NEW PORTABLE OVEN.

It is generally admitted that for some culinary operations the ordinary cook-stove and range are neither effective nor economical, and it has been determined by actual experiment that in the matter of baking, ordinary stoves are wasteful of both fuel and time.

The new portable oven shown in the engraving is designed to be used in connection with an ordinary portable furnace, and is not only capable of baking with a small amount of fuel, but it also prevents the dissemination of odors from the articles being cooked. The inventor contracts the fire pot of an ordinary portable furnace by inserting an extra lining, A, of fire brick; this serves the double purpose of materially reducing the fire space and of preventing the radiation of heat into the room—a very desirable feature in warm weather.

The top plate of the furnace has the usual opening for the reception of cooking vessels. To this opening is fitted a cylindrical casing, closed at the top by a removable cap, and to a flange surrounding the upper edge of the fire pot is fitted a cylinder concentric with the outer cylinder, forming between the two a flue, F. The inner cylinder has a central opening at the top, so that the products of combustion may pass upward in the inner cylinder, and downward in the flue, F, to the chimney flue.

An annular plate, B, and a plate, C, of refractory material are supported by legs which rest on the fire brick, A. The pans, D, which contain the dough, are supported one above another on the plate, C; the several pans are separated by light frames, and they are all inclosed by a cylindrical casing which rests upon the plate, C. By this arrangement the full effects of the fresh products of combustion is utilized in heating the inner casing and its contents, there being very little loss of heat by radiation, owing to the fact that the products of combustion, which pass upward around the inner casing, descending the flue, F, form an effectual air-jacket which prevents the chilling of the oven.

MACALPIN'S PORTABLE OVEN.

The design of the inventor is to concentrate and make use of all of the heat from the fire, so that none of it shall pass up the chimney and be wasted, and at the same time to have such control of it as to permit more or less of it to escape into the room as may be desired, and to carry off all offensive odors and smoke which commonly escape into the room when cooking is done in the usual way. Either coal or gas may be used as fuel. The oven is made in different sizes, large ones being made for hotels and bakeries.

The oven is raised from the furnace by cords or chains passing over pulleys in the ceiling, with counterbalance weights at the end.

These ovens may be adapted to broiling, frying, or cake making. We are informed by the inventor that a loaf of bread weighing two pounds two ounces has been baked in one of these ovens in thirty-two minutes, and that eight and a half pounds of bread can be baked in the same length of time.

This invention was recently patented by Mr. Daniel MacAlpin, 2041 Ridge avenue, Philadelphia, Pa., who should be addressed for further information.

ENAMEL FOR HOLLOW IRON WARE.

THE manufacture of enameled hollow ware has long been carried on in Silesia. The following are said to be the materials and processes employed in one of the larger establishments:

After being cleaned, the castings are pickled in dilute

sulphuric acid and scrubbed with sand. They are then dipped into hot water and dried, when they are ready for the body, which is made as follows. Fifty parts of finely-ground dried quartz, 23.5 parts of crystallized borax, and 7.5 parts of fine fluorspar are sintered in a clay crucible, yielding 68.5 to 69 parts of a mass, which, after being carefully sorted to keep out impure pieces, is reduced to powder. Sixteen parts of this sintered mass are mixed with 6.5 to 12.5 parts of quartz, 4 to 6.5 parts of gray clay, and 0.5 part of borax. While this is being ground with water, 2.5 parts of clay, and 0.66 part of borax are added. After being brought to a proper consistency by the addition of water, this mixture is applied with a brush, dried, and burnt on, yielding a yellowish-brown sintered body, which adheres to iron firmly. The hollow ware is allowed to cool, and the material for the glaze is put on as a fine wash. This glaze is prepared by mixing 25 parts of fluorspar, 1 part of commercial oxide of zinc, 4.75 parts of oxide of zinc as obtained from calcining furnace of the establishment, 0.75 part of bone ash, and 0.03 to 0.05 part of smalt. The latter ingredient is added to counteract any yellowish tinge in the enamel. This mixture is looked upon as constituting the secret of the establishment, and it is specially prepared in the laboratory; 9 to 25 parts of it are mixed with 16 parts of feldspar, 9 to 9.75 parts of crystallized borax, 3.25 parts of crystallized soda, and 1.25 to 1.50 parts of saltpeter. The whole of it is put into a refractory crucible, having a hole in the bottom, through which the fused mass falls into a vessel placed below the grate. The cooled mass is finely ground with water, and to 30 parts of it 6 pieces of white clay, about 10 cubic inches in volume each, and 0.3 part of oxide of zinc are added. The mass thus prepared is applied with a brush, and after being dried, the goods are exposed to a heat sufficient to produce the enamel required.

