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REPORT OF REGIONAL GEOLOGIST ON HOT SPRINGS NATIONAL PARK, ARKANSAS

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In response to a letter dated May 14, 1936, from H. C. Bryant, Acting Director of the National Park Service, signed by H. E. Rothrock, Acting Chief of Naturalist Division, I visited Hot Springs National Park and made an inspection of the same June 11, 12, 13 14, 1936. A copy of Mr. Bryant's letter is attached hereto.

On reaching the park I was very courteously received by Superintendent Donald S. Libbey and his associates. I found that in addition to the museum problem mentioned in Mr. Bryant's letter the park authroities were confronted with another problem much more serious, namely, the slumping of a bank along the road being built on West Mountain. The greater part of my time was spent in studying this problem.

A copy of my memorandum, dated June 16, 1936, to Mr. Maier covering this bank-slumping problem is enclosed herewith.

Hot Springs National Park is the oldest National Park in the United States, having been controlled by the Government since 1832.

The chief attraction in the park consists of 47 springs of hot water with a temperature of exceeding 140 degrees Fahrenheit. This water is controlled by the Government, being utilized in a number of bath houses and operated under rules and regulations approved by the Secretary of the Interior. The aggregate flow of the springs, which are grouped around the base of Hot Springs Mountain, is about one million gallons per day.

The geology of the Hot Springs area is fairly well understood, more than a score of publications having been written on the subject by various geologists, the first of which was published in 1806. A resume of the geology was recently prepared by Donald C. Hazlett, junior geologist of the National Park Service and submitted by him in November, 1935. A copy of this report, in manuscript, is now in the files in the Regional Office.

The following digest of the geology of this region is taken chiefly from the Hazlett manuscript, from Hot Springs Folio No. 215 of the U. S. Geological Survey, by A. H. Purdue and H. D. Miser, published in 1923, and from the chapter on Geology by Earl A. Trager, Chief of the Naturalist Division, in the pamphlet describing Hot Springs National Park published by the National Park Service in 1936.

Hot Springs National Park lies near the eastern end of the Ouachita Mountains, which mountains occupy parts of southeastern Oklahoma and western Arkansas. The rocks in the park belong to the Lower Paleozoic era, and consist of six separate formations. Beginning with the oldest or lowest in the series, these formations are as follows:

Bigfork chert, 700 feet thick, thin-bedded gray to black chert much shattered and black shale.

Polk Creek shale, 200 feet thick, black graphic shale in which graptolites are abundant.

Missouri Mountain shale, 150 feet thick, clay shale generally dark greenish, drab to black, but red in many places.

Arkansas novaculite, 500 feet thick, upper half mainly thin-bedded novaculite and black shale; lower half massive novaculite.

Hot Springs sandstone, 200 feet thick, hard quartzitic laminated gray sandstone with heavy-bedded conglomerate at the base.

Stanley shale, 3,500 feet thick, black, fissile, clay shale, and hard compact sanstone. Only the lower part of the Stanley shale, less than one thousand feet, is exposed in Hot Springs National Park.

These rocks were originally laid down as sediments on the bottom of a pre-historic ocean. After long periods of time the sediments were raised out of the water and became dry land. During this process the rocks were compressed or squeezed together, and raised into great mountains which stood possibly 20,000 feet above their present level.

After all this had been accomplished erosion took place, and the mountains were worn down about to their present level, so that now the total relief is only a few hundred feet.

In the process of compression or squeezing together of the rocks, great folds and faults were formed, so that the rocks as we now see them rarely lie level, but the beds dip at high angles. Hard rocks including the Arkansas novaculite and Hot Springs sandstones stand out as prominent hills and ridges. The softer shales have usually been worn away, forming valleys.

The drainage of the area in the vicinity of Hot Springs is into the Ouachita River. On account of their peculiar shape, the mountains lying to the north of the park are often spoken of as the Zigzag Mountains. The lowland to the south of the Park, across which the Ouachita River flows, is known as Mazarn Basin.

