The Tasmanian Naturalist

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The Tasmanian Field Naturalists' Club.

The Annual Meeting was held at the Royal Society's Rooms, the Tasmanian Museum, on Thursday, 16th September, 1926. Dr. W. L. Crowther presided.

Numerous specimens were exhibited and described. The Annual Report and Statement of Accounts was read and adopted. The following is a resume of the report:—

"The Committee has the honour to present the following report of the Tasmanian Field Naturalists' Club on the work of the past year. The general routine work of the Club has been carried out during the period of review, and the following is a resume of the meetings held:—

1925.

17th September.—Annual meeting, election of officers, Chairman's address.

15th October.—Illustrated lecture, "A Trip to the Hartz Mountains," J. C. Breaden.

19th November.—Illustrated lecture, "An Overland Trip to Port Davey," by L. Livingstone.

1926.

4th March.—Illustrated lecture, "South-Western Tasmania," by Clive Lord.

22nd April.—Illustrated lecture concerning the Easter Camp at Safety Cove, Port Arthur.

20th May.—Illustrated lecture, "A Walk in the Bush," by L. Rodway, C.M.G.

10th June.—Illustrated lecture, "Some Wild Flowers of Tasmania," by Donald Breaden.

15th July.—Illustrated lecture, "Tasmanian Birds," by M. S. R. Sharland.

12th August.—Lecturettes by Junior Members:
"On Native Implements," by Master Packman.
"On Native Birds," by Master Harmon.
"On Native Butterflies," by Master Denny.
Illustrated lecture, "Sea Coasts and their Story," by A. N. Lewis.

INCREASED MEMBERSHIP.

"One aspect to which it is desired to draw attention is the increase in membership as regards juniors. A large number of boys from the Hutchins School have joined the Club, and under the guidance of Mr. Norman Walker are taking a keen interest in natural history. Apart from the Club meetings the interest of the boys has been aroused sufficiently to make them take such an active interest in the matter that they are forming a small museum at the school. Such a movement as this speaks well for the future, not only of the Club, but for the advancement of Science generally, for it is from the boys of to-day that the naturalists and scientists of the next generation must be forthcoming, and the interest aroused in early life may be of great benefit in future years.

PUBLICATIONS.

" 'The Tasmanian Naturalist' has been issued to members during the year. The next issue will be in a different form, as the Committee has had to make certain alterations as regards printing the journal. In addition to 'The Naturalist,' an illustrated report of the Easter Camp was issued to members.

SUBSCRIPTIONS.

"The policy adopted at the commencement of the year of increasing the subscription has had good results as far as the finances of the Club are concerned, and has enabled the publication of the journal to be continued.

CONSERVATION OF NATIVE FAUNA.

"The Club has always taken a keen interest in the question of the conservation of our Tasmanian fauna. The present position is worse than it has been for many years, and a special committee has been appointed to investigate and bring up a report."

The Honorary Treasurer's statement showed a credit balance of £3/16/8. The 1926 Camp account a debit of £4/2/6. The Camp reserve fund a credit of £9/12/3.

Mr. L. Rodway, C.M.G., was elected the first Life Member of the Club as an expression of appreciation of Mr. Rodway's exceptional service to the Club in particular, and nature study in general.

Mr. G. W. Knight drew attention to the Gould League of Bird Lovers, and a motion was carried whereby the Club promised every support to the movement.

Dr. W. L. Crowther gave his presidential address, taking as his title, "The Conservation of Tasmania's Native Fauna."

An interesting discussion was held at the conclusion of the chairman's remarks.

The Conservation of Tasmania's Native Fauna.

By W. L. Crowther, D.S.O., M.B.

CHAIRMAN'S ADDRESS, 1925-26.

The meeting to-night concludes the work of the year 1925-26, and I must take this opportunity of thanking you for the honour of acting as your chairman for the last two years. It has been a very great pleasure to me, and my one regret is that I have not had more time to give to the junior members and the encouragement of field excursions, and I trust that my successor may be of more help to you in this respect.

