predicted position, and as an object easily visible in medium-sized telescopes. Because the comet was following its predicted path so closely we decided not to squander money in cabling the fact of its reobservation to European observers. Perrine observed his comet morning after morning as weather permitted, for fifteen days, until on February 14 a cablegram was received from Kiel, Germany, announcing that Lamp had reobserved Perrine's Comet *c* 1895 that morning. The cablegram in cipher code was received at the Lick Observatory by one of the astronomers, in perfect order as shown by the control word; but in converting the cabled right ascension of the comet from degrees and minutes of arc into hours and minutes of time the translator made an error of 24 minutes of time, equivalent to 6° of arc. The *erroneous* translation was handed to Perrine. He compared this with what he knew to be the real position of Comet *c* 1895, by virtue of his observations in the preceding half month, and saw that there was a discrepancy of about 24 minutes of time. Inasmuch as the check word in the cablegram was correct he judged that the object observed by Lamp in Kiel must be a different comet from his own. The following morning was clear and he pointed the 12-inch telescope to the position that was handed to him. In looking through the finder of the telescope *he saw an eighth magnitude comet in the field of view.* This did not surprise him. He observed the position of the new comet, and we transmitted the observation by telegraph and cable, as usual, as belonging to a new comet discovered by Lamp in Kiel. This new object was at once known as Comet *a* 1896. Naturally considerable mystery existed (see *Astronomical Journal,* Vol. 16, p. 56, 1896, and *Astronomische Nachrichten,* Vol. 139, pp. 365–66, 1896). Several weeks elapsed before the tangled situation was unravelled at Mount Hamilton by our looking up the original cipher cablegram and detecting the error of 24 minutes in the conversion of arc into time, made after the cipher message had been translated and checked.

It is a surprising fact that the error should have directed the telescope upon an unknown comet, but the surprise increases when we consider another attendant fact. The new comet was moving amongst the stars very rapidly; more than 2° east in right ascension and more than 3° north in declination, daily. When the cablegram was written in Kiel on the morning of the fourteenth the new comet was six or seven degrees from the cabled position. When the erroneous position was handed to Perrine on the morning of the fourteenth the new comet was three degrees from that position. When the first opportunity came, the following morning, to examine the erroneous position, the rapidly-traveling comet had moved into that position. Had the telescope been pointed to that position on any other morning whatsoever, the celestial visitor would have been far outside the finder field, and the chances are fair that it would have come and gone unseen. The cabled Kiel position of reobservation of Comet *c* 1895 and Perrine's position of Comet *a* 1896 were:

Comet *c* 1895, Feb. 14, R. A. = 19 h. 45 m.,
Dec. = — 2° 23′ (correct translation).
Comet *c* 1895, Feb. 14, R. A. = 19 h. 21 m.,
Dec. = — 2° 23′ (erroneous translation).
Comet *a* 1896, Feb. 15, R. A. = 19 h. 22 m.,
Dec. = — 2° 49′.

The angular radius of the finder field was about 1° .3.

I doubt whether another case of coincidence as remarkable as this one is on record in the literature of astronomy.

W. W. CAMPBELL

LICK OBSERVATORY,
June 4, 1917

REPORT OF DR. E. H. WILLIAMS ON THE FIRST PHASE OF PENNSYLVANIA GLACIATION

WHEN in 1880 Professor Lewis and myself conducted the survey of the terminal moraine across Pennsylvania (the results of which are embodied in volume Z of the Second Geological Survey of the State) we supposed at the outset that we were following the actual limit of glaciation. Soon, however, we were convinced of our error and spoke of a "fringe" of territory sparsely covered with glacial markings, extending an indefinite distance

beyond. In deference to others we had no objection to substituting the words "attenuated border" for the word we had selected. The only person who has studied this "attenuated border" comprehensibly and in detail, in Pennsylvania, is Dr. E. H. Williams, Jr., whose attention was called to the problem twenty-five years ago, while he was lecturer on mining and geology, at Bethlehem.

By good fortune Bethlehem is almost exactly on the exterior limit of this attenuated border; and Dr. Williams' familiarity with the mineralogy of the region and with the many problems connected with the work of mining engineering, specially fitted him for prosecuting the investigations which he began and pursued at his own expense until the work was completed. Though many of the results of this work had been presented in piecemeal in various publications, it is only now that they are published in complete form and with adequate description and illustrations, of which there are no less than fifty-six, mostly photographic reproductions.

Following the example of Professor Chamberlin, who first gave a satisfactory explanation of the lobate character of the moraines west of Pennsylvania, in the topography of the region, Dr. Williams has brought to light as never before the causes operating to direct and limit the movements of the ice over the mountainous regions of New England and the Middle States.

