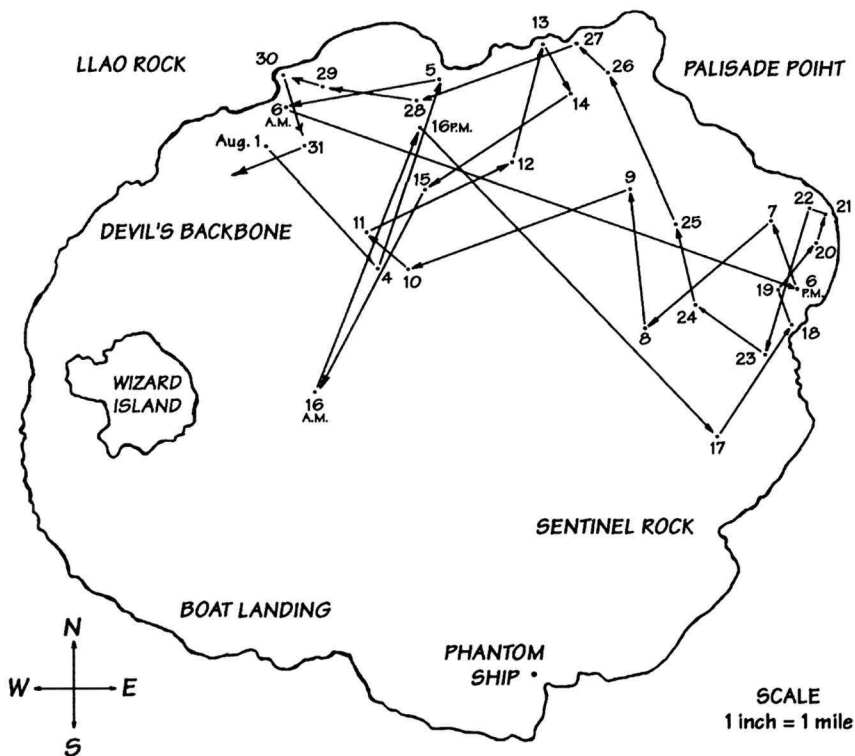


Nature Notes

from

Crater Lake





Above: Map showing the Old Man's movements, August 1938, by John E. Doerr.

Front cover: Ranger naturalist Loren Miller atop the Old Man of the Lake, ca. 1938. National Park Service photo.

NATURE NOTES FROM CRATER LAKE

Contents

Introduction	5
Adventure & Discovery, 1931: A Personal Account	6
<i>by W. Drew Chick, Jr.</i>	
Why enter a sleeping volcano in a submarine?	12
<i>By Mark Buktenica</i>	
Diving in Crater Lake	19
<i>By John Broward</i>	
The Old Man of the Lake	21
<i>By John Salinas</i>	
Llao Speaks	23
<i>By Tom McDonough</i>	
Wandering Through Wildflowers	25
<i>By Peter Zika</i>	
A Pause in the Panhandle.....	26
<i>By Steve Mark and Ron Mastrogiuseppe</i>	
Fossil Finds and the Age of Oregon Caves.....	29
<i>By John Roth</i>	
About the Authors	32
Illustrations	33

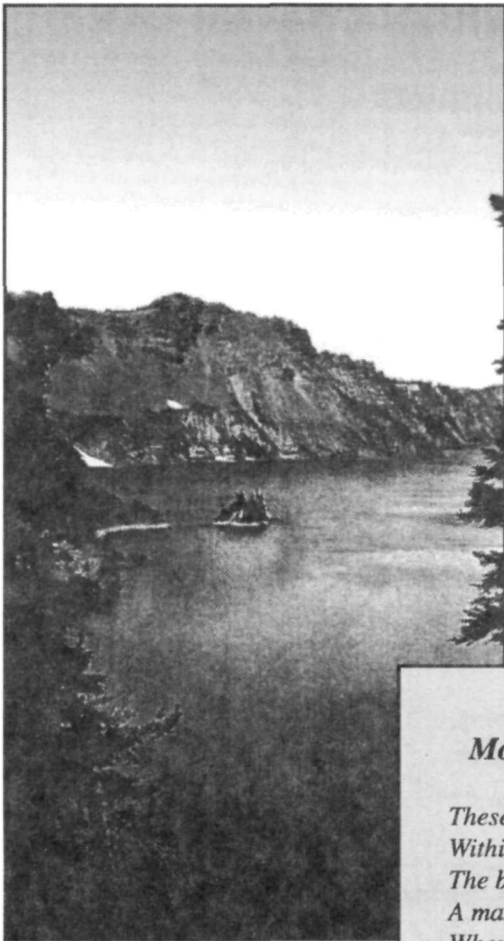
Presented by

National Park Service
Crater Lake National Park



Crater Lake Natural
History Association





Mount Mazama (Crater Lake)

*These breathless tones are but a bier,
Within these cliffs are tears of blue,
The brilliance of each morning unfolds
A massive shroud of ethereal hue
Where once a feverish, fiery tongue
Lapped for the coolness of the stars
In agony, as flowing blood had wrought
A futile effort to heal the festered scars.
Now pinned to its breast a ghostly ship
Sailing forever on a windless sea,
No port shall ever lure to rest
Till God sees fit to set it free.
We come to drink of this beauty
Which was born in the throes of death
Centuries have found it unchanging,
The living has given it breath.*

Ruth Neary, 1959

NATURE NOTES FROM CRATER LAKE

Volume XXVII - 1996

National Park Service
Crater Lake National Park

Crater Lake Natural
History Association

Introduction

Rarely does a volume of Nature Notes have the opportunity to present stories as significant to resource management at Crater Lake and Oregon Caves as what are in the articles by Mark Buktenica and John Roth. The manned submersible, as described by Buktenica, received national attention in 1988 and 1989 when he and other scientists used it to collect samples from the bottom of Crater Lake. This eventually allowed investigators to show that much of the park is a model for small caldera evolution. Roth has likewise shown how fossil finds made last summer at Oregon Caves can be put into a larger geological context, thereby changing the way many people view the monument.

This year we also make special note of a floating log called the Old Man of the Lake. Since it was first documented in Crater Lake a century ago, the Old Man has often been a memorable part of boat tours and sightseeing around the rim. John Salinas pays homage to this wayward voyager, while other submissions provide the usual mix of observation, reminiscence, or insight about the lake and its surroundings.

Established in 1942, the Crater Lake Natural History Association's purpose is to aid the National Park Service in its educational and resource management programs at Crater Lake National Park and Oregon Caves National Monument. The association therefore sponsors this edition of *Nature Notes from Crater Lake* and encourages reprinting articles therein so long as credit is given to authors and CLNHA. Nature Notes are made possible through CLNHA operation of three sales outlets. Two of these are in Crater Lake National Park, with another at the Illinois Valley Visitor Center in Cave Junction, Oregon. A list of items available for sale can be obtained by writing to CLNHA's Business Manager, P.O. Box 157, Crater Lake OR 97604.

Stephen R. Mark, Editor

Adventure and Discovery, 1931:

A Personal Account

by W. Drew Chick, Jr.

During the summer of 1931, at 19 years of age, I was privileged to accompany Ansel F. Hall, senior naturalist and chief forester of the National Park Service (NPS), as his "apprentice" field assistant. He was an active Scouter, known affectionately as "Chief" by me and all the other Boy Scouts whom he befriended.¹ Our itinerary included Yosemite, Craters of the Moon, Yellowstone, Grand Teton, and Crater Lake. I had just completed my freshman year at the University of California and was contemplating what major to select. To help me decide, Chief said he would give me as many different assignments as possible while he was on duty at these parks. In return I agreed to write a book describing my experiences so that others could consider a NPS career. This paper is derived from the chapters I wrote about Crater Lake. Part one deals with interpretive activities inaugurated that summer; part two relates to geological and historical discoveries.

Part One - Interpretation

Park Naturalist Donald S. Libbey had been planning a new service for the public for quite some time.² I was happy when he and chief asked me to go along to assist with the first, personally-conducted, rim auto-caravan trip. Following the regular evening programs at the Community House³ and at the Lodge, it was announced that those desiring to participate in this new service would meet at eight o'clock the next morning at the Sinnott Memorial for orientation. They would then travel in their own cars with the naturalist's car in the lead, and stops would be made at important view points. The naturalist would point out the significant features at each of these, once those attending left their cars and assembled at a central location.

We wondered how many people would come. Great was our surprise to find 12 autos lined up and 27 people ready to go.

To the group assembled on the Sinnott Memorial's parapet, Mr. Libbey described the lake's geological history and the evidence to support it. He concluded by giving instructions about how the balance of the trip would be conducted.

