

but we were hardly prepared until lately to learn how rapid the variation in their thickness is. Mr. Hull has now shown that the Great and Inferior Oolites thin out from a thickness of 792 feet in Gloucestershire to 205 feet in Oxfordshire, and the Lias and Trias from 1090 feet to 400 (?) feet; while in like manner the Trias decreases from 5600 feet in Lancashire and Cheshire, to 2000 in Staffordshire, and 600 feet in Warwickshire. We also know that on the northern flank of the Mendips, the Trias, Lias, and Oolites tail off, although their dimensions in Gloucestershire are so considerable. It would appear that all the Secondary rocks, except those of the Cretaceous series, show a distinct thinning-out in their range southward, which is doubtless due to the existence of an old pre-Triassic land on the south—such as would have been formed by the prolongation of the Palæozoic rocks of the Ardennes and Mendips through the south of England. It has been urged, on the other hand, that this thinning-out is a proof of the existence of a still older land in that area; but as the argument is based on the evidence of rocks of post-Carboniferous age, it is clear that, whether the land were of Cambrian and Silurian, or of Devonian and Carboniferous age, the result, as affecting the Secondary rocks, would be the same.

This thinning-out of the Secondary strata has now been proved not to be merely hypothetical. At three points, on or near the presumed line of the old underground range, the Tertiary and Cretaceous strata have been traversed in well-sections, and Palæozoic rocks found to underlie them at once, without the intervention of any Triassic, Liassic, or Oolitic strata. Thus at London the presence of red and grey Sandstones, apparently of Palæozoic age, has been proved under the Chalk at a depth of 1,114 feet. Again, at Harwich and at Calais, strata of early Carboniferous age have been found also immediately under the Chalk, at depths respectively of 1026 and 1032 feet. There is therefore reason to believe that the underground ridge of the Mendips and the Ardennes passes in a line from Frome through North Wiltshire, Berkshire, Middlesex, North-east Kent, and between Calais and Boulogne, at a depth beneath the Secondary strata of not more than from 1000 to 1500 feet, while the coal-troughs, which may flank this range on the north would, judging from the analogy of the structure and relations of the same rocks at Mons and Valenciennes, be met with at depths very little, if at all, greater.

To the north of this area it is probable that the thickness of the overlying rocks is greater; but we have no means of knowing exactly. In Northamptonshire the Great and Inferior Oolites and the Lias have been found not to exceed together 880 feet, at which depth the New Red Sandstone was reached; but its thickness was not proved beyond 87 feet; while at Rugby, the Lias was found to be about 905 feet thick, below which 136 feet of beds of New Red Sandstone were passed through. Looking at the proved thinning out from north to south of the New Red and Permian strata, there is no reason to suppose that they would be found of any very great thickness in the southern counties. Even immediately to the south of the known coal-fields of the Midland counties, the trials for coal have not yet proved any very great thickness of these rocks. It would seem, in fact, that the extensive tracts of Chalk, Oolites, and Trias, forming the substrata of our Midland and Southern counties, constitute but a comparatively shallow crust filling up the plains and valleys of Palæozoic rocks, the great framework of which stretches apparently at but a moderate depth under our feet, and of which the highest ridges only, such as those of the Ardennes and Mendips, now rise above ground.

It is clear, therefore, that in any search for coal, the relation of the Secondary and the Palæozoic groups of rocks to one another being perfectly independent, the latter must be considered entirely on their own internal evidence, and apart from the bearing of the newer rocks covering them and forming the present surface, except possibly in a few cases where old lines of disturbance have proved points of least resistance, and yielded again, as suggested by Mr. Godwin-Austen, to later movements, which have equally affected the overlying formations.

