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There has recently been presented to the geological collection of the University of Wisconsin a lightning tube or fulgurite which has considerable interest because of its shape — a perfect dextro-rotary helix. The specimen is the gift of Mr. G. H. Kruschke, town clerk of the town of Cutler, Wisconsin; who has furnished me with the data for the following description of the manner of its discovery.

The fulgurite was discovered in October, 1897, by Frank de Lap, Mr. Kruschke's son-in-law, while digging a cellar on the southeast quarter of the northeast quarter of Sec. 20, T. l8, R. 2E., Town of Cutler, Juneau County, Wisconsin. It was imbedded in a sand knoll about ten feet high, at a distance of five feet below the surface. A house has since been built upon the spot.

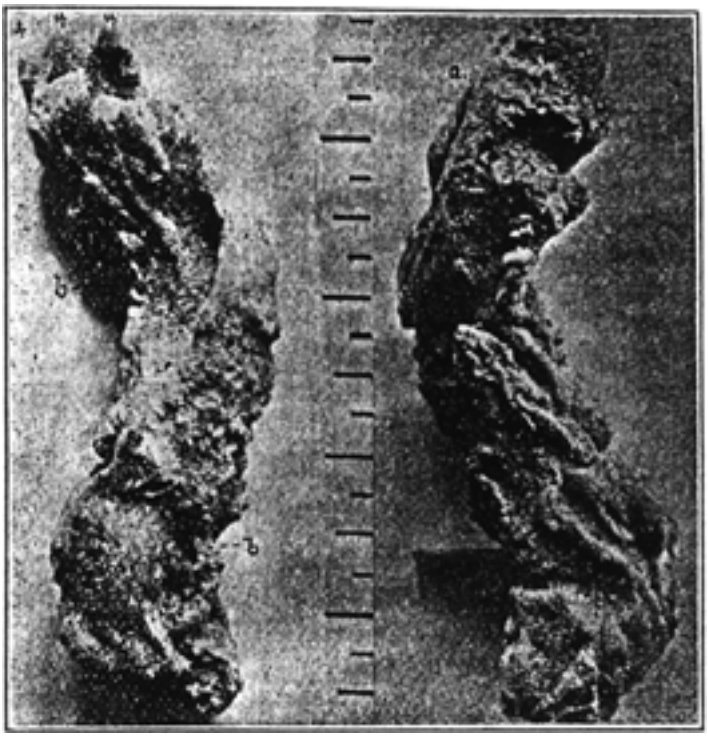

Figure 1: Spiral fulgurite from Cutler, Wisconsin, showing opposite sides. The units in the scale are inches. a, a, a, in the figure at the left, horn-like protuberances terminating the fulgurite. b of the same portion of the figure, corrugations broken open and exhibiting thin-walled tubes. a in figure at the right, point of emergence of main channel (hidden in the view).

A sample of the sand in which the tube was found has been kindly furnished by Mr. Kruschke, and proves on examination to be a fairly clean sand, of a light brown color, largely composed of translucent quartz grains which average about 1/64th of an inch in diameter. The coloring matter appears to be ferric oxide. The tube itself is about as thick as a man's thumb, and over five inches long. When found it was about three inches longer, but Mr. Kruschke reports that a piece was accidentally broken off and lost. Examination of the broken end shows that the fulgurite is composed of a dull gray slaggy mass, filled with larger and smaller cavities exactly like those observed in porous natural slags.

There are a few dark specks surrounded by stains of iron oxide. Somewhat excentrically located in this end section is a cavity of irregular cross-section which appears to extend into the fulgurite as a more or less continuous tube, but is so bent and locally contracted that it is impossible to follow it for any distance. Its average diameter is about 3/16th of an inch, but it is partly filled by blister-like eruptions which protrude from its walls. One of these blisters which is broken open has walls as thin as paper.

Figure 2: Artificial fulgurites made by Prof. Wood. The units in the scale are inches. a is a tube with branch-like protuberance at the side. b is a tube of nearly symmetrical cross-section. c is a tube with marked corrugation extending along one side. d exhibits the cross-section of a large tube.

The other end of the fulgurite has not been broken in any way but forms four irregular horn-like projections (a-a-a in the left of fig. 1). The channel (it cannot be asserted that this is continuous with the one observed at the other end) emerges at one side of the fulgurite (a, in right hand portion of fig. 1) with only a thin wall less than a millimeter in thickness on the outer side.

The surface of the fulgurite is very irregular, being traversed by corrugations whose greatest extension is in the direction of the longer axis of fulgurite, though they exhibit some tendency

to wrap themselves around it in a dextro-rotary manner. These corrugations appear to be, for the most part, thin walled tubes (b, at the left in fig. 1) which, are not now continuous passages, but are so distorted and contracted locally as to suggest that they have suffered collapse since their formation.

Over the entire outer surface of the fulgurite are grains of sand which show varying degrees of former fusion. Those which have been completely fused are opaque and white, and are firmly cemented to the glass of the tube. The others adhere less firmly and where distributed abundantly appear brown, as in the sample of loose sand from the locality. The photographs shown in fig. 1 exhibit opposite sides of the fulgurite and indicate, as well as any photographs are likely to do, its perfectly helical form. The only fulgurite known to me which shows any approach to this shape is that from Waterville, Maine, described by Bayley,* which has marked corrugations that wind about the axis of the fulgurite in the form of a dextro-rotary helix.

The fact that the Waterville and Cutler fulgurites show each a spiral twist of the same type is sufficient evidence that the structure is not an accidental one, but one to be explained by the conditions of the lightning discharge, which doubtless followed a spiral course through the sand. Professor R. Wood, of the Physical Department of the University of Wisconsin, has suggested to me that this may be explained in some way by the influence of the earth's magnetic field upon the discharge. There is at least a possibility that there may be some analogy between the experiments of Hittorf† with electric discharges in a magnetic field, and the lightning discharge. Hittorf found that in the case of negative discharge in a direction nearly parallel to a line of force that the spark takes the form of a dextro-rotary spiral and wraps itself about the line of force. It hardly seems possible that the earth's field would be sufficiently strong to effect such a change in the course of the lightning, and, moreover, the return discharge would be of an opposite character, and should produce a spiral of the opposite kind unless the initial discharge controls the form of the sand tube. The above

* A Fulgurite from Waterville, Maine, by W. S. Bayley, this Journal (3), 1892, xliii, p. 327.
† J. J. Thomson, Recent Researches in Electricity and Magnetism. Oxford, 1893, p. 134.

is, therefore, offered only as a suggestion and not in any sense as an adequate explanation.

I do not remember to have seen any description of artificial fulgurites. Professor Wood, on being shown the Cutler fulgurite, expressed the belief that he could make some of the ordinary kind. Within a half hour he had produced the tubes which are shown in fig. 2, by immersing, carbon electrodes in a bath of sand and passing the current from an ordinary arc circuit through them. In a of the figure is seen a fulgurite having a hollow protuberance on one side, really a branch of the tube; b is a tube of fairly symmetrical cross section; the tube c has a marked corrugation extending along one side, and shows perhaps a slight trace of spiral curving; while d (shown in cross section) indicates how large fulgurites may be made by this simple method. I am indebted to Professor Wood for permission to publish a photograph of these artificial fulgurites.

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