

A

Johnson

THE 1871 SURVEY OF YELLOWSTONE NATIONAL PARK

GEOLOGY 109

INTRODUCTION

Yellowstone was made our first National Park on March 1, 1872. It has dazzled tourists and scientists alike for over 100 years with its unique geologic processes, that can be witnessed first hand. The push to make Yellowstone a National Park and preserve its beauty for generations to come was largely thanks to the U.S. Geological Survey of the Yellowstone area in 1871. This paper will consider why the park was surveyed, who were the major characters involved in its survey and subsequent status as a National Park, the accuracy and hidden complexities of the survey itself, and what exactly it is about Yellowstone that makes it such a marvel.

YELLOWSTONE NATIONAL PARK TODAY

Yellowstone National Park lies in the corner of Wyoming where the borders of Wyoming, Idaho, and Montana come together. While the park is situated on the Wyoming - Archean Terrain, metamorphic rock 2.7 billion years old, its geology is much different than that of the rest of the Rocky Mountain Range. While outside of Yellowstone the Rockies are basically 1.7 billion year old metamorphic rock uplifted during the last 30 - 15 million years by isostatic uplift, Yellowstone is the current site of a continental hot spot. A hot spot is an area where magma has "risen" up from the mantle and persisted at a certain location for millions of years. This magma chamber has occasionally erupted in Yellowstone, producing violent, pyroclastic eruptions and leaving huge calderas. The major eruptions have been 1.8, 1.2, and 0.6 million years ago. Unlike the Hawaiian Island hot spots, the lava erupted is mainly rhyolitic in nature, not basaltic. This difference in rock composition is due to the distance the magma under Yellowstone has to travel (through the relatively thick continental crust), and the distance the magma under Hawaii has to travel (through the "thinner" oceanic crust). While the hot spot under

REFS

Yellowstone can explain its volcanic past, it is a part of the park's present and future also. When 2nd Lieutenant Gustavus C. Doane, a member of an expedition into Yellowstone in 1870, saw the varied geologic structures the park had to offer, he wrote "Yellowstone is probably the greatest laboratory that nature furnishes on the surface of the globe" (Hartzog 1972). The most famous of Yellowstone's features are of course the geysers. Formed by the interaction of meteoric water and heat from the underlying magma chamber, geysers like Old Faithful have been a source of amazement for tourists around the world. A feature that is closely linked to the geysers, are the mudspots. These mudspots are basically "boiling" cauldrons of mud, also heated by the underlying magma. A resurgent dome, or refilling of the once emptied magma chamber, has produced an area of uplift (a dome) in the park, another sign of active volcanism. Since the volcanic plateau of Yellowstone lies 7500-8000 feet above sea level, Yellowstone can also be used by geologists to look at weathering and the effects of downcutting streams. Yellowstone has its own version of the "Grand Canyon", formed the same way as its more famous counterpart - by the downcutting actions of streams above sea level. Lastly, of course, is the "yellow stone" itself. This discoloring of the metamorphic and lava flows in the park is the result of hydrothermal alteration - the effects of "hot water" in other words. This presence of relatively "foreign" geology to North America, is what makes Yellowstone so special and caused it to be made our first National Park in 1872.

STORIES OF A PLACE CALLED "YELLOWSTONE"

The first news that got back to the east coast about Yellowstone came mainly from fur-trappers and mountain men. In 1807, a guide with the Lewis and Clark Expedition, named John Colter, stumbled upon the Yellowstone area and brought back stories of mysterious geysers and

bubbling mudholes. It is no wonder Colter spoke so openly about the geysers and mudholes, that were until then only known of by the Native Americans in the area. Colter was branded a liar by geologists and publishers in the east - after all, the Rockies weren't an actively, volcanic range? The cynicism that Colter encountered was the same fate that befell fur-trappers and guides in both the 1830s and 1840s. It wasn't until the late 1850s and on that geologists decided to go out to Wyoming and see for themselves this place where "hell spouted up" (U.S. Dept. of the Interior 1973). The problem for these geologists was the fact the Yellowstone area was largely inaccessible most of the year because of the surrounding mountainous terrain and climate. Indeed, the passes that did provide access to the park area were filled with snow most of the year. These snow-filled passes are what kept Ferdinand Vandiveer Hayden, then just a member of the Raynold's expedition, from exploring the area in the early 1860s. Hayden would be heard from again however. Expeditions like the Folsom-Cook Expedition of 1869 were attempts, but were private parties that lacked the legitimacy to spark interest in the area. Legitimacy would come with the Langford-Doane Expedition of 1870. They were a military-sponsored expedition and now there was no doubt as to the mysteries Yellowstone held. When Hayden led his geological survey to the Yellowstone area in June 1871, it was the last unexplored area in the lower 48 states. Hayden would change that fact.

