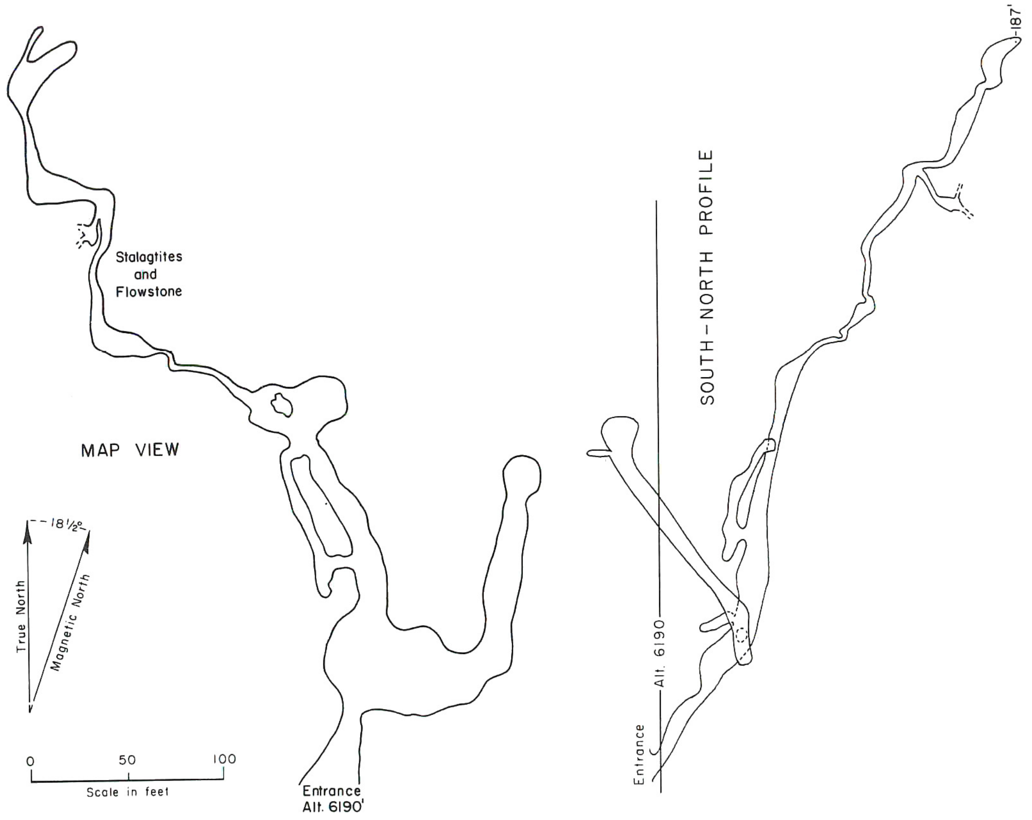


Figure 34.–Castle Mountain Crystal Cave

This cave is 7 miles east of White Sulphur Springs, near the mouth of Fourmile Creek Canyon, on land belonging to the Castle Mountain Ranch, and trespassing is prohibited. The entrance to the cave is a small sink with a 5-foot hole, which leads steeply downward (Fig. 34). The passage leads to a large 50- by 100-foot room with passages leading upward and downward following the dip of the rock (29° SW). The upper passage terminates within 100 feet but the lower passage leads to a second room about 50 feet wide. The cave is dry to this point, but a small hole at the rear of the room leads downward to a very muddy section of crawlways and small rooms. The mud is very black and in places is 10 feet thick. The cave follows the bedding dip to its end, 187 feet below the entrance. All passages are plugged with mud but would probably be seen to continue if the mud were removed. In 1970, 597 feet of cave passage was surveyed.

Although the lower levels of the cave still have some flowstone, stalagmites, and stalactites, many speleothems have been broken and removed by vandals.

Castle Mountain Crystal Cave formed just below the breccia zone of the Mission Canyon Formation. The cave is formed along two joint sets, one set trending N. 5° W., and the second N. 65° W. Black chert layers, 3 to 5 inches thick, partly control the solution. Speleothem growth is continuing in the lower part of the cave. This cave seems to have formed prior to uplift of the Castle Mountains and has only recently been opened to the surface. Spring runoff entering the cave slowly washes away the black mud and exposes new passage. Some speleothems seem to be developing rapidly on top of the mud. Several signatures dated in the 1880's already have a thin layer of flowstone over the carbide used to write on the walls.

Several kinds of fungus have been observed growing on the cave walls in the upper level. No attempts to identify them have yet been made.

Coburn Shaft

Cave no.:	8	Range:	Little Belt
County:	Meagher	Map coverage:	Ellis Canyon 1:24,000
Location:	sec. 17, T. 12 N., R. 4 E.	Altitude:	6,100 ft.

The Coburn Shaft lies 30 miles northwest of White Sulphur Springs, in a part of the Little Belt Mountains known as the Dry Range. The entrance is in heavy timber near the road at the summit of the Dry Range. The vertical pit is estimated to be more than 100 feet deep. The cave has never been explored and is difficult to find; only a few local ranchers have visited it. The cave formed in north-dipping Madison Group carbonate rocks.

Conway Shaft

Cave no.:	7	Range:	Little Belt
County:	Meagher	Map coverage:	Monument Peak 1:24,000
Location:	sec. 9, T. 13 N., R. 5 E.		

This cave is on Rimrock Ridge, 35 miles north of White Sulphur Springs, and is said to be a deep pit; other information is lacking. The cave probably originated as the result of a gravity slide (see Smokehole No. 1 and No. 2). Rimrock Ridge is capped by the Jefferson Formation.

Den Gulch Sink

Cave no.:	9	Range:	Little Belt
County:	Meagher	Map coverage:	Ellis Canyon 1:24,000
Location:	sec. 7, T. 12 N., R. 4 E.	Altitude:	5,500 ft.

This cave, probably on the west side of Den Gulch in the Dry Range part of the Little Belt Mountains, is a deep pit that has never been explored. A search for this cave in 1965 was unsuccessful, but because the area is overlain by nearly horizontal Madison Group carbonate rocks, such a cave could exist.

Dry Range Sink

Cave no.:	10	Range:	Little Belt
County:	Meagher	Map coverage:	Ellis Canyon 1:24,000
Location:	sec. 24, T. 12 N., R. 3 E.	Altitude:	6,000 ft.

This cave is on the summit of the Dry Range part of the Little Belt Mountains. The sink, which is visible on air photos, is 40 feet in diameter and 30 feet deep. Commonly, snow plugs the sink at the 30-foot level, making it difficult to determine whether the cave goes deeper. The cave formed in Madison Group carbonate rocks.

Ellis Canyon Caves

Cave no.:	11	Range:	Little Belt
County:	Meagher	Map coverage:	Ellis Canyon 1:24,000
Location:	sec. 11, T. 12 N., R. 3 E.	Altitude:	5,400 ft.

These caves lie in Ellis Canyon on the north side of the Dry Range, an extension of the Little Belt Mountains. At least three caves have been found near the canyon bottom in flat-lying Madison Limestone. One cave has been entered for a distance of 30 feet through a crawlway that opened into a large room; a strong breeze coming from the crawlway may indicate the existence of a large cave. All the caves formed in the Mission Canyon Formation.

Monument Peak Cave

Cave no.:	14	Range:	Little Belt
County:	Meagher	Map coverage:	Monument Peak 1:24,000
Location:	probably sec. 4, T. 14 N., R. 5 E.	Altitude:	approximately 7,000 ft.

This cave, on Monument Peak, is said to be a very deep pit. Although local ranchers may know the exact location of the cave, it has never been explored (to the author's knowledge). Monument Peak Cave formed partly in Madison Group carbonate rocks.

Natural Tunnel

Cave no.:	12	Range:	Little Belt
County:	Meagher	Map coverage:	Ellis Canyon 1:24,000
Location:	sec. 32, T. 13 N., R. 4 E.	Altitude:	5,900 ft.

This cave, east of Ellis Canyon in the Dry Range, is a 150-foot horizontal passage that runs completely through a small ridge, which separates two small ravines. The south entrance is about 10 feet in diameter and becomes slightly larger until it opens into a 10- by 20-foot passage at the north end. No side passages lead from the tunnel. The cave formed in Mission Canyon Formation that caps the ridge; dissection of the area into a series of small canyons has probably destroyed a much larger cave, leaving Natural Tunnel as the only remaining passage.

Ram's Horn Cave

Cave no.:	2	Range:	Little Belt
County:	Meagher	Map coverage:	Willow Creek Reservoir 1:24,000
Location:	sec. 35, T. 10 N., R. 7 E.	Altitude:	5,250 ft.
		Temperature:	42°F

Ram's Horn Cave is 7 miles east of White Sulphur Springs, in the foothills of the Little Belt Mountains. The cave, on land belonging to the Castle Mountain Ranch, is gated and has been closed permanently by the owners.

At present, Ram's Horn is Montana's fifth deepest cave at -496 feet and is the seventh longest with 4,750 feet of mapped passage and an estimated 400 additional feet still unmapped (Fig. 35). The entrance is a 3- by 10-foot south-facing opening that abruptly widens into a 200-foot-long room. Along the north side of the room a sloping passage leads steeply downward. Within 200 feet the cave branches into three main areas. An upper level contains about 1,000 feet of narrow twisting crawlways and small rooms. The main passage or most widely traveled part slopes steeply downward to a point 251 feet below the entrance. This part of the cave typifies Ram's Horn structure; it has steep sloping passage, large rooms, and huge piles of breakdown.

A third area, the lower level, branches from the main passage at the bottom of a 20-foot pit and contains a maze of small crawlways and steep pitches. One very tight squeeze called the "Popcorn Hole" leads to a series of upsloping passages that were only recently discovered. At the top of these passages the cave spirals steeply downward and ends in a 190-foot pit. A small pool of water at the bottom of this pit marks the end of the cave at -493 feet.

Ram's Horn Cave is difficult to explore; to reach the lowest point in the cave requires 10 to 15 hours. Speleothems are limited to a few stalactites and stalagmites and scattered patches of cave popcorn.

Ram's Horn Cave formed in the Mission Canyon Formation, which in this area strikes N. 50° W. and dips 46° SW. The cave developed along a 20-foot layer of gray-brown limestone that seems to be partly algal laminated. The ceilings of some of the larger rooms are in a solution breccia, probably caused by collapse. The solution breccia, which also makes up most of the cave breakdown, consists of ½-inch to 2-foot angular fragments of calcareous dolomite in a red-brown calcareous siltstone matrix.

Many of the cave passages follow the dip of the bedding, but the cave has at least three levels where the passage developed across the dip (Fig. 35). These areas may indicate changing water levels caused by successive stages of downcutting by the nearby Smith River.

Remains of a small vertebrate were found at the -250-foot level and were shipped by persons unknown to the Smithsonian Institution for identification and dating; so far, no information has been made available by the Smithsonian.

Rice Hole

Cave no.:	286	Range:	Castle
County:	Meagher	Map coverage:	Groveland 1:24,000
Location:	sec. 10, T. 8 N., R. 10 E.		

This cave is 7 miles west of Martinsdale, just inside the U.S. National Forest boundary in the Castle Mountains. The entrance is a 3- by 5-foot opening in the bottom of a small canyon. The cave, a vertical pit estimated to be more than 100 feet deep, has not been explored but could be deep, as it occurs in a thick section of Madison Group carbonate rocks.

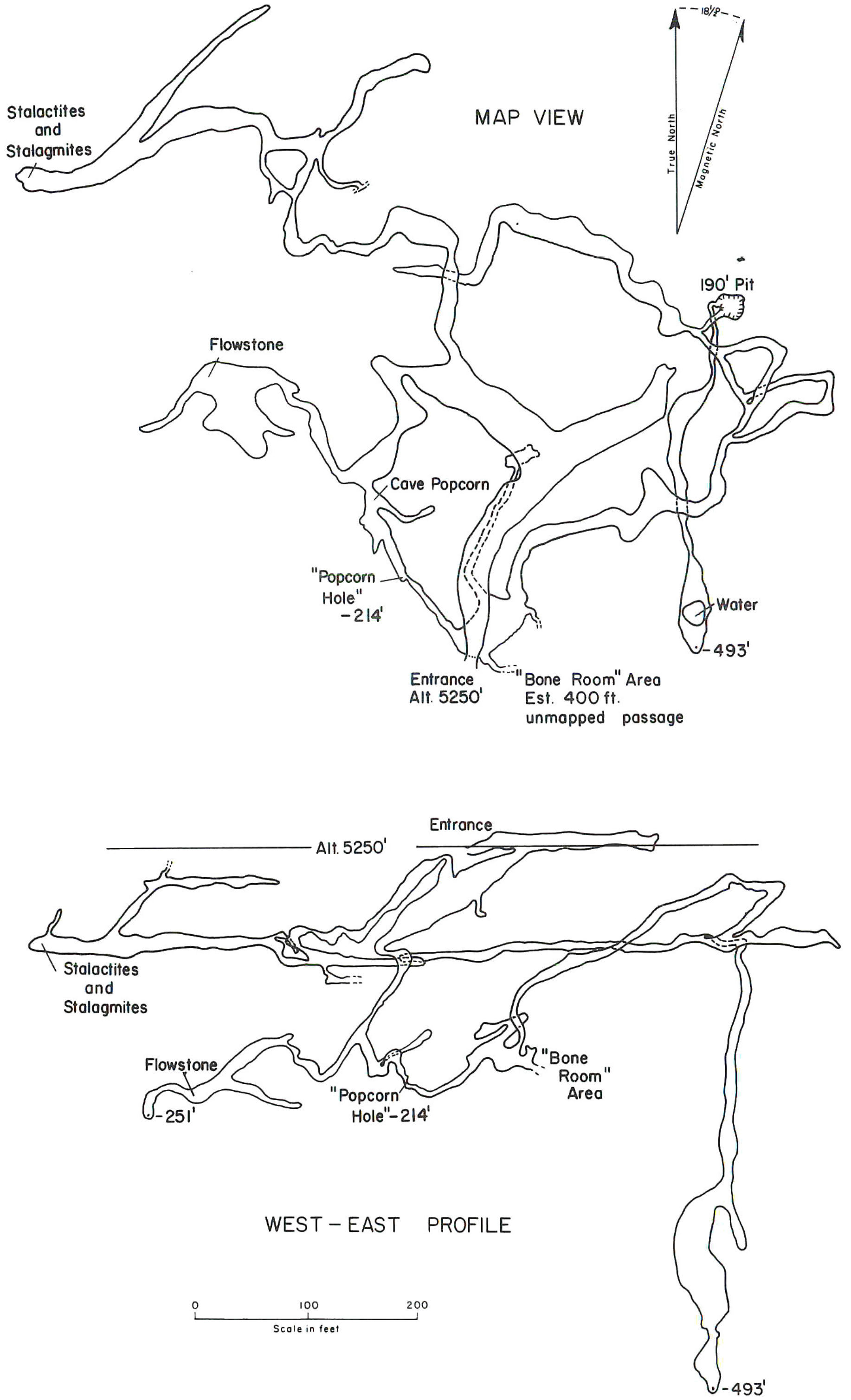


Figure 35.–Ram's Horn Cave

Sheepherders Cave

Cave no.:	3	Range:	Little Belt
County:	Meagher	Map coverage:	White Sulphur Springs 1:24,000
Location:	sec. 32, T. 10 N., R. 7 E.	Altitude:	5,150 ft.

This small cave lies 3 miles north of White Sulphur Springs. The entrance is a 3- by 20-foot vertical fissure on a lightly timbered sidehill. The cave is filled with clay at a depth of 40 feet; it has no speleothems or side passages. It formed in Mission Canyon Limestone.

Smoke Holes No. 1 and No. 2

Cave no.:	6	Range:	Little Belt
County:	Meagher	Map coverage:	Monument Peak 1:24,000
Location:	sec. 10, T. 13 N., R. 5 E.	Altitude:	6,850 ft.
		Temperature:	38°F

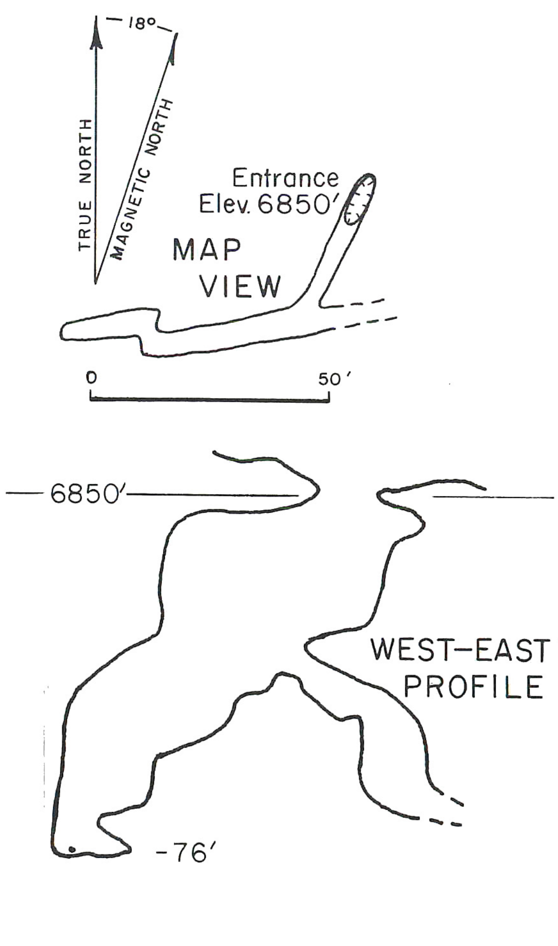


Figure 36.–Smoke Hole No. 1

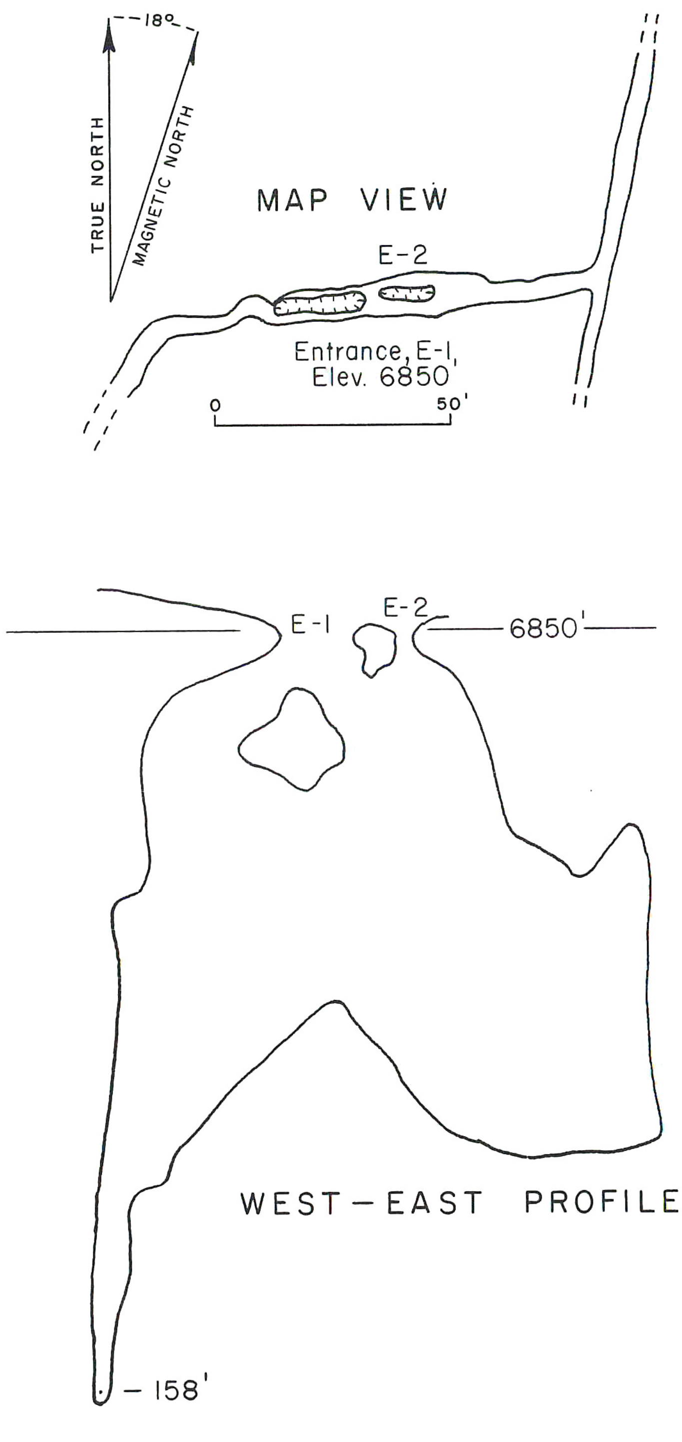


Figure 37.–Smoke Hole No. 2

These caves are on Rimrock Ridge about 35 miles north of White Sulphur Springs. Rimrock Ridge is capped by the Jefferson Formation, which here trends N. 40° E., 4° NW. Blocks of Jefferson strata are slowly sliding northward, and the entire east end of the ridge is covered with long sink-like depressions and fissures opened by the gravity sliding. Two of the larger fissures are known as Smokeholes No. 1 and No. 2, and although several other caves occur nearby (Smokeholes No. 3, 4, etc.), they all seem to be part of the same gravity-slide system.

Both caves have narrow vertical entrances that are 70 to 80 feet deep and require rope for entry. Smokehole No. 1, 76 feet deep, lies only 100 yards away from No. 2, and seems to connect with it, although the passage between them is too narrow to enter. Smokehole No. 2 intersects two north-trending fractures and reaches a depth of -158 feet. The caves have been slightly scalloped by vadose water, but features on one wall clearly match up with those on the opposite wall, thus indicating that sliding is the main force involved in the formation of the cave. There are no speleothems in the caves. The name, Smokehole, was given by local ranchers who saw steam emerging from the entrance in winter.

Spring Creek Cave

Cave no.:	5	Range:	Little Belt
County:	Meagher	Map coverage:	Coxcombe Butte 1:24,000
Location:	probably sec. 7, T. 10 N., R. 6 E.	Altitude:	5,100 ft.

This cave, near Spring Creek about 7 miles northwest of White Sulphur Springs, was found by a local rancher and has never been explored. The entrance is a 5- by 10-foot passage that slopes steeply downward for about 100 feet; it continues but has not been explored beyond this point. The cave developed in Madison Group carbonate rocks (Mississippian).

Van Hoose Cave

Cave no.:	13	Range:	Little Belt
County:	Meagher	Map coverage:	Ellis Canyon 1:24,000
Location:	probably sec. 7, T. 12 N., R. 4 E.		

This cave, named for the man who found it, was described in an 1882 issue of the *Rocky Mountain Husbandman*. A rope ladder was found or placed in the pit, and the first drop (40 feet?) was successfully negotiated. No other information is available, and a search in the early 1960's failed to locate this pit. The cave, in the Dry Range part of the Little Belt Mountains, probably formed in Madison Group carbonate rocks.

White's Gulch Ice Cave

Cave no.:	256	Range:	Big Belt
County:	Meagher - (may be in Broadwater County)	Map coverage:	Whites City 1:24,000
Location:	sec. 1, T. 10 N., R. 2 E.		

This ice cave is 40 miles northwest of White Sulphur Springs. An early edition of the *Helena Times* described the cave, which was in a side coulee near the head of White's Gulch. Found by a miner in the late 1800's, the cave has remained "lost" to date. It seemingly was small but contained some interesting ice speleothems. It probably formed in Mississippian carbonate rocks.

White Sulphur Cave

Cave no.:	4	Range:	Little Belt
County:	Meagher	Map coverage:	White Sulphur Springs 1:24,000
Location:	sec. 22, T. 10 N., R. 6 E.	Altitude:	5,400 ft.

This cave lies 5 miles northwest of White Sulphur Springs. The cave, found by a local rancher, is supposed to be horizontal and to contain several rooms, but has not been completely explored. It formed in Madison Limestone.

PHILLIPS COUNTY

Azure Cave (Zortman Cave)

Cave no.:	89	Range:	Little Rockies
County:	Phillips	Map coverage:	Zortman 1:24,000
Location:	sec. 29, T. 25 N., R. 25 E.	Altitude:	4,465 ft
		Temperature:	41°F

Azure Cave is about 2 miles southwest of Zortman, near Saddle Butte. The entrance is a 20-foot diameter opening on the south side of a steep canyon. At the rear of the entrance, a 6-foot-high passage leads into the top of a large room (Big Room); a 70-foot drop is required to reach its floor. Big Room has two pits leading downward to the lower level; the pits are about 40 feet deep and require rope for descent. Most of the lower level is horizontal and contains several rooms connected by small crawlways. One crawlway leads upward to a series of small rooms and dome pits. Many of the rooms are partly clay filled, and most of the crawlways are plugged with red clay after a short distance. Several false floors in the cave are probably due to cementation of the upper clay by vadose water and then excavation of clay under the false floors. Many stalagmites are built on these false floors. The cave reaches a depth of -220 feet and has 1,580 feet of mapped passage (Fig. 38).

Azure Cave contains more speleothems than any other cave in Montana except Lewis and Clark Caverns. The lower level has many stalactites and stalagmites, some of which are more than 6 feet long. Cave popcorn and flowstone decorate the walls of the cave. In one room, very large clusters of helectites are found that are probably the best in Montana. The cave is still active and wet; the formations are still growing. A large colony of bats occupies the cave during the winter.

Azure Cave was found by Pat Azure in 1960. In 1963 the U.S. Forest Service mapped part of the area to determine its commercial possibilities. In the late 1960's the U.S. Bureau of Land Management took over control of the cave, and trips now require special permission.

The cave formed in Mission Canyon Formation, which here strikes N. 75° E. and dips 28° SE. The cave follows the bedding in some places and follows joints in other places. No solution breccia was observed, and breakdown is not abundant. The blind leads filled with clay and the false floors have been interpreted by several geologists as indicative of a Paleozoic origin for the cave.

Beaver Creek Cave

Cave no.:	282	Range:	Little Rockies
County:	Phillips	Map coverage:	Bear Mountain 1:24,000
Location:	sec. 36, T. 26 N., R. 25 E.		

Beaver Creek Cave consists of a 40-foot entrance pit and less than 200 feet of side passage. The cave formed in Madison Group carbonate rocks.

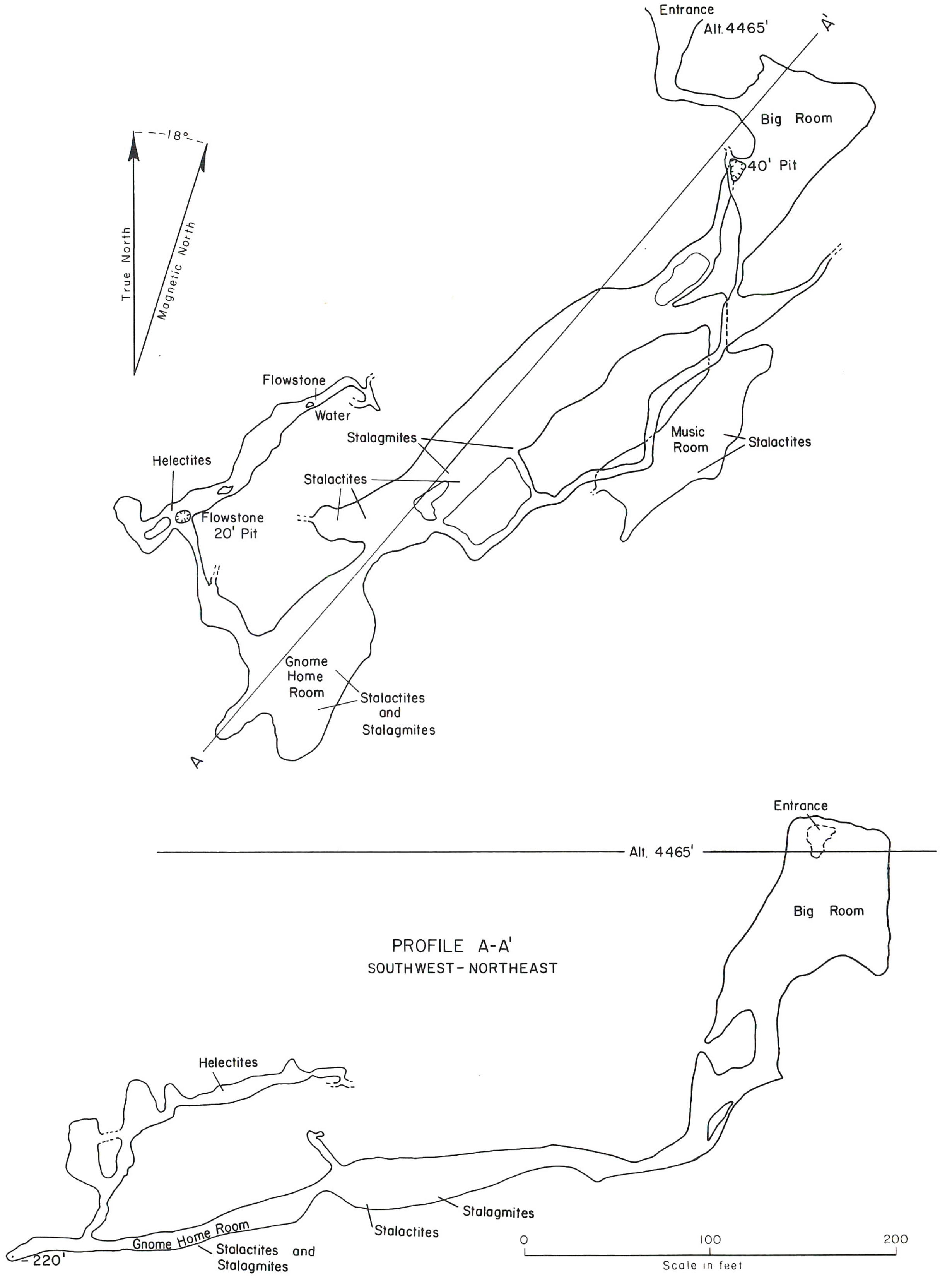


Figure 38.—Azure Cave

Coburn Cave

Cave no.:	90	Range:	Little Rockies foothills
County:	Phillips	Map coverage:	Coburn Butte 1:24,000
Location:	sec. 27, T. 25 N., R. 26 E.	Altitude:	3,500 ft.

This cave is southeast of Zortman, on the east side of Coburn Butte. The cave formed in the Madison Limestone.

Dry Gulch Cave

Cave no.:	283	Range:	Little Rockies
County:	Phillips	Map coverage:	Zortman 1:24,000
Location:	sec. 35, T. 25 N., R. 24 E.		

This cave, at the mouth of Dry Gulch, is a small horizontal cave containing less than 100 feet of passage. One large room near the entrance contains flowstone and a few small stalactites. The cave formed in Madison Group carbonate rocks.

Lookout Indian Cave

Cave no.:	284	Range:	Little Rockies
County:	Phillips	Map coverage:	Zortman 1:24,000
Location:	sec. 36, T. 25 N., R. 24 E.		

This one-room rock shelter formed in the Madison Limestone. It contains pictographs, and was excavated jointly by the U.S. Bureau of Land Management and the University of Montana. A thesis on the cave by Bert Williams is in press.

Two Hands Indian Caves

Cave no.:	285	Range:	Little Rockies
County:	Phillips	Map coverage:	Zortman 1:24,000
Location:	sec. 30, T. 25 N., R. 25 E.		

The area southwest of Saddle Butte contains Two Hands Caves as well as about fifteen other, smaller rock shelters. Many have yielded pictographs and artifacts.

WHEATLAND COUNTY

Sawmill Gulch Cave

Cave no.:	266	Range:	Little Belt
County:	Wheatland	Map coverage:	Roundup 1:250,000
Location:	sec. 8, T. 11 N., R. 14 E.	Altitude:	6,000 ft.

This cave is about 10 miles west of Judith Gap, in Sawmill Gulch. The entrance is a collapsed sink that contains a small section of horizontal passage. Several other collapsed sinks nearby probably connect with this cave, which formed in the Mission Canyon Formation.

PRYOR-BIGHORN REGION (II)

Except for two caves in the Beartooth Mountains and several rock shelters on the eastern plains, the caves of Region II are concentrated in the Pryor and Bighorn Mountains. The geology of this area has been described in detail by Richards (1955) and Blackstone (1940). The mountains were formed by vertical uplift and associated normal faulting. The Pryor Mountains are made up of a series of north-trending asymmetrical anticlines deformed by normal faulting into four major mountain blocks. The northern end of the Bighorn Mountains in Montana is a north-plunging anticline with a broad top and steeply plunging limbs (Richards, 1955, p. 9). The deformation of this area is thought to have begun prior to the deposition of the oldest Tertiary rocks and to have continued through Late Tertiary and Early Quaternary (Thom and others, 1935).

The Bighorn River flows between the two mountain ranges and is antecedent; the river cut a deep canyon as uplift took place. At least six terrace levels are recognized along the Bighorn River. The uppermost terrace, about 650 feet above the present river level, has been tentatively correlated by Alden (1932, p. 28) as equivalent in age to the Flaxville Gravel (Upper Miocene or Pliocene). Several caves in the Bighorn Mountains lie on this terrace, and one cave, Big Horn Caverns, is large enough (9 miles of passage) to show a 3° regional dip toward the Bighorn River. This cave and others near it probably formed in Flaxville time.

Caves in the Pryor Mountains lie at much higher altitudes, and passages dip more steeply than those in the Bighorn Mountains. Some cave passages slope away from the Bighorn River. Elliott (1963, p. 15) and Schultz (1969, p. 11) postulated that these caves were formed in Mississippian time, were buried and filled by Amsden deposition, and were exhumed by erosion during Tertiary uplift.

The principal cave-forming rock is the Mission Canyon Formation (Mississippian). Nearly every cave in the Pryor-Bighorn area is in the upper 100 feet of the Mission Canyon Formation, which contains solution breccia in the upper 50 feet. Most of the solution breccia consists of light-gray dolomitic limestone fragments cemented with red silty limestone. Fragments range from ½ inch to 2 feet in width.

Beneath the solution breccia is a very fossiliferous layer of yellowish-gray limestone containing horn corals, spiriferoid brachiopods, and bryozoans. Many of the caves seem to have formed in this layer and have the solution breccia as the cave roof. The exact reason for the selection of this layer for solution is unknown, but perhaps the less soluble breccia zone above helps to channel ground water along a single limestone layer and form mainly horizontal caves. Some breccia is dissolved from the ceilings of larger rooms and breakdown, but most of the solution breccia seems to be above the cave roofs.

A small amount of the red clay fill, common in most caves, is probably an insoluble residue from solution of the carbonate and matrix of the solution breccia, but most of the clay seems to be washed into the cave from the overlying Amsden Formation. Uranium (tyuyamunite) has been found in the clay in many of the caves. In fact, prospectors searching for solution pockets filled with clay uncovered many caves during mining operations in the late 1940's and early 1950's.

Of more than forty caves in the Pryor-Bighorn area, most are small horizontal caves, but large caves are also found. Montana's largest cave (Bighorn Caverns) is here.

Speleothems are numerous and show many forms. Calcite crystals coat many rooms and passages; soda-straw stalactites are common. The only known gypsum flowers and selenite crystals in Montana caves are in this region. Several caves above 8,000 feet contain ice all year, and crystals or stalactites of ice are common. The ice, according to local reports, melts back a few feet each year.

Plains Caves.—Small caves and rock shelters, formed in Cretaceous sandstone in several counties in the eastern part of the state, are listed in Region II for convenience. Their origin is quite different from solution caves: most are formed by wind erosion or related weathering.

BIG HORN COUNTY

Bighorn Caverns (Glory Hole)

Cave no.:	100	Range:	Bighorn
County:	Big Horn	Map coverage:	Hillsboro 1:24,000
Location:	sec. 31, T. 9 S., R. 29 E.	Altitude:	4,710 ft.
		Temperature:	45°F

This cave is on the north end of the Bighorn Mountains near the Wyoming border and is partly in the Yellowtail-Bighorn National Recreation Area. There are two entrances, both gated to prevent unauthorized access. Permission to enter the cave must be obtained from the Park Service at Lovell, Wyoming. Bighorn Caverns is at present Montana's largest known cave, with 48,956 feet mapped; at least 5 miles of passage is still unmapped (Pl. 1).

The Glory Hole entrance to Bighorn Caverns is a 10-foot sinkhole that changes to a 5- by 30-foot crack with depth. The entrance pit is 66 feet deep, and rope is required to enter.

Two main passages lead from the entrance pit. One passage, commonly called the "B Line", trends westward and consists of a maze of interconnecting 6-foot-high passages as well as small rooms. This part of the cave has a thick layer of red clay and angular breakdown on the cave floor. Well-formed gypsum crystals can be seen in several side passages.

A second passage ("A Line") leads eastward from the entrance room. This part of the cave has very large high rooms and numerous piles of breakdown. Some well-formed selenite crystals and "aragonite flowers" (may be composed of gypsum) occur in this area.

A third area called "AA Line" and "ABC Line" is north of the entrance room and contains about 1 mile of large rooms and interconnecting passage. Well-developed gypsum flowers and stalactities decorate the "AA Line" cave walls.

The entire cave, except for the entrance pit, is horizontal and developed along two joint sets. One set trends N. 65° E., the other N. 60° W., and nearly every segment of the cave is oriented in one of those directions. The overall trend of the cave, however, is S. 80° W., which is toward the Bighorn River. Bighorn Caverns show a 3° regional dip toward the river, which is thought to be equivalent to the slope of the water table in this area before the Bighorn River downcut to its present level. The cave is now dry and must be far above the present water table.

Some solution breccia can be seen in the ceiling of many rooms, but most of the cave formed below the breccia zone in a gray fossiliferous layer of the Mission Canyon Formation. The bedding trends N. 40° E., 7° NW.

The cave harbors a small colony of bats, and several cave crickets have been reported. Survey stakes placed in 1961 are now covered with several kinds of fungi of unknown genus and species. For more information on Bighorn Caverns read Sutherland (1976) and Hill and others (1976).

Devil's Balcony Cave

Cave no.:	301	Range:	Bighorn
County:	Big Horn	Map coverage:	Hillsboro 1:24,000
Location:	sec. 31, T. 9 S., R. 29 E.	Altitude:	4,620 ft.

Devil's Balcony Cave is on the south wall of Devil's Canyon about 100 feet below the rim. Rope is needed to reach the entrance–a 50- by 25-foot opening. The cave itself is small (Fig. 39) but was probably part of a much larger cave that was removed during the erosion of Devil's Canyon. The cave formed in Mission Canyon Formation. It has no speleothems.

