sixth, and *seventh* orders of magnitude, before those of the *third* and *fourth* had been correctly computed. This seems to be a sufficient reason for the nearly stationary condition of the lunar theory during the past three-quarters of a century, notwithstanding the great efforts which have been made to perfect its solution. Its advancement has been blocked by the obstacles thrown in its path by analysis itself; and we may therefore reasonably hope for substantial improvement in the theory and tables when they are no longer embarrassed with equations which have no existence in nature."

We may remark that there are two ways in which the correctness of Mr. Stockwell's conclusions may be tested: first, a mathematical expert competent to pronounce upon his theoretic processes should go over his work with the most searching criticism in every detail; and second, his theory should be compared with observations. But this latter would be a task of such immensity that no astronomer unassisted would hope for its completion.

NEW YORK ACADEMY OF SCIENCES.

Oct. 31, 1881.

The President, Dr. J. S. Newberry, in the Chair.

Twenty persons present.

The following paper was read by Mr. John H. Furman:

"The Geology of the Copper Region of Northern Texas and the Indian Territory."

The well-marked cretaceous beds of Parker County, Texas, extend for 30 miles north of west from Weatherford, on the road to Graham. They consist of strata of shelly limestone, sandstone and shaly clay, the latter grayish or reddish in color. An occasional thin seam of soft coal is found; and the water is strongly impregnated with lime. A stratum of sandstone stretches for thirty miles N. W. from Fort Worth. In this rock springs are found containing sodic carbonate, similar to the waters of the artesian wells of Fort Worth, Tarrant County, at a depth of about 270 feet. Towards Graham, the country assumes a semi-mountainous appearance, and, for twenty-five miles or more, sandstone ridges alternate with prairies, the hills being covered with scrub oak. Some of the ridges attain an elevation of two or three hundred feet above the prairies. The strata are horizontal, and large portions of the original surface have been carried away by erosion. The upper stratum is in many places a conglomerate, made up of small pebbles. In this region the seams of coal met with are generally soft, and the only workable bed known is one about three feet thick, yielding a fair quality of bituminous coal, which crops out and has been traced for several miles near the Clear Fork of the Brazos river in Young County. This supposed coal region has a general N. E. and S. W. direction.

Approaching Graham the prairies begin to resemble the plains; and the ridges, capped with sandstone, show bases of mottled reddish-colored shales, or clay; salt springs and salt streams are found, indicating the border of the great alkaline region. From Graham to Fort Griffin in Shackleford County, thence north in Throckmorton County, the country rises. Every few miles a steppe is mounted, the face of the escarpments showing horizontal thin limestone strata. The same features continue, and then the country slopes towards the Brazos river.

Turning westward through Haskell County, the surface lowers again towards the Brazos, the river coursing south to north, and a plain is crossed, the ground differing from any observed. The soil is mixed and covered with gravel, in many places several feet deep. The pebbles vary in size from half an inch to an inch and a half in diameter, and consist of feldspar quartz, porphyry, and basalt. On the western side of Haskell County the copper bed is reached not far from the Brazos river; and west of the copper a great belt of gypsum hills, several miles in width, extends northward, parallel with the copper bed, into the Indian Territory. Gypsum occurs there in most of its forms, including selenite which has been locally mistaken for mica.

On reaching a scene of attempted mining operations in search of supposed veins of copper, a very short examination convinced me that no vein would ever be discovered. Denudation has laid the bed bare, sweeping away the larger portion uncovered and leaving only patches; but these were sufficient to give a clear conception of the mode of occurrence. The copper-bearing stratum is an ashy-colored clay shale, more or less tinged with green, the upper portion showing the deep green carbonate of copper, usually two or three inches thick. Overlying this stratum is a cap-rock of gypsiferous sandstone, about three feet thick, with a layer ⅛ to ¼ inch thick, impregnated with carbonate of copper, as though it had soaked it up from below. Underneath the gray or green bed an intensely red clay shale is generally found. Nuggets of copper are scattered over the surface of the red bed, with pieces of cuprified wood and nuggets of iron pyrites. In the wood the original structure in many instances is perfectly preserved, also appearing cuprified in all stages of decay, as though it had become half rotten before the petrifaction was effected. The overlying sandstone frequently contains biscuit-like concretions of gypsum. Juniper trees abound and also cover the gypsum hills, the perfectly preserved cuprified wood, with its knots and bark, showing a fac-simile of that growth. I found in the gray bed fragments of wood partially unaltered, as though it had just commenced to absorb copper; also large pieces of coal, three or four inches or more in diameter, the cracks of the same piece being filled with crystalline carbonate of copper, or with white gypsum, thus appearing veined with copper and gypsum. In parts of the bed remaining the resemblance to piles of ashes and charcoal is strikingly deceptive; in one shaft, sunk to a depth of about thirty feet, the horizontal position of the strata was confirmed, the shaft passing through the cupriferous gray bed, and then through a succession of layers of red shale and soft red sandstone, in which not a trace of copper was found. The gray stratum extends seventy-five feet or more under a point of the gypsum hill. In a tunnel traversing this stratum I noticed occasionally pebbles belonging to the gravel drift. This copper formation has a general north and south course, usually less than fifty yards in width, and was traced for a distance of eight or ten miles to the southern boundary of Haskell County.