HORSESHOE NAIL MAKING.

A GREAT deal of attention has of late years been paid to the manufacture of horseshoe nails by machinery, and though the first attempts were scarcely successful in competing with the hand-made nails as regards quality, still the subject has been so persistently followed up, that at the present day some machine-made nails may fairly be said to surpass the hand-made article both in quality and finish. One principal reason why the machine-made nails had such an uphill battle to fight was that some manufacturers, having succeeded in producing machinery which would work tolerably well, at once seemed to jump to the conclusion that inferior metal might be used. This arose, no doubt, from the fact that such manufacturers lacked a practical knowledge of what a horseshoe nail should be, and merely copied the shape of the hand-made nail, and thought their task completed. A horseshoe nail, though required of a certain stiffness for driving, should, nevertheless, be capable of being easily bent by the fingers. One thing that has been very much against the makers of machine-made nails has been the enormous expense of keeping the tools in repair, some of which are of no more thickness than the back of an ordinary table knife, though having to do heavy duty. It is also noticeable that the machine-made horseshoe nail trade has almost entirely been usurped by the Americans. Keeping these points in view, Mr. H. P. Fenby, of the firm of Fenby & Fraser, of Leeds, has recently patented machinery of a novel type, which is now running at their works, and by which the evils mentioned above are avoided. In this process the bars are first rolled to a special section from billets of Siemens-Martin steel of Swedish make. These bars are then put into a pickling vat containing a solution which removes the scale caused by rolling, after which they are placed one at a time on a kind of small tramway feed, which continually urges the bar forward into a cutting-up machine, which is self-acting and continuous in its action. From this machine upwards of 100 nails per minute fall, the nails being delivered from the side of the machine into a box. By these means the entire bar is cut up automatically all but a short end, when the machine ceases cutting. The nails are then put into a special furnace, which keeps them at a blood red for a fixed time, when they are allowed to cool slowly, and are next put into a pickle, and afterward chemically treated, to thoroughly kill the action of the acid and cleanse them. They are now ready for the second machine operation, which consists in passing them through a special rolling machine, which by one operation gives a good square face and finish to the nail, and tempers it to a correct stiffness for driving without destroying the nature of the metal. The next and very important operation is pointing ready for driving. This is effected by a slight hammering action, which makes a sharp, clean point, without the burr often found on clipped points. The nails are now finished and ready for the market, being bright and pointed ready for driving.—*Ironmonger.*

ON THE TREATMENT OF FADED PRINTS FOR COPYING.

It is by no means unusual to see on the professional cards and prospectuses of photographers, more particularly those practicing in the provinces, the following announcement: "Faded photographs restored, copied, enlarged, or reduced." But we imagine that many who make, or used to make, this announcement (for it is by no means so general now as it was formerly) would be somewhat perplexed to carry out that part of their prospectus relating to the restoration of faded photographs, when the photograph happened to be an ordinary silver print. The usual practice in such cases is to copy the print in its yellow or faded state, and afterward to work up the reproduction by hand, either in colors or monochrome. By this means very satisfactory results can be obtained; but in all instances when the picture is much faded there is great danger of the likeness (in the case of portraits) being lost unless it is skillfully manipulated by a competent artist.

Although there is no satisfactory method known by which a paper print that has actually faded can be restored, still there are means by which those that have passed into the "sere and yellow" stage may be so renovated that they can be reproduced of a quality but little inferior to what they would have yielded had they been copied when they were in their pristine vigor. The method, although an old one, is, we imagine, not so well known as it deserves to be, because it is but seldom resorted to by the copyist; hence our reason for directing attention to the subject. It simply consists in removing the yellowness of the picture by the action of bichloride of mercury in much the same manner that the tarnish of a daguerreotype is cleaned from the plate with cyanide of potassium. By this treatment the yellow tones of the prints quickly disappear, the whites regain much of

their former purity, and the blacks become of a considerably warmer tone than they were originally. Although no detail is actually restored, still it appears to be because the yellowness that previously buried the lights and delicate half tints has been cleared away.

