PERPLEXING FEATURES OF LAVA TUBE CAVES IN SEMI-ARID REGIONS OF THE WESTERN UNITED STATES

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ABSTRACT

Recent volcanism in the western United States has created impressive landforms. Most are explained, but some have escaped attention because of their scarcity and/or remoteness. These include apparent speleogens found in lava tubes of semi-arid parts of Oregon. These unusual forms have been speculatively termed speleogens, speleothems, etc. They have been explained as the result of steam pockets, erosion, kaolinization, and even as phreatic forms (the latter for their remarkable resemblance to similar forms in solution caves). This presentation will draw attention to these features, hopefully resulting in an explanation of these vulcanospeleological oddities.

The strange rock forms described herein first attracted the attention of Oregon Grotto members in 1967, following visits to the Saddle Butte Lava Tube System in southeastern Oregon. At that time, new and undescribed features in lava tubes were quite commonly encountered; vulcanospeleology was young. So beyond noting that they resembled genetic features of solution caves, little further attention was paid them. Then in 1974, Burns and Rattlesnake caves were examined and it became apparent that some geological process was altering the interior of these caves in a highly unusual way (see Figure 9). A year later, upon examination of Raven Pit Cave and latter the Kitty Pooh caves (and others), it became obvious that the unusual forms first observed in Baker, Owyhee River and Tiretube caves in 1967 were present throughout the system.

In Raven Pit (see Figure 1), nearly all the ceiling and wall surfaces are modified by weathering and the floor is blanketed with fine grain weathering products, probably several feet deep locally. It was there that it was first observed that the weathering process was not limited to cave interiors. Raven Pit is a fairly well ventilated cave (there is a skylight in addition to a large entrance), and the weathered surfaces are distributed more or less evenly throughout and also in the walls of the adjacent collapse trench for a considerable distance outside the cave.

Figure 1. *Eroded walls in Raven Pit Cave. Note the products of erosion on the floor.*

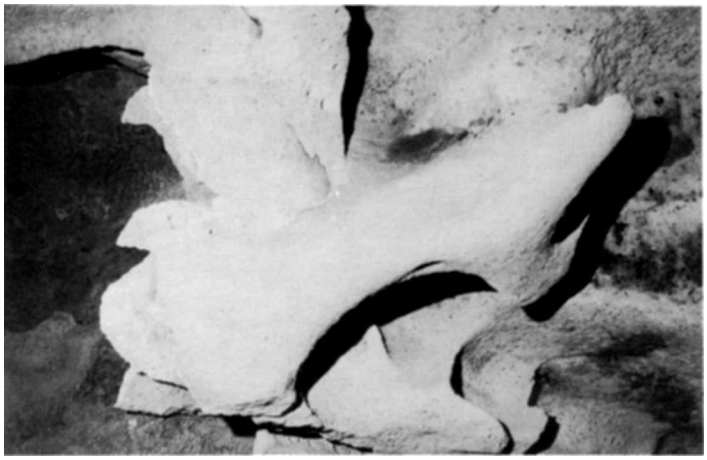

Figure 2. *Eroded basalt far inside Raven Pit Cave.*

Following study of Raven Pit Cave, enough was known about subterranean weathering in the cave system to predict the existence of hollow breakdown blocks (had anyone cared to). In 1980, in a hitherto unknown branch of the system, two caves were found which contained even more bizarre shapes, including hollow breakdown blocks (see Figure 4). Two significant variations were found there, as well: (1) shapes which retain no pre-weathering surfaces or reveal any relation thereto (see Figure 5); and (2) honeycomb or anastomotic patterns which suggest differential weathering along some sort of control plane (see Figure 6).

With one or two exceptions mentioned below, until 1982, all recorded observations of the weathered forms were limited to the Saddle Butte caves. In 1982, examples of the same sort, including the honeycomb variety, were identified in the Benjamin Lake Caves about 120 miles west of Saddle Butte and

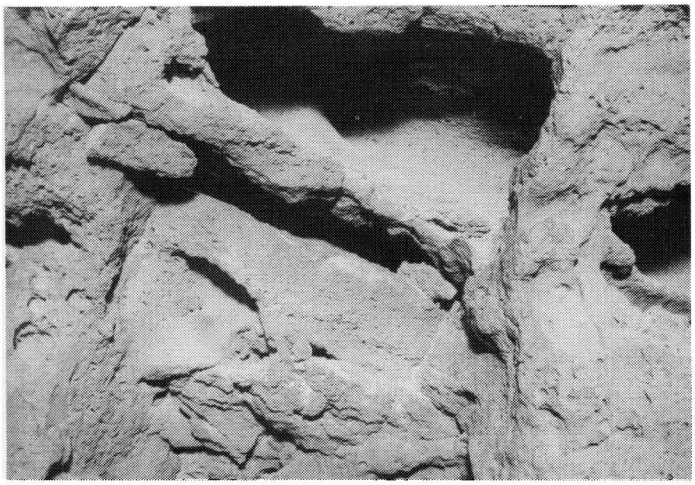

Figure 3. *Weathering recesses in wall inside Derrick Cave, Devils Garden lava flow, Newberry volcano, Oregon. Note penny at center for scale.*

