companion of another class, the great auk. Of prehistoric remains, I only know the solitary gigantic thigh bones of a huge mammal found at Cape Breton. Of those whose early extinction, perhaps in our own times we may reasonably expect, we may enumerate the fisher, (M. pennanti), now very rare, and next the marten, (M. americana). Both these great tree weasels require dense cover. The beaver, twenty-five years ago nearly extinct, is rapidly recruiting. The less value of his skin since velvet hats have been patented is not sufficient to account for his re-appearance. The few or no Indians now trapping in our forests is perhaps another cause. With these exceptions, allowing the same influence to exist, I see no reason why we should not retain our present fauna for centuries, including the large ruminants. Our last arrival was the wolf, endeavouring in vain to rehabit his old domains, to whom the skunk and the raccoon alone give precedence. All these coming in to us from the wild region of the Cobequid hills. Of introduced species, with the exception of the mice, we have only the horse (E. caballus), and the rabbit, (Lepus cuniculus). Both these species have been allowed to assume the feral state on Sable Island, a desert island about ninety miles south-east of Nova Scotia, in the Atlantic Ocean. Whilst the rabbits in fifty years have returned to one common silver-grey tint with white collars, it is curious to remark how the horse in one hundred and fifty years, the produce no doubt of the New England stock, has returned to the habits and form of the primal stock, or wild horse of antiquity, and reproduced all varieties of color, not only the bay, black and chestnut, but the rarer colors of piebald, duns, isabellas, blue duns, and duns with striped legs and black lists down the back.

Art. V. Zones of Lines of Elevation in the Earth's Crust. By Angus Ross, Esq.

(*Read January* 8, 1872.)

Eleven years ago I was living on Digby Neck, a prolongation of the North Mountain Range, and a district which with its great variety of quartz, and other minerals, and the obviously unsedimentary character of the trap and basaltic rocks of which it chiefly consists, is well fitted to stimulate curiosity and awaken thought as to its origin. I remarked that it had a corresponding and parallel synclinal or line of depression, along its more southerly side, extending its whole length from St. Mary's Bay to the Basin of Minas (inclusive); and that the general direction of the Atlantic coast line of the Province was approximately parallel to it; as also the Fundy coast of New Brunswick, and the Atlantic coast line of the United States, from Eastport to Baltimore, and from Cape Hatteras to Florida. Further examination showed that lines of elevation (and depression) parallel to these, formed the leading features of the Continent east of the Ohio. Of these the most remarkable are the valley of the St. Lawrence, and the Appalachian Mountain ranges. (See plate I. fig. 1.) Travelling afterwards in Newfoundland, I found that the chief lines of elevation in the Peninsula of Avalon had the same general direction. At Sandy Cove, on Digby Neck, I remarked that the ravine like break in the trap ridge, evidently at one time a sea channel, was not at right angles with the ridge, but running north and south—the ridge itself running nearly N. E. and S. W. I remembered that Trout Cove (now Centreville, five miles further up the Neck) was similar in this respect, and I found that the same was true of Grand and Petite Passages. I found, too, that most of the River basins of Shelburne and Yarmouth counties, as well as some of the river and lake basins in Hants, had the same direction, thus indicating another system of synclinals and anticlinals. The basin of Hudson River and Lake Champlain and the basin of the Connecticut, seemed correlated with this system. The trap ridge gave evidence of another system of lines of elevation, to the extent at least that produced an immense number of parallel fractures in the trap, having the direction (approximately) of east and west, and filled by quartz, sometimes nearly pure, sometimes in the form of jasper; sometimes containing pockets having beautiful crystals of variously colored quartz, and sometimes containing metallic minerals. This system seemed correlated to the Cobequid Range, and the line of depression which forms the great central basin of the province, commencing at Minas basin, and extending to St. George's Bay.

Since gold has been discovered in this province, attention has been prominently called to the fact that an important system of lines of elevation in the gold bearing rocks, have the same general direction—approximately east and west—and that the auriferous quartz veins uniformly have this direction. Now, it is evident to one even slightly acquainted with the Geology of the regions referred to, that not only the fractures but the trap itself was formed long after the east and west lines of elevation in the Cobequid and auriferous rocks had reached nearly their present position.