A picture that has been subjected to the action of a solution of bichloride of mercury will not possess the same range of tints from high lights to deep shadows that it did originally; for, although the whites will become nearly, or quite, as pure as they were at first, the shadows will not regain their original depth. But it will have a far greater range in its actinic qualities than when it was in its yellow condition, because we shall have white for the lights and a warm reddish-brown for the shadows; while before the treatment we had only yellow for the lights and certainly not a more non-actinic color for the shadows. Hence it will be seen that, notwithstanding the picture may not appear to be more vigorous visually, it is far more so chemically, and will consequently be much better adapted for copying as well as much improved in general appearance; for the color and vigor will correspond very nearly with the brown toned pictures at present so much in vogue.

There are two methods of treating prints with the bichloride of mercury. One is to remove the print from the mount and then to immerse it in a solution of the salt, which, if it be saturated, will remove the yellow tint, in most cases, in a few minutes. The print is then well washed to remove the bichloride, and after drying it is ready for remounting. Should the picture have been waxed, or, as it is more generally termed, "polished," with encaustic paste, it will be advisable to remove the wax with a little spirit of turpentine before soaking the print from its mount. The other method—which does not necessitate the removal of the print from the mount, which is sometimes an advantage—is the one originally published, now some twenty-five years ago, by Mr. R. F. Barnes, who was the first to suggest the employment of bichloride of mercury for restoring paper photographs. It is to place the print to be restored in contact with paper saturated with the mercurial salt.

In adopting this plan we have found that the most satisfactory results are obtained by damping several thicknesses of blotting paper with a weak solution of bichloride—about one part of a saturated solution diluted with three parts of water—and keeping it in contact with the print. This may be conveniently done by placing the print face upward on the glass of a pressure frame, then putting on the several thicknesses of the damp paper, on that a plate of glass, and screwing the whole up tight so that the paper is kept in close contact with the print and at the same time the moisture is prevented from evaporating. The time required by this method is much longer than in the previous one, frequently from six to twenty-four hours being requisite, according to the amount of yellowness to be removed. When the picture is sufficiently whitened the bichloride should be eliminated by gently sponging it several times with water, and blotting off each time with bibulous paper.

Although we have mentioned a saturated solution in the first method we should advise a dilute one to be employed, as then the action appears to be more even and regular, especially (and this is frequently the case with old prints) as the surface is very repellent of aqueous solutions. We have noticed but little difference between the action of the mercurial salt on prints that have been toned with the alkaline gold bath and those by the old hypo and gold toning and fixing bath, in which the toning action was probably as much due to sulphur as to gold—except, perhaps, that with the gold toned prints the action is a little quicker and the resulting picture somewhat less vigorous; but it is quite possible that this difference may be more due to the sulphur toned prints having been made from much stronger negatives than were the gold toned ones. However, with each the plan appears to be equally efficacious.

With regard to the future permanence of prints that have been subjected to the mercurial treatment, we may mention that we have some by us that were operated upon some years since which appear to have undergone no further change. The whites remain clear, and the shadows apparently unchanged; but how far such pictures may be considered permanent in the true sense of the term, we are scarcely in a position to hazard an opinion.—*Br. Jour. of Photography.*

THE REVERSED ACTION OF LIGHT IN SOLAR PHOTOGRAPHY.

By J. JANSSEN.

I HAVE been able to extend and complete, by a compendious study, the results which I had the honor of communicating to the Photographic Society of France at its last meeting.

At the point at which I have now arrived I have been enabled to ascertain that the action of light alone—whether, on the one hand, that action be prolonged, or, on the other, its intensity be increased in suitable proportion—I have ascertained, I say, that this action alone, and without the aid of any accessory reaction, produces on the photographic plate a succession of the six following conditions:

1. A negative image (the ordinary image).
2. A first neutral state, in which the plate becomes uniformly obscure under the action of the developer.
3. A positive image, which succeeds the first neutral state.*
4. A second neutral state, opposed to the first in so far as that the plate becomes uniformly clear under the action of the developer.
5. A new negative image, which succeeds the second neutral state. This image is similar to the first negative image, but differs from it both by the intermediate conditions which separate the two and by the enormous difference of luminous intensity necessary to produce it. The negative image of the second order demands, in fact, for its production a luminous intensity of more than a million times that which produces the negative image of the first order.
6. A second darkened state, in which the plate becomes uniformly obscure under the action of the developer.

