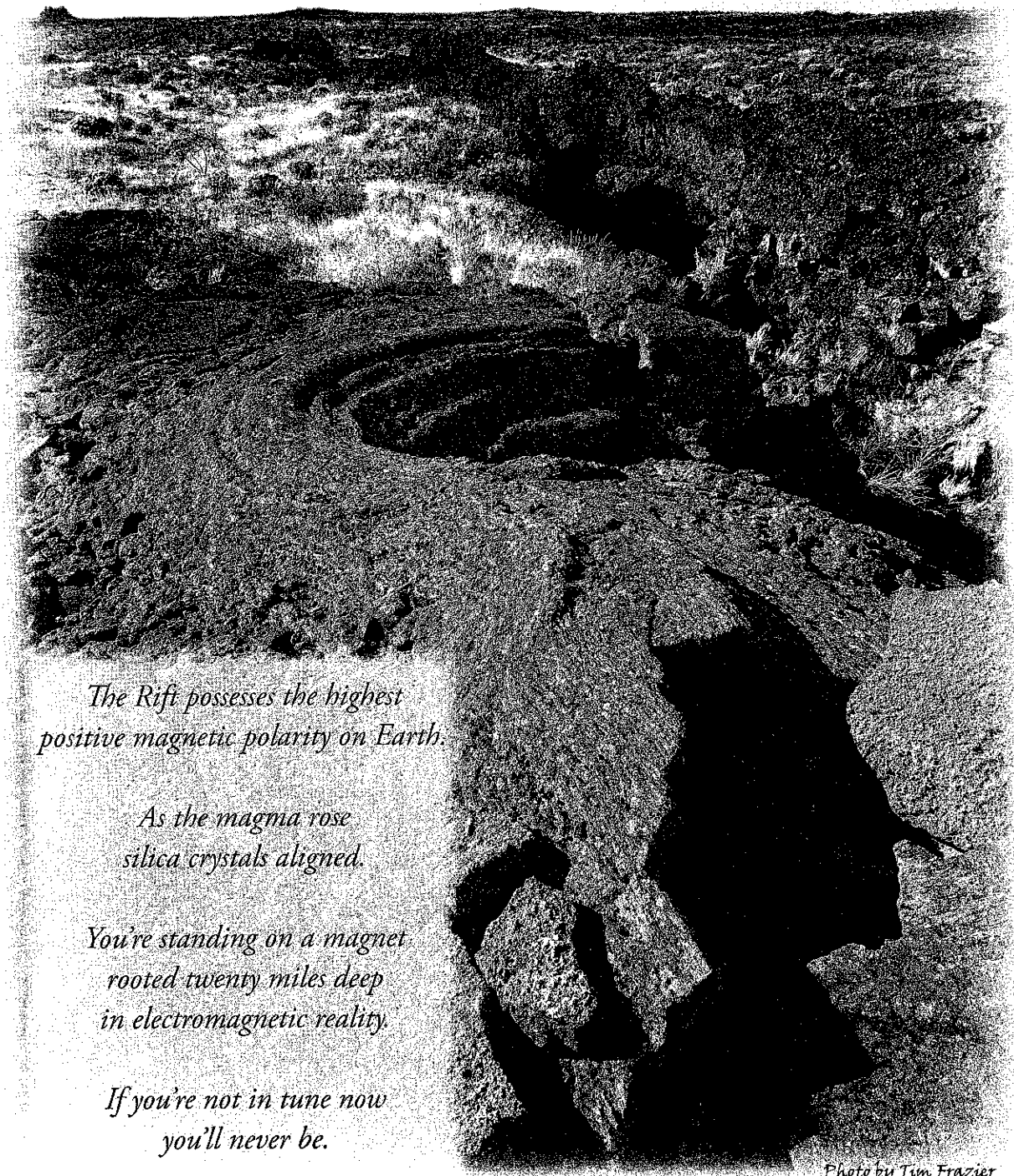




*The Rift possesses the highest
positive magnetic polarity on Earth.*

*As the magma rose
silica crystals aligned.*

*You're standing on a magnet
rooted twenty miles deep
in electromagnetic reality.*