Devil's Canyon Cave

Cave no.:	101	Range:	Bighorn
County:	Big Horn	Map coverage:	Hillsboro 1:24,000
Location:	sec. 31, T. 9 S., R. 29 E.	Altitude:	4,720 ft.
		Temperature:	46°F

This cave lies north of Devil's Canyon on a sagebrush-covered plateau in the Bighorn Mountains. The entrance is a collapsed sink that opens on the northeast side into a large room. Two small crawlways lead from the entrance room; the cave has less than 200 feet of passage.

The cave lies on National Park land and permission must be obtained from the Park Service before entering. The cave formed in flat-lying Mission Canyon Formation.

Hole-in-the-Wall Cave

Cave no.:	103	Range:	Pryor
County:	Big Horn	Map coverage:	Billings 1:250,000
Location:	T. 6 S., R. 28 E.		

This cave lies on Crow Indian tribal land north of the Pryor Mountains, and the law prohibiting trespassing on tribal lands is strictly enforced. The entrance is halfway up the side of a large cliff. The cave has at least one room but has not been completely explored. It formed in Madison Group carbonate rocks.

Indian Joe's Cave

Cave no.:	258	Range:	Pryor
County:	Big Horn	Map coverage:	Billings 1:250,000
Location:	T. 6 S., R. 28 E.		

This cave is north of the Pryor Mountains on Crow Indian tribal land and was supposedly inhabited in the early 1900's by a hermit named Indian Joe. The cave reportedly contains several hundred feet of passage and a deep vertical pit at the rear. The pit has not been explored. The cave is thought to be in Madison Limestone.

Pryor Creek Cave

Cave no.:	104	Range:	Pryor
County:	Big Horn	Map coverage:	Castle Rocks 1:24,000
Location:	sec. 16, T. 6 S., R. 26 E. (unsurveyed)	Altitude:	6,000 ft.

This cave is near the old town of Pryor, on the east fork of Pryor Creek. The entrance lies on the side of a limestone cliff near the top of the canyon. The cave is horizontal and contains

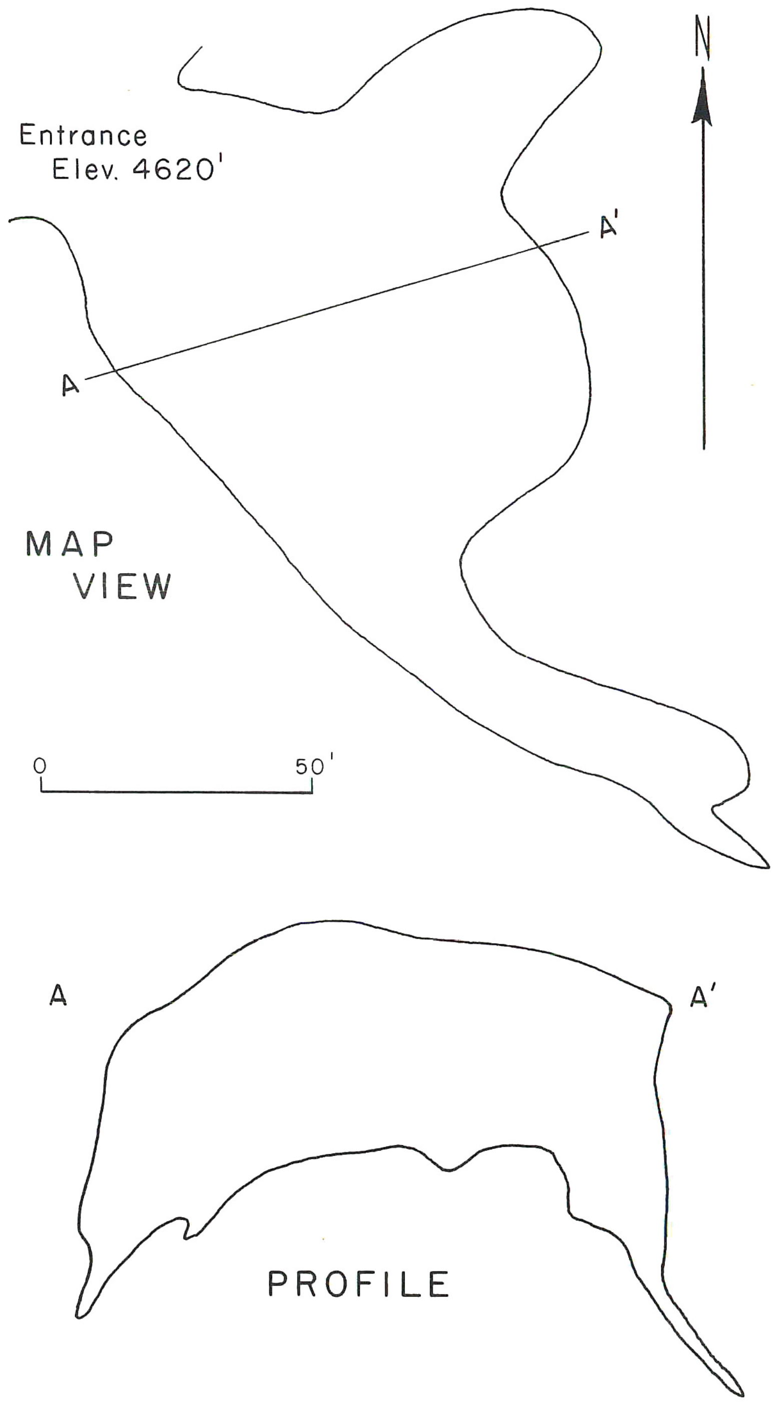


Figure 39.–Devil's Balcony Cave

about 100 feet of crawlway. This cave lies on Crow Indian tribal land, where trespassing and cave exploring are prohibited. The cave formed in north-dipping Mission Canyon Formation.

Summit Creek Cave

Cave no.:	105	Range:	Pryor
County:	Big Horn	Map coverage:	Castle Rocks 1:24,000
Location:	sec. 1, T. 7 S., R. 25 E.	Altitude:	4,000 ft.

This cave, south of West Pryor Mountain on Crow Indian tribal land, is probably a small rock shelter in Summit Creek Canyon. No other information is available.

CARBON COUNTY

Bear Canyon Cave

Cave no.:	106	Range:	Pryor
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	probably sec. 12, T. 8 S., R. 26 E. (unsurveyed)	Altitude:	approximately 8,500 ft.

This cave is at the head of the middle fork of Bear Creek on Big Pryor Mountain; the entrance is a vertical pit of unknown depth. Estimates of pit depth range from 40 to 100 feet. The cave is difficult to locate and has never been explored. It developed in west-dipping Mission Canyon Formation.

Bear Tooth Cavern

Cave no.:	270	Range:	Beartooth
County:	Carbon	Map coverage:	Billings: 1:250,000
Location:	Unknown		

This cave is in the Beartooth Mountains near Red Lodge. A 1930 edition of the *Great Falls Tribune* mentions the cave.

Blackie Ice Cave

Cave no.:	107	Range:	Pryor
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	sec. 6, T. 8 S., R. 27 E. (unsurveyed)	Altitude:	7,000 ft.

This cave, at the lower end of Commisary (Crooked Creek) Ridge, has a 10-foot sinkhole as the entrance, which is 40 feet deep. A small, domed room connects to the bottom of the pit. Ice covers the floor of the cave all year, and bones of horses and cattle have been found in the ice. The cave formed in south-dipping Mission Canyon Formation.

Canyon Wall Cave

Cave no.:	119	Range:	Pryor
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	sec. 3, T. 8 S., R. 27 E. (unsurveyed)	Altitude:	approximately 8,000 ft.

This cave lies about a half mile up the canyon from Big Ice Cave and is in the same canyon wall. The entrance is a low passage at the base of a 50-foot cliff and is very difficult to locate.

The cave, containing less than 200 feet of passage and one small chamber, formed in the Mission Canyon Formation.

Big Ice Cave

Cave no.:	118	Range:	Pryor
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	sec. 3, T. 8 S., R. 27 E. (unsurveyed)	Altitude:	7,530 ft.
		Temperature:	33°F

This cave lies near the head of Cave Canyon on East Pryor Mountain. The entrance, on the west rim of the canyon, is a 10- by 20-foot opening under a limestone cliff. The entrance opens into a room 150 feet long that has ice-covered floors. A second room is reached by descending a small vertical hole at the back of the first chamber (a ladder has been placed in this opening). The floors of the second room are also covered with about 25 feet of ice, and ice crystals decorate the walls and ceiling. Old Forest Service reports indicate that a third room may exist below the ice but it is not accessible. The ice level has been dropping in recent years, as it has in all the Pryor Mountain ice caves.

The cave has been gated by the Forest Service, and tours are conducted from 10 a.m. to 4 p.m. on weekends from July 1 to Labor Day.

The cave developed in Mission Canyon Formation, which here strikes N. 25° W. and dips 8° W. The cave lies in a very fossiliferous layer of limestone beneath a solution-breccia zone.

Crater Ice Cave

Cave no.:	117	Range:	Pryor
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	sec. 6, T. 8 S., R. 27 E. (unsurveyed)	Altitude:	8,690 ft.
		Temperature:	33°F

Crater Ice Cave is near the summit of Big Pryor Mountain and has two entrances, one a 20-foot vertical sink, and the other a 5-foot opening under a limestone ledge. The cave is horizontal and consists of one room, 150 feet in diameter, and 200 feet of passage. The floor contains much breakdown and clay fill. Near the back, ice forms all year from water dripping out of ceiling fractures. The entrance is commonly plugged by drifting snow. The cave formed in massive Mission Canyon Formation.

D-9 Cave

Cave no.:	108	Range:	Pryor
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	sec. 1, T. 8 S., R. 26 E. (unsurveyed)	Altitude:	approximately 8,650 ft.

This cave, on Big Pryor Mountain near Crater Ice Cave, was uncovered in the early 1950's by a uranium prospector. It is hard to find among numerous prospect trenches cut in the area.

The cave contains two talus-choked chambers and several crawlways; passage totals about 350 feet. Speleothems are limited to flowstone and small stalactites. The cave formed in southwest-dipping Mission Canyon Limestone.

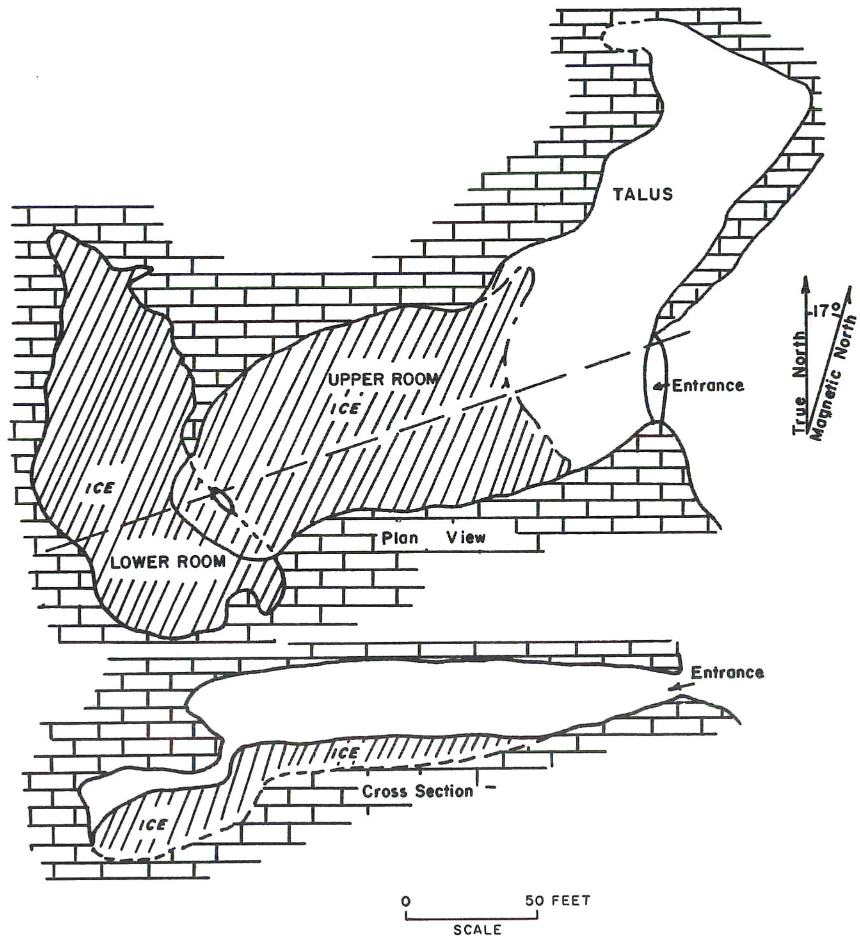


Figure 40.–Big Ice Cave. (Reprinted by permission from National Speleological Society Guidebook No. 10, 1969.)

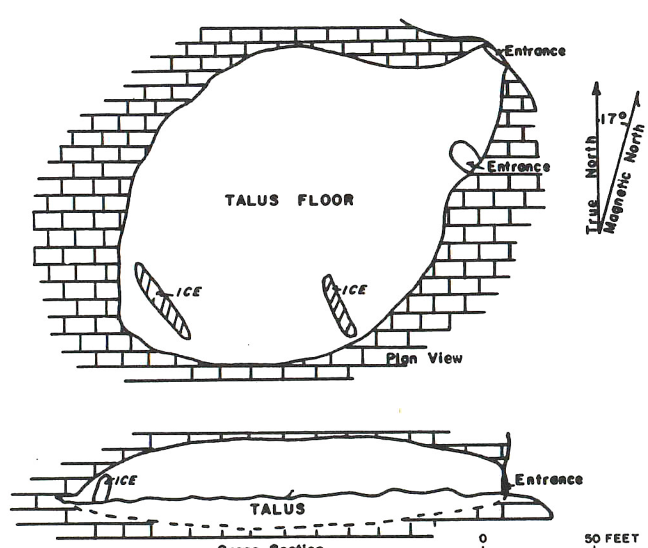


Figure 41.–Crater Ice Cave. (Reprinted by permission from National Speleological Society Guidebook No. 10, 1969.)

Four by Four Cave

Cave no.:	132	Range:	Pryor
County:	Carbon	Map coverage:	Mystery Cave 1:24,000
Location:	sec. 21, T. 9 S., R. 28 E.	Altitude:	5,450 ft.

This small cave, south of Mystery Cave on the same ridge, lies in timber and is difficult to find. The entrance is a 20-foot vertical sink, and the cave consists of one small room half filled with breakdown. No speleothems are developed in this cave, which formed in Madison Group carbonate rocks.

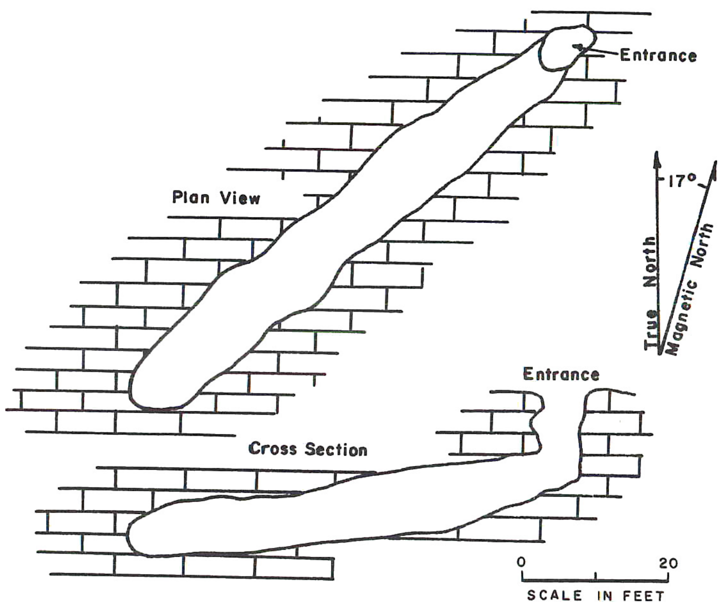


Figure 42.–Four by Four Cave

Four Eared Bat Cave

Cave no.:	131	Range:	Pryor
County:	Carbon	Map coverage:	Mystery Cave 1:24,000
Location:	sec. 27, T. 9 S., R. 28 E.	Altitude:	5,040 ft.

This cave lies about 7 miles south of Mystery Cave on a small flat-topped ridge. The entrance is a small sink that opens into two large rooms with flat, sandy floors. The cave has a population of about 40 California lump-nosed bats. The cave, formed in Madison Limestone, has a few stalactites.

Frogg's Fault

Cave no.:	130	Range:	Pryor
County:	Carbon	Map coverage:	Mystery Cave 1:24,000
Location:	sec. 16, T. 9 S., R. 28 E.	Altitude:	6,020 ft.
		Temperature:	40°F

Frogg's Fault is about 5 miles south of Mystery Cave on the same ridge. The name, Frogg, was found smoked on the cave walls at the base of the entrance drop. This is the deepest known cave in Region II and reaches a depth of -261 feet. The entrance is a vertical fissure 40 feet long and 15 feet wide. After an initial 25-foot free drop. two successive pitches, a 54-foot pit and a 19-foot drop, require rope. The rest of the cave is a S. 52° W-trending fissure with high ceilings and narrow walls. The cave has a total horizontal length of 766 feet (Fig. 43).

The term fault in the name Frogg's Fault is misleading; no evidence of faulting can be seen in the cave. At -248 feet the bedding in both sides matches perfectly, and yellow chert bands on both walls also match. The cave is strictly joint controlled and may have formed from gravity sliding, as several slide blocks can be seen in an escarpemnt a half mile away. Almost no solution features can be found in the cave, which is very dry and dusty. Although there are no speleothems, some thin plates of $CaCO_3$ cemented together resemble crude boxwork. The cave developed in the Mission Canyon Formation that here trends N. 30° W., 9° SW.

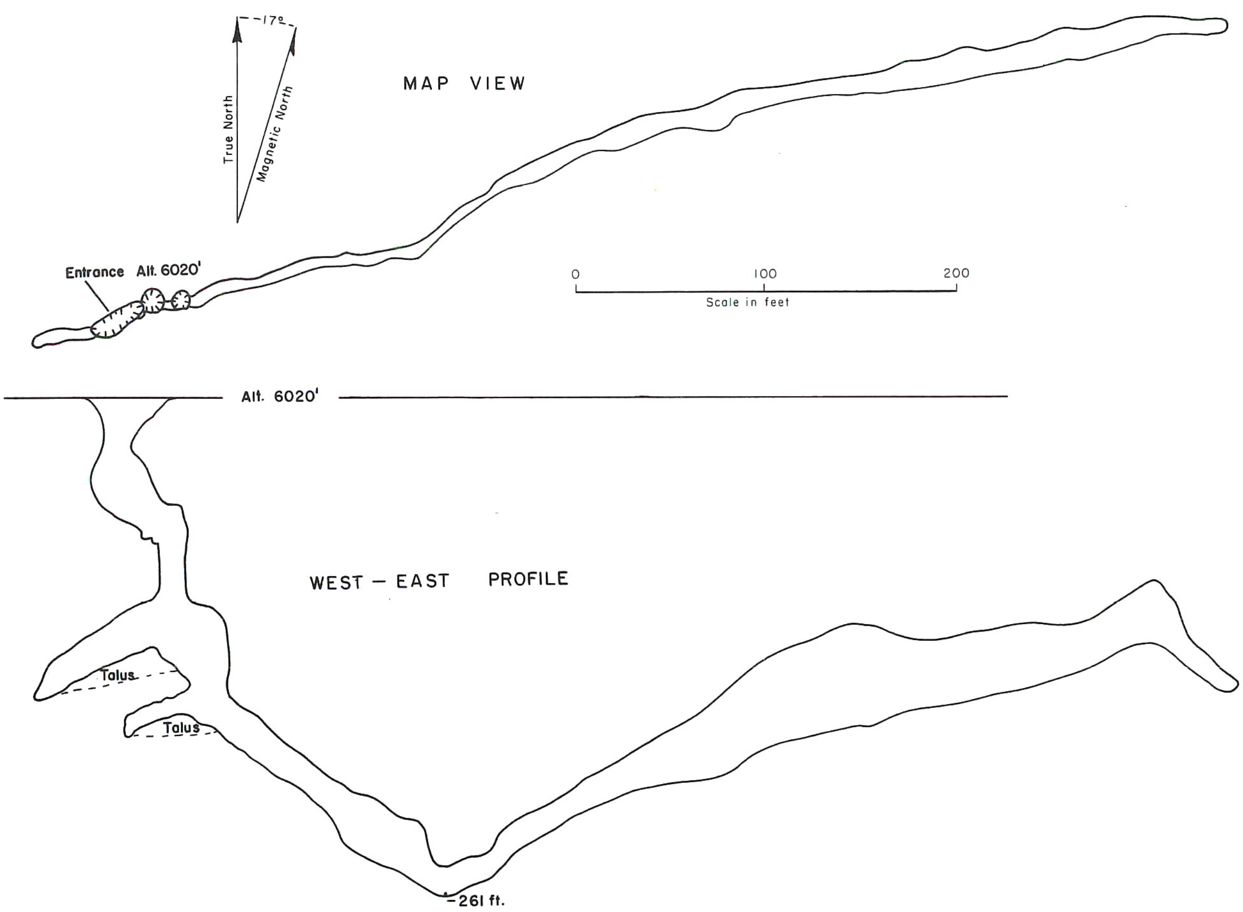


Figure 43.–Frogg's Fault

Karst Area Sinks

Cave no.:	109	Range:	Pryor
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	sec. 7, 10, and 19, T. 8 S., R. 27 E. (unsurveyed)	Altitude:	8,600 ft.

These caves are a series of sinkholes on Big Pryor Mountain between Crater Ice Cave and Red Pryor Ice Cave. At least one sinkhole is 50 feet deep; many have not been explored. The area seems to be in a youthful stage of karst development as sinkholes are widespread, side passages are few, and most drainage is surficial. This karst area developed on nearly horizontal Mission Canyon Formation.

Keyhole Cave

Cave no.:	121	Range:	Pryor
County:	Carbon	Map coverage:	Red Pryor Mountain 1:24,000
Location:	sec. 35, T. 8 S., R. 27 E. (unsurveyed)	Altitude:	5,600 ft.

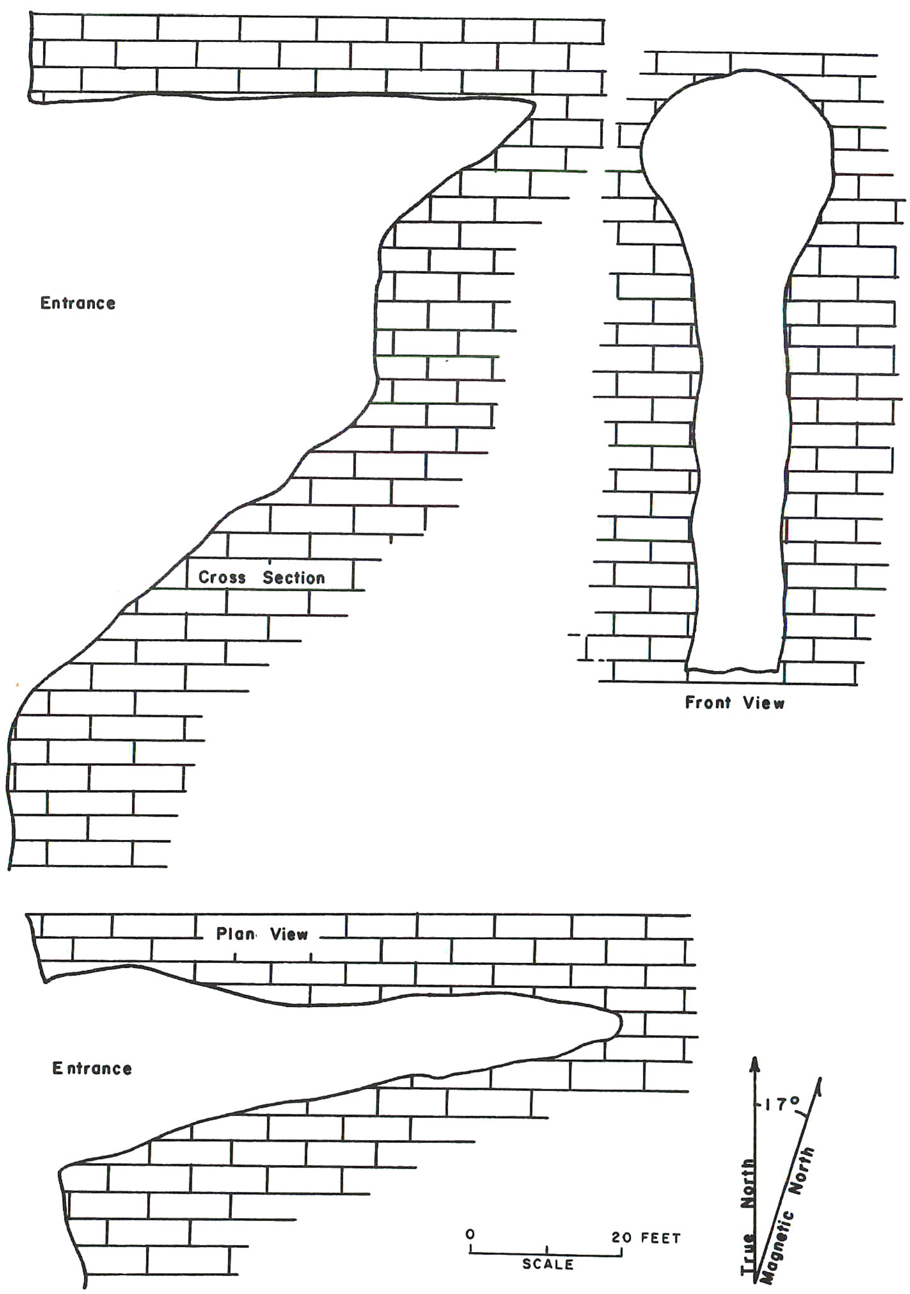


Figure 44.–Keyhole Cave

Keyhole Cave, named for its entrance shape, is a rock shelter on the east side of Crooked Creek. The entrance is a slit 80 feet high and 20 feet wide that opens into one large room. The cave floor is littered with breakdown and clay, and there are no side passages or speleothems. The cave formed in the Mission Canyon Formation.

Lisbon Mine Cave

Cave no.:	110	Range:	Pryor
County:	Carbon	Map coverage:	Red Pryor Mountain 1:24,000
Location:	sec. 4, T. 9 S., R. 27 E.	Altitude:	6,600 ft.

This cave is inside the Lisbon uranium mine on Red Pryor Mountain where an adit penetrated a series of interconnecting solution cavities. The cavities are lined with dogtooth spar crystals (a variety of calcite) that may have formed when the cave was still beneath the water table. The mine is no longer in operation, and the main adit is partly collapsed (1968). The cave formed in the Madison Limestone.

Little Ice Cave

Cave no.:	120	Range:	Pryor
County:	Carbon	Map coverage:	East Pryor Mountain 1:24,000
Location:	sec. 18, T. 8 S., R. 28 E.	Altitude:	8,180 ft.
		Temperature:	33½°F

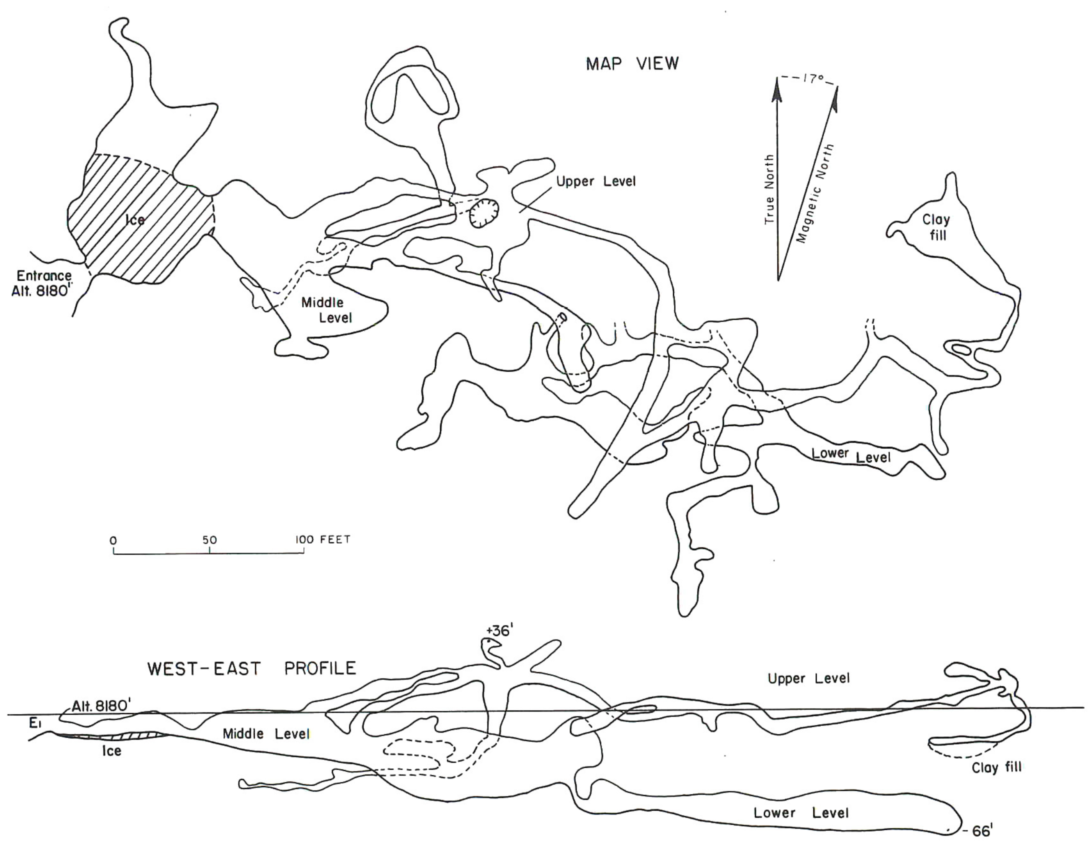


Figure 45.–Little Ice Cave

Little Ice Cave is near the summit of East Pryor Mountain about 2 miles northwest of Mystery Cave and on the east fork of Lostwater Canyon. The entrance, on the east side of the canyon, consists of a 3- by 8-foot opening beneath a low limestone ledge. The bedding strikes N. 80° W. and dips 8° S. The entrance opens into a 60- by 100-foot room; the floor is covered by 1 to 3 feet of ice. Passages from the west side of the room open into three cave levels consisting mainly of small rooms connected by low, twisting crawlways. Total mapped passage to date is 2,929 feet, but several leads remain unmapped; the true size of the cave is estimated at about 3,500 feet and it is the largest in the Pryor Mountains (Fig. 45). The cave is moderately dry beyond the ice area, but no gypsum was observed in the cave. Speleothems are limited to a small amount of flowstone, ice crystals, and ice stalagmites. Large numbers of horn corals and bryozoans as well as shell layers composed entirely of spiriferoid brachiopods were found in many areas of the cave. Many of the passages are choked or filled with red clay or with some breakdown mixed with clay.

The multilevel nature of the cave suggests that at least two, and perhaps three, changes in the level of the water table were necessary to form the different levels. No solution breccia was observed in Little Ice Cave. Many of the passages seem to have been developed along a 5- to 15-foot zone containing layers of carbonate made up entirely of spiriferoid brachiopods. Tests show that this layer (or layers) is slightly more soluble than the surrounding rock. Several blind leads were found to be clay filled, and suggested a Mississippian age for the cave, which developed in the upper part of the Mission Canyon Formation.

Little Sink Cave

Cave no.:	129	Range:	Pryor
County:	Carbon	Map coverage:	Mystery Cave 1:24,000
Location:	sec. 21, T. 9 S., R. 28 E.	Altitude:	5,300 ft.

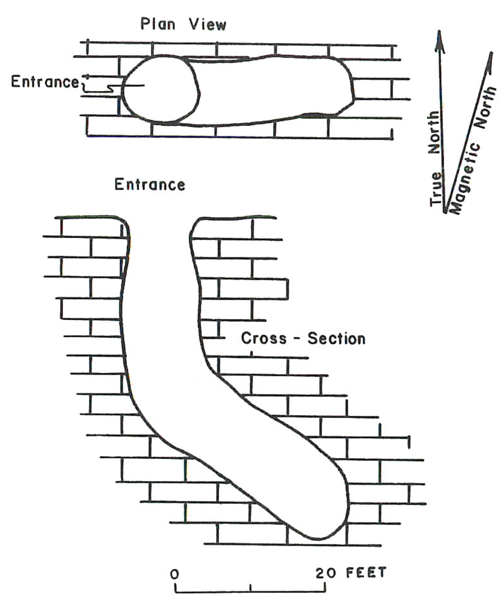


Figure 46.–Little Sink Cave

This cave is a small sinkhole about 20 feet deep with one small sloping passage leading steeply downward to a depth of about 40 feet. There are no speleothems, but numerous cave crickets have been found in the cave. The cave formed in nearly horizontal Madison Limestone.

Mystery Cave (Mystic Cave)

Cave no.:	122	Range:	Pryor
County:	Carbon	Map coverage:	Mystery Cave 1:24,000
Location:	sec. 21, T. 8 S., R. 28 E.	Altitude:	7,820 ft.
		Temperature:	38°F

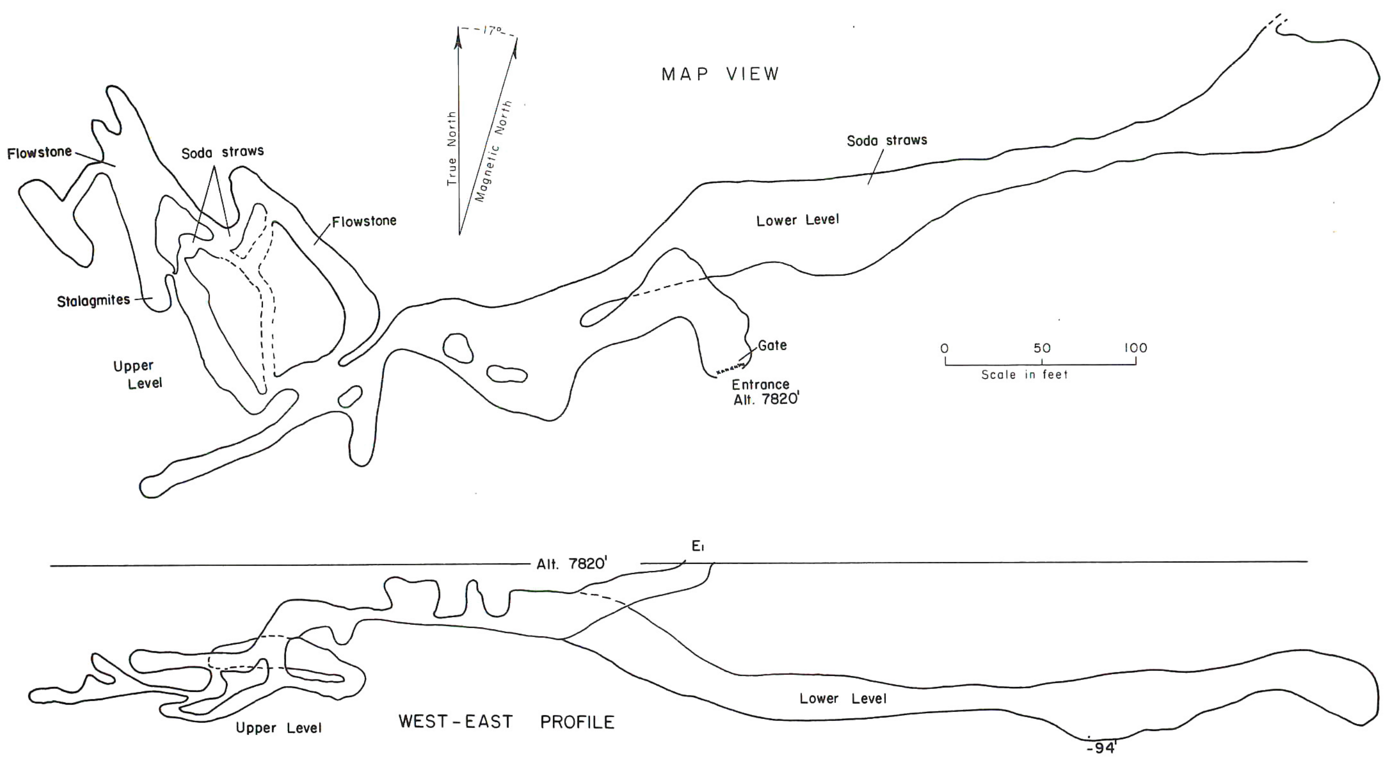


Figure 47.–Mystery Cave

Mystery Cave is near the south end of East Pryor Mountain; the entrance is a small sinkhole lying in a heavily timbered area. The cave lies on Bureau of Land Management land and has been gated to prevent vandalism; keys may be obtained from the Bureau of Land Management office in Billings. The cave slopes steeply downward from the entrance and then splits in two directions. The most traveled area is an eastward-trending passage that is very large: 25 to 50 feet wide and 30 feet high (Fig. 47). This passage, which is about 400 feet long, contains large piles of breakdown and a few small soda-straw stalactites. The "upper" level of the cave is a maze of about 1,000 feet of interconnecting small passages and rooms, contains many soda-straw stalactites, stalagmites, and flowstone, and is one of the better decorated caves in Montana. This part contains very little breakdown, and most of the passages and rooms are floored with red clay.

The cave developed in the Mission Canyon Formation, which trends N. 75° E., 11° SE. The "lower" level of the cave formed in a series of 2- to 4-foot layers of massive gray limestone, but most of the "upper" level developed in a single massive limestone unit about

10 feet thick. The cave is still active and wet where speleothems are forming. Some wet parts of the cave are coated with a dark-green algal or fungus slime. The total length of the cave is 1,646 feet and the vertical extent is 94 feet.

Nameless Pryor Cave

Cave no.:	124	Range:	Pryor
County:	Carbon	Map coverage:	East Pryor Mountain 1:24,000
Location:	sec. 7, T. 8 S., R. 28 E.	Altitude:	8,200 ft.

This cave lies near Mystery Cave on East Pryor Mountain. The entrance is a 60-foot pit with smooth walls; it has never been explored. It was found in 1961 but has been "lost" since then. The cave developed in the Mission Canyon Formation.

Natural Arch Cave

Cave no.:	123	Range:	Pryor
County:	Carbon	Map coverage:	East Pryor Mountain 1:24,000
Location:	sec. 36, T. 7 S., R. 27 E. (unsurveyed)	Altitude:	8,650 ft.