The only other system of parallel lines of elevation (and depression) in Nova Scotia, which now demands our attention, is well illustrated by a basin with which all here are necessarily well acquainted. I refer to our own Harbour and Bedford basin, and, further on in the same line, the Avon River basin. An important line parallel to this is the Strait of Canso. For further illustrations of this system I may point to most of the river and lake basins between Shelburne and Canso.

Having thus briefly indicated the chief systems of lines of elevation in our own Province and vicinity, I will proceed to discuss the general subject to which they introduced me, viz. the great zones of parallel lines of elevation in the earth's crust.

More than two-thirds of the crust of the earth is covered by the waters of the ocean. The more recent formations cover most of the remainder. Again the later formations were necessarily formed of the detritus of the older, so that these, where exposed to observation, must have suffered immense denudation, as is also shown by their metamorphic character, as they could only have become metamorphic when at a great depth below the surface. These circumstances tend greatly to obscure the lines of elevation in the older rocks. But obscurity yields to investigation. The higher summits of lines of elevation protrude themselves above the level of the sea, and afford no uncertain indication of their course beneath its waters. The more primitive formations are similarly found protruding through the later formations, or these last have been removed by denudation, exposing the former to view. Nor are we always left to infer the lines of elevation of the older rocks, from those portions of them which are exposed to view, since as we have already seen they impress their lines of elevation, to some extent upon the superincumbent later formations.

By an attentive study of the lines of elevation in the earth's crust, in so far as I had the means of information, I find that all the more important of them group themselves into seven great zones of parallel lines of elevation; the axial line of each zone being approximately a great circle of the earth, and characterized by lines of volcanoes. The apparent development of these zones is much affected by the fact that the northern hemisphere has the surface of its solid crust considerably more elevated than is that of the southern hemisphere. At the 45th degree of latitude respectively the difference by a rough estimate is nearly two miles. But if, for the sake of illustration, we imagine the north pole of the earth in Iceland, and compare the elevation of the resulting northern and southern hemispheres at the thirtieth degree of latitude respectively, the average elevation would then be found to be more than two miles greater in the northern than in the southern. Hence result the following laws:—

1st.—That it is the half north of the equator of each zone that is chiefly exposed to our observation.

2nd.—That of those zones whose axial lines do not pass near the poles, it is on the northerly side of the northern half of the axial line that the chief *visible* development occurs.

In each zone the proximity and elevation of the anticlinals diminish gradually from the axial line outwards; and if zone No. 1 be considered the most recent, and the others as successively less recent in the order in which I have named them, and comparing similar parts of any two zones, the height of the anticlinals is greater, the dip less, and the distance between their axes greater in the more recent. In a transverse section of zone No. 1 or of any subzone of any of the other zones, each plateau rises above the preceding in regular gradation from the coast line (or other boundary of the zone or subzone) until the greatest elevation is reached; and the same is true of the mountain ridges separating the plateaus. By substituting *subzones* for "anticlinals" in the above, the relations of those to each other will be defined.

Zone No. 1, or the Rocky Mountain system, has its axial line in the volcanic belt extending from the Middle Andes, inclusive, across Central America, along the Rocky Mountains, Alaska, the Aleutian Island, Kamtschatka, the Kurile Islands, Japan Islands, Loo Choo Islands, Philipine Islands, Palawan, and Borneo. The Islands of Amsterdam and St. Paul, the Kerguelen Islands, the South Sandwich Island and South Georgia, seem to indicate the completion of the more southerly part of the (approximately) great circle. A belt extending ten degrees on each side of this great circle, includes two-thirds of the volcanoes of the earth.

On the northerly side of the more northerly portion of this axial line, there is by far the greatest and most unbroken elevated zone of the earth's crust, commencing at the plateau of Bolivia, which has a mean elevation of two and one half miles above the sea-level, it extends to Thibet, which has a mean elevation equal to that of Bolivia. The higher plateaus in each of these immense and nearly antipodal table lands, as also in the intervening table lands of Equador, reach an elevation of three miles; and the higher mountain ranges adjacent to them, reach an elevation of from five to six miles above the sea-level. This zone of table lands contains all the plateaus on the earth that reach an elevation of two miles; and all the mountains of the earth that reach an elevation of four miles are found immediately adjacent to these plateaus.