Returning to the autos, we traveled around the rim in a clockwise direction following the government "pilot" car. By the time we reached The Watchman, only five miles from the start, our caravan had grown to 18 vehicles carrying 47 people. It was my duty to record the mileage to each

of the 11 stops, to list the principal subjects mentioned by Mr. Libbey, and to note the length of time spent at each one. The stops averaged about 15 minutes, which allowed plenty of time for the visitors to enjoy the view and to ask questions.

At the stops, Mr. Libbey called attention to prominent scenic features such as the perfect symmetry of Wizard island, told about the discovery of the lake, and named the wildflowers and trees. He also pointed out significant geologic formations like the Pumice Desert where volcanic ash lies fifty feet deep, glacial polish and scratches on the rocks at Hillman Peak, the vertical crack filled by the great volcanic dike called Devil's Backbone, columnar lava at the Wineglass, and the succession of flows exposed in cross-section beneath the rim. Kerr

Notch, the last stop, was a fitting climax for the caravan because it afforded an inspiring view of Phantom Ship and a full-circle panorama of the lake framed by the multicolored walls of the caldera. At this point Chief addressed the group, stating that this first trip was experimental and asked for written comments so that the service could be improved. It was continued during the balance of the season with remarkable success, in part because I prepared a log book after that first trip to aid other naturalists in conducting auto caravans.

Heartened by the favorable reception accorded the rim caravans, Chief and Mr. Libbey again set to work to extend the services of the government ranger naturalists in other ways. They spent several days exploring Wizard Island and took extended boat trips on the lake. Finally they announced a thriller—an all-day trip on Crater Lake which included exploration of Wizard Island—all this in the constant company of a ranger naturalist! Chief told me I would be assisting seasonal naturalist Earl Homuth on the first trip.



Ansel F. Hall.

Photo courtesy of the author.

At 9 a.m. sharp, I met the visitors at the head of the trail to the shore of Crater Lake⁴ and was very much surprised to find that Mr. Homuth had not yet arrived. We waited for several minutes expecting that he would come. (I found out later that he had taken sick at the last minute.) This put me in a quandary. Should I tell these people that the trip had been called off after they had prepared lunches and donned hiking clothes in expectation, or should I lead it myself? It seemed like an audacious thing for me to do—to conduct the first trip inaugurating a new service. Reinforced by the fact that I was in a ranger's uniform, however, I started down the trail.

I found it easy to interpret the wonderful forest of mountain hemlock, the creeping currant, and the wildflowers that I had come to know so well two years before while writing labels for a nature trail.⁵ I was much encouraged when I discovered that the visitors were giving me credit for being a real authority. All along, however, I remembered the admonition received from my training in Yellowstone: "Don't give misinformation." Occasionally I had to say, "I don't know." At the lakeshore, I found that my party had grown considerably larger. There was no chance to back out now.

After boarding the boat, we headed for Wizard Island. The group became most enthusiastic as I shared with it some of the information I had learned from Mr. Libbey when he instructed the park's naturalist staff at the beginning of the season.

We disembarked at the landing, crossed the jumble of lava blocks, and climbed the steep trail up the cinder slope to the top of the island. We rested at the rim of its crater and ate our lunches. It seemed only natural in this location to talk about the great Mount Mazama which once lifted its summit thousands of feet above us, of the glaciers that gouged out deep valleys along its sides, the mountain's subsequent destruction, and the comparatively feeble activity which built Wizard Island and two other cones now submerged in the sparkling blue lake. We then walked around the rim of the island's crater and enjoyed wildflowers blooming within the 100-foot deep crater, as well as the changing panorama of the caldera walls.

After scrambling down the island's outer cinder slope, we met the boat at the landing and boarded it again for an hour's voyage on the smooth, azure lake. It was a delightful experience to go around Wizard Island and pass through the "shallows" of Skell Channel before heading northward towards the Devil's Backbone. Here we paused to gaze at this immense, cleaver-like dike before crossing the lake to Phantom Ship. The time it took to do this helped to impress upon my party that a huge cataclysm caused the destruction of Mount Mazama, and an immense caldera resulted.

At Phantom Ship, the launch pilot called our attention to a vertical cliff which dropped to a depth of more than seventy feet under water. Then we circled this large rock formation with its slender "masts" towering as high as a fourteen-story building. This first trip concluded in the shadow of thousand-foot cliffs as the boat followed the shoreline back to the boat

landing. I felt a little guilty about leading the first trip, but Mr. Libbey assured me that I had done a splendid job.

Part Two - Discovery

On July 10, 1931, Park Ranger Ike Davidson discovered a machine on Wizard Island which he loaded onto a government boat and took to the dock at the foot of the caldera wall. With the aid of a pack horse, Ranger Ferdie Hubbard and I carried this machine up the trail to Rim Village the next day. We thought it would be something that W. G. (Will) Steel could identify. He had been hired by the U.S. Geological Survey to measure the depth of the lake in July and August 1886, and he was now serving as the U.S. commissioner.⁶ He recognized the machine immediately as the one he had built and used for that purpose. Mr. Steel told us, "After the survey was completed, the sounding apparatus was removed from the *Cleetwood* and cached among the lava blocks on Wizard Island; the boat was sunk in an inlet."

This sounding apparatus held a special interest to me, especially the two wooden spools or drums mounted on a square axle turned by a hand crank. The square shaft prevented the spools from turning independently of the axle. A leather strap laid across the narrower spool served as a brake while the weighted sounding wire was being raised or lowered in the water. The larger spool was still wound with wire. Mr. Steel showed us the leather tags attached to it at fifty-foot intervals to track the depth of the lake. The sounding apparatus is now part of a permanent exhibit in the Sinnott Memorial Museum, where visitors may see it each summer season when the building is open.

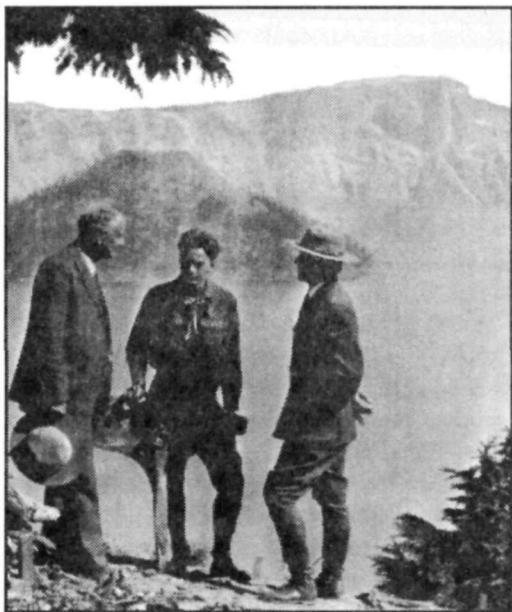
On July 18, Chief and I, with bundles of stakes and a surveying instrument, embarked for Wizard Island. We laid out a new trail to the top on an eight percent grade to replace the steeper trail that the visitors and I had struggled to climb on the first guided boat trip.

Chief wished to do some exploring after we used up our supply of stakes, so he asked me to go back to the landing and bring the rowboat around to West Cape where he would meet me. While skirting the shore, I heard a shout from Chief calling from somewhere on the lava flow: "Drew, come here!" After tying the boat to a rock at the shoreline, I scurried over the lava and found Chief kneeling beside some rusty objects. Upon close examination, we determined that they were window weights made of cast iron. Who had left these on Wizard Island, I wondered. "These could be some of the plummets," Chief was thinking out loud, "that Mr. Steel used while sounding the lake in 1886."

Now that Chief had found the plummets, hopefully the *Cleetwood* would be nearby. We looked around, and over a ridge, was a depression partly filled with water. Several pieces of wood, bleached white by the sun,

lay beside the pool. The black lava blocks around the pool were coated with a light-colored substance suggesting that this might have been an inlet six feet deeper when the lake was at a higher level. Looking into the water, we saw what appeared to be a rowboat flattened against the rocky bottom and covered with a thick layer of slime.

With the handle of an oar laying alongside the pool, I poked around in



*Author with transom, flanked by Will Steel
and Ansel Hall.*

the water looking for something unique that would provide positive identification. Sure enough, deep in the pool and wedged between two rocks, I could make out the form of the transom or stern portion of a rowboat. Barely discernible in the half light were the letters "US." Now this was a prize worth recovering!

The oar broke while prying and I looked around for a stronger stick, but there were not any to be had. This left only one alternative. After removing my shoes and stockings, I rolled up my breeches and sleeves as far as possible. Upon

wading in, I found that I had to stand on a slimy, sloping rock. I reached down into the water, saying to myself, "Gee, it's deeper than I thought. If I lean over any farther I shall lose my balance. How can I retrieve it?"

