

statements; the first concerning the discovery of the satellites of Mars:

It was an accidental discovery, interesting because it concerns the system of our nearest neighbor in space, useful because it has furnished a new means of considering certain problems in astronomy, but not to him a crowning achievement.

He was not easily carried away by any of the psychological waves that come and go in astronomy. During one of these at the Naval Observatory it was quite the fad to observe the companions of a certain well-known star. Each man, it proved, had his own companion that he thought he saw, and comparison showed later that no two had the same one. Only Hall of all the staff resisted the opportunity, and only he, it afterwards proved, was right, for all of the little companion stars were of the imagination.

The above statements were so inconsistent with the facts that I wrote to the editor on December 4, 1907, giving him a brief but true account of the matters at issue, asking that my communication be given as wide a circulation as was given to the incorrect article. It was not printed. When asked if my article had been received the editor replied, on December 17, that it had, and had been referred to the author of the article printed November 26, 1907. Nothing has since been heard from the editor or the author, and apparently neither is willing that the facts be known. Therefore, in the interest of truth and also of justice to Professor Hall I ask that the following comments on the *Transcript* article be printed in *SCIENCE*.

The statement that the discovery of the satellites of Mars was an accident is not only entirely without foundation but it is unjust to the professional reputation of Professor Hall. I knew Professor Hall intimately, had worked in the same building with him for fifteen years, we lived in adjoining houses and we walked together to and from the observatory nearly every day and frequently at night. His scheme for observing Mars was discussed with him in these walks and in his home, and I know that the discovery was the definite result of a carefully devised plan for an exhaustive search for satellites. At the time of the discovery an effort was made to divert the honor of the discovery from Professor Hall,

but, fortunately, that attempt failed. To say now that the discovery was an accident is a wide departure from historic truth.

With regard to the statements: "it was quite the fad to observe the companions of a certain well-known star"; "each man had his own companion that he thought he saw," and "only Hall of all the staff resisted the opportunity," it may be said, briefly, that they are absolutely untrue. None of the trained observers of the Naval Observatory saw these "companions." The discovery of these companions was made by an amateur, not a member of the observatory staff. The note books of that period will show the folly of the statement in the *Transcript*.

Another recent statement concerning the discovery of the satellites of Mars may be mentioned in this connection. In the March number of the *Cosmopolitan* magazine, page 343, Professor Todd, of Amherst College, tells a curious story of the discovery of Phobos, the inner satellite of Mars. He writes: "So mine was the first human eye that ever saw Phobos, recognizing it as a satellite."

This statement is remarkable in two ways: First, because this information has been withheld from the public and from astronomers for thirty years and only published after the death of Professor Hall; second, the statement will not deceive trained astronomical observers, but the general public ought to know that *before* and *since* that event it has been impossible for an astronomer to recognize the difference between a small star and a satellite, near the limit of vision, without extended observation or careful measures, which were not employed at the time mentioned in the magazine.

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SPECIAL ARTICLES

PRE-CAMBRIAN SEDIMENTS AND FAULTS IN THE GRAND CANYON OF THE COLORADO¹

THE work of Powell, Walcott and others

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has familiarized geologists with the great horizontal wedge of Proterozoic (Algonkian) sediments which thins out to the west just south of Vishnu Temple, but there is nothing in the literature of the Grand Canyon which prepares the visitor for encountering a mass of the same sediments some ten miles west of Vishnu Temple and directly opposite the hotels at the end of the Grand Canyon Railroad.

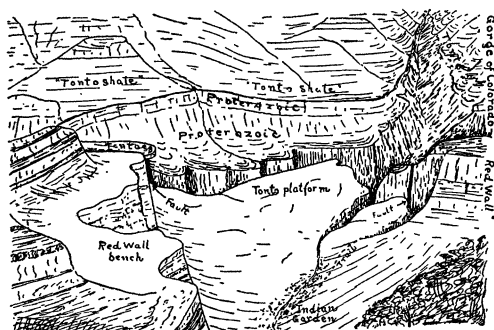


FIG. 1. Sketch from Bright Angel trail looking northward across the inner gorge of the Colorado and up Bright Angel Creek. The Bright Angel fault is shown on the right crossing a spur of gneiss capped by a small mass of Proterozoic sediments.

Doubtless other eyes than mine, practised in geological observation, have recognized the Proterozoic rocks in that part of the northern wall of the canyon lying just west of Bright Angel Creek, for the beds are visible from El Tovar hotel. It seems appropriate, however, that there should be published some accessible note calling attention to the interesting features there displayed, for the benefit of the thousands of people not necessarily geologists, who study with intelligent interest this, the most frequented part of the great chasm.