On the northerly side of the zone of table lands, is found a zone of plains—by far the greatest and most unbroken of the earth—extending from the mouth of the LaPlata to the Caspian Sea, and at an average elevation of about one-tenth of a mile above the sea-level. Their average breadth may be roughly estimated at 1000 miles, and that of the table lands at 1500.

Commencing at the N. W. extremity of the plateau of Thibet, a zone of table lands extends to the Cape of Good Hope—a distance equal to one quarter of the circumference of the earth. It seems primarily to have constituted part of zone No. 7, which I have not yet described, but to owe its present elevation to its connection with zone No. 1, to which it is here approximately parallel on the northerly side of its axial line. It has its great plain, the Sahara, on its northerly side. Taken in connection with the other zone of the table lands to which I have referred, we find an elevated zone extending three quarters of a circumference of the earth, over which one may travel (from Cape Horn to the Cape of Good Hope) at an average elevation of one mile above the sea-level, though no other plateau on the earth *reaches* an elevation of one mile.

Zone No. 2, the Appalachian, has its axial line in the volcanic line apparent along the Northern Andes, the Lesser Antilles, Sicily and vicinity, the volcanic Greek Islands, the Dead Sea region, Pondicherry, and completing the more *northerly* half of the great circle—the highly volcanic belt extending through the entire length of Sumatra. In the remaining part of the (approximately) great circle, we find the volcanic belt of New Zealand and the volcanic Islands of Chatham and Easter. Its apparent development is chiefly on the northerly side of the more northerly half of its axial line, embracing the eastern half of North America, and the South-west of Europe and Asia. Its highest plateaus reach an elevation of a little more than half a mile in North America and Europe, while in South America and Asia they owe their great elevation chiefly to zone No. 1.

In North America the part of this zone above the level of the sea consists of two well marked subzones, divided by the great line of depression extending from the Strait of Bellisle to the Gulf of Mexico. Of these the more northerly is the more extensive and unbroken; the more southerly having its strata more plicated (see Plate I. Fig. 2), and consisting largely of islands and peninsulas. Similar remarks would characterize the developments of this zone in Europe and Asia; the more southerly subzone consisting chiefly of the seven great peninsulas, Spain and Portugal, Italy, Greece, Asia Minor, Hindostan, Farther India, and also many islands;—and the more northerly, continental in character, and having for its chief lines of elevation, mountain ranges, such as the Carpathian, the Caucasus and part of the Himalaya.

Zone No. 3, or the Parimean has its axial line in that very remarkable line of fracture extending across Mexico in a nearly east and west direction, a little south of the city of Mexico, and in which many of the active volcanoes have appeared, for the first time, in the present century, although along the old line of fracture. Following this line of elevation along the Greater Antilles, we reach the volcanic Lesser Antilles. Further on, near the coast of Africa, we reach the volcanic Cape de Verde Islands. Crossing the unknown interior we reach the volcanic district at the mouth of the Red Sea. Still onwards and completing a semi-circumference of the earth, we reach in Java the most active volcanic region known. This belt extends nearly east and west from Java to New Britain (inclusive), or an extent of three thousand miles. This axial line seems to be about five degrees *north* of the great circle to which it is (approximately) parallel. In America the apparent development of this zone consists of four subzones: the West Indian, the Venezuelan, the Parimean Proper, and the Bolivian, which last constitutes the watershed between the basins of the Amazon and the Rio de la Plata. In Africa but two subzones are entirely apparent, one on each side of the axial line. On the northern side are the various parallel ranges of the Atlas Mountain region, and on the south, mountain ranges extending east and west, so far as the country has been explored, from Cape Verde to Cape Guardafui. In Asia the apparent development of this zone is great in consequence of the elevation produced by its intersection with zones Nos. 1 and 2. The Thian Chan, part of the Himalaya, and many other mountain ranges, seem immediately connected with this zone. In Australasia there are three subzones plainly apparent; Java and the Flores Islands, &c., on the axial line of the zone, with the Eastern Archipelago on the north, and Australia on the south.