This cave lies on East Pryor Mountain near Little Ice Cave. Its entrance was formed by the collapse of the top of a 20-foot-high chamber. A short 65-foot crawlway leads north from the room. The cave formed in the Mission Canyon Formation.

Old Glory Mine Cave

Cave no.:	111	Range:	Pryor
County:	Carbon	Map coverage:	Red Pryor Mountain 1:24,000
Location:	sec. 32, T. 8 S., R. 27 E. (unsurveyed)	Altitude:	7,810 ft.

The main adit of the Old Glory mine intersects a cave that is reported to contain several small rooms and interconnecting passages. Gypsum and calcite crystals are said to exist in the cave, but the total extent of the cave is unknown. The mine is now inoperative but the main adit can still be entered. The cave formed in south-dipping Madison Limestone.

Org Chasm

Cave no.:	280	Range:	Pryor
County:	Carbon	Map coverage:	Red Pryor Mountain 1:24,000
Location:	Unknown		

This cave lies near the top of Red Pryor Mountain in a small meadow, but the exact location is unknown. The entrance is a 15-foot vertical pit about 20 feet in diameter. A sloping passage leads to a small room about 40 feet below the entrance. The total length of the cave is about 85 feet. The entrance is usually partly plugged with snow and ice. This cave, which may be one of the Karst Area Sinks, is formed in Madison Group carbonate rocks. There are speleothems in the cave.

Peterson's Pit

Cave no.:	302	Range:	Bighorn
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	probably sec. 6, T. 8 S., R. 27 E. (unsurveyed)	Altitude:	8,700 ft.

This cave lies near Crater Ice Cave on Big Pryor Mountain. The entrance is a small sinkhole with a 3-foot hole in the bottom. Beyond the entrance, the cave takes on a cracklike appearance and is developed along a single joint. The bottom ends in an 80-foot pit and is 180 feet below the entrance. Rope is required to reach the bottom. An article in the September 1971 issue of the *National Speleological Society News* described the cave. Peterson's Pit formed in carbonate rocks of the Mission Canyon Formation.

Pryor Mountain Mine Cave

Cave no.:	112	Range:	Pryor
County:	Carbon	Map coverage:	Red Pryor Mountain 1:24,000
Location:	sec. 17, T. 9 S., R. 27 E.	Altitude:	5,400 ft.

This cave is on the south end of Red Pryor Mountain where a uranium mine adit intersected two underground chambers, one of which is lined with calcite crystals. The mine and cave are in the Mission Canyon Formation.

Red Lodge Creek Caves

Cave no.:	269	Range:	Beartooth
County:	Carbon	Map coverage:	Mount Maurice 1:62,500
Location:	center of T. 7 S., R. 18 E.	Altitude:	9,000 + ft.

These caves are at the head of Red Lodge Creek between Red Lodge and Absarokee. One large cave is reported, but no other information is available.

Red Pryor Ice Cave

Cave no.:	113	Range:	Pryor
County:	Carbon	Map coverage:	Red Pryor Mountain 1:24,000
Location:	sec. 30, T. 8 S., R. 27 E.	Altitude:	7,900 ft.
	(unsurveyed)	Temperature:	34°F

This cave, near the summit of Red Pryor Mountain, has two vertical entrances that open into the ceiling of a single large room 200 by 350 feet. A cone-shaped mass of ice and snow at each entrance results from snow drifting into the cave during the winter. Some parts of the cave floor are also covered with a thin layer of ice all year. The cave has no side passages.

The cave formed in or just below a mass of solution breccia in the Mission Canyon Formation. The breccia consists of 2- to 4-inch gray limestone fragments in a dark-red calcareous siltstone matrix.

Bone fragments, including the skull of a cougar, have been found in the cave; no speleothems were observed.

Royce Cave

Cave no.:	126	Range:	Pryor
County:	Carbon	Map coverage:	Mystery Cave 1:24,000
Location:	sec. 6, T. 9 S., R. 28 E.	Altitude:	6,160 ft.

Royce cave lies on the east side of Burnt Timber Canyon in moderately heavy timber. The entrance is a small opening at the base of a large sinkhole. About 100 feet of crawlway leads to

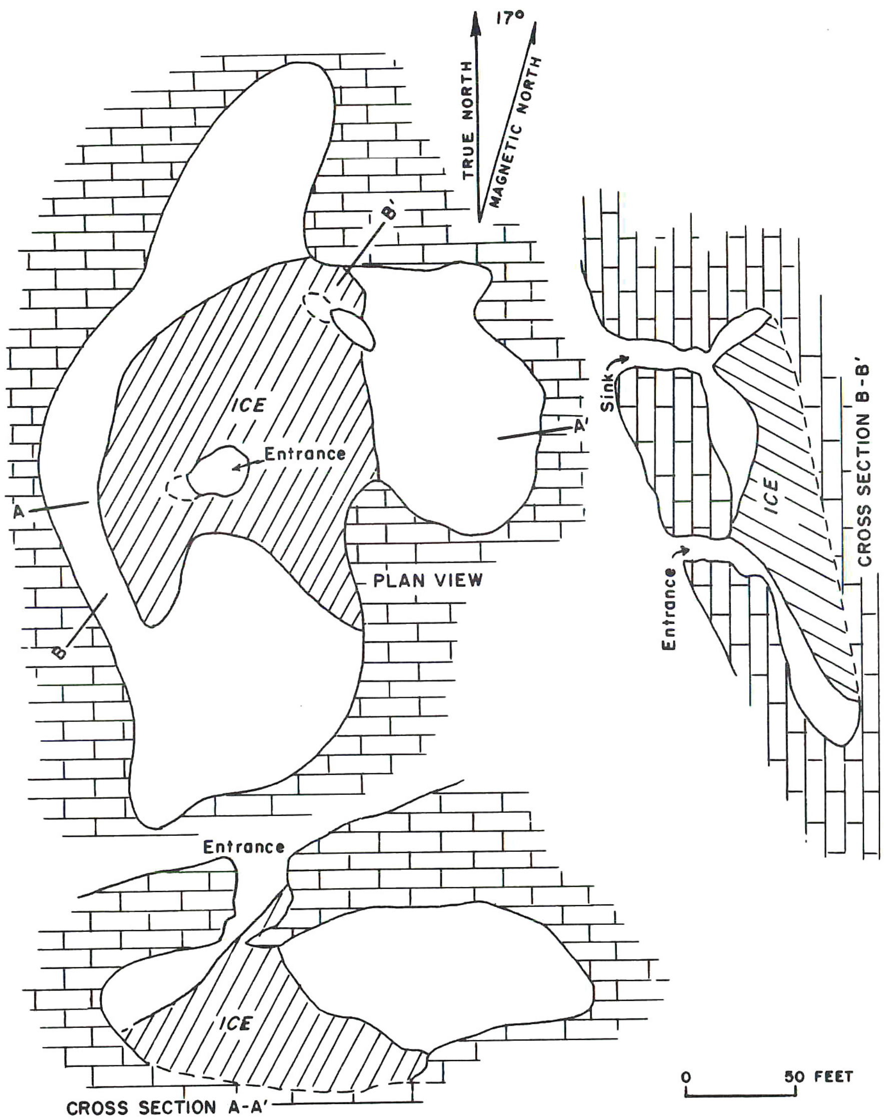


Figure 48.–Red Pryor Ice Cave
(Reprinted by permission from National Speleological Society Guidebook No. 10, 1969.)

a 40-foot circular room; about 50 feet of passage extends from the room, which is lined with calcite crystals and, from within, looks like a big geode; speleothems may have formed in this cave when it was still under water. The cave formed in the Mission Canyon Formation.

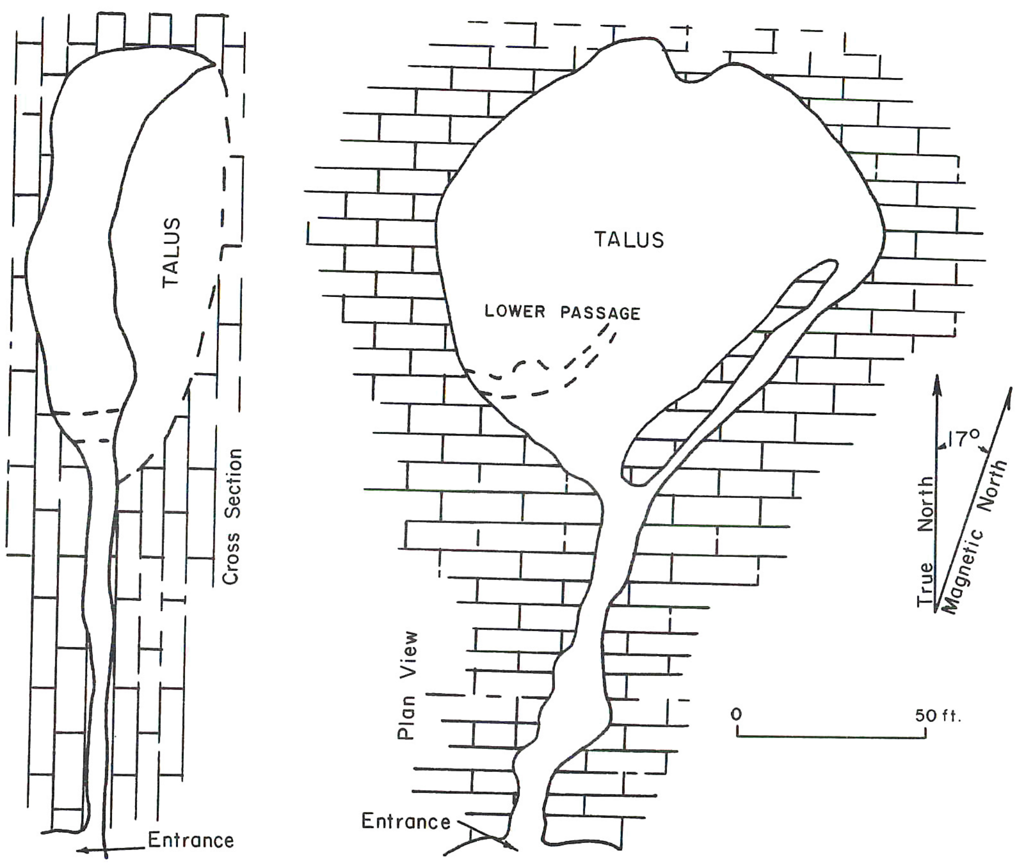


Figure 49.–Royce Cave
(Reprinted by permission from National Speleological Society Guidebook No. 10, 1969.)

Sage Creek Cave

Cave no.:	116	Range:	Pryor
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	probably south half T. 7 S., R. 26 E. (unsurveyed)	Altitude:	approximately 6,000 ft.

This cave is on the south rim of Sage Creek Canyon. The entrance, a small hole about halfway up the side of a 100-foot cliff, leads to a 45-foot pit; more than 2,000 feet of passage extends beyond. This cave has not been entered in recent years and is very difficult to find. Several attempts to find it in the 1960's were unsuccessful. The cave developed in Madison Group carbonate rocks.

Salt Lick Cave

Cave no.:	127	Range:	Pryor
County:	Carbon	Map coverage:	East Pryor Mountain 1:24,000
Location:	sec. 17, T. 8 S., R. 28 E.	Altitude:	8,150 ft.

This cave is about one mile east of Little Ice Cave and at the base of a large cliff. The south-facing 10-foot-diameter opening leads to a chamber 100 feet long and 30 feet wide. There are no side passages or speleothems. A wooden bed frame and old utensils remained in the cave after it was used by sheepherders in the 1930's. This cave formed in the Mission Canyon Formation.

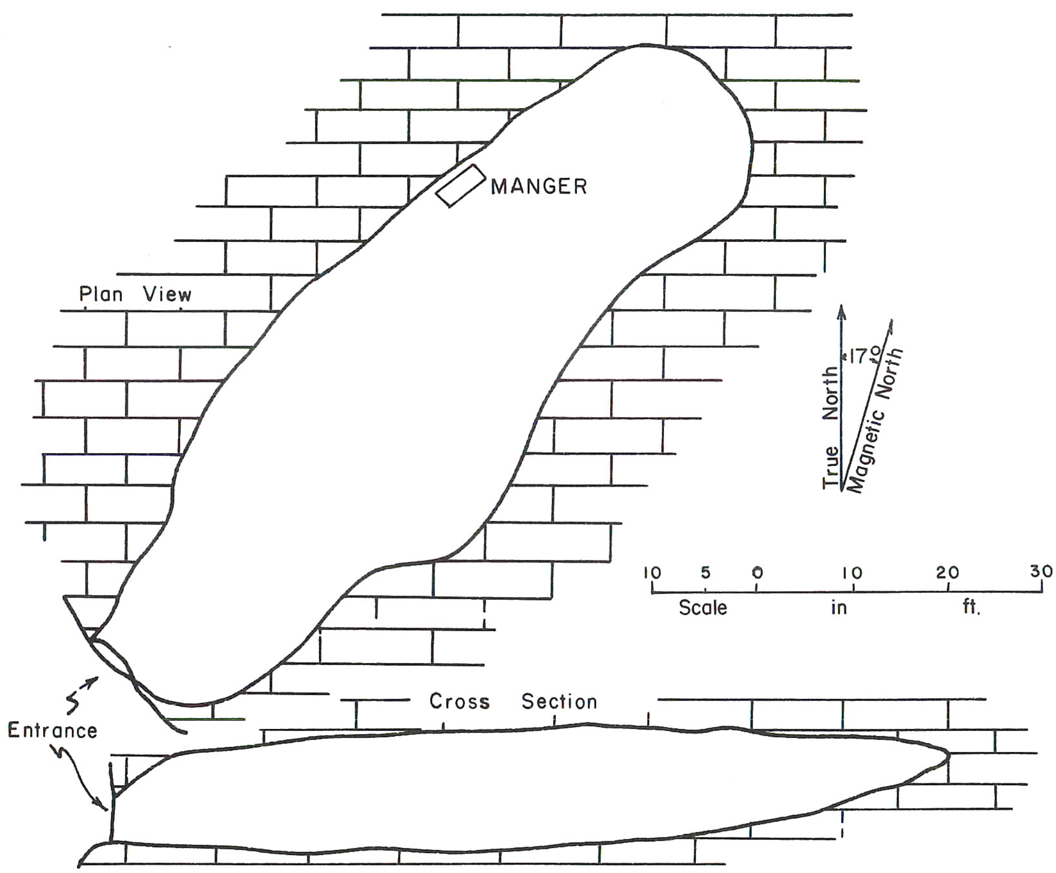


Figure 50.–Salt Lick Cave
(Reprinted by permission from National Speleological Society Guidebook No. 10, 1969.)

Snow Drift Cave

Cave no.:	267	Range:	Pryor
County:	Carbon	Map coverage:	East Pryor Mountain 1:24,000
Location:	sec. 17, T. 8 S., R. 28 E.	Altitude:	8,300 ft.

This cave is near Mystery Cave on East Pryor Mountain. It has a slanting entrance, plugged by snow for most of the year, and one room at the bottom. The cave formed in the Mission Canyon Formation.

Star Cave

Cave no.:	115	Range:	Pryor
County:	Carbon	Map coverage:	Indian Spring 1:24,000
Location:	sec. 12, T. 7 S., R. 25 E.	Altitude:	approximately 4,000 ft.

This rock shelter is on the north wall of Sage Creek Canyon near the Sage Creek Ranger Station. The cave has a 5-foot opening and large entrance room. It formed in north-dipping Mission Canyon Formation.

Summit Cave

Cave no.:	125	Range:	Pryor
County:	Carbon	Map coverage:	Big Ice Cave 1:24,000
Location:	probably sec. 35, T. 7 S., R. 27 E. (unsurveyed)	Altitude:	8,520 ft.

This cave is on the divide between Tony Island and the Dry Head drainage. The entrance is a 75-foot vertical pit, which has not been descended. The cave is very difficult to find, and several recent searches have failed to locate it. The cave formed in south-dipping Madison Group carbonate rocks.

Sykes Cave

Cave no.:	128	Range:	Pryor
County:	Carbon	Map coverage:	Mystery Cave 1:24,000
Location:	sec. 22, T. 9 S., R. 28 E.	Altitude:	5,700 ft.

This cave lies about 6 miles south of Mystery Cave on the same main ridge. The entrance, a small hole on the side of a cliff in a brush-filled canyon, opens into a large room that has two leads. One passage ends in breakdown after 100 feet, but the other crawlway winds eastward for about 350 feet. Most of the passage is less than 5 feet high and is floored with clay or cave popcorn. The cave was named for a man who supposedly lived in it, R. O. Sykes. The cave formed in west-dipping Mission Canyon Formation.

Teton Cave

Cave no.:	114	Range:	Pryor
County:	Carbon	Map coverage:	Indian Spring 1:24,000
Location:	sec. 18, T. 7 S., R. 26 E. (unsurveyed)	Altitude:	4,000 ft.

Teton Cave is on the east side of Sage Creek Canyon, 2½ miles northwest of the Sage Creek Ranger Station. The entrance is a large opening in limestone cliffs and is visible from the road. The cave consists of one large room and 30 feet of crawlway. It is named for Teton Jackson, an outlaw who used the cave as a hideout in the 1880's. The cave formed in north-dipping Mission Canyon Formation.

CARTER COUNTY

Medicine Rocks Caves

Cave no.:	92	Location:	various sections, T. 3 N., R. 58 E.
County:	Carter	Map coverage:	Ekalaka 1:250,000

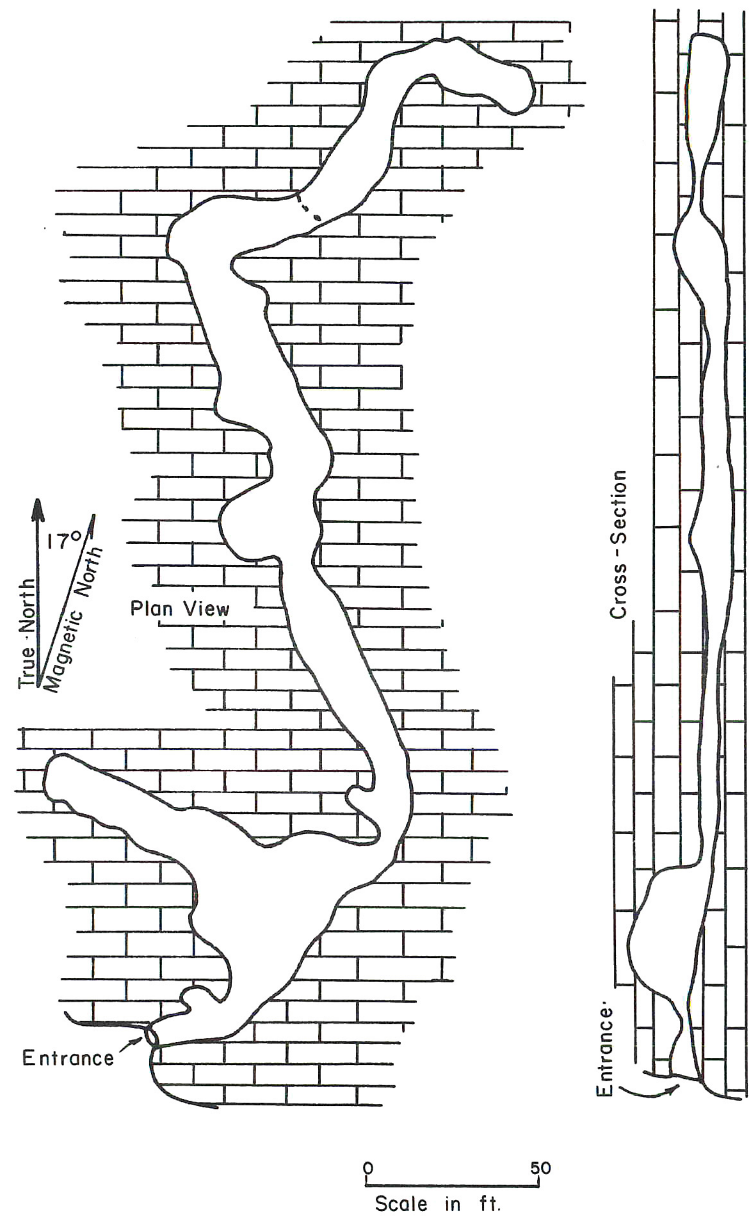


Figure 51.–Sykes Cave
(Reprinted by permission from National Speleological Society Guidebook No. 10, 1969.)

These rock shelters are in the Medicine Rocks State Park south of Baker. The rock shelters formed in the Fort Union Formation.

Starvation Butte Caves

Cave no.:	93	Location:	T. 1 S., R. 59 E.
County:	Carter	Map coverage:	Ekalaka 1:250,000

These caves are on Starvation Butte southeast of Ekalaka. They are a group of rock shelters formed in the Foxhills Sandstone.

MUSSELSHELL COUNTY

Bull Mountain Caves

Cave no.:	94	Range:	Bull
County:	Musselshell	Map coverage:	Musselshell 1:24,000
Location:	sec. 29, T. 9 N., R. 29 E.	Altitude:	3,100 ft.

These small rock shelters, south of U.S. Highway 12 one mile west of Musselshell, formed in sandstone of the Fort Union Formation, probably by wind erosion.

Cliff Dweller Caves

Cave no.:	95	Range:	Bull
County:	Musselshell	Map coverage:	Roundup 1:250,000
Location:	probably T. 7 N., R. 26 E.		

These caves, in the Bull Mountains south of Roundup, consist of several rock shelters developed in the Fort Union Formation.

ROSEBUD COUNTY

Forsyth Bat Cave

Cave no.:	279	Location:	probably T. 6 N., R. 41 E.
County:	Rosebud	Map coverage:	Forsyth 1:250,000

This large rock shelter is near the town of Forsyth. Exact dimensions are unknown, but the cave is said to house a large colony of bats. The cave formed in the Hell Creek Formation.

YELLOWSTONE COUNTY

Coburn Hill Indian Cave

Cave no.:	96	Map coverage:	Yegen 1:24,000
County:	Yellowstone	Altitude:	3,500 ft.
Location:	sec. 16, T. 1 S., R. 26 E.		

This rock shelter, formed in sandstone cliffs south of Billings, was described in the March 3, 1938, issue of the *Rocky Mountain Husbandman.* It has yielded charcoal, points, and ornaments as much as 1,000 years old from an ancient tribe known as the "Sheepeaters". The walls of the cave are covered with paintings showing hunting and religious scenes. More information is available from the Montana Historical Society in Helena.

Ghost Cave

Cave no.:	98	Location:	T. 1 S., R. 27 E.
County:	Yellowstone	Map coverage:	Billings 1:250,000

This cave is very near Inscription Cave southeast of Billings. The sandstone rock shelter is one small room that contains a few badly weathered pictographs.

Inscription Cave

Cave no.:	99	Location:	T. 1 S., R. 27 E.
County:	Yellowstone	Map coverage:	Billings 1:250,000

Inscription Cave is 8 miles southeast of Billings. The rock shelter developed in Eagle Sandstone cliffs high on the south rim of the Yellowstone River canyon. An article on this cave can be found in the March 16, 1941, issue of the *Billings Gazette*. The cave was excavated in the 1940's and yielded more than 30,000 artifacts from four distinct Indian groups. Some of the artifacts are believed to be at least 10,000 years old. In addition, pictographs (now vandalized) cover the cave walls.

Laurel Cave

Cave no.:	268	Location:	T. 2 S., R. 24 E.
County:	Yellowstone	Map coverage:	Billings 1:250,000

Laurel Cave is a small cave formed in sandstone cliffs along the Yellowstone River near Laurel. No other information is available.

Skeleton Indian Cave

Cave no.:	97	Location:	sec. 27, T. 1 N., R. 26 E.
County:	Yellowstone	Map coverage:	Billings East 1:24,000

This one-room rock shelter north of Billings was described in the April 16, 1942, issue of the *Billings Gazette*.

SOUTHWESTERN MONTANA REGION (III)

The southwestern region contains a large number of mountain ranges in ten counties of southern and southwestern Montana (Fig. 1). Region III is geologically complex and contains a greater variety of caves than any other area. Because most mountain ranges are unrelated from a geologic standpoint and because caves are found in different rock units, it is difficult to generalize about Region III. For a general description, the reader may refer to Perry (1962) and Thornbury (1965). The bibliography in each book cites articles dealing with more detailed geology of various parts of southwestern Montana.

Region III contains significant caves in four separate rock units: Cherry Creek Group (Precambrian), Meagher Formation (Cambrian), Jefferson Formation (Devonian), and Madison Group (Mississippian). In addition, some smaller caves are found in the Quadrant Formation (Pennsylvanian) and in Recent travertine.

About 80 percent of the caves formed in the Mission Canyon Formation of the Madison Group. Most of these caves are small and contain less than 300 feet of passage; many are vertical pits or have steeply dipping crawlways and rooms. Several good-size caves can be found in Cambrian carbonate rocks; maze-type caves having narrow passages and few rooms are characteristic. In extreme southwestern Montana, the principal cave former is the Jefferson Formation. Although Devonian rocks are dolomitic, caves formed in the more limy beds of the Jefferson Formation. Caves in Devonian rocks tend to be large and to have fault-controlled passages.

Most of the carbonate rocks in the region crop out at high elevations and many caves can be reached only on foot. Southwestern Montana may eventually yield the most caverns of any region in the state, as many square miles of limestone outcrops have never been systematically searched for caves.

Ice caves are not as common in Region III as in other parts of the state, but many of the caves are occupied by underground streams. Except during spring runoff, the streams are usually small (although one cave stream has pools as deep as 6 feet) and are best explored in the late fall when the water level is low.

Over all, the caves in this area are more decorated than those in other regions. Stalactites, stalagmites, and flowstone are common and, although much vandalized, can still be seen in the more inaccessible caves.

BEAVERHEAD COUNTY

Anderson Gypsum Pit

Cave no.:	180	Range:	Snowcrest
County:	Beaverhead	Map coverage:	Antone Peak 1:24,000
Location:	T. 11 S., R. 5 W.	Altitude:	7,500 ft.

This cave, 40 miles south of Dillon, on the Hans Anderson Ranch, is a vertical pit uncovered in a gypsum prospect. The depth is unknown as the pit has not been plumbed; the rock in the quarry is very crumbly. No other information is available.

Argenta Cave

Cave no.:	177	Range:	Pioneer
County:	Beaverhead	Map coverage:	Argenta 1:24,000
Location:	sec. 4, T. 6 S., R. 10 W.	Altitude:	7,280 ft.
		Temperature:	41°F

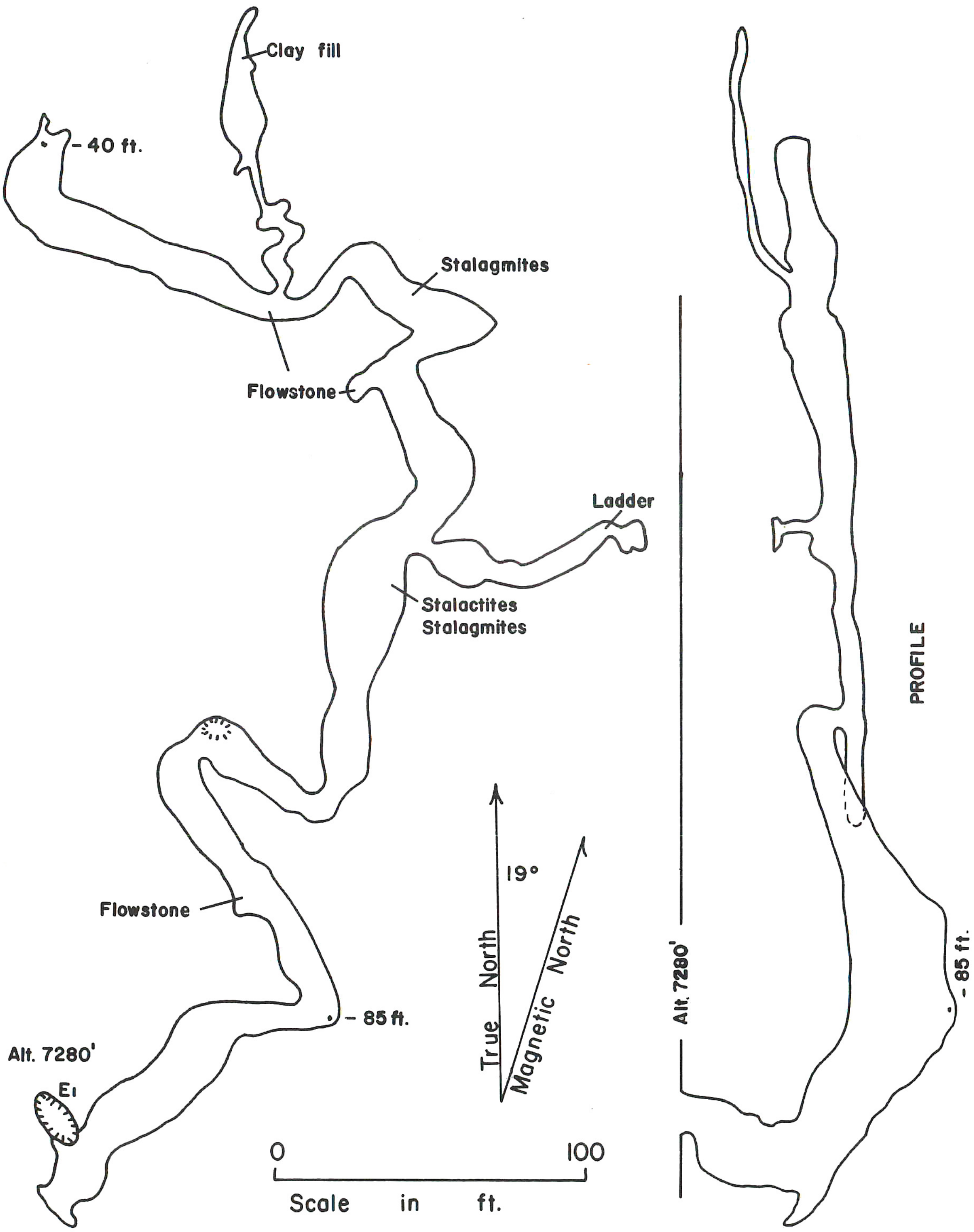


Figure 52.–Argenta Cave

Argenta Cave is 5 miles north of Argenta, in Cave Gulch. The entrance, in the bottom of the gulch in heavy timber, is a 40-foot pit about 5 to 15 feet wide; rope is necessary to enter. Although the creek sinks at a point 200 feet upstream from the entrance, it does not appear in the cave. The rest of the cave is horizontal and contains 805 feet of passage. The main passage trends roughly north and is large enough to walk through. Three small leads trend upward from the main passage but pinch out within 100 feet.

One pool of water, about 10 feet in diameter, is near the rear of the cave. Breakdown covers the floors of most of the passages although the smaller passages are filled with clay. Wooden ladders placed in several vertical cracks are rotted and dangerous. The cave has been known since the mid-1800's, and one name and date of 1874 seem to be authentic. The cave is now owned by Lee Smith of Argenta.

Argenta Cave contains massive speleothems. Large stalagmites, stalactites, columns, and flowstone decorate the cave, but many of the formations have been heavily vandalized.

The cave developed in the Jefferson Formation (Devonian), which here trends N. 65° E. 33° SE; part of the cave is joint controlled. The cave may have been an underground channel for Cave Gulch Creek; lowering of the water table below the cave has left it relatively dry.

French Creek Cave

Cave no.:	176	Range:	Pioneer
County:	Beaverhead	Map coverage:	Ermont 1:24,000
Location:	sec. 1, T. 6 S., R. 11 W.	Altitude:	7,332 ft.
		Temperature:	43°F

The French Creek Cave is 15 miles northwest of Dillon, on the French Creek branch of Rattlesnake Creek. The entrance is on the west side of the canyon in one of a group of adits known as the Park mine. The cave was discovered in the late 1930's while miners were driving the Steel Adit. The entrance to the cave is about 200 feet into the adit. Stanley Shafer of Dillon is the present owner of the mine and cave.

A steeply sloping entrance crawlway reaches to about 100 feet. At this point the cave opens into a relatively flat section where passages lead in three directions. The "upper level" consists of large rooms and walking passage totaling about 2,000 feet. Most of the cave floor in this part is composed of dry dirt and broken speleothems. The large amount of silt and fault breccia makes the rock very crumbly and unstable.

Near the entrance room, a second steeply dipping passage leads to two pits, the first of which is a 40-foot drop that requires rope. A short tunnel leads to a second 70-foot overhanging pitch. At the base of the second drop the cave opens into a very large room known as the Black Hall. Passages leading from this part (lower level) have been only partly explored, but more than 6,000 feet of passage has been mapped. The mapped part of the cave totals 9,669 feet, but an additional 1 mile of unmapped passage probably exists in the lower level. One side passage called "The Sump" reaches a depth of -434 feet and has not been explored to its total depth. French Creek Cave is currently Montana's sixth deepest and fourth longest cave. As one progresses deeper into the cave, it becomes wetter until at the -400-foot level many pools and small streamlets of water make it extremely muddy. At this point the cave must be very close to the water table. Formations are active at this depth in many parts of the cave. The only known cave pearls in Montana are found in the lower level along with abundant stalactites and stalagmites. Soda-straw stalactites, some more than two feet long, were found in the "Sump" area.

Breakdown and loose rock in the lower level make this cave very dangerous to explore. Several unexplored pits in the lower level require ropes; care should be used in any exploration attempts.

French Creek Cave developed in the Jefferson Formation (Devonian), which in this area is roughly 500 feet thick and consists of alternating layers of black massive crystalline dolomite and yellowish-brown thin-bedded silty limestone. Solution has taken place within the silty limestone (3 to 20 feet thick) rather than in the less soluble black dolomite. Ceiling collapse has left large slabs of dolomite breakdown littering many of the rooms and has exposed the dolomite in the walls and roof. The Jefferson Formation in the cave dips 35° NW and gives many of the passages and rooms a distinctly slanted look; passage development, however, is horizontal and not downdip as in most Montana caves. French Creek Cave does not have Paleozoic origin but was formed within the last few million years.

Although much of the solution has taken place along joints (one major set trends N. 45° W.), faults have played a role in forming many of the passages. One large fault trending N. 5° W. passes through the Black Hall area, where fault breccia and slickensides are abundant. Pits and passage that give access to the lower level were probably developed along this fault. Other smaller faults, also north trending, were observed in various parts of the cave and have passages developed along them.

Two distinct levels can be seen from the cross-section; perhaps a third level will be found in the "Sump" area once exploration is complete. These levels formed when the water table dropped after the level of a major stream in the area was lowered (probably the Beaverhead River). It is interesting to note that French Creek is only 220 feet below the mouth of the cave, but the cave is already explored to a depth of more than 400 feet, so French Creek may carry only surface runoff. The only spring in the area is 2 miles away and 700 feet lower than the cave entrance; it is possible that the cave may extend to a depth of 700 feet.

Comparison of the cave map with the Ermont quadrangle (1:24,000) shows that the cave is in the heart of a 4-mile northeast-trending ridge and that it roughly parallels the ridge. Therefore, the cave may contain many miles of passage.

Although the only known entrance is through an old gold mine, stream channels within the cave contain well-rounded pebbles of quartzite, sandstone, and granite and some boulders as large as 8 inches in diameter. These fragments, probably from nearby glacial moraines, must have been washed into the cave by surface streams, so a surface entrance exists or existed within the recent geologic past. Analysis of the gravel shows some gold.

Irishman's Hole Caves

Cave no.:	178	Range:	Ruby
County:	Beaverhead	Map coverage:	Ashbough Canyon 1:24,000
Location:	sec. 20, T. 9 S., R. 8 W.	Altitude:	7,100 ft.

Irishman's Hole is a steep canyon 10 miles south of Dillon. Near the head of the left fork of the canyon are several rock shelters known as Irishman's Hole Caves. They are found in a steeply dipping belt of Madison Limestone.

Lost Cave (Lost Cave of Irishman's Hole)

Cave no.:	179	Range:	Ruby
County:	Beaverhead	Map coverage:	Ashbough Canyon 1:24,000
Location:	sec. 17, T. 9 S., R. 8 W.	Altitude:	7,200 ft.

Lost cave, lying in a small canyon known as Irishman's Hole, 10 miles south of Dillon, is in a dense forest near "The Gap" (two large rocks near the mouth of the canyon). The cave was first found by two pioneers in the 1880's and was revisited in the early 1900's. Since then it has been lost. The entrance is a small hole that drops vertically for an unknown depth. Estimates indicate that the depth of the pit is more than 100 feet. The cave formed in near-vertical Madison Limestone.

Mont-Ida Cave

Cave no.:	186	Range:	Beaverhead
County:	Beaverhead	Map coverage:	Morrison Lake 1:62,500
Location:	probably T. 14 S., R. 12 W.	Altitude:	approximately 8,000 ft.

This vertical pit is almost exactly on the Montana-Idaho border. A Forest Service report mentions that a ranger once descended the pit for 200 feet without reaching the bottom. No further attempts have been made to explore the cave.

Nelson-Sprinkle Cave

Cave no.:	181	Range:	Ruby
County:	Beaverhead	Map coverage:	Gallagher Mountain 1:24,000
Location:	sec. 24, T. 9 S., R. 9 W.	Altitude:	6,680 ft.
		Temperature:	43°F

Nelson-Sprinkle Cave is approximately 13 miles south of Dillon in Sheep Canyon. The three entrances are about 200 feet above the valley floor near the "Rye Patch" and are aligned along a N. 70° W.-trending fissure. The entire cave formed along the fissure, and a series of vertical drops and climbs down rock wedged in the fissure leads to the bottom at -127 feet. The cave has no speleothems or other solution features.

Nelson-Sprinkle Cave is one of several gravity-slide caves developed in the Quadrant Formation. The Quadrant here trends N. 50° E., 9° NW. The caves formed in a friable calcareous sandstone member within the Quadrant Formation. The southeast side of Sheep canyon, for a distance of 2 miles, is in the process of sliding downdip toward the valley floor. The loose sand may act like small bearings on which the large blocks glide. The movement is recent, as some trees are bent by the sliding rock. Many caves formed as fractures in the blocks and as tunnels under piles of breakdown. Some of the caves in the area contain ice all year. Sliding action continuously creates and destroys this type of cave.

Nelson No. 2 Cave

Cave no.:	182	Range:	Ruby
County:	Beaverhead	Map coverage:	Gallagher Mountain 1:24,000
Location:	sec. 24, T. 9 S., R. 9 W.	Altitude:	7,050 ft.

This is a horizontal cave that lies about 200 feet above Nelson-Sprinkle Cave in Sheep Canyon. It is one of many gravity-slide caves formed in the Quadrant Formation. The floor of the cave contains about 1 foot of ice all year. Loose blocks of calcareous sandstone form the ceiling.