At one point the gray bed lies between beds of sandstone; the red bed does not appear, and the underlying sandstone strata are almost white, laminated, and very hard. The bed is more than two miles distant from the gypsum hills; the gravel drift is noticeable and even abundant. Observing the nuggets of copper ore and the drift pebbles lying about in places on the red bed, the idea forced itself upon me that there might be a remote connection between the two. However, the nuggets of ore are evidently concretions, and no pebbles occur in the gray bed. The gypsum range extends several miles across, with a western declivity similar to that on the eastern side. A plain, a little over one hundred feet below, reaches beyond to the foot of the great Llano Estacado. On these hills and on this western plain the gravel drift is wanting.

The copper bed was traced five miles further to the north; also in Knox county, not far from the Wichita river, and forty miles or more north of the southern portion of Haskell county, besides learning its supposed occurrence north of the Wichita river. The copper band

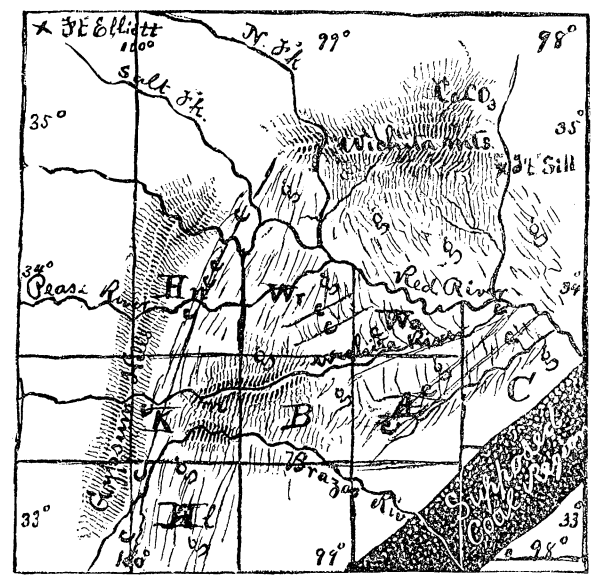
here lies between the sandstone and gray bed, with the red beds beneath. Eastward, between the Brazos and Wichita rivers, the gravel drift is abundant, with many stones of greater diameter. At the "Narrows," between the Wichita and Brazos rivers, the width is only sufficient to admit the passage of a single wagon. Continued caving in of the bluffs of the two rivers has widened an immense eroded area, rendering a large surface valueless, and while the channels of the rivers are several miles apart, their junction is only a question of time. In the copper region of the little Wichita river, near the centre of Archer county, the ore occurs under the same general conditions, with a different course, N. E. and S. W. and copper nuggets, coal and cuprified wood are found.

Embedded in the overlying sandstone, in some instances several feet above the gray bed, the sandstone frequently attains a thickness of more than fifteen feet. The cuprified wood is altogether different from that of Haskell county, and resembles the wood of the mesqui e tree, which I found scattered about. The gravel drift here is identical in character with that of the region further west, and pebbles occur in the gray copper-bearing bed beneath the sandstone. The extension of the gravel drift of Haskell county, beyond the Brazos river system, its absence west of the gypsum hills, the larger size of the pebbles in Knox county, bordering the Wichita river, and the occurrence of the drift only in the vicinity of the copper-bearing lines mentioned, and in Archer county, suggested to me a possible relationship of some kind between the two, perhaps their origination in the same region.

Between the Wichita and Pease Rivers I crossed several copper-bearing beds, having a general northeast and southwest direction. In Wilbarger County the gravel drift is in great quantity, and boulders from three to seven inches in diameter occur. In places, and having a northeast and southwest bearing, heavy deposits or lines of gravel and boulders attract attention, appearing as though a great flow towards the southeast had met obstructions along its course, the great incline of this region being directed toward the southeast. Beyond Pease River the gravel drift lessens, but the large boulders are occasionally seen as far west as the gypsum hills. Not far north from the centre of Hardeman County I again found the Haskell County copper bed, the accompanying sandstones being thin and much mixed with gypsum. The copper bed reaches higher than the surrounding country, except the gypsum hills to the west. From this high locality of the copper, known as Prairie-dog Mounds, the country inclines on one side northward to a creek emptying into Red River, and on the other side southward to the Pease River.