Zone No. 4, or the Scandinavian, has its axial line in a volcanic belt extending through the Azores, Iceland and Jan Meyen. Spitzbergen, not, however, known to be volcanic, is in the same line of elevation. Beyond this the Polar region is unexplored. In the same line in Eastern Siberia are the Aldan Mountain ranges, extending from the Arctic Ocean to the Sea of Okotsk. A line of islands in that sea, and the long island Saghalien, carry this line of elevation to the Japan Islands, which are highly volcanic, as are also the Marianne and other island groups which continue it to New Guinea (also volcanic), across which it is continued in a mountain range to Torres Strait. Across Torres Strait this line of elevation is apparent in a volcanic island range. From Cape York the Australian Alps extend to the southern extremity of this insular continent. It is continued in an island range across Bass Strait and in mountain range across the Island Tasmania; thus completing (from the Azores) a semi-circumference of the earth. The same line of elevation is again apparent in the highly volcanic range of South Victoria. Passing over the unexplored South Polar Region we find Graham Land volcanic. The Falkland Islands and the coast mountain ranges of Brazil are in the same line.

Scandinavia and the British Islands are examples of the development of this zone on one side of the axial line, and, as they are well known, illustrate well the *law* that the side of a zone or subzone next to the axial line, shows the most plication—the boldest and greatest anticlinals. Greenland—comparatively unexplored —represents its development on the other side of the axial line. Brazil is the only other part of this zone which is well known, and it also illustrates the law to which I have referred.

The Scandinavian zone is the region of "fiords," which characterize it alike in every part of the circumference of the earth. It is also characterized by a prodigious development of trachytic rocks, which, often being basaltic, form spires, and pyramids, and caves (Fingal's cave for example). Indeed the "family likeness" that regions of the same zone present, however widely apart, is very remarkable. Especially is this apparent in the three zones with which we are best acquainted, viz: Nos. 1, 2, 4. It may confidently be said that any one acquainted with their characteristic features, would have little difficulty in recognizing each by the general features of the face of the country, even without observing the direction of the strike—that is of the lines of elevation.

Zone No. 5, or the New Zealand zone, seems to have its axial line parallel to the chief lines of elevation of the New Zealand Islands, passing through Tasmania, the Fiji Islands, &c., through Hawaii in the Sandwich Islands, across North America from Cape Mendocino to Cape Race. From Cape Race it is continued in a chain of banks and volcanic Islands extending to Cape Juby. From Cape Juby it would pass through the unexplored regions of

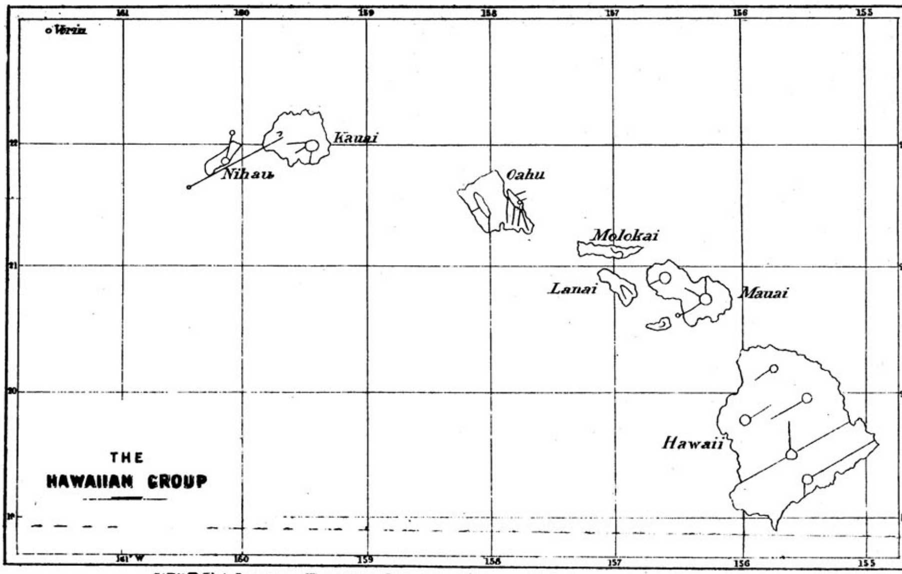
Africa to Cape Corrientes, and thence through the Kerguelen Islands to Tasmania. The New Zealand sub zone apparent from Macquarie Island to the Friendly Islands (inclusive)—a distance of about 2500 miles—and highly volcanic, is perhaps the most renarkable.

