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for compiling this information will be appreciated.

LAVA-TUBE CAVES IN THE SADDLE BUTTE AREA OF MALHEUR COUNTY, OREGON

by

Robert F. Ciesiel* and Norman S. Wagner**

Introduction



During the summer of 1967 the authors participated in a search for caves in an area of geologically young basalts situated in the Saddle Butte area north of the Burns junction in Malheur County. The project was initiated by the Vale District of the U.S. Bureau of Land Management as a result of a widely quoted press report concerning the alleged existence in this area of a cave 40 or more miles long. Although no single cave was found that even approached the dimensions reported in the press article, the evidence for there having existed a string of closely interrelated lava tubes extending for nearly 8.5 miles was considered worthy of detailed mapping and description.

The authors were aided on this project by several staff members of the BLM and two locally resident seasonal employees, all of whom had a great deal of first-hand familiarity with the terrain in the project area. Excellent aerial photographic coverage was available for the entire area and a helicopter was provided for scouting throughout the more inaccessible regions. Under the circumstances, the screening for potential cave entryways can be rated as quite comprehensive. Before preparing this report, however, the writers did revisit some portions of the area independently in 1969 to gather details not secured previously.

Results of Mapping

All caves encountered during the course of this investigation were explored to their ends and were mapped with a compass (Brunton) and tape survey and rod measurements to the roof. Exceptions were a few very short caves and two that were deemed too dangerous. The longest cave mapped proved to be 3620 feet by traverse distance from the portal to the face, while the second and third longest measured 1750 and 1550 feet respectively. Of special interest, however, is the fact that this group of caves clearly represents uncollapsed sections of what had once been a continuous chain

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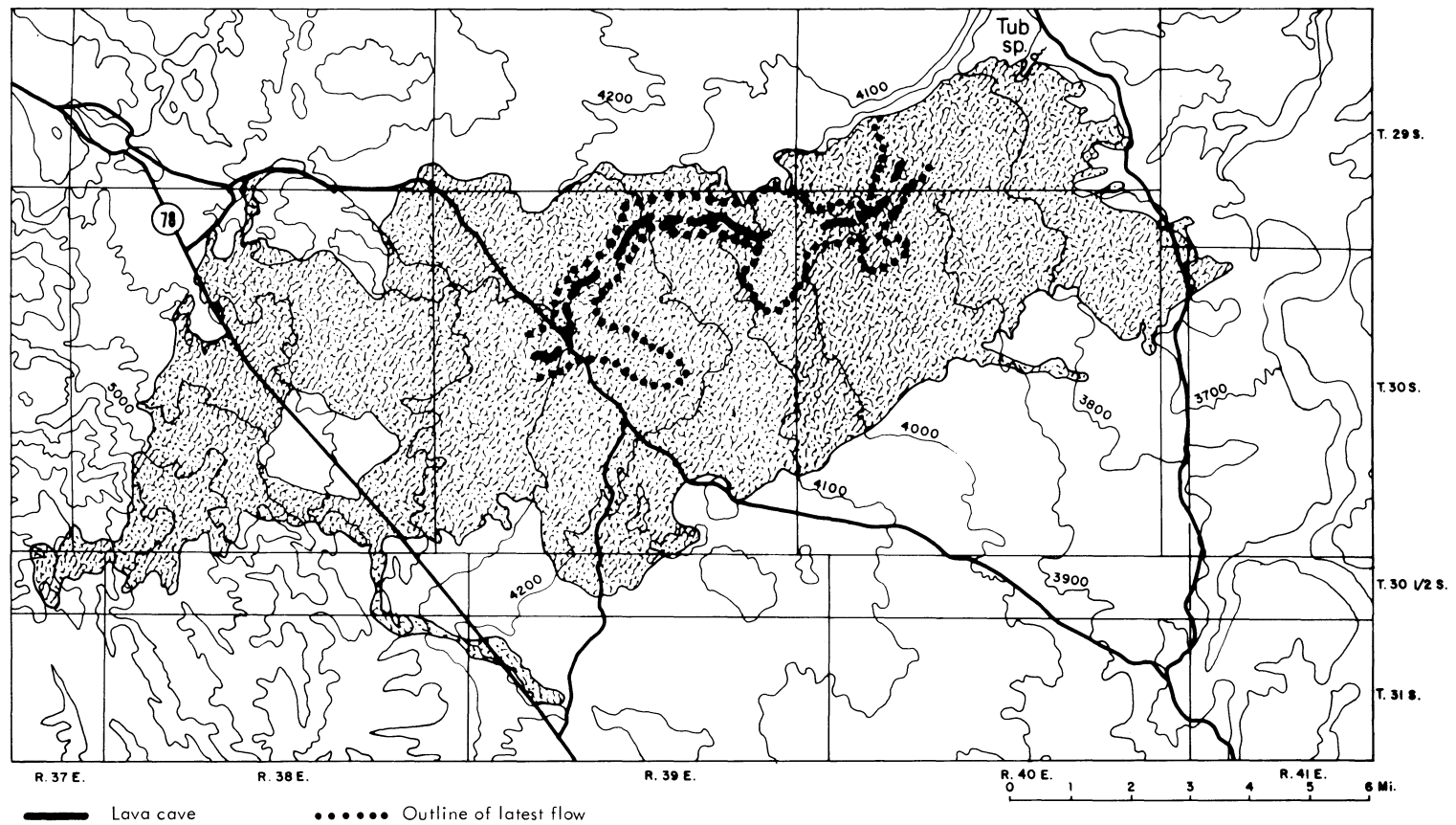
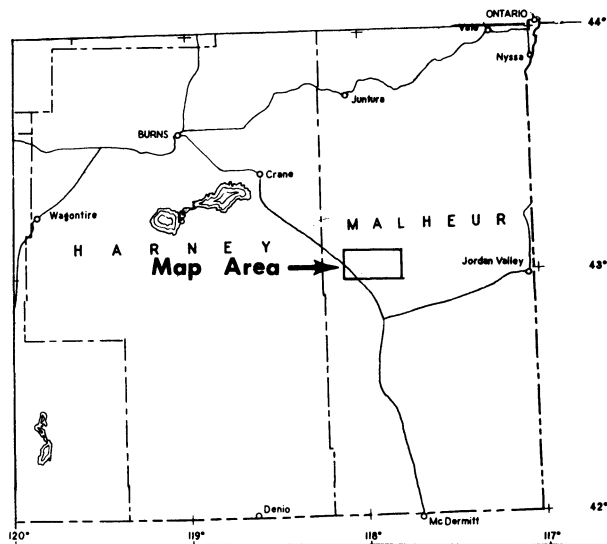


Figure 1. Map of the Saddle Butte area lava field showing the general outline of the youngest lava flow and its chain of tubes and collapse trenches.