*If you're not in tune now
you'll never be.*

- Will Peterson

Photo by Tim Frazier

Inside the Great Rift—Deep Inside! A Caver's Perspective

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INTRODUCTION

Anyone who has tried to get a good look at the Great Rift in person can tell you that it is difficult to see very much of the rift due to limited access and really rough terrain. A few people have gone to the extreme effort required to visit the entire length of the rift, requiring backpacking trips of over 50 miles carrying everything needed with them. Additionally a very few people have been privileged to visit the insides of the rift! Over the past 20 years, cavers associated with the Idaho Cave Survey (ICS) have conducted several almost expedition-type trips into the inner workings of the Great Rift. Caving at depths of sometimes over 300 feet below the surface, often while hanging from ropes, they have documented many of the fantastic geological wonders inside the Great Rift. This report documents one such cave.

On September 13, 1994 cavers discovered a magma chamber beneath a nondescript spatter cone in a restricted area in Craters of the Moon National Monument. Six members of Idaho Cave Survey (ICS, a chartered internal organization of the National Speleological Society or NSS); Jeff Baldwin, April Earl, Eirik Fowler, Dean Killian, Steve Peck, and Keith Pincock rappelled into the cave and through a newly opened passage into the chamber below.

Editors Note: The term "magma chamber" used herein refers to a cave feature accessible to entry, and not to the geological term, which refers to a pocket of molten rock in the subsurface.

The trip was initiated by the report of a prior visit by Marshall Neeck, a staff ranger at the Monument, who entered the spatter cone on August 8, 1994 on a cable ladder with rope belay to a depth of 23 feet to retrieve a dropped object. Neeck saw a new opening at floor level on the north edge of what was presumed to be the floor of the spatter cone and entered. He

continued down the steep side of a snow slope to a rock landing some 25 feet beyond. He then reported going deeper down an ice slide and seeing another drop in the distance, but was out of belay rope and returned to the surface.

The spatter cone normally has what appears to be a snow floor, but in actuality is a plug of ice lodged in the throat of the spatter cone with a very large void beneath. The unusually light winter of 1993-1994 and the following long, hot, dry summer allowed for the melting of all visible snow on this floor down to exposed rocks that were perched on an ice plug, and—combined with air flow and sublimation of the ice from below—opened up a passage down the north side of the ice plug to two lower passages, one continuing counterclockwise down and around the lower base of the ice plug to the chambers beyond.

HISTORY OF THE SPATTER CONE

H. T. Stearns, in a 1927 unpublished report, talks of entering the spatter cone by way of a wooden ladder. He describes the spatter cone and associated cave as follows:

"The first of the spatter cones is known as Ice Cave. It stands about five feet above the adjacent lava and is made up of clots of lava that adhered to each other when they fell. The throat of the cone, dark red in color, is descended by means of a wooden ladder. It is about 8 feet in diameter at the top but enlarges downward. The original depth of the pit was about 35 feet but it is now partly filled by a heap of ice and snow. With a light, one can enter a small cave about 20 feet long extending north from the bottom of the pit. On the roof and walls of this cave there are many long red stalactites and on the floor short red stalagmites."

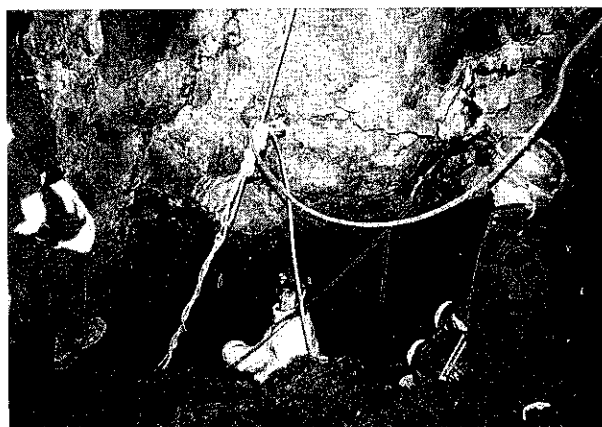


Figure 1. Cavers are on top of the ice plug. They will go down the rope and to the left past the ice plug (Scott Ryan, Diana Gardetto, April Earl).