The Club has had a good year without any outstanding events, and the usual programme of lectures has been carried through, also a very successful camp-out at Port Arthur. The event of most importance to us has been the opening up once more of the fur season, and its effect on the already very depleted native fauna.

I approach this matter not in any carping spirit, as under Tasmanian conditions the Minister has a very difficult situation to handle, and much influence can always be brought to effect the opening of what was to be a closed season. I instance the pleas of unemployment, damage to crops, etc. After all, the snaring and taking of our game is a specialised work, and one for which the average man "out of a job" has neither aptitude nor inclination. To prevent damage to crops there is nothing to prevent a man destroying the animals responsible, provided he obtains authority from the Police Department.

I feel that the Honourable the Attorney-General (Honourable A. G. Ogilvie) is, and has been, sympathetic to those who wish to control the Furred Fauna of Tasmania, and he has behind him all the influence of our Club in his efforts to amend the Animals and Birds Protection Act, and establish a fully qualified Board to administer the industry.

Our marsupial life is unique in its form. Australia is, as you know, the continent in which the marsupials are most fully represented, and the Commonwealth Government has of recent years taken much interest in the question of the export of living and dead animals. The Commonwealth Government is also giving very real support to Dr. Colin MacKenzie in his work on ductless glands, and everywhere there is a widespread feeling that our beautiful and unique animals shall be conserved for our descendants.

From the standpoint of an industry, the opossums and kangaroos are difficult animals to control. They are able to range freely and reproduce themselves slowly. Where the Thylacine and Tasmanian Devil each have several cubs, the kangaroo and opossum have only one or, at most, two joeys in the breeding season. The general rule is that both these species in their wild state breed only once in the twelve months. Their young, as you know, are very immature when born, and very dependent on their mothers for several months.

By an unhappy chance the season when the fur is at its finest (June and July) corresponds to the time when almost every adult female has young in the pouch, and the destruction of the doe entails the destruction of both. There should be some method of trapping which would hold the animal alive until it could be examined. Were this done all immature animals of both sexes could be released. All males and a certain proportion of does (such proportion to be estimated for each species) would then be slain and skinned. Generally, too, at least the hind quarters of the kangaroo and wallaby might be made available for food in the city. Controlled in this way the industry might not need even the alternate closed season that the Commissioner of Police recommends. The present system is such that most animals that are trapped are dead when the trapper examines the snare.

The Ring-tailed Opossum is being wiped out. In the old days of the 'possum dog and moonlight shooting it had some chance; now with the deadly spot light it is a systematic massacre. The use of this light should be absolutely forbidden, and the penalty for use a heavy one. In New Zealand, where the Australian fauna has been introduced with great success, and where a very valuable fur industry has been built up, such lights are absolutely forbidden.

The big bulky nest of the Ringtail is so easily found that the female has no protection as the Brush Opossum has in her hole in a hollow tree, and if the unfortunate doe gets away her home is marked down, and she becomes a victim a little later. In 1923-4-5 1,457,125 Ringtail skins have passed through the Department, and I defy contradiction when I anticipate over 250,000 will go through this year.

I desire to draw attention to the following extract from the report of the Commissioner of Police, dated 27th August, 1925, giving the number of skins taken in 1923-4-5. The figures speak for themselves:—

> "Before the season was opened I obtained reports from the police throughout the State as to the quantity of game. The reports received were almost unanimously to the effect that game was scarce, and the season should be closed. I strongly recommended this to the Hon. the Attorney-General. The surprised result of the open season as to the number of animals killed and the revenue received suggests that these reports were not well founded; but this is not so. It is true that this year the open season (three months

duration) resulted in a capture of animals fairly well in excess of the total during previous year (two months operation), but the number of pelts taken in 1925 (except ringtail opossum) were considerably under the 'take' for 1923. Very good weather prevailed during the greater part of the open period this year. enabling hunters to 'well comb' all game districts into the back country not previously well accessible. In addition, the splendid market value of skins proved an incentive to hunters on both Crown lands and private property to put forth their very best efforts while time permitfed it, and while general conditions were so favourable for the work. The toll taken this year, notwithstanding the shortage that existed, renders the matter one for serious consideration. The fur trade of the State is a very real and valuable asset, which, in my opinion, should be firmly preserved. I suggest alternate open and close seasons.

