NOTES OF SOME GEOLOGICAL OBSERVATIONS ON THE WEST COAST.

By A. Montgomery, M.A.

During a short visit to the mines of the West Coast in March of this year, I was able to make a few cursory observations of some geological features of the ground travelled over; and a few notes and remarks on these I have the honour to lay before you to-night. Travelling, as I was, rapidly, and for the set purpose of visiting the mines in the shortest possible time, I could not delay long enough to study the numerous interesting questions that presented themselves, and in this paper you will find that I rather state problems than contribute much towards their solution. By calling attention to points requiring elucidation, I hope that the numerous visitors to these till lately almost unknown districts who may have a taste for geological observation, may be induced to notice and record any facts that they may come upon that will throw light upon them. All facts thus noted and made known are stones cut ready for the hand of the builder, who will in time rear them into a noble temple of knowledge. In a newly-opened country we must first collect facts, however disconnected they may be; generalisations from them and complete knowledge will follow in due course. If these jottings, then, serve as foundations for more elaborate work, they will serve their end to the utmost of my hope.

On this occasion my route lay from Strahan to Mount Lyell, thence to the Howard Plains and back to Strahan, then on to Trial Harbour, Mount Zeehan, and Mount Dundas, then overland by Corinna and the Heazlewood silver field to Waratah. It was only such features as were apparent on the roadside that I could see at all. The keys to numerous questions to which I could give no answer may have been lying close at hand, but I could not delay to search for them.

The most interesting subject for geological research on the West Coast appears to me to be the relation to one another and to the sedimentary formations of the numerous igneous rocks, and the influence exerted by these upon the mineral contents of the mining districts. These igneous rocks comprise granite, greenstone, serpentinous greenstone, basalt, and a doubtful rock which may be diorite. Granite forms

the mass of Mount Heemskirk and the Meredith Range, and is also encountered on the Magnet Range, near Mount Bischoff. As quartz porphyry and eurite it comes in at Mount Bischoff itself. This porphyry is clearly intrusive through the slates there, as fragments of slate and sandstone are frequently seen embedded in it, and the workings of the Mount Bischoff mine also show it ramifying through the slate. One of the problems to be solved is the relation of this porphyry to the main granitic mountain masses; is it contemporaneous with their upheaval or intruded long subsequent to their formation?

The greenstones and serpentinous rocks are of much interest, more particularly as the serpentine at the Heazlewood is itself the matrix in which metallic lodes are found. There is probably more than a mere coincidence in the fact that serpentinous rocks are found in the vicinity of our three silver-lead fields, Mount Zeehan, Mount Dundas, and the Heazlewood. The intrusions of greenstone are met with in several somewhat widely-separated localities. On the road from Strahan to Mount Lyell, from the Queen River Hotel to about a mile past Lynchford, there is a large greenstone mass, which also is crossed by the prospectors' track from Lynchford to the Howard Plains nearly to the Queen River. As far as I could tell without analysis and microscopical examination, this rock is exactly the same as the greenstones which are so extensively developed in the central and eastern portions of the colony. I did not notice in it the change to serpentine that is shown by some of the other greenstones I have to speak of. Presumably, it has been intruded through the Silurian sandstones surrounding it, but its effect upon these as to local metamorphism, contortion, fracture, and mineral contents, has yet to be learned. It would be instructive to know if the veins and lodes of quartz traversing the Silurian strata are in any way affected by it, or show any evidence of having been caused by it.

Round Trial Harbour for about half-a-mile to the north and east there are steep hills of serpentinous greenstone, which decomposes to a dark red-brown barren soil, containing much magnetic and titaniferous iron ore. It is probably part of the same set of intrusive basic rocks as the serpentinous greenstone found nearer Mount Zeehan, extending for about $3\frac{1}{2}$ miles from above the Agnew Huts nearly to the Comstock mine. At the western side this rock has not been greatly altered, and is much like our common greenstones, but towards the east it gets more and more changed to serpentine. The razor-back ridge on Handley's section at Mount Dundas is somewhat similar serpentine, only finer for ornamental purposes, and contains asbestos and titanic iron ore. Serpentine is also found all along the boundary line of sections