Although the general relations of the Proterozoic rocks can be made out from the

southern rim of the canyon they may best be studied from the edge of the Tonto platform just west of Pipe Creek and overlooking the inner gorge—a vantage point easily gained by leaving the traveled Bright Angel trail at Indian Garden and walking or riding northward over the comparatively smooth upper surface of the Tonto sandstone (see Fig. 1). From this place the structure shown in the accompanying section (Fig. 2) is superbly displayed. The long straight gorge of Bright Angel Creek coincides with a fault of which the throw is at least 300 feet, the west side being relatively depressed. This fault-zone is visible at many points on the south side of the canyon, being crossed and recrossed by the Bright Angel trail as it zigzags down the steep slopes of gneiss along Pipe Creek. On the east side of the gorge the much contorted, truncated, Archean gneiss is capped by horizontal "Tonto sandstone" conformably overlain by the "Tonto shale" and the "Red Wall limestone"; on the west side the red sandstones and shales of the "Unkar terrane" rest, also unconformably, upon the Archean with a low dip to the east. About two miles west of the mouth of Bright Angel Creek the pre-Cambrian sediments are cut off by a second fault which, as shown in the section and sketch, does not displace the overlying "Tonto sandstone."

A partial and brief summary of the history of events recorded in this section is as follows: (1) The reduction of the Archean rocks to a plain of erosion. (2) The deposition of the Proterozoic sediments, (3) Faulting, by which a mass of the sedimentary rocks was inset into the Archean. (4) Peneplanation of the region. At the end of this erosion period, part of the inset block of pre-Cambrian rocks was left as a low monadnock above the general

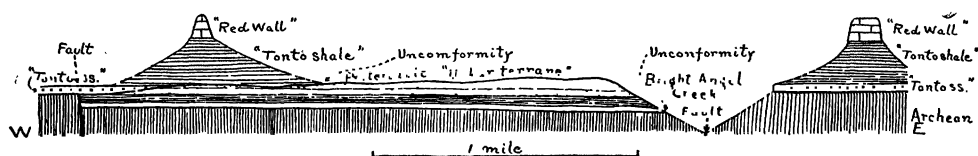


FIG. 2. Diagrammatic section of part of the north wall of the Grand Canyon near the mouth of Bright Angel Creek. Vertical and horizontal scales the same.

level. (5) The deposition of the Cambrian "Tonto sandstone" (which, however, did not cover all of the Proterozoic monadnock), succeeded by the accumulation of the "Tonto shale," "Red Wall limestone" and later Paleozoic formations.

It is clear that the present vertical distance between the pre-Tonto and pre-Unkar unconformities affords only a minimum measure of the throw of the pre-Cambrian faults. That there has been some slight post-Paleozoic movement along the Bright Angel fault, enough to fissure the "Red Wall" and "Aubrey" formations, is shown by the erosion of the Bright Angel gorge, the alcove of Indian Garden, and the shallow drainage trench followed by the Grand Canyon Railroad near the southern rim of the canyon. As may be seen from the Bright Angel topographic sheet of the U. S. Geological Survey, the three features mentioned together constitute a remarkable rectilinear depression at least 20 miles in length. F. L. RANSOME

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AN EARLY FIGURE OF THE KING-CRAB (*LIMULUS POLYPHEMUS*)

THERE has recently been placed on exhibition in the gallery of arthropoda in the Zoological department of the British Museum a copy of a water-color drawing made about 1585 and containing what is believed to be the earliest representation of the American king-crab (*Limulus*, or *Xiphosura*, *polyphemus*). As the subject is one of special interest to American naturalists, it may be worth while to place on record here some of the facts relating to it.

The original drawing was made by John White, who was one of the first settlers in, and for some time governor of, Virginia, and acted as lieutenant to Sir Walter Raleigh on several voyages to North America. Three volumes of drawings by him are preserved in the Department of Prints and Drawings in the British Museum, and have recently been described in detail by Mr. Laurence Binyon in the fourth volume of his "Catalogue of Drawings by British Artists . . . in the

British Museum" (1907, pp. 326-337). Many of White's delineations of natural objects are of great beauty and show a fidelity to nature which was very rare at the period when they were executed.

The drawing in which the figures of the king-crab are introduced is a view of Indians spearing fish, and two specimens of *Limulus* are roughly but quite unmistakably sketched among shells and other marine objects lying on the beach in the foreground. Like many of White's drawings this one was engraved for de Bry's "America" in 1590. In the engraving the figures of the king-crabs, like some other portions of the picture, are drawn in somewhat greater detail, suggesting that the engraver was working from some other drawing now lost. As Mr. Binyon suggests, "doubtless White made many repetitions of drawings which would have such lively interest for his countrymen." In de Bry's volume the text accompanying these drawings is a translation of Thomas Harriot's "A Brief and True Report of the New Found Land of Virginia, &c.," first published in 1588 and afterwards reprinted in Hakluyt's "The Principal Navigations, &c." in 1598 (the following quotation is from the Hakluyt Society's edition, 1904, Vol. VIII., p. 370). In his list of the natural products of Virginia Harriot mentions "Seekanauk, a kinde of crusty shel-fish, which is good meat, about a foot in bredth, having a crusty taile many legges like a crab, and her eyes in her backe. They are found in shallowes of waters and sometime on the shore." This doubtless refers to the king-crab. It would be interesting to know whether any readers of SCIENCE can give a reference to any earlier mention of this animal.

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A PLAN FOR INCREASING THE EFFICIENCY OF MARINE EXPEDITIONS

APART from their work in deep-sea sounding, and in the accumulation of meteorolog-

¹ Grands Voyages, Part I., pl. 13.