Index map for figure 1.

ence is made in this report to the hazards of spelunking in this area.

Location and Access

The lava field in which this chain of tubes is developed occupies an area of about 82 square miles in western Malheur County. It is named for Saddle Butte, a prominent topographic feature situated in the northeast corner of T. 29 S., R. 39 E., a short distance north of the mapped area shown in figure 1. Elevations of the lava surface range from around 3700 feet at the eastern end to 5000 feet at the western. The climate in this region is semiarid and vegetation is scarce.

Oregon State Highway 78 crosses the western end of the lava field, and side roads lead into other portions, as indicated in figure 1. A complication confronting any visitor not acquainted with the area is the low relief and lack of distinctive topographic landmarks. It is very easy to become confused, and even lost, in the wide-open expanse of the lava field, hence off-the-road exploration should be undertaken only by persons equipped with adequate vehicles, food supplies, water, and either maps or aerial photographs, or both.

Access to most of the still-open caves and their adjoining collapsed trenches is mainly by rough side trails not suitable for travel in vehicles other than trucks or four-wheel-drive units. Otherwise, these features can be reached only by hiking, horseback, or helicopter.

As pointed out earlier, none of the caves can be considered safe to enter because of their thin, highly fractured, and unstable roof capping. Unlike solution caverns in massive limestones, which can be developed into relatively safe tourist attractions, the accessible caves in this particular lava-tube complex represent natural hazards totally unsuitable as sites for family outings or for needless entry by anyone under any circumstances. Indeed, it is a coincidence that some of the presently accessible tube sections are still bridged by roof segments, and that collapse has not occurred before now, since a roof fall can be triggered by a sonic boom, the hoof beats of wild horses galloping over the lava flow, the seismic vibrations of a distant

of superimposed and coalescing lava tubes traceable over a distance of 8.5 miles. The portal and face of each open cave are aligned with conspicuous surface trenches marking collapsed portions of the original tube, while the few observable discontinuities are recognized as uncollapsed tube sections for which no accessible entryway presently exists.

Like old, abandoned mine workings, some of the caves are more dangerous than others, but all have a potential for collapse at any unpredictable time. Consequently, frequent refer-

earthquake, or any one of many other causative factors. Thus, despite their interest as geologic features, these caves are not recommended as sites for public visitation. Rather, they are recommended as places to avoid.

General Setting

Emplacement of the lava field occurred during late Pleistocene to recent time, according to geologic mapping by the U.S. Geological Survey (Walker and Repenning, 1966). The basalt making up the lava field is characterized by clear, fresh olivine and abundant titanite and, except in a few places, by flow surfaces only scantily modified by erosion. Over wide areas the soil covering is generally as sparse as the vegetation it supports.

The land surface in the area occupied by this lava field slopes eastward with minimal relief; however, aerial photographs indicate that the most recent flow, and the one in which the lava-tube chain developed, was confined to a relatively narrow, serpentine course having an over-all direction toward the northeast. In effect, therefore, the youngest outpouring of molten lava flowed like a river across its previously emplaced neighbors in a narrow channelway. This channel probably marked the trace of a shallow erosional gully which existed on the old land surface before any of the older companion flows were erupted. The approximate bounds of this "river of lava" in the cave area, as taken from aerial photographs and including local impoundments, is indicated in figure 1. How the differences in vegetative covering and soil development serve to make this boundary conspicuous when viewed from a high altitude is illustrated by figure 2, which represents a portion of one standard aerial photograph.

Figure 2 also illustrates the appearance of collapse trenches as seen from the air and the extent to which such collapse has taken place in comparison with the length of land-surface segments still bridged. Therefore, since aerial photographs covering other sections of the trench-tube chain show a similar ratio of collapse versus bridging, there are two conclusions which are strikingly evident. One is that it is only a matter of time until all remaining bridges break down to form one continuous long trench. The second is that, because of this propensity to collapse, these bridges and their underlying caves are doubly hazardous, in that it would be just as bad to be walking or driving over the top of a cave as it would be to be inside it when the roof fell in.

Origin of Lava Tubes

Lava tubes can be compared to the empty cavity in a cocoon after the moth has hatched and departed. In other words, they mark the place in the body of a lava flow from which a highly liquid core has drained after the rest of the surrounding lava has cooled and solidified enough to stand rigid. This does not happen in the case of all lava flows; instead, it occurs only in those in which there is a fairly rapid cooling and solidification along the sides and top, but also sufficient depth or thickness to insulate the interior lava and thus retain a state of liquidity in the innermost, lower portions. Even then this inner-zone lava will eventually cool to become solid rock if the physical conditions do not permit drain-out of the liquid core. This entails the existence of a slope down which to flow and some form of unobstructed place at the down-hill end at which to vent.