Figure 2. Huge Ice curtain beneath snow plug (Scott Earl).

The passage that continues to the Balcony Room was apparently blocked by ice at that time and thus was not found by Stearns.

DISCOVERY OF THE BALCONY ROOM

On September 13, 1994 the ICS team entered the spatter cone and continued on down the new opening 17 feet to a rock floor beyond (Figure 1). They laid out a phone line as they proceeded through the cave and reported their discoveries to the author on the surface. The team continued counterclockwise around the lower base of the ice plug, past a huge curtain of clear ice (Figure 2), and down an ice slope to the Balcony Room. The Balcony Room is a shelf on the southwest side of the vent throat. The temperature and humidity in this room were recorded later as 33.8° F. and 92%. The floor of this room is ice-covered rock, as evidenced from below. When standing in the Balcony Room, the ceiling is currently the bottom of the ice plug, which is precariously poised about 16 feet overhead. The ice plug is composed entirely of snow and ice except for a frozen plug of rocks and debris about 6 feet in diameter on the southwest side of the ceiling. This rock plug in the ice plug is currently held in place by frost. As sublimation continues, the exposed rocks and debris occasionally fall to the Balcony Room floor as observed between later trips into the cave.

A low dam of ice forms the edge of the Balcony Room and keeps one from easily falling from the balcony to the Magma Chamber Room floor 65 feet below. This dam is the continuation point for marvelous ice formations that start at the base of the ice plug and flow down to the dam and beyond. The ice columns and icicles, which continue from the dam (Figures 3 & 4), are ribboned together at the dam forming a curtain. This curtain of ice and its source appear to be very recent. The formation was named Surprise Ice Cascade by ICS. Past experience in the King's Bowl area leads the author to believe most of the ice cascade developed in the spring and early summer of 1993 following extremely heavy winter snows and a very wet

spring. In King's Bowl South cave, this large volume of meltwater and spring precipitation carried external heat with it as it flowed into the normally 32° F. cave and melted a perched ice floor. The residual combined water flowed into a colder room below forming huge ice columns in the period of a few months. The ice dam at the edge of the Balcony Room, on the other hand, exhibits seasonal banding and is probably much older, perhaps a remnant of the original ice plug which must have formed after the last eruption at Craters of the Moon had cooled and snow began filling the Balcony Room, forming the now missing base for the current ice plug. It is possible, but unlikely, that the base of the ice plug once reached all the way to the Magma Chamber Room floor. Looking up from the Magma Chamber Room it appears that snow entering the original throat of the spatter cone would soon bridge over the throat at the Balcony Room. It is quite possible that over the past 2000 years the ice plug formed, filled the throat of the spatter cone, and then eroded away from beneath through sublimation until it collapsed. This may have occurred several times and may simply continue to repeat this cycle.

THE MAGMA CHAMBER ROOM

Continuing down to the Magma Chamber Room from the balcony is a real thrill (Figure 5), rappelling 65 feet past the curtain of ice, ice columns, and icicles that are 40 feet long onto the side of the ice mound below and then down its slope to the ice-covered floor (Figure 6). The Magma Chamber Room is kidney shaped and is typically 30 feet wide, 40 feet high, and 170 feet long. The highest point on the floor of this room is directly below the opening in the ceiling, as would be expected since anything coming down the throat of the spatter cone would land here. Much of the floor is covered with breakdown. The southern end of the room contains many huge breakdown blocks. Initially the origin of these blocks was puzzling. Many do not appear to be breakdown from either the ceiling or walls. Later examination of photographs revealed that molten lava had ponded in the

chamber for a significant period of time at the end of the eruption, allowing a strand line and bench to form half way up the walls. When the lava finally drained out of the chamber several large pieces of the strand line bench broke from