WHY DID YELLOWSTONE GET EXPLORED?

While one might think the strive to explore Yellowstone would be based on the reported geologic wonders it contained, it was largely used as a centerpiece for bragging rights among the four competing surveys of the time (Pike 1972). The four great surveys of the Rocky Mountains were conducted by Clarence King, Lieutenant George M. Wheeler, John Wesley

Powell, and Ferdinand Vandiveer Hayden. These four men conducted their own, separate surveys. These surveys required the limited funding of a government, in the hands of Congressmen, who could have cared less about projects that didn't have any bearing on their chances of getting reelected. Every year these survey leaders would have to go before Congress, give their survey results, and try to convince Congressmen that there were practical applications to their results. This competition for funding often caused the survey directors to exaggerate sound, scientific reports to present an impressive report to Congress. The survey directors were always suspicious of each other, that one of them might be unreasonably "glowing" in their reports on an area to gain the favor of an important Congressman. In other words, geologic surveying was like everything else in this world, political. It was believed by Congressmen that good news on their districts could be used as ammunition back home in their reelection campaigns. The following is one such example. An agronomist with Hayden's survey named Cyrus Thomas, noted in his 1869 survey that during the years 1862-1869, rainfall had increased along the semiarid Front Range of Colorado. Odd, but not necessarily an outrageous observation, except for the fact Thomas based the increased rainfall in direct proportion to population growth. Farmers along the range waited in vain, with ground ready for the rain to come. It obviously never did (Pike 1972). At the same time, geologists weren't able to say anything too terrible about a region in fear of upsetting Congressmen. This need of survey directors to compromise themselves and the integrity of their surveys to acquire funding, explains why Yellowstone was such an enticing prize. The wondrous geysers and mudspots weren't mythical and didn't need to be made up. They were just what the ambitious survey directors needed in their reports to impress Congressmen. The Yellowstone area's

Your paragraphs
need to be
broken
up

exploration by the militarily led Langford-Doane Expedition of 1870, raised awareness of the area and the race was on to see which director would survey the area first. Ferdinand Hayden, probably the most ambitious and egotistical of the survey directors, pushed hardest for his survey to be the first. Hayden was afraid someone was going to “beat him to the punch” and he had his eyes on Yellowstone ever since the failed expedition of 1860. Hayden coveted Yellowstone and knew he needed it to bring him and his survey the acclaim, and subsequent funding they so desperately needed. Indeed, during Hayden’s survey of Yellowstone he was always conscious of the need to stay in favor of Congress. The boat Hayden’s survey used to explore Yellowstone Lake was christened the Anna - the name of the daughter of a prominent Congressman who supported the expedition. This overriding need for fanaticism and acclaim to acquire funding should always be kept in mind when considering the Hayden Survey of Yellowstone in 1871.

THE 1871 SURVEY OF YELLOWSTONE

Ferdinand Vandiveer Hayden finally got the O.K. from Congress and its appropriations committee to take his geological survey to the Yellowstone area in June of 1871. Congress allotted Hayden \$40,000 to carry out what proved to be the most ambitious survey to date. The Hayden party congregated at Boetler’s Ranch in the Yellowstone Valley, some 140 miles north of Yellowstone (Fig. 1). Among his party were a geologist and Hayden’s executive officer, James Stevenson, mineralogists, topographers, artists, and photographer William H. Jackson. The artist Thomas Moran and Jackson would prove to be an invaluable innovation for the Yellowstone Survey and play a key role in the passage of the bill to make Yellowstone our first National Park. In all, Hayden’s team was composed of 34 men. They joined the Barlow-Heap military party, not

