taken place before, and we need not again go over the ground which we have already traversed several times in these pages, when we have endeavoured to point out their most probable origin and mode of propagation.

We propose, however, in this place to devote a few lines to the discussion of a question which we think has not as yet received the attention it deserves, namely: When is a mine in such a state that it may be termed *well-ventilated?* and our principal reason for doing so is that a statement has been already put forth to the effect that the ventilation of Risca Colliery was as perfect as it well could be, the total volume of air passing through it being considerably over 100,000 cubic feet per minute.

An air-current of given dimensions may be sufficient to thoroughly ventilate the workings of a fiery mine at one time, and it may be quite insufficient at another: for the degree of sufficiency is obviously wholly dependent on the amount of fire-damp given off per unit of time. Each unit of volume of coal contains a certain volume of fire-damp in a state of great compression—it may be in a liquid or solid condition—and this gas begins to be given off when the workings approach to within a certain distance of the space within which it is confined. The greater proportion of the fire-damp is probably given off immediately before the coal is laid bare, and at the instant it is being detached from the face; but some of it still continues in the coal long after it has left the mine.

If the workings of a fiery mine are stopped abruptly and allowed to remain unworked for a considerable time, we find that the amount of fire-damp given off gradually decreases, until in the course of a year or so it is not more than one-tenth of what it was when the mine was in full work. If, on the other hand, the output of a fiery mine is largely increased, we find that the workings soon lapse into a dangerous condition unless the ventilation has been largely in excess of its requirements in the first place. The character of the ventilation is thus dependent upon the output of coal for the time being as well as on the amount of air.

The daily output of Risca Colliery is stated to have been 1,000 tons, and supposing the amount of gas given off to have been 2,880 cubic feet per ton of coal, which is the actual amount we have found by observation and calculation in similar mines, then we know that, if the volume of the ventilating current had amounted to 30,000 cubic feet per minute, the whole of it would have been explosive as it returned from the workings; if it amounted to 50,000 cubic feet per minute it would show a cap half an inch high in the small oil-flame of a lamp, and when charged with coal-dust it would form a *highly explosive* mixture; if it amounted to 100,000 cubic feet per minute it would still show a small cap $\frac{1}{8}$ to $\frac{3}{16}$ inch, and it would still produce an explosion when mixed with coal-dust, and ignited.

It is notorious, however, that as a rule the volume of air which reaches and passes round the working faces is much less than that which descends the down-cast and ascends the up-cast shaft; and when we are told that the ventilation of a mine is represented by a certain number of cubic feet of air per minute, we are on the safe side if we estimate the useful volume to be little more than two-thirds of the stated one.

It is further notorious that the practical miner of almost every grade regards a small cap on the flame of the lamp, even if $\frac{1}{4}$ to $\frac{1}{2}$ inch high as a very trivial matter, so long as he finds little or no explosive gas in the mine; and he only begins to speak of the return air as being heavy or rather heavy when the size of the cap on the small oil-flame reaches or exceeds a height of $\frac{3}{4}$ of an inch; but still even in this case he is not much troubled with thoughts of immediate danger.

What then constitutes a well-ventilated mine?

We say in reply that no mine containing dry coal-dust is well-ventilated when the cap on the small oil-flame of a lamp is over $\frac{1}{8}$ or $\frac{3}{16}$ inch in height, that is to say, when the return air contains more than 2 per cent. of gas. Even with that amount, as we know, it will form an explosive mixture with coal-dust, and we should prefer to see a standard insisted upon in which not more than 1 per cent. was allowed.

This aspect of the question is well worthy of the attention of the Royal Commissioners on Accidents in Mines, and we hope they will not allow their present opportunity to pass without endeavouring to arrive at some definite settlement of such an important question.