I called Chief, who had been busy with the camera during this performance, and he came to my assistance. He set the automatic timer hoping to get a picture. Bracing himself on the rocks, he grabbed my belt while I loosened my prize, raised it out of the water intact, and deposited it onshore. It was well worth it, for all of the letters, forming the initials of the United States Geological Survey, could now be read. This was evidence that we had actually found the hull of the *Cleetwood* sunk in this cove nearly 45 years ago. A heavy iron ring for mooring was bolted to the transom and it was well preserved, too.

After putting my shoes on again, I shouldered the heavy, slimy, water-logged transom. Chief carried the window weights. Once these objects had been placed safely in our boat, we rowed across the lake to the foot of the trail to Rim Village. The next day, Mr. Steel confirmed what we had found: the transom is the stern of the *Cleetwood* and the window weights are the plummets he used when sounding the depth of the lake.

Both the sounding apparatus and the transom are now treasured parts of the park's museum collection. If Will Steel had not purposely scuttled his "ship," in 1886, nothing would have survived. For this we owe him a debt of gratitude. Without Ansel Hall's faith in me, this paper could not have been written. I have tried to convey through its text the feeling of adventure I felt as I participated in these and other learning experiences under Chief's direction.⁷ 

Notes

- ¹ Ansel Hall (1894-1962) had an 18 year career with the NPS which began in 1920 at Yosemite National Park. He rose to become the agency's chief naturalist three years later.
- ² Donald Libbey (1892-1959) served as park naturalist at Crater Lake from 1930 to 1933 and remained with the NPS until his death.
- ³ Located in what is now the picnic area at Rim Village, this building is sometimes referred to as the "Rim Center." Evening programs were presented there through the 1988 summer season.
- ⁴ Until 1960 the trailhead was located at Rim Village, something which necessitated a descent of 900 feet instead of the 700 foot drop to Cleetwood Cove that visitors have at present.
- ⁵ In 1929, as a member of a Boy Scout expedition, I had accompanied Chief and Dr. Harvey Stork (a professor of botany at Carlton College in Northfield, Minnesota—ed.) on a trip to Crater Lake and other national parks. The labels were prepared for the Castle Crest Wildflower Garden near Park Headquarters.
- ⁶ William Gladstone Steel (1854-1934) led the campaign to establish Crater Lake National Park, which, after 17 years, met with success in 1902. During his career he was the park's first concessioner (1907-1912), second superintendent (1913-1916), and first U.S. Commissioner (1916-1934).
- ⁷ The original version of this paper was read on May 16, 1992, at a symposium in Ashland, Oregon, celebrating the park's 90th anniversary.

Why enter a sleeping volcano in a submarine?

A summary of results and observations from hydrothermal, biological, and geological submersible studies at Crater Lake National Park, 1988-1989.

By Mark Buktenica

I was sitting alone in Crater Lake, 600 feet underwater in a small submarine called Deep Rover. I had just completed collecting rock samples along an underwater edge of Wizard Island, and I had 135 pounds of rocks in a basket attached to the front of the submarine. Unknown to me at the time, a couple of O-ring seals were leaking throughout the dive. Water seeping through the seals into the submarine, combined with condensation from my breathing, created an uncomfortable amount of water on the floor. My feet were near the front of the vessel, and as I prepared to start to the surface with the rocks, the submarine tilted forward. As the submarine tipped, the water level at my feet rose rapidly, giving the distinct impression that the submarine was filling with water. Garbled and intermittent communications with the surface crew aggravated the situation. Everyone operated expertly and efficiently; Deep Rover and the rock samples were recovered smoothly. Actual dangers and repairs turned out to be minimal, and the submarine dove again the next day. Nonetheless, I thoroughly reviewed emergency procedures at my first opportunity.

Crater Lake partially fills the caldera of the Mount Mazama Volcano to an elevation of 6,172 feet. Once rising nearly a mile above the rim of the caldera, Mount Mazama experienced a climactic eruption and simultaneous collapse roughly 7,700 years ago. Crater Lake filled with water to nearly its present level within a few hundred years of the collapse. With a maximum depth of 1,932 feet, Crater Lake is the deepest lake in the United States. The lake is well known for its deep blue color and extreme water clarity, and visitors are amazed to see portions of the lake bottom at water depths up to 115 feet on calm days.

Enabling legislation for Crater Lake National Park and the National Park Service (NPS) allow for scientific study if there is no impairment of natural resources. As the fifth oldest national park in the United States, Crater Lake has a long tradition of hosting investigations aimed at obtaining information about the physical, chemical, and biological properties of the lake. Until 1982 lake research had to be done on a sporadic basis, as funding and personnel would allow. Congress then ordered the NPS to begin investigating Crater Lake in a more systematic way, and by 1986 directed that the park's hydrothermal resources be studied. A geothermal energy company was drilling exploratory wells adjacent to the park boundary, evaluating the potential for geothermal energy development, about the same time these requirements were passed. Although the objectives of the park's hydrothermal studies were not related to



Author in Deep Rover submersible, photo by Mathis Von Hesemans.

the drilling, undoubtedly this activity provided some political impetus to fund the research. As a result, the one- person submarine, *Deep Rover*, was flown into the caldera by helicopter to conduct hydrothermal studies in 1988 and 1989. Simultaneously, other studies, also using the submersible, were initiated to explore the distribution of deep-water plants and animals and to assess the early volcanic evolution and the postcaldera volcanic history of Mount Mazama.

Operating a program that utilizes a submersible is a difficult undertaking in the best of settings, but especially challenging in remote areas at high altitude such as Crater Lake. The only access by land to the lake was the steep, one mile-long Cleetwood Cove Trail. Small four-wheel-drive tractors were the primary means of carrying supplies and materials from the top of the caldera to the lake shore on a daily basis. A base camp was established on Wizard Island and over 30,000 pounds of scientific and technical support equipment, including the 7,000-pound *Deep Rover*, were flown to the island by helicopter. The NPS insisted that no evidence of the operation remain on the island or in the lake after we were done. Researchers were meticulous in this regard and even transported dishwater out of the caldera.

Deep Rover is a highly technical submarine that the NPS, National Geographic Society, and U.S. Geological Survey leased from Can-Dive, Inc., a company based in Vancouver, British Columbia. The vessel is engineered for intuitive operation by its single occupant, who must serve as pilot and scientist. The operator sits in a five inch thick sphere of clear acrylic measuring six feet in diameter. This sphere is attached to two battery pods, each containing ten 12-volt marine batteries. The acrylic sphere opens at the bottom, like a clam

shell, allowing the scientist to enter and exit. Mechanical, electrical, hydraulic, and life-support systems are mounted inside and outside of the sphere. Two large manipulator arms are mounted on the front of the submarine and are operated by the pilot inside. A basket mounted below the manipulators is used to stow scientific samples. Cameras, sample bottles, suction samplers, and sophisticated thermometers are other examples of equipment attached to the submarine. Learning how to operate *Deep Rover* required an intensive one-week training program that included classroom instruction and field work in operation, safety, and emergency response. This ensured that myself and two Oregon State University Oceanographers, Dr. Jack Dymond and Dr. Robert Collier, were ready by the time dives commenced in 1988.

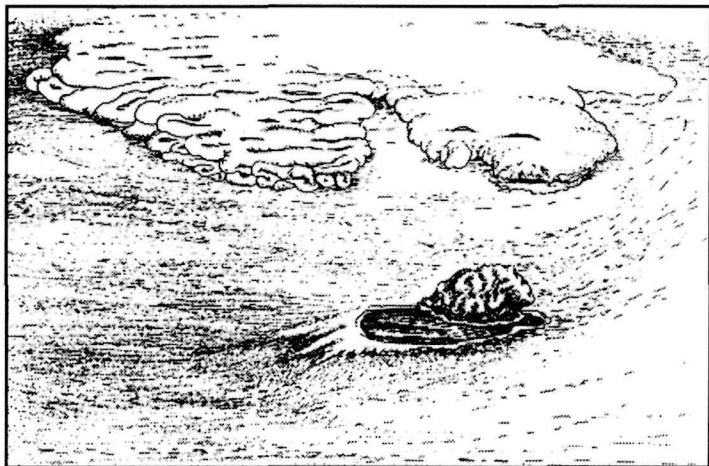
Each dive day began with a trip to the dive site, which usually took one or two hours. *Deep Rover* was towed behind a research boat in a submersible "tender," designed specifically for use at Crater Lake. Once all systems were judged to be functional, the operator crawled through the narrow opening into *Deep Rover*, the submarine hull was sealed, and all outside noise was suddenly muted. Upon being sealed shut, *Deep Rover* heated up like a mini greenhouse, typically reaching 92°F before descending into the lake un-tethered. With permission to leave the surface, the pilot began the commute to the bottom of Crater Lake.