Sand Cave

Cave no.:	183	Range:	Ruby
County:	Beaverhead	Map coverage:	Gallagher Mountain 1:24,000
Location:	sec. 24, T. 9 S., R. 9 W.	Altitude:	7,200 ft.

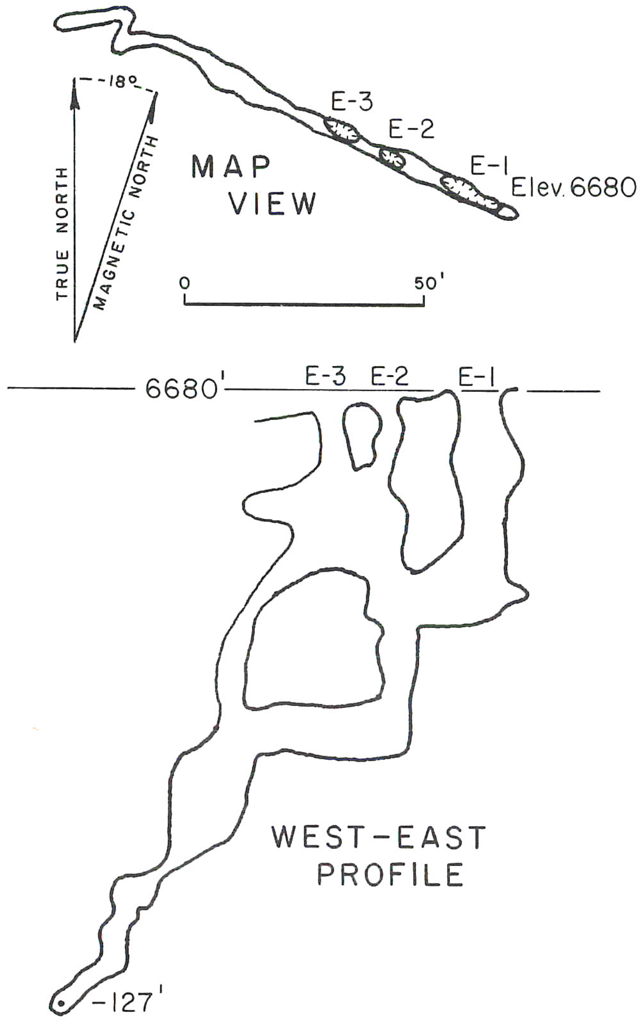


Figure 53.–Nelson-Sprinkle Cave

This cave is above Nelson-Sprinkle Cave in Sheep Canyon and is one of many gravity-slide caves in sandstone of the Quadrant Formation. The entrance is a narrow fissure between two large blocks of sandstone. Collapse of other blocks and dirt fill form the roof of the cave. There are no speleothems.

Sheep Canyon Cave

Cave no.:	184	Range:	Ruby
County:	Beaverhead	Map coverage:	Gallagher Mountain 1:24,000
Location:	sec. 1, T. 9 S., R. 8 W.	Altitude:	6,300 ft.

This cave is at the mouth of Sheep Canyon about 10 miles south of Dillon. The entrance is high above the valley floor on the south side of the canyon and can be seen for many miles. The cave has one room about 30 feet in diameter and 20 feet high. When it was excavated by Phillip Orr between 1925 and 1930, ash and charcoal were uncovered in the upper 6 inches of clay, and bones of horse, camel, bison, and sheep were found to a depth of 3 feet. Large barite crystals were found attached to some bones. The entire collection is now housed in the Santa Barbara Museum of Natural History. The cave formed in solution breccia in the upper part of the Mission Canyon Formation.

Sourdough Cave

Cave no.:	185	Range:	Tendoy
County:	Beaverhead	Map coverage:	Deer Canyon 1:24,000
Location:	sec. 13, T. 12 S., R. 11 W.	Altitude:	8,380 ft.

This caves lies 16 miles northwest of Dell, at the head of Sourdough Creek. The entrance is on the west side of the canyon near Sourdough Spring. A large collapsed sinkhole forms the entrance, which connects to a room about 20 feet in diameter; no side passages lead from the room. Sourdough Cave formed in Madison Group carbonate rocks.

BROADWATER COUNTY

Big Belt Cave

Cave no.:	157	Range:	Big Belt
County:	Broadwater	Map coverage:	Duck Creek Pass 1:62,500
Location:	sec. 22, T. 6 N., R. 3 E.	Altitude:	4,800 ft.

This cave is south of Dry Creek near the Forest Service Boundary about 20 airline miles southeast of Townsend. The entrance is a steeply sloping tunnel that becomes vertical after about 50 feet. Rope is required for further exploration; the depth of the pit is unknown. The cave formed in Madison Group carbonate rocks.

Burnt Canyon Cave

Cave no.:	158	Range:	Big Belt
County:	Broadwater	Map coverage:	Toston 1:62,500
Location:	sec. 35, T. 6 N., R. 4 E.	Altitude:	5,600 ft.

This cave is southeast of Townsend, in a burned area near Timbeı Gulch. The entrance is at the extreme head of "Burnt Canyon". The cave, found by fire fighters, consists of a deep vertical pit that has never been explored. The cave formed in west-dipping Madison Limestone.

Crow Creek Crevice

Cave no.:	156	Map coverage:	Radersburg 1:62,500
County:	Broadwater	Altitude:	4,300 ft.
Location:	probably sec. 8, T. 3 N., R. 1 E.		

This cave is not near Crow Creek but is at the crest of a hill between Toston and Three Forks. It has a 2- by 15-foot fissure-type entrance, which is vertical and is estimated to be between 60 and 100 feet deep. Water can be heard running at the bottom of the pit, and sheepherders may have descended the pit in search of water for their stock. The total extent of the cave is not known. It formed at the crest of a small anticline in the Mission Canyon Formation.

Gold Saver Shaft

Cave no.:	159	Range:	Big Belt
County:	Broadwater	Map coverage:	Toston 1:62,500
Location:	sec. 33, T. 5 N., R. 3 E.	Altitude:	4,880 ft.

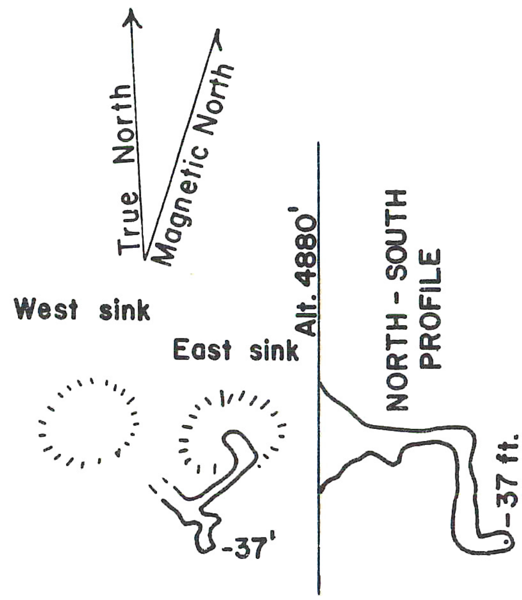


Figure 54.–Gold Saver Shaft

This cave is about 4 miles southeast of Toston and north of Sixteenmile Creek. The cave consists of two side-by-side 18-foot sinks. The west sink is plugged at a depth of 10 feet, but the east sink has a 2-foot hole at its base. This passage leads downward about 25 feet to a short crawlway. Air moving in the lower end suggests a connection with the west sink or a deeper cave. The sinks formed in the Mission Canyon Formation, which here trends N. 5° W., 20° E.

Hardy Hole

Cave no.:	271	Range:	Limestone Hills
County:	Broadwater	Map coverage:	Townsend 1:62,500
Location:	T. 7 N., R. 1 E.		

This cave is about 5 miles west of Townsend, according to an article in the *Townsend Messenger* dated July 30, 1894. The cave may be the same as Old Woman Cave, but no other information is available. The cave probably formed in Madison Group carbonate rocks.

Horse Thief Cave

Cave no.:	272	Range:	Limestone Hills
County:	Broadwater	Map coverage:	Townsend 1:62,500

Horse Thief Cave lies west of Townsend, in the Limestone Hills. The exact location and size are unknown.

Old Woman Cave

Cave no.:	160	Range:	Limestone Hills
County:	Broadwater	Map coverage:	Townsend 1:62,500
Location:	sec. 3, T. 6 N., R. 1 E.	Altitude:	4,800 ft.

Old Woman Cave lies at the summit of a high ridge about 4 miles west of Townsend. The entrance is a 4- by 8-foot sink that dips steeply northward to a depth of 75 feet. The cave is clay filled at this point, but attempts to dig through the fill have disclosed about 15 feet of horizontal passage. The cave formed in east-dipping Mission Canyon Formation.

T-Mountain Cave

Cave no.:	163	Map coverage:	Three Forks 1:62,500
County:	Broadwater	Altitude:	4,800 ft.
Location:	sec. 30, T. 2 N., R. 1 E.		

This cave is on T Mountain—named for a large T placed on the hill by the Three Forks High School. The entrance is on the southeast side of the hill under a low cliff. Two large openings narrow rapidly and become a crawlway within a few feet. The crawlway ends about 100 feet from the entrance. The dry and dusty cave, containing abundant rat and bat guano, developed in Madison Group carbonate rocks.

Toeckes Cave

Cave no.:	162	Range:	Big Belt
County:	Broadwater	Map coverage:	Canyon Ferry 1:62,500
Location:	sec. 11, T. 10 N., R. 1 E.	Altitude:	approximately 5,000 ft.

Toeckes Cave is near Canyon Ferry Dam east of Helena and lies on a divide between the Hellgate Gulch and Avalanche Creek drainages. The cave is an extremely large rock shelter composed of three interconnecting rooms that open to the north. The largest room, about 100 by 200 feet, is partly filled with breakdown; two smaller rooms, about 20 feet in diameter, are connected by low crawlways to the main room. The cave developed in the Mission Canyon Formation. Toeckes Cave probably represents a small portion of a much larger cave that was destroyed through canyon erosion by a nearby stream.

West Cave

Cave no.:	161	Range:	Limestone Hills
County:	Broadwater	Map coverage:	Townsend 1:62,500

This cave lies west of Townsend in the Limestone Hills. No other information is available, but the cave may be the same as Old Woman Cave.

DEER LODGE COUNTY

Garrity Cave

Cave no.:	187	Range:	Flint Creek
County:	Deer Lodge	Map coverage:	West Valley 1:24,000
Location:	sec. 2, T. 5 N., R. 12 W.	Altitude:	8,250 ft.
		Temperature:	36°F

Garrity Cave is 12 miles northwest of Anaconda, on Foster Creek—the cave lies in a meadow near the canyon head. The entrance has been shored up with logs, and a 6-foot steel ladder has been placed in the entrance room. A small hole in the floor opens into the top of a large room. A 29-foot steel ladder allows easy descent of this vertical pitch. The cave beyond consists of three large rooms connected by moderately dipping walking passage. Two other ladders have been placed to ease descent. A total of 602 feet of passage constitutes the cave, which reaches a depth of -227 feet (Fig. 55).

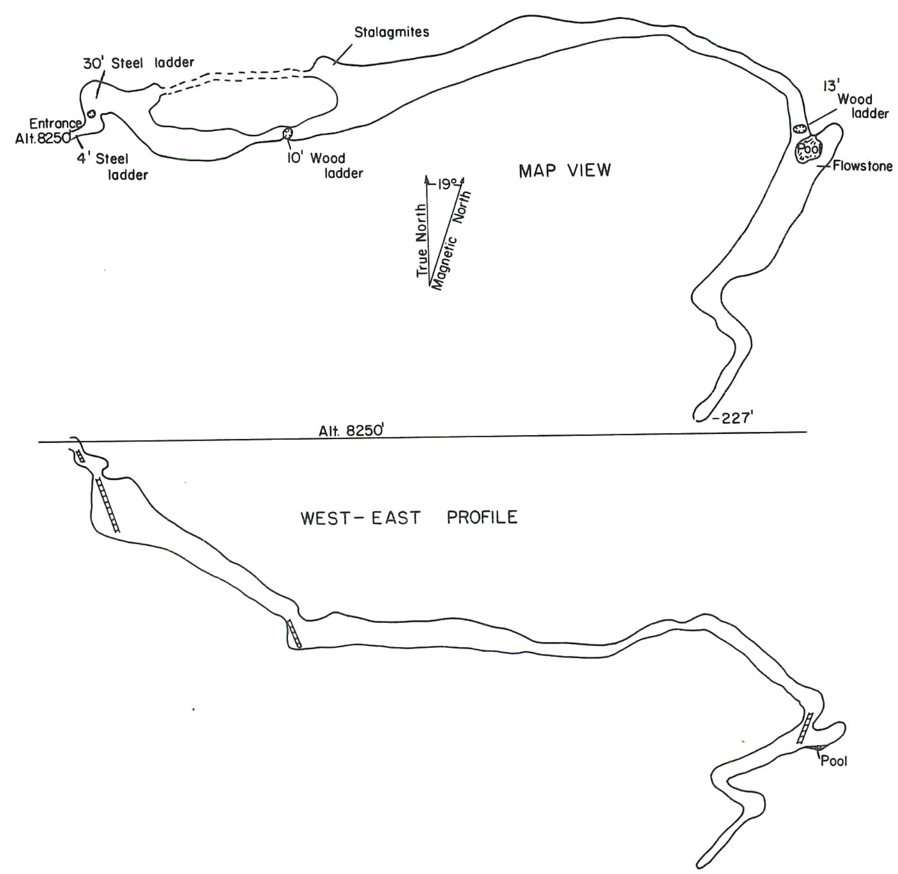


Figure 55.–Garrity Cave

This cave is well decorated with flowstone and stalagmites that range from light brown to white. The cave is wet and all the formation is active. Flowstone cements most of the breakdown to the floor in the lower half of the cave. A large pool, 10 feet wide and 4 feet deep, is near the end of the cave.

Garrity Cave formed in the Meagher Formation. The black and white mottling of the Meagher Formation stands out on several walls. The cave must lie near a fault or intrusion, as some breccia in the cave and in several prospect pits nearby contains mineralized and fractured rock. The cave passage runs at an angle to the bedding strike and dip and is probably joint controlled. Marbelization of the Meagher give the rock the appearance of a very coarse texture.

GALLATIN COUNTY

Arch Pit

Cave no.:	300	Range:	Gallatin
County:	Gallatin	Map coverage:	Bozeman 1:62,500
Location:	sec. 10, T. 4 S., R. 5 E.	Altitude:	8,400 ft.

Arch Pit lies on the south side of Wheeler Mountain in a grassy meadow near the summit. The entrance is a hole 8 feet wide and 30 feet long spanned by a limestone arch that divides the hole roughly in half. The cave, probably 30 feet deep, is often filled with snow. A few small stalactites hang near the bottom of the pit. The cave formed in the Mission Canyon Formation.

Atkin Cave

Cave no.:	246	Range:	Spanish Peaks
County:	Gallatin	Map coverage:	Spanish Peaks 1:62,500
Location:	probably sec. 15, T. 4 S., R. 3 E.	Altitude:	approximately 5,600 ft.

Atkin Cave lies on property belonging to Turner Atkin near Spanish Creek southwest of Bozeman. The cave has about 200 feet of tight crawlway, and a small stream flows down the main passage. The cave seems to be joint controlled and is developed along two sets of joints in the Jefferson Formation. The cave may contain some unexplored side passage but has no speleothems.

Bear Canyon Bottomless Pit (Moonmilk Pit)

Cave no.:	148	Range:	Gallatin
County:	Gallatin	Map coverage:	Bozeman 1:62,500
Location:	sec. 10, T. 4 S., R. 5 E.	Altitude:	8,400 ft.

This cave lies on the south side of Wheeler Mountain about 10 miles south of Bozeman; the opening is in heavy timber near the summit. A 30-foot sink drops 37 feet to the cave below, and rope is needed to enter. The cave consists of one large room 70 feet long and 30 feet wide. The walls are coated with moonmilk, a spongy $CaCO_3$ speleothem. The cave formed in the Mission Canyon Formation.

Chestnut Cave

Cave no.:	145	Range:	Gallatin
County:	Gallatin	Map coverage:	Bozeman Pass 1:62,500
Location:	sec. 29, T. 2 S., R. 7 E.	Altitude:	6,000 ft.

This cave, about 5 miles east of Bozeman, is on a limestone cliff south of the highway. Two small entrances lead to a 20-foot room. The rest of the cave consists of low, narrow passages with dirt floors. The general slope is 5° to 10° to the north along the bedding. The only speleothems are cave popcorn and calcite crystals. The cave, formed in the Mission Canyon Formation, has 325 feet of passage.

Lion Cave

Cave no.:	151	Map coverage:	Manhattan 1:62,500
County:	Gallatin	Altitude:	4,100 ft.
Location:	sec. 9, T. 2 N., R. 2 E.		

This cave is near Trident, at the Headwaters of the Missouri State Park; the entrance is a large hole in a cliff on the Gallatin River. The cave, which has been blasted shut just beyond the entrance, consisted of a single narrow passage about 100 feet long. It developed along a single joint in the Mission Canyon Formation.

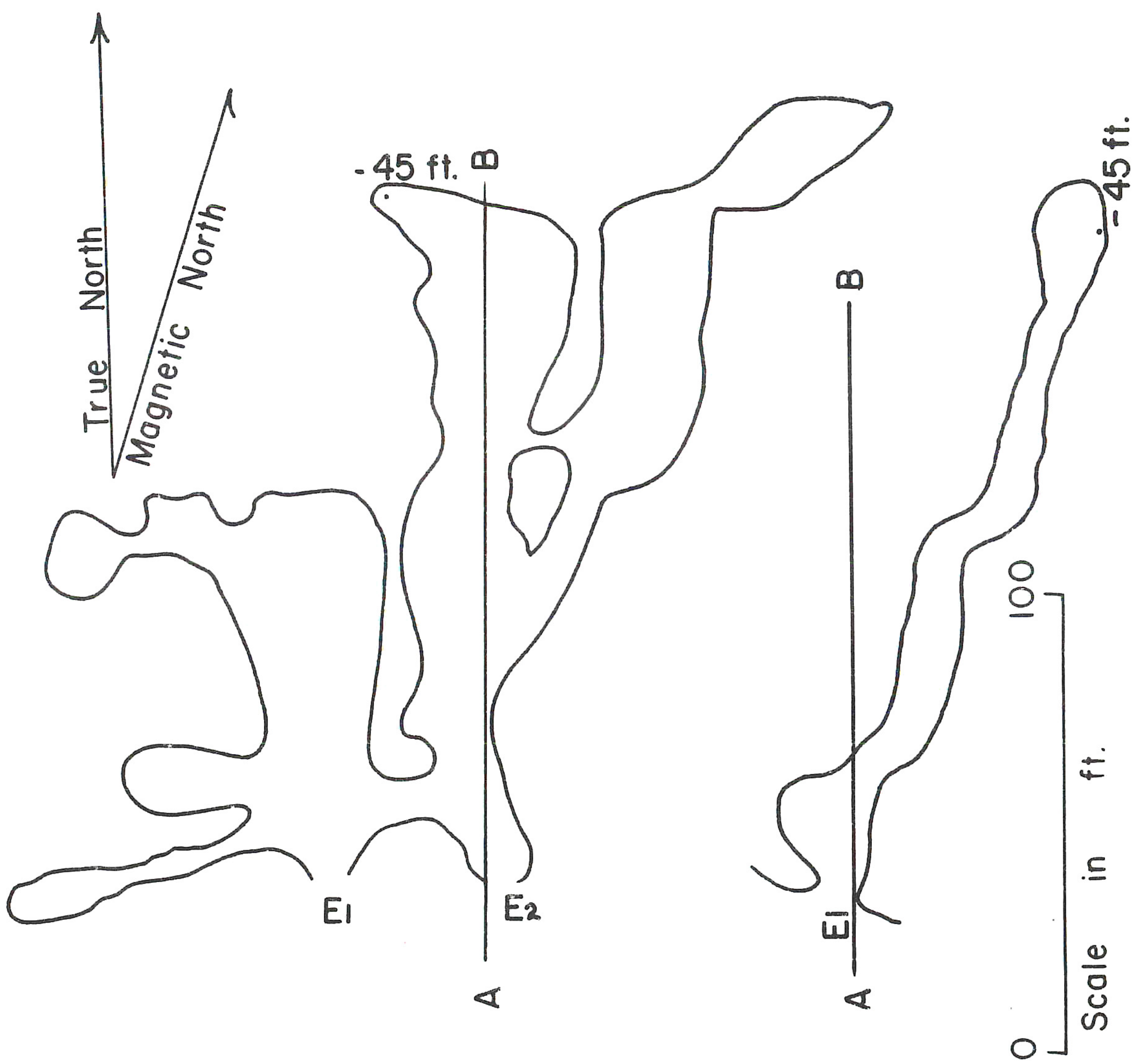


Figure 56.–Chestnut Cave

Lombard Cave

Cave no.:	155	Location:	probably sec. 18, T. 4 N., R. 3 E.
County:	Gallatin	Map coverage:	Toston 1:62,500

This cave is in the Lombard Loop area at the junction of Sixteenmile Creek and the Missouri River. It is reported to be small and developed in the Mission Canyon Formation.

Lost Cave of the Yellowstone (Yankee Jim Cave)

Cave no.:	259	Range:	Gallatin
County:	Gallatin	Map coverage:	Bozeman 1:250,000

This cave is supposed to be in Yankee Jim Canyon along the Yellowstone River. A book in the Leggat rare-book collection in Butte refers to the cave, which has not been visited since the early 1900's. Little is known about its size or exact location.

Lower Chestnut Cave

Cave no.:	252	Range:	Gallatin
County:	Gallatin	Map coverage:	Bozeman Pass 1:62,500
Location:	probably sec. 29, T. 2 S., R. 7 E.		

This cave is reported to be in the same area as Chestnut Cave but at a lower altitude. It may have a vertical entrance, but most of the passage is horizontal, and the exact size is unknown. The cave formed in Madison Group carbonate rocks.

Natural Ice Box

Cave no.:	149	Range:	Gallatin
County:	Gallatin	Map coverage:	Bozeman 1:62,500
Location:	sec. 2 or 3, T. 4 S., R. 5 E.		

Natural Ice Box, 10 miles south of Bozeman, near Wheeler Peak, is a pit about 60 feet deep, which can be climbed without rope. It contains ice all year and has been used by hunters to store food. The cave developed in Madison Group carbonate rocks.

New World Gulch Caves

Cave no.:	147	Range:	Gallatin
County:	Gallatin	Map coverage:	Bozeman Pass 1:62,500
Location:	sec. 1 or 11, T. 3 S., R. 6 E.	Altitude:	6,000 ft.

These caves are in New World Gulch southeast of Bozeman—one is a large rock shelter, and several pits are nearby. None of the pits have been explored, and they are difficult to find without local help. The caves formed in the Madison Group.

North Bridger Cave

Cave no.:	253	Range:	Bridger
County:	Gallatin	Map coverage:	Maudlow 1:62,500
Location:	South half, T. 5 N., R. 5 E.		

This cave is at the northern end of the Bridger Range near upper Sixteenmile Creek. No other information is available.

Roy Gulch Caves (Moonshine Pits No. 1 and No. 2)

Cave no.:	154	Range:	Horseshoe Hills
County:	Gallatin	Map coverage:	Toston 1:62,500
Location:	sec. 19, T. 4 N., R. 4 E.	Altitude:	5,040 ft.

These caves, at the head of Roy Gulch near Lombard, have entrances on top of the cliffs that form the north side of Roy Gulch. Two deep fissures and several smaller pits are nearby. Pit No. 1 is a fissure 10 feet wide, 40 feet long, and 140 feet deep. Pit No. 2 is about 2 feet wide and 50 feet deep. The bottom of both pits is choked with talus and dirt. No side passages lead from the caves.

These gravity-slide caves formed in a block of Madison Limestone that has been faulted over black shale. Blocks of limestone are slowly sliding down toward the bottom of Roy Gulch. The sliding is recent, as shown by bent and broken trees growing on the blocks. Bones of deer and other vertebrates can be found on the cave floors, and numerous bats inhabit both caves.

Spring Hill Cave

Cave no.:	146	Range:	Bridger
County:	Gallatin	Map coverage:	Sedan 1:62,500
Location:	sec. 9, T. 1 N., R. 6 E.	Altitude:	5,500 ft.

This cave is on the dry fork of Ross Creek, 15 miles north of Bozeman. The entrance is a small hole in a cliff near the top of the ridge. The horizontal cave contains 125 feet of passage and has small rooms 2 to 6 feet high. Moonmilk is abundant on the walls. Spring Hill Cave developed in the Madison Limestone.

Toston Cave

Cave no.:	153	Map coverage:	Toston 1:62,500
County:	Gallatin		

This cave lies south of the small town of Toston, in cliffs along the Missouri River. The cave is reported to be small and it may be one of the many rock shelters found in the Lombard Loop area. Toston Cave probably formed in the Madison Limestone.

Twin Dome Cave

Cave no.:	150	Range:	Gallatin
County:	Gallatin	Map coverage:	Bozeman 1:62,500
Location:	probably sec. 11, T. 4 S., R. 5 E.		

This cave lies near Wheeler Mountain, south of Bozeman. It is reported to be a small horizontal cave with two dome-shaped rooms near the entrance, which is under a lower limestone ledge near the head of Wheeler Gulch. It formed in Madison Group carbonate rocks.

GRANITE COUNTY

Black Hole of Calcutta

Cave no.:	189	Range:	Anaconda
County:	Granite	Map coverage:	Storm Lake 1:24,000
Location:	sec. 28, T. 4 N., R. 14 W.	Altitude:	7,500 ft.
	(unsurveyed)	Temperature:	32°F

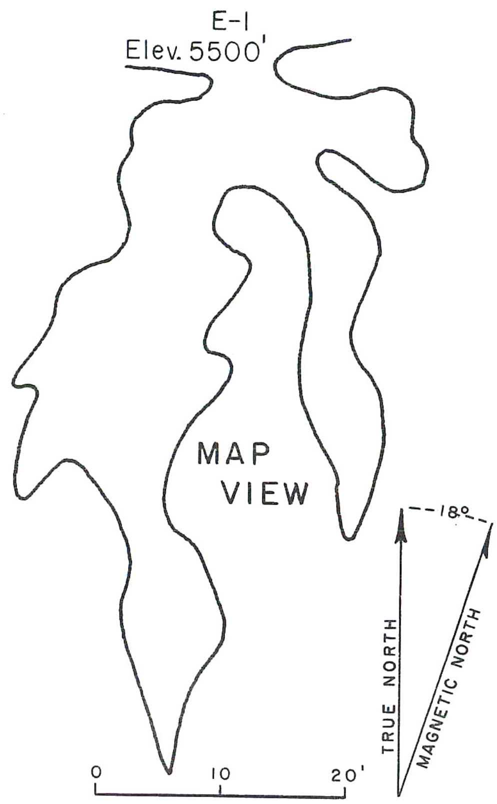


Figure 57.–Spring Hill Cave

This cave is 10 miles south of Philipsburg, in the East Fork Rock Creek drainage. The entrance is a large 20- by 30-foot sinkhole on top of a ridge. A small hole at the base of the sink leads to a large room 40 feet below. A small crawlway at one end leads to a smaller room and an 80-foot pitch (rope required) below. Total depth of the cave is -180 feet. There are no speleothems, and much breakdown now litters the floor of the cave.

The cave formed along a northwest-trending joint in the Jefferson Formation. Three clay-filled side passages also trend in the direction of the joint. The cave is wet and contains much loose ceiling rock.

Flint Creek Range Caves

Cave no.:	273	Range:	Flint Creek
County:	Granite	Map coverage:	Butte 1:250,000

These caves are a group of rock shelters and small caves scattered throughout the Flint Creek Range. Some of the caves are shown on old Forest Service maps.

Hall Holes

Cave no.:	248	Map coverage:	Drummond 1:62,500
County:	Granite	Altitude:	approximately 4,700 ft.
Location:	T. 10 N., R. 13 W.		

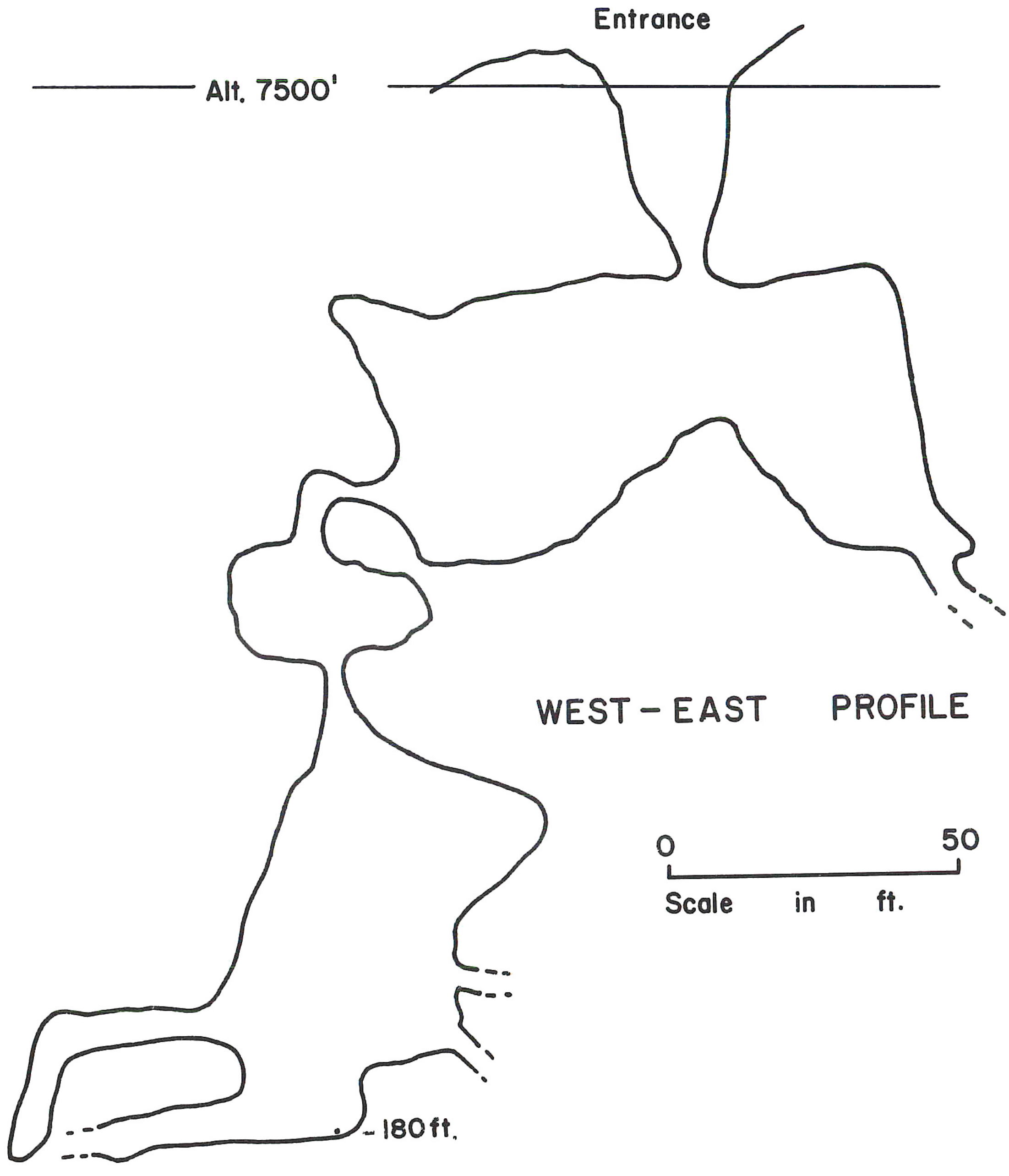
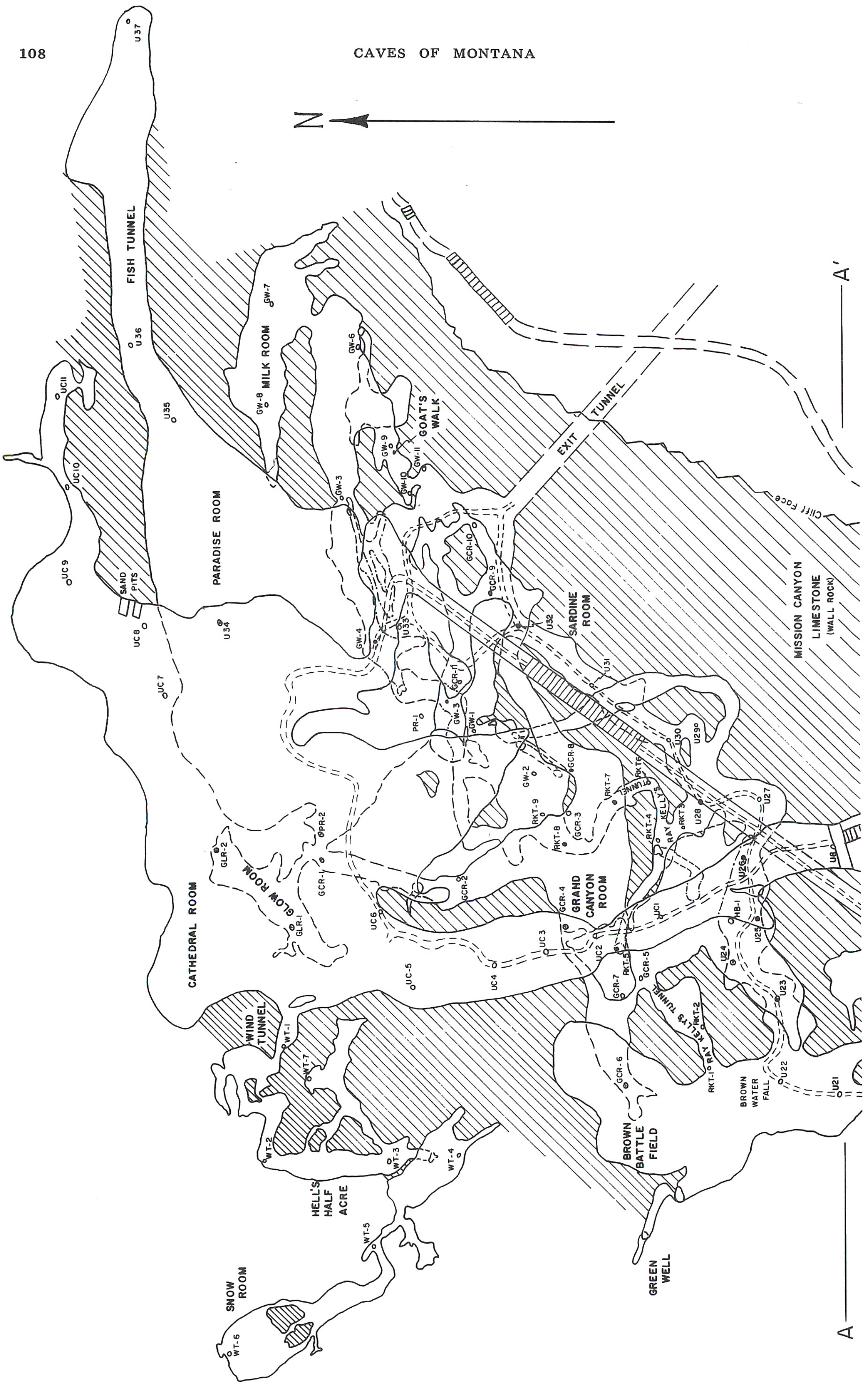


Figure 58.–Black Hole of Calcutta

The Hall Holes are a group of rock shelters south of Hall. They formed in cliffs of the Madison Limestone.

Maxville Caves

Cave no.:	190	Range:	Flint Creek
County:	Granite	Map coverage:	Maxville 1:24,000
Location:	probably sec. 9, T. 8 N., R. 13 W.		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FISH TUNNEL
MILK ROOM
GOAT'S WALK
PARADISE ROOM
SAND PITS
EXIT TUNNEL
SARDINE ROOM
Cliff Face
MISSION CANYON LIMESTONE (WALL ROCK)
CATHEDRAL ROOM
GLOW ROOM
GRAND CANYON ROOM
KELLY'S TUNNEL
RAY KELLY'S TUNNEL
WIND TUNNEL
HELL'S HALF ACRE
SNOW ROOM
BROWN BATTLE FIELD
BROWN WATER FALL
GREEN WELL
A
A'

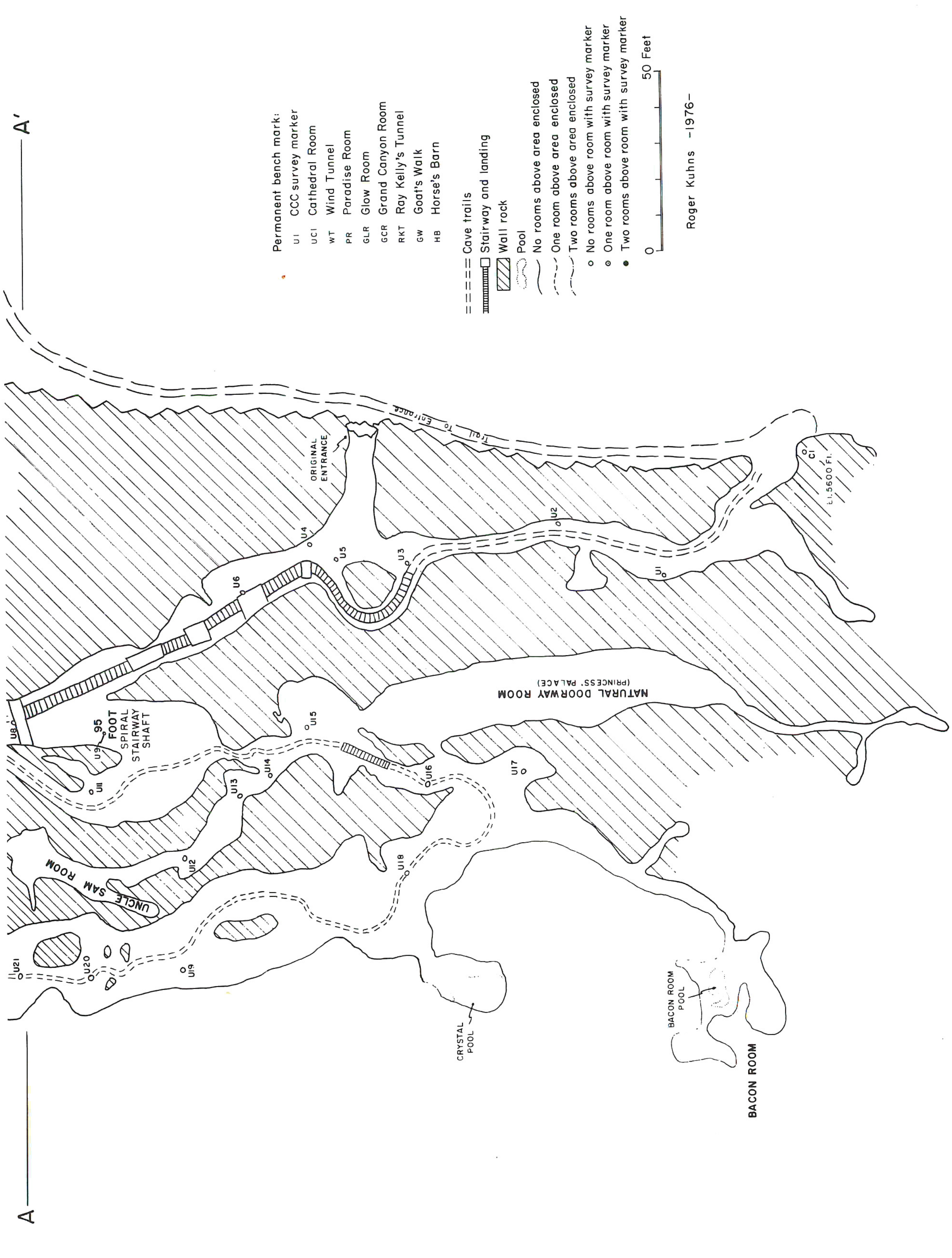


Figure 59.–Lewis and Clark Caverns.

