Mt. Olympus
Mt. Ida
Traveller Plateau
Mt. Hugel
Cuvier Valley
Lake St. Clair
A
B.
Datum Line 1800 Feet above Sea Level
Ducane Range
Magnetic
Narcissus River
B
Mt. Manfred
L. Laura
Mt. Ida
Lake St. Clair
Mt. Cuvier
Mt. Byron
Traveller Range
Mt. Olympus
Coal Hill
L. Petrarch
Curier River
Traveller Lakes
GICAL
Mt. Hugel
L. Basin
— SKETCH MAP AND SECTION —
— OF —
-THE LAKE St. CLAIR DISTRICT —
A
Cynthia Bay
Traveller River
Derwent River
— Scale of Section —
Horizontal 2½ Miles to 1 inch.
Vertical 2000 Feet to 1 inch
Mt. Rufus
The Heights are approximate only
Bedlam Walls
Greenstone
Sandstone (Carb?)
Mt. Charles
Sandstone actually observed

NOTES ON THE GEOLOGY OF LAKE ST. CLAIR AND ITS IMMEDIATE NEIGHBOURHOOD, TOGETHER WITH OBSERVATIONS REGARDING THE PROBABLE ORIGIN OF OUR NUMEROUS TASMANIAN LAKES AND TARNS.

By R. M. Johnston, F.L.S.

Apart from the unrivalled beauty of the scenery, there is nothing particular in the *geological* features of Lake St. Clair and its immediate neighbourhood, which is not common to and far more perfectly represented by nearly all the elevated greenstone mountains and plateaux, which form the most familiar physiographic features of the greater part of Tasmanian landscape. The great elevated greenstone plateau of Tasmania—which occupies so large a portion of our island, and not only embraces the Lake St. Clair region, but also includes the greater portion of our notable mountain peaks and bosses—is of the most uniform and simple character, of which the following divisions, where perfect sections are disclosed, may be regarded as more or less *constant* and *typical*, taken in ascending order:—

General Characteristics.

1. *Base* either (*a*) slates, schists, limestones, or conglomerates of *Upper* or *Lower Silurian* age, as at Mount Tyndall, Eldon Peak, Eldon Bluff, La Perouse, Adamson's Peak, Ben Lomond on one side, and Mount Picton, or (*b*) *Archæan* or *Metamorphic* Rocks, as at Amphitheatre, Mount Gell, Mount Hügel, Mount King William, Little Sugar Loaf, Gould's Sugar Loaf, Mount Ossa, Mount Pelion, Barn Bluff, Cradle Mountain, Mount Manfred, and Du Cane Range.

2. *Permo-Carboniferous Rocks*, with their varied divisions of grits, conglomerates, mudstones, blue slaty shales, impure limestones; winged Spirifer, Productus, Stenopora, and Fenestella Zones; Lower Coal Measures (Tas.), with
   Glossopteris, *Gangamopteris*, and *Nœgarathiopsis;* common throughout Eastern Tasmania.
   Middle Coal Measures (Tas.), with
   Gangamopteris and *Vertebraria*, as on Ben Lomond, Mount Cygnet, and slopes of Mount Wellington.

3. *Lower Mesozoic Sandstones*, with *Vertebraria* and remains of *ganoid fishes*, as on slopes of Mount Wellington and Mount

Pearson, and common elsewhere throughout Eastern Tasmania.

4. *Upper Mesozoic Sandstones, Shales, and Upper Coal Measures* (Tas.) with *Zeugophyllites, Thinnfeldia, Sphenopteris, Pecopteris, Neuropteris, Alethopteris, Odontopteris, Tæniopteris, Cyclopteris, Baiera, Salisburia, etc.*, as at Ben Lomond, Mount Nicholas, Fingal Tier, Mount Gray, slopes of Mount Wellington, and probably Mount Pelion and Coal Hill, and common elsewhere throughout Eastern Tasmania.

5. *Greenstones*—Massive, Core Crest (?), or Covering Cap (?) —associated with mesozoic coal measures, and occupying the summit of Great Plateau and of most of our mountains in Eastern Tasmania.