I had the distinct privilege of conducting 17 dives in *Deep Rover*. As I slowly sank into the depths of the lake, I was engulfed in blue which eventually turned to darkness. The only sounds in the submarine were the creaking and popping of the hull as it adjusted to the increasing water pressure and the persistent hum of the carbon dioxide scrubbers cleaning the air. The journey to the bottom could take up to 30 minutes, during which time my personal fears were easily extinguished by the intrigue and demands of the work. After reaching the bottom on my dive to the deepest part of Crater Lake, I shut off the scrubbers and instrument lights to better experience the solitude and quiet, and to briefly reflect on being the first person to visit the deepest part of the lake. After several moments, I looked up through the clear acrylic hull and noticed that the dive flag mounted on top of the submarine was visible, and silhouetted against a slightly lighter background. At 1,932 feet in depth my eyes could detect the vague light from the surface, a surprising testament to Crater Lake's incredible clarity. Yet there was little time for introspection. With less than six hours allowed per dive, I was fully occupied with monitoring electrical and life-support systems, operating the submarine, collecting samples, recording observations on tape and film, and communicating with the surface boat via an underwater wireless telephone. Although the submersible was designed to operate instinctively, many of the tasks I had to perform required extreme concentration and were mentally challenging, physically demanding, and sometimes frustrating.

Most of the lake floor is covered by fine sand colored sediments, and operating the sub there was like flying at night over an uncharted desert. One of the highlights of the research was discovery of bacteria colonies associated with

hydrothermal fluids deep in the lake. These colonies form yellow-orange mats which appeared to hang on to or cascade down sediment slopes and rock outcrops. The mats consist of thousands of *Gallionella* and *Leptothrix* bacteria, which live on chemicals (primarily reduced iron) in the hydrothermal fluids that slowly enter Crater Lake through the lake sediments. It is unusual that the chemical energy from the fluids allows the colonies to live in darkness on the floor of the lake, independent of photosynthesis, since that process energizes most biological communities on the planet. Temperatures measured inside of the mats were as high as 68 °F, whereas ambient water temperature was 38 °F. Chemical geothermometry models suggest that source temperatures of 104 to 329 °F would account for observed water chemistry and temperatures at the lake-sediment interface.

Another interesting discovery was the presence of discrete pools of saline water on the lake floor that had a distinct blue color. The first “blue pool” discovered was named Llao’s Bath by Jack Dymond, after the legendary spirit of the lake. The pool resembled an oblong bath, 10 to 13 feet long and 3 to 5 feet across. It appeared to be elevated on one side by precipitates, and was surrounded by golden-colored bacteria. This pool and others like it are composed of hydrothermal water with salt content as much as ten times higher than the surrounding lake water. The presence of the salts makes the liquid in the pool heavier than lake water, and the pools appear blue because of the optical properties of the chemically enriched fluids. In general, many chemical indicators of hydrothermal origin were detected in fluids taken from the pools. In the most anomalous pool fluids, manganese was enriched by as much as a million times and Radon (^{222}Rn) was enriched 100,000 times over typical lake values. Helium-3, perhaps the most distinctive indicator of a magmatic heat source, was enriched 500 times more than values for water in equilibrium with the atmosphere.



Llao's Bath and “brain” mat complex. Llao's Bath is in the foreground.

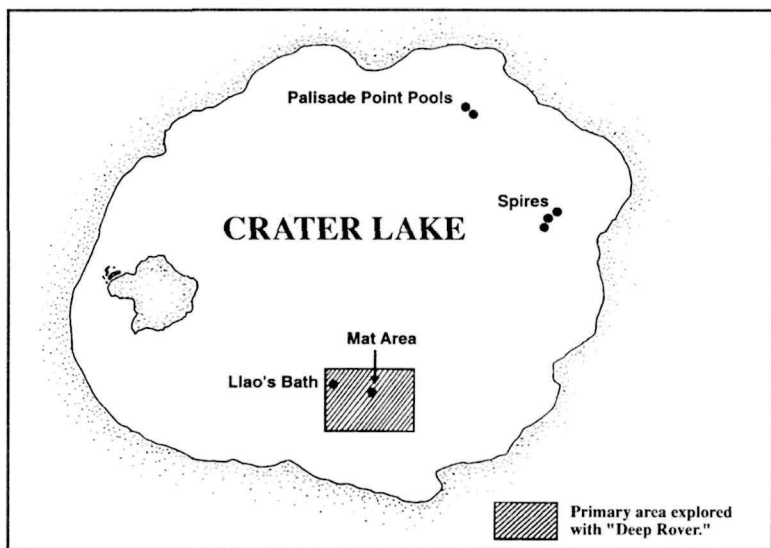
We were surprised to find another area of hydrothermal activity below the Palisades along the northeast caldera wall during one of the dives. Small stream-like features originated from underneath boulders or rock outcrops along the base of the caldera wall. The stream-like channels were two to three inches in width and equally as deep. Although no flow was observed at the time, the channels formed networks which exhibited classic erosional flow patterns. The channels were lined with brilliant gold bacteria and often terminated down slope in a series of blue pools. Twenty or more pools with associated islands, embayments, and delta-like features were observed in an area approximately 160 feet wide and 320 feet long.

Along the base of the east wall below Skell Head, remnant spires served as a record of past hydrothermal activity. Over 30 feet high, the spires had a chemistry indicative of a hydrothermal origin and a morphology consistent with underwater formation. Similar spires have been observed around active, high-temperature, hydrothermal sources in oceans around the world. The spires form when chemically rich hydrothermal fluids come in contact with cold ambient water and the chemicals precipitate out of solution to form chimneys around the vents.

In addition to the hydrothermal studies, *Deep Rover* provided a unique opportunity to survey the lake floor for plants and animals. Previous biological studies of Crater Lake were limited to sampling from a surface boat, collections along the shoreline, or shallow dives using SCUBA gear. During the submersible studies, several unusual and interesting biological discoveries were made. A thick band of moss, *Drepanocladus aduncus*, encircled the lake, and was observed growing at depths from 85 to 460 feet. It hung like icicles on vertical cliffs and formed thick lush fields on the gentler slopes around Wizard Island. The remarkable lower depth limit of 460 feet was due to the ability of light to penetrate deep into Crater Lake's clear water.

Animals were found living in Crater Lake's deepest basin at 1,932 feet below the surface. This was particularly fascinating because of the extreme water pressure that these animals must sustain to live at this depth. The deep-water animals were found at relatively low densities and included flatworms, nematodes, earthworms, copepods, ostracods, and the midge fly *Heterotrissocladius*. Many specimens survived the rapid pressure change during the retrieval from the lake floor and lived in the laboratory for several weeks after collection.

The geological studies conducted with *Deep Rover* expanded our knowledge of the eruptive history of Mount Mazama. Most of the rocks sampled from the caldera walls were lava flows which came from Mount Mazama, but a few samples collected from greater depth were rocks which predate Mount Mazama. These studies also provided new information on postcaldera volcanism by indicating which lava flows occurred beneath lake water and which erupted before the lake filled. Flows that formed the central platform, located east of Wizard Island, came about prior to the lake level



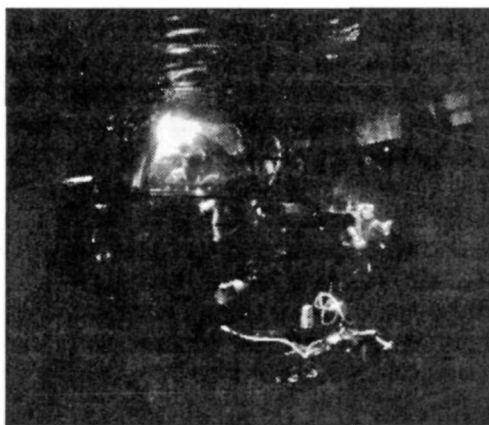
reaching them. Merriam Cone and most of the submerged portion of Wizard Island formed beneath the water surface when the lake was approximately 250 feet below its present level. All of the postcaldera rocks sampled were andesite, with the exception of those from a small rhyodacite dome on the east flank of Wizard Island. The rhyodacite dome rises to approximately 100 feet of the lake surface and may have formed when the lake was close to its present level. The dome is the youngest volcanic feature known, with an age of approximately 5,000 years before present.

The dives were not without an element of mystery. I observed craters with a diameter of two to three inches in the deepest part of the lake. The origin of these craters is still unknown, though they may have formed from biological activity or from processes associated with gas and/or fluid release from the lake sediments. With so much to explore, it was hard to accept that the voltage remaining in the submarine's main batteries dictated the length of each dive. At the end of a typical six-hour dive, the temperature of the submarine was a comfortable 68 °F. Tired but still operating on adrenalin, I stretched the length of the dives out as long as possible. When the dive was over, air was added to the submarine's ballast tank allowing *Deep Rover* to slowly leave the lake floor. This was the first opportunity to relax during a dive. The ascent into natural light was peaceful. As *Deep Rover* rose and the water pressure decreased, air in the ballast tank would expand and spill out the base of the submarine rising around the sphere in a silvery blue veil of bubbles. Once on the surface, a crew of scientists and technicians quickly descended upon the submersible to secure and preserve the invaluable samples.