The area of the park is 1009 acres, including Hot Springs Mountain, North Mountain, West Mountain, Sugar Loaf Mountain and Whittington Park.

By far the most perplexing question is that of the cause of the hot water. Many theories have been advanced to account for this phenomena, the most plausible of which seems to be the theory of meteoric water.

In this connection, I am quoting from the chapter on geology, Page 7, Hot Springs National Park, Edition of 1936, written by Mr. Earl A. Trager.

"One explanation is that these springs begin as meteoric water or rainfall which seeps into the Bigfork chert, a sandy formation, near the top of a fold in the rocks just northwest of West Mountain. According to this explanation, the water passes downward through the porous, sandy layers where it is heated by a buried mass of cooling rock. After this water crosses the lower bend of the rock, called a syncline, then it rises to the surface through the upward-dipping layers of rock on the southwest side of Hot Springs Mountain. Lack of evidence of recent volcanic activity in the area to provide heated rocks at reasonably shallow depths, together with the fact that part of the intake area is w 200 feet lower than the springs, would indicate that this theory requires revision at least in part."

Kirk Bryan has advanced another hypothesis, namely, that of juvenile water. I quote:

"On this hypothesis the water is of deep-seated origin, derived from a covered mass of igneous rock intruded into the sediments, but not showing at the surface, which discharges water expelled from its molten interior by the gradual crystallization of its mass, or the water is derived from a deeper, less definite, but similar mass and rises to the upper crust through a deep, probably fault, fissure. Such water is commonly called juvenile, i.e., new water coming to the surface for the first time."

Among other theories which have been proposed to account for the hot water is that of chemical reaction.

To my mind the most feasible theory is that the water carried by gravity down into a synclinal trough where it comes in contact with a mass of heated rock of volcanic origin. It is a well-known fact that there are in this part of Arkansas a number of exposures of volcanic rocks, two of which are near Hot Springs.

The rocks at Magnet Cove, 12 miles southeast of Hot Springs, and the unnamed igneous intrusion at Potash-Sulphur Spring, six miles southeast, are both of volcanic origin. In each case the rock is known as nephalite syenite. In both instances the volcanic rocks were extruded so long ago that they have lost practically all their original heat. It is at least significant that Magnet Cove, Potash-Sulphur, and Hot Springs are in alignment.

To my mind it appears logical that the water at the springs is now being heated by an underground mass of igneous rock, possibly of the character of the other exposures named above. This sub-surface igneous rock never having been exposed to the surface would naturally retain its original heat much longer.

One evidence of the presence of sub-surface igneous rocks in the region is the great number of dikes in the vicinity of Hot Springs. Most geologists believe that only a comparatively few of these dikes have yet been discovered. As shown on the geologic map of Arkansas they are most abundant in the region east and southeast of Hot Springs, in the region between the Springs and Magnet Cove. These dikes are believed to connect with the sub-surface mass of volcanic work just discussed. If their presence on the surface is any criterion, the area of this underground mass must occupy an area of at least 100 square miles.

The particular reason of my visit to the Hot Springs National Park at this time, was to act as a consultant on the geological specimens now being installed in the museum in the National Park Headquarters. Mr. Raymond E. Gregg, the Park Naturalist, acting in connection with Mr. Lewis of Washington, had designed three cases for displaying geological specimens. I went over these designs rather carefully with Mr. Gregg, and have very little criticism to offer. A temporary display of rocks and minerals is already in one of the cases, and has received considerable attention from visitors.

The only suggestion I was able to make was in the matter of the wording on some of the labels. My suggestions were to the effect that in a few cases the language might be simplified. Some of the statements, particularly those regarding the length of geologic time, seemed to me to be somewhat arbitrary. Mr. Gregg and his associate, Mr. Lix, are doing a very fine piece of work in the preparation of the museum, and I have nothing but praise for their efforts.

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