$\frac{2303}{87}$ and $\frac{1851}{87}$, apparently forming the back of the hill into the face of which the Mount Dundas Company's tunnel is being driven. Though the serpentine rocks at the Heazlewood are considerably distant from the above, their similarity in lithological character would lead one to suppose that they also are related to the same series. They first appear on the road from Corinna to Waratah, at about thirty chains past the 21 mile post, at what are called the Eighteen-mile Huts. From there they extend on to past the Heazlewood and Heazlewood Extended mines. On the track from the Heazlewood to the Specimen Reef mine the serpentine extends to about half-a-mile from the crossing of the Savage River. The stone varies very much in appearance, from a greenstone to almost pure serpentine. Parts of it contain much schillerspar, and closely resemble gabbro. The appearance of all these serpentinous greenstones is consistent with the theory that the rock is a dolerite or gabbro, with its constituents metamorphosed by schillerisation, or internal chemical change, and by weathering, or external atmospheric influences. The more or less complete alteration into serpentine is probably due to the unequal distribution of olivine in the original rock. The change of olivine into serpentine would also account for the formation of the magnetic and titanic iron ore so common in portions of the rock. An interesting deduction from the appearance of these greenstones is that they were once very deeply buried, schillerisation being believed to take place only at great depths. It is possible, then, that these are the roots of one time mighty volcanic masses, possibly covering the western side of the island with their lavas. The microscopic study of these rocks promises a most fascinating field for the petrologist. Should there prove to be grounds for the idea I have advanced, that the volcanic rocks were once much more widely spread than now, the mineral nature of the country would be to some extent explained, the conditions being then such as may be presumed on many grounds to have been favourable for the formation and filling of mineral veins. Every fact that can be adduced to illustrate the history and relations of these intrusive masses will be of service to the cause of geological science in many ways. It has occurred to me that these old matamorphosed igneous masses may possibly represent the lower members of the great greenstone flows that have covered so much of the colony.

Throughout the mineral fields of Mount Zeehan, Mount Dundas, and the Heazlewood, there is another set of igneous rocks that appear to be of quite different character from the greenstones. They seem to be closely connected with the mineral veins, and when more is known about them, I am inclined to believe that the connection will be found to be even closer than it at present appears. They are so much

decomposed wherever I have met with them that it is quite impossible to name the rock with any accuracy. As far as can be judged from the decomposition products, it must have been chiefly composed of felspar and hornblende without free quartz, and is likely therefore to be a diorite or hornblende andesite. Till further research reveals its true nature we may without much inaccuracy speak of it as a dioritic rock. I noticed it more especially at the Mount Zeehan and Whyte River Silver-fields, but at Mount Dundas there are also rocks of this series. At Mount Zeehan it is found plentifully on the main road between the Comstock and Silver Queen holdings, some of the belts being close on a quarter of a mile in width. It is notable that the slates in this vicinity are much contorted and broken by small faults, as may be seen in the roadside cuttings. The dioritic rock is most easily distinguished by its coarse granular appearance on the fresh fracture, and by its clayey nature, being almost free from grit. On the surface it forms a stiff yellowish brown clay, quite unlike the dark red-brown clay resulting from the weathering of the serpentines. In the Argent, Balstrup's, Silver Spray, and Western mines it is cut through by tunnels, also in Evans's section $\frac{1110}{87}$, and a dyke of it was noticed in section $\frac{1470}{87}$ of the Tasmanian Silver Mining Company. In Balstrup's and the Western mines it clearly occurs as dykes penetrating the Silurian country slates and sandstones. In the Argent tunnel no lodes were met with in it, but some veins of pyrites and loosely coherent quartz crystals were passed through. The inner end of the adit is in clay slate, the outer half being in the volcanic rock. This has here much the appearance of a tufa, and may prove not to be a weathered dyke penetrating the slates, but a tufaceous bed resting upon them. In the lower tunnel of the Silver Spray company the igneous rock is clearly of a fragmentary character, containing numerous angular fragments of clay slate imbedded in the clayey matrix of weathered volcanic rock. Here we probably have a remnant of a tufa bed, most likely one of many that were formerly widely spread over the district. Some quartz veins were found in this tufaceous rock, and on the surface there is a large mass of gossan, supposed to have been the cap of a lode, until the tunnel was driven underneath it and far past the line of it on the surface without success. Quartz veins and a lode of quartz of considerable size are also found traversing the dioritic dyke in Balstrup's section, and in the similar dyke near the Whyte River on which Godkin's, Smith and Bell's, and the Whyte River company's claims are situated, quartz veins have again been found. The outcrops of both these dykes, too, are marked by large masses of gossan. It appears to me that the weathering of the dioritic rock is of itself