Deep Rover opened a brief and rare window of opportunity to view and explore secrets hidden at the depths of Crater Lake, yet less than two percent of the lake floor was explored. Discoveries from the submersible program not

only provided valuable information on lake ecology and evolution important to understanding and protecting the lake. The program also documented previously unrecorded lush fields of moss, animals living at the bottom of the lake, and hydrothermal streams and vivid blue pools that supported exotic gardens of yellow-gold bacteria. The unusual scenes on the lake floor are consistent with the aerial view that visitors experience today; a sight only slightly altered from that which inspired people a century ago to dedicate themselves toward the establishment of Crater Lake National Park. 

The author would like to thank cooperative biological investigators Gary L. Larson, C.D. McIntire, and Harry K. Phinney, principal geological investigator Charles R. Bacon, and principal hydrothermal investigators Robert Collier and Jack Dymond. This program would not have been successful without the tireless work of submersible and scientific technical teams, and the staff of Crater Lake National Park.



References

- C.R. Bacon and M.A. Lamphere, "The geologic setting of Crater Lake, Oregon," pp. 19-27 in E.T. Drake, et al. (eds.), *Crater Lake: An Ecosystem Study*. San Francisco: Pacific Division, American Association for the Advancement of Science, 1990.
- R.W. Collier, et al. *Studies of Hydrothermal Processes in Crater Lake, Oregon*. College of Oceanography Report #90-7. Corvallis, OR: Oregon State University, 1991.
- J. Dymond, et al. "Bacteria mats from Crater Lake, Oregon and their relationship to possible deep-lake hydrothermal venting," *Nature* 342(1989), pp. 673-675.
- C.D. McIntire, et al. "Survey of deep-water benthic communities," pp. 661-679 in G.L. Larson, et al. (eds.), pp. 661-679 in G.L. Larson, et al. (eds.), *Crater Lake Limnological Studies Final Report*. Technical Report NPS/PNROSU/NRTR-93/03. Seattle: USDI, NPS, Pacific Northwest Region, 1993.
- C.H. Nelson, et al., "The volcanic, sedimentologic, and paleolimnologic history of the Crater Lake caldera floor, Oregon: Evidence for small caldera evolution," *Geological Society of America Bulletin* 106(May 1994), pp. 684-704.

Diving in Crater Lake

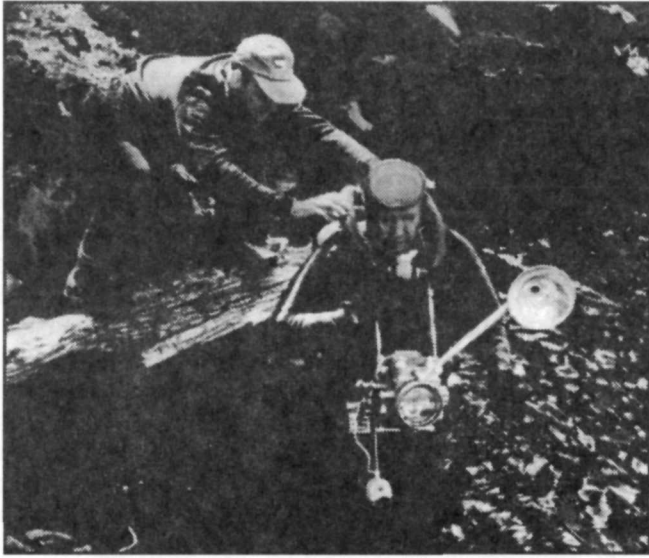
By John Broward

Despite what some people might like to think, bubbles coming from the surface do not usually signify arrival of the Crater Lake Monster. What you are probably seeing is a group of SCUBA divers. In choosing from among all the other recreational activities available in the park, they prefer to dive in the crystal clear (but cold!) water. Crater Lake has attracted people from all over the world for almost a century, including divers from as far away as Florida. If you are considering diving below the deep blue surface of this famous lake, there are a few things you need to know.

It is important that you understand the lake surface is just over 6,100 feet above sea level. Since Rim Drive (from where Crater Lake is reached) climbs to an altitude of 8,000 feet, you need to use high elevation dive tables. At these heights an average 60 foot dive has an equivalent adjusted depth of 81 feet, a distance considered risky when the nearest full service decompression chamber is over 400 miles away! The water can be very cold with below surface temperatures hovering around 37 degrees fahrenheit. This is why National Park Service staff recommend a full wet suit, (or even better, a leak proof dry suit) be used.

The trip to the lake surface can be quite an adventure for a diver with full equipment. You must descend 700 feet on a trail and return without mechanized or wheeled assistance. Once at the lakeshore, you may want to explore Cleetwood Cove since it is the closest area for diving and has several enjoyable features. One is a relatively shallow place just east of the boat dock, where depths are around 10 to 20 feet, before dropping beyond the range of sport divers. In this long but narrow area, one can find large boulders that provide habitat for two types of fish in Crater Lake—rainbow trout and kokanee salmon. Another interesting feature is the steep wall that suddenly drops away from the narrow shoreline. With the sharp angle of this precipice and crystal clear visibility, one may feel a sensation of floating across a distant cosmic landscape.

Wizard Island is the other main area for diving, though access to it is only by concession tour boat. Be sure to call ahead for current prices and boat schedules. The waters surrounding the island offer similar precipices to Cleetwood Cove, but a wide and somewhat shallow area called Skell Channel is also close at hand. Shallow water makes diving safer and the area around Wizard Island has more than a few interesting features. One is the sharp volcanic rock that dots subsurface terrain and is close enough to the surface to be examined without air tanks. Fumarole Bay is also accessible from the island and provides a view of the submerged geological features for which it received its name. The fumaroles were once vents for gases released while



Allen Cherry and unidentified ranger, first recorded dive in Crater Lake, August 1956. Photo by Life photographer A.Y. Owen

Crater Lake formed and many of them can be seen at a depth of 50 to 60 feet.

It is hard to describe the feeling of swimming along a great precipice which drops to great depths, while suddenly encountering a curious trout who approaches from a deep blue background and then quickly darts beyond your reach. Please remember, however, that collecting indigenous rocks and native biota in Crater Lake is not permitted. These items should be left in place so that they may be enjoyed by this and future generations. Also note that spear fishing is prohibited in the lake, but fishing with rod and reel is allowed (since rainbow and kokanee were introduced) and a good way to pass the time between dives.

Prospective divers need to arrange for a special use permit before coming to the park. These can be obtain by writing to the Chief Ranger and should be done several weeks in advance so that park staff have a chance to inform you of restrictions and regulations which may be in effect at the time of your dive. These rules are intended to protect the diver, other park visitors, and the lake's ecosystem. The required permit is \$50.00, which is used to cover administrative costs associated with the dive. All permits must be obtained in person, a stipulation that allows park staff to notify the diver of any changes in restrictions affecting the dive, while also providing a chance to verify diving certification and review safety procedures. All members of the dive group need to attend this briefing. As you prepare, remember one of the first rules of diving: plan your dive and dive your plan. If you do, and are prepared for a variety of challenging circumstances, then a fascinating adventure in diving may await you. 🏠

The Old Man of the Lake

By John Salinas

On the calmest of days and with a bit of luck, one might be able to see a boat on Crater Lake or even a floating weather station from the rim. The sharpest eyes may catch a glimpse of something very peculiar on the lake surface, what appears as a very small and whitish dot. Like other objects seen from a distance, however, its size from the rim belies how large it actually is. This untethered voyager has been observed even before the lake became part of a national park and seems to be as unchanging as Wizard Island or Phantom Ship. For just as long this denizen of the deep blue has been called the Old Man of the Lake.

Many, if not all, lakes contain floating and sunken woody material. Few lakes, though, have a large conifer floating in a vertical position which appears to be rooted to the bottom of the lake wherever it is seen. The Old Man is about 30 feet long and has a diameter of roughly two feet at waterline. Its top stands approximately four feet out of water and is bleached white. The exposed end is splintered but buoyant and wide enough to support a person's weight.