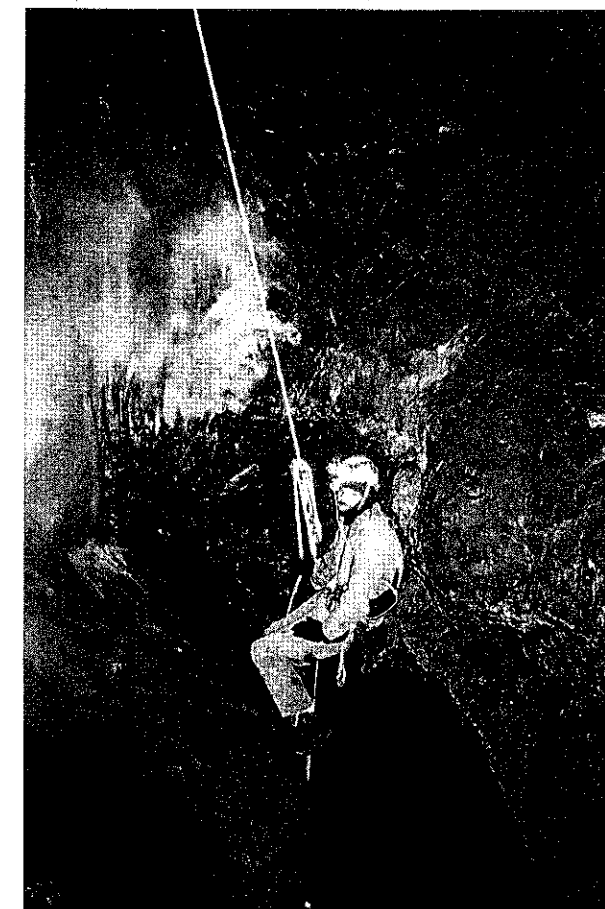


Figure 3. Ice plug is above. Caver is using a "rack" and is about to go "free" (Dean Killian).



Figure 4. Caver going down against the ice. She was the first person to ever enter the magma chamber (April Earl).