1. There was a lobe extending southward between the Green Mountains and the Adirondacks through the Hudson Valley, the rock floor of which, between Lake Champlain and the Hudson River, was only 150 feet above tide. The average breadth of the upper Hudson Valley between the 500-foot contour is sixteen miles. Between the 1,000-foot contours it is thirty-two miles; but at South Kingston, New York, Storm-King and Marlborough Mountains rise abruptly 1,200 feet above the valley with a gorge between them, through which the river flows, only three fifths of a mile broad at the 500-foot contour and two miles at 1,000 feet. As a consequence the ice stream was diverted to the southwest through the Walkill-Rondout saddle into the great Pennsylvania valley, extending as far as Bethlehem, and damming up the Lehigh Valley so that the outflow of the drainage was turned over the watershed between the Lehigh and the Schuylkill at Topton; thus accounting for the glacial drift, which had been recognized by Salisbury, in the Schuylkill River at Norristown.

A natural explanation of the northwest trend of the glacial border, as shown in eastern and middle Pennsylvania, is found in the gradual rise of land to the west, which in Potter County attains an elevation of 2,500 feet. But in Schuylkill County the swelling mass of ice surrounding and finally overtopping the Catskill Mountains penetrated to Morea a few miles north of Pottsville leaving glacial markings of great interest on the surface of the mammoth coal bed, at an elevation of 2,100 feet above tide.

Again, as the Labrador ice advanced and increased in volume, passing around the elevation of the Adirondack Mountains it penetrated the Mohawk Valley through the Black River sag and entered the east fork of the Susquehanna, reaching the valley of the West branch at Williamsport and crossing over it so as to produce a dam causing the water to extend up Eagle Valley and run over into the Juniata at Tyrone, thus accounting for the glacial débris that I. C. White had found in the lower Juniata.

But it is in northwestern Pennsylvania that most interesting facts come to light. It appears that there was a long interval after the Kewatin and the Labrador glaciers set out upon their careers before they became confluent; so that when the Kewatin ice invaded the valley of the Great Lakes and poured its torrential drainage into that valley, Labrador ice was obstructing the eastward exits both through the St. Lawrence and through the Mohawk. This caused a rise of water over the basin of western Ontario and western New York, until, through the Conewango, it eventually found an exit into the Allegheny Valley, which then was not continuous but was separated by a col somewhat

south of Franklin from which streams were flowing both north and south. But this col was rapidly reduced by the glacial torrents and thus the present channel was formed. It was during this period that those remarkable deposits in the Conewango and the Allegheny about Warren were formed. At the bottom there is an immense deposit of fine sediment in horizontal laminæ giving place towards the surface, which rises 300 feet or more from the rock bottom, to coarser deposits indicating a southward flow of water.

One of the most interesting discoveries at this point is a nugget of Lake Superior Copper embedded in undisturbed deposits of glacial origin, dropped as Dr. Williams believes by icebergs floating in this temporary lake. Nuggets of copper which Dr. Williams is pretty confident are from the Lake Superior region are also found in glacial deposits of eastern Pennsylvania, brought thither as he believes by icebergs, which in an earlier period passed through the Mohawk Valley before it was completely obstructed by the Champlain-Hudson lobe of ice.

Dr. Williams names his brochure "Pennsylvania Glaciation; First Phase," and gives ample reasons for believing that in the East, at any rate, there is not that immense separation between the earliest and latest phases which geologists in the Mississippi Valley have been accustomed to assume as separating the Kansan from the Wisconsin stages. In Pennsylvania it is certain that such a wide separation can not be maintained; for, though it is true that the glacial deposits over the attenuated border are in general more highly oxidized than those in and north of the moraine, *they are not all highly oxidized.* Mingled with the highly oxidized material of this area there is a small proportion of comparatively fresh material, and it is that which must determine the age. It is evident that the most of the material on the attenuated border was oxidized in preglacial times and was brought forward in that condition by the ice movement. For example, numerous pebbles are found which are oxidized on the outside, while there is a core on the inside that is unoxidized, while in some instances such pebbles have been ground off on one side by the glacial movement, exposing this unoxidized core and leaving the thick covering of oxidization on the other side.

Certainly the scientific public is greatly indebted to Dr. Williams for the pains which he has taken: first, to collect the facts which are found in this brochure, and second for bringing them before the public in such full measure, at his own expense. No glacialist can afford to remain ignorant of the facts and discussion of principles contained in it. The reader will lack only a detailed map of the state of Pennsylvania, which he needs to have constantly before him. The small relief map accompanying the publication is good so far as it goes, but needs to be supplemented for reference by one that gives minute details of topography and geology.

G. FREDERICK WRIGHT

OBERLIN,
May 22, 1917

QUOTATIONS

THE WAR AND SCIENTIFIC INVESTIGATION

THE commendable patriotic ambition of every rightminded American to render his best help in the time of his country's need has raised questions of choice for many citizens. The spirit of service is rife throughout the country, and one's first impulse frequently urges him to enter those avenues of activity that lead nearest to the combat. A sane, calm review of the situation indicates, however, that there are many fields which require profound attention, even though they often seem quite remote from the trenches. The chemist in the munitions works, the bacteriologist who is testing the efficiency of the latest antiseptics, the agriculturist who is striving to solve the immediate difficulties of farm practise or aiding in the "speeding up" of the production of staple crops, live stock and other food products—all of these workers are an indispensable part of the great human organization that must cooperate to lead the way to victory. Frequently many workers, par-