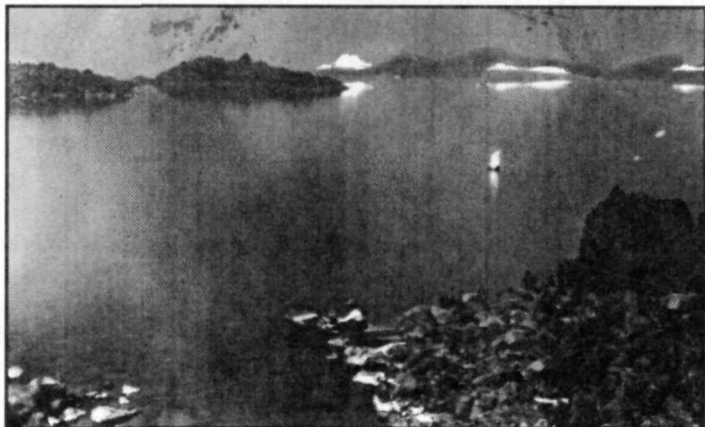
The Old Man poses a few questions which have been asked continually by park employees and visitors alike. One concerns his age. Joseph S. Diller published the first geology of Crater Lake in 1902, the same year that this area became a national park. In his work, a short paragraph describes a great stump he found six years earlier to be rooted below the lake's surface on the west shore of Wizard Island. Diller wrote that if a tree once grew in this location, the lake must have been much lower in recent times. He did not, however, hypothesize about the tree in question being the Old Man. Instead, Diller stated that trees commonly slide into Crater Lake, roots first. This was attributed to the caldera's steep slopes, but how is it that only one log floats vertically in Crater Lake? There may be a specific set of circumstances which give rise to this phenomena. The Old Man presently meets all of the criteria. Perhaps this is similar to the occurrence of life in this universe—it just happens to fit the criteria!

In 1896, the Old Man floated just as it does at present. This, of course, prompts the question of how a log can float in such a position. Some have suggested that when the Old Man slipped into the lake, he had rocks bound within his roots. This might naturally make him float vertically, though no rocks appear to still be there. At any rate, the submerged end could become heavier over time through being waterlogged. Acting like the wick on a candle, the shorter upper portion of the Old Man remains dry and light. This apparent equilibrium allows the log to be very stable in the water.

Diller established that the Old Man could travel by tying bailing wire around the log and pulling it a short distance in 1896. Five years later Diller observed the Old Man to be a quarter mile from where he previously noted its

location. This should not imply, however, that the log is slow-moving and confined to one part of the lake. An article which appeared in the 1938 volume of *Nature Notes from Crater Lake* documented that the Old Man rides the winds and currents to travel the lake's entire surface area and can cover almost four miles in a single day.

Just as the verdure of the trees surrounding Crater Lake provide a sharp contrast to the deep blue water, green moss on the Old Man produces the same effect below the waterline for those fortunate enough to see this log at close range. In addition to the luxuriant growth of moss below the surface, there are



Old Man near Wizard Island. Photo by J.S. Diller, 1901.

spiders and ants above the water. Although limited in its diversity, this thriving community of life is just one of the ways that the Old Man commands attention.

Since he can be seen virtually anywhere on Crater Lake, boat pilots commonly communicate his position to each other as a matter of safety. At two feet across and four feet high, the Old Man would not be someone to meet when traveling by boat across the lake. During the submarine explorations in 1988, scientists agreed to the idea of tying up the Old Man off the eastern side of Wizard Island. They reasoned that this navigational hazard had to be neutralized until the day and night shifts of research work had ended. Strangely enough, the weather went from clear to stormy and even scientists get nervous when this occurs on the lake. It seemed as if the weather was poor so long as the Old Man remained bound. Once the log was freed, however, the weather settled.

In more than one article about the Old Man, writers have expressed doubt as to whether he will persist through the stormy blasts of winter weather on Crater Lake. It now appears that mortals should worry about something else, because the Old Man has shown he knows this lake and can take care of himself. A better question might be will you be back to see the Old Man? 🏠

Llao Speaks

By Tom McDonough

The story of Crater Lake centers on the destruction of a large volcano, Mount Mazama, and the subsequent accumulation of a deep blue body of water in its place. The events preceding and immediately following a final eruption of this volcano occurred at a time when Native Americans had already established themselves in the region. Whether the tales about the origin of Crater Lake told to the pioneers a century ago by the Indians actually date from prehistoric times may never be known. The stories describe a powerful spirit living beneath the mountain which the Klamath people called *Llao*. When angry, *Llao* would journey toward the surface and sit atop the mountain to speak with a voice like thunder. It is difficult to trace the relationship between these people and the spirit since this began so long ago. The occurrence of thunder is another matter.

Thunderstorms are more a phenomena of summer than winter in the region around Crater Lake. Winter thunderstorms are not unknown, but snowstorms are much more common. That is not to say that thunderstorms are common in the park during summer. If anything, these weather events are more of an exception. Summer weather is usually mild during July and August. Daytime highs are mostly in the mid to upper 70s and night time lows are in the 40s. A high pressure system aloft, the Pacific High, dominates our summer climate. The resulting warm and dry surface conditions at the higher elevations are ideal for camping and sightseeing from July to September.

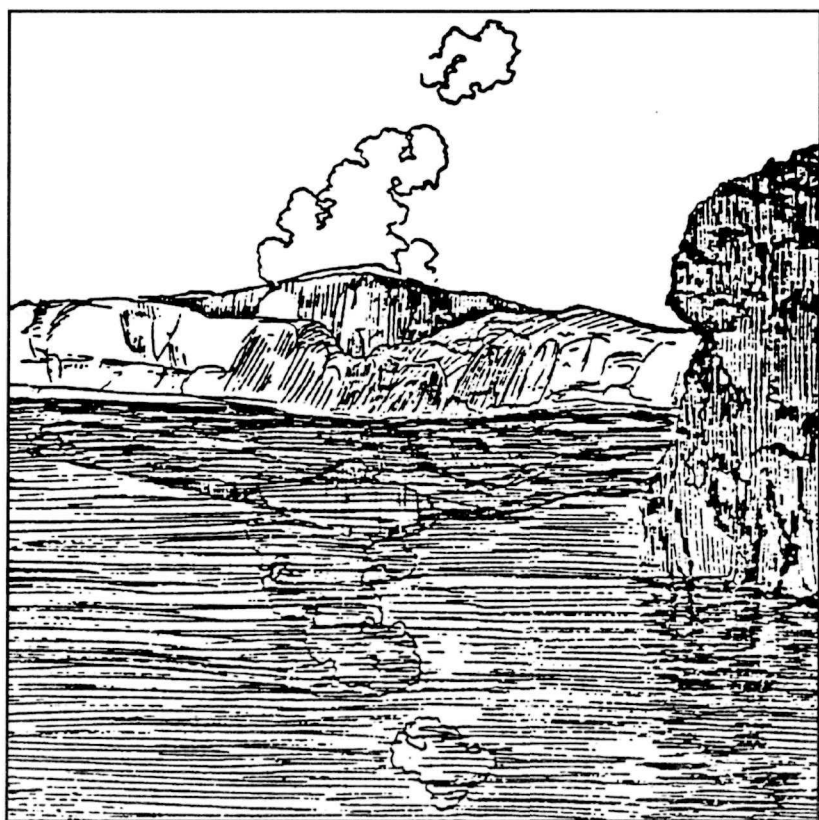
Summer thunderstorms arise when moisture is lifted to form the tall cloud type called *cumulonimbus*. This happens when an upper level low pressure system located offshore of northern California directs moisture inland and across the Cascade Range. Thunderstorms can also occur in the area when moisture is drawn in a northerly direction along the western edge of high pressure centered over Nevada or Utah.

What happens inside the growing cloud to separate static charges, with a thunderstorm being the eventual result, is thus far imperfectly known. What we do know is that charges separate with the cloud's base becoming negatively charged and the ground or water body below being positively charged. Since the air acts to insulate the charged cloud droplets, a potential of 3,000 volts per meter can develop prior to a lightning strike. The lightning bolt is electrical current connecting the ground or lake surface with the cloud base in order to neutralize the charge separation (lightning can also connect clouds to one another and isolated cells within a cloud). The flash of lightning, which lasts for less than a second, heats the nearby air to over 10,000 degrees Fahrenheit. The rapidly expanding air travels at supersonic speeds and produces a shock wave we hear as thunder. This sound is louder the closer an observer is to the discharge. Thunder is rarely heard if the observer is more than 12 miles away, even when the lightning is clearly visible. To estimate distance from a dis-

charge, some people count between seeing a flash and hearing thunder. If five seconds elapsed between the lightning and subsequent thunder, then the discharge occurred about one mile away from the observer.

Lightning is attracted to high spots around the rim of Crater Lake since the distance between cloud base and surface is less. Since many park trails ascend points such as Garfield Peak, Mount Scott, and the Watchman, hikers should keep a watchful eye to the sky on days when cumulus clouds fill the air. As a safety measure, weather forecasts are posted at the two visitor centers each morning. In addition to trees and rock outcrops around the rim that attract lightning, Crater Lake can be struck by discharges from the clouds. Water conducts electrical charges easily, and with a surface area of roughly 25 square miles, the lake presents quite a target.