6. *Occasionally lignites and Tertiary leaf beds*, as on Magnet Range.

7. *Occasionally (in patches) olivine basalt sheets,* as at Bronte, River Nive, and Lake Sorell.

While I cannot but compliment Mr. Officer for his interesting notes on the geology of the Lake St. Clair region, and for the general accuracy of his observations, so far as they go, it is unfortunate that his lack of acquaintance with the literature of Tasmanian Geology should have led him to give so bald an account of the most familiar geological features of a region which is classic to the local observer as the field wherein one of Tasmania's ablest geologists (Mr. Charles Gould, during the years 1860, 1861, and 1862) accomplished his best work as an explorer, geographer, and geologist. Even Mr. Officer's geological sketch, with its details of lake-depth, mountain and ravine, would not now be possible, were it not almost entirely based upon the earlier elaborate investigations of Mr. Charles Gould, covering a period of two or three years, and aided by a field staff of about 32 men. This much-undervalued observer not only gave us all our existing routes and tracks in this western region, but, owing to his long and ably conducted explorations, he gave us, in his geological and physiographical maps and vertical sections of 1860 and 1862, the knowledge of all the physiographical features and principal geological characteristics which we are possessed of at the present moment, and which form, for this region, the base of the delineations on our latest survey maps, which are partly reproduced by Mr. Officer. During my own later explorations in this region, I could only, by the aid of more definite palæontological data, *confirm* what Gould so well described and delineated over thirty years ago. Nor, in spite of some adverse conceptions of Mr. Officer, so far as I am concerned, as regards the still doubtful age of the greenstones of the Great Plateau, can I admit any novelty of conclusion formed by him; for, in this respect, he simply follows and adds weight to the original conclusions of Messrs. Gould, Milligan, and Strezelecki, against whose judgment, as to age of greenstone, I have always felt myself to be in an uncongenial atmosphere of opposition, even when that opposition, as so frequently expressed by me, is both very doubtful and only at most *tentative.* This attitude on my part is only natural, when it is considered that, in my ideal section from Dry's Bluff to George Town, published in this Society's Journal* twenty years ago, I then followed Gould and Strezelecki, in regarding the greenstone of the Great Plateau as younger than the Permo-Carboniferous and Mesozoic sedimentary formations. Owing also to Mr. Officer's imperfect acquaintance with local sources of information relating to Tasmanian Geology, he has, in his small chart of Lake St Clair, unwittingly, reproduced a *fac simile of a fragment* of a geological "Map of a portion of Western Tasmania,"† explored during the summer of 1860 by an expedition under the command of Charles Gould, B.A., F.G.S., Government Geologist (lithographed and coloured by F. Dunnett, of Hobart). That it simply reproduces a fragment of the geological and physiographical details of this region of the west of Tasmania as originally mapped by Gould, is best appreciated when I mention that this scarce, but locally well-known, coloured geographical map of Mr. Gould, embracing the portion mapped and coloured by Mr. Officer, and agreeing with it perfectly in all essentials, covers an area of about 2,500 square miles, situated between Cradle Mountain and the Mount Murchison region in the north, and between Lake St. Clair and the Mount Lyell region in the south. When I state that Mr. Officer's chart is a less perfect delineation or *fac simile* of a portion of the region, covering at most 234 square miles of the south-eastern portion of the area embraced in Mr. Gould's more perfectly detailed geological map (that is, only 9·36 per cent. of the area) we may more easily appreciate how far the map of Mr. Officer falls short of the more extended original map of 1860, while, for obvious reasons, it also compares unfavourably with the latter in exactness of physiographical and geological definition. I say this is unfortunate, because, were it not for the original elaborate and comprehensive geological map of Mr. Gould, Mr. Officer's smaller chart of a portion of the region would, unquestionably, be considered a most meritorious delineation, regarded as the result of the unaided observations of a geologist who had briefly examined the country for the first time.

*Proc. Roy. Soc. of Tas., Aug , 1872 "Composition and extent of Tertiary beds in and around Launceston."

† Scale, 2½ inches to the mile

Lack of Palæontological Evidence as to the Age of the Coal Hill Coal Measures and Associated Sandstones.