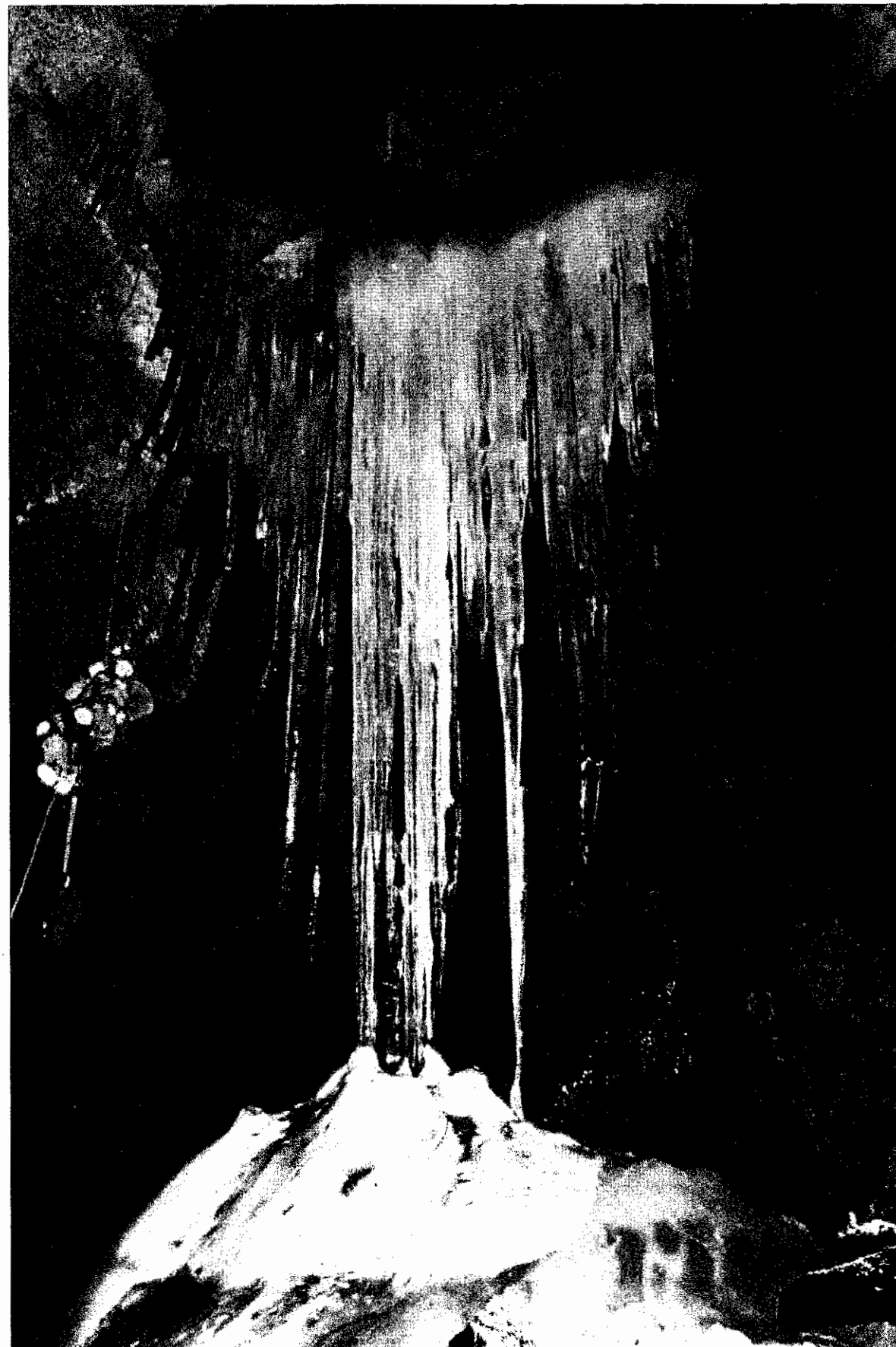


Figure 5. Ice Falls is 65' high to the balcony room. Ice curtain visible at the very top of the picture (Scott Earl).

the walls generating the breakdown on the floor (Figure 7). On the southwest wall, a huge section of bench and wall has peeled away from the rest of the wall and is leaning out into the room a few feet. This slab varies in height from 15 feet to 25 feet, is 53 feet long, and typically is 1 foot thick at the top and up to 8 feet thick at the base. At the lower end of this leaning wall a very significant vertical slab of rock (Figure 7, right side foreground) is a large section of the previous floor of the cooled stranded lava pool that hinged down into the void below as the lava drained from the magma chamber. It exhibits strange air pockets and inclusions of different colors and textures of lava.

Fine crystals cover most of the breakdown boulders in the room, and in the northern reaches of the room pieces of mineral crust are abundant. It was not readily apparent on our two short surveying trips whether these crusts formed on the floor or fell there from the ceiling or walls. At about the midpoint of the northern half of this room is an area with exceptional crystal growth containing several hexagonal to octagonal shaped clear crystals standing on end on a boulder. Most are very small, about 1/8 inch in height, but one is 3/4 inches tall and 3/8 inches in diameter. (Figure 8) These are likely gypsum. Under a large rock to the west of this spot are a couple of white mineral stalagmites that are 3 inches long and 1/8 inch in diameter. Again the composition is likely gypsum. In the lower end of the north extension are mineral secondary deposits so thick we could not negotiate the area without damaging them and a small alcove on the wall in that area was left unexplored. A very high chimney is situated in the ceiling almost directly above the deepest spot in the cave. The ceiling and this chimney were measured with an optical triangulating rangefinder. A powerful spotlight was brought into the cave for the purpose of lighting this area. The ceiling is 50 feet high in this spot and the chimney extends another 37 feet straight up to a height of 87 feet (Figure 9). Later examination of the 3D survey line plot showed this chimney to be the magma source