Zone No. 6, the Sardinian, seems to have its axial line in the volcanic belt of which Etna, Stromboli and Vesuvius, are the principal centres of apparent activity. The Hawaiian Archipelago, the Society Islands, and South Victoria, are other volcanic regions through which this line would pass. In Europe, on one side of the axial line, the chief line of elevation apparent in the islands of Sardinia and Corsica, and the Peninsula of Denmark, is most conspicuous. A series of parallel lines of elevation in Britain—best known in the north of England—is also parallel to this axial line. On the other side of the axial line the most remarkable development is in the parallel mountain ranges which extend from the Red Sea to the Black Sea, and of which the basin of the Jordan forms one of the synclinals. The Oural mountains also seem to belong to this zone.

Zone No. 7, the Hawaiian, has its axial line passing through the very remarkable volcanic region of that Archipelago, (see Plate 2), through Yesso (in Japan) across Asia; through Arabia and Africa (near the coast) to Cape of Good Hope, and thence through the islands of South Georgia, Tierra del Fuego, and Easter to the Hawaiian Islands. The Island of Madagascar and other islands in the same range show the existence of a subzone, of which the apparent length is about 2000 miles. On the other side of the axial line and parallel to it are ranges of elevation apparent for 9000 miles, from the Cape of Good Hope to the Sea of Okotsk.

It is obvious that the axial lines of the several zones (being approximately great circles of the earth) will each intersect every other twice, and that the two intersections of any two axial lines will be (approximately) antipodal to each other. These intersections are, as might be anticipated, specially remarkable for volcanic activity, and where the intersections of more than two axial lines occur in the same vicinity, as might be anticipated, also the

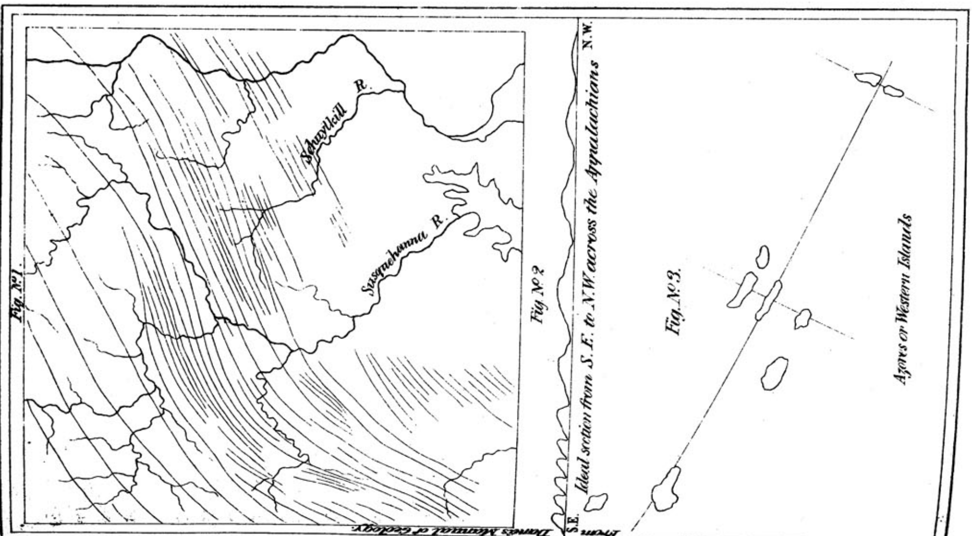
Plate, No. 2.



Wm. T. Brigham on Hawaiian Volcanoes. (From Bost. Journal of N. Hist. Vol. I.)

St. John & Halifax lith. Co.

Plate No. 1.