Because these conditions prevail, or are likely to prevail, in the many types

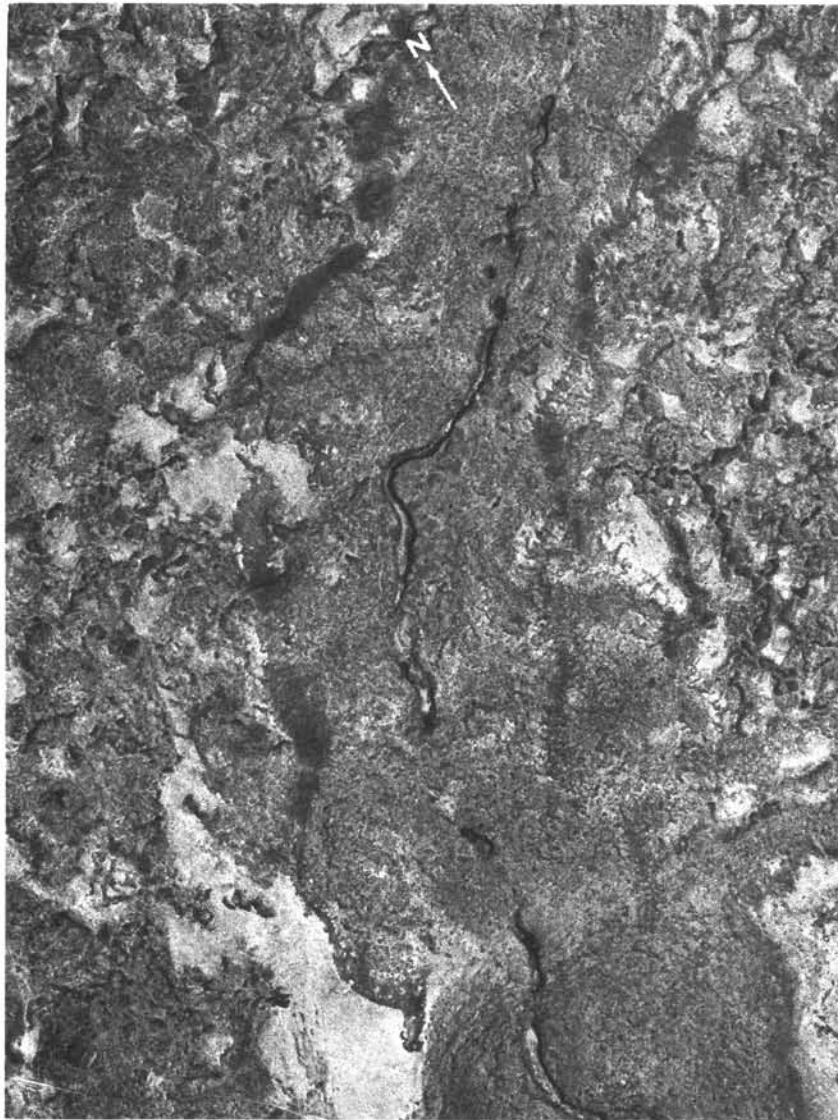


Figure 2. Aerial photograph of part of the Saddle Butte lava field showing the difference in appearance between the older lava surface and the youngest flow. The prominent worm-like lines in the youngest lava are trenches formed by collapse of the shallow 8.5-mile tube near its southwestern end. Scale is 1 inch = 1430 feet.

of terrain over which basaltic lavas can be erupted, lava tubes or other voids within the body of a congealed flow are not uncommon. For the most part, however, the area over which ideal gradient and vent conditions can occur is more likely to be localized than extensive; hence, the length of the essentially continuous chain of tubes and related collapse sections of the Saddle Butte lava field is unusual.

In some instances lava tubes contain a great deal of ornamentation comparable to the stalactite and stalagmite formations found in caves in limestone; however, when it occurs in lava tubes, this ornamentation is composed of lava rock and not calcite, and it is formed by molten lava dripping from the roofs and sides of the tubes or squeezing out into the tube from crevices during the final stages of solidification of the tube walls. Converging and diverging lateral branches constitute another characteristic commonly found in connection with lava tubes, and it is not unprecedented to find tubes developed one above another.

Lava Tubes and Trenches in the Saddle Butte Area

Few of the characteristics described above are found in the Saddle Butte area tubes. For example, the picturesque ornamentation such as lava circles hanging from the roof, drip accumulations on the floor, and fan-like sheets extruded from joints are almost totally lacking, and even where present they are poorly developed. Also lacking in any of the accessible tubes is evidence of splits with lateral converging and diverging branches. Present, however, at the portal of the 40-Mile Cave (figures 3 and 5) is a fine example of one tube above another. Here, entrance to the longer, lowermost tube is achieved by entering the upper tube through a small collapsed hole and thence by walking on the rubble-covered shell separating the tubes for a distance of 200 feet to a point where both merge and where descent can be made into the lowermost tube. A similar superpositioning of two tubes is also indicated at the far end of this cave, where the last third of the lowermost tube underlies a well-developed surface trench which represents the remains of the now collapsed upper tube.

The natural floors of the Saddle Butte area tubes are extensively obscured, either by accumulations of rock which have dropped from the top roof shell, or by a layer of clayish silt which represents soil carried into the tube by rain and snow water entering through crevices which extend between the tube ceiling and the surface. The rubble from natural stoping occurs frequently in the form of large, steep-sided piles involving scores to hundreds of tons of blocky rock. In contrast, the washed-in soil occurs in the form of a fairly thin, level, and widely distributed floor covering which, interestingly enough, often exhibits a well-developed pattern of five-sided shrinkage cracks similar to those commonly observable on sun-baked surface clays. Where observable, though, the natural floor in all of the tubes slopes consistently eastward in conformity with the slope of the overlying land surface. This suggests that a fairly uniform gradient prevailed throughout the entire 8.5-mile distance over which the lava tubes formed.

Only at intervals, and for relatively short distances, do any of the tubes exhibit their original lining of comparatively homogeneous, solidified lava in the form of an unbroken shell. Instead, the top section of this lining is lacking more frequently than not. This is due to caving primarily; however, the tendency for caving is due in turn to the fact that the overhead arch of lining is very thin and poorly developed in the first place -- too thin, that is, to offer substantial support for the covering of overlying rock for any prolonged period of time. This lack of a thick, strong lining in the roof section accounts for the fact that so much of the original tube has



(Above) This large, wide-open cave entrance was caused by massive collapse of an adjoining section of the tube. The thin shell of rock still bridging the cave is characteristic of all remaining lava tubes in the area.