quite capable of producing deposits of iron ore on the surface, without there being any lodes required to account for their formation. The ferruginous waters resulting from the solution by carbonic acid of the iron of the rock on coming to the surface are sure to deposit their iron as hydrated oxide. A gossan formed in this way would be rather a bog iron ore than a true lode gossan; and many of the so-called gossan outcrops on these silver-fields appear to me rather to be beds of surface bog iron ore than true gossans. The highly ferriferous serpentine rock has yielded much surface bog iron ore in the same way, as may be seen on the road from Trial Harbour to Mount Zeehan, almost immediately after coming upon the serpentine. Too much importance should therefore not be attached to gossan outcrops as indications of mineral lodes. In this connection, too, I may point out that it frequently happens that quite a small lode has a large "iron hat" owing to the ferruginous waters issuing from it spreading over the surface of the ground. A big "gossan blow" need not cover an equally big lode by any means. In making these remarks I am not forgetting that in Smith and Bell's section the gossan is in at least one place clearly derived from the oxidation of a lode containing much carbonate of iron.

At Mount Dundas I did not notice any dioritic dykes, but in the southern of Webster and Bennett's sections I found a volcanic breccia of fragments of felspathic rock, similar to the diorite. In all probability the igneous rocks will prove to be common at Mount Dundas as well as at Mount Zeehan. Their intrusion may have been the cause of the fractures in which the lodes formed, and the solfataric action accompanying volcanic activity may have had much to do with the filling of the fissures with their mineral contents.

Between the Whyte River and the Magnet Range there is a large quantity of a rather fine-grained greenstone, which does not closely resemble the serpentinous greenstone on the west side of the Heazlewood field. In the cuttings for the road on the long grade down from the top of the Magnet Range, this rock is seen penetrating the slates and altering them to hard brown porcelain-jaspers. I am not at all clear as to whether this is not yet another separate igneous intrusion. Analysis and microscopic comparison with the other greenstones are required to solve this problem, together with field observations to the northward of the Whyte River silver-field, where the Magnet Range greenstone seems likely to join with the serpentine rocks.

The basalt dykes and flows met with on the West Coast all probably belong to the series of tertiary basalts found abundantly along the North and North-West Coasts. About 10 miles and 8 miles south of Corinna I noticed two dykes or

streams of basalt crossing the road, the first about a quarter of a mile wide, the second about half that width. It occurs again at 21 miles from Corinna on the road to the Heazlewood, and on the track to the Specimen Reef at about one and a half and quarter miles from Hall's Creek. Round Waratah it is rather extensively developed. Looking southward from the top of Mount Bischoff it appears likely that the plateau, out of which Mount Pearse stands up like an island from the sea, is all basalt. If this is the case there is a very interesting geological problem here, to determine as far as possible the configuration of the country previous to the lava flow. This may have important economical results in leading to the discovery of buried tin-bearing leads heading from Mount Bischoff. Ever since the discovery of this wonderful ore deposit, the small quantity of alluvial tin ore found in the creeks running from it has been a subject of surprise to observers, and the existence of leads buried under the basalt has frequently been conjectured. The interesting leaf beds underlying the basalts at Waratah have more than once been brought under the notice of this Society. As usual, the basaltic soil appears to be very fertile, and in the event of a large population becoming established on the West Coast, these strips of good land will doubtless be very valuable for farming purposes.