important as far as the survey is concerned, and headed out for Yellowstone on July 20, 1871. The party set out heading south down the Yellowstone River Valley. Hayden commented on the mission he was about to undertake. "The objects of the deepest interest in this region are the Falls and the Grand Canon (Yellowstone's Grand Canyon). I will attempt to convey some idea by a description, but it is only through the eye that the mind can gather anything like an adequate conception of them" (U.S. Dept. of the Interior 1973). While Hayden tried his best to describe the wonders of Yellowstone with what proved to be "imaginative" prose - the prose of an excited boy, his geologic assessment of the Yellowstone area was largely superficial. Hayden's style of writing in his reports was a sequential one. As Hayden walked down the Yellowstone River Valley toward the Yellowstone Basin, he just wrote what he saw as he was walking. "But no language can do justice to the wonderful grandeur and beauty of the canon below the Lower Falls; the very nearly vertical walls, slightly sloping down to the water's edge on either side, so that from the summit, the river appears like a thread of silver foaming over its rocky bottom; the variegated colors of the sides, yellow, red, brown, white, all intermixed and shading into each other; the Gothic columns of every form standing out from the sides of the walls with greater variety and more striking colors than ever adorned a work of human art" (Hayden 1871). What Hayden's prose is awkwardly saying here is something inherent in Yellowstone - volcanic activity and mountain making. The "yellow, red, brown, white" intermixed rocks were mixtures of the Archean 2.7 billion year old metamorphic rocks and basalt flows that occurred over the last 2 million years. These "variegated colors of the sides" were also tilted, suggesting evidence for Laramide activity. Also, Hayden noticed the "very nearly vertical walls," another sign of mountain building. The Yellowstone

River is downcutting so rapidly that it forms steep mountain walls. The steep walls cut by the Yellowstone River revealed entire ages to Hayden.

After passing Devil's Slide, Hot Springs, and 3rd Canon, Hayden and his party began the ascent of Mt. Washburne - named after the leader of the previous year's expedition. From Mt. Washburne's summit, Hayden got his first view of the Yellowstone Basin, and the focal point for the rest of the survey, Yellowstone Lake. Hayden noted, "We caught the first glimpse of the great basin of the Yellowstone, with the lake, which reminds one much, from its bays, indentations, and surrounding mountains, of Great Salt Lake. To the south are the Tetons, rising above all the rest, the monarchs of all they survey, with their summits covered with perpetual snow" (Hayden 1871). Hayden believed the Yellowstone Basin had been "one vast crater," a place where there had been, "as great volcanic activity as that of any portion of the globe" (Hayden 1871). Hayden was right. Besides its smaller eruptions, Yellowstone had erupted almost 4500 km³ of volcanic material since around the beginning of the Quarternary, 2 million years ago. A remarkable quantity considering that Mt. Saint Helens only erupted 1 km³ in 1980!

From Mt. Washburne, Hayden's expedition passed the "object of deepest interest," the Grand Canon of Yellowstone, but took time to admire the majestic Upper Falls and Lower Falls that separate the Yellowstone Basin and Lake from the Grand Canon. Again we get a look at Hayden's "sweeping" assessments of the area, not going into deep geologic analysis. "Standing near the margin of the Lower Falls, and looking down the Canon . . . with its sides 1200 to 1500 ft. high . . . from any point of view, the Upper Falls are most picturesque and striking. The entire volume of water seems to be, as it were, hurled off the precipice with the force which it has accumulated in the rapids above, so that the mass is detached into the

most beautiful snow-white, bead-like drops, and as it strikes the rocky basin below, it shoots through the water with a sort of ricochet for the distance of 200 ft” (Hayden 1871).

Finally on July 28th, the Hayden expedition reached Yellowstone Lake, the base for their expeditions. “We arrived at the Lake, and pitched our camp on the northeast shore . . . the lake lay before us, a vast sheet of quiet water, of a most delicate ultramarine hue, one of the most beautiful scenes I have ever beheld . . . such a vision is worth a lifetime, and only one of such marvelous beauty will ever greet the human eye” (Hayden 1871). Hayden also noted that the lake seemed to be “superheated”, obviously from the underlying magma chamber. While at Yellowstone Lake, Jackson and topographers took out the aforementioned Anna, and explored the lake. They took pictures and mapped its margins.

