

**GEOLOGICAL SERIES, VOL.  
V. NO. 4. AN EXCURSION  
TO THE GRAND CANYON  
OF THE COLORADO**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649431946

Geological Series, Vol. V. No. 4. An Excursion to the Grand Canyon of the Colorado by W. M. Davis

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MAY 29 1901

14964

Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE.

VOL. XXXVIII.

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GEOLOGICAL SERIES, Vol. V. No. 4.

AN EXCURSION TO THE GRAND CANYON OF THE  
COLORADO.

By W. M. DAVIS.

With Two Plates.

CAMBRIDGE, MASS., U. S. A. :  
PRINTED FOR THE MUSEUM.  
MAY, 1901.

MAY 29 1901

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### Introduction.

IN June, 1900, it became possible for me to visit the district of the Grand Canyon of the Colorado, and to see upon the ground the wonderful features of a region that had long been familiar from the reports of our governmental surveys. Our party consisted of Prof. R. E. Dodge of Teachers' College, Columbia University, Prof. H. E. Gregory of Yale University, Mr. R. L. Barrett of Chicago, Mr. Richard Wetherill of Pueblo Bonito, N. M., Dr. Tempest Anderson of York, England, and the writer. We reached Flagstaff, Arizona, by the Santa Fe Western Railroad on June 3, spent twenty-three days travelling irregularly across country, and went out from Milford, Utah, to Salt Lake City by a branch of the Oregon Short Line on June 26. Our itinerary is shown on the accompanying outline map, Figure 1, with dates of camps, and in the list of camps given below. We travelled partly in wagon, partly on horseback, and averaged about twenty-five miles a day. The clouds of thunder showers were frequently seen in the distance, but we had rain only twice; first a few drops in the canyon, June 7, and next a brisk shower near the Little Colorado crossing on the morning of June 10; the centre of this shower passed north of us, and the muddy streams from its short-lived down-pour met us as we were ascending a dry arroyo, or "wady." Many days were almost cloudless and oppressively hot over noon. The nights were cool, with the exception

of one that we spent near the bottom of the canyon, which was unpleasantly warm. A brief report upon our trip has already been published in the "American Journal of Science," for October, 1900.

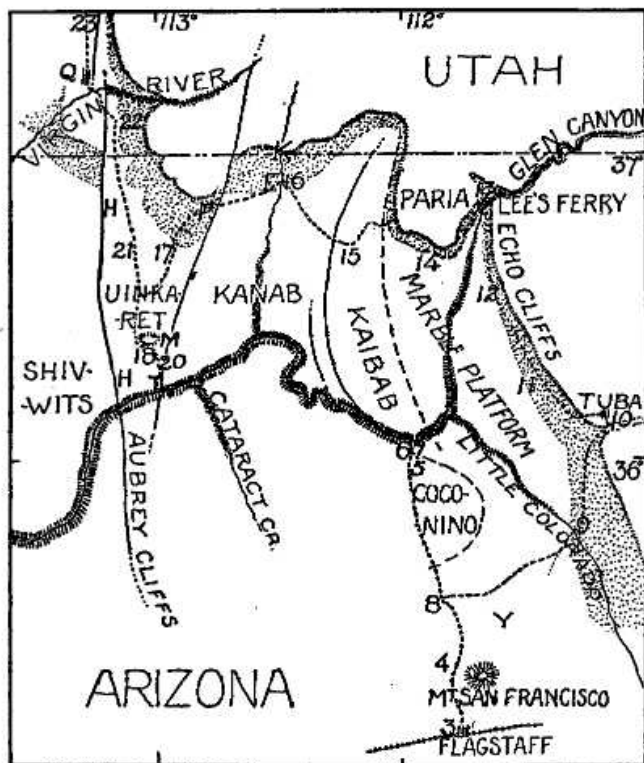


FIGURE 1.

Route-map of Grand canyon district. The dotted belt represents the weak lower Triassic and Permian strata separating the mesozoic area on the northeast from the paleozoic area on the southwest. The several blocked plateaus are separated by faults (continuous lines) or flexures (broken lines). The route followed is marked by a fine broken line, with numbers to indicate dates of camps in May, 1900. F, Fredonia; H, H, Hurricane ledge and fault; K, Kanab; M, Mt. Trumbull; P, Pipe spring; Q, Toquerville; T, Torowasp valley; Y, recent lava mass. Outline taken from Dutton's Atlas.



ITINERARY. — June 4th, 1900, Flagstaff northward to Stokes spring, at northwest base of San Francisco mountain; 5th, northward to the Coconino forest, within four miles of Hance's on the canyon rim; 6th, descended from Cameron and Berry's Hotel by Grand View trail into canyon and spent the night at the level of the lower Tonto shales; 7th, returned to Cameron and Berry's; 8th, southward to Hull's spring on road to Flagstaff; 9th, northeastward to Little Colorado river at crossing of road from Flagstaff to Tuba; 10th, northward to Tuba; 11th, northward along base of Echo cliffs to Cottonwood tanks; 12th, still northward along Echo cliffs to Tanner's tanks; 13th, still northward along Echo cliffs, crossing the Colorado river at Lee's Ferry; 14th, southwest to Jacob's pools under the Vermilion cliffs of the Paria plateau; 15th, west to Jacob's lake on the Kaibab plateau; 16th, northwest to Fredonia; 17th, westward to Pipe spring and southwestward to Yellowstone spring near Antelope valley; 18th, southwestward to Trumbull spring at southern base of Mt. Trumbull; 19th, ascended Mt. Trumbull, then southward to Oak spring; 20th, southward to Vulcan's throne in the Toroweap, and back to Oak spring; 21st, northward to Clay holes; 22nd, northward to Gould's (Workman's) spring; 23rd, northward past Toquerville to Kelsey's ranch; 24th, northward past Cedar City to Rush lake; 25th, northwest to Minersville; 26th, northwest to Milford; night train to Salt Lake City.