Such is the succession of the phenomena which the dry plate may present when submitted to the prolonged action of light. It is only the use of our instruments of solar photography that enables us to realize the enormous variations of luminous power by which these results have been obtained. The plates experimented upon have been principally gelatine, tannin, washed collodion emulsion, etc., etc.

I have obtained, notably, plates showing the succession of the different states—the negative, positive, and the negative of the second order—both for sun pictures and for landscapes; some plates in which the sun is seen in positive in

* This positive image has recently been recognized in Germany.

the midst of a negative, cloudy, sky; others in which the sun is negative in a positive telluric halo in a negative cloudy sky, etc.

As I said at the last meeting of the society, it seems as if these new results might be usefully applied in obtaining photographs of the solar chromosphere. There is no doubt that they throw great light on the theory of photographic phenomena.

I hope at a future meeting to lay before the society more details of these experiments, and to show specimens of the results I mentioned. The sole object of this communication is to describe the results already obtained.

GEOLOGY.

THE annual meeting of the British Association for the Advancement of Science took place at Swansea, August 25, 1880. The first paper was the following inaugural address of the President, Andrew Crombie Ramsay, LL.D., F.R.S., V.P.G.S., Director General of the Geological Survey of the United Kingdom, and of the Museum of Practical Geology:

ON THE RECURRENCE OF CERTAIN PHENOMENA IN GEOLOGICAL TIME.

In this address I propose to consider the recurrence of the same kind of incidents throughout all geological time, as exhibited in the various formations and groups of formations that now form the known parts of the external crust of the earth. This kind of investigation has for many years forced itself on my attention, and the method I adopt has not heretofore been attempted in all its branches. In older times, Hutton and Playfair, in a broad and general manner, clearly pointed the way to the doctrine of uniformity of action and results, throughout all known geological epochs down to the present day; but after a time, like the prophets of old, they obtained but slight attention and were almost forgotten, and the wilder cosmical theories of Werner more generally ruled the opinions of the geologists of the time. Later still, Lyell followed in the steps of Playfair, with all the advantages that the discoveries of William Smith afforded, and aided by the labors of that band of distinguished geologists, Sedgwick, Buckland, Mantell, De la Beche, Murchison, and others, all of whom some of us knew. Notwithstanding this new light, even now there still linger the relics of the belief (which some of these geologists also maintained) that the physical phenomena which produced the older strata were not only different in kind, but also in degree, from those which now rule the external world. Oceans, the waters of which attained a high temperature, attended the formation of the primitive crystalline rocks. Volcanic eruptions, with which those of modern times are comparatively insignificant, the sudden upheaval of great mountain chains, the far more rapid decomposition and degradation of rocks, and, as a consequence, the more rapid deposition of strata formed from their waste—all these were assumed as certainties, and still linger in some parts of the world among living geologists of deservedly high reputation. The chief object of this address is, therefore, to attempt to show that, whatever may have been the state of the world long before geological history began, as now written in the rocks, all known formations are comparatively so recent in geological time, that there is no reason to believe that they were produced under physical circumstances differing either in kind or degree from those with which we are now more or less familiar.

It is unnecessary for my present purpose to enter into details connected with the recurrence of marine formations, since all geologists know that the greater part of the stratified rocks were deposited in the sea, as proved by the mollusks and other fossils which they contain; and the order of their deposition and the occasional stratigraphical breaks in succession are also familiar subjects. What I have partly to deal with now are exceptions to true marine stratified formations, and after some other important questions have been considered, I shall proceed to discuss the origin of various non-marine deposits from nearly the earliest known time down to what by comparison may almost be termed the present day.

METAMORPHISM.

All, or nearly all, stratified formations have been in a sense metamorphosed, since, excepting certain limestones, the fact of loose incoherent sediments having been by pressure and other agencies turned into solid rocks constitutes a kind of metamorphism. This, however, is only a first step toward the kind of metamorphism, the frequent recurrence of which in geological time I have now to insist upon, and which implies that consolidated strata have undergone subsequent changes of a kind much more remarkable.

Common stratified rocks chiefly consist of marls, shales, slates, sandstones, conglomerates, and limestones; generally distinct and definite; but not infrequently a stratum, or strata, may partake of the characters in varied proportions, of two or more of the above-named species. It is from such strata that metamorphic rocks have been produced, exclusive of the metamorphism of igneous rocks, on which I will not enter. These may be looked for in every manual of geology, and usually they may be found in them.

