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REPORT NO. 119

INSPECTED
February 25-26, 1937

SECOND GEOLOGICAL REPORT

ON

HOT SPRINGS NATIONAL PARK

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SECOND GEOLOGICAL REPORT ON HOT SPRINGS NATIONAL PARK

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My first inspection of Hot Springs National Park was made on June 10-14, 1936, and embodied in report No. 50. This report deals with the topography and geology of this part of Arkansas in general and of Hot Springs National Park in particular. To it reference is made for a discussion of these topics. At that time I was also asked to make certain suggestions regarding the installation of geological exhibits in the museum. These suggestions have been carried out, and the museum is now functioning.

On the second inspection, which forms the basis of the present report, I was accompanied by Forester Wirt, Engineer Riehl and Landscape Architects Cornell and Diederich. Superintendent Libbey and Acting Park Naturalist Lix of Hot Springs National Park gave every assistance. Assistant Engineer Crom of the NPS also gave us valuable information.

My chief concern at the time of my first inspection was the matter of slumping along a road which had been constructed

by the Bureau of Public Roads on the slope of West Mountain, back of the town of Hot Springs. In the construction of the road the bank had been cut too deep, apparently without geological advice, and the material on the slope above was slumping and sliding into the road for a distance of nearly half a mile.

As immediate corrective measures, I suggested in my report that the drainage of the entire road system on the mountain be studied, and that a terraced retaining wall be constructed in the effort to prevent further slumping.

An attempt has been made to correct the evil by the installing of a system of drainage. It has been described in the report submitted by Engineer Diehl. This attempt has been only partially successful. In January, 1937, 15 inches of rain fell at Hot Springs, and, in consequence, the slumping and sliding of material on the mountainside was greatly increased, so that great quantities of earth and clay have since slumped down into the roadway, as shown in Figures 1 and 2.

Rocks belonging to two geological formations outcrop on the east slope of West Mountain, namely, the Hot Springs sandstone and the Stanley shale. In ordinary stratigraphic sequence, the Hot Springs sandstone underlies the Stanley. But, at this place, the reverse is true. Throughout the Ouachita Mountains, in which Hot Springs is located, there are many folds, including anticlines and

synclines, where the rocks have been sharply folded, and in some cases overturned, so that they now lie "on their backs," as shown in Figure 5 of the letter by H. W. Lix attached hereto.

On West Mountain, at the site of the slumping above the road, the Hot Springs sandstone forms the crest of the ridge, while, on account of the overturned position of the beds, the Stanley shale outcrops along the slope below. Both formations dip into the mountain, the angle of dip being approximately at right angles to the slope of the hill. The slumping along the road appears to be entirely in the material overlying the bed rock Stanley shale. This upper material is composed of a mixture of residual clay and earth, with fragments, large and small, of sandstone, derived from the Hot Springs sandstone, rolled down the hill. The geological term "detritus" is used for such material.

As shown in pits which had been dug on the mountain slope previous to our arrival, the thickness of the various members of the overburden above the shale varies from 5 feet near the upper part of the slope, to 8 or 12 feet further down the slope along the road.

An approximate section of the detritus above the Stanley shale bed rock, as shown in the pits, is as follows:

1 to 2 feet, top soil
2 to 6 feet, earth, clay, sandstone mixture
1 to 4 feet, yellowish clay
Stanley shale

It should be remembered that only the lower part of the Stanley shale is exposed on West Mountain. This formation is in places as much as 8,000 to 10,000 feet thick.

The natural weathering of the rocks along the slope of the mountain, through long periods of time, has produced a slope varying from 20 to 30 degrees. This is known as the angle of repose.

Under normal conditions when the various materials have come to a state of equilibrium, this angle remains constant, and very little material is displaced or moves down the hill. On unusually steep slopes landslides sometimes occur, and on normal slopes there is frequently a very slow but constant "creep" toward the valley.

The slumping on West Mountain, which is occurring in the detritus above the Stanley shale, is the result, chiefly, of two factors, namely, gravity pull, and the lubrication of the detritus by water.

Nature is now attempting to re-establish the angle of repose which has been destroyed by man.

To me, it appears very probably that this slumping might have been prevented, at least in a large measure, by the construction of a retaining wall, or by other mechanical means, at the time when the road was first built, and before there had been any movement of material in the slopes above. On Hot Springs Mountain, across the valley, where geological conditions are quite similar,

walls were built at the time of the construction of the road and little slumping has occurred. Even at the time of my first visit such a wall would doubtless have prevented a considerable amount of slumping. But water from the January rains have so affected the slope that cracks parallel to the road are now opening up all along the mountainside above the road, as shown in Figure 5. Some of them are 200 feet above the road.

Water from future rains will continue to pour into these cracks, loosening the detritus and augmenting the sliding of the material down onto the road. As long as the laws of gravity continue to operate, and while water from rainfall continues to soften and lubricate the material, this detritus will continue to slump downhill, and this will not stop until either a natural or an artificial equilibrium has been established.

The curing of the slumping is an engineering rather than a geological problem.

My comments on the situation may be summarized as follows:

> The slumping on West Mountain is being caused by gravity aided by water which loosens the detritus.
>
> Nature's angle of repose, or angle of rest, which had been established through long periods of time, has been disturbed.
>
> Nature is now attempting to re-establish this equilibrium, and will continue to do so.

To check the slumping some mechanical means should be employed.

Competent engineers, experienced in problems of this kind, should suggest the best remedy.

Slumping could probably have been prevented by proper means at the time when the road was built, and before the detritus had started slumping.

It has now assumed major proportions, and will probably be an expensive proposition.

Any method of control adopted should include a careful study of the entire drainage system of the roads on the mountain.

In this connection, I am appending a letter report, dated February 24, 1937, prepared by Henry W. Lix, Acting Park Naturalist at Hot Springs, addressed to the Superintendent. Mr. Lix has been in constant touch with the building of the road and the resultant slumping. His remarks are very pertinent to the situation.