Appendix 1.

Season.	Opossum, Black, *Trichosurus*, Vulpecula.	Opossum, Grey, *Fuliginosa.*	Opossum, Ringtail, *Pseudochirus* cooli.	Kangaroo, *Macropus* rufi-collis var. bennetti.	Total. Wallaby, *M. Billardieri.*	Total.	Licence Fees Received.	Royalty Received.
23–4–5	71,576	140,580	1,457,125	281,663	409,003		8,593	33,954
1923	34,094	71,874	587,179	146,236	201,365	104,748	4,119	15,878
1924	16,154	29,824	273,421	59,448	86,393	465,240	1,974	6,928
1925	21,326	38,886	596,526	75,979	121,245	853,942	2,500	11,148

This year's figures will show the inevitable effect of year after year of slaughter without respite.

Although mild winter weather has enabled the trapper to penetrate further afield, and the effects of last year's bush fires have brought in the game to where tender shoots and new grass are to be had, and make their capture certain. Yet one can anticipate with certainty an immensely lessened take of skins.

The animals must have rest and a chance to breed and reproduce themselves or one of our most valuable industries will cease to exist. We have still the remains of our herds of fur bearing seals to remind us of the way the Fur Seal Industry was destroyed, and also to assure us that, like the Bison of America, their herds may yet be built up again by wise administration. Recently some attention has been directed to the fur industry. I would urge every member of our Club to impress his or her relations, and in the case of junior members their school mates, on this matter. Each Tasmanian as he or she grows up should be able to have the same pleasure in our native fauna as we adults have had, and it is we ourselves who must unite now to ensure this by giving full support to the proposed amendment of the Act.

I hope by the next annual meeting that the matter will be placed in the hands of a Board formed as the Minister proposes. I desire to wish the incoming chairman and all members a very happy and successful year.

Some Tasmanian Naturalists.

(6)

JOSEPH MILLIGAN.

By John Reynolds.

Whilst Gunn was performing his great botanical labors in almost every part of Tasmania, a young Scotch doctor was also rendering great services to Anthropology and Science generally. Arriving in Tasmania in 1829, at the age of 22, Joseph Milligan took the position of surgeon to the Van Diemen's Land Company's establishment at Surrey Hills. That Company had by Royal Charter been granted some large tracts of virgin land in the North-Western portion of the island. When Milligan commenced his duties in 1830, the Company had only been in existence a little more than four years. Most of the wide lands they held south of Emu Bay were little more than half explored, and were full of interest to a naturalist. In 1830 the aboriginal tribes were still at large in fairly considerable numbers. The rounding up a year or so previously had failed, and whilst Governor Arthur still aimed at segregation, the means were not immediately at his disposal.

Evidently Dr. Milligan came into close contact with the North-Western tribes, for he must have commenced studying the habits of the race very soon after his arrival. Since the short visits of the Frenchmen, Peron and Labillardiere, little sympathetic interest had been shown these unfortunate people. The Frenchmen, we have seen, were greatly interested in them, but their sojourn was too limited to make anything more than a few general observations of their habits. What they have left us in their accounts was, and still is, both interesting and valuable. But they were unable to undertake those physical descriptions which are the basis of anthropological science. Still less were they able to describe their customs, their tribal organisations, and their religious instincts. Language, of course, was the great bar. The early settlers came into contact with the aboriginals, but even the most kindly disposed do not appear to have seriously attempted to learn their language. We have an instance of this in the way the second Lieutenant-Governor, Colonel Thomas Davey, was forced to resort to pictures to illustrate the meaning of his commands to the natives. This happened twelve years after the first settlement, and it is doubtful whether in 1830 more than a handful of settlers could converse with the natives. Certainly nobody thought of placing what they knew of the strange language on record in the form of a dictionary. Even George Augustus Robinson, the concilliator between the two races, and the acknowledged authority, had left us practically no record of his knowledge.