Two caves are reported near the town of Maxville, but no other information is available.

Mount Baldy Sink

Cave no.:	251	Range:	Garnet
County:	Granite	Map coverage:	Bearmouth 1:62,500
Location:	probably sec. 2, T. 11 N. R. 15 W.	Altitude:	6,000 ft.

This sink is about 35 miles east of Missoula, on the western slope of Mount Baldy. The entrance, which lies on a heavily timbered ridge, is an opening 110 by 75 feet and is 60 feet deep. The entrance resulted from the ceiling collapse of a large 100- by 200-foot chamber; all sides of the opening are overhanging. At one end of the chamber is a small lake. The cave, formed in Madison Limestone, has no side passages.

Mount Sentinel Cave

Cave no.:	188	Range:	Anaconda
County:	Granite	Map coverage:	Storm Lake 1:24,000
Location:	sec. 21, T. 4 N., R. 14 W. (unsurveyed)	Altitude:	7,500 ft.

This cave lies in the northeast part of the Anaconda-Pintler Wilderness on the Rock Creek-Page Creek divide. The entrance sink is visible on air photos; the cave has been seen from the air but never entered. It lies close to the Black Hole of Calcutta Cave, but it is higher on the same ridge.

Quarry Cave

Cave no.:	249	Range:	Garnet
County:	Granite	Map coverage:	Drummond 1:62,500
Location:	sec. 15, T. 11 N., R. 12 W.	Altitude:	5,200 ft.

This cave is about 5 miles northeast of Drummond, in the Royal Crystal Sugar Company quarry. The cave, when first discovered, was more than 300 feet long, but quarrying operations have reduced it to about 50 feet. Stalactites and cave popcorn have been removed by local rockhounds. The cave formed in Madison Group carbonate rocks.

Wagner's Cave

Cave no.:	250	Range:	Flint Creek
County:	Granite	Map coverage:	Maxville 1:24,000
Location:	T. 8 N., R. 13 W.		

Wagner's Cave is south of Maxville. It contains nearly 500 feet of horizontal passage and reportedly featured many speleothems, but it is now vandalized. It developed in Madison Group carbonate rocks.

JEFFERSON COUNTY

Lewis and Clark Caverns (Morrison Cave)

Cave no.:	168	Range:	Tobacco Root
County:	Jefferson	Map coverage:	Jefferson Island 1:62,500
Location:	sec. 17, T. 1 N., R. 2 W.	Altitude:	5,595 ft.
		Temperature:	46°F

Lewis and Clark Caverns is the only fully commercial cave in Montana. For more information about the cave, the interested reader can refer to E. S. Perry (1946), L. W. Link (1971), and Roger Kuhns (in preparation).

The cave was first discovered by Bert Pannell and Tom Williams in the late 1800's, but Dan Morrison is often given credit for both the discovery and exploration of the cave in 1902. By 1908 the area was made into a national monument and, after development by the Civilian Conservation Corp in the 1930's, the cave was turned over to the State of Montana in 1936. The name of the cave has been changed from Lewis and Clark Cave to Morrison Cave at least twice, but in 1954 the name "Lewis and Clark Caverns State Park" was officially adopted. More than half a million people have visited the cave; during the 1969 season 83,241 toured the caverns.

The entrance is a small sloping passage about 1,000 feet above the highway. The cave is reached by a foot path from the parking lot on the canyon floor. From the entrance, winding stairs lead to the lower cave. Exit is through a 500-foot tunnel driven to the surface. About 3,000 feet of cave is open to public viewing, and 1,832 feet of additional passage exists in the cave. The total length of the cave is 4,832 feet. The cave is 352 feet deep at its lowest point.

Lewis and Clark Caverns has the best-developed speleothems in the entire northwest and must be seen to be appreciated. Large stalactites and stalagmites, abundant flowstone, and cave popcorn are everywhere. Helectites and dogtooth spar are also found in many parts.

Lewis and Clark Caverns developed in the Mission Canyon Formation, which here dips about 59° NW. Many of the passages developed steeply downward along the dip but some passages and large rooms developed across the bedding following joint planes. At least four cave levels formed, each resulting from the successive lowering of the water table through downcutting by surface streams. Vadose water is still flowing into the cave, as shown by pools of water; most of the formations are still growing.

Oven Hole

Cave no.:	166	Map coverage:	Three Forks 1:62,500
County:	Jefferson	Altitude:	4,200 ft.
Location:	sec. 34, T. 1 N., R. 1 W.		

Oven Hole is a small cave southwest of Three Forks, at the base of a cliff along the Jefferson River. The cave consists of two small adjoining rooms about 30 feet in diameter. The total length of the cave is about 75 feet. There are no speleothems, but a colony of bats inhabits the cave. Oven Hole formed in Madison Group carbonate rocks.

Pigeon Cave

Cave no.:	165	Map coverage:	Three Forks 1:62,500
County.	Jefferson	Altitude:	4,200 ft
Location:	sec. 34, T. 1 N., R. 1 W.		

Pigeon Cave is southwest of Three Forks, in cliffs overlooking the Jefferson River. The entrance is a vertical cleft 10 feet wide and 50 feet deep. In the first 100 feet of passage, the floor of the narrow, high crack is covered with pigeon guano. A small crawlway high on the rear wall of the crack leads to a small room and the end of the cave.

The cave houses a large flock of pigeons that have left the walls and floor of the entire cave coated with guano. The cave, which has no speleothems, formed in flat-lying Mission Canyon Formation.

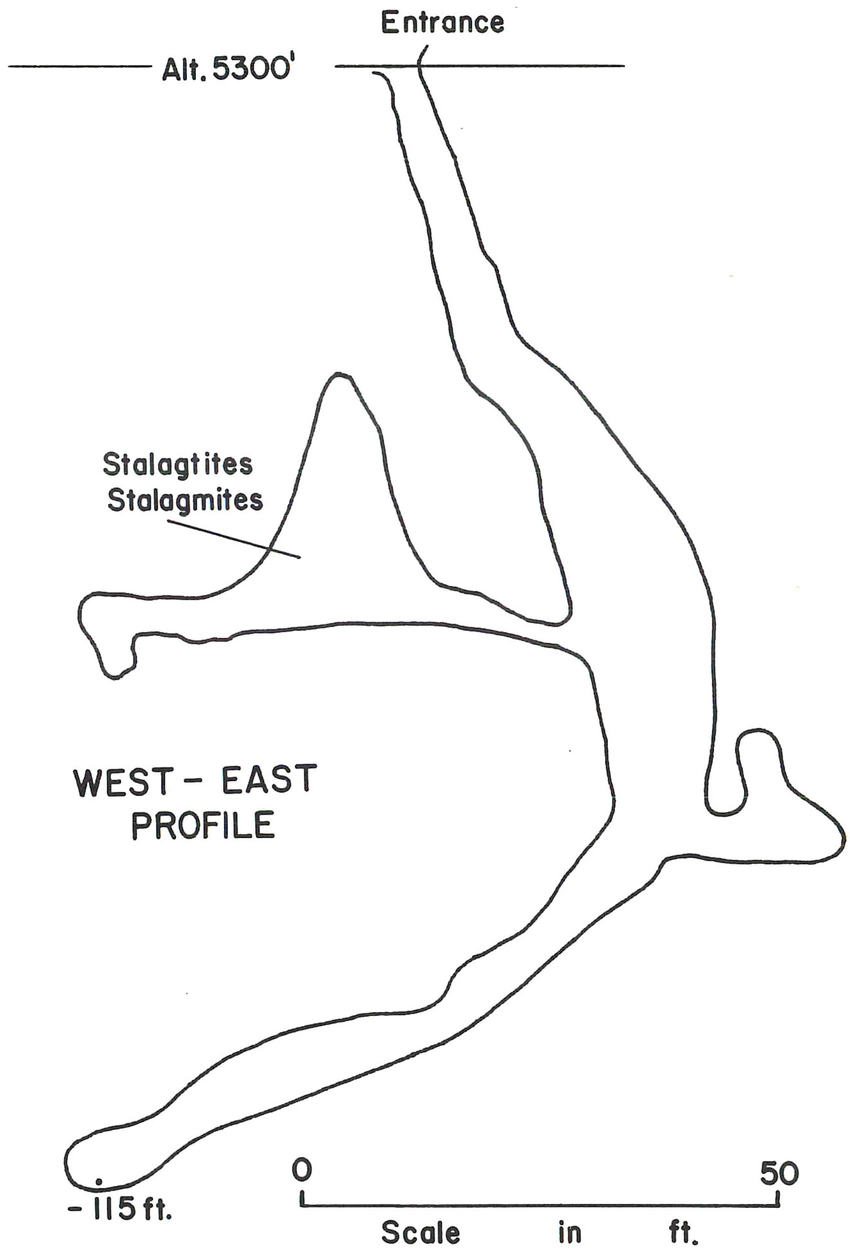


Figure 60.–Woodwards Cave

Pleasant Surprise Pit

Cave no.:	164	Map coverage:	Three Forks 1:62,500
County:	Jefferson	Altitude:	4,200 ft.
Location:	sec. 33, T. 1 N., R. 1 W.		

This pit lies on the north side of the Jefferson River southwest of Three Forks. The entrance is a small hole on cliffs just above the river level. The pit has a diameter of 2 feet at the top and drops vertically 55 feet, where it ends in breakdown. There are no side passages or speleothems. The cave formed in the Mission Canyon Formation.

Point-of-Rocks Cave

Cave no.:	167	Map coverage:	Whitehall 1:24,000
County:	Jefferson	Altitude:	5,000 ft.
Location:	sec. 32, T. 1 N., R. 4 W.		

This cave is south of Whitehall on Point-of-Rocks Hill. The entrance is a 9- by 3-foot opening visible from the valley below. The one-room cave measures about 25 by 50 feet and is 20 feet high. It was excavated by the Smithsonian Institution in the early 1940's to a depth of 9 feet. Numerous artifacts including arrowheads, scrapers, bone tools, and charcoal were recovered. Pictographs were found on the cave walls but these have been chipped off by vandals.

The cave formed in a Recent travertine deposit. A hot spring flows into the Jefferson River below the cave, and the entire hot-spring deposit is pockmarked with small fissures and cracks. No other caves of any size have been found in the travertine.

Woodwards Cave

Cave no.:	169	Map coverage:	Jefferson Island 1:62,500
County:	Jefferson	Altitude:	5,300 ft.
Location:	sec. 32, T. 2 N., R. 2 W.		

This cave is north of Cottonwood Creek Canyon near LaHood Park, Montana. The entrance is a 3- by 6-foot opening at the head of a small gully. It opens into a 10-foot pit, which drops vertically 100 feet. Two horizontal passages, one 60 feet down and a second at the pit bottom, add 270 feet of length to the cave. The total depth is -115 feet.

The upper passage contains abundant flowstone, stalactites, and stalagmites. Woodwards Cave developed along a single joint in west-dipping Meagher Limestone.

MADISON COUNTY

Cave Mountain Cave

Cave no.:	175	Range:	Gravelly
County:	Madison	Map coverage:	Cliff Lake 1:62,500
Location:	sec. 32, T. 10 S., R. 1 W.	Altitude:	9,560 ft.
		Temperature:	32°F

Although Cave Mountain Cave is small, it has the distinction of being the highest in Montana at 9,560 feet. The entrance is a 20-foot sink on the grassy top of the peak. The initial drop is about 30 feet, but one side may be climbed without rope. The cave narrows at this point and is choked with snow and ice; the cave continues downward to a small room

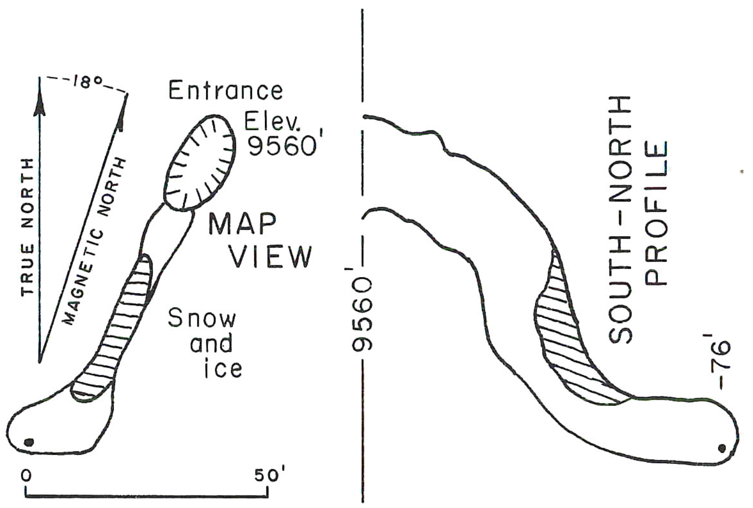


Figure 61.–Cave Mountain Cave

half-filled with breakdown. The total depth is -76 feet. Although the cave does not have speleothems, the rock at the entrance yielded good specimens of brachiopods and crinoids from the Lodgepole Formation, which here trends N. 50° W., 8° SW.

Centennial Cave System

Cave no.:	255	Range:	Gravelly
County:	Madison	Map coverage:	Ashton 1:250,000
Location:	approximately T. 13 S., R. 1 W.		

This cave (or caves) is in the Centennial Valley near the Montana-Idaho border. The cave, reported to be very large, was discovered in the early 1960's but has not been entered since then. No other information is available.

Fish Hatchery Sink

Cave no.:	174	Range:	Gravelly
County:	Madison	Map coverage:	Virginia City 1:62,500
Location:	sec. 13, T. 7 S., R. 2 W.	Altitude:	5,600 ft.

Fish Hatchery Sink is a long, linear depression at the Federal Fish Hatchery near Varney. Originally, several pits developed at the base of this half-mile depression, one of which reached a depth of -120 feet, but most of the pits have been covered with bulldozed fill. One pit can be entered to a depth of 40 feet. The cave beneath the pit is 160 feet long and parallels the trend of the depression, N. 20° E. At one time, the entire length of the depression was probably open, but slumping has bridged over most of the fissure. The area around the sink is a broad flat bench composed entirely of Pleistocene or Recent travertine. Gravity sliding of a large travertine block is the most likely cause of the fissure. There are no speleothems in the cave, but a few bones (cattle) litter the floors.

Goodrich Gulch Caves

Cave no.:	171	Range:	Tobacco Root
County:	Madison	Map coverage:	Waterloo 1:62,500
Location:	sec. 21, T. 3 S., R. 5 W.	Altitude:	6,000 ft.

These caves are east of Twin Bridges, in Goodrich Gulch; they are a series of rock shelters in limestone cliffs on the north side of the canyon. They formed in northwest-dipping Madison Group carbonate rocks.

Hollow Mountain Cave

Cave no.:	173	Range:	Gravelly
County:	Madison	Map coverage:	Virginia City or Varney 1:62,500
Location:	probably T. 7 S., R. 2 W.		

This cave is in a small gulch on Hollow Mountain near Varney. No other information is available.

Mill Creek Cave (Tobacco Root Pit)

Cave no.:	170	Range:	Tobacco Root
County:	Madison	Map coverage:	Copper Mountain 1:24,000
Location:	sec. 11, T. 4 S., R. 4 W.	Altitude:	8,460 ft.
		Temperature:	39°F

This cave is at the head of Bridge Canyon in the Mill Creek drainage. The entrance is a small vertical fissure about 15 feet deep. An inclined tunnel at the base of the fissure slopes downward to a pit 80 feet deep. Rope is needed to descend this pit, but by chimneying across the top of the pit, it is possible to come within 20 feet of the cave bottom by climbing the walls. Below this point timbers once used by miners to reach the pit bottom are now rotted. No side passages lead from the cave; the floor is choked with breakdown. The total depth of Mill Creek Cave is -130 feet. A small amount of cave popcorn and flowstone is in the lower part.

Mill Creek Cave developed in marble in the Cherry Creek Group. The marble at the cave is light brown and very coarse grained, seems to be slightly dolomitic, and contains a few brecciated zones that are visible on the pit walls. This is the only known cave in the Cherry Creek Group, but others probably exist. A large amount of an unidentified fungus clings to the rotted timbers in the pit. The fungus is white with spidery stringers hanging downward.

Shell Creek Cave

Cave no.:	172	Range:	Madison
County:	Madison	Map coverage:	Ennis 1:62,500
Location:	sec. 33, T. 6 S., R. 1 E.	Altitude:	6,050 ft.
		Temperature:	37°F

This cave lies on the north side of Shell Creek Canyon 7 miles southeast of Ennis. The entrance is about a quarter of a mile up the ridge from the canyon mouth. One walk-in entrance and two small vertical entrances lead to a large 100- by 200-foot room that slopes downward at about 30°. The floor of the room is covered with dirt and guano. At the rear of the room is about 300 feet of crawlway. One crawlway leads to a pool of water 15 feet wide and 3 feet deep. A second tunnel connects to a 40-foot pit that ends in breakdown. There are a few patches of flowstone and cave popcorn on the walls. A colony of bats and many birds live in the large entrance room. The cave developed in the Mission Canyon Formation.

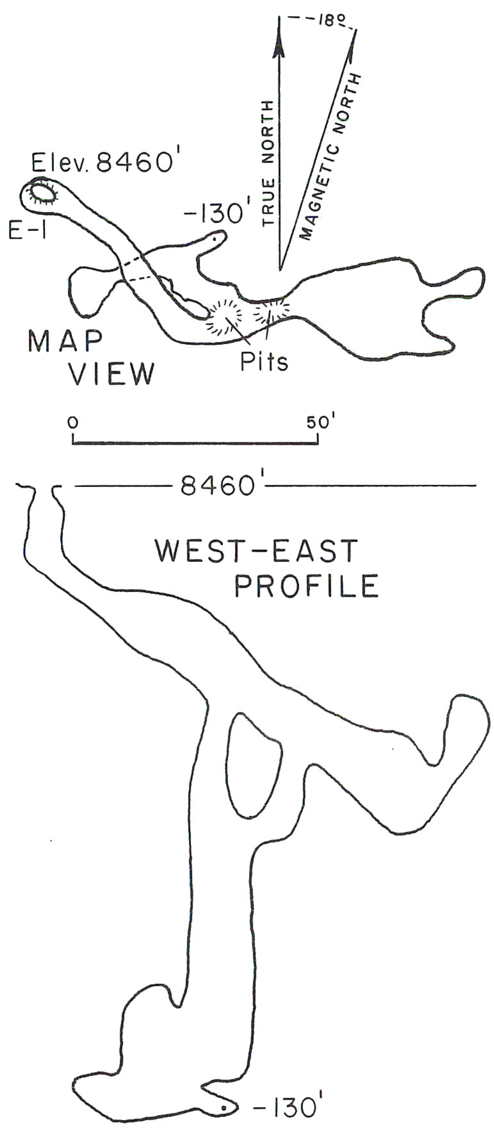


Figure 62.–Mill Creek Cave

Toad Cave

Cave no.:	152	Range:	Madison
County:	Madison	Map coverage:	Spanish Peaks 1:62,500
Location:	sec. 20, T. 4 S., R. 3 E.	Altitude:	6,200 ft.
		Temperature:	41°F

Toad Cave is on the Cuff Creek near its junction with North Fork Spanish Creek. The entrance is a 3-foot circular hole near the creek bed; water flows from the entrance into Cuff Creek. The cave contains about 850 feet of narrow crawlways and passages that average 2 to 8 feet in width and 5 to 15 feet in height. The passages seem to be developed along three joint sets, one trending N. 75° E., one N. 10° W., and one N. 60° W. The cave is nearly horizontal and many of the passages contain flowing water that ranges from ½ foot to 3 feet in depth. The cave is known to flood during spring runoff or heavy rains. Although the dry

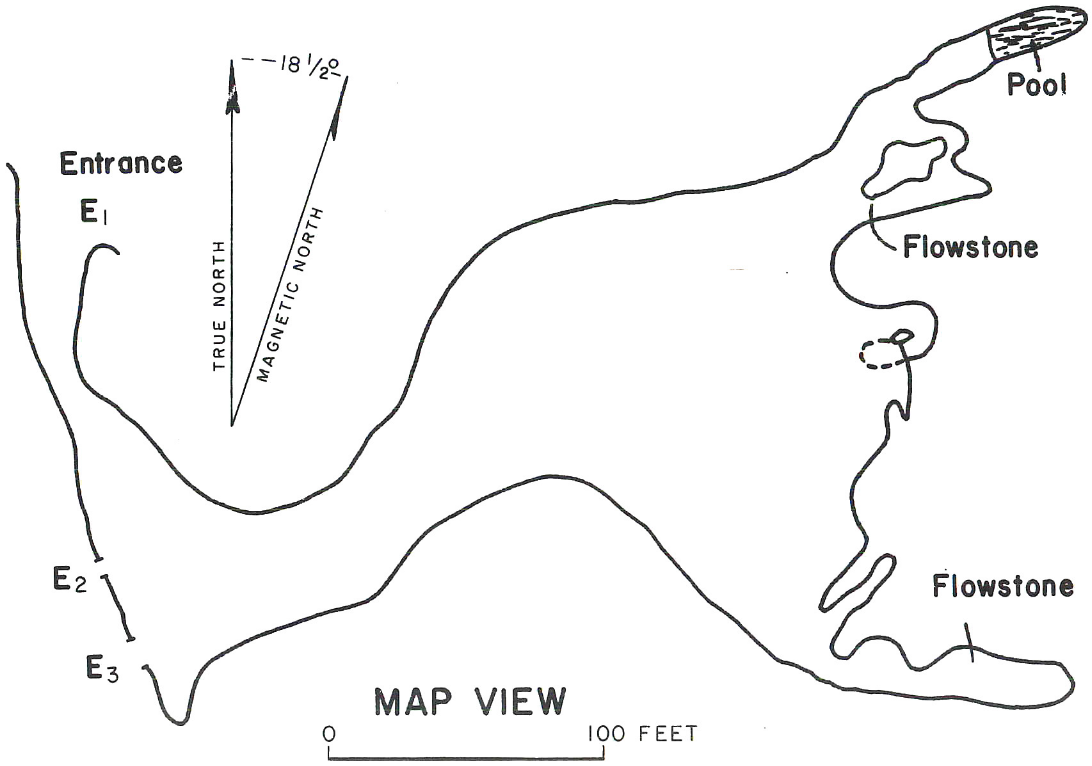


Figure 63.–Shell Creek Cave

part is floored with reddish-brown clay and silt, many passages are terminated by clay fill. There are no speleothems.

Toad cave formed in the Meagher Formation, which here trends N. 10° E., 25° NW. The cave probably originated in the phreatic zone, Cuff Creek having only recently entered the cave. Very little, if any, modification by the stream is apparent, except for some passages that are choked by organic debris.

PARK COUNTY

Aldridge Pit

Cave no.:	144	Range:	Absaroka
County:	Park	Map coverage:	Miner 1:62,500
Location:	sec. 36, T. 8 S., R. 7 E.	Altitude:	approximately 6,000 ft.

This pit is 10 miles northwest of Gardiner, near Aldridge Lake. The opening, about 30 feet in diameter, lies near a group of old mine buildings. The pit, which has not been descended, is probably very deep; this hole may actually be an abandoned mine shaft or may be a mine that intersected a pit. No other information is available.

Bullis Creek Cave

Cave no.:	140	Range:	Absaroka
County:	Park	Map coverage:	Brisbin 1:24,000
Location:	probably sec. 16, T. 3 S., R. 9 E.	Altitude:	5,800 ft.

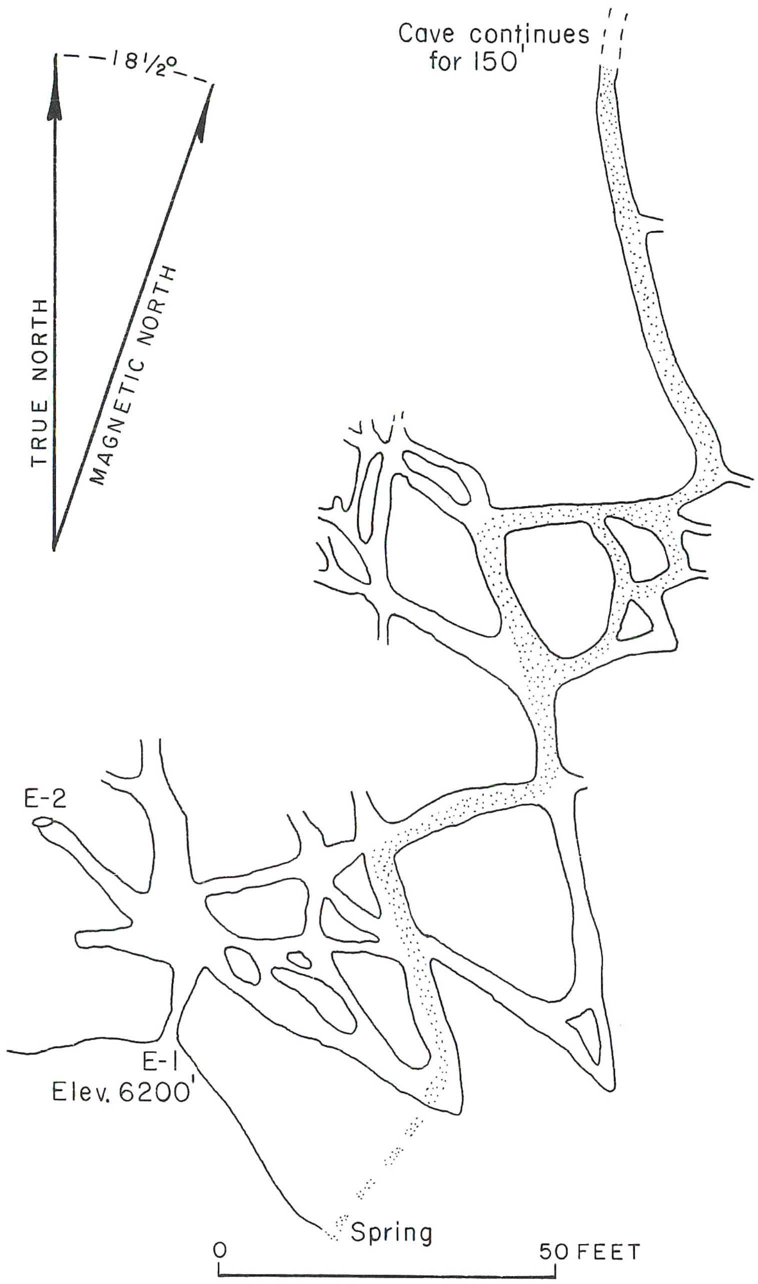


Figure 64.–Toad Cave

This cave is north of Bullis Creek on the south side of Wineglass Mountain. It probably formed in Madison Group Carbonate rocks, but its exact size and location are unknown.

Gardiner Travertine Caves

Cave no.:	143	Range:	Absaroka
County:	Park	Map coverage:	Gardiner: 1:62,500
Location:	sec. 10, 14, and 15, T. 9 S., R. 8 E.	Altitude:	6,000 ft.

These caves developed in a travertine hot-springs deposit (Pleistocene). Numerous small caves and fissures have been formed by gravity sliding of the travertine, but quarrying operations have destroyed many of these caves.

Grouse Creek Siphon

Cave no.:	138	Range:	Absaroka
County:	Park	Map coverage:	Mount Rae 1:24,000
Location:	sec. 6, T. 4 S., R. 12 E. (unsurveyed)	Altitude:	approximately 7,200 ft.

Grouse Creek flows underground on part of its route to the West Boulder River. The cave beyond the siphon is normally not accessible. Only during very low water (if at all) can the cave be reached. Grouse Creek sinks into the Madison Limestone.

Lost Creek Siphon

Cave no.:	137	Range:	Absaroka
County:	Park	Map coverage:	Mount Rae 1:24,000
Location:	sec. 12, T. 4 S., R. 11 E. (unsurveyed)	Altitude:	6,800 ft.
		Temperature:	34°F

Lost Creek drains a part of the West Boulder Plateau between the West Boulder and Boulder Rivers. At a point near the limestone-granite contact, the entire creek flows into a large pit. When the site was visited in June 1971, an estimated 5,000 cfs of snow meltwater was flowing into the cave. The water falls 77 feet and flows down two smaller pits (Fig. 65). During March 1972 the cave was entered and explored to a depth of 200 feet. The cave was reentered twice during March 1973 and explored to a depth of 710 feet, making it Montana's third deepest known cave. More than 800 feet of rope was needed for the descent, which included three vertical drops of more than 120 feet.

The cave is extremely dangerous and can be entered only during times of low water. Wetsuits and waterproof lights are necessary, as water from Lost Creek pours down all of the pits and the water temperature is 34°F.

The cave developed in the Madison Limestone, which is folded into a south-plunging anticline; the entrance pit formed along the west limb of the fold. The fault contact between the Madison Limestone and Precambrian granite of the West Boulder Plateau is only about 200 feet west of the cave; the cave may reach this contact at depth.

The point of resurgence of Lost Creek is on the West Boulder River in sec. 2, T. 4 S., R. 11 E. Water resurges from a spring at West Boulder Cave, 1,120 feet below the Lost Creek Siphon. In 1974, Rhodamine dye was placed in Lost Creek at the entrance to Lost Creek Siphon. It was detected at West Boulder Cave three days later. The dye may have been delayed in one of the plunge pools beneath waterfalls in the cave. Chemical analysis of the water also indicates that West Boulder Cave spring is the most likely resurgence (Campbell, 1977b).

Mill Creek Crystal Cave (Crystal Cave)

Cave no.:	141	Range:	Absaroka
County:	Park	Map coverage:	Mount Cowan 1:62,500
Location:	sec. 1, T. 6 S., R. 10 E. (unsurveyed)	Altitude:	7,175 ft.
		Temperature:	37°F

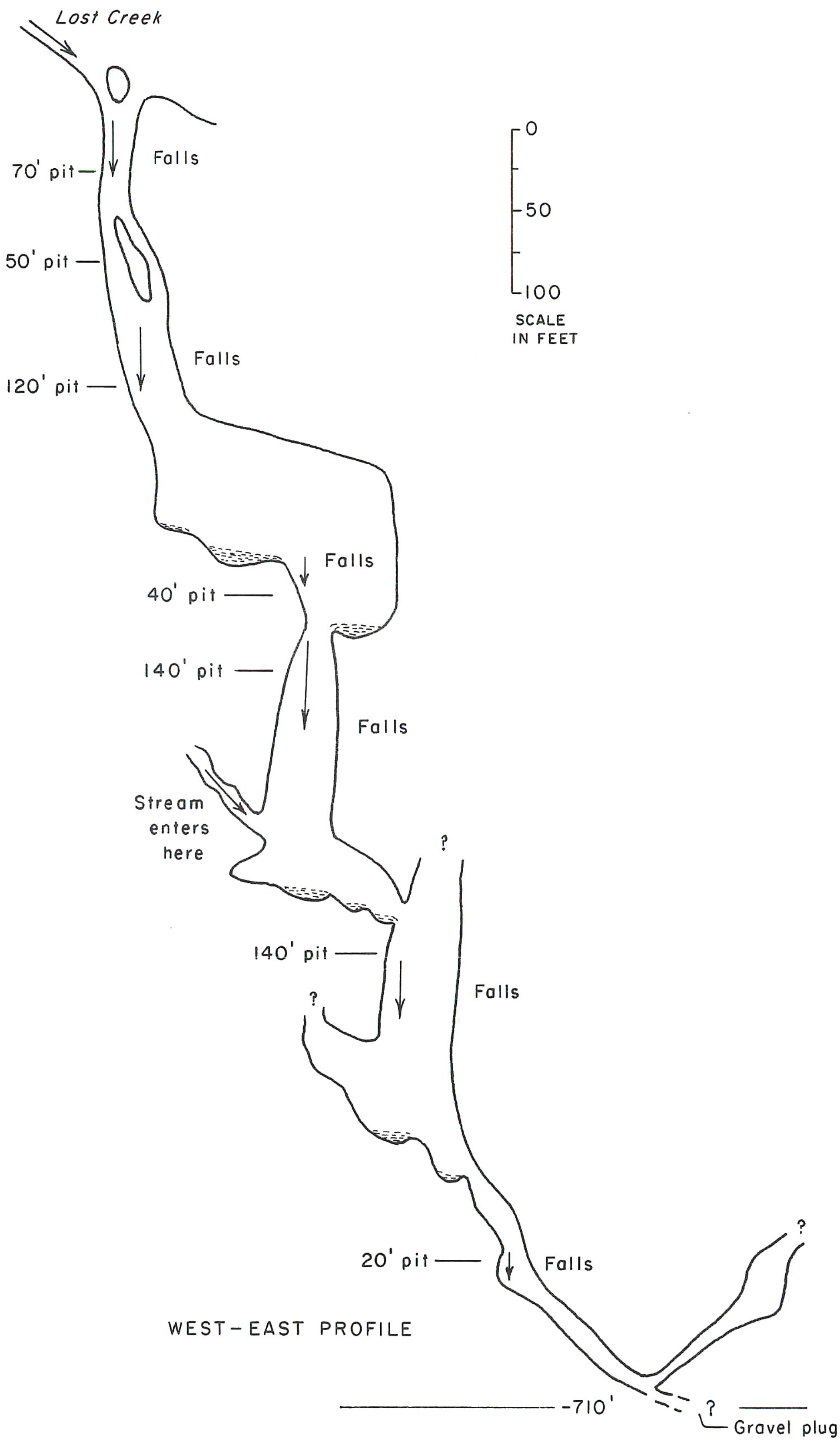


Figure 65.–Lost Creek Siphon

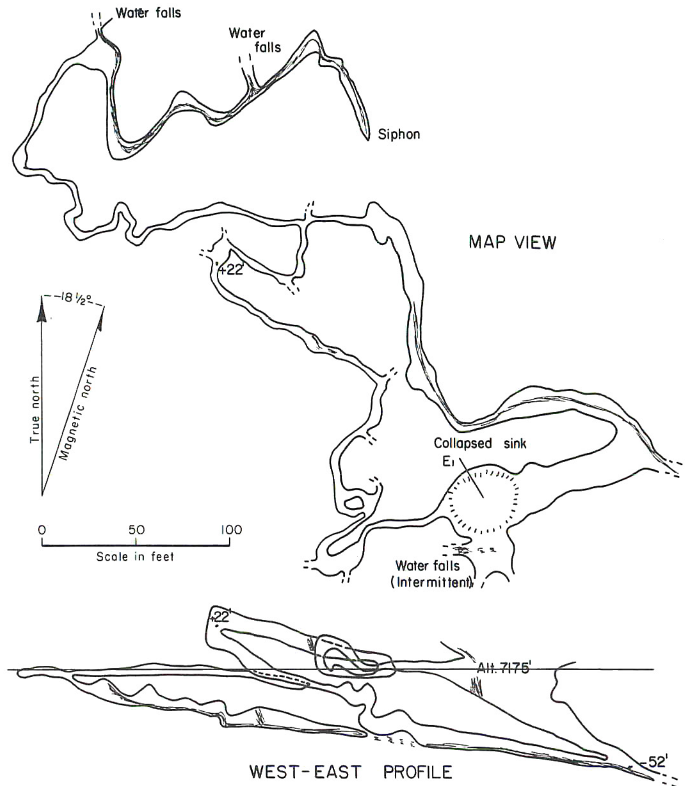


Figure 66.–Mill Creek Crystal Cave

Mill Creek Crystal Cave is on the East Fork of Mill Creek about 15 miles south of Livingston. A 5-mile walk is necessary to reach the cave. A high crack-like hole in the cliff face leads to a large collapsed sink. Passages lead in two directions from the sink. A very tight, twisting crawlway about 600 feet long leads to a tunnel that contains a large stream, which siphons after a short distance downstream. High waterfalls, siphons, and boulder chokes hinder exploration of the upstream passage.

The second passage from the collapsed sink joins an underground stream that is probably the same one encountered in the upper passage. The size of the stream (8 feet wide and 3 feet deep) has prevented downstream exploration, but several side leads have been partly explored. The cave has 2,950 feet of passage mapped and an additional 1,000 feet explored but not mapped. It has a vertical depth of more than 300 feet and may be very large. The limestone crops out over a large area; the vertical relief within the limestone is at least 600 feet. Agate Springs, about 200 feet below the cave entrance, is probably the point of resurgence for the cave stream. The cave is very difficult to explore because the narrow crawlways are wet and the air is cold (37°F). Exploration is best accomplished in the fall when the water level is low. The cave contains a few small stalactites and stalagmites and some flowstone. At several places, stream-rounded pebbles and boulders of granite were observed, indicating that another entrance, upstream from the collapsed sink, is large enough to allow stream-washed material into the cave. Some of this material was found high on the sides of the passage, indicating that flooding takes place during spring runoff or in heavy rainstorms. Two joint patterns, one trending N. 60° E. and the other N. 55° W., seem to control passage development. The cave formed in the Meagher Formation, which here strikes due north and dips 19° east.

Montanopolis Cave

Cave no.:	142	Range:	Absaroka
County:	Park	Map coverage:	Mount Cowan 1:62,500
Location:	T. 6 S., R. 10 E.		