As a general rule, metamorphic rocks are apt to be much contorted, not only on a large scale, but also that the individual layers of mica quartz and feldspar in gneiss are bent and folded in a great number of minute convolutions, so small that they may be counted by the hundred in a foot or two of rock. Such metamorphic rocks are often associated with masses of granite both in bosses and in interstratified beds or layers, and where the metamorphism becomes extreme it is often impossible to draw a boundary line between the gneiss and the granite; while, on the other hand, it is often impossible to draw any true boundary between gneiss (or other metamorphic rocks) and the ordinary strata that have undergone metamorphism. Under these circumstances it is not surprising that when chemically analyzed, there is often little difference in the constituents of the unmetamorphosed and the metamorphosed rock. This is a point of some importance in relation to the origin and non-primitive character of gneiss and other varieties of foliated strata, and also of some quartzites and crystalline limestones.

I am aware that in North America formations consisting of metamorphic rocks have been stated to exist of older date than the Laurentian gneiss, and under any circumstances it is obvious that vast tracts of pre-Laurentian land must have existed in all regions, by the degradation of which sediments were derived wherewith to provide materials for the deposition of the originally unaltered Laurentian strata. In England, Wales, and Scotland attempts have also been made to prove the presence of more ancient formations, but I do not consider the data provided sufficient to warrant any such conclusion. In the Highlands of Scotland, and in

some of the Western Isles, there are gneissic rocks of pre-Cambrian age, which, since they were first described by Sir Roderick Murchison in the Northwest Highlands, have been, I think, justly considered to belong to the Laurentian series, unconformably underlying Cambrian and Lower Silurian rocks, and as yet there are no sufficient grounds for dissenting from his conclusion that they form the oldest known rocks in the British Islands.

It is unnecessary here to discuss the theory of the causes that produced the metamorphism of stratified rocks, and it may be sufficient to say, that under the influence of deep underground heat, aided by moisture, sandstones have been converted into quartzites, limestones have become crystalline, and in shaly, slaty, and schistose rocks, under like circumstances, there is little or no development of new material, but rather, in the main, a rearrangement of constituents according to their chemical affinities in rudely crystalline layers, which have very often been more or less developed in pre-existing planes of bedding. The materials of the whole are approximately the same as those of the unaltered rock, but have been rearranged in layers, for example, of quartz, feldspar, and mica, or of hornblende, etc., while other minerals, such as schorl and garnets, are of not infrequent occurrence.

It has for years been an established fact that nearly the whole of the mountain masses of the Highlands of Scotland (exclusive of the Laurentian, Cambrian, and Old Red Sandstone formations), mostly consist of gneissic rocks of many varieties, and of quartzites, and a few bands of crystalline limestone, which, from the north shore to the edge of the Old Red Sandstone, are repeated again and again in stratigraphical convolutions great and small. Many large bosses, veins, and dikes of granite are associated with these rocks, and, as already stated, it sometimes happens that it is hard to draw a geological line between granite and gneiss and *vice versa*. These rocks, once called Primary or Primitive, were first proved by Sir Roderick Murchison to be of Lower Silurian age, thus revolutionizing the geology of nearly one-half of Scotland. To the same age belongs by far the greater part of the broad hilly region of the south of Scotland that lies between St. Abb's Head on the east and the coast of Ayrshire and Wigtonshire on the west. In the southwest part of this district several great masses of granite rise amid the Lower Silurian rocks, which in their neighborhood pass into mica-schist and even into fine-grained gneiss.

In Cornwall the occurrence of Silurian rocks is now well known. They are of metamorphic character, and partly associated with granite; and at Start Point, in South Devonshire, the Silurian strata have been metamorphosed into quartzites.

In parts of the Cambrian areas, Silurian rocks in contact with granite have been changed into crystalline hornblende gneiss, and in Anglesey there are large tracts of presumed Cambrian strata, great part of which have been metamorphosed into chlorite and mica-schist and gneiss, and the same is partly the case with the Lower Silurian rocks of the center of the island, where it is almost impossible to disentangle them from the associated granite.

In Ireland similar metamorphic rocks are common, and, on the authority of Prof. Hull, who knows them well, the following statements are founded: "Metamorphism in Ireland has been geographical and not stratigraphical, and seems to have ceased before the Upper Silurian period."

"The epoch of greatest metamorphism appears to have been that which intervened between the close of the Lower Silurian period and the commencement of the Upper Silurian, taking the formations in ascending order."