It may be asked if any correlation can be established between the coal-measures of Bristol and South Wales and those of France and Belgium. So far as the identity of any particular bed of coal or of rock, it is impossible, and we should not expect it; for the variation in all the beds of any coal-basin is well known to be so great and rapid, that in the different parts of the same basin it is often difficult, and sometimes impossible, to establish any correlation; while in adjacent basins, such as those

of Wales and Bristol, or of Hainaut and Liège, such attempts have, with few exceptions, hitherto utterly failed. There are, however, more general features which serve to show, at all events, some relationship. The great dividing mass of from 2,000 to 3,000 feet of rock called Pennant exists in both the Welsh and Bristol coal-field; and the total mass of coal-measures is not very different, it being 10,000 to 11,000 feet in the one, and from 8,000 to 9,000 in the other, and there being in Wales 76, and in Somerset 55 workable seams of coal. In the Hainaut (or Mons and Charleroi) basin, the Measures are 9,400 feet thick, with 110 seams of coal; in the Liège basin 7,600 feet, with 85 seams; and in Westphalia 7,200 feet, with 117 seams. On the other hand, none of our central or northern coal-basins, with the exception of the Lancashire field, exceed half this thickness, and more generally are nearer one fourth. Further, the marked difference which exists between the northern coals and those of Wales and Somerset, the preponderance of caking-coals in the north, and of anthracite, steam, and smiths' coal in the south, equally exists between our northern coals and those of Belgium, which latter show, on the other hand, close affinities with those of Wales and Bristol. I am informed by two experienced Belgian coal-mining engineers and good geologists, who have twice visited our coal-districts, that the only coals they found like those of Belgium were the coals of South Wales and Radstock—there was the same form of cleavage, the same character of measures, and the same fitness for like economical purposes. Organic remains help us but little, but too little is yet known of their relative distribution. The plants are, as usual, the same; so also are shells of the genus *Anthracosia*, and a number of small *Entomostraca*; while there is a scarcity of many of the marine forms which are more common in some of our central and northern fields. That, therefore, which best indicates the relation between the coal-fields of the south-west of England and those of the north of France and Belgium, is the similarity of mass and structure, uniformity of subjection to like physical causes, and identity of relation to the underlying older and to the overlying newer formations.

It was in the north that the conditions fitted for the formation of coal first set in. The common *Stigmaria ficoides* and various Coal Measure plants appear at the base of the Carboniferous or in the Tuedian series of Northumberland, which there overlies conformably the Upper Old Red Sandstone; and productive beds of coal exist low down in the Mountain-Limestone series. These disappear in proceeding southward, and the great productive coal-series becomes confined to beds overlying the Millstone Grit. If the coal-growth set in earlier in the north, it seems to have been prolonged farther south, under more favourable conditions, to a later period. What those conditions were—whether the proximity of a greater land-surface, of a long *w* and greater subsidence, with more numerous rests—we cannot yet pretend to say.

Of the prolongation of the axis of the Ardennes under the south of England there can be little doubt; nor can there be much doubt that the same great contortions of the strata, which in Belgium placed the crown of the anticlinal arch at a height of four or five miles above the level of the base of the accompanying synclinal trough, to the bottom of which the Coal Measures descend, and was the cause of similar folds in the Coal Measures of Somerset and Wales, were continued along the whole line of disturbance, and that the preservation of detached portions of the same great supplementary trough is to be looked for underground in the immediate area, just as it exists above ground in the proved area; for the minor subordinate barriers dividing the coal-basins can, I conceive, in no way permanently affect the great master disturbance, by which the presence of the Coal Measures is ruled. Whether, however, admitting that the Coal Measures were originally present, they have been removed by subsequent denudation is another question.

(To be continued.)

SCIENTIFIC SERIALS

Annalen der Chemie und Pharmacie, December 1871. A considerable part of this number is occupied by a valuable paper "On valeric acids from different sources," by Erlenmeyer and Hell. They prepared isobutyl iodide acid, and from this the corresponding iodide, which they treated with alcoholic potash to convert it into potassic valerate; the valeric acid from these reactions had no action on polarised light. They prepared valeric acid from valerian root, and this also had no rotating action on a

polarised ray. A series of experiments was made on the valeric acids obtained from active and inactive amylic alcohols, and also on the acid obtained from leucin; this latter is found to rotate a ray of polarised light to the right, but not to so great an extent as the acid which is obtained from the left-handed amylic alcohol. The acids from isobutyl cyanide, from valerian root, and from inactive amylic alcohol, show very great similarity; whilst the acids from the active alcohol and from leucin agree in most of their properties. The valeric acid made from inactive amylic alcohol is almost certainly isopropacetic acid, and that from the active alcohol is probably methethacetic acid, although the authors consider that the latter acid might possibly be a molecular compound of two isomeric acids, such as isobutylformic and methethacetic acids. Besides this communication, there are several important physiologico-chemical papers, together with translations of two others from foreign periodicals.