From Dana's Manual of Geology.

volcanic phenomena are still more remarkable, and when these intersecting axial lines are those of the latest (and greatest) zones, the result is the most extensive and intense display of volcanic activity which exists on the earth. Thus the intersections of the axial lines of zones Nos. 1, 2, and 3 produce, in the East Indian Archipelago, the most volcanic region of the earth, and their antipodal intersections produce in Mexico, Central America, the Northern Andes, and the lesser West India Islands, the only other volcanic region at all approximating to it in extent and activity. The intersection of zones Nos. 2, 4, and 5, gives the volcanic regions of the Azores and Canary Islands. (See Plate I, Fig. 3.) Their antipodal intersection in Tasmania though indicating great volcanic activity formerly, is not now actively volcanic; but the intersection of the axial line of zone No. 2, with the great New Zealand subzone of No. 5, is marked by a high degree of volcanic activity. The intersection, apparently at one point, of zones Nos. 5, 6, 7, produces the exceedingly active volcanic group of the Hawaiian or Sandwich Islands. (See Plate 2.) Their antipodal intersection is in the unexplored interior of South Africa.

Where the axial lines of two zones intersect each other the volcanoes are found along the axial line of the older; thus where the axial line of zone No. 1 intersects that of zone No. 3, we find in Mexico a line of active volcanoes across the country in the line of No. 3, and in Java the result is similar. At the intersections of the axial lines of zone No. 1 with that of zone No. 2 we find the volcanic lines of the Northern Andes, and Sumatra in the axial line of zone No. 2.

Where three axial lines intersect each other at, or near, the same point, the volcanoes are found along the axial line of the oldest zone, though the systems of parallel lines of fracture of the other zones are very apparent; thus in the Hawaiian Islands (see plate No. 2) a line extending along the northern volcanoes of Hawaii to the northern volcano of Ohau, represents the direction of the axial line of the oldest zone—zone No. 7; while the other systems of parallel lines marked on the map represent the lines of fracture—that is the directions of the lines of elevation of zones Nos. 5 and 6. Fig. 3, Plate No. 1 represents the direction of the lines of elevation of zones Nos. 4 and 5 with accuracy, and as I had not seen it until I had become convinced from observations of other parts of these zones that they must intersect each other at the Azores, in the precise directions which they are there represented as having, I was pleased to find that figure in Dana's Manual of Geology, made without any thought of the zones of parallel lines of elevation, but simply by observing the facts of the case, thus well illustrating the correctness of the conclusions to which I had come by induction.

The axial line of a subzone sometimes becomes volcanic where intersected by the axial line of a later zone; thus where the axial line of zone No. 1 intersects the sub zones of zone No. 4 on the east of Asia, we find on one side of the axial line of zone No. 4 the volcanic Peninsula of Kamtschatka, and on the other side the volcanic Peninsula of Corea, and the more distant subzone of which the axial line passes through the volcanic islands, Formosa and Luzon. Where the axial line of zone No. 2 intersects the New Zealand subzone of zone No. 5, that subzone is also volcanic.

The forms of the craters of volcanoes seem to be largely determined by the lines of fracture, and these are determined by the lines of elevation; hence it follows that the forms of the craters of the volcanoes of any group have a striking similarity to each other, and resemble those of other groups, in proportion as the producing causes, the intersections of axial (and related) lines, are similar. The longer axis of a crater is found, not in the line of the volcanoes, that is the older of the intersecting axial lines, but in the later axial line (or parallel to it). Thus the Latin line of volcanoes (Etna, Stromboli, Vesuvius, &c.) is in the axial line of zone No. 6, the Sardinian, and has the major axis of its volcanoes parallel to the axial line of zone No. 2, as these axial lines intersect each other here. Where the axial lines of three zones intersect each other as at the Hawaiian Islands, the result is more complicated, but governed by the same law. Thus Kilauea in Hawaii (the more important of the two active volcanoes in that group) has its major axis in the line of zone No. 5—the most recent of the three intersecting zones,—while the extinct volcanoes of this group have their major axes in the lines of zone No. 6 (an older zone), and the volcanoes themselves are in the line of zone No. 7,—the oldest of the intersecting zones.

There is a remarkable coincidence between the prevailing zone of parallel lines of elevation in any given region, and the lines of equal magnetic intensity in that region. Thus in the west of North America and east of Asia they coincide with zone No. 1; in the east of North America, in Central Europe, and in the south-west of Asia with zone No. 2; in the Parimean region of South America, and the Kong and Komri mountain region of Africa, as also in the central regions of Asia, with zone No. 3; in Scandinavia with zone No. 4; in the Ural Mountains, with zone No. 6; and on the south-eastern side of Africa and the Yabloni Mountain region of Asia, with zone No. 7.