On July 31, Hayden and some members of his group headed out for the Firehole River - a place reportedly where geysers flourished, where “hell spouted up.” There Hayden and his men were to see geysers of every kind - mysterious holes in the earth that for whatever reason shot up water (Fig. 2,3). The company finally reached what’s called Upper and Lower Basin. He wrote, “A vast column of steam issues from a cavern in the side of the hill, with an opening about 5 feet in diameter. The roaring of the waters in the caverns, and the noise of the waters as they surge up to the mouth of the opening, are like that of the billows lashing the sea shore. The water is as clear as crystal, and the steam is so hot that is only when the breeze wafts it aside for a moment one can venture to take a look at the opening” (Hayden 1871). Hayden, having never seen a geyser first-hand before, referred to the opinions of scientists that examined geysers in Iceland, as to what caused these magnificent geysers. “Both kinds of springs owe their origin to the water permeating the surface and

sinking through fissures into the bowels of the Earth, where it gets heated by the still existing volcanic fires” (Hayden 1871). So far so good. Hayden and the other geologists he quoted were correct in assuming it was meteoric water being shot up and it was these “volcanic fires” that were heating it underneath the earth. However, they couldn’t as easily grasp the reason why this water was shot up hundreds of feet into the air. They assumed the process was essentially the same as a volcanic one, but instead of releasing magma, the geysers released water, and pretty much left it at that. Hayden and his crew also found many extinct geysers along the way, not knowing of hot spots yet, Hayden wrongly assumed the major volcanic force had exited the area and that the existing geysers were gradually declining. A major assumption for someone seeing the geysers for the first time. Maybe Hayden wanted to present a fascinating and safe picture when he reported back to Congress. Hayden and the others got an unsuspected treat in the form of mudspots at Firehole Basin. “Located higher up on the side of the hill, not far from the Grotto (a Hayden named geyser), is the most remarkable mud-spring we have ever seen. It may not improbably be called Giants Cauldron. It does not boil with an impulse like most of the mud-springs, but with a constant roar which shakes the ground for a considerable distance, and may be heard for half a mile” (Hayden 1871)(Fig. 4). Hayden would find out how dangerous these mudholes were, falling in one up to his knees.

I mentioned them briefly before, but while Hayden and the other geologist were off exploring the park, the photographer Jackson and painter Moran were busy constructing what would prove to be the most vital aspect of the Hayden Survey. Jackson’s photographs of places like Mount of the Holy Cross (Fig. 5), and the Upper and Lower Falls, combined with Moran’s paintings, were powerful testimonials to Yellowstone’s

majestic beauty. They could accomplish what no words could and stirred up public interest to establish the area as a national park.

The survey party returned to Boetler's Ranch and disbanded on October 1, 1871. In keeping with the attention to theatrics, Jackson declared the party had been out in the wilderness for 40 days and nights, even though it was closer to 37.

After the survey had disbanded, Hayden focused his attention on pushing Congress to declare Yellowstone our first national park. Hayden submitted a 500 page report, Jackson's photos, and Moran's sketches to Congress and influential businessmen who could help get the bill passed. The following are Hayden's thoughts on the bill: "(The bill) will mark an era in the popular advancement of scientific thought, not only in this country, but throughout the civilized world . . . this noble deed may be regarded as a tribute from our legislators to science, and the gratitude of the nation and of men of science in all parts of the world is due them for this munificent donation" (U.S. Dept. of Interior 1976). The biggest concern for legislator's was whether the area had any possible agricultural worth. Hayden reassured them. "The entire area . . . is not susceptible of cultivation with any degree of certainty and the winters would be too severe for stock raising" (U.S. Dept. of Interior 1976). Another concern Hayden had was that if left unprotected, foresters and industrialists would move in and ravage Yellowstone. The following is Congress' views on the bill: "In a few years this region will be a place of resort for all classes of people from all portions of the world. The geysers of Iceland, which have been objects of interest for the scientific men and travelers of the entire world, sink into insignificance in comparison with the Hot Springs of the Yellowstone and Firehole Basins" (U.S. Dept. of Interior 1976). It is obvious to see Hayden's influence and why he is credited with the passage of the