Figure 4. *A hollow breakdown block. Interior was eroded away. Thunder Cave, Saddle Butte Lava Tube System, Malheur County Oregon.*

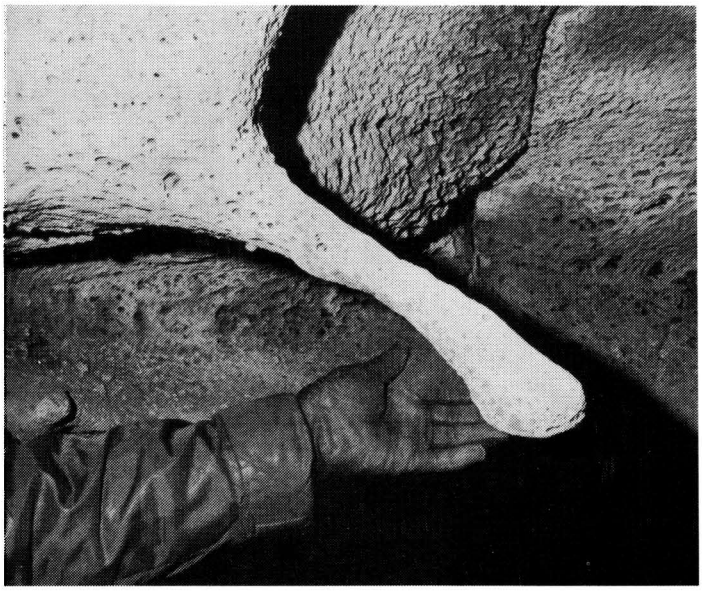

Figure 5. *A basalt projection remaining after surrounding material was removed by weathering. Often the resulting shapes indicate control by contraction cracks, or grain (direction of flow). Thunder Cave, Saddle Butte System.*

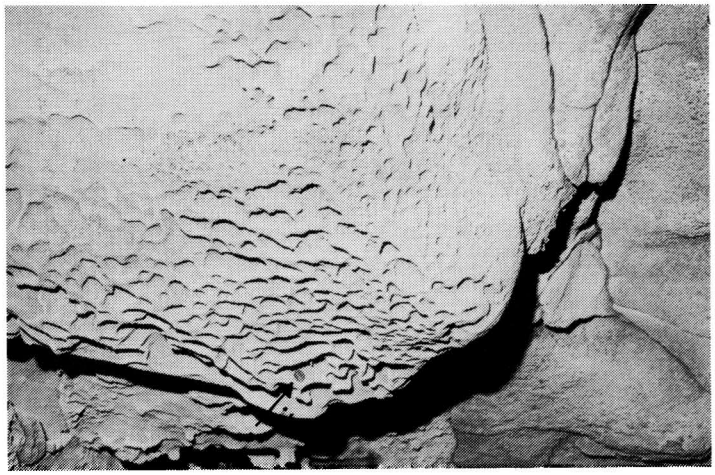

Figure 6. *Weathering of the ceiling leaves anastomotic pattern of many small pockets, Thunder Cave, Saddle Butte System, Oregon. Note penny, lower center, for scale.*

Figure 7. *Growth of crystals (probably gypsum) are wedging small shards of basalt off the ceiling in Lost Blowing Hole Cave, Saddle Butte System, Oregon. Note paper match for scale.*

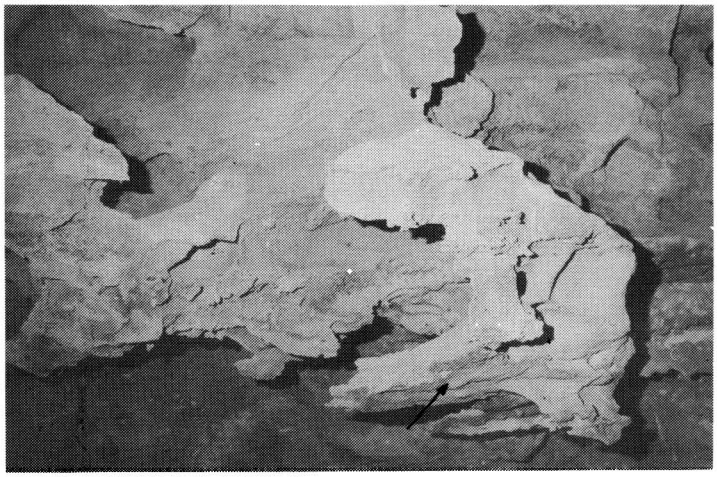

Figure 8. *Pendant remnant of weathered basalt outside the wall of Thunder Cave, Saddle Butte System, Oregon. Small patch of primary tube lining remains at lower right (see arrow).*