(Below) Typical view of a cave entrance taken from inside. Note the size of the blocks of rock that have fallen in the past and the size of those ready to fall in the future.



already collapsed into trenches.

Without doubt, many factors contributed to the lack of development of a substantially thick lining in the arching top section of these particular tubes. The most significant is evidence indicating that the tubes carried no sustained flow of molten lava from a replenishing source over any prolonged period of time. Instead, during much of their later history they carried only a partial load, as is indicated by horizontal bulges on the side walls of some of the tubes at various midway heights between the floor and the top. In other words, these bulges represent local thickenings of the side wall and they indicate where the level of the stream of draining lava stood during different periods of the drainage cycle. Had the tubes run more nearly to capacity over a longer period of time, more of the molten material would have splattered onto the ceiling and thereby contributed to the build-up of a thicker lining in the topmost portion. Such a thicker lining could have contributed to the support needed for the preservation of a greater amount of the original tube than exists. Since the few remaining intact sections lack the support needed to counteract the steady pull of gravity on their thin, highly fractured shells of overlying basalt, eventual total collapse is inevitable. Indeed, two major rock falls can be reported as having taken place between the time the caves were mapped in 1967 and re-examined in 1969.

The surface trenches formed as a result of bygone collapses are for the most part abrupt, steep-sided channels ranging from 20 to 80 feet wide and from 10 to 20 or more feet deep. All are bottomed with a jagged jumble of broken blocks of what was once surface basalt. Soil washed or blown in over the years has accumulated in sufficient amounts in a few trenches to modify the harshness of the scene by supporting some grass and brush; however, in most trenches soil is very scarce, or absent. The inescapable conclusion is, therefore, that most of the collapsing is comparatively recent in age and that some of it is very new. That more trenches can be expected to develop in the future as a consequence of collapsing is a conclusion rendered virtually certain by the character of the remaining roof structures and the weakening effects constantly being generated by natural stoping.

Descriptions of Individual Caves

The six major caves in the Saddle Butte lava field are described individually in the following paragraphs. For convenience, these descriptions begin with the Coyote Trap Cave, shown on the southwestern corner of figure 3, and continue thereafter in the order of their succession as shown on the map. Included also are maps of the Tire Tube, 40-Mile, and Owyhee River Caves.

Coyote Trap Cave

Entrance to this cave consists of a very narrow, irregularly shaped passageway leading downward on a sloping course through the nested blocks of the collapsed margin for a distance of about 20 feet. From this point a compass bearing confirms that the still intact remnant of the tube leads to and terminates against collapse rubble located an estimated distance of 150 feet to the northwest. Beyond this no detailed measurements were made, since the main cave was considered too dangerous to enter due to the fact that stoping has progressed to a level so near the surface of the ground that the remaining roof is obviously very thin and fragile.



(Above) Natural stoping is well illustrated by the fallen rock on the floor and the jagged, fractured roof overhead. Note the thinness of the lava lining of the tube arch visible in the background. This is the condition of Tire Tube Cave some 100 to 200 feet beyond the entrance.

(Below) This scene is in 40-Mile Cave and is one of the few places where one can relax in comparative safety. The natural tube lining of fairly homogeneous lava is still well preserved, providing support to the overlying bridge of fractured basalt.