By the early thirties the aborigines must have been steadily declining in numbers. Forty years later they became an extinct race, their existence being only a memory, too often coloured by exaggeration and prejudice. The need for someone possessing the requisite training and sympathy to study these people was at that time very great, and into the breach stepped Milligan.

In his spare time this energetic young man learnt the language of this primitive people. After much labour he at length produced the first work on the subject, entitled "Vocabulary of Dialects of the Aboriginal Tribes of Tasmania." The task was a large one, owing to the fact that almost every tribe had a different dialect depending upon the locality of their haunts. To us the words seem entirely different when read, but possibly they had a similarity of sound. This helps us to realise the nature of the task Milligan imposed upon himself. Other men have added to his vocabulary, but with Milligan rests the honour of this important contribution to anthropology. The Tasmanian Government of the day showed their appreciation of his work. In 1843 he was given the position of Superintendent of Aborigines. This gave him complete control of the last remnants of the race at the settlement on Flinders Island and Oyster Bay. It fell to his lot to have charge of the transfer of the last of the natives at Oyster Bay to the island, and there are many testimonials of his humanity in his dealings with this unfortunate race.

However, Milligan had other interests apart from the care and observations of his aboriginal flock. Botany also claimed his attention. Although he was not as great a figure as his contemporary, R. C. Gunn, for there are few men of Gunn's calibre in a generation, he took a lively interest in the island's flora. In his travels over the country he collected plants, and described many species for the first time. As we have seen those were heydays for botanical investigators. Every expedition into the mountains or along the shores a careful observer may possibly add not one new species to the growing list, but several. There is a *Eucoyphia* and a *Hakea* which bear his name, and the genus Milligania was named in his honour.

Whilst at the Hampshire Hills (V.D.L. Co.) Milligan kept a close watch on the metrological conditions, and he published a useful abstract of our earliest pælontologists, and he made an examination of the fossil plants found round Hobart and Launceston. The Government of the day must have been quick to recognise the abilities and talents of its gifted colonists. The existence of coal beds had been noted in the very early days of the settlement. When it became apparent that they would possibly be of economic value in the not too distant future, Milligan was sent to examine the strata at Port Arthur, Schouten Island, and the Mersey and Don River districts. His reports were valuable, and are interesting as some of the earliest records of geological research. The Royal Society of Tasmania owes a lasting debt to Joseph Milligan, inasmuch as he was one of its founders, an early secretary, and an energetic worker in its cause. In 1860, after thirty years of worthy effort for science and public welfare, Milligan left the colony, returning, it appears ,to his native land, where he died 23 years later, at the age of 76.

Outlines of Tasmanian Geology.

SECTION 20.

IGNEOUS ROCKS.

The Origin of Igneous Rocks.

Having seen the way in which the mineral constituents of the rocks are made up, we can now turn to a study of Rocks themselves. A rock is a mineral aggregate, and may consist of any series of characteristics. We will commence our consideration of rocks with Igneous rocks. The original surface of the earth has long since entirely disappeared, and so to-day every rock we see must consist either of an aggregation of particles of older rocks or a rock formed from a fluid magma of fused mineral substances squeezed into older rocks or poured over their surface. It is in such rocks that we can best study the arrangement of mineral constituents on which classifications are built, and so we will study them first.