Beaumont has the honor of having first developed the doctrine of parallel lines of elevation. His observations apply chiefly to Europe, and have great merit. He classifies the lines of elevation in Europe alone into nineteen systems, assigning a definite age to each. It seems to me that he obtains this large number, in consequence of two misconceptions, that were likely to occur in the early study of this subject, especially in Europe, where the great typical zone is not present at all to an appreciable extent. The first mistake consists in his indicating the systems by ascribing to them definite directions with regard to the cardinal points, and thus failing to take into account the difference in this respect produced by a difference in longitude; and the second that he did not sufficiently take into account the principle of successive epochs of activity along the same lines of elevation. I find, however, that he has attempted a generalization which would include all the chief mountain ranges of the earth, and which I give in the words of E. Lambert in his "Cours Elémentaire de Geologie."

Les lignes parallèles, considérées par M. de Beaumont, sont des arcs de grands cercles du sphéroïde terrestre qui, prolongés, vont toutes concourir en un point, qui serait le pòlê d'un autre grand cercle perpendiculaire à ceux des systèmes; mais dans une petite étendue les arcs peuvent être considérés comme parallèles.

M. de Beaumont considers the parallel lines to be arcs of great circles of the earth which, if prolonged, would all meet in a point which would be the pole of another great circle perpendicular to those of the systems, but that for short distances the arcs referred to may be considered as parallel.

The defect of this admirably simple and complete theory is that it is not in accordance with the facts. I confess some astonishment, too, at his getting his nineteen European systems to conform to it. The circumstance that gives it a certain value is that the axial lines of the chief lines of elevation intersect each other in the neighborhood of the two great Archipelagoes.

As a rule the regions in the vicinity of the axial lines of zones or subzones of elevation are slowly rising, and the depressed regions between them are undergoing still further depression. This process may be best observed in Australasia and Polynesia, where the coral rocks and islands may be said to preserve a record of the changes of elevation in regard to the sea-level. It seems to result from lateral pressure in the earth's crust caused by a shrinkage of the liquid interior from loss of caloric.

In describing the zones and pointing out the locality of their axial lines, it will be remembered that I found them, as a rule, to be on the southerly side of the continents—the *apparent* development of the zones being on their northerly sides. This in connection with the greater intensity of the plicating forces in the vicinity of the axial lines, explains why the southerly slopes of the continents are steep and abrupt, with high mountains near the sea, and deep sea near the land, and affording many peninsulas and islands. But where in exceptional cases, as South America and Africa, there is an axial line (zone No. 3) extending along or near its northern part also, we find a rapid and abrupt descent from the Venezuelan coast range and the Atlas mountains, to the remarkably deep Caribbean and Mediterranean seas, characterized by Archipelagoes.

As the lines of elevation of zones Nos. 1, 2, 5, 7, have their intersections with the equator at an angle of approximately 45 deg. it follows that within some fifty degrees on each side of the equator, very many of the more important lines of elevation have the directions of north-east or of north-west (approximately); and as the lines of elevation of zone No. 3 are approximately east and west, and those of the other two zones—Nos. 4 and 5—intersect the equator nearly perpendicularly, it follows that within the fifty degrees on each side of the equator the remaining lines of elevation will be east and west, or north and south (approximately). It will be remembered that our own Province is one illustration; the four systems of lines of elevation which I have indicated as being found in Nova Scotia have these directions; and any country in the world (within fifty deg. of the equator) will constitute another. In the Polar regions, and their vicinity, it is for an obvious reason impossible to assign any definite directions to the Mountain ranges generally.

From what has been said it appears that the structure of a country—the stratification of its rocks—depends chiefly upon the mode in which the various systems of parallel lines of elevation intersect each other there. The region of the Alps being at once specially well known to geologists, and specially remarkable in itself, is a good illustration. The lines of zones Nos. 2, 3, 4, 5, and 6, can be distinctly made out; hence its complicated structure.

It is evident that the various zones and subzones of elevation largely affect the currents of the ocean, and of the atmosphere; thereby determining the denudation and formation of rock, and largely affecting the distribution of plants and animals. Thus the Atlantic equatorial current, being finally stopped in its westwardly progress by zone No. 1, forms a great current known as the Gulf Stream, which bears the warm waters and some of the organic productions of the tropical regions along the west coast of Europe to the Polar Regions beyond Spitzbergen. If we compare the Sahara of Africa with the silvas of the basin of the Amazon, we see the effect produced by having a zone of elevation on the eastern side of a tropical country thus intercepting the moisture of the prevailing winds.