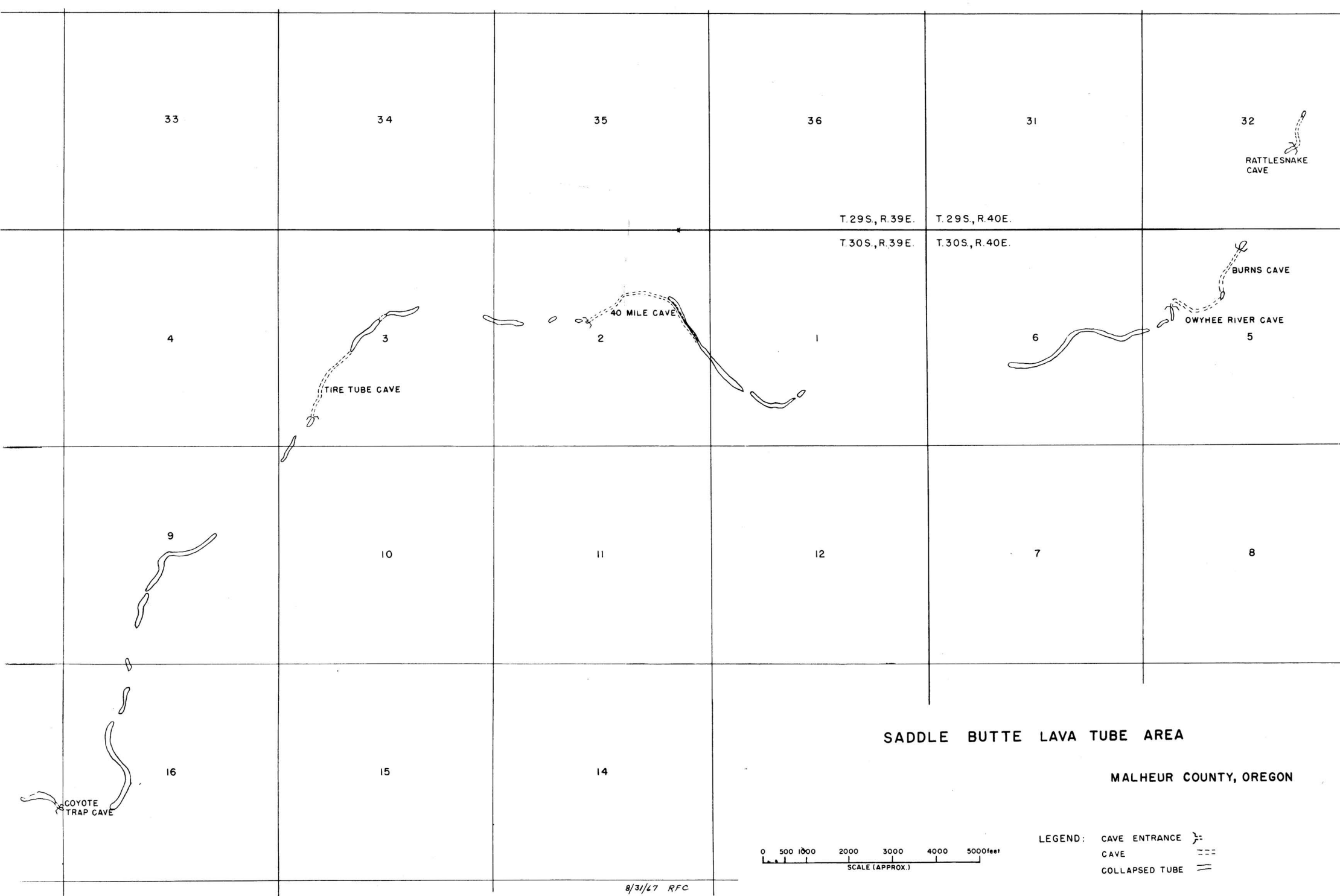


Figure 3. Map showing the interrelation between collapsed and still-intact sections of the Saddle Butte area lava tube, as expressed by prominent surface trenches and presently accessible caves. Discontinuities represent tube sections with no visible entryway.



The forms resembling ghosts in this picture are the real flesh-and-blood individuals who made this time exposure possible by walking back and forth and playing lights on the walls and ceiling of a section of the 40-Mile tube.

Tire Tube Cave

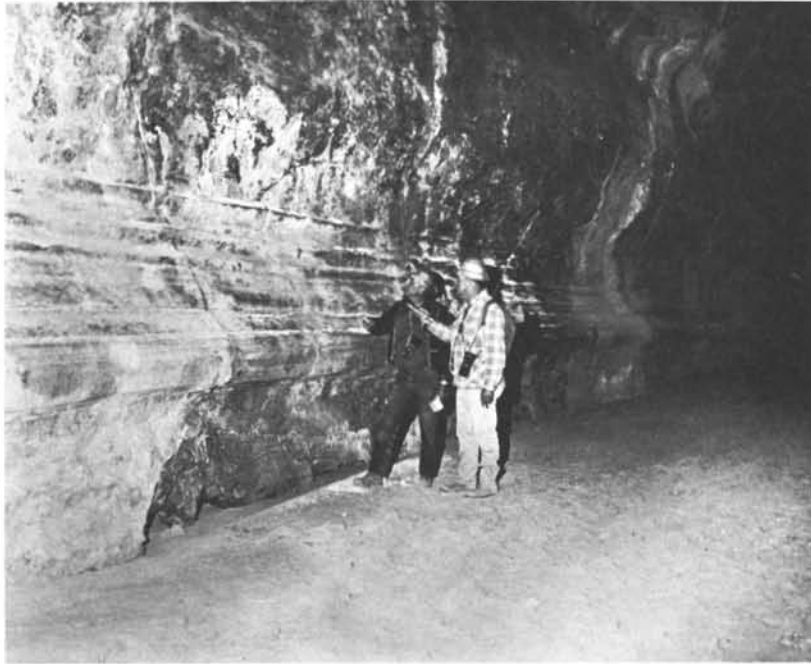
A local collapse of the side wall constitutes the entrance to this cave, the first several hundred feet of which consists of blocky rubble under foot and rough, jagged, highly fractured rock above. In fact, it was in this cave at a distance of about 250 feet from the entrance that one of the major post-1967 rock falls was noted. Therefore, since the area directly in front of this recent fall measures approximately 50 feet wide by 23 feet high, with nothing but interwedged blocks of fractured rock in the roof, no re-examination was made in 1969. The 1967 notes show, however, that this tube had a measured traverse distance of 1705 feet to the face and that it tapered fairly consistently from the portal to the end. The last third is floored with silt introduced through crevices at the end. Because this silt leaves only the narrow upper portion of the tube open, the mapped width in plan view appears to decrease (figure 4). Of interest in the cave are the shrinkage cracks in the silt. Although developed in total darkness, these are in all respects similar in appearance to the cracks commonly found on the surface of sun-baked mud flats.

40-Mile Cave

This cave is referred to as the "40-Mile Cave" because of the press reports in which it was described as being that long. However, the measured distance between the entrance and the face on its easternmost extension is 3620 feet. This tube is reported to extend an additional 1200 feet to the westward, according to a speleologist who supposedly entered this portion of the tube by crawling for a distance of approximately 50 feet through a narrow, crooked opening in places only 15 inches high. In any event, two ladders are needed for access into this cave -- one to descend through a small hole in the roof to the floor of an upper tube, and another to descend from the floor level of the upper tube to the floor level of the lower tube at the place where the two tubes merge.

Except for stoping conditions in the vicinity of the entrance and at three places where the top arch of the lower tube has been breached by caving between the entrance and the end (figure 5), this is probably the best preserved of any of the Saddle Butte area caves. It is also one of the most impressive, in that cross-sectional tube dimensions in the open, nonsilted half nearest the entrance exhibit sustained widths of 40 and 60 feet by heights of 35 to 47 feet over a long distance.