The Igneous Rocks are those that have been formed by the consolidation of molten material. As was explained in the early pages of these notes, it is presumed that on the consolidation of the planet out of its parent substances the denser materials tended to congregate near the centre, and the general arrangement of the planet was in zones of materials decreasing in specific gravity outwards. Prof. Suess gave the name *Nife* to the very dense core of the earth. This he postulated was surrounded by a less dense envelope called the *Sima*, on which "floated" a still lighter mass of the litosphere termed the *Sal*, which composed the great land masses.

The Density Stratification of the Earth.

The general idea has been elaborated, and is now generally accepted. The outermost shell consists of sedimentary rocks, seldom over 40,000 feet in thickness, and in broken and fractured beds which have been accumulating at varying rates since earliest Geological history. Beneath these is postulated a *Granitic* (acid) shell, which forms the base of the continental masses, and on which the sedimentary rocks lie. This, it is presumed formed the original crust of the earth, from the denudation of which the earliest sedimentary rocks were derived. The original surface has long since disappeared, but much of this material lying deeper in the crust has from time to time been refused, and intruded into more recently deposited rocks.

Below this crust lies a *Basaltic* (basic) zone. It has been proved that the Basalt class of igneous rocks cannot have been formed by the fusing of sediments or granite rocks. These basaltic rocks are of a higher density than the granitic ones, and it is assumed on reasonable data that the original earth magma was basaltic in nature, and from this other types have differentiated Basaltic rocks are the only type that is indifferently distributed over the whole earth. When a magma has been extended most rapidly or on a larger scale with too brief a time for differentiation or for the incorporation of foreign material, it has always been of the basaltic type. For a great variety of reasons it is clear that the whole earth's shell is underlain by basaltic magma.

Below this shell we must have materials of higher density still to make up the known density of the globe. It is postulated that these exist in succession layers of sulphide minerals, then of iron and then of platinoid minerals with a still denser core of hitherto unknown material. Of course each of these zones merge gently into the neighbouring ones. Igneous eruptions have been caused by the interaction of lower belts of mineral substances on those above them in response to pressure induced by great earth movements. In other words portions of these have been reduced to a molten state—which state, by reason of their great heat, they are readily liable to adopt—and then squeezed—or injected—into overlying rock by a change of equilibrium. It is rocks formed from this molten magma that we term *Igneous Rocks*

Formation of Magmas.

A magma is a mass of fluid moltern rock forming a reservoir deep within the earth. It has been explained that although the earth is very rigid, still the materials are at such a heat, induced by pressure, that were this pressure released, they would immediately fuse. At times this pressure is released, allowing masses of rock to become liquid. This occurs usually in the course of great earth movements due to isostacy . As has been explained in the opening sections of these notes, the solid crust of the earth is kept in position because the various segments making it up exert equal pressure on the plastic interior. When through erosion the land segments become lighter, the pressure of the denser ocean segments weighing on this plastic core, squeeze the land segments ,as it were, back into their places . In the course of this process they crumple the newly laid sediments of the geosynclinal off the continental coasts into a series of folds and overthrust beds and thus into a much smaller volume. In the course of these processes, pressure is lessened on the zones below, especially along the cleavage line between isostatic segments, thus allowing superheated rock masses to fuze. The simplest instance is in the case of a geanticline—an upward arching of strata of sufficient dimensions to be of world signifigance. The pressure is released on the rocks under the arch and they fuse into a magma.

Abyssal Injection.

A magma is seldom allowed by these movements to recrystalize where it fuzed. The very fact of isostatic movement means to some degree a shrinking globe. Shrinking is also proceeding from the re-arrangement of materials not originally in equilibrium into compounds that are stable at high pressure. This shrinking sets up strains giving a zone of compression inclosing a zone of tension. When pressure is relieved by great movements, cracks or cleavage zones tend to develop. A fluid magma cannot oppose the same degree of resistance to pressures that a rigid mineral mass can and immediately an upper zone is broken by great earth movements, some of this magma will be forced as a wedge into these areas of cracks . This injection will relieve the pressure and will ultimately be checked in its upward movement by the resistance of the rocks above. Abyssmal injection is due primarily to the relief of compressive stress in the external shell due to mountain building, consequent on a readjustment of isostatic equilibrium, and the great occurences of igneous rocks are all related to powerful abyssal injections from the substratum into overlying rocks.