"It is as yet undecided whether Laurentian rocks occur in Ireland. There are rocks in northwest Mayo very like those in Sutherlandshire, but if they are of Laurentian age they come directly under the metamorphosed Lower Silurian rocks, and it may be very difficult to separate them."

"Cambrian purple and green grits are not metamorphosed in the counties of Wicklow and Dublin, but the same beds at the southern extremity of County Wexford, near Carnsore Point, have been metamorphosed into mica-schist and gneiss."

"In the east of Ireland the Lower Silurian grits and slates have not been metamorphosed, except where in proximity to granite, into which they insensibly pass in the counties of Wicklow, Dublin, Westmeath, Cavan, Longford, and Down; but in the west and northwest of Ireland they have been metamorphosed into several varieties of schists, hornblende-rock, and gneiss, or foliated granite."

It would be easy to multiply cases of the metamorphism of Silurian rocks on the continent of Europe, as, for example, in Scandinavia and in the Ural Mountains, where, according to Murchison, "by following its masses upon their strike, we are assured that the same zone which in one tract has a mechanical aspect and is fossiliferous, graduates in another parallel of latitude into a metamorphic crystalline condition, whereby not only the organic remains, but even the original impress of sedimentary origin, are to a great degree obliterated." The same kind of phenomena are common in Canada and the United States; and Medlicott and Blanford, in "The Geology of India," have described the thorough metamorphism of Lower Silurian strata into gneiss and syenitic and hornblende schists.

In Britain, none of the Upper Silurian rocks have undergone any serious change beyond that of ordinary consolidation, but in the Eastern Alps, at Gratz, Sir Roderick Murchison has described both Upper Silurian and Devonian strata interstratified with separate courses of metamorphic chloritic schist.

Enough has now been said to prove the frequent occurrence of metamorphic action among Cambrian and Lower and Upper Silurian strata.

If we now turn to the Devonian and Old Red Sandstone strata of England and Scotland, we find that metamorphic action has also been at work, but in a much smaller degree. In Cornwall and Devon, five great bosses of granite stand out amid the stratified Silurian, Devonian, and Carboniferous formations. Adjoining or near these bosses the late Sir Henry De la Beche remarks that "in numerous localities we find the coarser slates converted into rocks resembling mica-slate and gneiss, a fact particularly well exhibited in the neighborhood of Meavy, in the southeast of Tavistock," and "near Camelford we observed a fine arenaceous and micaceous grauwacke turned into a rock resembling mica-slate near the granite." Other cases are given by the same author of slaty strata turned into mica-schist and gneiss in rocks now generally considered to be of Devonian age.

The Devonian rocks and Old Red Sandstone are of the same geological age, though they were deposited under different conditions, the first being of marine, and the latter of fresh-water origin. The Old Red Sandstone of Wales, England, and Scotland has not, as far as I know,

suffered any metamorphism, excepting in one case in the northeast of Ayrshire, near the sources of the Avon Water, where a large boss of granite rises through the sandstone, which all round has been rendered crystalline with well-developed crystals of feldspar.

On the Continent of Europe, a broad area of Devonian strata lies on both banks of the Rhine and the Moselle. Forty years ago, Sedgwick and Murchison described the crystalline quartzites, chlorite, and micaceous slates of the Hundsruck and the Taunus, and from personal observation I know that the rocks in the country on either side of the Moselle are, in places, of a foliated or semi-foliated metamorphic character. In the Alps also, as already noticed, metamorphic Devonian strata occur interstratified with beds of metamorphic schists, and Sir Roderick adds, "we have ample data to affirm that large portions of the Eastern Alps are occupied by rocks of true paleozoic age, which in many parts have passed into a crystalline state."

I know of no case in Britain where the Carboniferous strata have been thoroughly metamorphosed, excepting that in South Wales, beds of coal, in the west of Caermarthen-shire and in South Pembrokeshire, gradually pass from so-called bituminous coal into anthracite. The same is the case in the United States, in both instances the Carboniferous strata being exceedingly disturbed and contorted. In the Alps, however, Sir Roderick Murchison seems to have believed that Carboniferous rocks may have been metamorphosed: a circumstance since undoubtedly proved by the occurrence of a coal-measure calamite, well preserved, but otherwise partaking of the thoroughly crystalline character of the gneiss in which it is embedded, and which was shown to me by the late Prof. Gastaldi, at Turin.