There is, however, another matter of great local importance which Mr. Officer's paper reminds us of, viz., the doubtful age of the coal measures which we know exist at Coal Hill, and the lack of knowledge regarding the positive existence of Lower and Upper Mesozoic formations succeeding the Permo-Carboniferous mudstones, of which we have here and elsewhere along the crests of the Great Plateau the most abundant evidence. Had Mr. Officer been more perfectly acquainted with our local wants in this respect (see "Geol. of Tas." p. 164), I am sure his labours and observations would have been more profitable to science, as well as of more lasting satisfaction to himself. Let us hope that he may yet be encouraged to return to this interesting out-of-the-common track region, and direct his observations rather to fill up the *blanks* in our knowledge regarding the doubtful age of the Coal Hill coal measures, and also help us in discovering positive evidence (stratigraphical and palæontological) of the presence, or otherwise, with boundaries, of the rocks of Mesozoic Age of both upper and lower horizons, which are so familiar to us in similar situations in the more eastern elevated greenstone plateaux. Without palæontological evidence we can proceed no further at present, and it is unfortunate in this respect that Mr. Officer's observations afford no light whatever.* As regards certain new aspects of portions of the greenstone plateau, my own observations during the last four or five years have again independently disposed me to regard with more favour the possible later or Post-Mesozoic age of the greenstones of the Great Plateau and elsewhere. My difficulty still exists as regards the apparent older greenstones lying between Blackman's Bay and Adventure Bay. But I take this opportunity of acknowledging that my continued failure to detect the remains of undoubted greenstone rocks among the abundant erratics and derived conglomerates in our mudstones, together with the undoubted similarity of character of supposed older and later greenstones, have for the last year or two weighed strongly in my mind in favour of the later age of all our typical diabasic greenstone rocks, and I should not now be surprised in the least if reasons should soon be forthcoming which

*It would be interesting to learn how Mr. Officer arrived at the knowledge that the whole of the Sandstones mapped by him as *Carboniferous* are really so. He does not support this conclusion by a single reference to the characteristic fossils, by which means alone can such a conclusion be accurately arrived at; for the Sandstones of Permo-Carboniferous Age and Lower Mesozoic Age in Tasmania are so similar in lithological characters, that references so hazarded are pure guess-work.

might reconcile my judgment with the apparently strong opposing evidences presented by the extent, mass, positions, and continuous relationship of the greenstone rocks underlying the mudstones between Blackman's Bay and Adventure Bay in South-Eastern Tasmania. Mr. Montgomery's and Mr. David's reasonings, I confess, have also had much weight in disposing my mind to contemplate a result of this kind. Let me be just to myself, however, by quoting my earlier remarks on this important question. In commenting upon the *pros* and *cons* relating to the age of the greenstones, I have always accepted the fact that the larger portion of the greenstones of the lower levels were younger than the Upper Mesozoic coal measures, although I was, and am still, doubtful of the age of the massive greenstones of the more elevated regions, and such was, and is, my tentativeness of opinion, that, in my paper on the Geology of Bruni, read before this Society on April 13th, 1886, I stated—"That the opinions advanced by me have merely the force of probability, in my mind, from which all doubt has not yet been wholly removed;" and again (p. 8), "I am only anxious for the truth of my opinions, and therefore shall always be prepared to modify them in accordance with the weight of available evidence." As yet I have not heard of any satisfactory reasons which would account for the position and relationship of the Bruni and Blackman's Bay greenstones in such a manner as would favour an origin more modern than the Upper Palæozoic rocks, which appear to have been quietly deposited upon their upper irregular surfaces. I have considered the possibility of lateral thrust between the bedding on a gigantic scale, but there are still many positive objections lying beyond, which at present prevent me from accepting this solution.

The Regions in the Neighbourhood where the Formations Around Lake St. Clair may be Studied Most Advantageously.