Magmatic Stoping.

When once a magma has been injected as described above, it has inherent power to continue its invasion of overlying rocks apart from the original forces which set it in motion and after their effect has ceased. In the first place the magma is probably at a vastly higher temperature than the rock walls of the chamber inclosing it. This will heat the rock and thus produce tensional stresses, these being increased by pressures due to heated water. Cracks develop and quantities of the magma force their way along these. Then cross cracks and lines of weakness between strata are found until a block of the magma chamber is entirely surrounded by intruding magma. It then sinks into the molten mass as a xenoleth. Such blocks of included older rock are common in masses of igneous rock. The magma thus works outward by a process analogous to mining and can grow very considerably, although not indefinitely, in this way without the pressure of the forces which caused the original injection.

Magmatic Assimilation.

Although many rocks when merely molten could not assimilate all other rocks, most magmas are at a far higher temperature than would be required merely to melt the rock. When, by stoping, the magma detaches xeoleths from its roof, these, provided the magma is hot enough are gradually melted and their mineral constituants are absorbed into the general molten mass to recrystalize when the time comes in accordance with laws of mineralogy governing the new mixture so formed . Owing to marginal cooling there is little mixing at the junction between the magma and surrounding rock. It is only absorbed blocks that are thoroughly assimilated. In general, this assimilation can only proceed at abyssal depths, also as the magma cools it loses its power of assimilation.

Magmatic Differentiation.

As we have seen, there are good grounds for believing that the original earth magma was basaltic. How, then do varieties of igneous rock originate? By a variety of processes, now to be described a magma, given a considerable length of time in a fluid state, tends to separate into bodies of sub magmas each differing chemically from the parent substance and from each other. In the first place the edge of magma nearest its retaining walls cools quickly owing to radiation of heat. In this zone the time necessary for differentiation is not allowed and the condition in which the magma reached the point at which it ultimately possessed insufficient heat to proceed further ,is reproduced in the resultant rock. This is termed the *chilled margin* and in cases of a simple injection represents the original composition of the margin.

If stoping proceeds to any extent the assimilated rocks will alter the composition of the magma. Sinking blocks of great sizes will tend to mix the fluid mass and to set up convection currents. If the blocks melt near the top this will tend to alter the composition of the upper zones. As sedimentary rocks are always higher in quartz than original basaltic or basic magmas, they will thus tend to produce a zone of more acid rock. Secondly when the magma is sufficiently cool to allow crystalization to take place, crystals will commence to form around the sides and top of the magma. Part of this crystalised material will attach itself to the chilled margin and form a crust, and part will remain in the liquid moving with currents through the mass. These would attract crystals of similar minerals and gradually will attain a size sufficient to make them sink through the magma by force of gravity. The crystals forming will be of the minerals that crystalise at the highest temperatures. This will tend to give a shell and a floor to the magma, consisting predominantly of these minerals. The abstraction of these minerals will alter the composition of the liquid, and so magmas tend to solidify in zones of differing mineral constituants. Again, certain liquids will mix perfectly at high temperatures. As the temperature decreases they draw apart. So the early and quickly cooled rock may be a perfect mixture of certain minerals, in later and more slowly cooled portion, this mixture has crystalized into two or more separated rocks. Also the withdrawing of certain constituants by crystalization and the addition of others by assimilation, often alters the miscability of the rest, again producing differences in the solid rock.

