times that of Angström's map, and in definition are more than equal to any map yet published, at least to wave-length 5325. The 1474 line is widely double, as also are b_3 and b_4, while E may be recognized as double by the expert. In the region of the H line these photographs show even more than Lockyer's map of that region. Negatives have also been prepared down to and including the B group, and they may be made ready for publication, one of which shows eleven lines between the D lines. A scale of wave-lengths is printed on each plate, and in no case does the error due to displacement of the scale amount to one part in fifty thousand. The wave-lengths of over 200 lines have been determined to within one part in five hundred thousand, and these serve as reference lines to correct any small error in the adjustment of the scale. The great value of such a map lies not only in the fact that it gives greater detail and is more exact than any other map in existence, but that it actually represents the real appearance of the spectrum in giving the relative intensities and shading of groups of lines so that they are readily recognizable. The photographs were taken with a concave grating six inches in diameter, and having a radius of curvature of 21½ feet, and the photographs were taken when the plate was placed directly opposite the grating; both the sensitive plate and grating being perpendicular to a line joining their centres, and placed at a distance apart equal to the radius of curvature of the grating, the slit being on the circumference of the circle, whose diameter is the distance between the grating and plate. With this arrangement, the spectrum is photographed normal for wave-lengths without the intervention of any telescopes or lens systems; and a suitable scale of equal parts applied to such a photograph at once gives relative wave-lengths.

Few persons have any idea of the perseverance and patience required to bring such a task to a successful issue. More than a year was devoted to preliminary experiments designed to discover the best mode of preparing the plates for the particular regions to be photographed. Hundreds of preparations were tested to find their influence on the sensitized plate, and the whole literature of photography was ransacked, and every method tested to the utmost, before the work of taking the negatives could begin.

The Rogers-Bond comparator, which has been already referred to as having been purchased by the university lately, is one of two instruments that were constructed in 1881 by Pratt & Whitney of Hartford, Conn. The general plan and requirements were made out by Prof. W. A. Rogers of Cambridge, and the drawings and details were worked out by Mr. George M. Bond, then a student at Stevens institute. The comparator was designed for making exact comparisons of standards of length. The other similar comparator is owned by the Pratt & Whitney manufacturing company, and is used by them in testing and constructing their standard gauges.

The instrument consists essentially of two microscope carriages, which slide on two parallel cylindrical steel ways between stops, which may be clamped at any point. A carriage entirely independent of the ways on which the microscopes slide, supports the two bars to be compared, and is provided with means of accurate and rapid adjustment, by which the bars may be successively brought into position under the microscopes, and the lengths compared by the micrometers attached to the microscopes; or one microscope only need be used, and slid first against the stop at one end, and then against that at the other end. The instrument also affords great facility in determining fractions of a given length with any desired degree of precision. The instrument is one requiring the utmost skill in its construction, and it cost several thousand dollars to make it. A full account of this remarkable instrument is given in the Proceedings of the American academy of arts and sciences for 1882–83. K.

NORTH CAROLINA COAL-FIELDS.

THE coal-deposits of North Carolina have recently been examined by Dr. H. M. Chance,[1] under the direction of the North Carolina state board of agriculture, with the view of determining their commercial value.

There are two isolated triassic areas in North Carolina in which coal has been mined, — one on Deep River, and the other on Dan River. Dr. Chance's explorations in the Deep River coal-field consisted mainly in a re-examination of the coal outcrop, which follows the west border of the area, and passes through Farmville, Gulf, and Carbonton. The various sections obtained show that in general there are two workable coal-seams in this field, as was proven long ago in the Egypt shaft and at several mines along the coal outcrop. The upper seam averages 2.5 to 3 feet, and the lower 2 feet in thickness. In the Egypt shaft the upper coal measured 4 feet, and the lower 1 foot 10 inches; twenty-seven feet below the lowest of these workable seams, another, 1 foot thick, was penetrated. At Gulf three workable seams outcrop, but their thickness is variable owing to

[1] *Report on the North Carolina coal-fields to the department of agriculture* [of North Carolina]. By Dr. H. M. CHANCE. Raleigh, 1885. 66p., 3 maps. 8°.

disturbances due to trap-dikes and faults. The dip of the coal-seams is in general S. E. 25–30°.