By confining his observations to the immediate shores of the charming Lake St. Clair, and to the romantic valleys of the Cuvier and Narcissus, Mr. Officer lost no advantage, so far as the lover of the picturesque is concerned; but, so far as the profitable study of the particular geological formations is concerned, he could not have chosen his field of observation more unfortunately. It is quite possible that if Mr. Officer could have obtained a view of the complete series of the rocks from the actual bed of Lake St. Clair, which is buried as much as 552 feet beneath the surface of its water level in the immediate vicinity of Mount Olympus, he might obtain a fair knowledge of the character and sequence of the typical rocks of this interesting locality. But although

Mr. Gould assures us that the Metamorphic rocks (not carboniferous sandstones, as in Mr. Officer's chart) form the deepest bed of the lake, which he had sounded so carefully in every direction in 1860, it is impossible from *direct* observation to confirm or disprove his statement. It is when we leave the Lake and its affluents (the Cuvier and Narcissus), and traverse the region of mountain and valley, beginning with that of the Lakes Dixon and Undine, and thence proceeding westward, along Gould's well-known section, by way of Mount Gell, Coal Hill, Gould's Pyramid, Rocky Hill, Camp Hill, Last Hill, and Eldon Peak, across to North Eldon, that we have a fairly complete glimpse of the grand range and sequence of the varied and interesting geological formations of the Western Highlands of Tasmania. The region of Lake St. Clair proper, with the valleys of its northern affluents, the Cuvier and Narcissus, disclose the *merest fragment* of this splendid sequence of rock formation; a fragment, moreover, which can be studied with greater advantage and in much greater perfection within one mile of the City of Hobart, and nearly everywhere in the more accessible regions of the east.

I can say no more of this fragment of Tasmanian geology—which, however, embraces all our rich and interesting Permo-Carboniferous and Mesozoic formations—than has been so fully described by me already in numerous geological papers to this Society, and whose study has occupied my own close attention for a period of nearly a quarter of a century. The fact that in my work on "The Geology of Tasmania" alone I have devoted 123 royal quarto pages to its history, accompanied by numerous plates and sections, and illustrated also by over 230 figures of typical fossils, is surely sufficient evidence that it has not been neglected, and that we have acquired a considerable knowledge of its leading characteristics. Between the North Eldon River bed and Lake Dixon valley, however, we have, as shown in accompanying section, a grand development of rocks, embracing probably a complete series of all the older formations from the *Archæan* to the *Upper Silurian*, and possibly also—in the upper conglomerates of some of the mountains, such as Mounts Lyell and Owen—the equivalents of the Devonian of other countries. The general character and relationship of this grand series of rocks, as disclosed by Mr. Gould's section, part of which I have myself verified from palæontological and lithological data, may be summarised as follows :

1. Row or Granite Tor—*granite axis.*

2. Row Tor, across the Murchison Valley to North Eldon River, *metamorphic schists, etc.*—apparently devoid of fossils.

3. North Eldon River, across Eldon Peak, Camp Hill, and Rocky Hill to Inkerman River: base Lower

Palæozoic rocks; those most apparent being of Upper Silurian Age, and in the Eldon Valley, Princess River, consisting largely of clay slates, mudstones, and schistose, sandstones with thin quartz reefs, and in certain beds, richly fossiliferous, the following forms are especially prolific:—*Calymene, Pentamerus, Orthis, Strophomena, Spirifera, Atrypa, Lingula, Rhynchonella, Leptaena, Loxonema, Favosites,* encrinital stems, etc. Unconformably lying upon these we have in succession, as on Eldon Peak, Camp Hill, Rocky Hill, etc., in ascending order:—

I. Upper Palæozoic grits, conglomerates, and mudstones, with the usual abundance of winged spirifers *Productus, Terebratula, Strophalosia, Aviculopecten, Pachydomus, Sanguinolites, Streblopteria, Avicula, Palæarca, Tellinomya, Inoceramus, Pterinea, Notomya, Platyschisma, Orthonata, Conularia, Goniaites, Stenopora, Protoretepora, Fenestella, Encrinites,* etc.