The intersections of several subzones sometimes form basins which have no outlet to the sea for their drainage, and therefore form lakes, which, since their waters are carried off only by evaporation, and thus leave their salts behind them, are necessarily salt. The most important basin of this kind is in the greatest subcontinent—Asia-Europe—and has an extent about equal to Europe, the United States, or the Dominion. The more important lines of elevation, especially when they have a direction approximately east and west, form almost impassable barriers to the migration of many plants and animals, on account of the low temperature everywhere prevailing at a considerable elevation above the sea-level. The Himalaya mountains present perhaps the best illustration. As the more important lines of depression are in regions covered by the sea, these also serve as barriers to the migration of most land plants and animals. Thus the narrow seas separating Asia from Australia, separate regions whose fauna and flora are as unlike each other as we might expect to find those of different planets. Scarcely less relatively important have been the effects of the more important lines of elevation and depression on the development of the human race, as these chiefly have determined the migrations and nationalities of mankind.

> "Mountains interposed
> Make enemies of nations, who had else,
> Like kindred drops, been mingled into one."

The course of civilization has been along the subzone of Peninsulas belonging to zone No. 2, on the south-west of Asia-Europe; and our American cousins would say thence across the Atlantic to the Appalachian subzone, also of zone No. 2. Not only is inter-communication by the more primitive methods much more feasible along the prevailing lines of elevation of any region, but these also usually determine the location of railways and canals. The Caledonia canal constructed along a line of depression of zone No. 4, may be taken for an example. It would be easy to show the great importance for the purposes of civil engineering, of an accurate knowledge of the lines of elevation and depression of any country, nor is the importance of such knowledge relatively any less for military purposes. Zone No. 1 seems to date, as to the elevation of much of it above the sea, to the close of the Secondary or Mesozoic period; zone No. 2 from the close of the Paleozoic, and zone No. 4 from the close of the Azoic period. It is probable that each zone, in its turn, had an apparent development comparable to that of zone No. 1 at the present day—giving approximate continuity to the land surface of the earth. That such is the case may, I think, be proved from the distribution of existing plants and animals and of fossil remains, but the limits of a paper forbid my entering upon the subject at present. The same reason forbids my indicating more particularly the terrestrial forces which seem to me adequate to produce the zones of parallel lines of elevation, and to have broken up each successively into subzones.

ART VI. ON PRE-CARBONIFEROUS ROCKS OF THE PICTOU COAL FIELD. BY THE REV. D. HONEYMAN, D. C. L., F. G. S., MEMBER OF THE GEOLOGICAL SOCIETY OF FRANCE, &C., *Director of the Provincial Museum.*

(*Read Feb.* 12, 1872.)

ABSTRACT.

IN my last paper I showed that Sir W. E. Logan's opinion relative to the Devonian age of certain rocks in the northern part of McLellan's Mountain, and the district of Sutherland's River, was contrary to the evidence of palæontology and stratigraphy. I shall proceed further to examine the character of the evidence upon which the opinion is based.

The supposed Devonian Rocks on the west side of East River which are considered by Sir W. Logan to be "somewhat similar" to those of McLellan's Mountain, are indicated on Sir W. Logan's map, by a Devonian coloured area on the north-west. These pre-carboniferous rocks of Waters' Hill are regarded by Dr. Dawson as "probably of Devonian age"—vid. page 319 of Acadian Geology, 2nd Ed. It will be observed that this cautious expression hardly warrants the positive conclusion which Sir W. Logan derives from it.

At the time when I read the report I had not seen the rocks of this locality, Waters' Hill, in the north-west corner of the Pictou Coal Field. I therefore examined the map already referred to in order to get some idea of the relative position of the rocks in question. I was astonished to see Devonian rocks having insulated patches of millstone grit, and to find a limestone quarry in Devonian rocks, as all the limestone quarries with which I am acquainted in Nova Scotia, and Cape Breton besides, are of Lower Carboniferous