Lightning strikes over the park can be an awesome display of nature's power. The associated thunder can fill the old glacial valleys of Mount Mazama and put fear into animals as well as humans. During a brief episode of thunder and lightning, as the wind bends the trees and marble-size hail pounds the ground, the ancient story of *Llao* comes to mind, reminding some of us that great power is nearby and can shake the earth. 



Wandering Through Wildflowers

By Peter Zika

The hiking trails at Crater Lake National Park will take you to elegant floral displays as the snows recede and spring seeps up the caldera walls. Botanists have found roughly 700 species of flowers, ferns, and conifers in the park. You can sample a rich diversity of plants by simply stretching your legs and setting out from the macadam.



While snow drifts still surround Park Headquarters, western flowering dogwood, *Cornus nuttallii*, Shelton's violet, *Viola sheltonii*, and pink fairy slippers, *Calypso bulbosa*, are luring bees in the warmer depths of Red Blanket Canyon, on the lower trail to Stuart Falls. Legions of lupines, *Lupinus latifolius*, and scarlet paintbrushes, *Castilleja miniata*, greet you when summer's heat has opened the footpaths along Annie Creek and into the Castle Crest Wildflower Garden.

You might be pleased by a walk on the south-facing Garfield Peak Trail, located east of Crater Lake Lodge. Melting snowfields water a delightful mix of plants through the summer. As you pause for yet another splendid view of the lake, you can admire the blue blossoms of squaw carpet, *Ceanothus prostratus*, or later in the season see shocking purple and pink beardtongues, *Penstemon davidsonii* and *P. rupicola*.



Midsummer brings monkeyflowers into bloom on wet ledges and streamsides. Pink and yellow monkeyflowers, *Mimulus lewisii* and *M. guttatus*, form festive natural bouquets on the shores of Crater Lake and even in roadside ditches. The relentless sunshine sears the well-drained treeless expanses at high elevations. Graded paths up Mount Scott and Crater Peak take you to pumice fields tinted red with the fading and drying leaves of fleecflower, *Polygonum newberryi*. When fleecflower is conspicuous on the caldera and in Pumice Desert, brilliant yellow-flowering shrubs beckon butterflies along the eastern side of Rim Drive. This is rabbitbrush, *Chrysothamnus nauseosus*, a cousin to the locally rare sagebrush, *Artemisia tridentata*. Rabbitbrush draws on reserves in its deep root system to flower so late in the year. In doing so, it seems to defy drought conditions common to the upper slopes of Mount Mazama during summer and early autumn.



Frost and early snow withers vegetation on the rim in September, but pearly everlasting, *Anaphalis margaritacea*, holds persistent white flowers at lower elevations until later in the year. Cold nights finally leach the pink from loose mist-like masses of ticklegrass, *Agrostis hyemalis*, at Spruce Lake which is located due west of Llao Rock near the park boundary. By November, new snow drifts end another season of wandering through the wildflowers. 🏠

A Pause in the Panhandle

By Steve Mark and Ron Mastrogiuseppe

When Congress established Crater Lake National Park in 1902, the enabling legislation called for the reservation to take a rectangular form which encompassed much, but not all, of the mountain that holds the nation's deepest and clearest body of water. Congress excluded most of the



Highway 62 through Panhandle.

lower elevation forests of Mount Mazama which has trees of comparatively greater size than what thrives in the higher elevations. Rising visitation fueled appropriations for improving park's roads throughout the 1920s, and this led the National Park Service to begin negotiating for a small, but impressive, forest corridor along Annie Creek. This addition to the park eventually took the form of a Congressionally-approved land transfer from the U.S. Forest Service in 1932. It effectively extended the park's south entrance and consisted of 973 acres. Due to its tongue-like configuration, this area quickly became known as the "panhandle."

Most visitors who journey between Crater Lake and the Klamath Basin never leave their cars when traveling along the two and a half miles of road that runs through the panhandle. If they did, many of them would have a chance to distinguish among three great coniferous tree species native to several western states: ponderosa pine (*Pinus ponderosa*), sugar pine (*P. lambertiana*), and Douglas-fir (*Pseudotsuga menziesii*). The more adventurous might enjoy a walk along Annie Creek, where the riparian area harbors many of the plant species found in the panhandle. The panhandle area, in fact, has the greatest botanical diversity of anywhere in the park. With more than 230 species known in this locality, it is relatively rich when compared to the total park count of only 700. This is impressive when one considers the panhandle's size is barely more than half of one percent of Crater Lake National Park's 183,000 acres.

For those interested in stretching their legs and seeing the panhandle

on foot, there is a highly recommended place along Highway 62 for motorists to pause and perhaps saunter into the forest. This is a picnic area located near the south entrance, where the prospective hiker can find all of those conifer species previously mentioned in close proximity to the pavement, but even more sylvan variety if they descend to the stream. Down logs provide an opportunity to cross Annie Creek and explore the pine-dominated woodland on the



other side, or perhaps discover the work of beavers (*Castor canadensis*) on deciduous trees such as aspen (*Populus tremuloides*) and alder (*Alnus incana ssp. tenuifolia*) within the drainage.

The only other place to stop is a small paved pull out located about two miles further north. It served as the park's south entrance prior to 1932 and still has a boundary marker from early this century. After a peek into Annie Creek Canyon, carefully cross the highway and go south a few yards to the small wetland formerly called Wildcat Camp. This area has standing water in spring through early summer and contains black cottonwood (*Populus balsamifera ssp. trichocarpa*) whose broad leaves contrast markedly with the surrounding coniferous forest. From here it is only one tenth of a mile before the intrepid cross-country walker reaches the park boundary by going due west. It is, of course, clearly signed and also very evident due to extensive clearcutting on adjacent land.

Human-induced change in the forest profile is, however, not confined to places outside the park. An astute visitor can see stumps resulting from attempts to control insects ponderosa pine, as well as numerous fire scars that bear witness to prescribed burning within the panhandle. From the 1930s to the 1960s, insect control work in this locality focused on the western pine beetle (*Dendroctonus brevicornis*) which preyed on older or drought-weakened ponderosa pine. The fear that this insect could spread into apparently healthy stands led to periodic cutting or removal of trees throughout the forest corridor. Prescribed burning is a more recent management program in the panhandle, having begun in 1976. It centered on evidence that regeneration of ponderosa pine was being stymied in areas where fire had been suppressed historically. Management-ignited burning in the panhandle consequently aimed at promoting the pine at the expense of its associate, white fir (*Abies concolor*), which tends to shade out the sun-loving ponderosa.



*National Park Service employees fall a Ponderosa Pine
as part of beetle control. Photo by Vicki Boucher.*

With an elevation range of 4300 to 4800 feet above sea level, this area is easily accessible from May to November. There are no formal trails in this part of the park, but remnants of the old Crater Lake Highway and an earlier wagon road make fine footpaths for visitors who want to identify plants or have a relaxing jaunt among the trees. A number of shrubs can be seen in open and dry areas, with snowbrush (*Ceanothus velutinus*) and greenleaf manzanita (*Arctostaphylos patula*) being very common. More shaded places often feature sticky currant (*Ribes viscosissimum*) and two types of huckleberry (*Vaccinium membranaceum* and *V. scoparium*). Wildflowers generally bloom in June and July, but a bigger splash of color comes in October when the leaves of deciduous trees turn yellow and orange. There are few places in the park that rival the panhandle, especially that portion of Annie Creek which runs through it, for walking on clear and crisp autumn days. At such a time, only an occasional sound associated with vehicle traffic on the highway could disturb the sense of solitude that a visitor gains by pausing to explore this magnificent portal to the park. 🏠

Fossil Finds and the Age of Oregon Caves

By John Roth

How old is a hole in the ground? How do you pin a date on what has dissolved away? Geologists have a hard time figuring out when Oregon Caves formed. To dissolve marble made of calcite, all you need is a weak acid, such as carbon dioxide dissolved in water which is the fizz in soft drinks. Yet understanding how something works does not always help in knowing how fast it works.