NORTH AMERICAN GEOLOGY—IDAHO AND WYOMING[1]

IN spite of the revolution that was recently effected among the Government geological surveys of the American Union, provision has wisely been made for the completion of the Reports of the different corps which have been abolished. It is pleasant to welcome still another of the stout black volumes issued annually by the Geological and Geographical Survey of the Territories. On the completion of the Survey of Colorado in 1876 Dr. Hayden and his corps of active coadjutors moved northwards across the belt of country included in the Survey of the 40th Parallel under Mr. Clarence King, with the intention of mapping the territories of Idaho and Wyoming to the north and west. A number of reconnaissances had been made by various observers in these regions since the days of Bonneville and Fremont, some of the earlier work of Hayden's Survey having been accomplished there. But no general survey of the whole area had been attempted, and many parts of it had never been penetrated by white men. It was a vast territory, including within its borders the sources of the Green, Snake, and Yellowstone Rivers, and embracing the most varied forms of surface and the greatest diversities of geological structure. To survey this unknown domain and bring its geography, geology, mineralogy, ethnology, zoology, botany, and general economic capacity to the knowledge of the world was the aim with which Dr. Hayden and his staff started in the summer of 1877. During the season the primary triangulation was extended over an area of 28,000 square miles, from West Long. 107° to 112° and between North Lat. 41° 10′ and 43° 50′, and was connected with the stations made by the Survey of the 40th Parallel, and by the Boundary Survey of Wyoming. Topographical field-work was carried on by three parties, each having an area assigned to it of about 11,000 square miles. The total area thus surveyed amounted to about 29,000 square miles. The geological staff was likewise divided into three divisions, each being intrusted with a separate district, viz., the regions of the Sweetwater, Teton, and Upper Green River.

In the report of Dr. Endlich of the Sweetwater division, one of the most interesting features is his account of the structure of the Wind River Mountains. This important portion of the true Rocky Mountain range is formed of three parallel chains, of which the western, and chief, rises to heights of more than 13,000 feet and forms the watershed of the continent. Even now its huge snow-fields, which, through the clear summer air can be seen gleaming from a distance of more than 100 miles, suggest the presence of glaciers. When Dr. Endlich and his party traversed these mountains in 1877 they found, indeed, no recognisable glacier, but abundant freshly-grooved and polished rocks and moraine mounds, showing the comparatively recent existence of land-ice in these elevated regions. On the west side of the

[1] "Eleventh Annual Report (1877) of the United States Geological and Geographical Survey of the Territories, embracing Idaho and Wyoming." (Washington: F. V. Hayden, 1879.)

mountains the evidences of glacial action are specially striking, one valley in particular bearing witness to the former presence of a glacier sixteen to eighteen miles long, extending for several miles into the low country, where it threw down its heaps of moraine-stuff in mounds a mile and a half broad, and from 800 to 900 feet high. Next summer, however, the covering of snow having partially melted, true glaciers of small extent were found in the Wind River and Teton ranges.

East of the Wind River Mountains there lies a suite of palæozoic formations from the Potsdam sandstone to the top of the Permian group, having a united thickness of 3,350 to 3,750 feet, and covered by 2,500 to 2,920 feet of Triassic, Jurassic, and Cretaceous rocks. Dr. Endlich computes the total depth of stratified formations in the Sweetwater region at more than 16,000 feet. Underneath them in the Wind River range lies a great series of crystalline rocks. According to Dr. Endlich the Potsdam rocks have been converted into quartzites by the same metamorphic action which has changed the rocks immediately below them into granites and schists. His section shows three zones of granite in descending order, the lowest of all being what he terms prozoic, while the youngest, from its stratified or schistoid character, and the coincidence of the inclination of its strata with that of the overlying stratified formations, he classes as of metamorphic origin.