This cave is south of Montanopolis Springs, 20 miles south of Livingston. It is probably a small, horizontal cave, but no other information is available.

West Boulder Cave

Cave no.:	136	Range:	Absaroka
County:	Park	Map coverage:	Mount Rae 1:24,000
Location:	sec. 2, T. 4 S., R. 11 E. (unsurveyed)	Altitude:	5,770 ft.
		Temperature:	41°F

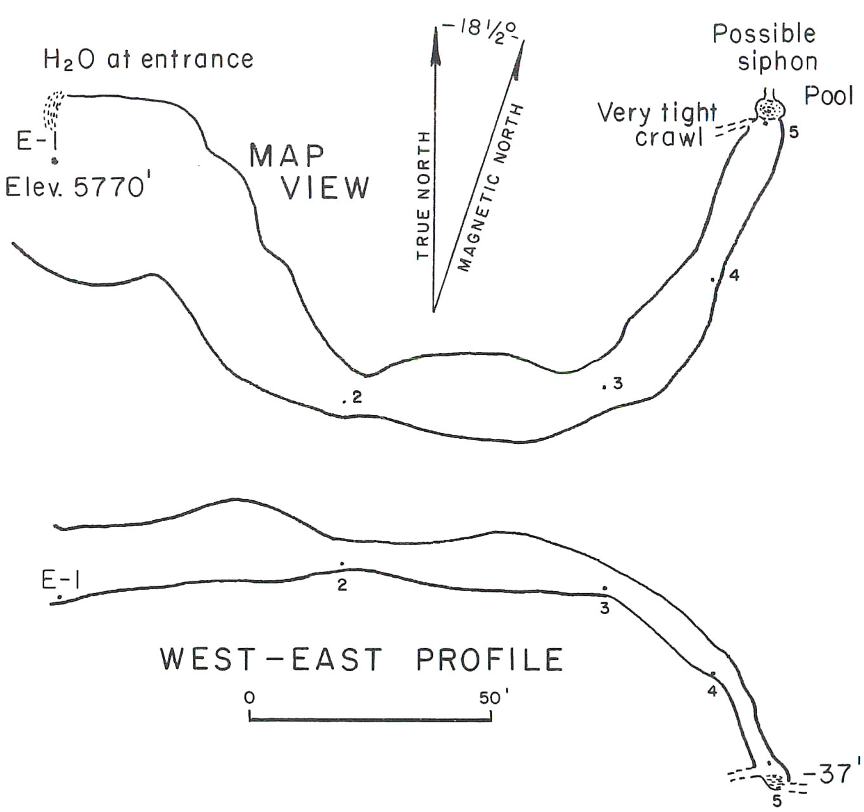


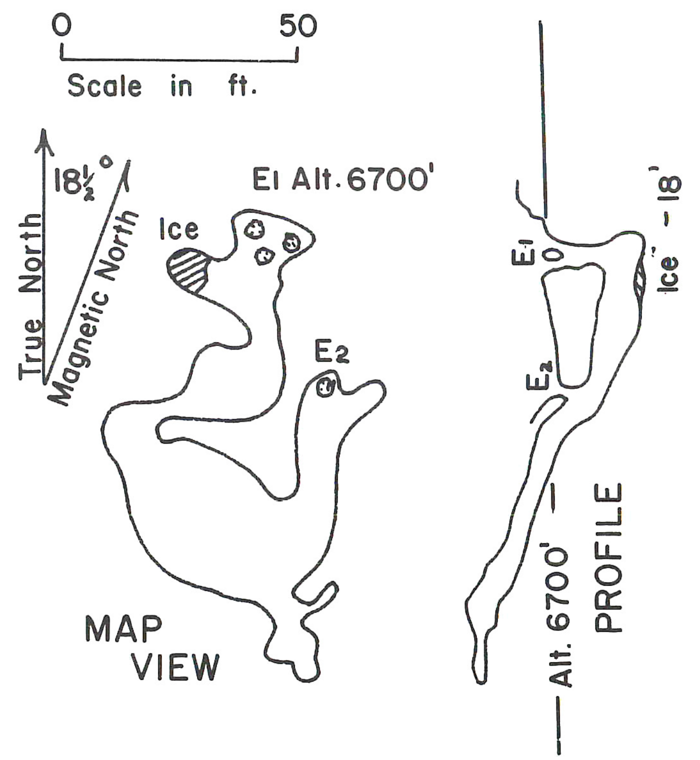
Figure 67.–West Boulder Cave

This cave is southwest of Big Timber, on the West Boulder River. The entrance is a 30-foot opening in a cliff above the river; a small stream flows from a talus slope just below the cave mouth. The entrance room is large and is partly filled with breakdown. The cave narrows near the rear of the room and descends more steeply to a small pool of water, which is 3 to 4 feet deep and seems to be a siphon. It may be possible to get through the siphon in the dry season. A dull roar can be heard at the pool, indicating a large stream or falls somewhere beyond. A tight crawlway near the pool is choked with breakdown, and the stream noise is much louder there. More cave probably exists beyond this point.

Boulder River Cave developed in carbonate rocks that strike N. 85° W. and dip 30° NE. The lower part of the cave developed along the dip in a sandy calcareous layer. There are no speleothems.

Wine Glass Mountain Caves (No. 1 and No. 2)

Cave no.:	139	Range:	Absaroka
County:	Park	Map coverage:	Chimney Rock 1:24,000
Location:	sec. 5, T. 3 S., R. 9 E.	Altitude:	6,700 ft.



Wine Glass Mountain Caves (No. 1 and No. 2)

Wine Glass Mountain is 6 miles south of Livingston. Two caves can be found at the 6,700-foot level, both on private land.

Wine Glass Mountain Cave No. 1 has two entrances, a small pit and a 2-foot crawlway. A cone of snow and ice extends from the pit to the cave floor, and a few ice stalagmites can be found nearby. The cave consists of one sloping room 45 feet long and 15 feet high and three smaller domed rooms. Several small passages from the main chamber pinch out in a short distance. Cave No. 1 contains a small amount of cave popcorn and moonmilk.

Wine Glass Mountain Cave No. 2 is about 100 feet from Cave No. 1 and consists of a 25- by 15-foot room. The floor is covered with clay and there is no breakdown. An 8-foot-wide hole leads to a lower chamber. Moonmilk was observed on the cave ceiling.

Both caves formed in solution breccia of the Mission Canyon Formation, which here trends N. 60° W., 41° NE.

SWEET GRASS COUNTY

Boulder River Cave

Cave no.:	134	Range:	Absaroka
County:	Sweet Grass	Map coverage:	McLeod Basin 1:24,000
Location:	sec. 26, T. 3 S., R. 12 E.	Altitude:	5,100 ft.

This cave is on the side of a cliff, south of the Boulder River Falls. The entrance is a 10- by 20-foot opening; passage leads back into the hill, but the cliffs surrounding the cave have not been scaled so the exact size of the cave is unknown. Boulder River Cave formed in Madison Group carbonate rocks. Because the siphon formed by the Boulder River lies directly below the cave mouth, Boulder River Cave could connect with the siphon and allow entrance (see Boulder River Siphon).

Boulder River Indian Cave

Cave no.:	133	Range:	Absaroka
County:	Sweet Grass	Map coverage:	McLeod Basin 1:24,000
Location:	sec. 26, T. 3 S., R. 12 E.		

This cave is on cliffs high above the Boulder River near Boulder Falls. The one-room cave has a large 20- by 30-foot opening. The cave formed in the Mission Canyon Formation.

Boulder River Siphon

Cave no.:	135	Range:	Absaroka
County:	Sweet Grass	Map coverage:	McLeod Basin 1:24,000
Location:	sec. 26, T. 3 S., R. 12 E.	Altitude:	5,100 ft.

This cave is at the Natural Bridge and Falls of the Boulder River southwest of Big Timber. During low runoff, part of the river sinks, about 100 yards above the falls, and reappears out of a cave just below the natural bridge at the falls. In fact, the natural bridge is probably a remnant of an old cave.

Just below the falls, during the dry season the river sinks completely for a distance of about a half mile. Neither siphon has ever been entered; one entrance might be accessible during times of very low runoff. Numerous sinkholes and caves along the river banks might give access to the cave system, but these have never been studied in detail. The entire karst area developed in east-dipping Madison Group carbonate rocks.

NORTHWESTERN MONTANA REGION (IV)

Region IV includes the Rocky Mountains from Helena northward to the Canadian border, the Sweetgrass Hills, and the portion of Montana north of Missoula and west of Glacier National Park (Fig. 1). Most of the caves are in and around the Bob Marshall Wilderness, but caves occur near Kalispell and in the Sweetgrass Hills.

The structural geology of the northern Rocky Mountains shows numerous thrust faults and complex folding. The development of these mountains was summarized by Mudge (1970). Thrusting has shoved blocks of Paleozoic and Precambrian rocks eastward over younger rocks, placing carbonate rocks at the top of many of the ridges. As a result, many caves lie near crests of the highest peaks in the northern Rocky Mountains. These caves are nearly inaccessible and few have been explored; most have been located from the air or by hunting parties. Thick carbonate sections and a cool wet climate seem to favor the development of large deep caves in this area.

Most of the caves formed in Mississippian and Cambrian carbonate rocks, but several have been found in the Siyeh Limestone (Precambrian) and in Devonian rocks. In general, caves are found in progressively younger rock as one moves from west to east across Region IV because of the general change in the age of the rocks that crop out in the area.

Of the caves known in Region IV, more than half are vertical pits that require rope and other special gear to descend; many contain ice and underground streams or waterfalls. Organized caving expeditions are restricted because of cold temperatures, inaccessibility, and the need for special equipment. Much more work is required before the true cave inventory of this area is known.

FLATHEAD COUNTY

Diamond Lake Caves

Cave no.:	243	Range:	Flathead
County:	Flathead	Map coverage:	Amphitheatre Mountain 1:24,000
Location:	sec. 20 or 21, T. 22 N., R. 12 W. (unsurveyed)	Altitude:	Approximately 7,500 ft.

Several sinkholes are reported near Diamond Lake on Sphinx Peak. One snow-filled sink of unknown depth is south of the mountain; other sinks may exist on the north side. The Diamond Lake area is overlain with Cambrian carbonate rocks.

Fred's Cave

Cave no.:	291	Range:	Flathead
County:	Flathead	Map coverage:	Whitcomb Peak 1:24,000
Location:	sec. 4, T. 24 N., R. 13 W. (unsurveyed)	Altitude:	5,500 ft.

On the west side of Silvertip Creek, about halfway up the valley, a large sinkhole can be seen from the air. Its entrance is in a heavily timbered area and is 100 feet in diameter. The depth of the sink is 56 feet. Several small caves and sinks in the same area are all formed in east-dipping Cambrian rocks.

Gladiator Mountain Cave

Cave no.:	204	Range:	Flathead
County:	Flathead	Map coverage:	Haystack Mountain 1:24,000
Location:	probably sec. 33, T. 22 N., R. 12 W. (unsurveyed)	Altitude:	8,000 ft.

This cave was reported by a pilot to be a "square-shaped sink" with overhanging sides south of Gladiator Mountain. A search in 1970 failed to locate the cave, but a square patch of trees was sighted that could have been mistaken for the cave. The south side of the peak was not checked carefully, so the cave may actually exist.

Haystack Mountain Cave

Cave no.:	242	Range:	Flathead
County:	Flathead	Map coverage:	Haystack Mountain 1:24,000
Location:	probably sec. 4, T. 21 N., R. 12 W. (unsurveyed)	Altitude:	approximately 7, 000 ft.

This cave lies somewhere north of Haystack Mountain along the Chinese Wall; the entrance is a vertical pit of unknown depth. The cave formed in Cambrian rock; no other information is available.

Hissing Well Cave

Cave no.:	196	Range:	Whitefish
County:	Flathead	Map coverage:	Mount Hefty 1:24,000
Location:	sec. 25, T. 37 N., R. 23 W. (unsurveyed)	Altitude:	5,000 ft.

This cave is west of Glacier National Park near Yakinikak Creek. It has a vertical entrance, but the extent of the cave is unknown. This cave may be confused with a pit in Yakinikak Creek Cave No. 1 (see Yakinikak Creek Cave). The area is underlain by Madison Group carbonate rocks.

Hritsco's Ice Cave

Cave no.:	193	Range:	Salish
County:	Flathead	Map coverage:	Kalispell 1:250,000

This cave lies west of Kalispell near U.S. Highway 2. The cave may be in the same general area as Little Bitterroot Canyon Ice Cave but no other information is available.

Ibex Mountain Cave

Cave no.:	201	Range:	Flathead
County:	Flathead	Map coverage:	Bungalow Mountain 1:24,000
Location:	sec. 25, T. 24 N., R. 13 W. (unsurveyed)	Altitude:	7,600 ft.

This cave is on the south side of Ibex Mountain at the head of Silvertip Basin. The entrance consists of a 5- by 15-foot sinkhole that drops vertically for an unknown depth. An article featuring the cave was published by Dickey and Bridge in the November 1968 edition of the *National Speleological Society News*; at least one other sinkhole can be found in the same area. The sinks remain snow filled until late August or September. The cave formed in Cambrian limestone, which trends N. 20° W., 21° W. Silvertip Basin is a large north-trending syncline, and Ibex Mountain makes up part of the east limb of the fold. Because the caves are more than 1,000 feet above the valley floor, they may be deep. The caves were snow filled and inaccessible when visited in August 1971.

Limestone Cave

Cave no.:	200	Range:	Flathead
County:	Flathead	Map coverage:	Whitcomb Peak 1:24,000
Location:	sec. 17, T. 25 N., R. 14 W. (unsurveyed)	Altitude:	5,350 ft.
		Temperature:	39°F

Limestone Cave is 12 miles east of the Spotted Bear Ranger Station near the Bob Marshall Wilderness. The cave is north of Sergeant Mountain and 800 feet above the Spotted Bear River. A one-mile walk is necessary to reach the cave. The entrance is a 20- by 30-foot opening that narrows to low walking passage. The cave is horizontal (Fig. 69) and is developed along a series of S. 45° E.-trending joints. Several pools of water hinder exploration; the water level in the cave varies with the seasons. In several places, old water line marks reach the ceiling, and stream gravel and silt fill many of the passages. Argillite and quartzite pebbles and fresh ripple marks indicate that the cave acts as an overflow for surface runoff during the spring thaw (see Limestone No. 2 Cave). The cave seems to continue beyond the large pool shown on the map and may connect to sinkholes on Sergeant Mountain. A few small stalactites can be found in the upper part of the cave. A search in 1971 failed to locate any surface pits, but the area southwest of the cave was not checked carefully. Nearly 2,000 feet of passage has been mapped. The cave is formed in a small syncline in Cambrian rocks. Most of the passages lie in the trough of the fold.

Limestone Cave No. 2

Cave no.:	294	Range:	Flathead
County:	Flathead	Map coverage:	Whitcomb Peak 1:24,000
Location:	sec. 17, T. 25 N., R. 14 W. (unsurveyed)	Altitude:	5,200 ft.

About 200 yards east and 150 feet below the entrance to Limestone Cave, a second cave occurs in the side of the cliff face. The opening is a narrow crack, about 1 foot wide and 10 feet high, trending S. 35° W. During the dry season, a small stream (about 60 gal./min., September 1971) flows from the crack; the stream fills the crack to a depth of about three feet. Much more water pours out during the spring runoff; when this cave is filled to overflowing, water backs up into Limestone Cave, which acts as an overflow outlet.

The cave was not entered, but the crack continued for at least 40 feet without widening. A waterfall could be heard from within the cave. Limestone Cave No. 2 is developed in Cambrian carbonate rocks.

Little Bitterroot Canyon Ice Cave

Cave no.:	192	Range:	Salish
County:	Flathead	Map coverage:	Hubbart Reservoir 1:24,000
Location:	sec. 29, T. 26 N., R. 24 W.	Altitude:	3,920 ft.
		Temperature:	33°F

This cave is 26 miles west of Kalispell, on the Hubbart Reservoir road. The cave lies in a small gully about 5 miles from U.S. Highway 2. Two vertical entrances connect at a depth of

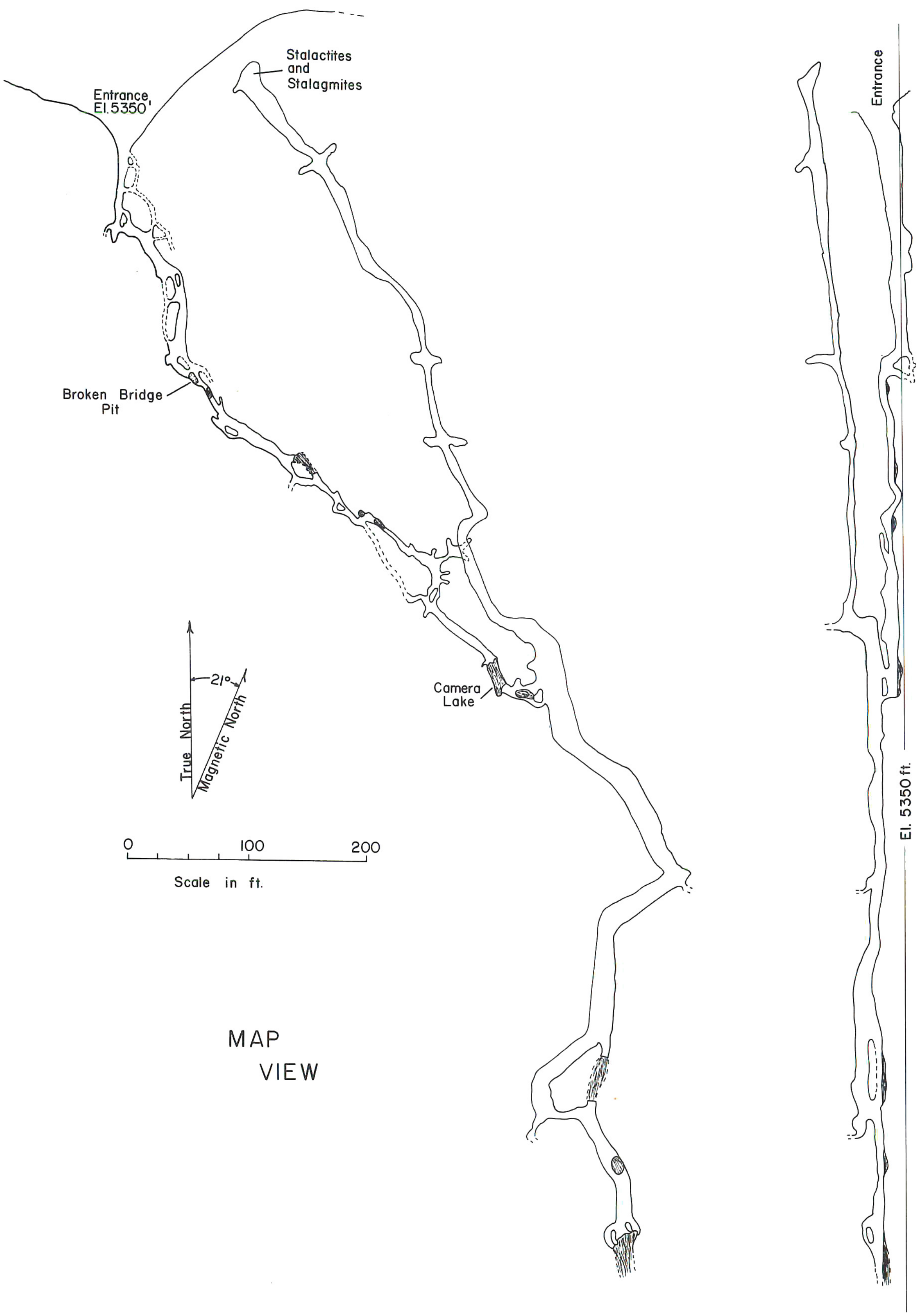


Figure 69.–Limestone Cave

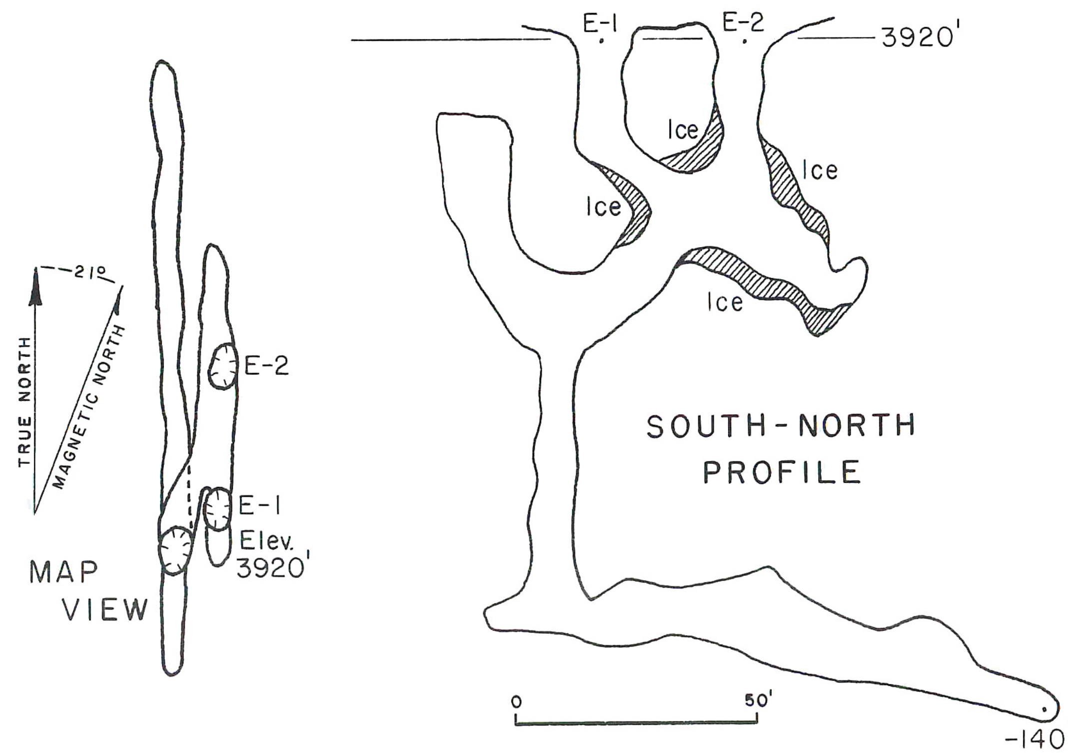


Figure 70.–Little Bitterroot Canyon Ice Cave

about 50 feet (Fig. 70); at this level, the floors and walls are coated with ice. A small pit at the south end of the chamber drops 55 feet to the bottom of the cave, a room 120 feet long and 4 feet wide. The cave has no ice at this depth; rope is necessary to enter.

This typical gravity-slide cave formed in Precambrian argillite, which strikes N. 80° W. and dips 9° S. Several other fissures, all trending N. 5° W., are parallel to the edge of Little Bitterroot Canyon nearby. Blocks of argillite are slowly sliding down into the canyon, and the openings between blocks have temporarily formed caves.

Cold air moving down the gully is trapped in the fissure and cannot be displaced by warm air in summer; thus, any water flowing into the cave is frozen into ice. Layers of dirt and argillite can be seen in the ice at 2- to 6-inch intervals. Each layer may correspond to one year of ice deposition. Ice stalactites and ice crystals line the walls at the 50-foot level. The reason for the lack of ice at the bottom of the cave is unknown; the temperature throughout the cave is between 32° and 33°F.

Logan Creek Pit

Cave no.:	292	Range:	Flathead
County:	Flathead	Map coverage:	Felix Peak 1:24,000
Location:	probably sec. 24, T. 28 N., R. 17 W. (unsurveyed)	Altitude:	6,500 ft.

This cave lies just above timberline near Logan Creek, probably closer to Unawah Creek, east of Hungry Horse Reservoir. The cave, a 200-foot sinkhole of unknown depth, was spotted from the air in 1970. It probably has not been entered.

Needle Falls Cave

Cave no.:	290	Range:	Flathead
County:	Flathead	Map coverage:	Haystack Mountain 1:24,000
Location:	sec. 1, T. 21 N., R. 13 W. (unsurveyed)	Altitude:	5,400 ft.
		Temperature:	42°F

Needle Falls Cave lies on the White River in the Bob Marshall Wilderness. A 30-mile walk is necessary to reach the cave, which lies on the east bank of the White River just below the falls. The cave is horizontal and contains about 400 feet of passage. Most of the passage is 15 to 20 feet high, but the rear of the cave becomes constricted and is plugged with clay (Fig. 71). The walls show stream carving that indicates White River may have flowed through the cave at one time. The river sinks at the falls and emerges below the falls in talus. The falls area and the cave are underlain by Cambrian carbonate rocks.

Pagoda Mountain Cave

Cave no.:	244	Range:	Flathead
County:	Flathead	Map coverage:	Pagoda Mountain 1:24,000
Location:	sec. 3, T. 22 N., R. 13 W. (unsurveyed)	Altitude:	approximately 8,000 ft.

Pagoda Mountain lies in the Bob Marshall Wilderness and is partly made up of Cambrian carbonate rocks. A vertical pit of unknown depth has been reported near the top of the peak. No other information is available.

Pentagon Mountain Cave

Cave no.:	228	Range:	Flathead
County:	Flathead	Map coverage:	Trilobite Peak or Pentagon Mountain 1:24,000
Location:	sec. 14, T. 25 N., R. 12 W. (unsurveyed)		

Pentagon Mountain is about 20 miles east of the Spotted Bear Ranger Station in the Bob Marshall Wilderness. Several pilots have reported seeing a large, deep sinkhole on the south side of the peak. A reconnaissance crew traveling in the area in 1974 did not find this cave, but several large horizontal holes were seen on cliffs on the north side of Pentagon Peak. Several small caves and sinkholes were visited around Pot Lake, 2 miles northwest of the peak. In 1976, several large pits were seen from the air in the cirque south of Pentagon Mountain. All of the solution features in this area are developed in Devonian rocks.

Silvertip Basin Sinks

Cave no.:	202	Range:	Flathead
County:	Flathead	Map coverage:	Bungalow Mountain and Cathedral Peak 1:24,000
Location:	sec. 35, T. 24 N., R. 13 W. (unsurveyed)	Altitude:	7,200 to 8,000 ft.

The area known as Silvertip Basin lies at the head of Silvertip Creek and contains Silvertip Creek. The basin is part of a north-trending syncline composed of Paleozoic carbonate rocks. In most places along the syncline only Cambrian rocks are preserved, but at Silvertip Basin a

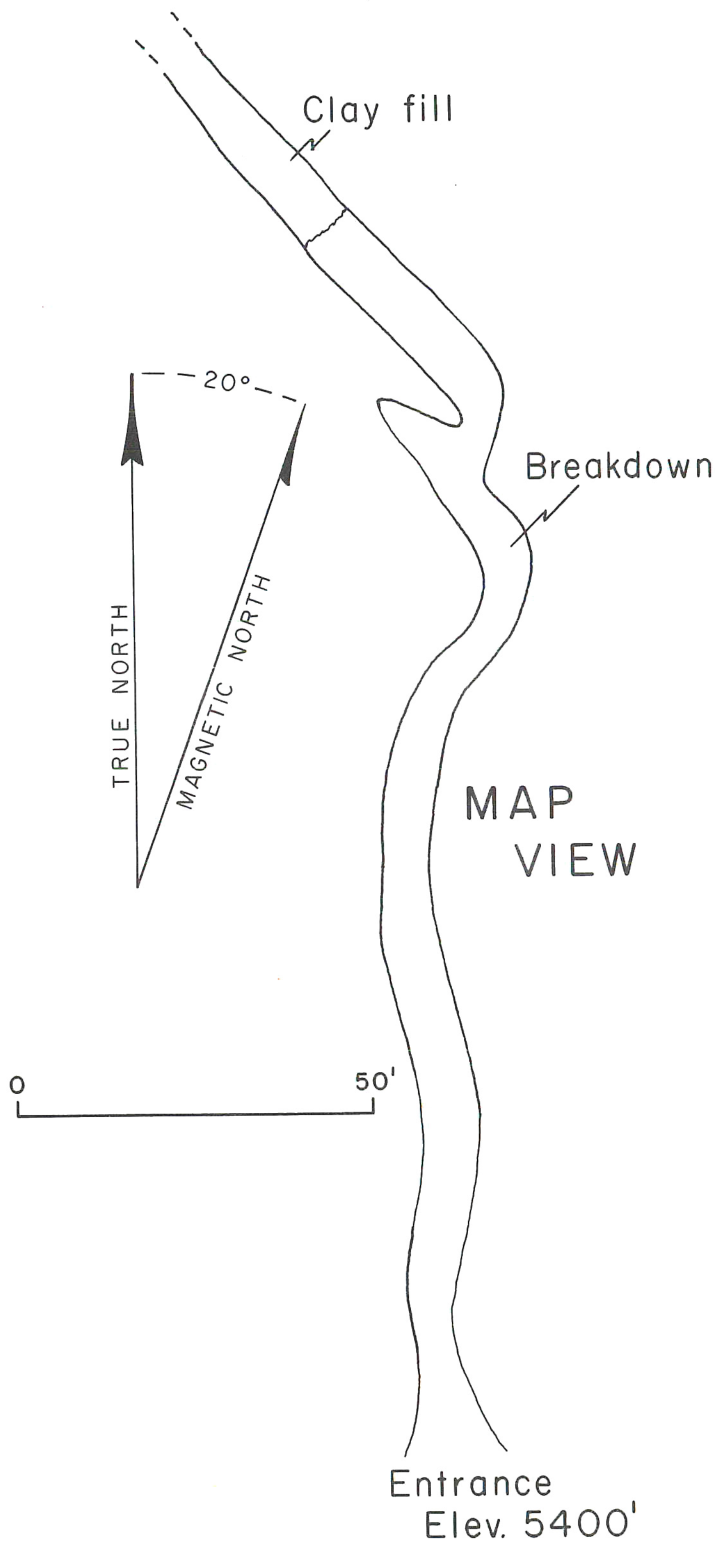


Figure 71.–Needle Falls Cave

thick sequence of Devonian and Mississippian carbonate strata occupies the center of the fold. These rocks form a high plateau on each side of Silvertip Peak. Air photos show numerous solution features developed principally on Devonian carbonate beds of the plateau. Caves and sinkholes are formed in the upper part of the Jefferson Formation and in the Three Forks Formation. Caves are most abundant in the center of the syncline, where dips are low and snow meltwater can slowly seep underground. Caves are also found in the steeply dipping west flank of the syncline. At least two of these connect with caves in the syncline trough, forming extremely deep systems. As of 1976, seven large caves, containing more than 30,000 feet of passage, had been mapped. Eventually all of these caves may be found to connect. One cave has been mapped to a depth of 1,052 feet and is the fourth deepest cave in the United States. Two other caves have depths of 820 feet and 527 feet. A maximum depth of 1,430 feet is possible. Only the northern part of the plateau has been explored, and many more caves and pits are likely to be found in the larger southern part. Silvertip Basin recently has been studied by Ayers (1976).

Spotted Bear Lookout Cave

Cave no.:	199	Range:	Flathead
County:	Flathead	Map coverage:	Spotted Bear Mountain 1:24,000
Location:	sec. 25, T. 25 N., R. 15 W. (unsurveyed)	Altitude:	7,200 ft.

This cave lies near the Spotted Bear Lookout near the west margin of the Bob Marshall Wilderness. The cave entrance is a 41-foot vertical pit that leads to a 150-foot-long room partly filled with breakdown. There are no side passages or speleothems in the cave, which formed in Mississippian carbonate rocks.

Turtlehead Mountain Cave

Cave no.:	245	Range:	Flathead
County:	Flathead	Map coverage:	Amphitheatre Mountain 1:24,000
Location:	sec. 15, T. 22 N., R. 13 W. (unsurveyed)		

Turtlehead Mountain has at least one vertical pit near its summit. A 30-mile walk is necessary to reach it. The extent of the cave is unknown.

Twin Creek Crevasse

Cave no.:	293	Range:	Flathead
County:	Flathead	Map coverage:	?Circus Peak 1:24,000
Location:	sec. 16, T. 26 N., R. 15 W. (unsurveyed)	Altitude:	4,500 ft.

This cave is a northwest-trending fissure developed as a result of gravity sliding in Precambrian argillite. The fissure is 80 feet deep and about 5 feet wide. It is possible to walk into it from a point near Twin Creek; the cave is open to the surface throughout its entire length.

Whale Creek Caves

Cave no.:	195	Range:	Whitefish
County:	Flathead	Map coverage:	Red Meadow Lake 1:24,000
Location:	T. 36 N., R. 23 W. (unsurveyed)		

These caves are on Whale Creek, west of Glacier National Park. The size and exact location of the caves are unknown, but they probably formed in Mississippian carbonate rocks.

Yakinikak Creek Caves (Thoma Caves)

Cave no.:	197	Range:	Flathead
County:	Flathead	Map coverage:	Mount Hefty 1:24,000
Location:	sec. 25, T. 37 N., R. 23 W. (unsurveyed)	Altitude:	4,700 ft.
		Temperature:	37°F

These caves are about 60 miles north of Columbia Falls, on Yakinikak Creek (some maps show this as Tuchuck Creek). Four separate caves are labeled No. 1, No. 2, No. 3, and No. 4 for identification purposes. Three of the caves lie on the north side of the canyon at the Yakinikak-Thoma Creek junction; the fourth is 2.6 miles upstream.

Yakinikak Creek Cave No. 1 contains 769 feet of fairly large passage (Fig. 72). Incised stream channels in the horizontal cave suggest that at one time the cave contained an underground stream. A loud roaring noise issues from a small pit near the back of the cave, indicating that the present stream level is only a few feet below. A few soda-straw stalactites decorate the cave walls.

About 100 yards downstream Yakinikak Creek Cave No. 3 is directly above Yakinikak Creek Cave No. 2. No. 2 has been mapped for about 522 feet but probably contains much more passage (Fig. 73). About 150 feet from the entrance a stream is encountered. Upstream, the water exceeds 6 feet in depth, but downstream the water depth is 1 to 2 feet (July 1971). It is possible to explore the stream for 350 feet before it flows under a low ledge. During low

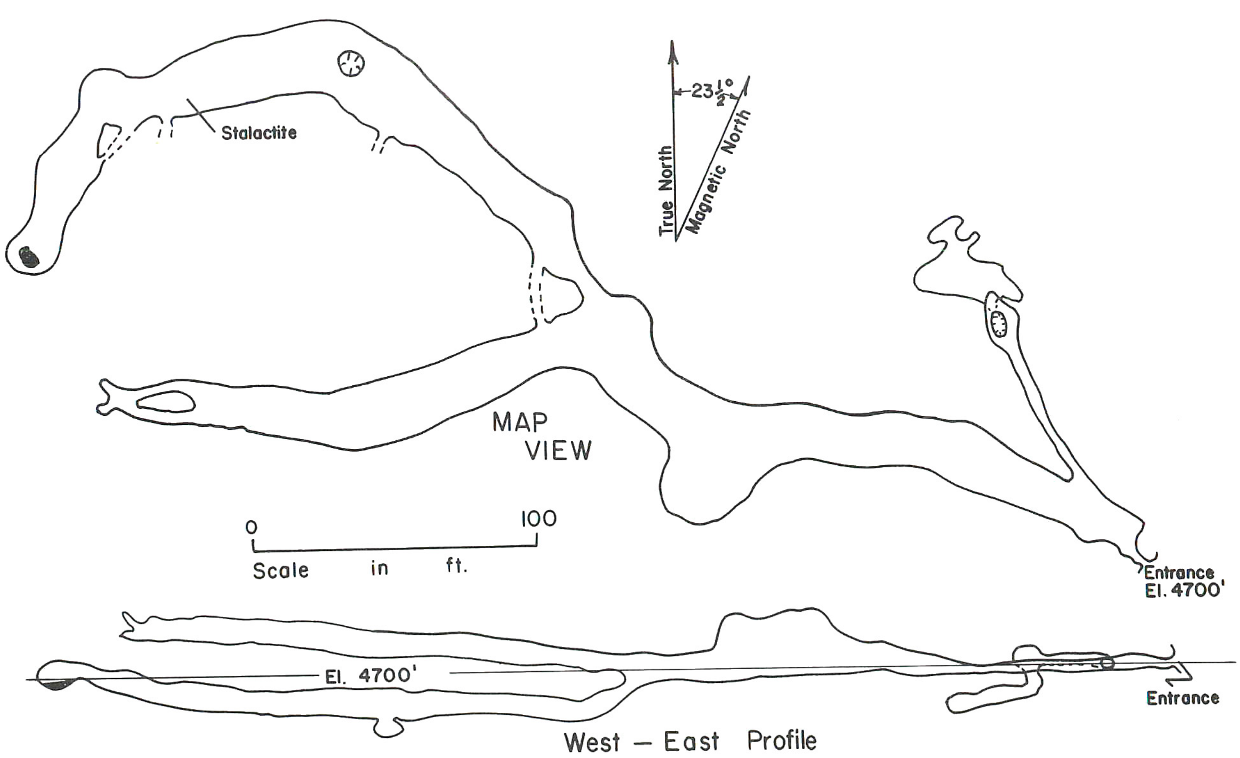


Figure 72.–Yakinikak Creek Cave No. 1

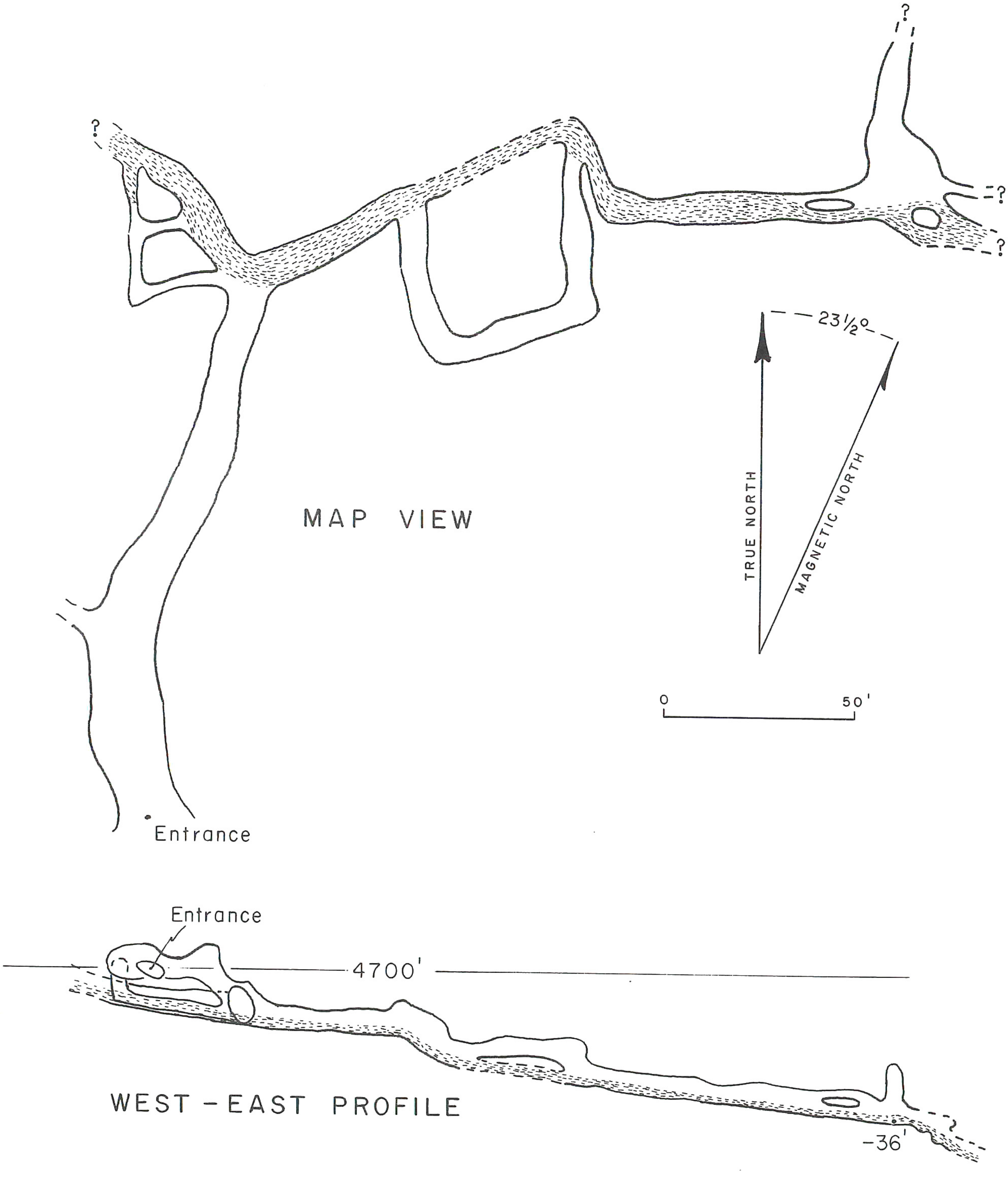


Figure 73.–Yakinikak Creek Cave No. 2

water it may be possible to penetrate farther into the cave. The stream probably flows under Yakinikak Creek Cave No. 1 and accounts for the noise heard in that cave. The water may originate from a part of Yakinikak Creek or Thoma Creek. Boulders of red and green argillite as much as 2 feet in diameter fill the stream channel, indicating that another surface entrance lies somewhere upstream. Yakinikak Creek Cave No. 3 lies directly above Cave No. 2 and contains less than 100 feet of passage. It may represent a portion of a higher stream channel or it may be vadose in origin (Fig 74).

