

NOTICES OF MEMOIRS.

THE SOUTHERNMOST GLACIATION IN THE UNITED STATES. By D. W. JOHNSON.¹

IN a recent number of *Science*² H. W. Fairbanks and E. P. Carey report evidences of "Glaciation in the San Bernardino Range, California", in latitude about $34^{\circ} 7' N$. Concerning this interesting discovery the writer says: "It has hitherto been assumed that the southernmost point of glaciation in the United States was in the Sierra Nevadas, nearly 200 miles to the north" (north of latitude $36^{\circ} N$). If their observations are correct they have found the most southern instance of satisfactory evidence of glaciation in this country, so far as I recall; but there are several records of glaciation farther south than the point in the Sierra Nevada referred to by them. Brief references to these may be of interest.

Science for November 22, 1901,³ contained a "Note on the Extinct Glaciers of New Mexico and Arizona", by George H. Stone, in which he reported evidences of glaciation in one of the Rocky Mountain Ranges "as far south in New Mexico as a point not far north of Santa Fé" (latitude about $35^{\circ} 41'$). In a later paragraph we read—

"The farthest south and west I have found traces of extinct glaciers is at Prescott, Arizona. Around Prescott are numerous moraines. The highest part of the névé of this glacier could not have been much above 9000 feet. The central part of the glacier is approximately in N. lat. $34^{\circ} 30'$. The occurrence of an ancient glacier so far south as this was probably due to a very great snowfall owing to the proximity of the ocean . . . Probably there were then small glaciers in some of the cirques of northern exposure among the mountains directly south-east of Prescott."

R. D. Salisbury published an article on "Glacial Work in the Western Mountains in 1901", in vol. ix of the *Journal of Geology*, 1901. Beginning with p. 728 is a brief description of glacial features in the mountains near Santa Fé, between $35^{\circ} 45'$ and 36° North latitude. Some fifty cirques were found, and about eighty ponds and lakelets. One of the glaciers had a length of 7 miles. Moraines, striae, and roches moutonnées were observed. In 1902 I had an opportunity to visit this same region, and I entertain no doubt as to the ample proof of local glaciation in those mountains.

In the *Journal of Geology* for 1905⁴ is a paper by Wallace W. Atwood on the "Glaciation of San Francisco Mountain, Arizona". This writer describes and figures terminal and lateral moraines, and an outwash plain, and reports the occurrence of striated boulders and polished and grooved bedrock. I have briefly mentioned evidences of glaciation on this same peak, attributing a somewhat greater amount of erosive work to the glacier than is recognized by Atwood, and mentioning what I then believed to be a terminal moraine located near the mouth of a cirque.⁵ The latitude of San Francisco Mountain is about $35^{\circ} 21' N$.

¹ Reprinted from *Science*, n. s., vol. xxxi, No. 789, pp. 218–20, February 11, 1910.

² January 7, 1910.

³ Vol. xiv, p. 798.

⁴ Vol. xiii, p. 276.

⁵ *Technology Quarterly*, 1906, vol. xix, p. 410.

F. J. H. Merrill reports in *Science* for July, 1906,¹ "Evidences of Glaciation in Southern Arizona and Northern Sonora." In the vicinity of Nogales, and elsewhere, were found deposits which he believed to be of glacial origin, while the surface had "the rolling topography and pitted surface of a moraine". Nogales is in latitude 31° 20' N.

The above references may be but a partial list of the published reports of glaciation south of the point in the Sierra Nevada referred to by Fairbanks and Carey; I have made no effort to prepare a complete list. Of these reports, the one on glaciation near Nogales is the most striking, because of the low latitude and low altitude in which the deposits are found. The evidence as reported does not appear sufficiently convincing, in view of the strong probabilities against the occurrence of glacial deposits in the region in question. Merrill's descriptions suggest a landslide origin for the deposits which he took to be glacial. With reference to the glaciation of San Francisco Mountain I wish to add the following paragraphs.