bill to make Yellowstone a National Park. Congress was relying totally on Hayden's descriptions and the artists photos and paintings when considering Yellowstone. None of them had ever seen it. Maybe now we can see Hayden wrote with the style of an "awestruck youth", rather than in scientific, technical language. Hayden knew who his audience was going to be and realized high sounding words and technical jargon would not help to increase interest in the area and a bill in the future. On March 1, 1872, President Grant signed the bill into law making Yellowstone our first National Park and set a precedent for the preservation of other such areas within the United States.

HAYDEN

Ferdinand Vandiveer Hayden (Fig. 6), was the single biggest reason Yellowstone is a national park today. Although Jackson's photographs and Moran's paintings may have been what captured the public and Congress' attention, it is Hayden who made it possible through unyielding ambition and ego.

Hayden was born September 7, 1828, in Westfield, Massachusetts. He would go to Oberlin College in Ohio and receive a medical degree. However, it was during his college years that Hayden's love for nature and geology took root. In 1853, Hayden would go on his first expedition up the Missouri River and into the Dakotas. It was this mission, along with subsequent trips into the Rockies, including his failed attempt to enter Yellowstone in 1860, that Hayden would build his reputation as a geologist on. However, Hayden had a deep rooted ambition not to be viewed as just another naturalist roaming around west of the Mississippi. This ambition was spurred on by the competition of rival surveys at the time like Clarence King's for the financial support of Congress. To be a geologist was to live in relative anonymity and Hayden hated that. He loved geology

with an enthusiastic, youthful presence and didn't understand why everyone else didn't too. The overall feeling toward geologists was best summed up by the Sioux Indians. When Hayden came through Sioux land, the Sioux avoided him and his crew completely, "figuring that whatever made a man run all over the badlands . . . pecking at hillsides, might be catching" (Pike 1972). For Hayden to achieve the acclaim he so desperately sought, only one "trophy" of a survey would do: Yellowstone.

The Yellowstone Survey would prove both beneficial and detrimental to Hayden's career. His style of reporting in the survey, sequential fashion, was seen by other geologists as poor analysis, often missing the bigger picture. Hayden is seen as the "popularizer of natural wonders" (Foster 1994), and his geologic reputation suffered for it. Another factor would have to be jealousy. Hayden became immensely popular after Yellowstone, adding to his already considerable ego. "Many persons who have seen me grow up from nothing imagine I should do for them the same things I did years ago, but I claim some respect now . . . you know how complicated my relations are getting to be with the world" (Foster 1994). It was probably a little of both; Hayden's arrogance and jealousy of his fame, that caused the geologic community to reject their famous popularizer. In 1877, Hayden was denied the head position of the U.S. Geological Survey, the survey he built, for both of these reasons.

CONCLUSION

What are the long-lasting effects of the 1871 Survey? The survey didn't bring Hayden the title as head of the U.S. Geological Survey. Also, Jackson's photographs have long been forgotten and Moran's paintings no longer hang in the Capitol. What the 1871 Survey did do is set a precedent - a precedent of preserving the wonders of nature that if left unprotected, would surely be ravaged by man. The establishment of Yellowstone NP

can be viewed as the beginnings of America's tourism industry. Soon after, other parks and natural areas would be set aside for the future enjoyment of generations. For that, we should be grateful to Ferdinand Vandiveer Hayden and his survey of Yellowstone in 1871.