South of these mounds, where only here and there patches of the bed are preserved in the midst of a general erosion, I found the largest mass of copper ore thus far discovered, consisting of an aggregation of cuprified wood, resembling the trunk of a tree, more than one foot in diameter. Beyond Red River the bed continues to the vicinity of the Salt Fork of Red River, distant but little over 20 miles from the Wichita Mountains of the Indian Territory. The bed probably continues nearly to the western end of these mountains, and here must be found the true centre of elevation and the origin of the gravel drift. The Haskell County copper bed was also traced south to the Wichita River, thus establishing its continuity from the southern portion of Haskell County, through Knox and Hardeman Counties, into the Indian Territory, a length of more than 100 miles. Subsequently, the northern end of the bed was found a short distance from the western end of the Wichita Mountains, on the south side of the range. The copper formations of Archer and Wichita Counties continue through Clay County to the Red River boundary of the Indian Territory. The gravel drift does not extend to the north of the Wichita Mountains, but a limestone district occurs about 20 miles in width, that reaches probably as far out to the north, from the Wichita Range, the course of the latter being east and west. This limestone area may be called mountainous, is much disturbed and tilted, and is similar in appearance to the metalliferous limestone formation of Mexico. The Wichita Mountains are mainly made up of porphyries, trachytes and basalt, and appear to be two parallel ranges with transverse ranges and small valleys between. About 12 miles west of Fort Sill an extensive body of hornblende slate makes its appearance between the two main ranges. The drift from the mountains extends to the south and southeast. It is found as far west as the Haskell County copper bed, and as far east as the Archer County copper bed is known. The river channels of that section of the country have been formed since this drift period. The development of the Wichita Mountains seems to have marked the close of a period of uplift and simultaneous erosion.

These mountains have the same general appearance as the Rocky Mountains, which pass through the western portion of Texas and the State of Coahuila, Mexico; and it has been a matter of much interest to observe that similar drifts of local origin are frequently met in the latter regions. The Wichita Mountains appear to be identical in origin with the Rocky Mountains, and constitute the most eastern spur of that system. In Northern Mexico short ranges are encountered, striking east and west, and of these the Wichita Mountains appear to be a reproduction. The Wichita Mountains will be found to contain mineral deposits, possibly of some value; veins of copper ores do exist 40 miles west of Fort Sill, near Otter Creek, in the mountains; but I am convinced that the copper bed or stratum of Northern Texas will prove of no commercial importance.



SCALE—52 MILES TO 1 INCH.

A.	Archer County.
B.	Baylor County.
C.	Clay County.
Hl.	Haskell County.
Hn.	Hardeman County.
Wa.	Wichita County.
Wr.	Wilbarger County.
c. c. c.	Copper Bed.
g. g. g.	Gravel Drift.
n.	Narrows.

Prof. Newberry remarked that the communication of Mr. Furman was of great interest, since no accurate description had before been given of the geological

structure of the region where the copper occurs in northern Texas and the Indian Territory. He had received specimens from that region long ago and recognized their similarity to the copper ores of New Mexico, where in the upper portion of the Triassic formation copper forming concretions and replacing wood occur in many localities, and have been more or less mined for. In one locality near Abiquini very extensive galleries have been cut in the sandstone in search of copper which there replaces branches and trunks of trees and forms concretions which are irregularly scattered through the rock. Here the work was done by the early Spanish explorers perhaps 200 years ago, and the remains of the furnaces in which the copper was smelted are still to be seen at the mouth of the mine. Still further west, in southern Utah, the same formation carries copper and considerable silver, at Silver Reef enough to pay well for mining, but in no locality yet known are the deposits of copper ore sufficiently concentrated and continuous to make mining for that material profitable, so it would doubtless be found in Texas and the Indian Territory. The copper was deposited with the Triassic rocks from a shallow sea in which an unusual quantity of copper was held in solution. This impregnated the sediments found at the bottom replacing wood and forming as nodules about some nucleus. The aggregate quantity of copper in this formation was enormous, but, except where by the erosion of the beds it accumulated at the surface and could be picked up without any expense in mining, it would hardly pay to attempt to obtain it by ordinary mining processes.

The wood replaced by copper Dr. Newberry said was undoubtedly all coniferous, and different from any now living. The beds which contained the cuprified wood also contained much that was silicified. Of this he had examined many specimens under the microscope and had found the peculiar dotted cells which are characteristic of the coniferæ, and these grouped in such a way as to prove the trees to have belonged to the Araucarian group of conifers. So far as yet known the angiosperms, or higher order of plants, did not make their appearance on the earth's surface until after the copper bearing rocks of the southwest had been deposited.