On my visit to San Francisco Mountain I ascended the volcano by the north-west slope, and I descended into the north-western part of the 'crater'. I was impressed with the cirque-like form of the depression, and came to the conclusion that the original crater had been destroyed by stream and glacial erosion, and that the encircling cliffs were to be regarded as cirque-walls rather than as crater-walls. The great central depression of the volcano consisted of several more or less distinct cirques uniting down-stream. Near the mouth of one of these was what I interpreted as a crescentic terminal moraine, rising 150 feet or more above the valley floor. But there were certain associated features which puzzled me at the time. Up-stream from the supposed moraine the floor of the cirque appeared to be deeply buried by an accumulation of rock débris which was generally as high as, and near the head of the cirque distinctly higher than, the morainal ridge. This débris was in places, especially near the marginal walls arranged in parallel ridges trending with the axis of the valley; and in the depressions between the ridges were patches of snow and some small ponds. Thus the moraine had a steep frontal slope, but at the back merged with the ridged rock débris, which rose to still higher levels. There were some depressions in the rock débris, 25 to 40 feet deep, which I took to be ice-block holes. No bedrock was seen in the cirque floor.

During the recent meeting of the Geological Society of America, Professor H. B. Patton, of Boulder, Colorado, exhibited some photographs of the rock streams of Veta Mountain, Colorado. One of these photographs showed the high and steep front terminus of a rock stream, and resembled very closely the front slope of the supposed moraine in the San Francisco cirque. Others of his pictures showed the longitudinal parallel ridges which characterize some rock streams, with bands of snow lying in the hollows between the ridges, just as was the case in the San Francisco cirque at the time of my visit. If the concentric wave-like ridges pictured by Howe² were present in the San Francisco deposits, I did not notice them.

¹ Vol. xxiv, p. 116.

² "Landslides of the San Juan Mountains": U.S. G.S. Professional Paper, No. 67.

I am inclined to believe that the features which puzzled me at the time of my visit may have been due to landslides or rock streams. This does not mean that the depression in which the features occur is not a glacial cirque, nor that the moraines reported by Atwood are not true moraines. It simply means that I am not wholly satisfied with the evidence of glaciation as reported by myself. It would seem that the possibility of a landslide of rock-stream origin for features apparently due to glaciation must be carefully considered, especially when glaciation in doubtful localities is involved.

REVIEWS.

I.—CRYSTALLINE STRUCTURE AND CHEMICAL CONSTITUTION. By A. E. H. TUTTON, D.Sc., M.A. (Oxon.), F.R.S., A.R.C.Sc. (Lond.). pp. viii+204, with 54 figures in the text. London: Macmillan and Co., 1910. Price 5s. net.

DR. TUTTON'S reputation for crystallographical research stands so high that the announcement of a book from his pen on a subject of such primary importance as crystalline structure and chemical constitution cannot fail to awaken general interest among those interested in crystallography, but we fear that on realizing the true scope of the book many readers will feel considerable disappointment. Far from discussing the wide subject comprehended by the title of the book, Dr. Tutton confines himself entirely to a comparatively small section of it, and, moreover, to his own contributions to that section. Everyone may not have seen the prospectus relative to the series of science monographs of which this is the first volume, and may not be aware of the intention of the publishers that "each volume will be unique, inasmuch as the author will describe chiefly his own contributions to the specific subject of scientific research with which it deals": to prevent misunderstanding it is desirable that this restriction should appear on the title-page. This volume, at least, cannot pretend to be at all an adequate discussion of the subject with which it is supposed to deal.

On the other hand, the book provides an admirable summary of the fine series of investigations upon which Dr. Tutton has for the past twenty years been engaged, and the reader may obtain a clear idea of the nature and results of the research without the labour of hunting up the original papers in the various periodicals in which they appeared. The most casual reader cannot fail to be struck with the pains taken to ensure that the apparatus and the crystals used in the investigations were of the most perfect quality obtainable, and with the indefatigability that has characterized the observational work. In the introductory pages the author, doubtless carried away by his enthusiasm, has depicted in unduly dark colours the state of the knowledge of isomorphism obtaining at the time he commenced his researches. The book is well printed, and its value is enhanced by several excellent illustrations, in one of which the author is seen in the act of grinding a crystal-section.