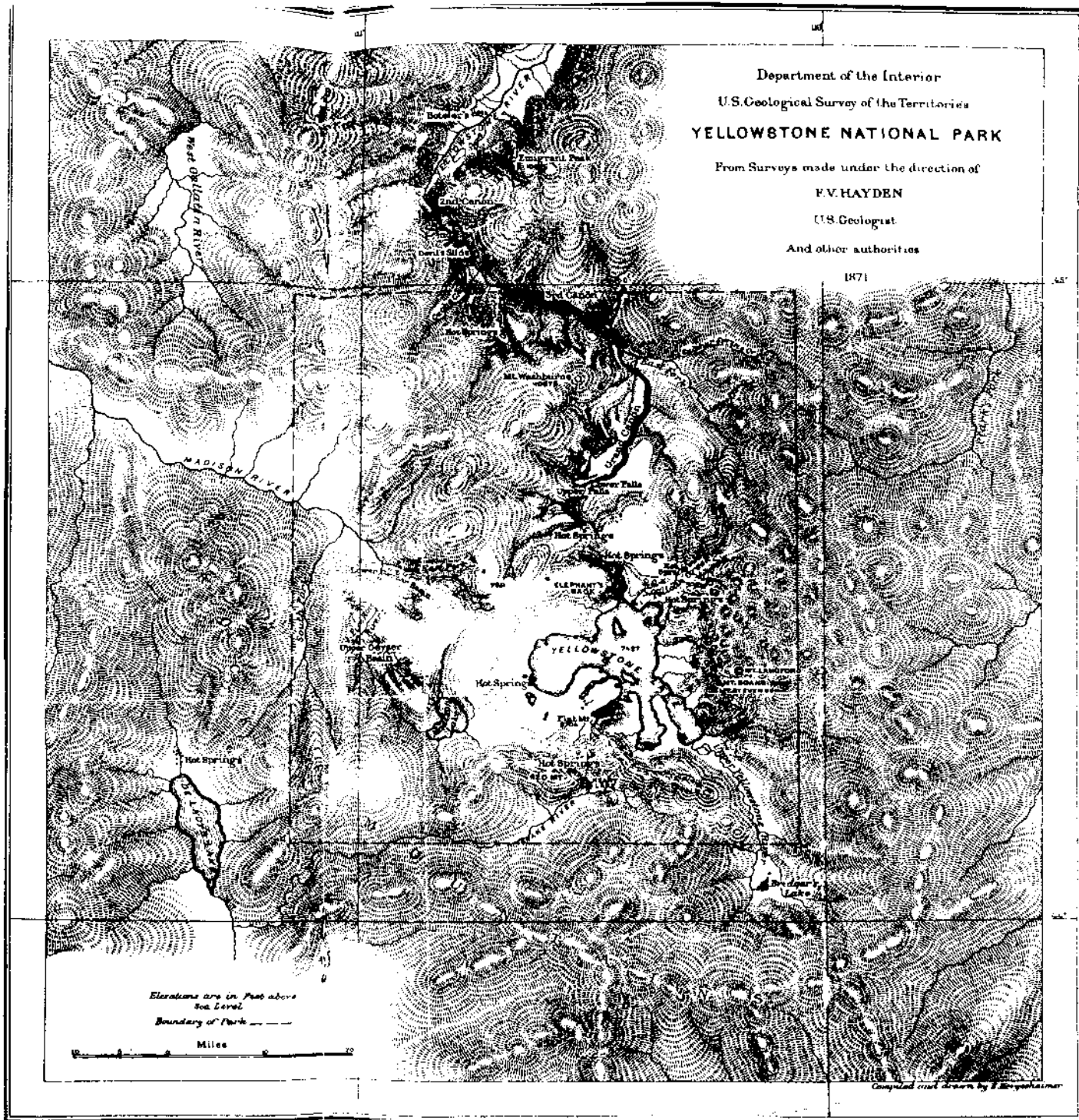
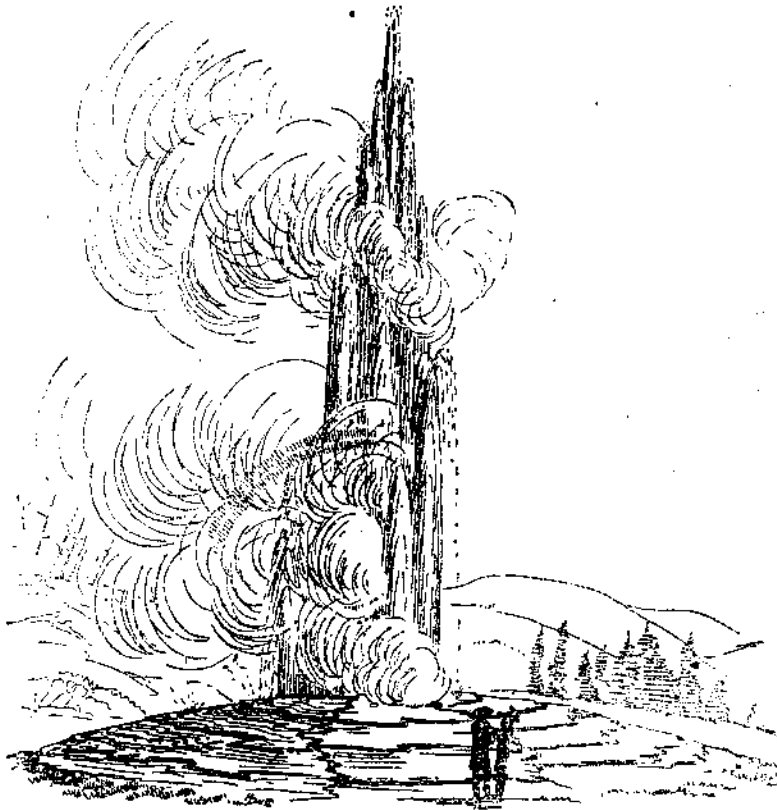