II. Thick bedded sandstones, shales, and coal, as at Coal Hill, Mount Gell, etc., of which no fossil evidence has yet been obtained, but which may possibly embrace the *Lower Coal Measures* with *Glossopteris, Gangamopteris,* and *Nœggarathiopsis;* the *Lower Sandstones of Mesozoic Age,* with *Vertebraria* and ganoid fishes; and the *Upper Coal Measures Shales and Sandstones,* with *Zeugophyllites, Baiera, Pecopteris, Spenopteris, Thennfeldia, Neuropteris, Tæniopteris, Salisburia, Pterophyllum,* etc.

III. Massive cap (?) or elevated cores (?) of diabasic greenstones—the most characteristic feature of all our mountain peaks, bosses, and plateaux, from Mounts Tyndall and Dundas on the west, to St. Patrick's Head and La Perouse on the east.

IV. Inkerman River, across the spurs of Gould's Pyramid, Alma River, Mount Gell to valley of the Dixon and Undine; *base*—Metamorphic schists quartzites, gneiss, conglomerates, etc., with overlying rocks, as on Eldon Peak, at Mount King William, Mount Hügel, and Mount Gell; and on intervening ridges and peaks, as Rocky Hill, Gould's Pyramid, and Coal Hill, the usual sandstone shales, grit, etc., whose age may be Upper Palæozoic or Mesozoic, or include both; but in the absence of palæontological data, cannot now be determined.

Apart from the Brachiopod sandstones, Clay-shales, Hydromica-schists, and more recent conglomerates further west, between Mount Lyell and the Tertiary Lignites and Leaf Beds of Macquarie Harbour, this region affords a grand field for original investigation in the future, as at present we have only a very bald view of its history and stratigraphic sequence. It is here that the Tasmanian geologist in the future may expect to win fresh laurels, rather than in the immediate vicinity of Lake St. Clair, just lying beyond its most easterly limits, *i.e.*, across the great eastern and western watershed-dividing ranges of Mounts Hügel and Rufus. Southward across the Frenchman, Gordon River, Arthur Ranges, towards Port Davey, a still more interesting region awaits systematic exploration; for all that we know at present is, that the whole region is similarly occupied, mainly by the *Lower Palæozoic* and older *Metamorphic* rocks, whose geological history is still, practically, a closed book, and even its exact physiographical features are far from being perfectly delineated on our charts.

Origin of the Numerous Lakes, Tarns, and Lakelets of the Great Plateau of Tasmania.

While I am fully convinced that a large number of our small lakes and tarns, mostly carved out of the harder crystalline rocks, towards the mouths of the Alpine Valleys of our Western Highlands leading from the Great Plateau (such as Lakes Undine, Dixon, and Augusta), have been originated mainly by the agency of glaciers and their terminal moraines, I have, from long observation, arrived at the conclusion that our larger lakes on the higher levels of greenstone plateau—such as Lake St. Clair, Lake Sorell, Lake Echo, Lake Arthur, and Great Lake, together with innumerable lakelets and lagoons on the upper levels—have been mainly determined by the original irregularities of surface, produced partly by the anastomoses of successive flows of greenstones during their eruption, and partly by the unequal contraction due to lack of homogeneity of the cooling surfaces of the more massive horizontal flows of greenstone magma, which are so characteristic on the mountain plateaux of Tasmania, and which cover continuously, or in an anastomosing network of ranges, so large a portion of the superficial area of Eastern Tasmania. This conclusion has again and again been forced upon my mind by the closer study of our upland lake systems, as it seems to account satisfactorily for all the known facts; and, moreover, it is in harmony with the views of leading physicists when contemplating the causes which produced the initial and universal irregularities of surface on our globe, and which in their turn determined the limits of land and sea during the later epoch in its history, which marked the stage of change from the expansive free gaseous envelope of vapour to precipitation and condensation from cooling and gravitation, in the form of lake, river, sea, and oceanic waters, within the limits determined already, by irregularities of the surface of the earth's crust.

A diversified distribution of the original surface magma of our globe is assumed with good reason by Mallet J. D. Dana,* Professor Hennessy, Archdeacon Pratt, Sir Archibald Geikie, and many other eminent physicists and geologists, as a primary condition; and this primary condition, owing to the unequal rates of cooling, and differences of density of different masses of magma, is assumed to be the initial factors in producing elevated and depressed surfaces, including cup-shaped basins. The denudation of agencies such as the mobile gravitating force of water, only come into play at a subsequent stage, so that the older caused irregularities of surface, to a large extent, initiate and govern the direction and local intensities of subsequent denuding agencies.