THE *American Naturalist* for February commences with an exhaustive account of the Mountains of Colorado by Dr. J. W. Foster, read before the Chicago Academy of Sciences. Mr. E. L. Greene, in a short paper on the Irrigation and the Flora of the Plains, shows how a gradual alteration is going on in the character of the flora of those parts where a system of irrigation has been established, *Typha* and other marsh and water plants supplanting the original inhabitants of the drier plains. Mr. John G. Henderson, on the former range of the buffalo, brings forward evidence to show that the buffalo was at a not very remote period extremely abundant over almost the whole of the Northern United States, while he thinks that it is doomed in a short time to become extinct like the great Irish elk, the mastodon, and the dodo. The remainder of the number is occupied with reviews and short notes.

A CONSIDERABLE portion of the *Canadian Naturalist*, vol. vi., No. 2, is occupied with a report of the Edinburgh meeting of the British Association. Prof. Dawson continues his note on the Post-pliocene Geology of Canada. Prof. H. A. Nicholson (late of Edinburgh) contributes an article on the "Colonies" of M. Barrande, in which the best account we have yet seen is given of the celebrated theory of the French palaeontologist. Dr. J. W. Anderson has a short article on the Whale of the St. Lawrence; Mr. S. W. Ford some notes on the Primordial Rocks in the vicinity of Troy, N. Y.; and Mr. E. S. Billings a paper on some new species of Palaeozoic Fossils belonging to the classes Pteropoda and Brachiopoda.

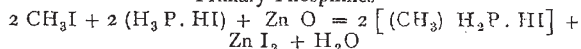
SOCIETIES AND ACADEMIES

LONDON

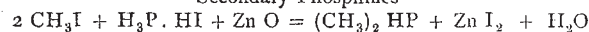
Royal Society, March 21.—"New Researches on the Phosphorus bases," by Dr. A. W. Hofmann, F.R.S. Ten years since the author presented to the Royal Society a series of papers on the remarkable group of phosphorus compounds first discovered by Thenard in 1847. These researches were devoted to the investigation of the tertiary and quartary derivatives of phosphoretted hydrogen, exclusively accessible by the methods then known. Since then numerous attempts have been made to prepare the primary and secondary phosphines, but with no result until the present time. The author wishing to obtain pure phosphoretted hydrogen for lecture experiments, was led to prepare it by the action of water or soda on the beautiful compound of phosphoretted hydrogen and hydriodic acid. The ease with which this body decomposed led the author to think that it might be made available for the production of the missing compounds. For this purpose it was necessary to liberate phosphoretted hydrogen in the presence of an alcohol iodide under pressure. This could be done by heating together the phosphonium iodide and alcohol iodide in presence of some substance capable of slowly decomposing the former body, such as zinc oxide. This process yields the alcoholic phosphines, easily giving rise to the formation exclusively of primary and secondary phosphines. A further simplification of the process was tried, namely, by utilising the hydriodic acid from the phosphonium iodide in the formation of the alcohol iodide to be acted on by phosphoretted hydrogen. This was accomplished by digesting the phosphonium iodide with the alcohol; by this method it was found that only the tertiary phosphines and the quartary phosphonium compounds already known were produced, but which were more easily and plentifully obtained by the new than by the old method. The reactions by which the various groups of phos-

phines are produced from phosphonium iodide are as follows, the reaction being assumed to take place in the methyl series:—