Thus from an original basaltic magma we get the great variety of possible types of igneous rocks. To give one example —the basaltic magma contains no free quartz. Its constituents are, generally speaking, *augite*—a lime iron magnesia silicon dioxide, and *labradorite*, a lime, soda silicate of aluminium. The augite crystalises first, with a result that the mixture eventually may become so high in silica that it cannot absorb it all, and some crystalises out of free silica—quartz. In most masses of igneous rocks which are exposed crystalised magma we find first a chilled margin of basaltic rock, below this comes a granitic rock—the most highly differentiated type—with much quartz. Lower the quantity of quartz diminishes, and then disappears, and the other minerals become higher in magnesia and iron until the true basaltic rock is reached On the floor is a zone of deposited crystals of the pyroxene mineral, which commenced to crystalise first, forming a rock termed peridotite.

During differentiation repeated stresses due to earth movements, as described before, may inject the magma repeatedly into the overlying rocks, where it will quickly cool. Each of the injections will form rocks corresponding to the stage of differentiation reached by the parent magma at the time of injection. Thus from one magma reservoir a granitic rock may be forced into overlying rock at one time, and at another a basaltic. Hence it follows that differences in types of rock do not mean necessarily different ultimate sources. Differentiation tables have been worked out for most varieties of Igneous Rocks, but readers must be referred to text books for these.

We must now discuss a classification of igneous rocks according to their mode of origin.

(a) PLUTONIC ROCKS.

Plutonic rocks are formed from the crystalisation of magnetic reservoirs ,or abyssally injected bodies. They have been given time to crystalise fully—that is the magma has remained fluid long enough for every particle of its substance to arrange itself into compounds according to laws of mineralogy, and is now seen in crystals of the various minerals formed from the elements composing the mixture. In other words, although cooling must have taken place it never overtook the process of crystalisation. As a matter of fact, given a certain stage of crystalisation the heat generated by the mechanics of crystilisation will maintain the magma at a sufficient heat to allow the process to be completed. Therefore the whole mass will be crystalised into mineral bodies, whose size depends on the quantity of their constituents in the original mass, and this crystalisation will be complete. The rock will be devoid of spaces or holes, and will usually be very compact. Differentiation may or may not have proceeded. Plutonic rocks may be divided into—(1) Subjacient Bodies and (2) Injected Masses.

(1) *Subjacient Bodies.*—These represent crystalized magma chambers. When they are exposed by denudation they are called "*Batholiths.*" The distinguishing mark of a batholith is that it has no discernable floor. A small batholith is termed a *stock* and a stock round in plan a *boss*. Batholiths are usually if not always located in the main lines of mountain building activity. They represent the original fuzed rock magma. The walls are usually smooth and grow larger as they descend. The longer axis of a batholith or a group is the tectonic axis of the mountain built zone and at right angles to the direction of the isostatic pressure which gave rise to that zone. They are usually granite. The granite mountains of the east coast present typical examples. It follows that when a batholith is exposed a tremendous amount of erosion must have taken place.

(2) *Injected bodies.*—These may be—

(a) Concordant injections (injected along bedding planes)—

(i.) Sills and sheets—these have been injected between beds of strata which they replace. They are the result of the upward injection of the magma being overcome by pressure from above and finding an outlet laterally along the bedding planes. In some cases they wedge layers apart but they usually extend by lateral stoping and replace the assimilated rock. Coal measures are commonly so invaded. Many of the doleritic sills in Tasmania are upwards of 1,000 feet in thickness. After intrusion the sill may be folded with the adjacent intruded rock. If it is turned on end it may be mistaken for a dyke.

(ii.) Laccoliths.—These bodies are usually formed from a sill when from cooling margin or resistance of surrounding rock it can no longer extend along the bedding planes and yet the supply of magma is not slackened. In time it will have power to uparch the strata and will then form an irregular magma chamber, which on crystalisation forms an irregular shapeless mass of igneous rock invading the injected rock which arches over it and which it often trangresses. The distinguishing features of a laccolith are a visible floor and arched strata above. Some dolerite mountains here are laccoliths.

(iii.) Phacolites.—Folding releases the pressure on the strata in the bends at the crests and troughs of the folds. Along these less dense portions igneous rock may find its way as in a tunnel. They are thus of different origin to laccoliths which in many respects they resemble.