In accounting for the origin of Alpine lakes generally, by the Glacier Theory—according to Ramsay's view, which, during the first quarter of this year, has again been prominently brought before our notice by a discussion of the subject in the pages of *Nature* by Mr. T. G. Bonney,† the Duke of Argyle, ‡ and Dr. Alfred Wallace § it would seem that the fascinations of Compte's "Law of the Simplest Hypothesis" have a dangerous tendency to promote a retrograde movement in geological science; and that some of her most brilliant exponents are not altogether mail-proof in resisting their fascinating influence when the charmingly disguised errors of *simplicity* of causation, by their aid, are championed in opposition to the truer, though, perhaps, less attractive *complexity* of variable or combined causes. In geological science, as in economic science, there is ever a danger of mutilating a complex truth for the sake of erroneous simplicity; and the bed of Procrustes was but a feeble engine of distortion or mutilation, as compared with all simple or *specific* hypotheses of causation specially devised to embrace somehow all effects, notwithstanding that the points of similarity in the latter may only appear to be of congeneric value, and not conspecific.

Professor Marshall, in his recent work on "The Principles of Economics" (Methods of Study) has given us earnest warning of this danger to all students of complex problems of science; and has shown that the "Physical sciences made slow progress so long as the brilliant but impatient Greek

*The fact that the Continental and Oceanic areas were determined in the first cooling of the globe signifies that in the cooling or radiation of heat into space, there were areas of greatest and least contraction. This difference in cooling and the resulting level of the surface must have been owing to some difference of quality or condition in the material. (Dana's "Manual of Geology," 3rd edition, 1879.)

† *Nature*, p. 341 (Feb.). ‡ *Ibid.*, p. 369. § *Ibid.* (March) p. 437.

genius insisted in searching after a *single basis for the explanation of all physical phenomena*; their rapid progress in the modern age is due to a breaking up of broad problems into their component parts. There is no doubt an underlying unity in all the forces of nature, but whatever progress has been made towards discovering it has depended on knowledge obtained by persistent specialised study, no less than an occasional broad survey of the field of nature as a whole," and accordingly, with Mill, he approves of another of Compte's sayings, that "a person is not likely to be a good economist (might we not add also for local application, *a good geological specialist*) who is nothing else." Although these observations are directed to quite a different matter, the central idea may yet be applied with advantage to all who are apt to be carried away by the fascinations of simple universal hypotheses of causation, as accounting for complex though superficially similar effects. I am of opinion, therefore, that the effort on the part of some brilliant geological investigators to account *generally* for the origin of Alpine Lake basins by reference to the Glacier Theory is a retrograde movement and a mistake. It may account for a large number of lake basins, but if all previous observations are not a blunder, it cannot account for all lakes, even in Alpine regions. Every geologist who desires to avoid imparting error into his inferences from local facts of observation, must therefore rigidly guard against deceptive general hypotheses, lest they should unconsciously bias and disturb his mind in making correct interpretations of observed facts; and hence each lake basin, wherever situated, is best studied apart from all others on the basis of local evidences. This method, moreover, does not exclude the Glacier or any other particular agency, regarded as a cause. Apart from one's own experience in support of this view, we have the best positive evidence of its truth in the writings of all authors of Geological Text Books, whose imagination is kept under stricter control, partly by the feeling that they are more responsible for the teaching imparted by them, and partly by the circumstance that in giving the outline of any particular subject, they are led to review all the varying circumstances and conditions, and, in unsettled questions, to give the facts upon which they are based, in order that the student may be properly equipped to grapple with similar difficulties when they appear to him.