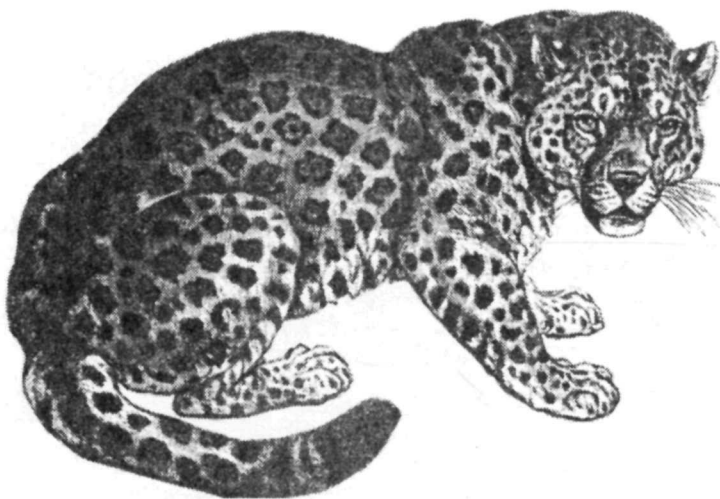
For example, the yearly amount of dissolved calcite exiting by way of Cave Creek is known. The entire cave could have been dissolved out in ten thousand years *if* the same concentration of dissolved calcite left the cavern every year. That is a very big *if*! Water exiting the cave during its birth probably had less calcium in it. The size of stream gravels and horizontal notches dissolved on cave walls indicate massive flooding at one time and thus resulted in a much faster enlargement of Oregon Caves.

Another way to estimate the age of Oregon Caves is to compare it with similar mountain caves which have been better dated. Most caves on steep slopes form close to the earth's surface. Since mountains erode relatively fast, geologically speaking, most such caves do not survive long before they are breached by erosion and destroyed. These caves usually are older than ten thousand years but rarely last more than a hundred thousand. Such comparisons, however, are dangerous. There may have been geological or hydrological factors affecting Oregon Caves that differed substantially from those in superficially similar topography which sped up or slowed down cave formation.

Geologists can fix the minimum age of Oregon Caves because of what it has preserved. While most surface features are eroding or decomposing on the surface, things can be deposited in caves. An example is the jaguar, *Panthera onca*, found in Oregon Caves during August of 1995. The size of its bones compares with jaguars living in North America between 15,000 to 40,000 years ago. As the last Ice Age ended roughly 10,000 years ago, the size of jaguars decreased. This seems to have happened because being smaller and thinner helped jaguars survive in an increasingly warmer climate.

The jaguar's bones could have been buried and then later washed into a much younger Oregon Caves. The fact that this may be the most complete jaguar fossil ever found, however, is strong evidence against this possibility. It would thus seem reasonable to assert that the cave must be at least as old as the jaguar.

Comparing evidence of past life (fossils) and erosion rates with similar examples usually give scientists only approximate dates. To be



Sketch of modern jaguar. The Pleistocene relative was substantially larger.

more precise, methods which hinge on changes occurring at a uniform rate are needed. Uranium atoms are consistently unstable and "overweight," but release particles at constant rates. This changes the uranium into another element called thorium. One of the best materials to use for this dating method is calcite, such as the crystal layer left by water on the jaguar skull in Oregon Caves.

Since uranium is soluble in water, whereas thorium is not, the layer of calcite that formed on the jaguar skull at first contained uranium but no thorium. As time passed, uranium decayed to thorium. The thorium to uranium ratio thus increases over time at a constant rate and can be dated. Unlike most calcite formed on the earth's surface, calcite in caves tends to be very dense and waterproof. Therefore, compared to surface calcite, cave calcite is much less likely to have uranium leach out and thus give a wrong calculation for age of the calcite.

Other ways exist that can independently confirm the accuracy of dates determined by uranium/thorium ratios. Natural radiation traps free electrons in defects in calcite crystals. The rate of trapping is determined by background radiation. The energy of the trapped electrons can be measured and a date derived from the ratio between this figure and the trapping rate.

There is yet another way to get a more precise age for the jaguar. Carbon 14, like uranium, is also composed of "fat" atoms that release particles at constant rates. Since carbon 14 only forms in the earth's atmosphere and becomes part of the protein of live animals, the ratio of it and more stable carbon starts to change when the animal dies. If the age of the skull is 45,000 years old or younger, there is likely to be enough carbon 14 remaining in the skull for a fairly precise age to be calculated. The

uranium-thorium date of the calcite will help determine whether it is worthwhile to obtain a carbon 14 date on the skull.

Other fossil bones, most likely from a single grizzly bear, *Ursus horribilis*, have also been found in Oregon Caves. With only about one percent of the original protein remaining in the bones, investigators could determine that no carbon 14 was left. The age of the bones and the cave, therefore, must be at least 46,400 years old.

Why should we be concerned with how old things are? An important part of the answer has to do with park managers being able to better protect, preserve, and restore ecological processes if they know how fast and how often events occur. We may also find that our understanding of time is highly relative. A person's emphasis on man-made things might change when they can perceive time as going beyond human experience and forming part of a broader history. Since we have been around for a very short period, relatively speaking, it may be difficult sometimes to accept that there is far more to the past than one life form's view of itself as the goal of time. All species are kin if you go back far enough in time; all rocks come from the same source. 



Oregon Caves has been explored for more than a century. Not until 1995 did cavers uncover fossils in its passages. U.S. Forest Service photo, 1927.

About the Authors

John Broward is a backcountry ranger stationed at Crater Lake National Park.

Mark Buktenica has worked at Crater Lake since 1985 and is currently the park's aquatic ecologist.

W. Drew Chick retired after a career with the National Park Service and now resides in Lakewood, Colorado.

Tom McDonough teaches science at Chemeketa Community College in Salem, Oregon, and has been a seasonal naturalist at Crater Lake since 1969.

Steve Mark is the park historian at Crater Lake. He has been the editor of *Nature Notes* since its revival in 1992

Ron Mastrogiuseppe is a forest ecologist who has worked as a seasonal naturalist at Crater Lake.

John Roth is the natural resources management specialist at Oregon Caves National Monument and a geologist by training.

John Salinas teaches science at Rogue Community College in Grants Pass, Oregon, and has worked as a limnologist and seasonal naturalist at Crater Lake.

Peter Zika recently updated checklists of plants at Crater Lake and Oregon Caves. He is a professor of botany at Oregon State University in Corvallis, Oregon.



Even the seemingly barren Pumice Desert has wildflowers in June and July.

Photo by Glen Kaye

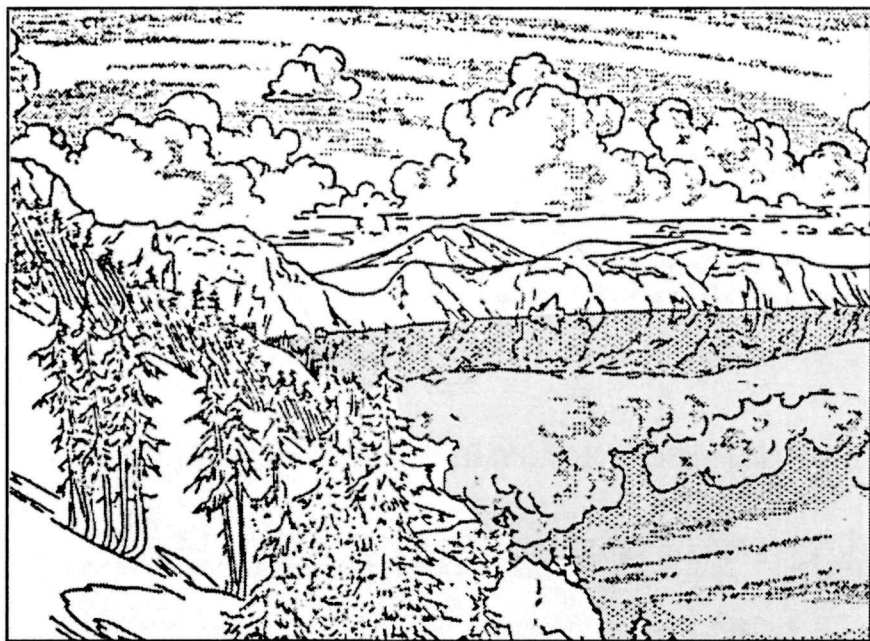
Illustrations



- p. 4 Phantom Ship from Kerr Notch in 1936. Homer Marion photo, NPS files.
- p. 15 Drawing by Kathryn Brooksforce.
- p. 24 Karl J. Belser in Ernest G. Moll, *Blue Interval*, Portland: Metropolitan Press, 1935, p. 26.
- p. 25 Drawing by Amelia Bruno.
- p. 27 Clear evidence of beavers gnawing a cottonwood along lower Annie Creek, photo by O.L. Wallis, 1947.
- p. 30 Drawing #89 from Jim Harter (comp.) *1419 Copyright Free Illustrations*, New York, Dover Publications, 1979.
- p. 34 Drawing by L. Howard Crawford, 1936.

Above: from *Protection for the Coyotes* by Frank Solinsky, 1931 Nature Notes.

Back Cover: Allen Cherry and Phil Bayouth with unidentified child, first recorded dive in Crater Lake, August 1956. Photo by *Life* photographer A.Y. Owen.



Nature Notes from Crater Lake, 1996

National Park Service
Crater Lake National Park

Crater Lake Natural
History Association

Design by: Savage Photo*Graphics (541) 482-0411