SUMMARY OF PREVIOUS WORK. — An account of new observations made in such a district as that of the Grand Canyon of the Colorado, already well studied by the explorers of our western surveys, naturally lays more emphasis on novel interpretations of former observations or on subordinate matters newly observed, than on the great structural features of the region or on the principal events of its history. But whatever of novelty is now to be gleaned in that marvellous region must rest so immediately on the work that has been already done there that I wish at the outset to express the great indebtedness that all of our party felt to the pioneer work of Newberry, Powell, Gilbert, Dutton, and Holmes, whose labors have transformed a desert wilderness into classic ground for the geologist, and whose reports are quoted whenever it is desired to illustrate all that is marvellous in the way of displace-

<sup>1</sup> Trumbull spring is on the slope of the mountain several hundred feet above its base: at the time of our visit it gave very little water. The place is not to be recommended as a camping ground. Oak spring, four miles further south, is much better.

ment and denudation. The topographical maps prepared by Bodfish and Renshawe in 1879 are also of great service to the traveller. The main conclusions of the earlier explorers are not to be disputed. The great unconformities at the base of the plateau series, the enormous volume of nearly horizontal and conformable strata from lower Palæozoic to Tertiary, the division of the region into great blocks by displacements, either faults or flexures, trending about north and south, the great denudation by which the plateaus bordering the canyon have been stripped of thousands of feet of strata, the sharp erosion by which the canyon has been incised in the plateaus, and the superb development of volcanic phenomena, — all these great features are standard examples for citation. There are, however, certain subordinate conclusions announced in the earlier reports which seem open to question, and it is chiefly to a consideration of these debatable points that the present essay is devoted.

The following brief summary of certain aspects of the work of three earlier observers may be of service to the reader.

*Newberry*, geologist of the Ives expedition to the Colorado river of the west in 1857-58, ascended the Grand Wash-cliffs to the plateaus from the deserts among the Basin ranges on the south of the river, descended northward into the Grand canyon near its western end by the side canyon of Diamond creek, and, ascending again, traversed the southern plateaus past San Francisco mountain from west to east. He recognized the fundamental crystalline rocks beneath their heavy unconformable cover of palæozoic strata (pp. 54-58); he perceived the importance and efficacy of ordinary erosive processes not only in the excavation of the narrow canyons beneath the plateaus by the larger and smaller streams (pp. 45, 46), but also in the broad recession of the cliffs upon the plateau (pp. 45, 62), indeed he regarded the opening of the broad upland valleys on the plateaus, such as that of the Little Colorado, as "a much grander monument of the power of aqueous action than even the stupendous cañon of the Colorado" (p. 86). He noted a "slight arching of the strata" in passing from what we may now call the southern Shivwits to the southern Uinkaret plateau (p. 58), and a "curve of the underlying rock" on descending from the Coconino plateau (south of the Kaibab) to the platform of the Little Colorado valley (p. 61); but he denied the occurrence of other displacements, not only in the canyons but also along the north-south escarpments, saying that "the strata of the table-lands are as entirely unbroken as when first deposited" (p. 46); and this is not unreasonable

when it is remembered that his route led him across the southern plateaus where the great displacements weaken and disappear as they come down from the north. He did not demand two periods of erosion for the sculpture of the plateaus and the narrow canyon; difference of resistance in the upper and lower strata seemed to him to account for these contrasts in the amount of destructive work (p. 62), but he inferred a more active erosion in former times than at present; "everything indicates that the table-lands were formerly much better watered than they now are" (p. 47, also pp. 62, 76).

*Powell* in his adventurous expedition down the canyon (1869) and in his journey over the northern plateaus (1870), discovered the double unconformity in the Kaibab section of the Grand canyon (*a*, pp. 212, 213), gave many new details concerning the rock series, and emphasized the production of the canyons by erosion in his announcement of the "antecedent" origin of certain rivers (p. 163). He presented a clear account of the great displacements by faults and flexures which divide the Grand canyon district into huge "blocks," trending north and south (*a*, pp. 185-190, Figure 73), as well as of the great cliffs of erosion or retreating escarpments, north of the canyon, facing south and trending irregularly east and west (*a*, pp. 190, 191, Figure 74); "the cliffs of erosion are very irregular in direction, but somewhat constant in vertical outline; and the cliffs of displacement are somewhat regular in direction, but very inconstant in vertical outline" (*a*, p. 191). *Powell* does not seem to have felt the necessity of supposing an uplift of the region between the great denudation of the uplands and the incision of the narrow canyons (pp. 206, 213), but he states that "the carving of the cañons . . . is insignificant when compared with the denudation of the whole area, as evidenced in the cliffs of erosion" (*a*, p. 208). The date of the displacements is not very sharply defined; when the great denudation began "there were no faults and no benches" (*a*, p. 200). The first displacements occurred after the erosion of valleys had been begun, the displacements were long continued, and must have been slower than the erosion of valleys by the principal streams, for the displacements did not modify the stream courses (*a*, p. 201). "Though the entire region has been folded and faulted on a grand scale, these displacements have never determined the course of the streams. . . . All the facts concerning the relation of the water-ways of this region to the mountains, hills, cañons, and cliffs lead to the inevitable conclusion that the system of drainage was determined antecedent to the faulting and folding" (*a*, p. 198). The