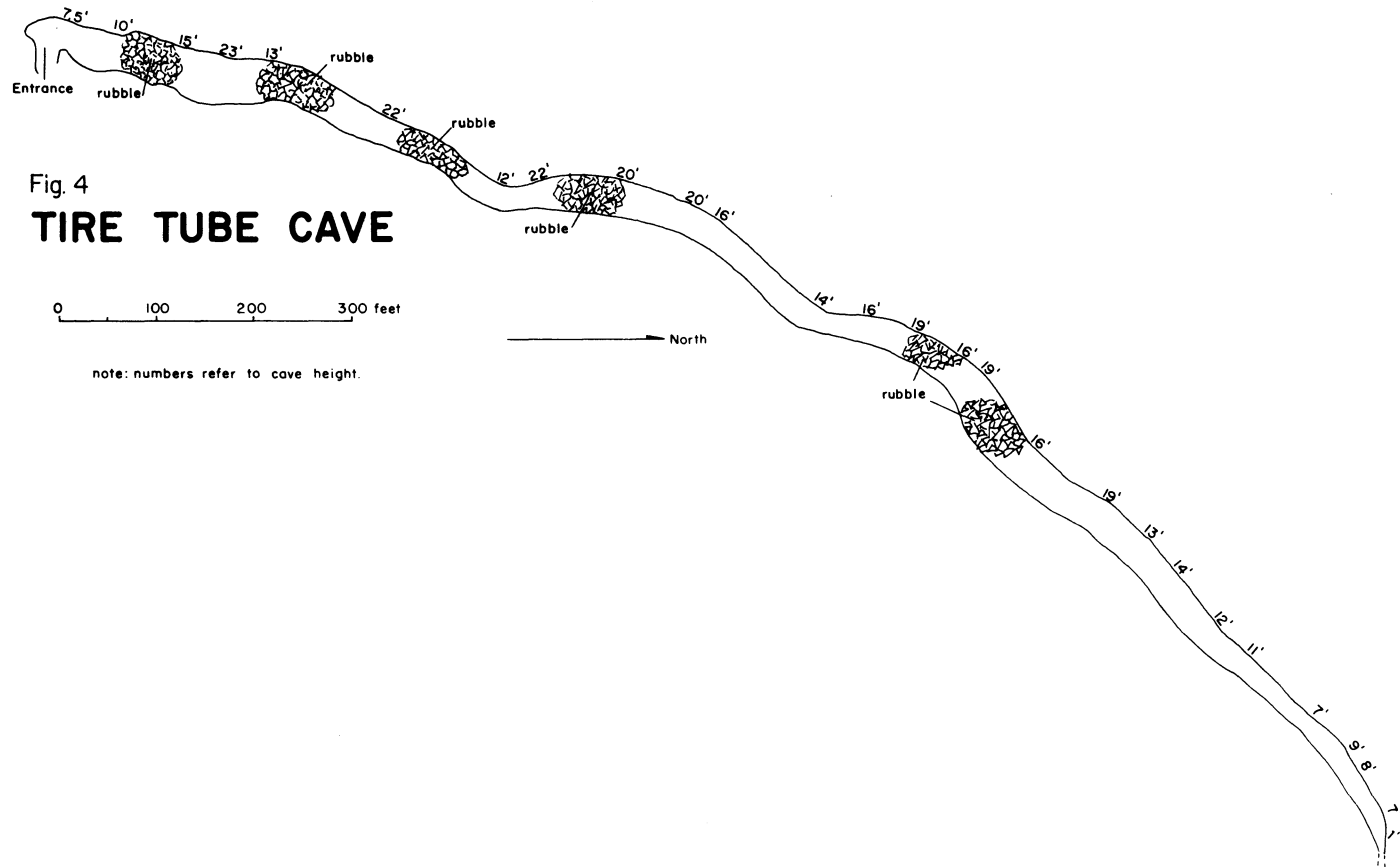
Towards its end, this cave is progressively filled with silt to the point where the silt merges with the back or ceiling, thereby ending the cave. However, as is indicated on figure 3, the survey of its configuration indicates that the last several hundred feet of this cave closely parallel and apparently underlie a well-defined collapse trench on the surface. The Brunton survey is sufficiently accurate to show that this tube relates intimately with the one represented by the surface trench. But whether the 40-Mile Cave underlies or is laterally offset in relation to the trench is a question which would require a more precise survey inside the cave and the establishment of a picket line on the surface for a positive determination. On the basis of the present data, however, a small lateral offset is believed probable because of the relatively sound, fracture-free nature of the arched lining in the portion of the 40-Mile Cave paralleling the surface trench. In either case, the 40-Mile Cave and its upper companion segment are functional links in the 8.5-mile chain of tubes and relating trenches.