Fig. 1

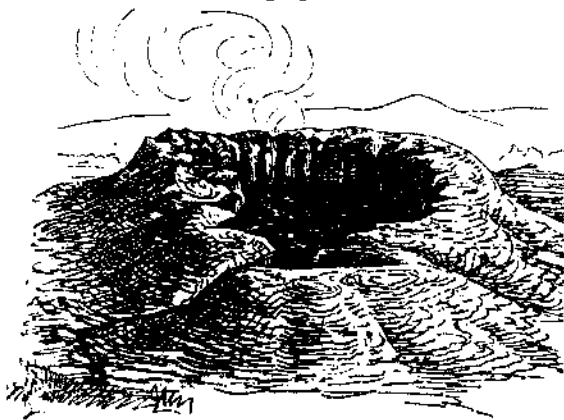
Fig. 48.



GRAND GEYSER, UPPER BASIN GEYSER, FIRE-HOLE RIVER.

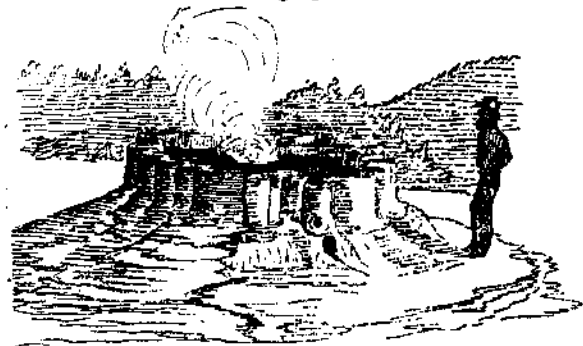
Fig. 2

Fig. 52.



DENTAL CUP.