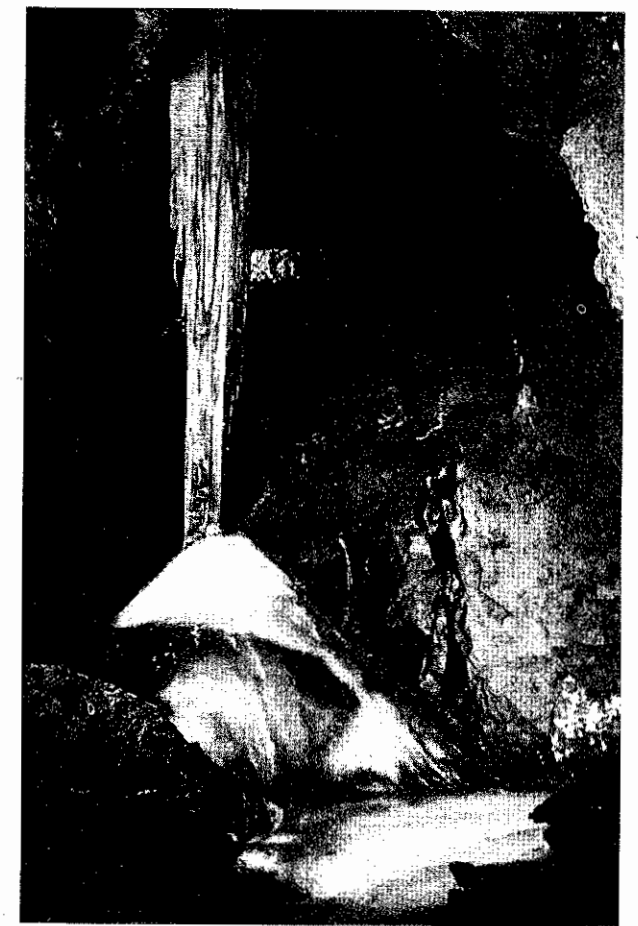


Figure 6. Left side view of the falls & ice cone.



Figure 7. View across the magma chamber from the right. Note the large slab on the right.

for the taller of the two spatter cones on the surface just north of the main spatter cone. This chimney appears to have an ice plug at its top, or perhaps a rock plug that is coated with ice crystals. The second highest spot in the ceiling, fairly near the room entrance, is full of huge ice crystals.



Figure 8. Gelfling's Crystal Shard. Tiny 3/4 inch tall perfect crystal. It is unknown whether these crystals are growing from the base or at the top.

Several carcasses of small animals were found throughout the room. Past experience in ice caves indicates that the carcasses that still have fur on them are fairly recent additions to this room. That the animals survived all three falls and then made their way to the far reaches of the cave is intriguing.

SUBLIMATION

It is likely that as sublimation continues over the next several years the ice plug will become unstable and eventually fall into the Magma Chamber Room. This has been documented recently in several ice caves in the Kings Bowl

area, a continuation of the Great Rift 42 miles south of the developed portion of Craters of the Moon. These caves include Crystal Ice Cave, Great Cavern, and King's Bowl South cave. Ice in all of these caves is sublimating and floors from upper rooms are collapsing into rooms below—not due to melting, since the temperatures are below freezing—but due to sublimation. They exhibit very similar erosion from below as is currently seen in the ice plug in this cave. Several cavers involved in the mapping of this cave have suggested that future trips require attachment to a rope at all times when on top of the ice plug in case it should give way.

INITIAL RESEARCH

After the initial discovery, a research project was proposed by ICS and accepted by CRMO. Specialists in various sciences were assembled, taught to rappel and ascend the ropes using Single Rope Technique, collected samples of the minerals, fauna, and flora. ICS acted as the trainers and safety monitors. They also surveyed, mapped (Figure 9), and photographed the cave. In order to protect the fragile resources, entry into the cave is not permitted.