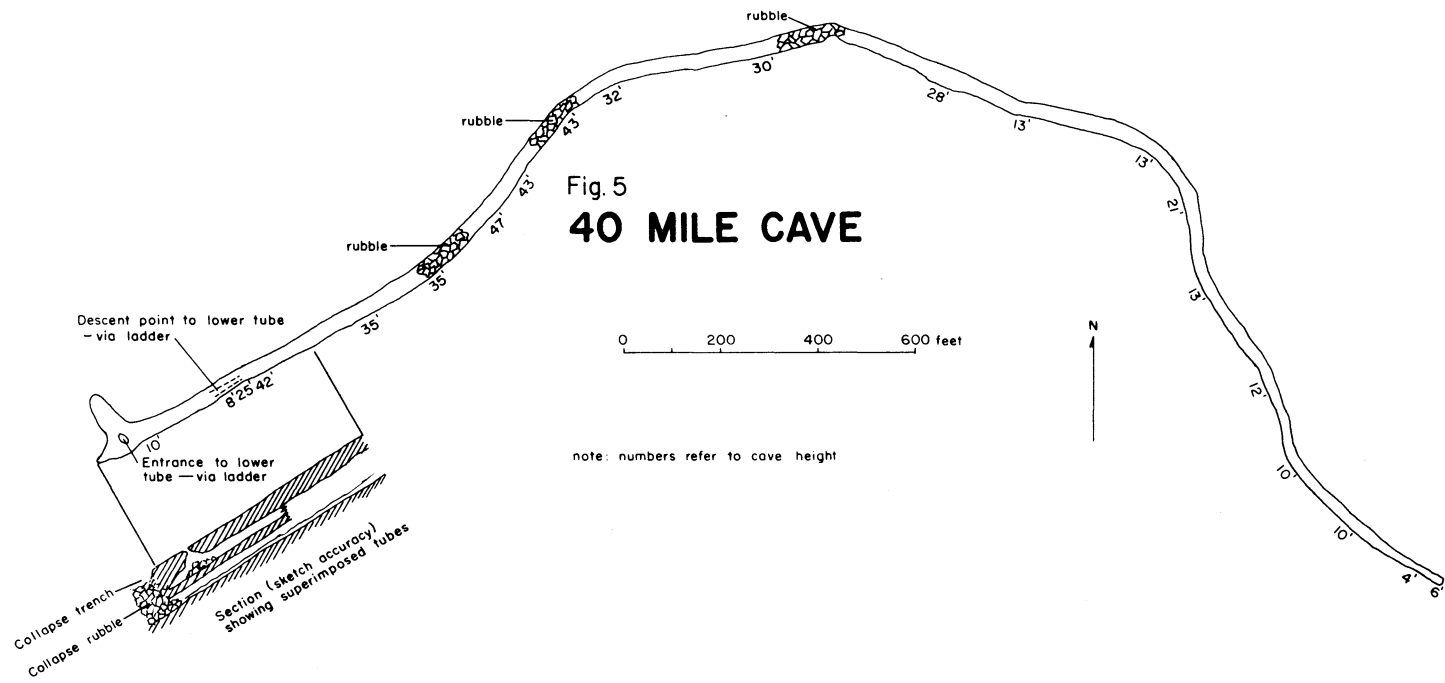


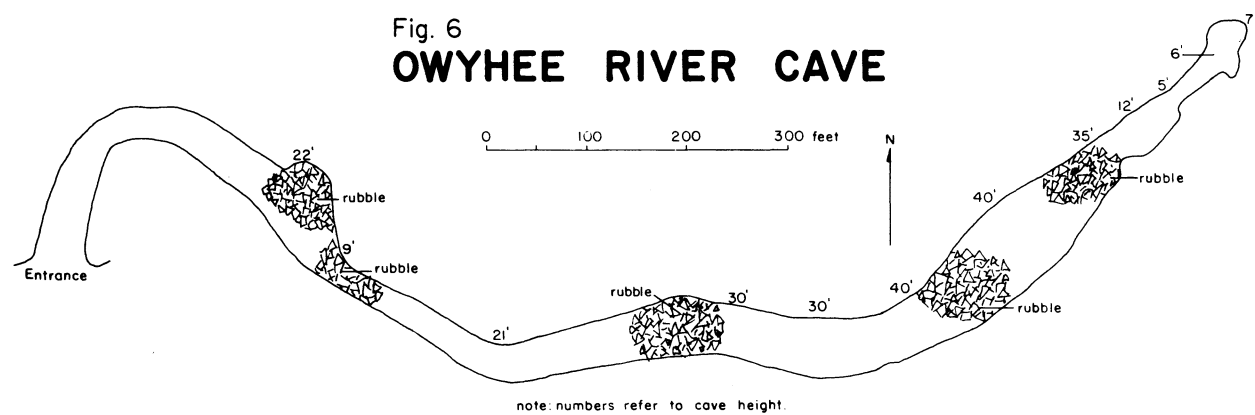
(Above) Horizontal ridges on the side walls of one of the better preserved sections of 40-Mile Cave show that the level of the stream of outflowing molten lava was both low and relatively stationary at times during the final drain-out stage of this tube's history.

(Below) Some caves like the Tire Tube Cave shown here are completely blocked by silt washed in from the land surface through open cracks and crevices in the roof. Other caves have merely a thin layer of silt on the floor near the crevices.









Owyhee River Cave

Entrance into the open end of this cave exists as a result of a massive collapse of part of the original tube. Distance to the back is 1550 feet by a circuitous course. Cross-sectional dimensions vary greatly to a maximum width of 85 feet by a height of 40 feet at a point near the end. Crevices in the floor, together with a drum-like sound produced by footsteps at places in this cave, suggest the possibility of there being an underlying tube.

Although the original tube cross-section is intact and nicely preserved in parts of this cave, much of the presently existing height is due to stoping, which in places must leave the ceiling practically at grass-root level. Indeed, there are five such places (figure 6) where the accumulated rubble on the floor assumes frightening proportions from the standpoint of the amount of material that has fallen and the size of many of the slabs. Moreover, the instability of the roof is such that it was at one of these places where the second large post-1967 rock fall took place.

Evidence in the form of a note on an old, yellowed paper cached in a bottle at the very end of this cave indicates that it was visited and explored prior to the turn of the century and again 10 years later. At least, in two different sets of handwriting this note reads "Arego Harrison, February 6, 1897" and "George P. Buckley and W. H. Gripe, June 6, 1906." Who Buckley and Gripe were is not known, but the name Arego Harrison is recognized as that of a sheep-camp tender working in the area at the time indicated on the note. How much the stoping has progressed between the time these notes were written and now would be interesting to know; however, in view of the unstable conditions currently observable, there is little room to doubt that the tonnage of rock in the various rubble piles on the floor is today many times greater than it was when Harrison, Buckley, and Gripe made their visits.

Burns Cave

This cave begins with a narrow, tortuous passageway between slumped and interwedged blocks of rock on the margin of a collapse trench. Beyond that, the still-remaining section of intact tube extends southward to a small but definitive collapse area which is all that keeps it and the previously described Owyhee River Cave from joining end to end as one continuous tube (figure 3). This was established by entering the cave the distance needed to confirm the bearing of the course of the main tube as recorded by a previous survey party on a plaque left at the entrance. Otherwise, no time was spent examining this cave for the reason that it seemed a needless risk; hence, no map showing configuration details is available in this instance.

Rattlesnake Cave

Found from a cruising helicopter and named after the guardian of its entrance, this cave measures only 882 feet in length and exhibits no features or dimensions differing materially from those observable in the other caves. For this reason the survey consisted of the center-line traverse only, with no height or width measurements. It is to be noted, however, that while the tube terminates against a collapse in the way the other caves do, there is at the end a small dog hole which angles upward through the rubble to the surface, where it emerges on the lower flank of a pressure ridge. This "exit," if it can be called that, is thus similar in its basic make-up to the entrances to the Burns and Coyote Trap Caves.

How much farther the lava-tube chain extends to the north and northeast from the collapse barrier which terminates forward progress in the Rattlesnake Cave can only be surmised, since no collapse trenches are to be seen on the aerial photographs beyond this point. There are, however, in places where the tube course can logically be projected, some patterns which can be interpreted as evidence of incipient subsidence. If this can be accepted as sufficient grounds for surmising that the tube does indeed continue northward on a winding course which could very likely lead to the Tub Springs area, if not to Tub Springs itself, then the total length of the original tube system may possibly be 1.5 to 2 miles longer than mapped.