THE AMERICAN CHEMICAL SOCIETY.

The November meeting of this Society was held on Friday evening, November 4th, with Vice-President Leeds in the Chair.

The following gentlemen were duly elected members: Dr. C. W. Volney, Dr. Witthaus, Messrs. C. E. Munsell, W. W. Share, J. D. O'Connor, and Day. The first paper of the evening was "On some New Salts of Thymole Sulphoacid, and some new facts concerning the same," (a second paper) by Mr. J. H. Stebbins, Jr., S. B. The sodium salt having the formula

$$C_6H_2\,(CH_3)\,(C_3H_7)\,(NaSO_3)\,O\,Na+2\tfrac{1}{2}H_2O$$

was described, and also the free sulphur salt had its characteristics enumerated.

Mr. Stebbins followed with a second paper "On the Combination of Diazo Compounds with Thymole Sulpho-Acid."

In this he described the experiments which he performed in his work, the results of which were given in the first paper. Both were technical and not of any popular interest.

The third paper was by Dr. C. W. Volney, and was entitled, "The Constitution of the Explosive Derivatives of Glycerine."

In this communication the author tried to prove that the nitro-glycerine was composed by the substitution of the nitrogen trioxide (NO_3) instead of the nitrous oxide NO_2, making the formula $C_3H_5\,(NO_3)_3$ instead of $C_3H_5\,(NO_2)\,O_3$, and secondly, he showed how it was possible to substitute chlorine for the nitrogen trioxide and so produce a new explosive compound.

This paper provoked much discussion on account of the theoretical arrangement of the atoms necessary to sustain Dr. Volney's statement.

Subsequently the Committee on Nominations reported that the following ticket was recommended to the Society for their votes at the December meeting.

Corresponding Secretary.— P. Casamajor.
Recording Secretary.—J. H. Stebbins, Jr.
Treasurer.— M. Alsberg.
Librarian.—Geo. A. Prochazka.
Curators.—A. J. Rossi, Wm. Rupp, A. A. Fesquet.
Committee on Publications.—Arno Behr, A. R. Ledoux, H. Endemann.
Committee on Nominations.—A. H. Elliott, O. H. Krause, J. P. Battershall, J. B. F. Herrishoff, T. O'C. Sloane.
Board of Directors.—P. Casamajor, J. H, Stebbins, Jr., H. Morton, C. F. Chandler, M. Alsberg, E. R. Squibb, W. H. Nichols, W. H. Habershaw, E. Waller, A. H. Gallatin, Geo, A. Prochazka.

ON THE NATURE OF THE DIPHTHERITIC CONTAGIUM.

By Dr. H. C. Wood.

The lecturer began by stating that the researches which formed the basis of the present address had been made under the auspices, and, indeed, at the suggestion, of the National Board of Health, by Dr. Henry F. Formad and himself, who were jointly responsible for the facts and inductions and jointly deserving of whatever reprobation or approbation might be due. The full text of the work is now in the hands of the National Board, and will be shortly published by them as an appendix to their annual report, and the lecturer desired that criticism be withheld until this was done, as the memoir will contain much that cannot be spoken of in the present lecture.

In the spring of 1880 work was begun by inoculating rabbits with diphtheritic membrane taken from the throats of patients at Philadelphia. An account of the labors of the following summer has been already published, but it seems necessary to epitomize them here. It was found that only in a very few cases was anything like diphtheria produced in the rabbit by inoculating with the membrane. The inoculations were practised by putting pieces of the material sometimes under the skin, sometimes deep in the muscles. Many rabbits died after some weeks, not of diphtheria, but of tuberculosis. In a series of experiments it was shown that this tuberculosis was an indirect and not a direct result of the inoculation, and that any apparent relation between the two diseases is only apparent, not real. Next, the tracheas of a series of rabbits were opened and false membrane inserted. It was found that under these circumstances a severe trachitis was frequently produced, and was attended by an abundant formation of pseudo-membrane. Careful studies made of the false membrane of diphtheria and of this false membrane showed that the two were identical, both containing in abundance fibrin fibres, corpuscular elements, and various forms of micrococci. To determine whether other inflammations of the trachea than that caused by diphtheria or its membrane are accompanied by the formation of false membrane, a number of experiments were made, and it was demonstrated that the production of false membrane has nothing specific in it, but that any trachitis of sufficient severity is accompanied by this product. Careful studies also showed that this false membrane does not differ in its constitution from that of true diphtheria, except it be that the micrococci are not so abundant in it. We always found some micrococci, and in some of these traumatic pseudo-mem-

*AN ADDRESS MADE BEFORE THE ACADEMY OF NATURAL SCIENCES.