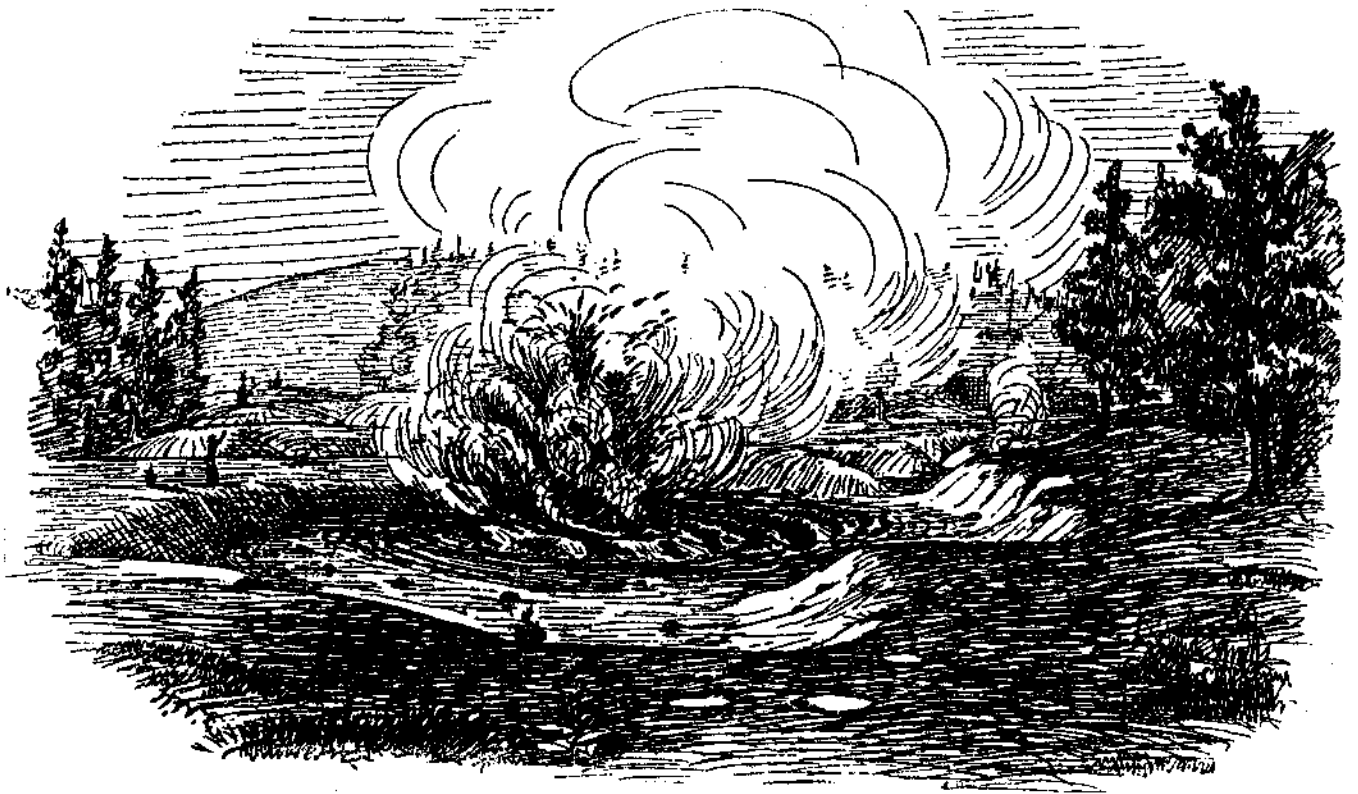
Fig. 51.



PUNCH BOWL, NO. 1.

Fig. 3

Fig. 4



MUD GEYSER.



Fig. 5



Fig. 6

BIBLIOGRAPHY

- Bartlett, Richard A., 1962, Great Surveys of the American West.
University of Oklahoma Press, pages 408.
- Chittenden, Hiram M., 1964, The Yellowstone National Park.
University of Oklahoma Press, pages 208.
- Fenton, Carroll Lane and Mildred Adams Fenton, 1956, Giants of Geology.
Doubleday, pages 333.
- Foster, Mike, 1994, Strange Genius: The Life of Ferdinand Vandiveer Hayden.
Roberts Rinehart Publishers, pages 351.
- Goetzmann, 1966, Exploration and Empire.
Alfred A. Kropf, Inc., pages 649.
- Hartzog, George B., 1972, A Master Plan for Yellowstone.
National Geographic, May, pg. 632.
- Hayden, F.V., 1872, 5th Annual Report of the Territories.
U.S. Govt. Printing Office, pages 538, Fig.2 pg. 119, Fig. 3 pg. 117, Fig. 4 pg. 94.
- Pike, Donald G., 1972, Four Surveyors Challenge the Rocky Mountain West.
American West, Vol. 9, pages 4-13, Fig. 5 pg. 5.
- Schneer, Cecil J., 1979, Two Hundred Years of Geology in America.
The University Press of New England, pages 385.
- U.S. Department of the Interior, 1973, Ferdinand Vandiveer Hayden and the Founding of Yellowstone National Park.
U.S. Govt. Printing Office, pages 45, Fig. 1 pg. 22, Fig. 6 pg. 1.