Conclusion

The chain of tubes and collapse trenches traceable for 8.5 miles in the Saddle Butte lava field was originally one continuous tube, or a closely interrelated system of individual tubes functioning as a unit. This feature formed near the surface of the parent lava flow without producing a strong reinforcing lining. Therefore, the thin, fractured, and poorly supported roof has collapsed over long distances. The potential for further collapse is too great to warrant developing as a tourist attraction the few short cave sections that are still fairly safe to enter.

Reference

Walker, G. W., and Repenning, C. A., 1966, Reconnaissance geologic map of the west half of the Jordan Valley quadrangle, Malheur County, Oregon: U.S. Geol. Survey Misc. Geol. Invest. Map I-457.

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GEOLOGIC MAP OF OREGON FOR SALE BY DEPARTMENT

A small, multicolored map of Oregon on a scale of 1:2,000,000 has just been published by the U.S. Geological Survey. The map shows the various types and ages of rocks, the major faults, and a few geographic features. It was prepared by George W. Walker and Philip B. King and appeared originally in black and white patterns at a smaller scale in Oregon's Mineral and Water Resources report (Department Bulletin 64) compiled for the Committee on Interior and Insular Affairs. The colored version, Map I-595, is on a sheet 11 by 20 inches. It is for sale by the Department at its Portland, Baker, and Grants Pass offices for 25 cents.

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GROUND WATER IN COLUMBIA RIVER BASALT DESCRIBED

"Effect of tectonic structure on the occurrence of ground water in the basalt of the Columbia River Group of The Dalles area, Oregon and Washington," by R. C. Newcomb has been published as Professional Paper 383-C by the U.S. Geological Survey. The report discusses the geology and hydrology of a 620-square-mile area covering both sides of the Columbia River between lat. 45°30' and 45°45' and long. 120°45' and 121°30'. The report includes a geologic map at the 1:62,500 scale, cross sections, and photographs. It is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington D.C., 20402 for \$1.25.

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TECTONIC MAP OF NORTH AMERICA PUBLISHED

"Tectonic Map of North America," on a scale of 1:5,000,000 (1 inch = 80 miles), has been compiled by the U.S. Geological Survey in collaboration with other national geological surveys, and with the assistance of various individuals. The multicolored map, printed on two sheets, each 40 by 65 inches, is available from the U. S. Geological Survey, Federal Center, Denver, Colorado 80225, at \$5.00 per set.

A separately published companion to the map is Professional Paper 628, "The Tectonics of North America," designed to aid in the use and understanding of the map. This 95-page report can be purchased from the Superintendent of Documents, Washington, D.C. 20402, at \$1.00 per copy.

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EARTHQUAKE FELT IN HAINES-POWDER AREA

A slight earthquake was felt at both North Powder and Haines in Baker County on August 14, 1969, according to the Record-Courier and the Democrat-Herald of Baker, Oregon. It was the first quake experienced by residents in that area in many years. The tremor was confirmed at the Blue Mountain Seismological Observatory as having occurred at 7:37 a.m., with a magnitude of 3.5 and centering $3\frac{1}{2}$ miles south of North Powder. Larry Jaksha, chief of the station, said that the tremor persisted about 3 or 4 minutes on the instruments, but that it was localized possibly about 10 seconds.

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HORSE HEAVEN EXPLORATION GETS OME LOAN

The partners in the Horse Heaven Mining Co., Al Franco, Milton Roumm, and Dr. Charles Fine of Seattle and Ray Whiting, Jr. of Reno have received an OME loan of \$24,000 to explore for mercury in a new area just west of the old Horse Heaven mine in Jefferson County. Proceeds of the loan will be used for shaft sinking, drifting, and long-hole drilling. Ray Whiting, who has been exploring the region around the Horse Heaven for the past 3 years, has shipped 17 flasks of mercury from the new site.

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JOHN DAY GEOLOGY BOOKLET AVAILABLE

A booklet, "The geologic setting of the John Day Country, Grant County, Oregon," has just been issued by the U.S. Geological Survey. The 23-page booklet, illustrated with photographs and diagrams, was prepared by the Survey in cooperation with the Oregon Department of Geology and Mineral Industries, the Oregon State Highway Department, and the Grant County Planning Commission. The booklet is obtainable from these agencies free of charge.

The information for the booklet was supplied by Dr. T. P. Thayer, who is an authority on the geology of this region. Designed especially for visitors touring the area, the publication is written in nontechnical style. It contains a summary of the geologic history of the area and a road log of the John Day "loop," which begins near Mount Vernon and makes a circuit through Picture Gorge, Kimberly, Monument, Long Creek, and back, with stops at points of special geologic interest.

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AVAILABLE PUBLICATIONS

(Please include remittance with order. Postage free. All sales are final and no material is returnable. Upon request, a complete list of the Department's publications, including those no longer in print, will be mailed.)

BULLETINS

2.	Progress report on Coos Bay coal field, 1938: Libbey	\$ 0.15
8.	Feasibility of steel plant in lower Columbia River area, rev. 1940: Miller	0.40
26.	Soil: Its origin, destruction, preservation, 1944: Twenhofel	0.45
27.	Geology and coal resources of Coos Bay quad., 1944: Allen and Baldwin	1.00
33.	Bibliography (1st supplement) of geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin	3.00
36.	Vol. 1. Five papers on western Oregon Tertiary foraminifera, 1947: Cushman, Stewart, and Stewart	1.00
	Vol. 2. Two papers on foraminifera by Cushman, Stewart, and Stewart, and one paper on mollusca and microfauna by Stewart and Stewart, 1949	1.25
37.	Geology of the Albany quadrangle, Oregon, 1953: Allison	0.75
46.	Ferruginous bauxite deposits, Salem Hills, Marion County, Oregon, 1956: Corcoran and Libbey	1.25
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