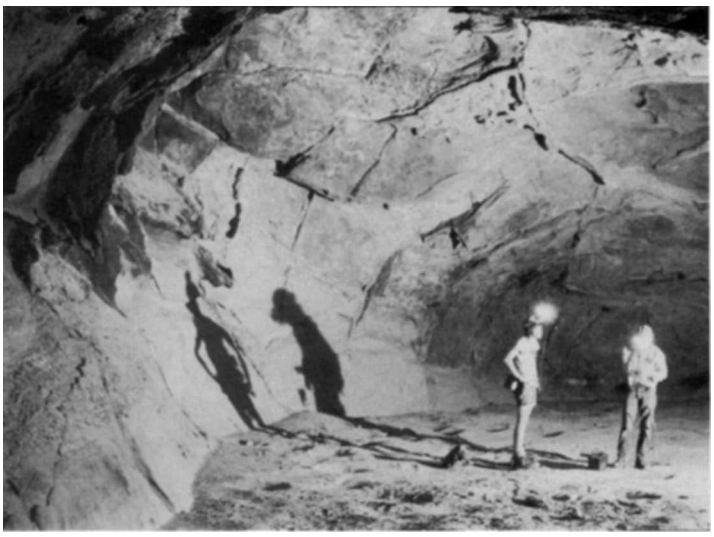

Figure 9. "Free standing" contraction cracks inspired the name Boxwork Room, in Rattlesnake Cave No.2, Saddle Butte System, Oregon. Weathering has removed as much as 2 feet of cave wall, leaving blades about one inch thick adjacent to contraction cracks. Blades projecting 26 inches from the wall (just above center left of this photo). Rattlesnake Cave, Saddle Butte System, Oregon.

in Derrick Cave, not far from Bend, Oregon. Also, there are similar forms in the Arnold System caves just outside Bend (Greeley 1971), in Horse Cave on the outskirts of Bend, and in Redmond Cave a few miles north. Examples have been found, in fact, in most lava caves east of the Deschutes River in Oregon.

Speleological literature regarding these forms is practically non-existent. The earliest extant observation is a brief 1962 description in Oregon Speleological Survey files of a "smooth sponge-like rock" in Horse Cave just east of downtown Bend.

There is as yet no satisfactory name for these weathered forms. In the abstract, I referred to them as "apparent speleogens," but now conclude that term is misleading. They are not, as some contemporary definition and usage of the term "speleogen" implies, an original feature of the cave boundary. In most cases, some small parts of the original cave boundary are retained, but for the most part, they are as different from the original cave boundary as are speleothems. Also, it may be that the prefix "speleo" itself is inappropriate because these forms are to be found outside of caves; for example, in the walls of collapse trenches and elsewhere on basalt faces protected from rainfall, for example in the walls of Crack-In-The-Ground adjacent to the Four Craters Lava Flow. "Petromorph" has been suggested, but contemporary definitions of that term, while contradictory, most often distinguish between the subject material and bedrock in which the cave formed. Until a better term evolves, I will refer to them as "weathered forms."

It now appears likely that most of the sediments in the Saddle Butte caves are the product of decomposition and disintegration of the basalt — weathering — and, to a lesser degree, tephra. Also, it is probable that most of the geologically recent breakdown is induced by weathering, and consequently, very insidious. Progressing west, into the ash shadow of Mount Mazama and other more recent volcanism, tephra probably predominates in cave sediments, though subterranean weathering products are present.

The forms described herein appear to be the result of weathering; physical disintegration and chemical decomposition, and may be related to hydration and transpiration by and of capillary groundwater over long periods of time. Requisite long periods of time would explain the seeming resistance of exposed boundaries of discrete blocks of basalt (see Figure 9) which, though occasionally drenched by rain waters, quickly dry in the caves' uncharacteristically low humidities. (On the other hand, there is a possibility that rainwater removes some constituent of the basalt adjacent to the exposed surfaces, causing the seeming resistance to attack.)

Contact with groundwater-bearing strata seems to be a requisite (e.g., hollow rocks are found only in contact with the floor fill, never in well aerated, isolated positions such as piled loosely atop other rocks). The transpiration of groundwater theory is further strengthened by:

1.The similarity of the weathered forms regardless of position, whether far inside caves or exposed to freezing temperatures (though sheltered from rain) in an adjacent collapse trench.

2.The process seems more active in basalt which is highly vesicular, a condition which improves its porosity.

3.No indication of seasonal variation has been found.

4.To date, the weathered forms in caves have been found only in arid climates where the caves have uncharacteristically low humidity (in the 50-60% range), a condition favoring transpiration. In and west of the Cascades, where rainfall is far heavier and cave humidities are typically at or near 100%, secondary minerals (principally silica) are deposited, but no weathered forms have been found.

The weathered forms described in this paper are located east of the Cascade Mountains in the State of Oregon. If it were not for the outstanding examples found in the caves of the Saddle Butte Lavatube System, their relative abundance might have escaped attention far longer. Surely similar examples of spelean weathered forms exist elsewhere. Hopefully, this paper will stimulate additional study.

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