Several new analyses of the coal of this area are presented, some of them being of average samples from large quantities. The coal is 'bituminous,' as is shown by the following average of a large number of analyses: volatile matter, 30; fixed carbon, 54; ash, 12; sulphur, 3.6 per cent. At times the coal has been altered to a semi-anthracite, and even to a natural coke, by the heat of trap-dikes.

The expense of working the coal in seams 2 feet thick is estimated at $1.50, and in seams 3 feet thick at $1.20, per ton. In the mines of Tennessee and West Virginia, with which the North Carolina coal comes in competition, mining is carried on at the rate of about 65 cents per ton. Combining these figures with the cost of transportation, it is shown that there would remain a sufficient margin in favor of Deep River coal to command the market in eastern North Carolina. This is favorable to the development of the Deep River deposits: still the fact that these mines have not been worked for many years is significant.

The Richmond coal-field, which is of the same age and of the same general character as the Deep River deposit, but in which coal occurs in much thicker seams, and in general is of better quality, has also been a failure, when the mining operations of the whole field are considered. It is evident, therefore, that there must be some sufficient reason why mining in these fields, which are in close proximity to good markets, has not succeeded. Dr. Chance enumerates some of the more obvious difficulties that present themselves in the Deep River area: there are variations in the thickness and quality of the seams, faults, trap-dikes, presence of explosive gas, water, spontaneous combustion, and absence of coal from certain areas. Nearly all of these obstacles are probably much more difficult to surmount in these mines than in the great coal-fields to the west, with which the North Carolina coal comes in competition. To the present writer, who has recently examined all of the triassic areas south of the Potomac, it appears that the difficulty in the way of economical mining in the various triassic coal-fields arises mainly from the structure of the deposits. All of these areas are extensively faulted, and are traversed by an extended system of trap-dikes. Along the faults the coal has been so completely crushed that it is usually of little commercial value. At the same time, the continuity of the beds has been broken, and their dip disturbed and rendered irregular.

This wide-spread disturbance renders the expense of working the coal extremely uncertain, mainly on account of the difficulty of following faulted beds. The numerous trap-dikes that intersect the triassic areas north of the Potomac have caused disturbances which are even more injurious to the coal-deposits than the effects of faulting. The dikes are frequently accompanied by a displacement of the beds on either side, and also by an alteration of the adjacent coal. At times the coal in proximity to the dikes has been ruined by the heat; but in some instances, however, a natural coke has been produced which is more valuable than the unaltered coal. Trap-dikes more than a few feet thick are so expensive to penetrate that they are practically insurmountable obstacles when met with in coal-mines. This was the case in certain mines formerly worked at Gulf. Again, the trap sometimes penetrates the coal-bearing strata in intrusive sheets, approximately parallel with the planes of bedding, and in these even more troublesome to the coal-miner than when it forms vertical dikes.

A study of the numerous mining operations that have been carried on, commonly with failure, in the Richmond coal-field, would illustrate the peculiar difficulties to be expected in the Deep River basin. The lack of success in so many mining ventures in the triassic areas south of the Potomac, owing to the disturbances that have affected the coal, proves conclusively that mining should not be undertaken in the triassic coal-fields of the south without a careful preliminary examination with a diamond drill of the entire property that it is proposed to work. The quantity, quality, and position of the coal should be accurately determined before expensive mining operations are begun. With these precautions, it is probable that portions of the Deep River coal-field can be developed with profit, but it is safe to predict financial failure for those who begin mining with the expectation of working continuous coal-seams in the manner followed in West Virginia and Pennsylvania.

The coal-deposits on Deep River were also examined by Dr. Chance, who pronounces them to be valueless for commercial purposes.

This report will be of value to those interested in the coal-deposits of North Carolina, but it contains little that can be considered as a contribution to geology. I. C. RUSSELL.

THE AMERICAN FERRET.

ALTHOUGH the philosophical biologist measures the importance of a species by the light it throws upon the problem of the science which he cultivates, there are certain animals and plants which, while not intrinsically of unusual importance, enjoy a special prominence on account of their