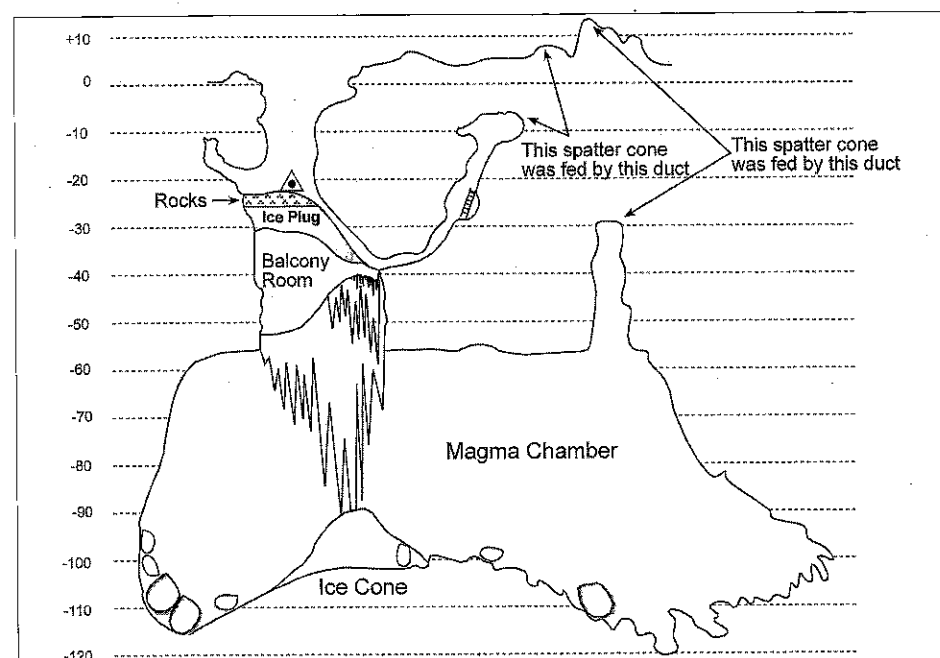


Fig. 9 Profile map of the magma chamber. Total depth is 120.

Petrogenesis of A-type Quaternary Rhyolite and Cogenetic Mafic Magmatic Enclaves at East Butte Volcanic Dome, Eastern Snake River Plain, Idaho

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ABSTRACT

East Butte is one of four compositionally similar Quaternary high-silica rhyolite domes (HSR) on the eastern Snake River Plain (ESRP) segment of the Yellowstone hot spot track. It has geochemical and mineralogical features in common with 'A-type granitic rocks', and may constitute an analog for magmatism leading to production of A-type magmas. The rhyolite contains an anhydrous phenocryst assemblage consisting of 10% sanidine > quartz > fayalite, ferroaugite, Fe-Ti oxides, and accessory zircon, chevkinite and apatite. It also contains a distinctive assemblage of pl+cpx-phyrlic mafic magmatic enclaves - mostly Craters of the Moon-type basaltic trachyandesite (BTA) - and minor amounts of mafic and felsic crustal xenoliths. Most BTA enclaves are vesicular, suggesting post-mixing degassing, and some contain cumulate-like plagioclase megacrysts, and even more mafic, olivine tholeiite basalt-like magmatic (?) enclaves. BTA enclaves plot on fractional-crystallization-dominated curvilinear trends observed at other intermediate-rock-bearing volcanoes of ESRP (e.g., Craters of the Moon and Cedar Butte). EMP analyses of melt inclusions in pyroxene, olivine and quartz phenocrysts consistently yield high-silica rhyolite compositions and low-totals, suggesting that the original rhyolite magma contained ~4-6% H₂O prior to eruption. A hydrous phase of rhyolite evolution is further supported by the presence of pronounced granophyric textures in one of three texturally distinct populations of sanidine.

INTRODUCTION

East Butte is the easternmost of several Quaternary rhyolite lava domes located in the middle of the Eastern Snake River Plain (ESRP), 30-60 km northeast of the Great Rift (Kuntz et al., 1992). These prominent buttes are anomalous in the otherwise topographically subdued ESRP. They are a product of geochemically distinctive, 'A-type' (Frost et al., 2001) rhyolitic volcanism that has overlapped in space and time with dominant, more primitive basaltic volcanism (McCurry

et al., 1999). Both postdate voluminous late Tertiary rhyolitic volcanism of the Yellowstone hot spot track (Pierce and Morgan, 1992). Genesis of rhyolites in such 'bimodal' volcanic fields remains controversial. Processes include recycling of preexisting felsic continental crust by due to heating by basalt intrusions (e.g., Leeman, 1982), low-degrees of fractional melting of basalt-modified crust (e.g., Frost and Frost, 1997), and extreme fractional crystallization of a basaltic parental magma (Nekvasil et al., 2000; McCurry et al., 1999).