Sir Archibald Geikie's luminous writings and observations alone suffice to overthrow the "ONE CONDITION, ONE CAUSE" theory of lake origin. In his text book (p. 927) he gives a most true and lucid account of the various causes which are known to have produced lake basins, and may be briefly summarised as follows:—Lakes may be formed in several ways:—

1. By subterranean movements, as in mountain-making, and in volcanic explosions, and as in the subsidence of the central part of a mountain system, which might conceivably depress the heads of valleys below the level of the original outflowing channel of stream, and as in the cup-like basins of extinct craters. Types of the latter are exemplified in Australia, by the Blue, Middle, and Centre lakes of Mount Gambier, and possibly some of the lakes of the Great Plateau of Tasmania.

2. By ponding back of streams by lava. Type, Lake Aidat in Auvergne, and probably Lake St. Clair in Tasmania. The latter, however, can only partly be the result of this cause, for its great depth of 592 feet, in a trough of older rocks lying *below* the igneous flows, the igneous ponding flow being so much above its deep bed, the present head, now even 180 feet below the lake surface, has by depression of the head of the valley, mainly aided in the formation of its great depth of water bed. The flow of greenstone which closes the mouth of the Lake, and through which its affluent the Derwent cuts its shallow course, would not, by itself, account for its present great depth; nor would glacier erosion account for all its peculiar characteristics.

3. By subsidence of surface, caused by the dissolution of rock salt, limestone, etc., such examples of the former occur in the Peak caverns of Derbyshire, grottoes of Anteparos and Adelsberg, and the vast labyrinths of the Mammoth Cave, Kentucky, and Salt Pans, Tasmania. Examples of the latter form are found frequently as small lakes and ponds in Tasmania, as at the Circular Marshes and Ilfracombe.

4. By the original irregularities of surface, produced by the irregular anastomosing flows, and unequal cooling of massive unhomogeneous igneous rock, as on the Great Plateaux of Tasmania; combined, probably also, with violent and abrupt alterations of level during the cataclysmic upheavals, which raised the rocks bodily, as on Ben Lomond, Mount Wellington, Great Plateau, and many other mountain table-lands, to a height of about 2,500 feet above their former levels. Geikie (p. 925, Text Book) states that most of the great table-lands of the globe seem to be platforms of little disturbed strata, either sedimentary or volcanic, which, as in the case of most of the elevated greenstone plateaux of Tasmania, "have been upraised bodily to a considerable elevation."

This cause, therefore, accounts most satisfactorily for the greater number of our elevated Tasmanian lakes, such as

Lake St. Clair, Lake Echo, Lake Arthur, Nineteen Lagoon, Lake Sorell, Lake Crescent, and Great Lake on Great Plateau, and Lake Youl on Ben Lomond.

5. By the irregularities of surface caused by ice sheet movements, as in the northern parts of Europe and North America; leaving, on the retirement of the ice, clay and mound enclosed hollows, forming, subsequently, numerous tarns and lakes.

6. By the irregular erosion of valley systems, leading from high table lands and mountain chains, by former glaciers, of which, Lakes Undine, Dixon, George, Rufus, Dora, Spicer, Beatrice, Augusta, Edgar, and innumerable other lakes and tarns in similar situations in Alpine Valleys in Tasmania afford good local examples. Dr. Wallace has attempted to show that glacier regions and lakes and tarns are constant concomitants, and by inference these are desired to be regarded as cause and effect. But in the light of the preceding review of the mutability of causation, there is surely a better reason to be given for the prevailing concomitance in the higher latitudes of Europe and North America, and the absence of numerous lakes in lower latitudes, except, as he allows, in *volcanic regions.* May the absence of lakes in the lower levels of low latitudes be not better accounted for, partly by the absence of precipitation, as in desert regions, and partly by rapid evaporation exceeding precipitation in other lower levels of warm regions?

On the other hand, as igneous rocks are also largely characteristic of the higher altitudes of all great mountain chains, peaks, and plateaux of glacier and other regions, may not be irregularities of surface produced on the surface of such rocks in glacier regions, caused by an unequal cooling, anastomoses of flow and violent alterations of level by upheaval, account for a larger number of the lakes in glacier regions than even the admittedly numerous examples which may be fairly referred to glacier erosion alone?

These are considerations well worthy of close attention, and whatever differences of opinion may still exist, it is hoped that the experience gained by the study of the numerous lakes of Tasmania may be of some service in arriving at a true conception of the whole subject.