The questions connected with the igneous rocks are by no means the only interesting geological problems that present themselves. Others there are in profusion, apparent even to the cursory glance of the passing traveller. I may mention some of these, not to throw any light upon them, but merely to direct attention to them. The Tertiary leaf beds fringing Macquarie Harbour have been scarcely at all studied as yet, though Dr. Milligan and Mr. R. M. Johnston have made a valuable beginning and given us a glimpse of the riches there awaiting both botanist and geologist. The sand dunes through which the railway passes between Strahan and the Henty River also deserve some attention. They extend inland from the beach for a very considerable distance, and are now covered with a dense growth of ti-tree scrub. Are they overlying the leaf beds, or do they lie against the face of an escarpment of these such as we see at Strahan? The latter seems to me at present the more likely. But apart from their geological age these dunes suggest some interesting questions: How have they been formed? Have they been caused by the sand being blown inland from the beach, as we know sand dunes frequently are formed, encroaching on low-lying coast lands and gradually covering them, or has their growth been quite in the opposite direction by the sand accumulating on the beach gradually extending further and further seaward, and so reclaiming a strip of shore? If, as

seems likely, Macquarie Harbour once had a wide mouth instead of a narrow one, and the sand driven southward by the north-westerly winds has gradually formed a sandspit from Strahan to the Heads, it seems likely that the dunes represent successive lines of sandhills formed above high water mark, and that the land has been reclaimed by the constant deposit of sand brought in to the shore by the action of the winds and waves. The reclamation would be similar to that which often takes place in the angle where a breakwater meets the shore line on the side exposed to the prevailing winds and currents. In this case Cape Sorell and the strong current from the Harbour would be the obstacles preventing the further southward travel of the sand, and causing it to accumulate on the beach to the northward. If this suggestion is correct, the depth of the deposit of sand is probably considerable, much more so than if the dunes were formed by the action of wind alone. Perhaps some of the railway cuttings may throw some light on the question. It is interesting from an engineering as well as from a geological point of view, and has a certain bearing upon the proposed harbour works at Macquarie Heads. From its geological aspect, a section through such a sand deposit as I have indicated would exhibit an instructive succession and overlap of horizontally bedded sands, false bedded sands, and blown sands.

The gravel deposits in the neighbourhood of the Pieman River and along the road from Corinna to Long Plains deserve some attention. They cover a large extent of country, and are found at very various levels, and they appear to have been laid down when the river systems were not altogether as they now are. As gold has been found almost universally in these gravels, though in small quantity, they may become of economical importance, and leads may be found in them. Their distribution and formation are therefore worthy of study.

An alluvial deposit at the Linda River, in the neighbourhood of Mount Lyell, where sluicing operations for gold are being carried on, also came under my notice. The streams that piled up the auriferous gravels were probably much larger than those now existing. Under the gravel there is a peaty bottom, containing very numerous fragments of wood, apparently of one of the pine family. Below this bottom another layer of gravel has been found in places. Search would probably reveal leaf beds, from which valuable information might be obtained. The alluvial flat through which the Linda Company's tail-race runs, may very probably have been at first a small lake, then gradually filled up to a marsh, and finally covered over with a layer of gravel. If so, what force scooped out the Lake basin? Was it a glacier,

or has a landslip blocked the exit from a valley, and so formed a lake?

There are any number of other points on which information would be useful, sometimes purely in the cause of science, but oftener, perhaps, on account of their bearing on the mining industry; but in rapidly traversing the district as I did, it was of course impossible that I could take any note of nine-tenths of them. For example, I had no time to look for fossils, though some of the localities passed through are evidently rich in them, and if one had the opportunity of examining them, doubtless many discoveries would result. A cutting in the main road close to the Government township of Mount Zeehan is especially rich, and will doubtless be much visited by collectors on account of its easy accessibility. The sandstones between the Heazlewood and Whyte Rivers are also fossiliferous.

In conclusion, I have to say that these notes are given for what they may be worth as to the facts related in them, for I confess I attach no importance to any theories I have indulged in, and am quite prepared to find that further exploration will disprove them, or cause them to be altered beyond recognition. If I have succeeded in drawing your attention to the extent and variety of the geological harvest that stands waiting to be gathered, I shall have done all that I can hope for at present.

At some future time, after the more elaborate examination of these districts, which, as time goes on, I hope to have opportunities of making, I trust that I may have the honour of bringing under your notice solutions of some of the problems that to-night I have only been able to mention as existing.