I am well acquainted with all the Permian strata of the British Islands and of various parts of continental Europe, and nowhere, that I have seen, have they suffered from metamorphic action, and strata of this age are, I believe, as yet unknown in the Alps. This closes the list of metamorphism of paleozoic strata.

I will not attempt (they are so numerous) to mention all the regions of the world in which Mesozoic or Secondary formations have undergone metamorphic action. In Britain and the non-mountainous parts of France, they are generally quite unaltered, but in the Alps it is different. There, as every one knows who is familiar with that region, the crystalline rocks in the middle of the chain have the same general strike as the various flanking stratified formations. As expressed by Murchison, "as we follow the chain from N.E. to S.W. we pass from the clearest types of sedimentary rocks, and, at length, in the Savoy Alps, are immersed in the highly altered mountains of Secondary limestone," while "the metamorphism of the rocks is greatest as we approach the center of the chain," and, indeed, any one familiar with the Alps of Switzerland and Savoy knows that a process of metamorphism has been undergone by all the Jurassic rocks (Lias and Oolites) of the great mountain chain. Whether or not strata of Neocomian and Cretaceous age have been well metamorphosed in this region I am unable to say; but it seems to be certain that the Eocene or Lower Tertiary Alpine formation, known as the Flysch, contains beds of black schists which pass into Lydian stone, and also that in the Grisons it has been converted into gneiss and mica-schist, a fact mentioned by Studer and Murchison. I also have seen in the country north of the Oldenborn, Nummulitic rocks so far foliated that they formed an imperfect gneiss.

In Tierra del Fuego, as described by Darwin, clay slates of early cretaceous date pass into gneiss and mica-slate with garnets, and in Chonos Islands, and all along the great Cordillera of the Andes of Chili, rocks of Cretaceous or Cretaceous-oolitic age have been metamorphosed into foliated mica-slate and gneiss, accompanied by the presence of granite, syenite, and greenstone.

This ends my list, for I have never seen, or heard, of metamorphic rocks of later date than those that belong to the Eocene series. Enough, however, has been said to prove that from the Laurentian epoch onward, the phenomenon of extreme metamorphism of strata has been of frequent recurrence all through Paleozoic and Mesozoic times, and extends even to a part of the Eocene series equivalent to the soft unaltered strata of the formations of the London and Paris basins, which, excepting for their fossil contents and sometimes highly inclined positions, look as if they had only been recently deposited.

VOLCANOES.

The oldest volcanic products of which I have personal knowledge are of Lower Silurian age. These in Wales consist of two distinct series, the oldest of which, chiefly formed of feldspathic lavas and volcanic ashes, lie in and near the base of the Llandeilo beds, and the second, after a long interval of repose, were ejected and intermingled with the strata forming the middle part of the Bala beds. The Lower Silurian rocks of Montgomeryshire, Shropshire, Radnorshire, Pembrokeshire, Cumberland, and Westmoreland, are to a great extent also the result of volcanic eruptions, and the same kind of volcanic rocks occur in the Lower Silurian strata of Ireland. I know of no true volcanic rocks in the Upper Silurian series.

In the Old Red Sandstone of Scotland lavas and volcanic ashes are of frequent occurrence, interstratified with the ordinary lacustrine sedimentary strata. Volcanic rocks are also intercalated among the Devonian strata of Devonshire. I know of none in America or on the Continent of Europe.

In Scotland volcanic products are common throughout nearly the whole of the Carboniferous sub-formations, and they are found also associated with Permian strata.

I now come to the Mesozoic or Secondary epochs. Of Jurassic age (Lias and Oolites), it is stated by Lyell with some doubt, that true volcanic products occur in the Morea and also in the Apennines, and it seems probable, as stated by Medlicott and Blanford, that the Rajmahal traps may also be of Jurassic age.

In the Cordillera of South America, Darwin has described a great series of volcanic rocks intercalated among the Cretaceous-oolitic strata that forms so much of the chain; and the same author in his "Geological Observations in South America," states that the Cordillera has been, probably with some quiescent periods, a source of volcanic matter from an epoch anterior to our Cretaceous-oolitic formation to the present day. In the Deccan volcanic traps rest on Cretaceous beds, and are overlaid by Nummulitic strata, and according to Medlicott and Blanford, these were poured out in the interval between Middle Cretaceous and Lower Eocene times.

In England the only instance I know of a volcano of Eocene age is that of Monte Bolca, near Verona, where the volcanic products are associated with the fissile limestone of that area.