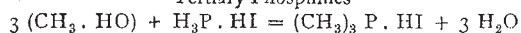
Primary Phosphines



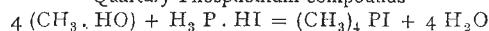
Secondary Phosphines



Tertiary Phosphines



Quartary Phosphonium compounds



The primary and secondary methylic derivatives of phosphoretted hydrogen are prepared by placing together in a sealed tube 2 molecules of methylic iodide, 2 molecules of phosphonium iodide, and 1 of zinc oxide. The mixture is heated to 100° for six or eight hours, when the reaction is complete; on cooling the tube contains a white crystalline solid, and also a considerable amount of compressed gas. The crude product of the reaction is first treated with water, which decomposes the salts of monomethylphosphine, liberating it as a gas, which is collected in concentrated hydriodic acid; and secondly with potash, which decomposes the salts of dimethylphosphine, and liberates the dimethylated phosphine as a liquid. The whole process must be conducted in an atmosphere of hydrogen, as the two bodies are powerfully acted on by the oxygen of the air.

Methylphosphine $\text{CH}_3 \text{H}_2 \cdot \text{P}$, is a colourless and transparent gas of a most overwhelming odour, which, by cooling and by pressure, can be condensed to a colourless liquid floating on water. It boils at -14° under a pressure of 0.7585 metre. At 0° it began to liquefy at $1\frac{3}{4}$ atmospheres pressure, and at $2\frac{1}{2}$ atmospheres it was entirely liquefied. At 10° liquefaction commenced at $2\frac{1}{2}$ atmospheres and was completed at 4 atmospheres pressure, and at 20° under a pressure of 4 and $4\frac{1}{2}$ atmospheres. The volume weight of the gas was determined by decomposing a known weight of the iodhydrate over mercury. Experiment gave the number 24.35, the theoretical value being 24. Methylphosphine is nearly insoluble in water free from air; if it contain air the gas disappears, owing to oxidation; it is rather soluble in alcohol, more especially at low temperatures; ether dissolves but little at ordinary temperatures, but at 0° one volume of ether dissolves in less than 70 volumes of methylphosphine. When gently heated in contact with air it takes fire, as it does also in pressure of chlorine or bromine. By its union with acids it forms a remarkable series of salts, distinguished by the remarkable property of being decomposed by water.

The chlorhydrate is obtained by mixing methylphosphine with gaseous hydrochloric acid, the gases at once condense to beautiful four-sided plates; the iodhydrate $\text{CH}_3 \text{PI}$ is obtained by passing the gas into a concentrated solution of hydriodic acid; it can be crystallised in plates, which may be easily sublimed.

Dimethylphosphine $(\text{CH}_3)_2 \text{HP}$, obtained as above, is a transparent colourless liquid which is lighter than water and insoluble in it; readily soluble in alcohol and ether. Its boiling point is 25° . In contact with the air it instantly takes fire, and burns with a powerfully luminous phosphorus flame. It unites easily with acids, all its salts being exceedingly soluble. The chlorhydrate furnishes with platinum perchloride a fine crystalline salt.

Methylphosphine passed into fuming nitric acid is absorbed and oxidised, with the formation of a new acid, small quantities of phosphoric acid being also produced. The excess of nitric acid is removed by evaporation in a water bath, and the phosphoric acid by boiling with lead oxide, which forms the lead salt of a new acid which is soluble in acetic acid, and lead phosphate which is insoluble. The lead salt is decomposed by sulphuretted hydrogen, and the acetic acid removed by evaporation, which leaves the new acid as a crystalline mass resembling spermaceti, melting at 105° . Its composition is found to be $\text{CH}_3 \text{H}_2 \text{PO}_3$, and may be called methylphosphinic acid. It forms two series of salts, in which H_1 and H_2 are replaced by metals. The primary silver salt crystallises in beautiful white needles which, in contact with water, are converted into the secondary salt. The lead and barium salts of this acid have also been obtained.

Methylphosphinic acid has the same composition as methylphosphorous acid, but they are two absolutely different bodies. Methylphosphorous acid is an uncrystallisable ephemeral compound, decomposing at a gentle heat into phosphorous acid and methyl alcohol, whilst methylphosphinic acid may be distilled without decomposition.