XXIII.—*On the Meteoric Stone of Rochester, Fulton County, Indiana*; by CHARLES UPHAM SHEPARD, Massachusetts Professor of Natural History in Amherst College.

A FALL of a meteoric stone took place at about 8:45 Thursday evening of the 21st of December, 1876. The circumstances connected therewith are drawn from several communications.* The first is from Professor Daniel Kirkwood, of Bloomington, Indiana, Professor of Mathematics in the Indiana State University, as published in the Indianapolis Journal. Professor Kirkwood's account says: "Last evening, Dec. 21,

* See also this volume, p. 166.

about 8:45 o'clock, our citizens witnessed a meteoric display of extraordinary brilliancy. A fire-ball, described by many observers as surpassing the moon in apparent magnitude, followed by a great number of smaller meteors, was seen in the northern heavens, moving in an easterly direction. Its first appearance was at a point 12° or 15° north of west, and about 10° above the horizon. Its greatest altitude, as seen from Bloomington, was about 18° or 20° , and its disappearance occurred at a point in the northeast, some 5° or 6° above the horizon. A remarkable feature of the meteoric group was the slowness of its apparent motion. The time of flight was variously estimated. Most observers, however, think it could not have been less than three minutes. Many of the meteors following in the train of the principal bolide were larger than Venus or Jupiter. No attempt was made to count them, but their number was certainly nearly one hundred. Some minutes after the disappearance a rumbling noise was heard, which was supposed to result from the meteor's explosion."

The second is from the Columbus (Ohio) State Journal.

"A meteoric display, which, for singularity and beauty, few persons in a lifetime have the good fortune to behold, was witnessed by six or seven persons, myself included, on the evening of the 21st inst., at just 9 o'clock. Four of us were in the caboose car, and two or three others on the engine of the freight train, due in Columbus at 9:20 P. M., on the Cleveland, Mount Vernon and Columbus Railroad, and within about four miles of the depot. At that point the track runs nearly north and south. The cluster or flock of meteors, from forty to sixty in number, varying in apparent size from a water-bucket down to the size of large apples, were seemingly huddled together like a flock of wild geese, and moved with about the same velocity and grace of regularity. The color of their light was a yellowish red, resembling the light from the red balls of fire thrown out by the explosion of some kinds of sky-rockets. There was no illumination, nimbus, or trail from them. The display was a little below an angle of 45 degrees from our point of observation, and seemed not over a quarter of a mile distant from the rear end of our train. The course was from west to east, crossing the railroad at nearly right angles. The party on our engine, and our conductor, who was looking out of the rear window of our car, made the discovery at about the same moment, in a westerly direction. When seen by the rest of us, the meteors were just passing over the track and very slowly approaching the earth. I cannot pretend to put this statement in scientific form, having witnessed it from a moving train, but simply state the facts as they appeared to myself and others as worthy of note."

The third notice attended one of the specimens sent me, and consists of a letter addressed to Professor Kirkwood, from Mr. A. J. Morris, the finder of this stone.

"Enclosed you will find a specimen of the meteorite. The circumstances under which the stone was found are these. Hearing a rumbling noise, I stepped out of the house, and heard the stone fall. I marked the direction of the sound, and the next morning repaired to the field whence it had proceeded, where I discovered it lying upon the snow. I saw two places where it had previously struck, and from whence it had bounded to its resting place. No appearance of any other stone was visible in the region. Its weight was about three-quarters of a pound."

The following is from a letter (dated Bloomington, Ind., Jan. 19th) from Professor Kirkwood to myself:

"You were kind enough to express a wish that I would furnish you some notes in regard to the meteor. I have written many letters of inquiry, to some of which I have received replies. I have also a number of newspaper accounts of the phenomenon. I regret to say, however, that many of the statements made by observers are so inaccurate and contradictory as to be of little value. Being busy with other matters, I placed nearly all of them in the hands of Professor Wylie. The following conclusions, derived from the observations at Bloomington, Indiana, and Wooster, Wayne County, Ohio, can be relied upon as nearly correct:

Rev. Dr. Wylie, Professor of Natural Philosophy in the Indiana State University, noticed the point in a tree apparently passed by the meteor. The angle of elevation was subsequently measured, and found to be about 15 degrees. But the meteor passed our meridian 131 miles north. These data, making allowance for the curvature of the earth's surface, give about 38 miles as the height of the body when passing the boundary line between Pulaski and Fulton Counties, Indiana. At Wooster, Wayne County, Ohio, the meteor apparently passed a particular point of the steeple of a public building. From this observation the apparent altitude when over Lake Erie, immediately north of the city, was found by Professor Samuel J. Kirkwood to have been about 24 degrees, corresponding to a true height of 28 or 29 miles.

The most western point from which I have received a report is Emporia, Kansas. It passed that place a few degrees S. E. of the zenith. I think the meteor became visible over the N. W. corner of Texas, at an elevation of 70 or 80 miles. The estimates of time for the meteor are so discordant that it seems impossible to determine whether it was moving in an ellipse, a parabola, or an hyperbola."

Description of the Rochester Stone.

It belongs, by way of eminence, to my order of Oolitic, of the class Litholites, and resembles most closely the Pegu (India) stone of December 27, 1857, particularly in the character of its crust and in its pisiform external structure. The two stones are not unlike in color and in the facility with which they may be broken, both yielding to separation when in small masses, under the mere strength of the fingers. The thickness of the crust in each is double that in the majority of litholites. The general tint of color is also the same in both. In the Rochester stone, however, the shade is less gray, from the greater prevalence of an almost pulverulent, nearly white mineral, in which the dark ash-gray globules are imbedded. This white mineral forms less than one-tenth of the mass. The globules vary in size from a millet-seed up to that of a pepper-corn. Their shape is almost perfectly spherical, and plainly indicates an origin from fusion, the surfaces of many of them being obviously mammillary, while internally they present a porcelainous, compact structure.

The globules are probably forsterite, of a variety nearly identical with boltonite. This appears the more likely from the circumstance that those situated just below the crust have the yellowish tint acquired by boltonite after its subjection to heat with access of air; and it is presumable that this alteration of the globules in the meteorite took place on its entrance into our atmosphere when the fusion of the surface occurred.

The white semi-pulverulent basis of the stone I take to be Chladnite (Mg^2Si^2). In one of my specimens, it shows itself at a single point in its characteristic loosely crystalline structure; and there closely resembles this species as seen in the Bishopville (March 25, 1843) meteorite.

The metallic iron (chamasite?), as in the Pegu stone, is very obvious; and rather evenly distributed, though probably not exceeding one per cent in quantity. In place of being in shapeless grains or points, or in curved wire-like fibers, it is semi-crystalline in structure, showing occasional rectangular and triangular facets. Troilite is barely visible at two minute points in the specimens thus far examined. Two distinct grains of Chrysolite, of the size of half a rice grain, are present, showing in each case the cleavage, color and luster of this species, as existing in Krasnojarsk meteoric iron. Moreover, these grains have not the perfect spherical form of the forsterite globules.

The specific gravity of a fragment, whose surface was one-third crust, is 3.65. It may be added in conclusion, that the inspection of this rather peculiar stone strongly suggests the idea that the pisiform globules were produced by the sudden

fusion of what was originally a chladnitic material (similar to the Bishopville stone), amid particles of chamasite attended by access of oxygen, whereby the silicate of magnesia became converted into the more fusible double silicate of magnesia and iron.

New Haven, Conn., Jan. 22, 1877.