(b) Discordant injections (injected across the bedding planes).

(i.) Dykes (Dikes)—may be described as upward ascending shafts of igneous material. Their shape and proportions are infinite but they merely represent an injection through the overlying strata. Very often the length of surface covered by a dyke is very long—190 miles has been reported, and width varying from under a millimetre to several miles are known. The angle of ascent may be anything. These are common features wherever igneous rock occurs. They often occur in systems.

(ii.) Intrusive veins—are due to intrusion up an irregular crack as opposed to a dyke which cuts strata as a wall.

(iii.) Tongues—upward extensions of irregular shape and short length, from a batholith, laccolith or sill.

(iv.) Volcanic neck—these are due to solidification of of lava in the vent feeding a volcano.

(v.) Chonoliths—intrusions irregular in every respect formed by the squeezing of magma into cavities and openings of strata during folding. It usually occurs as a zone of igneous rock more or less invading dislocated sedimentary rock in long tongues and leaves between strata and with local extensions in cavities.

(b) HYPABYSSAL ROCKS.

Hypabyssal rocks comprise the group in which crystallisation has commenced, but has not been completed before the magma has so far cooled that it could not proceed further. The earlier formed crystals appear more or less perfect, but instead of the whole rock being an aggregate of crystals, these earlier formed crystals are set in a ground mass which may be a glass or totally uncrystallised mineral matter, or a mass of rudimentary and imperfect crystals, or a mass of perfectly formed but minute crystals, which have not had time to aggregate into the masses attained by the earlier ones. The characteristic of these rocks therefore is a fine grained ground mass enclosing larger crystals. Plutonic rocks shade off into Hypabyssal rocks as the edges of the intrusion are reached. Smaller injected bodies are more usually this type, and the occurrence of these rocks usually indicates that the rock mass is portion of a sill, laccolith, dyke or volcanic neck, in short was intruded so far into overlying rocks or so near the surface, or in such small volume that cooling caused by radiation overtook the crystalisating process. All the various forms described before may be from these cause hypabyssal in type as well as Plutonic. The Tasmanian dolerite is a typical example of a hypabyssal rock.

(c) EXTRUSIVE BODIES.

This class includes all the rocks from magmas which have been forced right out on to the surface. In this case there has been no time for crystallisation or the process has only commenced. Again we get an even grained rock, but the individual crystals if they exist are either indistinguishable to the naked eye or barely so. This type of rock is associated with volcanic activity. The classes of occurrences of these rocks are as follows:—

(a) *Fissure Eruptions.*—In this case lava has been squeezed through a crack or a line of cracks on the surface representing a compression crack caused by mountain building movements. The greatest occurrences of this type of rock is the Deccan basalt, which covers an area of over 300,000 square miles to a depth of up to 6000 feet. The basalts of our North Coast are probably lavas from fissure eruptions. The characteristics of this type of eruption are the absence of violence and the great volume of lava extruded.

(b) *Extrusion by De-roofing.*—This is the maximum effect of stoping, when the magma has removed its roof entirely and reached the surface. Such occurrences are rare. The rock produced would at the surface have the characteristics of an erupted one, and at no great depth would attain plutonic characters.

(c) *Central Eruptions.*—These are exemplified by existing volcanos, which are the last phase of a volcanic epoch.

(i.) Necks.—Feeding vents filled by solid lava, which have been exposed by the erosion of the cone. Subsequent eruptions may thrust this up as a plug —as occurred at Mt. Pelee.

(ii.) Lava flows.—The most frequent phenomena of volcanic eruptions. The lava may exist in any state, from a magma in the first stages of crystalisation to a "rock froth" formed by escaping gases.

(iii.) Volcanic cones.—Piled up masses of material thrown from the crater, dust, ash, scoria, bombs and small flows of lava. These are portions of magma either poured out and quickly cooled or blown from a "froth" to dust by gaseous elements, expanding as pressure is released.

(To be Continued.)

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