About 2 miles upstream in sec. 34, T. 37 N., R. 23 W., Yakinikak Creek sinks under a limestone cliff and does not reappear for 1.6 miles. Logs are jammed against the cliff, but it is possible to enter the cave formed by the sinking creek. About 30 feet inside the cave, water depth exceeds 6 feet, but the cave continues for at least another 100 feet. The roar of underground rapids can be heard in the distance; it may be possible to follow the stream for a considerable distance. Part of this underground stream may reappear in Cave No. 2, but the main point of resurgence is in sec. 35. Another cave may be accessible behind the resurgence, and digging might open a second entrance at this point. Special equipment would be necessary to completely explore the cave.

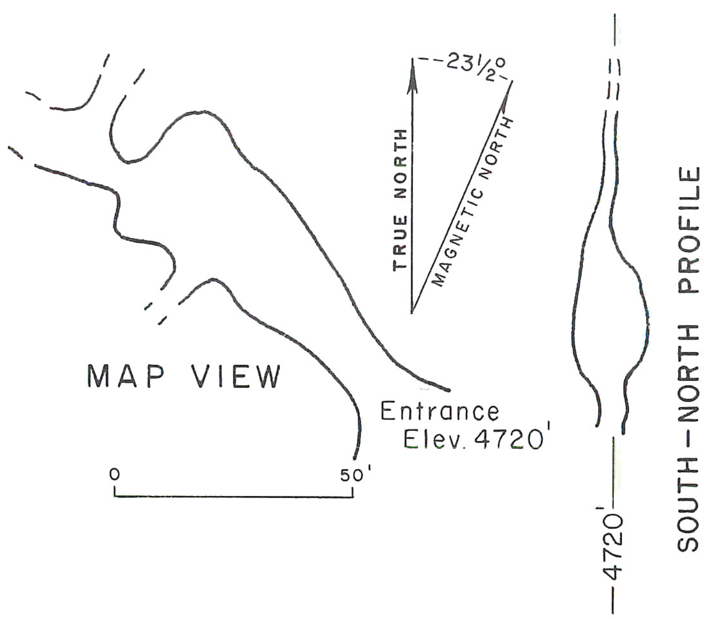


Figure 74.—Yakinikak Creek Cave No. 3

GLACIER COUNTY

Trick Falls Cave

Cave no.:	225	Range:	Lewis
County:	Glacier	Map coverage:	Squaw Mountain 1:24,000
Location:	sec. 31, T. 32 N., R. 13 W. (unsurveyed)	Altitude:	5,000 ft.

Trick Falls lies on Two Medicine Creek in Glacier National Park. Part of the creek siphons above the falls and emerges from fissures at the base of the falls. Eventually all the water will flow underground, forming a natural bridge. A cave may exist behind the falls but it has never been entered; diving equipment would be necessary to gain access. The Trick Falls area is underlain by Siyeh Limestone.

LAKE COUNTY

Lick Cave

Cave no.:	191	Map coverage:	Wild Horse Island 1:24,000
County:	Lake	Altitude:	3,000 ft.
Location:	probably sec. 8, T. 23 N., R. 20 W.		

This cave is about 7 miles north of Polson near the West Lakeshore access road. The entrance is a small fissure 15 feet deep, and passages run northwest and southeast. The cave contains about 200 feet of breakdown-filled crawlway and has no speleothems. It formed in Precambrian argillite that is sliding toward the southeast. Several collapsed fissures and broken blocks can be observed downdip from the cave; other fissures in the area are too small to enter.

LEWIS AND CLARK COUNTY

Bean Hole

Cave no.:	213	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Bean Lake 1:24,000
Location:	sec. 25, T. 18 N., R. 7 W.	Altitude:	5,500 ft.

This cave is 20 miles west of Augusta, near Bean Lake. The cave entrance is a 10- by 20-foot vertical sink 170 feet deep situated on top of an east-trending ridge. The entrance pit widens to 50 feet near the bottom. A single passage leads upward from the pit toward the ridge top. A few helectites were found at the base of the pit. A detailed description of the first exploration of this cave was printed in the August 3, 1950, edition of the *Great Falls Tribune*. The cave formed in the Mission Canyon Formation and developed along a single northwest-trending joint.

Birdsnest Cave

Cave no.:	275	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Choteau 1:250,000

Birdsnest Cave is a small rock shelter near the town of Aitken; other details are not available.

Blacktail Ranch Cave

Cave no.:	220	Range:	Blackfoot
County:	Lewis and Clark	Map coverage:	Rogers Pass 1:24,000
Location:	sec. 31, T. 16 N., R. 5 W.	Altitude:	4,975 ft.
		Temperature:	43°F

This cave is on property of the Blacktail Ranch on the south fork of the Dearborn River. The entrance is at the base of a small ledge about 100 feet above the river level. Steps have been built to the first room of the cave, a chamber about 10 feet in diameter. The cave is

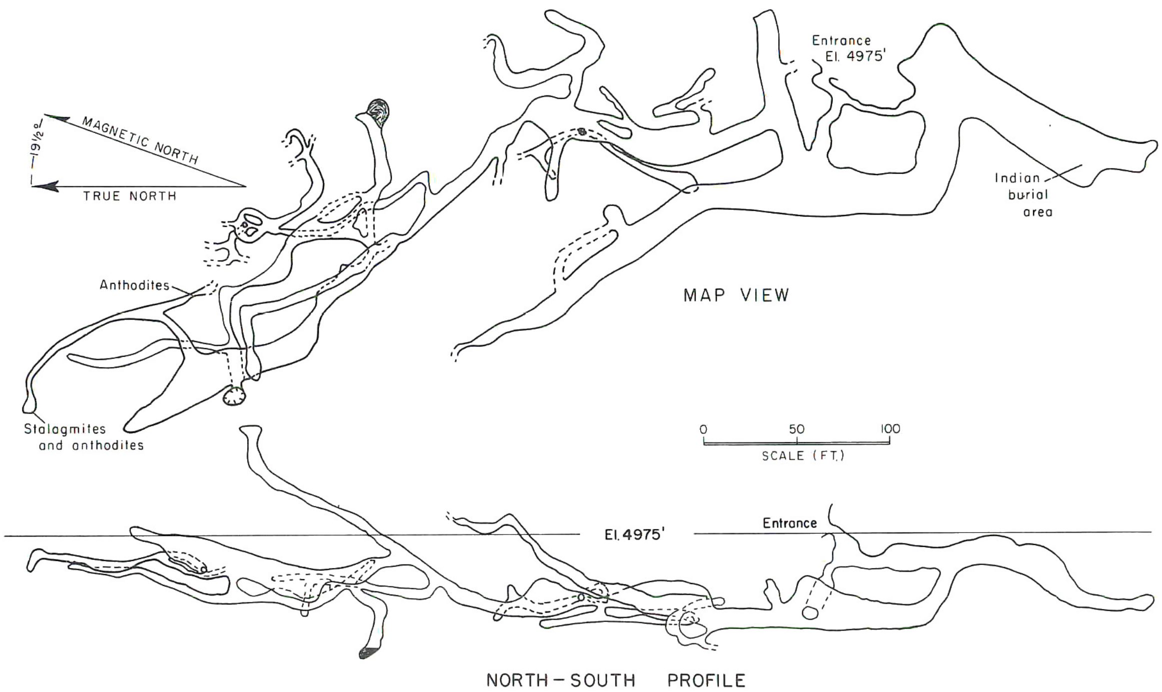


Figure 75.–Blacktail Ranch Cave

mainly horizontal, the passages trending N. 40° W. (Fig. 75). Several large rooms are grouped near the entrance, but most of the cave consists of low mud-filled crawlways. A total of 2,023 feet of passage has been surveyed and an estimated 400 feet of passage still remains unmapped.

The cave formed in Madison Group carbonate rocks that here trend N. 40° W., 36° NE. Many of the passages formed along the strike of a thin silty limestone bed that is sandwiched between more massive layers. There is no evidence that the Dearborn River ever flowed through the cave, although flood water may have washed some of the clay and silt into it.

A short distance inside the entrance, bones and artifacts of early man were discovered by the owner in 1948, and pictographs are visible at the entrance. The age of the artifacts is unknown, but they may be more than 5,000 years old. The cave entrance was plugged with debris that had to be dug out before entrance could be made. The owner conducts limited tours of the cave for visitors to his guest ranch.

Blowing Cold Hole

Cave no.:	214	Range:	Helena
County:	Lewis and Clark	Map coverage:	Butte 1:250,000

This cave is north of Helena on the road to York. The entrance is a small ice-plugged hole that was intersected by a roadcut. A cold current of air was coming from the cave when it was discovered. The cave seemingly has never been entered, and its exact location is now unknown.

Cave Creek Caves

Cave no.:	208	Range:	Blackfoot
County:	Lewis and Clark	Map coverage:	Scapegoat Mountain 1:24,000
Location:	sec. 19, T. 18 N., R. 9 W. (unsurveyed)	Altitude:	approximately 7,000 ft.

Two caves can be found at the head of Cave Creek, east of Scapegoat Mountain. Both caves, high on the side of Scapegoat Mountain, are visible from the Cave Creek trail. A horizontal passage leads from the lower entrance, which is about 30 feet in diameter, back into the mountain. The cave has been explored for about 600 feet, but passage continues beyond this point. A second entrance, 200 feet above the lower cave, has not been explored. Cave Creek Caves developed in a thick sequence of Cambrian carbonate rocks that crop out in the area.

Crown Mountain Cave

Cave no.:	238	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Wood Lake 1:24,000
Location:	sec. 21, T. 19 N., R. 9 W. (unsurveyed)	Altitude:	approximately 8,000 ft.

A pit of unknown depth has been located on Crown Mountain, 20 miles west of Augusta. No other information is available.

Danaher Mountain Cave

Cave no.:	261	Range:	Blackfoot
County:	Lewis and Clark	Map coverage:	Danaher Mountain 1:24,000
Location:	sec. 31, T. 18 N., R. 11 W.	Altitude:	approximately 8,000 ft.

Danaher Mountain cave is about 20 miles north of Lincoln and is on the north side of the peak near the summit. The exact size of the cave is unknown, but it is reported to be large. Danaher Mountain is capped by Cambrian carbonate rocks.

Fairview Mountain Cave

Cave no.:	237	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Wood Lake 1:24,000
Location:	sec. 16, T. 20 N., R. 9 W. (unsurveyed)	Altitude:	8,000 ft.

A pit has been found on the southwest side of Fairview Mountain about 15 miles west of Augusta, but the depth of the sinkhole is unknown. The cave formed in Madison Group carbonate rocks.

Falls Creek Ice Cave

Cave no.:	276	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Blowout Mountain 1:24,000
Location:	T. 17 N., R. 7 W.		

This ice cave lies on Falls Creek about 25 miles southwest of Augusta. Local ranchers have been in the cave and report that a large mound of ice fills the entrance room nearly to the ceiling. Descent down the ice to the back of the room is difficult, and few people have reached the bottom. It is not known whether the cave continues beyond this point. The cave formed in Mississippian carbonate rocks.

Foggy Brennan Cave

Cave no.:	215	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Bean Lake 1:24,000
Location:	sec. 27, T. 18 N., R. 7 W.	Altitude:	6,000 ft.

Foggy Brennan Cave is a vertical pit near the Diamond Bar-X Ranch southwest of Augusta. The entrance is a 3-foot hole at the top of a ridge capped by Madison Group carbonate rocks. The sink drops 25 feet and ends in a room 70 feet long. A few patches of flowstone decorate the cave. The first exploration was described in the August 10, 1950, edition of the *Great Falls Tribune.*

Ford Creek Cave

Cave no.:	297	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Double Falls 1:24,000
Location:	sec. 14, T. 19 N., R. 9 W. (unsurveyed)	Altitude:	6,300 ft.

Ford Creek Cave is a small ice cave near the Ford Creek Guest Ranch. It formed in Madison Group carbonate rocks.

Green Mountain Caves

Cave no.:	274	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Sawtooth Ridge 1:24,000
Location:	T. 21 N., R. 9 W.		

These caves or rock shelters lie near Gibson Reservoir on a ridge known locally as Green Mountain. They formed in Mission Canyon carbonate rocks.

Grizzly Gulch Cave

Cave no.:	296	Range:	Blackfoot
County:	Lewis and Clark	Map coverage:	Slategoat Mountain 1:24,000
Location:	sec. 29, T. 22 N., R. 11 W. (unsurveyed)	Altitude:	6,200 ft.

This cave has a 4- by 8-foot opening in Cambrian limestone near a thrust contact with Precambrian argillite. Ground water channeled down into the limestone seemingly flows along the top of the argillite until it emerges on the north side of Grizzly Gulch. When visited in July 1971, the entire opening was filled with water. It may be possible to enter during low water, but the cave, to date, is unexplored.

Hannan Pit

Cave no.:	298	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Castle Reef 1:24,000
Location:	sec. 27, T. 22 N., R. 9 W. (unsurveyed)	Altitude:	6,100 ft.

This cave lies on the divide between Hannan Gulch and Blacktail Gulch about 2 miles from Gibson Reservoir. The cave is a vertical pit of unknown depth and has never been entered. The divide formed in Mississippian carbonate rocks.

Junction Mountain Cave (Pearl Cliff Cave)

Cave no.:	239	Range:	Flathead
County:	Lewis and Clark	Map coverage:	Prairie Reef 1:24,000
Location:	sec. 11, T. 20 N., R. 12 W. (unsurveyed)	Altitude:	6,900 ft.
		Temperature:	33°F

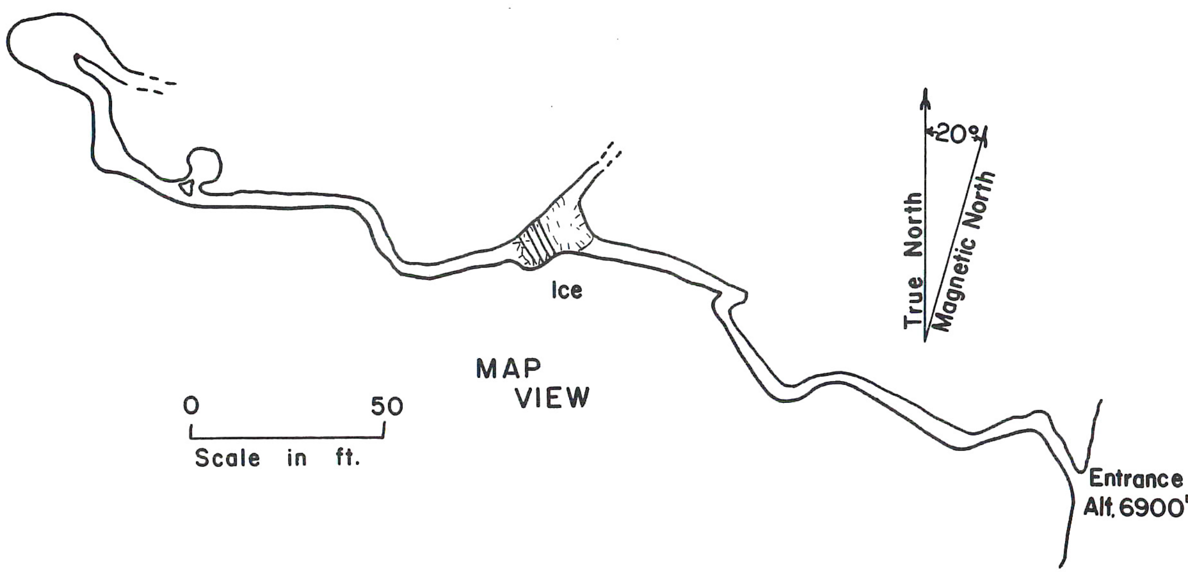


Figure 76.–Junction Mountain Cave

This cave is at the head of Pearl Basin in cliffs extending from Junction Mountain. The cave is horizontal and is formed in flat-lying Cambrian carbonate rocks. It consists of a narrow crawlway that trends N. 60°W. along a single joint. It has 430 feet of mapped passage, and two small crawlways are still unexplored (Fig. 76). One room about 200 feet from the entrance is floored with ice. There are no speleothems.

Klick Caves

Cave no.:	295	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Arsenic Peak 1:24,000
Location:	sec. 26, T. 22 N., R. 10 W.	Altitude:	5,700 ft.

The Klick Caves, near the Klick (KL) Ranch at the west end of Gibson Reservoir, are less than 50 feet long, but both contain hot springs. One of the caves was used as a "steam bath house" in the past. The caves formed near a fault in Cambrian carbonate rocks.

Little Chinese Wall Cave

Cave no.:	207	Range:	Blackfoot
County:	Lewis and Clark	Map coverage:	Blowout Mountain 1:24,000
Location:	probably sec. 3, T. 16 N., R. 7 W. (unsurveyed)	Altitude:	7,000 ft.

The east-trending part of the continental divide near the Alice Creek Ranger Station is known as the "Little Chinese Wall". The cave entrance is about halfway up the cliff face and can be seen from the ranger station. One unsuccessful attempt was made to reach the cave (described in the September 11, 1952, edition of the *Great Falls Tribune*), which formed in Cambrian carbonate rocks. The cave has probably never been entered, and its exact size is unknown.

Lookout Cave (Fer-de-lis Cave)

Cave no.:	216	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Bean Lake 1:24,000
Location:	sec. 27, T. 18 N., R. 7 W.	Altitude:	6,000 ft.

Lookout Cave, very near Foggy Brennan Cave southwest of Augusta, is a rock shelter about 8 by 15 feet in size. It formed in the Mission Canyon Formation. An article in the August 10, 1950, edition of the *Great Falls Tribune* described the cave.

Observation Point Cave

Cave no.:	263	Range:	Blackfoot
County:	Lewis and Clark	Map coverage:	Flint Mountain 1:24,000
Location:	sec. 6, T. 18 N., R. 10 W. (unsurveyed)	Altitude:	approximately 8,000 ft.

This cave is at the 8,000-foot level just east of Observation Point. Several guides have been to the cave entrance, which is a deep sinkhole, but no one has ever descended the pit. It formed in Cambrian carbonate rocks.

Ophir Cave

Cave no.:	221	Range:	Helena
County:	Lewis and Clark	Map coverage:	Elliston 1:62,500
Location:	sec. 9, T. 11 N., R. 7 W.	Altitude:	7,000 ft.
		Temperature:	41°F

Ophir Cave is on Cave Gulch, a tributary of Ophir Creek (Carpenter Creek according to U.S. Forest Service sign), about 10 miles northeast of Avon. The entrance is under a low limestone ledge near the top of the west ridge. A small hole at the base of a sink leads down a talus cone to a 60- by 80-foot room. Near the front of the room, a 4- by 4-foot man-made shaft about 38 feet deep (Fig. 77) has been sunk. The floor of the room is covered with large blocks of breakdown; a small hole leads down through the breakdown to the top of a second 100-foot-long room. A 40-foot free drop reaches the bottom of this chamber; several small leads pinch out in breakdown in this room. The total depth of the cave is 184 feet.

Speleothems are abundant in the lower room; flowstone, cave popcorn, and small stalactites decorate the walls. Several names smoked on the walls, dated in the 1880's, seem to be authentic, as a thin layer of flowstone now covers the dates. Bones of a small rodent were found encrusted with 1/8 to 1/4 inch of calcite, but radiocarbon dating of the bones has not been attempted. The

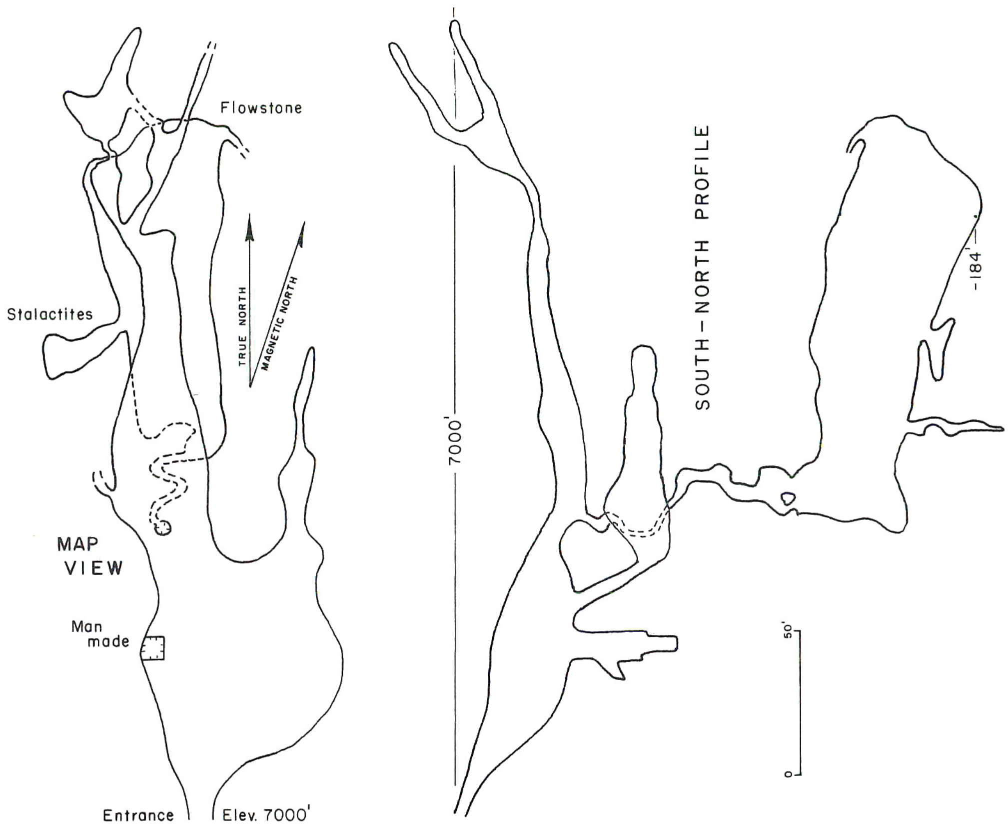


Figure 77.–Ophir Cave

cave contains 669 feet of passage and is formed in Mission Canyon Formation, here striking N. 50° E. and dipping 20° SE. The cave developed mainly along a series of N. 20° W.-trending joints. The cave was the object of national attention in the 1950's when reports indicated that it was more than 3,000 feet deep. It has been carefully explored many times since then, but no leads have been found beyond the -184 foot level. It is doubtful that the cave goes much beyond that depth.

Pretty Prairie Cave

Cave no.:	210	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Pretty Prairie 1:24,000
Location:	sec. 6, T. 21 N., R. 8 W. (unsurveyed)	Altitude:	7,130 ft.

This cave, 9 miles northwest of Benchmark, has not been entered. The entrance is a sinkhole that lies on top of a ridge west of the Pretty Prairie airstrip. The cave, formed in Madison Group carbonate rocks, drops vertically for about 50 feet, then slants off to the west at a steep angle. Several other sinkholes on the same ridge have been observed from the air.

"Q" Cave

Cave no.:	217	Map coverage:	Choteau 1:250,000
County:	Lewis and Clark		

This cave, near Wolf Creek, on the south fork of the Dearborn River, is actually a small rock shelter.

"R" Cave

Cave no.:	260	Map coverage:	Choteau 1:250,000
County:	Lewis and Clark		

"R" Cave is a small rock shelter on the south fork of the Dearborn River near Wolf Creek. It probably lies near "Q" Cave.

Sawtooth Mountain Caves

Cave no.:	211	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Sawtooth Ridge 1:24,000
Location:	sec. 19, 30, 31, 32, T. 21 N., R. 8 W.	Altitude:	7,600 and 8,000 ft.

Sawtooth Mountain Caves consist of two large openings on the east face of Sawtooth Mountain and two sinkholes on the ridge top above. The larger cave is visible for many miles and has an opening 100 feet high and 50 feet wide. A zone of solution breccia 100 feet high and 40 feet wide extends up the cliff to the cave mouth (Fig. 78). The cave is probably an old solution feature on a Mississippian karst surface that was filled with solution breccia and buried during late Mississippian time. Sliding and erosion have exposed the old sinkhole, allowing the breccia to erode away leaving a hole in the cliff face (Fig. 78). Part of the breccia that filled the pit still remains in place. The cave will be destroyed when new slides break away more of the escarpment.

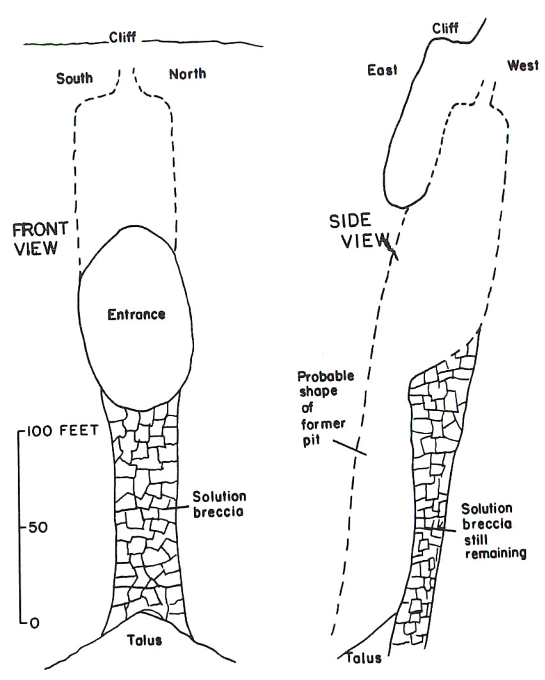


Figure 78.–Sawtooth Mountain Caves.

On the ridge above, and behind the large cave, fractures are forming as blocks of limestone begin to break off and slide down slope. Large masses of breakdown can be seen below Sawtooth Ridge, indicating that the process has been going on for some time. One of the fractures can be descended to a depth of about 40 feet. This "cave" does not connect to a large cave below, although it lies directly above it.

About one-half mile south, a second cave is visible on the cliff face. The opening is about 20 feet in diameter and about 50 feet long. A collapsed sink on the ridge above may connect with the cave, but it cannot be entered. Sawtooth Mountain is composed of Mission Canyon (Castle Reef) Formation, which strikes N. 20° W. and dips 10° W.

Scapegoat Mountain Caves

Cave no.:	209	Range:	Blackfoot
County:	Lewis and Clark	Map coverage:	Scapegoat Mountain 1:24,000
Location:	sec. 3, 4, 9, 10, 14, 15, 16 T. 18 N., R. 10 W. (unsurveyed)	Altitude:	7,800 to 8,200 ft.
		Temperature:	32-33°F

West of the summit of Scapegoat Mountain, a high plateau is composed of horizontal Cambrian carbonate rocks. Air photos show more than 200 sinkholes scattered over the 6-square-mile area. The sinks all developed along three joint sets (N. 65° W., N. 35° W., and N. 20° E.); the largest sinks are at the intersection of joints. Most of the sinks formed at the top of the Pagoda Limestone, but a few large pits can be seen along higher ridges in the Steamboat Limestone. The position of large snowbanks on top of the plateau controls the location of the sinkholes. The additional water released by the snowbanks enlarges nearby joints and creates deep vadose pits (Campbell, 1977).

When the area was visited in July 1971 and August 1972, many of the pits were still filled with snow and ice. About half of the pits were entered, but snow and running water made exploration difficult. Figure 79 shows a selection of pit profiles.

All of the snow meltwater on the plateau flows directly into the sinkholes and is carried into a vast underground drainage system. The resurgence of nearly all the meltwater is thought to be into the Green Fork of Straight Creek from a series of streams that run out of caves at the base of the Damnation Limestone. Water running out of these caves at the 6,800-foot level pours out of the entrances and falls to the canyon floor. Three of the caves were entered, and two were partly mapped (Fig. 80); these are also joint controlled. The map of Cathy's Ice Box (Fig. 80) shows that the three joint directions in the lower part of the Cambrian section are the same as in the rocks in the plateau above. Although several trips into the area (15 miles by foot) will be necessary before all of the caves can be explored and completely mapped, the area will probably yield some of the nation's deepest caves. The total carbonate thickness is almost 1,700 feet at Scapegoat Mountain, and the vertical relief between the highest pits and the lowest caves in Green Fork Canyon is 1,400 feet. Because the joints seem to penetrate the entire Cambrian section here, caves may be as deep as 1,000 feet or even more.

In the fall of 1973 during low water, Cathy's Ice Box was mapped to its end, a total length of more than a mile. Green Fork Falls Cave was explored for an estimated 2.5 miles (not mapped) with no end in sight. The cave is now the third largest known in Montana.

Sheep Sheds Cave

Cave no.:	212	Range:	Flathead
County:	Lewis and Clark	Map coverage:	Patricks Basin 1:24,000
Location:	sec. 32, T. 21 N., R. 9 W. (unsurveyed)	Altitude:	7,300 ft.

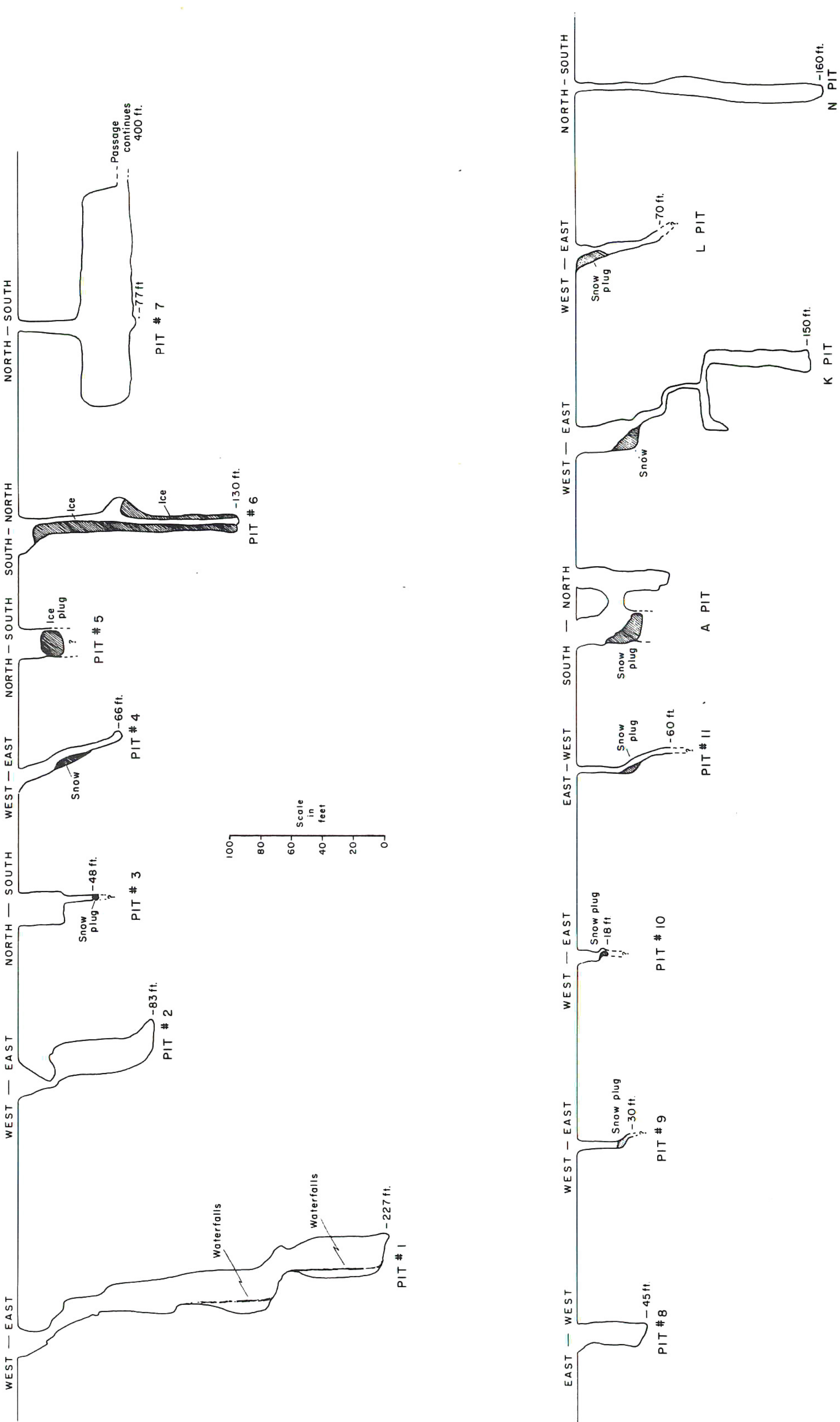


Figure 79.–Scapegoat Mountain Caves

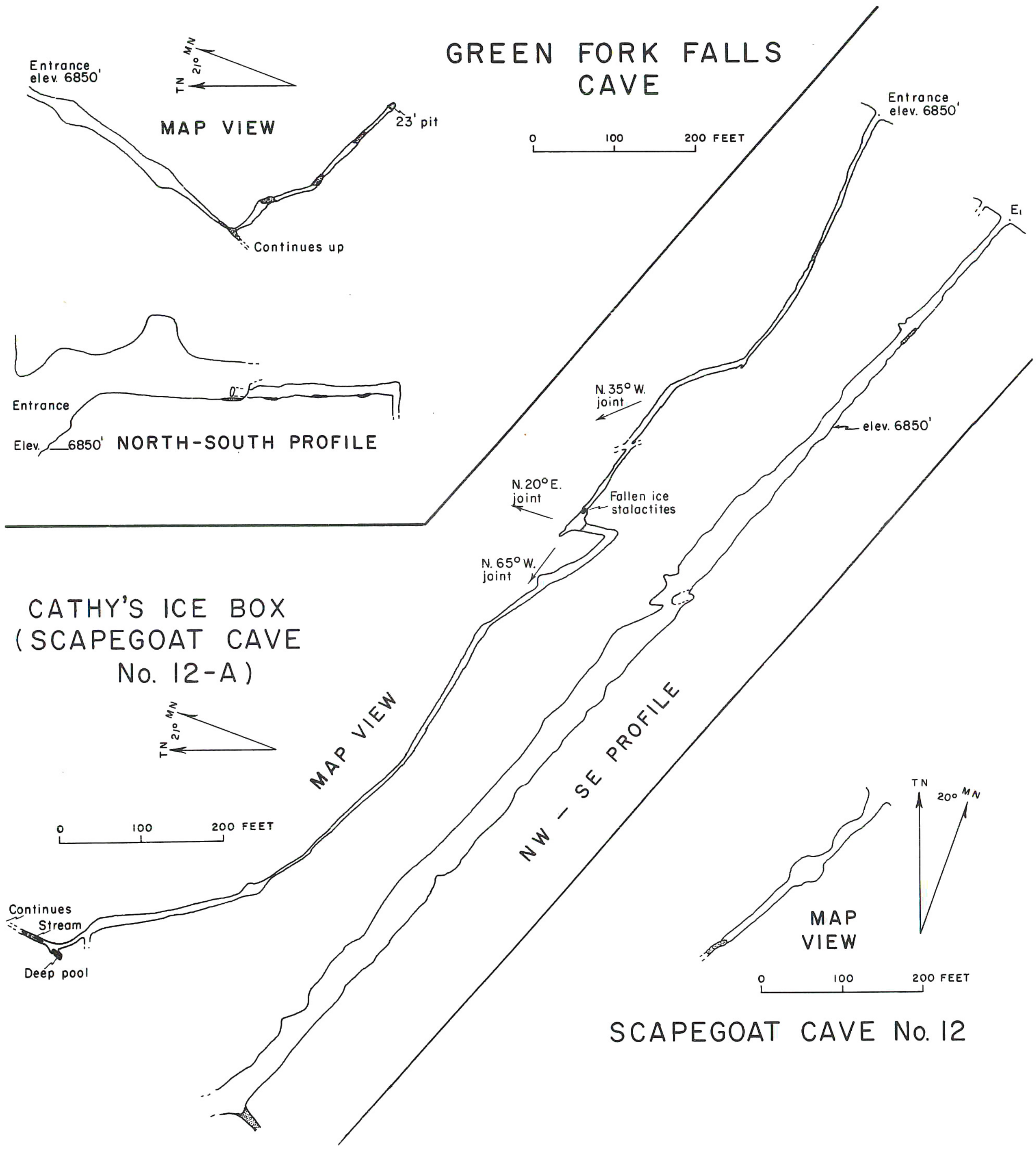


Figure 80.–Scapegoat Mountain Cave

This cave is on Sheep Sheds Mountain five miles south of Gibson Reservoir. The entrance is a sinkhole of unknown depth. The cave formed in Madison Group carbonate rocks.