The researches of Prof. St. John were devoted to the exploration of that wonderfully interesting region round the head waters of the Snake River and the Teton Mountains. The traveller who journeys wearily over the vast desert lava-fields of the Snake River plains looks wistfully from time to time at the great snow-rifted peaks which the Teton range far to the east raises into the sky. What would he not give for a glass of the cool water which dashes down so profusely among these far mountains and disappears so utterly before it reaches that thirsty desert? Extending the observations of Hayden, Bradley, Comstock, and others, Mr. St. John has given us an interesting narrative of the structure of the mountain region and of the lower territory on its flanks. The core of the Teton range, culminating in Mount Hayden, consists of massive granites, gneisses, and schists, flanked by quartzites and slates. On these ancient rocks lie from 500 to 1,000 feet of limestones, shales, and sandstones, containing Lower Silurian fossils, and from 400 to 600 feet of a buff-coloured magnesian limestone referable to the Niagara group of the Upper Silurian. The Carboniferous system, consisting mainly of limestones and sandstones, reaches a thickness of from 2,500 to 5,000 feet. Secondary formations, referred to the Triassic, Jurassic, and Cretaceous systems, attain depths of from 2,300 to more than 5,000 feet. The volcanic history of this portion of America is specially noticeable. According to Mr. St. John's observations the usual chronological sequence obtains in the areas traversed by him. The early eruptions have been of a trachytic nature, great variety of aspect and lithological structure being traceable among the various outflows. The surface presented by the trachytic areas is markedly uneven—the result doubtless partly of original irregularities of extrusion and partly of subsequent extensive denudation. The latest eruptions were of basalt, which has flooded the bottoms of the valleys, and now covers an area of many thousand square miles. Mr. St. John speaks of the difference of level between different plateaux of basalt as being due to subsequent elevation. But it is not necessary to suppose that there ever was any common level for the outflows. Some were no doubt poured out at much higher elevations than others even in their vicinity. The same observer calls attention to the remarkable volcanic conglomerates described by Hayden from this and the Yellowstone region, and by Whitney from the Territories lying further west. These deposits, 3,000 feet or more in thickness, consist of angular and subangular or rounded blocks of trachytes, basalts, and other volcanic rocks imbedded in a dull brown tuff-like matrix. They cover wide tracts of country in the volcanic districts, and point to a phase of volcanic or inter-volcanic action which is not yet well understood.

Dr. A. C. Peale contributes an interesting report on the varied region lying to the north of the 41st Parallel between Green River City, Wy., and Ogden, Utah. He estimates the total mass of stratified formations in that region from the base of the Lower Silurian system to the top of the Quaternary series at upwards of 30,000 feet. He has added some additional fossils to the list of Lower Silurian forms collected from the district in 1872 by the late Prof. F. Bradley. He has likewise made important additions to the Carboniferous fauna of that area, and has shown how dominant a part is taken by the 6,000 feet or more of Carboniferous limestones and quartzites. The Jura-Trias attains a depth of between 5,000 and 6,000 feet, consisting of the usual red sandy and argillaceous strata below, and passing up into laminated limestones and shales. A considerable number of organic remains were obtained from several zones in these beds, but they do not yet appear to be sufficient for drawing a satisfactory line between the Trias and Jurassic series in the Rocky Mountain region. To our knowledge of the Cretaceous and Tertiary geology of the district Dr. Peale was enabled to make some valuable additions.

Besides these geological reports, the labours of the Survey in 1877 included a detailed palæontological research in the field by Dr. C. A. White, who contributes an important report of his work, and the first of what we hope will be a series of papers on invertebrate *palæontology*. He specially treats of the Cretaceous fossils of the Western States and Territories. The topographical work of the year was well done by Messrs. Nelson and Gannett. As subsidiary but very valuable parts of the work accomplished by the Survey, reference may be made to the researches on fossil insects by Mr. Scudder of Boston, which have been aided by the Survey and will be published among its memoirs; to the great monograph by Dr. Leidy on the Rhizopods, which has already appeared as one of the Survey's quarto volumes; and to the interesting particulars collected by the Survey regarding the archæology of the San Juan and South-Western Colorado.

There will be, we presume, one further Report for 1878—the last year of the existence of the Geological and Geographical Survey of the Territories. Though this mode of annual publication necessarily involves incompleteness, and is apt to overload the reports with unimportant detail, there can be no doubt that the series of volumes issued by this Survey form a permanent record of great value, which for the districts to which they refer will serve as the basis of all subsequent work. It is not without regret that one can regard the cessation of these volumes. On this side of the Atlantic, where they can be calmly considered apart altogether from scientific rivalry and political entanglements, they have been received with general approbation. It is impossible not to be struck by the largeness of the plan conceived by Dr. Hayden for the scope of his survey. Not geology merely, but every branch of inquiry touching the natural history, archæology, geography, and meteorology of the Territories, was embraced within his plan, and has been illustrated as far as the means at his disposal would allow. To have conceived this broad and scientific scheme, and to have possessed the administrative power to secure and keep in working concert so large and able a body of observers, are qualities of no mean order, and deserve grateful recognition wherever an intelligent interest is taken in the general progress of science and in that human advancement which scientific progress insures.

ARCHIBALD GEIKIE