Sun River No. 1 Cave

Cave no.:	235	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Sawtooth Ridge 1:24,000
Location:	sec. 3, T. 21 N., R. 9 W. (unsurveyed)	Altitude:	5,000 ft.

This is a small horizontal cave in the Sun River Canyon east of Gibson Reservoir. The cave formed in Madison Group carbonate rocks.

Sun River No. 2 Cave

Cave no.:	236	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Pretty Prairie 1:24,000
Location:	probably sec. 34, T. 22 N., R. 10 W. (unsurveyed)	Altitude:	approximately 5,000 ft.

This cave is on the South Fork of the Sun River west of Gibson Reservoir, but its size is unknown.

Triple Divide Cave

Cave no.:	262	Range:	Blackfoot
County:	Lewis and Clark	Map coverage:	Flint Mountain 1:24,000
Location:	sec. 6, T. 18 N., R. 10 W. (unsurveyed)	Altitude:	7,700 ft.

This cave is on the east side of Triple Divide Peak on a ridge running toward Scapegoat Mountain. The cave is reported to be a deep pit, but it has not been explored. Triple Divide is capped by Cambrian carbonate rocks.

Warm Air Blowing Hole

Cave no.:	278	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Rogers Pass 1:24,000
Location:	probably sec. 21, T. 16 N., R. 6 W.	Altitude:	6,000 ft.

This cave is 30 miles southwest of Augusta, near the east side of Rogers Pass. It is a pit on top of a ridge formed in Madison carbonate rocks. The cave was visited once in the early 1950's, but no details on its length or depth are available.

Willow Peak Cave

Cave no.:	222	Range:	Big Belt
County:	Lewis and Clark	Map coverage:	Candle Mountain 1:24,000
Location:	probably sec. 15, T. 13 N., R. 2 W.	Altitude:	approximately 6,000 ft.

This cave is in the Gates of the Mountains Wilderness Area northeast of Helena. It was discovered by fire fighters during the Mann Gulch fire of 1949. The cave has a small horizontal entrance and contains several rooms. Speleothems were reported to be numerous and well developed. The cave formed in the Mission Canyon Formation.

"Y" Cave

Cave no.:	218	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Bean Lake 1:24,000
Location:	T. 18 N., R. 7 W.		

"Y" Cave is a small rock shelter near Bean Lake, west of Augusta. The cave may have formed in Madison Group carbonate rocks, but its exact location is unknown.

"Z" Cave

Cave no.:	219	Range:	Sawtooth
County:	Lewis and Clark	Map coverage:	Bean Lake 1:24,000
Location:	T. 18 N., R. 7 W.		

"Z" cave, a small horizontal cave containing about 100 feet of passage, is near Bean Lake, west of Augusta. The cave formed in Madison Group carbonate rocks.

LIBERTY COUNTY

Cave-With-Seven-Rooms (Seven Rooms Cave)

Cave no.:	227	Range:	Sweetgrass Hills
County:	Liberty	Map coverage:	Bingham Lake 1:24,000
Location:	sec. 17, T. 36 N., R. 5 E.	Altitude:	4,940 ft.

This cave is north of Chester, in the East Butte area at the head of Sage Creek. The entrance, a 20-foot sink, is about 50 feet above the creek level. A small hole at the base of the cave leads to nearly 400 feet of tight crawlways and breakdown-filled rooms. A small stream runs through the breakdown at the low point in the cave. A second possible entrance lies at the creek level where part of Sage Creek flows into a small crack and is probably the source of the water in the cave. About a quarter-mile northeast of the cave, on top of the ridge at 5,450 feet, a pit has been found by a local rancher. It may connect with Seven Rooms Cave below, but it has not been descended. The area contains Madison Group carbonate rocks striking northeast.

Sage Creek Siphon

Cave no.:	254	Range:	Sweetgrass Hills
County:	Liberty	Map coverage:	Bingham Lake 1:24,000
Location:	sec. 17, T. 36 N., R. 5 E.	Altitude:	4,800 ft.

Sage Creek flows eastward out of the Sweetgrass Hills (East Butte), 26 miles north of Chester. During low water, the entire creek disappears into cracks in the creek bottom. Most of the water flows into a fissure 2 feet wide, which may connect with Seven Rooms Cave. Sage Creek resurges about a mile away in sec. 8 at an altitude of 4,550 feet. The fissure or the stream within Seven Rooms Cave has not been explored, so a large cave could exist downstream. Sage Creek Canyon is cut in Mississippian carbonate rocks.

Sweetgrass Wind Hole (Devil's Chimney)

Cave no.:	226	Range:	Sweetgrass Hills
County:	Liberty	Map coverage:	Mt. Lebanon 1:24,000
Location:	sec. 20, T. 36 N., R. 5 E.	Altitude:	5,350 ft.

This cave lies at the head of Tootsie Creek north of Chester. The entrance is a 49-foot vertical pit that leads to two small rooms that reach a depth of -67 feet (Fig. 81). The cave formed in solution breccia of the Mission Canyon Formation. A second entrance at the base of the pit connects to the cliff base outside (see map). A third entrance can be seen from the inside of the cave but cannot be reached from outside. The cave may have been part of a larger system, part of which was removed by stream erosion. There are no speleothems.

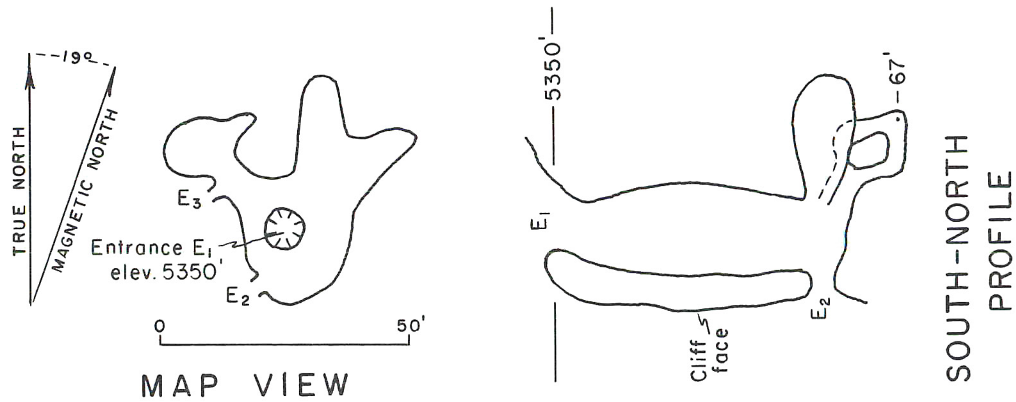


Figure 81.–Sweetgrass Wind Hole

LINCOLN COUNTY

Kenelty Cave

Cave no.:	194	Range:	Salish
County:	Lincoln	Map coverage:	Kenelty Mountain 1:24,000
Location:	sec. 4, T. 26 N., R. 29 W.	Altitude:	4,100 ft.

This cave is 25 miles southeast of Libby, north of U.S. Highway 2, on a ridge south of Kenelty Mountain. The entrance is a small horizontal hole opening into a 30-foot crawlway that leads to a large 50-foot room. A second 50-foot crawlway extends from the room and ends in a 20-foot-deep pit plugged with clay and silt. Moonmilk reportedly coats the pit walls but otherwise there are no speleothems. The cave formed in rocks of the Missoula Group.

MINERAL COUNTY

Hungry Hollow Hole

Cave no.:	288	Range:	Bitterroot
County:	Mineral	Map coverage:	Superior 1:62,500
Location:	T. 15 N., R. 27 W.	Altitude:	5,300 ft.
		Temperature:	45°F

This cave is on a ridge above Deep Creek, south of Superior. The entrance is in a S. 73° E.-trending trench near the crest of the ridge and is about 10 feet in diameter. Below the entrance is a narrow cave about 50 feet long and 2½ feet wide, the total depth of which is 60 feet. Other sinks in the area are all choked with debris.

The cave is a gravity-slide feature formed in argillite of the Wallace Formation. The whole hillside above Deep Creek seems to be slowly sliding southward; parallel depressions indicate where fissures are forming between slide blocks. Most of the fissures have collapsed roofs, but the crack forming the cave has a roof of broken rock and soil. Hungry Hollow Hole will soon be destroyed as sliding continues. A few small calcite crystals were found on one cave wall.

POWELL COUNTY

Apex Mountain Cave

Cave no.:	206	Range:	Flathead
County:	Powell	Map coverage:	Danaher Mountain 1:24,000
Location:	sec. 25, T. 18 N., R. 12 W. (unsurveyed)	Altitude:	7,600 ft.

This cave is near the top of Apex Mountain in the Bob Marshall Wilderness. The entrance is a very large hole on the north face of the peak. The cave has probably never been entered. The upper part of Apex Mountain is made up of Cambrian carbonate rocks.

Avon Cave

Cave no.:	247	Range:	Blackfoot
County:	Powell	Map coverage:	Avon 1:62,500
Location:	T. 11 N., R. 8 W.		

This cave is north of Avon, near Ophir Cave. The entrance is a shallow pit that is not more than 50 feet deep. The total extent of the cave is unknown.

Fault Peak Cave

Cave no.:	240	Range:	Flathead
County:	Powell	Map coverage:	Haystack Mountain 1:24,000
Location:	sec. 19, T. 21 N., R. 12 W. (unsurveyed)	Altitude:	approximately 7,200 ft.

This cave, as reported by forest rangers, consists of a pit of unknown depth that is south of Fault Peak. No other information is available.

Flathead Alps Cave (Flathead Double Pit)

Cave no.:	241	Range:	Flathead
County:	Powell	Map coverage:	Haystack Mountain 1:24,000
Location:	sec. 5, T. 20 N., R. 12 W.	Altitude:	7,100 ft.
	(unsurveyed)	Temperature:	34°F

The Flathead Alps lie near the continental divide in the Bob Marshall Wilderness Area. The cave has two 20-foot sinkholes side by side that connect with depth. The sinks are 15 feet deep. A narrow passage leads steeply downward to a depth of 50 feet (Fig. 82). A short walking passage leads to an 80-foot pit, so far unexplored. Snow and ice lie in the cave near the entrance. Flathead Alps Cave formed along a single N. 60° E.-trending joint in Cambrian carbonate rocks.

Foolhen Mountain Cave

Cave no.:	205	Range:	Flathead
County:	Powell	Map coverage:	Hahn Creek Pass 1:24,000
Location:	sec. 27, T. 18 N., R. 12 W.	Altitude:	approximately 8,000 ft.

This cave is on Foolhen Mountain in the Bob Marshall Wilderness. The cave has been seen from the air but has never been explored.

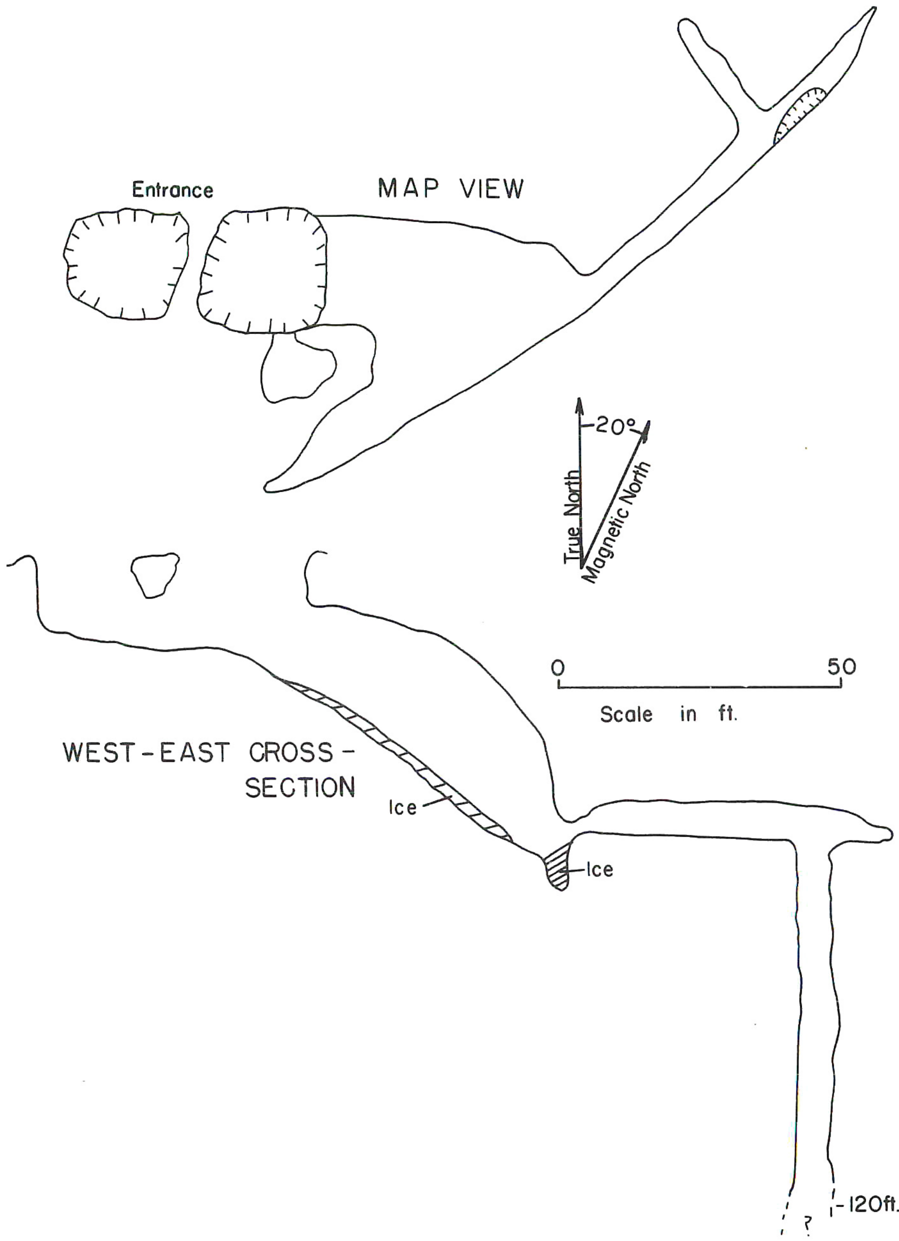


Figure 82.–Flathead Alps Cave

Pikes Peak Creek Siphon (The Crater)

Cave no.:	281	Range:	Flint Creek
County:	Powell	Map coverage:	Rock Creek Lake 1:24,000
Location:	sec. 10, T. 8 N., R. 11 W.	Altitude:	6,000 ft.

At a point about 10 miles west of Deer Lodge, Pikes Peak Creek disappears into a small hole in the creek bed. The creek does not reappear again, although springs below the siphon may be the point of resurgence of the water. Although the siphon has never been entered, a cavern system may exist beyond. The area lies near the contact of a Tertiary intrusive body with Madison Limestone, and the water may be following a cavern in the Madison.

Pinnacle Mountain Cave

Cave no.:	203	Range:	Flathead
County:	Powell	Map coverage:	Danaher Mountain 1:24,000
Location:	sec. 14, T. 18 N., R. 12 W. (unsurveyed)	Altitude:	7,500 ft.

This cave is on Pinnacle Peak in the Bob Marshall Wilderness and is 25 miles from the nearest road. The cave was spotted by airplane and nothing is known about its size. The Pinnacle Peak area is overlain by Cambrian carbonate rocks.

Una Creek Caves

Cave no.:	299	Range:	Blackfoot
County:	Powell	Map coverage:	Una Mountain 1:24,000
Location:	sec. 25, 35, T. 20 N., R. 14 W.	Altitude:	7,500 ft.

Numerous pits and sinkholes occur at the head of Una Creek and on Una Mountain in the Bob Marshall Wilderness. A few sinkholes contain permanent ice. Most of the pits are shallow, but one exceeds 200 feet in depth and has not been completely explored. The upper part of Una Creek is underlain by Cambrian carbonate rocks.

TETON COUNTY

Cave Mountain Pits

Cave no.:	232	Range:	Sawtooth
County:	Teton	Map coverage:	Cave Mountain 1:24,000
Location:	probably sec. 22, T. 25 N., R. 9 W. (unsurveyed)	Altitude:	6,800 ft.

Cave Mountain lies 25 miles west of Choteau, on the North Fork of the Teton River. Several pits or sinkholes are said to exist on the top of Cave Mountain, but they have never been explored and their depth is unknown. Cave Mountain is made up of Madison Group carbonate rocks.

Crooked Mountain Cave

Cave no.:	231	Range:	Sawtooth
County:	Teton	Map coverage:	Gateway Pass 1:24,000
Location:	sec. 9, T. 27 N., R. 10 W. (unsurveyed)	Altitude:	7,000 ft.

Crooked Mountain lies 30 miles west of Bynum. A cave, probably a deep pit, is near the top of the peak. The pit has not been descended, and its exact size is unknown.

Ear Mountain Cave

Cave no.:	224	Range:	Sawtooth
County:	Teton	Map coverage:	Ear Mountain 1:24,000
Location:	sec. 19, T. 24 N., R. 8 W.	Altitude:	8,420 ft.
		Temperature:	34°F

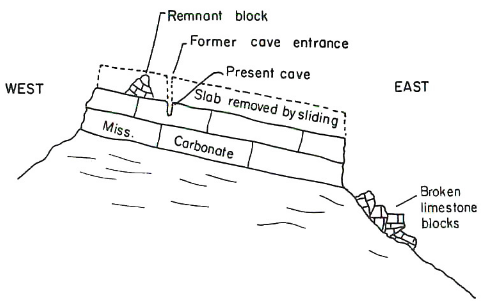


Figure 83.–Ear Mountain Cave

This cave is at the top of Ear Mountain, west of Choteau. The top of the peak is composed of Madison Group carbonate rocks that form a flat surface trending N. 47° E., 16° SE. Numerous N. 50° E.-trending joints cut the rock, and the cave formed along one of the joints. The cave has two entrances, one a 6- by 20-foot slit that is 49 feet deep, and the other a 5-foot pit. When visited in June 1971, the small pit was snow filled at a depth of 15 feet. The two pits do not connect at depth, and local ranchers say that the small pit is much deeper than 49 feet.

Ear Mountain Cave is unusual because some speleothems are within 5 feet of the entrance. Flowstone and stalagmites line the top of both pits. The cave may have been much deeper; a slab of limestone containing the upper part of the cave may have slid eastward off Ear Mountain, leaving behind only the lower part of the cave (Fig. 83). A few rotated remnant blocks perched on top of Ear Mountain are all that remain of the limestone slab, but limestone slide blocks can be seen east of the peak.

Headquarters Creek Cave

Cave no.:	234	Range:	Sawtooth
County:	Teton	Map coverage:	Our Lake 1:24,000
Location:	sec. 29 or 32, T. 24 N., R. 9 W. (unsurveyed)	Altitude:	7,200 ft.

This cave is near Headquarters Creek Pass, about 30 miles west of Choteau. The cave is said to be large and horizontal, but other details are unavailable.

Miners Creek Cave

Cave no.:	233	Range:	Sawtooth
County:	Teton	Map coverage:	Our Lake 1:24,000
Location:	sec. 6 or 7, T. 23 N., R. 9 W. (unsurveyed)		

A cave has been found near the head of Miners Creek west of Choteau, but its size and the rock formation in which it formed are unknown.

Mount Drewyer Cave

Cave no.:	230	Range:	Sawtooth
County:	Teton	Map coverage:	Gateway Pass 1:24,000
Location:	sec. 20, T. 27 N., R. 10 W. (unsurveyed)	Altitude:	8,000 ft.

Mount Drewyer, which lies 30 miles west of Choteau, has a vertical pit on the southwest-trending ridge. The depth of the pit is unknown.

Mount Field Cave

Cave no.:	229	Range:	Sawtooth
County:	Teton	Map coverage:	Gateway Pass 1:24,000
Location:	sec. 2, T. 27 N., R. 11 W. (unsurveyed)	Altitude:	8,000 ft.

A cave has been located on a northeast ridge of Mount Field, 30 miles west of Choteau; the size of the cave is unknown.

Volcano Reef Cave

Cave no.:	223	Range:	Sawtooth
County:	Teton	Map coverage:	Volcano Reef 1:24,000
Location:	sec. 2, T. 26 N., R. 9 W. (unsurveyed)	Altitude:	6,600 ft.

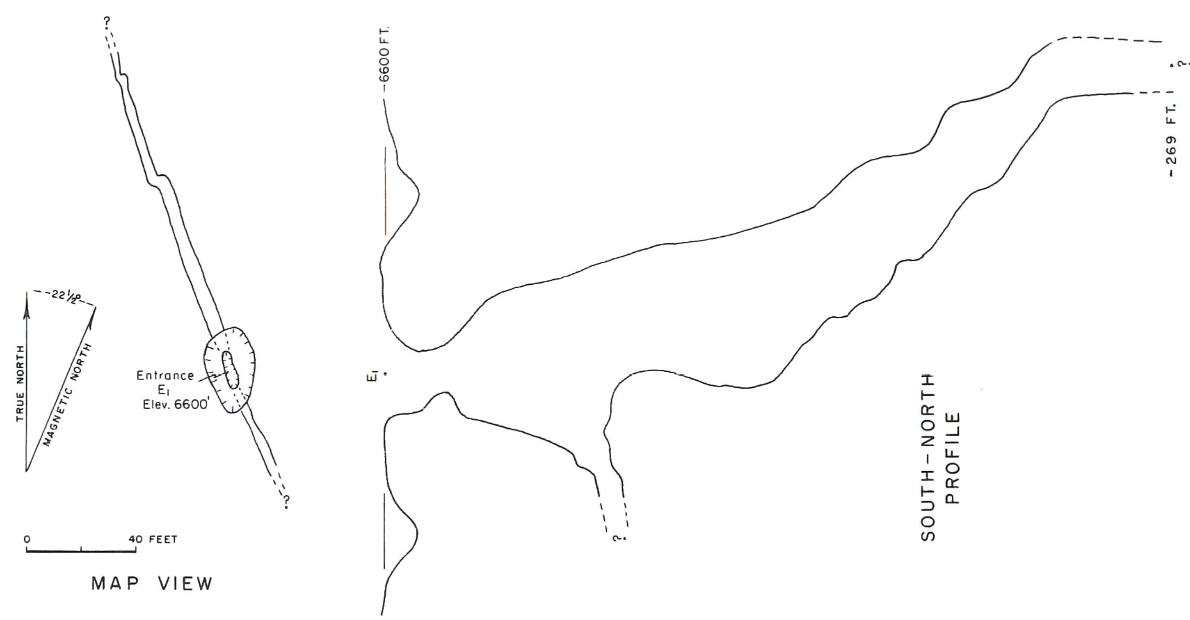


Figure 84.–Volcano Reef Cave

This cave is 25 miles west of Bynum and north of Blackleaf Canyon. The cave entrance, at the top of Volcano Reef Ridge, is a 2- by 15-foot crack at the base of a long narrow sink. The cave is vertical and rope is needed to descend. After an initial drop of 63 feet, the cave trends N. 20° W. and maintains a 3- to 5-foot width (Fig. 84). After several drops, the crack narrows to about 1 foot and is too small to enter. The fissure was plumbed another 30 feet to a depth of -269 feet, but it may go deeper. Volcano Reef Ridge is composed of Mission Canyon Formation, which strikes due north and dips 15° west. A narrow depression runs parallel to the ridge top (north-south) for 400 yards, but only one cave entrance gives access to the fissure underneath. This fissure is formed behind a block of limestone that is about to break off the ridge and slide eastward. Broken rocks and soil have covered the crack except at the cave entrance. The name "Volcano Reef" was given to the mountain because moisture condensing from warm air can be seen rising from the cave entrance in cold winter months. The cave is not in an area of volcanic activity.

REFERENCES

ADAMS, C. S., and SWINNERTON, A. C., 1937, Solubility of limestone: Transactions of the American Geophysical Union, 18th Annual Meeting, Pt. 2, p. 504-508.

ALDEN, W. C., 1932, Physiography and glacial geology of eastern Montana and adjacent areas: U.S. Geological Survey Professional Paper 174, 133 p.

AYERS, J. F., 1976, A hydrologic study of an alpine karst, Flathead County, Montana: Washington State University, Pullman, M.S. thesis.

BACK, WILLIAM, CHERRY, R. N., and HANSHAW, B. B., 1966, Chemical equilibrium between the water and minerals of a carbonate aquifer: National Speleological Society Bulletin, v. 28, no. 3, p. 119-126.

BLACKSTONE, D. L., JR., 1940, Structure of the Pryor Mountains, Montana: Journal of Geology, v. 48, no. 6, p. 590-618.

BROECKER, W. S., and OLSON, E. A., 1959, C^{14} dating of cave formations: National Speleological Society Bulletin, v. 21, pt. 1, p. 43.

BROECKER, W. S., OLSON, E. A., and ORR, P. C., 1960, Radiocarbon measurements and annual rings in cave formations: Nature, v. 185, no. 4706, p. 93-94.

CALVERT, W. R., 1909, Geology of the Lewistown coal field, Montana: U.S. Geological Survey Bulletin 390, 83 p.

CAMPBELL, N. P., 1968, The role of gravity sliding in the development of some Montana caves: National Speleological Society Bulletin, v. 30, no. 2, p. 25-29.

________1973, Scapegoat alpine karst, Montana: National Speleological Society Bulletin, v. 35, no. 2, p. 49-58.

________1977, Possible exhumed fossil caverns in the Madison Group (Mississippian) of the northern Rocky Mountains; a discussion: National Speleological Society Bulletin, v. 39, no. 2, p. 43-54.

________1977a, Geohydrology of the Lost Creek cave system, Park County, Montana: Northwest Science, v. 51, no. 1, p. 1-12.

CARROLL, DOROTHY, 1962, Rainwater as a chemical agent of geologic processes—A review: U.S. Geological Survey Water-Supply Paper 1535-G, 18 p.

CHELINI, J. M., 1965, Limestone, dolomite, and travertine in Montana: Montana Bureau of Mines and Geology Bulletin 44, 53 p.

CONN, H. W., 1966, Barometric wind in Wind and Jewel Caves, South Dakota: National Speleological Society Bulletin, v. 28, no. 2, p. 55-69.

CURL, R. L., 1962, The aragonite-calcite problem: National Speleological Society Bulletin, v. 24, pt. 2, p. 57-73.

DAVIES, W. E., 1960, Meteorological observations in Martens Cave, West Virginia: National Speleological Society Bulletin, v. 22, pt. 2, p. 92-100.

DAVIS, S. N., 1966, Initiation of ground-water flow in jointed limestone: National Speleological Society Bulletin, v. 28, no. 3, p. 111-119.

DAVIS, S. N., and MOORE, G. W., 1965, Semidiurnal movement along a bedrock joint in Wool Hollow Cave, California: National Speleological Society Bulletin, v. 27, no. 4, p. 133-142.

DAVIS, W. M., 1930, Origin of limestone caverns: Geological Society of America Bulletin, v. 41, no. 3, p. 475-628.

DEAL, D. E., 1962, Geology of Jewel Cave National Monument, Custer County, South Dakota: University of Wyoming, Laramie, M.S. thesis, 182 p.

DEISS, C. F., 1933, Paleozoic formations of northwestern Montana: Montana Bureau of Mines and Geology Memoir 6, 51 p.

ELLIOTT, J. K., 1963, Cave occurrences in the Mississippian Madison Limestone of the Pryor Mountains, Montana: Billings Geological Society Papers for 1963, no. 2, 15 p.

ELLIS, A. J., 1959, The solubility of calcite in carbon dioxide solutions: American Journal of Science, v. 257, no. 5, p. 354-365.

FORD, D. C., and GOODCHILD, M. F., 1968, Geomorphology of the Nakimu Caves, Glacier National Park, British Columbia [abstract]: National Speleological Society Bulletin, v. 30, no. 2, p. 34.

FORD, D. C., THOMPSON, P. T., and SCHWARZ, H. P., 1972, Dating cave calcite by the uranium disequilibrium method; some preliminary results from Crowsnest Pass, Alberta *in* International Geography, International Geographical Congress, 22d, Montreal, Canada. 1972.

HANSON, A. M., 1952, Cambrian stratigraphy in southwestern Montana: Montana Bureau of Mines and Geology Memoir 33, 46 p.

HAWKSLEY, OSCAR, 1966, Pleistocene bear fossils from a "bear bed" in Perkins Cave, Missouri [abstract]: National Speleological Society Bulletin, v. 28, no. 2, p. 96.

HEDGES, J. A., 1967, Geology of Dutton's Cave, Fayette County, Iowa: National Speleological Society Bulletin, v. 29, no. 3, p. 73-90.

HEINRICH, E. W., and RABBITT, J. C., 1960, Pre-Beltian geology of the Cherry Creek and Ruby Mountains area, southwestern Montana—Part 1, Geology of the Cherry Creek area: Montana Bureau of Mines and Geology Memoir 38, p. 1-14.

HEWETT, D. F., 1926, Geology and oil and coal resources of the Oregon Basin, Meeteetse, and Grass Creek Basin quadrangles, Wyoming: U.S. Geological Survey Professional Paper 145, 111 p.

HILL, C. A., 1976, Cave Minerals: National Speleological Society, Huntsville, Alabama, 137 p.

HILL, CHRIS, SUTHERLAND, W. M., and TIERNEY, LEE, 1976, Caves of Wyoming: Wyoming Geological Survey Bulletin 59, 229 p.

HOLLAND, H. D., KIRSIPU, T. V., HEUBNER, J. S., and OXBURGH, U. M., 1964, On some aspects of the chemical evolution of cave waters: Journal of Geology, v. 72, no. 1, p. 36-67.

HUBBERT, M. K., 1940, The theory of ground-water motion: Journal of Geology, v. 48, no. 8, pt. 1, p. 785-944.

JENNINGS, J. N., 1971, Karst: Massachusetts Institute of Technology Press, Cambridge, Massachusetts, 241 p.

JOHNS, W. M., 1961, Progress report on the geologic investigations in the Kootenai-Flathead area, northwest Montana, pt. 3, northern Lincoln County, Montana: Montana Bureau of Mines and Geology Bulletin 23, 57 p.

KAUFFMAN, M. E., 1963, Geology of the Garnet-Bearmouth area, western Montana, with a chapter on metallic resources by F. N. Earll: Montana Bureau of Mines and Geology Memoir 39, 40 p.

KLEPPER, M. R., WEEKS, R. A., and RUPPEL, E. T., 1957, Geology of the southern Elkhorn Mountains, Jefferson and Broadwater Counties, Montana: U.S. Geological Survey Professional Paper 292, 82 p. [1958].

KRAUSKOPF, K. B., 1967, Introduction to geochemistry: McGraw-Hill Book Co., New York, 721 p.

KUHNS, R. J., The speleology of Lewis and Clark Caverns State Park: Montana Bureau of Mines and Geology [in preparation].

LAUDON, L. R., and SEVERSON, J. L., 1953, New crinoid fauna, Mississippian, Lodgepole Formation, Montana: Journal of Paleontology, v. 27, no. 4, p. 505-536.

LINK, L. W., 1971, Lewis and Clark Cavern: published privately, 112 p.

MERRILL, G. K., 1960, Additional notes on vertical shafts in limestone caves. National Speleological Society Bulletin, v. 22, pt. 2, p. 101-108.

MOORE, G. W., 1962, The growth of stalactites: National Speleological Society Bulletin, v. 24, pt. 2, p. 95-106.

_______1970, Checklist of cave minerals: National Speleological Society News, v. 28, no. 1, p. 9-10.

MOORE, G. W., and NICHOLAS, B. G., 1964, Speleology—The study of caves: D. C. Heath and Co., Boston, Massachusetts, 120 p.

MOREHOUSE, D. F., 1968, Cave development via the sulfuric acid reaction: National Speleological Society Bulletin, v. 30, no. 1. p. 1-10.

MUDGE, M. R., 1970, Origin of the Disturbed Belt in northwestern Montana: Geological Society of America Bulletin, v. 81, no. 2, p. 377-392.

MUDGE, M. R., SANDO, W. J., and DUTRO, J. T., JR., 1962, Mississippian rocks of Sun River Canyon area, Sawtooth Range, Montana: American Association of Petroleum Geologists Bulletin, v. 46, no. 11, p. 2003-2018.

PERRY, E. S., 1946, Morrison Cave, Lewis and Clark Caverns State Park: T. Greenfield, Inc., Butte, Montana.

_______1949, Gypsum, lime, and limestone in Montana: Montana Bureau of Mines and Geology Memoir 29, 45 p.

_______1962, Montana in the geologic past: Montana Bureau of Mines and Geology Bulletin 26, 78 p.

POHL, E. R., 1955, Vertical shafts in limestone caves: National Speleological Society Occasional Papers, no. 2, p. 1-10.

REID, R. R., 1957, Bedrock geology of the north end of the Tobacco Root Mountains, Madison County, Montana: Montana Bureau of Mines and Geology Memoir 36, 27 p.

RICHARDS, P. W., 1955, Geology of the Bighorn Canyon-Hardin area, Montana and Wyoming: U.S. Geological Survey Bulletin 1026, 93 p. [1956].

ROBERTS, A. E., 1966, Stratigraphy of Madison Group near Livingston, Montana, and discussion of karst and solution-breccia features: U.S. Geological Survey Professional Paper 526, 23 p.

ROBINSON, G. D., and BARNETT, H. F., 1963, Geology of the Three Forks quadrangle, Montana: U.S. Geological Survey Professional Paper 370, 143 p.

ROSS, C. P., SKIPP, B. A. L., and REZAK, RICHARD, 1963, The Belt Series in Montana: U.S. Geological Survey Professional Paper 346, 155 p.

RUSHIN, C. J., 1973, Interpretive and paleontologic values of Natural Trap Cave, Wyoming: unpub. M.S. thesis, University of Montana, Missoula, 97 p.

SAHINEN, U. M., 1950, Geology and ore deposits of the Highland Mountains, southwestern Montana: Montana Bureau of Mines and Geology Memoir 32, 63 p.

SANDO, W. J., 1967, Madison Limestone (Mississippian), Wind River, Washakie, and Owl Creek Mountains, Wyoming: American Association of Petroleum Geologists Bulletin, v. 51, no. 4, p. 529-557.

SANDO, W. J., DUTRO, J. T., JR., and GERE, W. C., 1959, Brazer dolomite (Mississippian), Randolph quadrangle, northeast Utah: American Association of Petroleum Geologists Bulletin, v. 43, no. 12, p. 2741-2769.

SCHULTZ, R. L., 1969, Caves of the Bighorn-Pryor Mountains of Montana and Wyoming: National Speleological Society Guidebook 10, 28 p.

SLOSS, L. L., 1952, Introduction to the Mississippian of the Williston Basin: Billings Geological Society Guidebook, 3d Annual Field Conference, p. 65-69.

SLOSS, L. L., and HAMBLIN, R. H., 1942, Stratigraphy and insoluble residues of the Madison Group (Mississippian) of Montana: American Association of Petroleum Geologists Bulletin, v. 26, no. 3, p. 305-335.

SLOSS, L. L., and LAIRD, W. M., 1945, Mississippian and Devonian stratigraphy of northwestern Montana: U.S. Geological Survey Oil and Gas Investigations (Preliminary) Chart 15.

SLOSS, L. L., and MORITZ, C. A., 1951, Paleozoic stratigraphy of southwestern Montana: American Association of Petroleum Geologists Bulletin, v. 35, no. 10, p. 2135-2169.

SUTHERLAND, W. M., 1976, The geomorphic history of Horsethief Cave, Bighorn Mountains, Wyoming: University of Wyoming, Laramie, M.A. thesis, 73 p.

SWEETING, M. M., 1973, Karst landforms: Columbia University Press, New York, 362 p.

SWENSON, F. A., 1968, New theory of recharge to the artesian basin of the Dakotas: Geological Society of America Bulletin, v. 79, no. 2, p. 163-182.

SWINNERTON, A. C., 1932, Origin of limestone caverns: Geological Society of America Bulletin, v. 43, no. 3, p. 663-693.

THEODOSIS, S. D., 1955, Cambrian system in northwestern Montana: Billings Geological Society Guidebook, 6th Annual Field Conference, p. 64-69.

THOM, W. T., JR., HALL, G. M., WAGEMANN, C. H., and MOULTON, G. F., 1935, Geology of Big Horn County and the Crow Indian Reservation, Montana: U.S. Geological Survey Bulletin 856, 200 p.

THOMAS, G. E., 1962, Grouping of carbonate rocks into textural and porosity units for mapping purposes: American Association of Petroleum Geologists Memoir 1, p. 193-223.

THOMPSON, PETER, November 1970, A method for absolute age determinations of speleothems: Canadian Caver, no. 3, p. 8-18.

_______May 1971, A new method for dating speleothems, part 2: Canadian Caver, no. 4, p. 23-30.

THORNBURY, W. D., 1954, Principles of geomorphology: John Wiley & Sons, Inc., New York, 618 p.

_______1965, Regional geomorphology of the United States: John Wiley & Sons, Inc., New York, 609 p.

THRAILKILL, JOHN, 1968, Chemical and hydrologic factors in the excavation of limestone caves: Geological Society of America Bulletin, v. 79, p. 19-45.

_______1968a, Dolomite cave deposits from Carlsbad Caverns: Journal of Sedimentary Petrology, v. 38, no. 1, p. 141-145.

WALTHAM, A. C., 1974, Caves: Crown Publishers, Inc., New York, 240 p.

WHITE, E. L., and WHITE, W. B., 1968, Dynamics of sediment transport in limestone caves: National Speleological Society Bulletin, v. 30, no. 4, p. 115-129.

WRIGHT, H. E., JR., SPROSS, BARBARA, and WATSON, R. A., 1966, Pollen analyses of the sediment from sinkhole ponds in the central Kentucky karst: National Speleological Society Bulletin, v. 28, no. 4, p. 185-188.

CAVE INDEX BY NAME

***Indicates a Cave Map**

CAVE INDEX BY COUNTY AND NAME

CAVE INDEX BY NUMBER